OCTOBER 25, 1979

ANNUAL TECHNOLOGY UPDATE ISSUE

On the threshold of the '80s, 16-bit microprocessors emerge in systems while megabit bubble memories and new mainframes make their mark / 102

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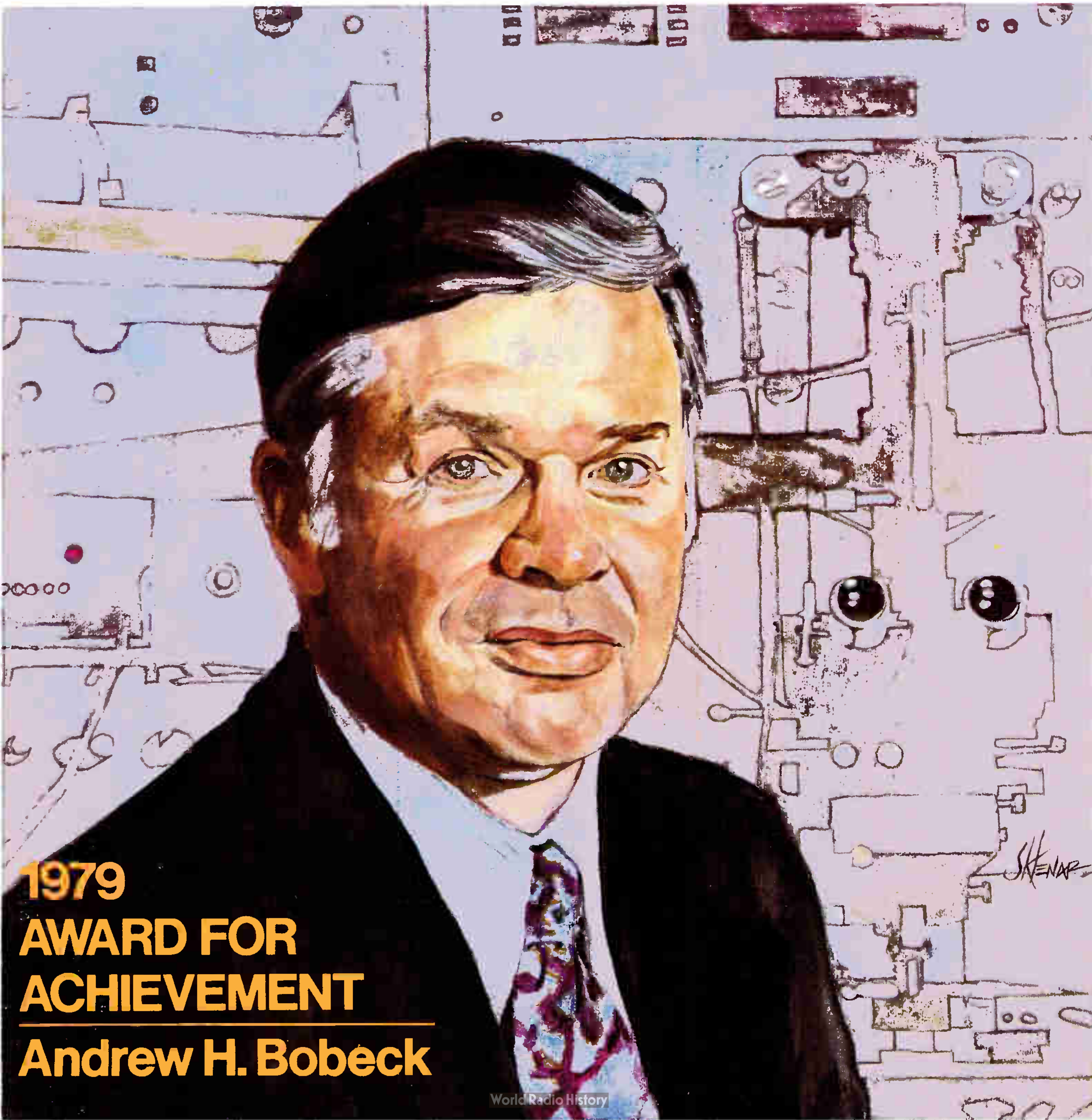
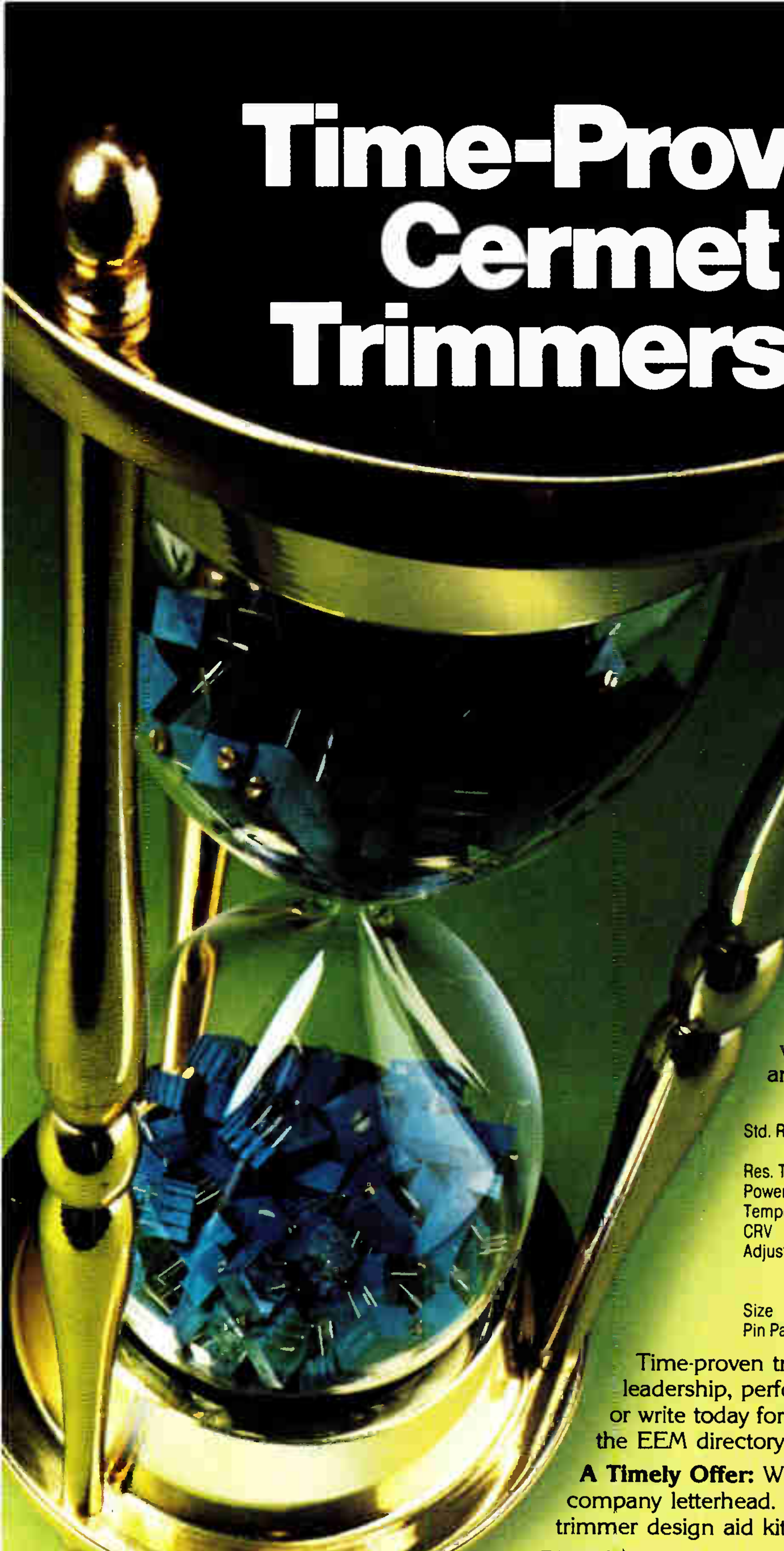


1979
AWARD FOR ACHIEVEMENT

Andrew H. Bobeck



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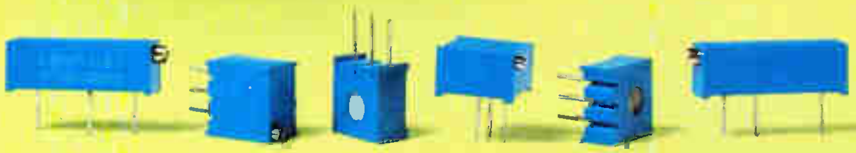

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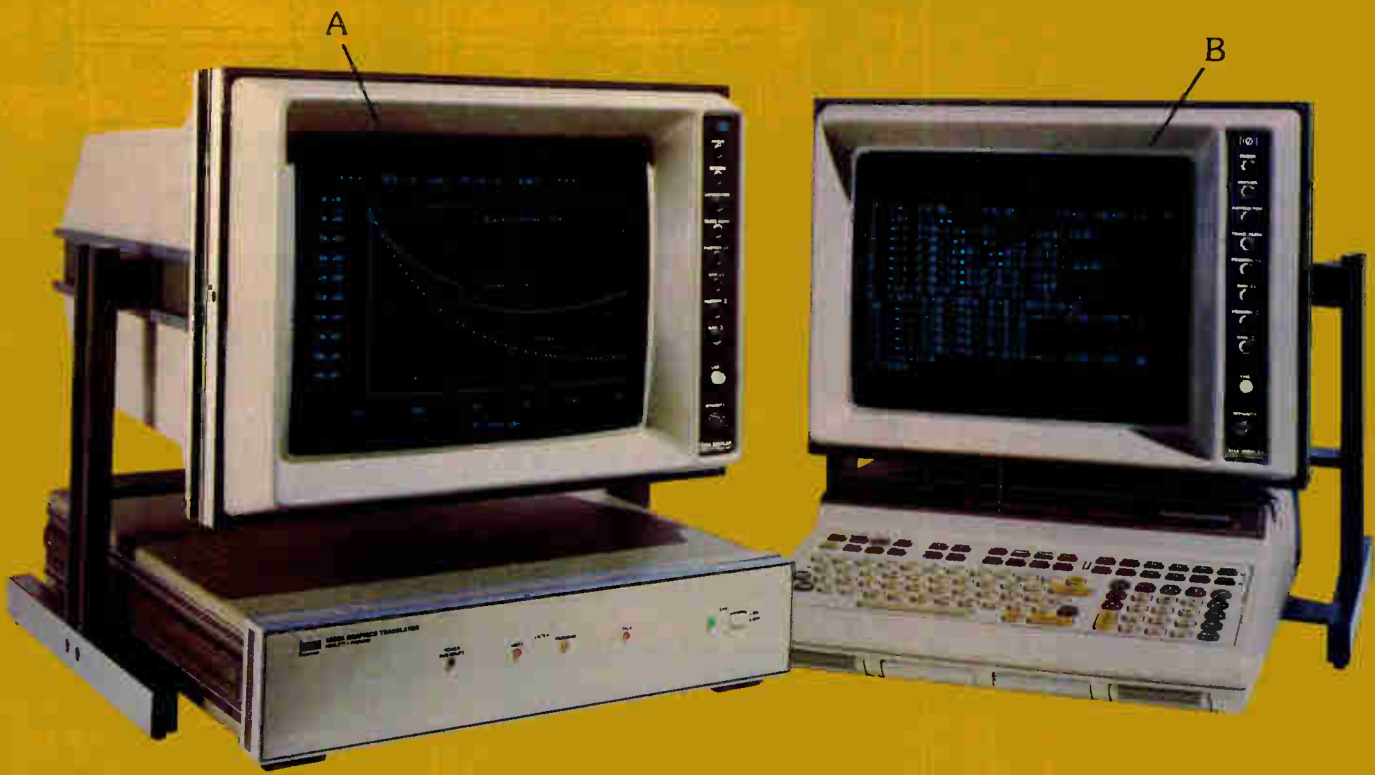

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068/12

Circle 1 on reader service card

COUNTERACTING THE INCREASED COST OF LARGE DIGITAL CIRCUIT BOARD TESTING.

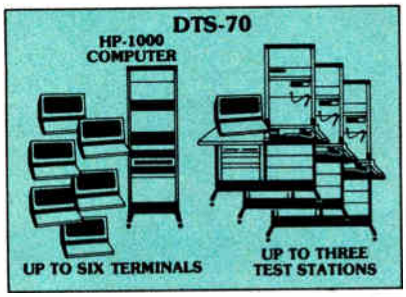
The amount of logic on today's average PC board poses some difficult problems for production test . . . bottlenecks and increasing costs of testing and rework, to name a few. Yet, many of these costs and problems can be minimized with efficient test techniques. Often, that calls for a simulator-based test system.

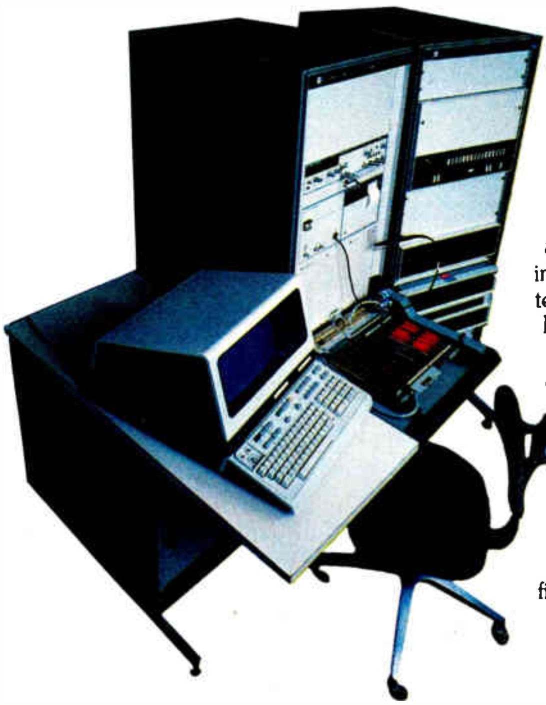
Simulator-based testing defined. Board-test simulation is a technique in which the circuit to be tested is modeled—component by component and node by node—in the test system computer. From this model, the system can calculate the correct response to any input pattern, plus predict failure modes and their responses. This allows only those patterns which identify faults to be used as the test pattern stimulus.

A major benefit of simulation is that it provides an accurate measure of test effectiveness. You know to what extent you're exercising board components. Thus, you can determine test efficiency, and, just as important, you know when to halt test software development.

Another benefit of having the circuit and all of its failure modes stored in the computer is that you then have detailed information to aid in fault isolation. Finally, advanced simulation techniques allow circuit modeling in the test system so that engineering can test designs before they're built and thus eliminate many problems before they reach production.

The advantages of test flexibility. HP's answer to simulation and to the reduction of testing costs and time is the DTS-70 Digital PC Board Test System ($90,350* for standard operating system). It provides the benefits of a simulator and offers other advanced features as well.

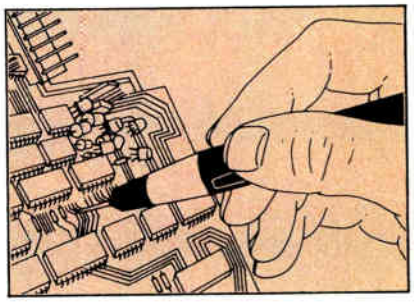




When you expand your production capacity, you can add test stations (to a total of three) without buying additional computing power. Need more test software development capability? Then simply add an inexpensive CRT terminal to your basic system. You can add up to six software development terminals, as shown, and they won't interfere with your production testing.

In addition, the DTS-70 software is compatible with data base management software to keep track of data and help you better manage your production. For example, the system can store test data and give you reports such as specific board or component failure rates and modes. The DTS-70 will easily fit into your long range computer network plans, too, providing distributed processing and communication to your data processing center.

Simplified troubleshooting. Testing isn't the only problem. You also need a rapid and inexpensive way to locate the specific faulty component or components for replacement. Using HP's FASTRACE software,



the DTS-70 accesses faulty board models developed by the simulator and guides the operator in a quick series of probe tests to isolate faults. Unlike many simulator systems, the DTS-70 catches intermittent faults. And it has zero delay capability, allowing you to detect races and hazards—a critical problem in logic circuit operation.

For more information. There are other benefits to PC board testing with the HP DTS-70. And for analog and hybrid circuit testing, HP offers the 3060A with combined functional and advance in-circuit testing. To get complete details, send for our circuit test system data sheets. Or, contact your local HP field engineer.

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Electronics
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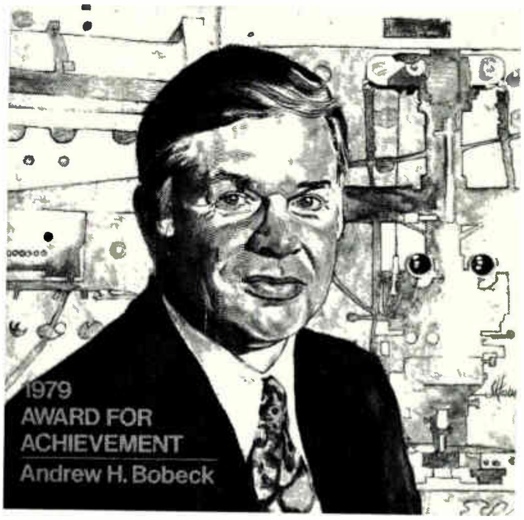

Cover: Basic bubble work earns award, 92
For his pivotal contributions to the invention of the magnetic-bubble memory, *Electronics* honors Andrew H. Bobeck of Bell Laboratories, Murray Hill, N. J.

Cover is by Art Director Fred Sklenar.

. . . and in the next issue
Inside IBM's 4300 . . . two microprocessors share logic . . . bubble memory system has standard computer interface.

Publisher's letter

A 19th-century French writer once commented ironically, concerning revolutions, that the more things change, the more they stay the same. But those in the electronics industries might well disagree about the technological revolution that has been sweeping the world.

Our annual Technology Update report in this issue (p. 102) might be a good place to test that contention. First, let's go back to the very first update, the Great Takeover issue published in 1973.

Six years ago we wrote about tremendous growth, with company after company claiming record revenues and profits. We reported that "industry's problems have shifted from wooing customers to finding enough materials and components to meet their commitments." We suggested that energy shortages would cause problems and new opportunities for electronics. And we concluded that the pervasiveness of electronics throughout society would continue to fuel the industry.

Sound familiar? Virtually the same script could be written today. However, a look at the 1974 Technology Update reveals that five years is a long time in the electronics industry. Then we wrote excitedly about "fast" 1,024-bit and 4,096-bit dynamic n-channel random-access memories coming on stream and static n-channel devices with "speedy" 300-nanosecond access times becoming widely available.

Then we were talking about microprocessor boards of "limited performance," 4-K memory chips, smart test instruments, the possibility of a standard test instrument interface, and IBM's long-awaited "future system." What we report in this year's update shows how outdated those achievements are. And another example: back in 1974 the internationalization of technology was hardly mentioned, whereas today it's taken for granted.

In this revolution, has anything remained the same?

We began the first Achievement Awards in 1974, too. The recipient chosen by the *Electronics* staff this year is a worthy successor to those honored in the past. Andrew H. Bobeck, the Bell Laboratories scientist primarily responsible for magnetic-bubble memories, is also excited by other technologies, including solar cells. In addition, he is an amateur astronomer who once photographed the first Russian Sputnik through a telescope he had constructed.

Bobeck is very modest about his contributions to electronics. "Remember, there are four names on the original patent," he points out, "and hundreds of others got involved."

Bobeck has a trait appreciated by journalists; he is easy to talk to. "The interview, originally scheduled for an hour starting at 10 in the morning, ran through lunch," reports assistant managing editor Howard Wolff, who prepared the profile on Bobeck.

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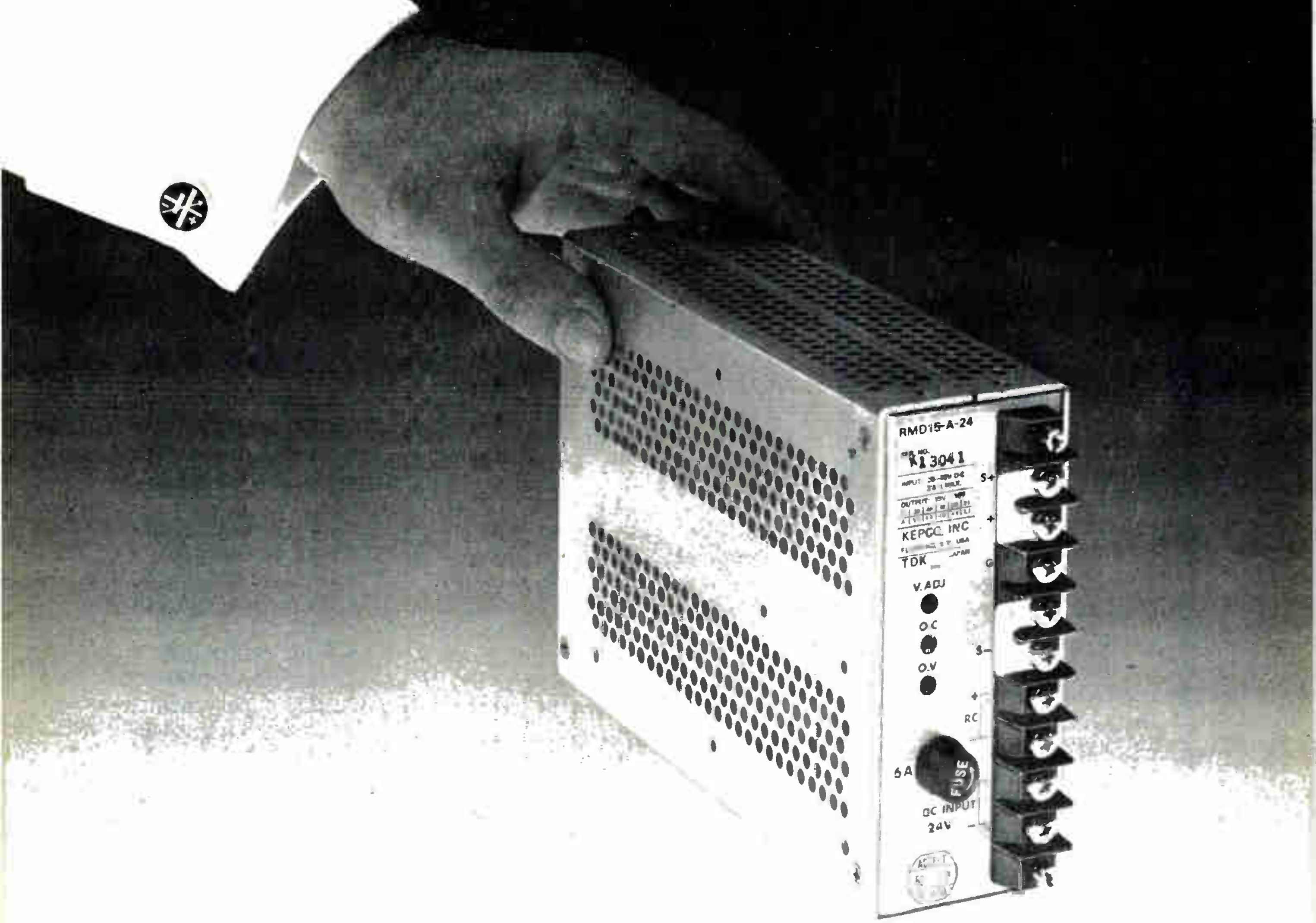

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Circle 5 on reader service card

Readers' comments

A brighter scenario

To the Editor: With regard to the editorial on progress in electronics technology ["Which way is up?" Sept. 27, p. 24], while hesitating to take issue with such industry giants as Gordon Moore and Bill Davidow, I would like to propose a less gloomy scenario.

Surely the whole history of computer technology is replete with examples of its practitioners' inability to foresee the range of applications for major steps forward in that technology. If, in fact, we ever do run into an inability on the part of users to exploit such advances, it will quickly become apparent in declining sales—hardly the situation today, with everything from the TMS 100 to the IBM 4330 in desperately short supply. Of more concern is the increasing risk involved in developing complex logic products. With development costs approaching, or even exceeding, a million dollars for a component alone, and software costs going out of sight, one cannot afford too many mistakes in defining a new product.

However, based upon my 15-year involvement with minicomputer and microcomputer technology and marketing, I feel confident that component manufacturers will continue to develop "smart" circuits utilizing all of the density and performance the technology makes available.

These products will be employed in an increasing range of applications, of which some can be foreseen today and others are yet to be conceived of.

Andrew Allison
Los Altos Hills, Calif.

Not first, but smaller

To the Editor: In response to Mr. J. Tweedy's letter in your September 27th issue [p. 6], I stand corrected for my statement that AMI's 68045 was "the first and only MOS mask-programmable CRT controller." Mr. Tweedy rightly points out that Standard Microsystems Corp.'s CRT 5027 is a mask-programmable and processor-programmable cathode-ray-tube controller.

However, my quotation was taken

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from a discussion held with the author of the article on chip CRT controllers [July 19, p. 85]. We were talking about differences between the AMI 68045 design approach and other CRT controller approaches.

The SMC product, as well as other MOS CRT controllers, is programmed by the processor to set up the attributes of the particular CRT terminal. The SMC part also allows the option of having the attributes permanently programmed into the chip. This would save program storage space in the microcomputer system, as it would not be necessary to set up the attributes of the cathode-ray-tube system.

The AMI 68045 CRT controller is designed using only ROM programmable registers, since the majority of users need only set up the attributes of the CRT initially and do not usually wish to change them. Because of the use of read-only memory storage rather than read/write registers, the 68045 has a die area about half that of the SMC 5027 and other competitive MOS CRT controller chips. It was this characteristic that I intended to convey.

Mitchel Goozé
American Microsystems Inc.
Santa Clara, Calif.

Standing corrected

To the Editor: In my article "Digital phase-locked loop finds clock signal in bit stream" [Aug. 30, p. 126], the caption for Fig. 1 incorrectly refers to the digital bit-timing recovery chip as a "complementary-MOS device that requires only one 5-volt supply for operation." In fact, the device is MOS, but not C-MOS, and requires ±12-V supplies as well as a 5-V one.

Also, on page 129, the addition of parentheses will rectify the expression for normalized frequency offset, which should be:

$$\Delta R/R = \pm 1/(30N)$$

The last entry in the box on page 128, Harry Luhrs' telephone extension, should be 238.

John Snyder
Comsat Laboratories
Clarksburg, Md.

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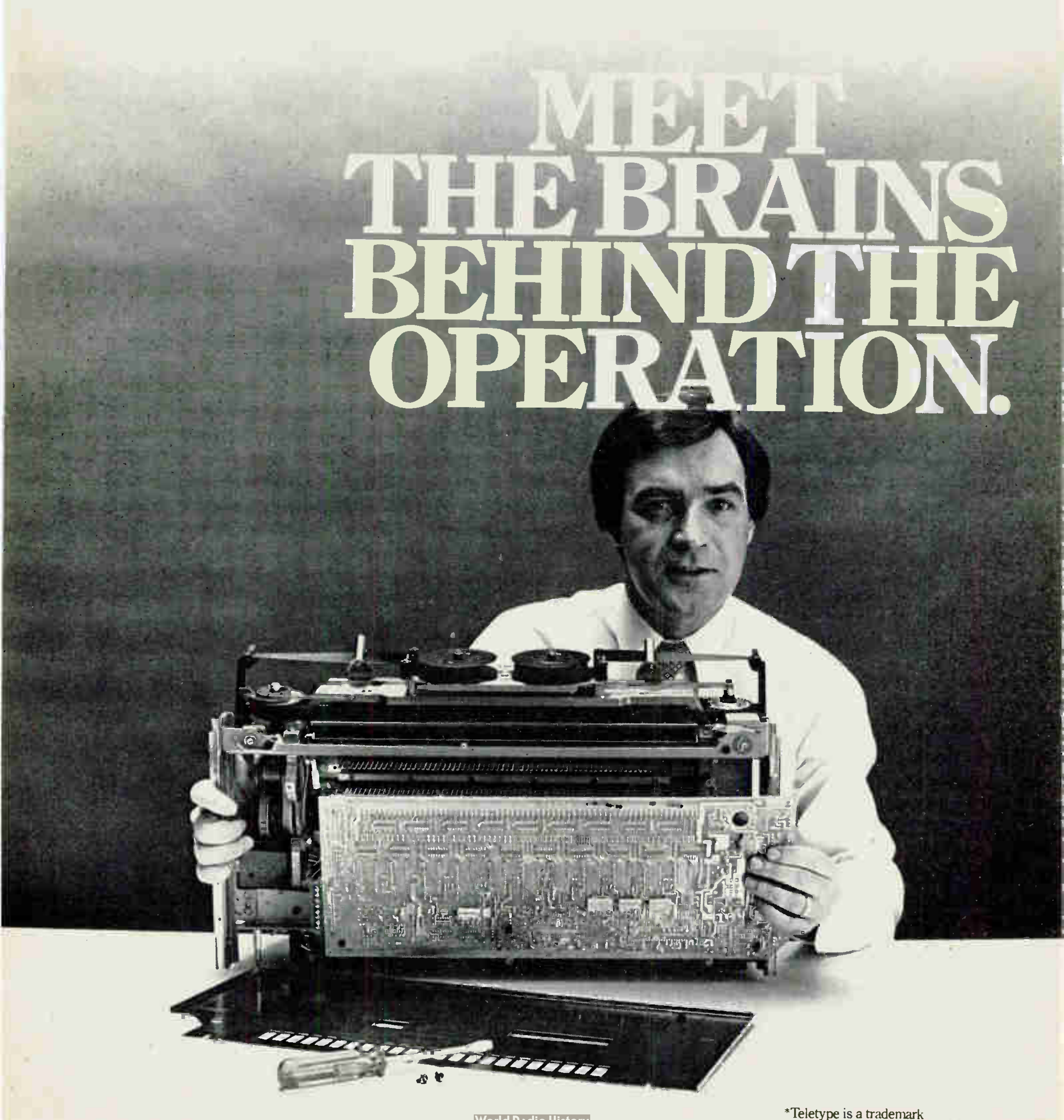

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Circle 11 on reader service card

News update

■ With about a dozen companies trying to turn out lower-cost silicon for solar-energy applications, one of them has come up with an approach that could be a major step toward a cost-quality figure that would make photovoltaics a viable alternate energy source.

Fabrication techniques including silicon sheets, ribbons, or ingots are being used in the drive to reduce the cost of electricity produced by photovoltaics to 50 cents per peak watt [*Electronics*, Sept. 28, 1978, p. 97]. But Crystal Systems Inc. of Salem, Mass., has come up with squared-off single-crystal ingots, desirable because of their higher packing density. The work was done as a part of the Low-Cost Solar Array Project that is being monitored by the Jet Propulsion Laboratory of Pasadena, Calif.

Crystal Systems uses what it calls a heat exchanger method (HEM), developed in 1971, to obtain the square ingots. As described by Chandra P. Khattak, the company's research and development director, HEM is a motionless process in which ingots are directionally solidified in shaped crucibles in a vacuum—that is, molded and not pulled, as are Motorola Inc.'s almost-square Czochralski single-crystal ingots [*Electronics*, Oct. 11, p. 43]. Khattak says that HEM requires less equipment, labor, and power than competing methods.

The technique also yields ingots of high quality, according to Khattak. He says crystallinity is the best produced by any casting process and that vacuum processing means low oxygen content in the cast material. Because of its directional solidification, impurities are rejected in the last of the material to freeze, says the company, which has fabricated solar cells from HEM silicon with the excellent efficiency of 15%.

Crystal Systems had to solve three major problems in casting its squared-off silicon ingots: cracking, historically the worst problem of them all; formation of silicon carbide impurities in vacuum processing; and extraction of heat through an insulating crucible. **-Howard Wolff**

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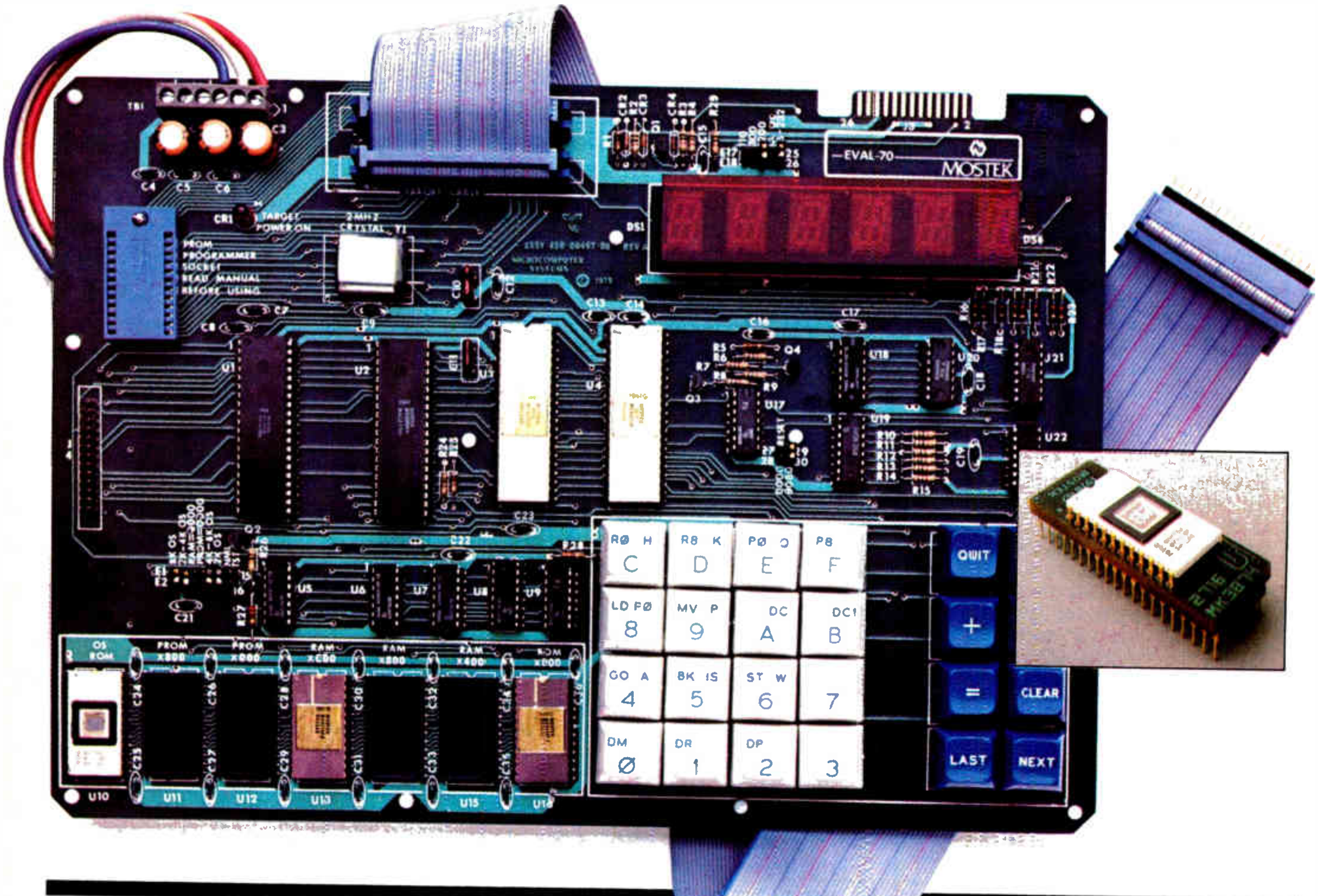

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MK3874 is our piggyback EPROM single-chip microcomputer with the same architectural features, pinouts and I/O lines as other 3870 family members. Using 24-pin EPROMs, the 3874 can address 1K, 2K or 4K bytes of memory, for ideal 3870 family prototyping, testing or low volume production.

Take your programmed PROM from the EVAL-70, insert it in the 3874, put the 3874 in the target socket and field test your idea.

An inexpensive yet powerful combination: the EVAL-70 is $499; an MK3874 without PROM is $92.

See both at your Mostek distributor. Or contact Mostek, 1215 West Crosby Road, Carrollton, Texas 75006; phone 214/323-6000. In Europe, Mostek Brussels; phone 660.69.24.

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People

O'Sullivan wants to back new companies for Ireland

Emerald touch. Eoin O'Sullivan means to show U. S. industry the advantages of Eire.

The names come from the list of blue-chip electronics firms in the U.S.—Mostek, Memorex, Digital Equipment Corp., Analog Devices, Amdahl, Computer Automation. All of them have plants in Ireland and another Irish connection, this one with the Industrial Development Authority–Ireland, a quasi-governmental body with about 600 employees around the world that exists to create jobs for the people of Eire.

Now the IDA's North American operations have a new director, Eoin (pronounced "Owen") D. C. O'Sullivan, a gifted conversationalist who also happens to know exactly what he wants and how to get it. O'Sullivan's track record since he left Dublin's National University with a degree in physics reads as though he has been deliberately preparing for the job he has had since August. He worked first for English Electric Co. but in 1969, instead of going to Nigeria for the company, he took a friend's advice and answered an IDA ad. Ever since, he has moved smoothly through positions in the organization—he was director of European operations, then headed the foreign and Irish investment division in Dublin.

"I have a lot of experience with startups—all that grief of the first two or three years when nothing runs the way it's supposed to," he says. But he is also well acquainted with doing business in Europe and has dealt with many U. S. firms—electronics and others—going to Europe for the first time. "For five years I set up deals in the head office," O'Sullivan recalls, "and half the business was with Americans."

O'Sullivan would like his organization to get involved at an earlier stage with young would-be engineers and young companies. His organization has already started work on a plan with Irish universities to turn out more engineers.

As for his other goal, he observes, "Two or three years ago I put together a $10 million package with three American MOS executives and two Irishmen. The deal would have been something like England's Inmos. Even though it fell through at the last moment—we had even built a road to the site of the proposed plant—I want to do more of that kind of venture-capital, risk-taking deal. It is now easier because we have more confidence."

O'Sullivan points out that in 1974 IDA officials picked some target electronics sectors that they preferred as Irish plant owners. From the perspective of 1979 those selections make O'Sullivan and his associates look like pretty sharp planners. The targets were MOS technology, control systems, and, perhaps most interesting of all, environmental control—with an eye toward future energy shortages.

Philips emphasizes speed in N. J. scope operation

When NV Philips Gloeilampenfabrieken moved its U. S. sales facilities for test and measurement instruments to Mahwah, N. J., a few years ago, it was only a matter of time before the Dutch company would start production operations there. That time has come: by December an assembly plant will be on stream, initially putting out oscilloscopes a

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Saxon Business Products, Inc.: "Mostek's 3870 cost-effectively replaced a three-chip microprocessor set. As the controller in the Saxon 301, 302, and soon—the 301R—bond copying machines, the 3870 has improved the Saxon-line reliability with field uptime at all time highs." *Mike Bonavia, Electronic Engineer.*

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Circle 15 on reader service card

move "that will put us closer to our American customers, and they will benefit," says Henk Bodt, the 41-year-old deputy director of Philips' Science and Industry division and responsible for international marketing and production for the division's Test and Measuring Group. "With us producing in the U.S., our customers there will get the same high-quality products, but much faster than it takes for products to arrive from Holland. Also, service will be enhanced."

For Philips, which rates itself as the No. 3 instrument maker after Hewlett-Packard Co. and Tektronix Inc., there is another motive. "About 35% of the oscilloscope market is closed to us because of the 'buy American' policy of Government-run organizations," Bodt says. "But that policy does not apply to those manufacturing in the U.S., and hence we can penetrate deeper into the market." The Dutch company has about 10% of the American market for portable oscilloscopes.

For the industry as a whole, Bodt puts this year's worldwide consumption of traditional test equipment such as generators, analyzers, multimeters, and oscilloscopes at close to $2.5 billion and predicts it will rise between 7% and 9% annually through 1983.

A much steeper growth, more like 25% a year, is in store for advanced systems encompassing data test equipment (including logic analyzers), microcomputer development systems, and automated test equipment for use in the lab and in production, Bodt says. He pegs this year's world market for such systems at about $300 million.

Philips' Mahwah assembly operations will start in a 30,000-square-foot leased facility. "At this time it is difficult to say what instruments other than oscilloscopes we'll be making in the U.S. in the future," says Bodt, who has been with Philips for 23 years.

A graduate of the Technical University at Eindhoven, Bodt lists his family, sailing, and building his own furniture as his main spare-time interests. ☐

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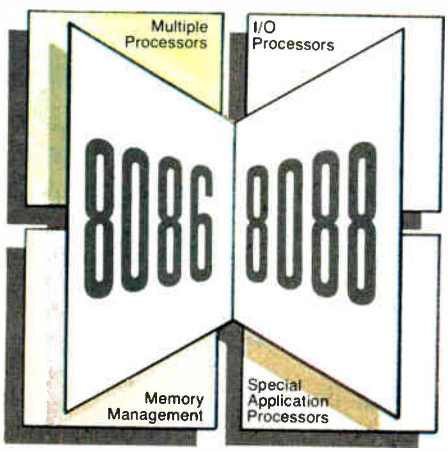

the performance, yet preserves your entire hardware investment. And with the CONV-86 code converter and PL-M/86 compiler, your software can be easily upgraded, too.

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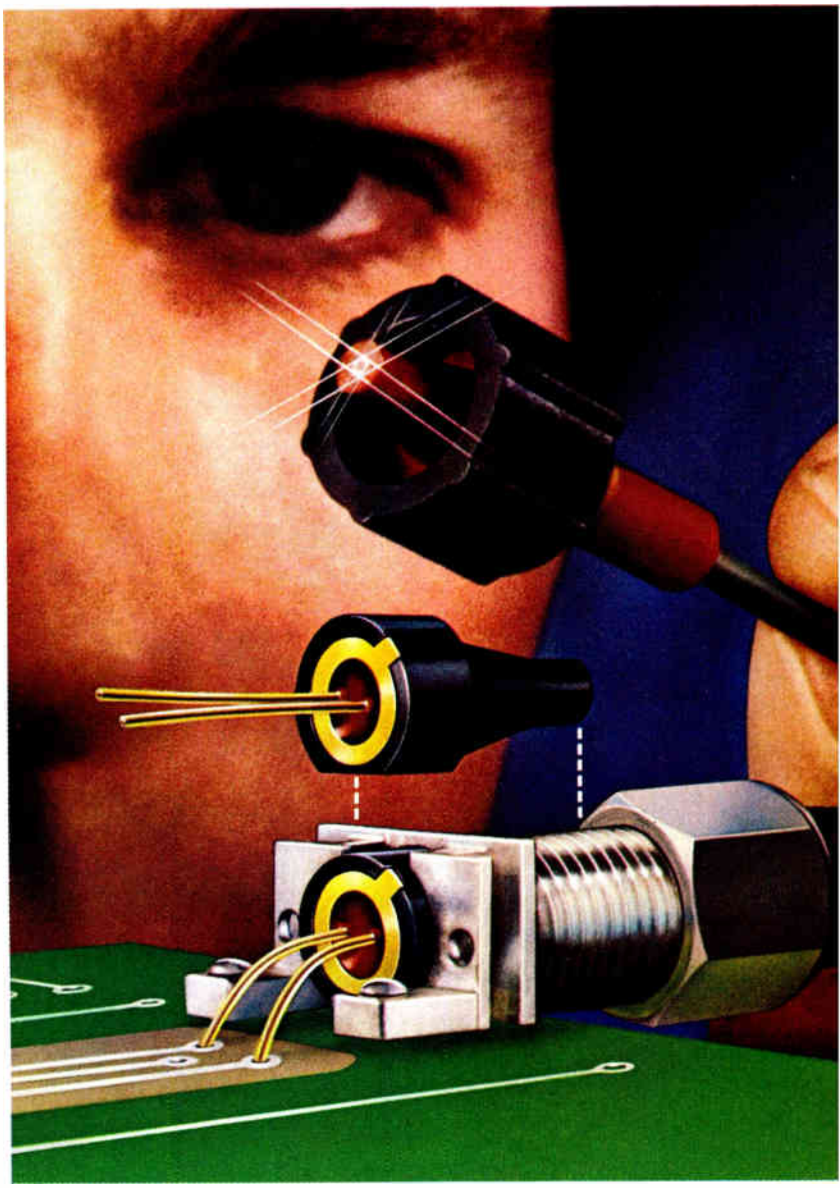

If you need an "experienced" line of fiber optics connectors, then you need AMP Optimate. With this complete line you can terminate cable down to 125 microns with less than 2 db loss. And do it simply, quickly, with highly repeatable accuracy. The principal reason? AMP's now well-proven resilient ferrule technique. Get precision alignment, and most important, the price is right for production runs

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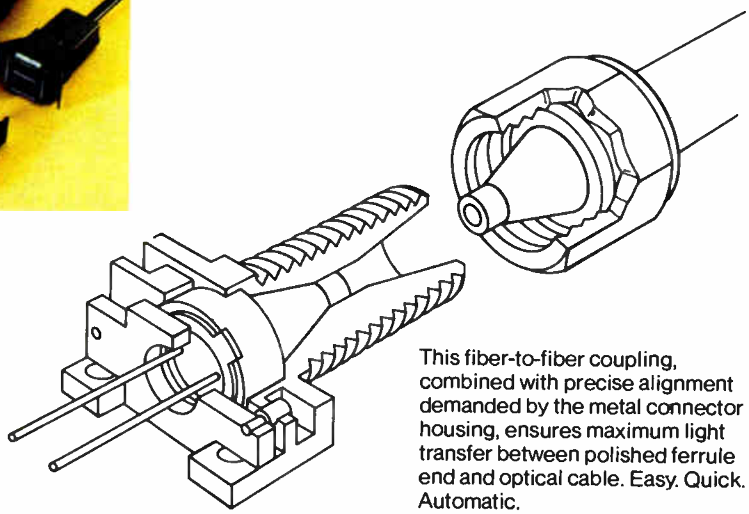
ITT 433	125μm
Valtec LD MG05	125μm
Times Fiber GP1/G6-600	125μm
Times Fiber GP1/G10-250	125μm
Belden 225001	125μm
Valtec MD MG05	125μm
Siecor 112	125μm
Siecor 122	125μm
Canstar D1G-061	125μm
Hewlett Packard	140μm
Pilkington H20SR	150μm
Galileo 3000 LCMS	245μm
Pilkington H20LR	245μm
Hewlett Packard	245μm
Pilkington 75LR	245μm



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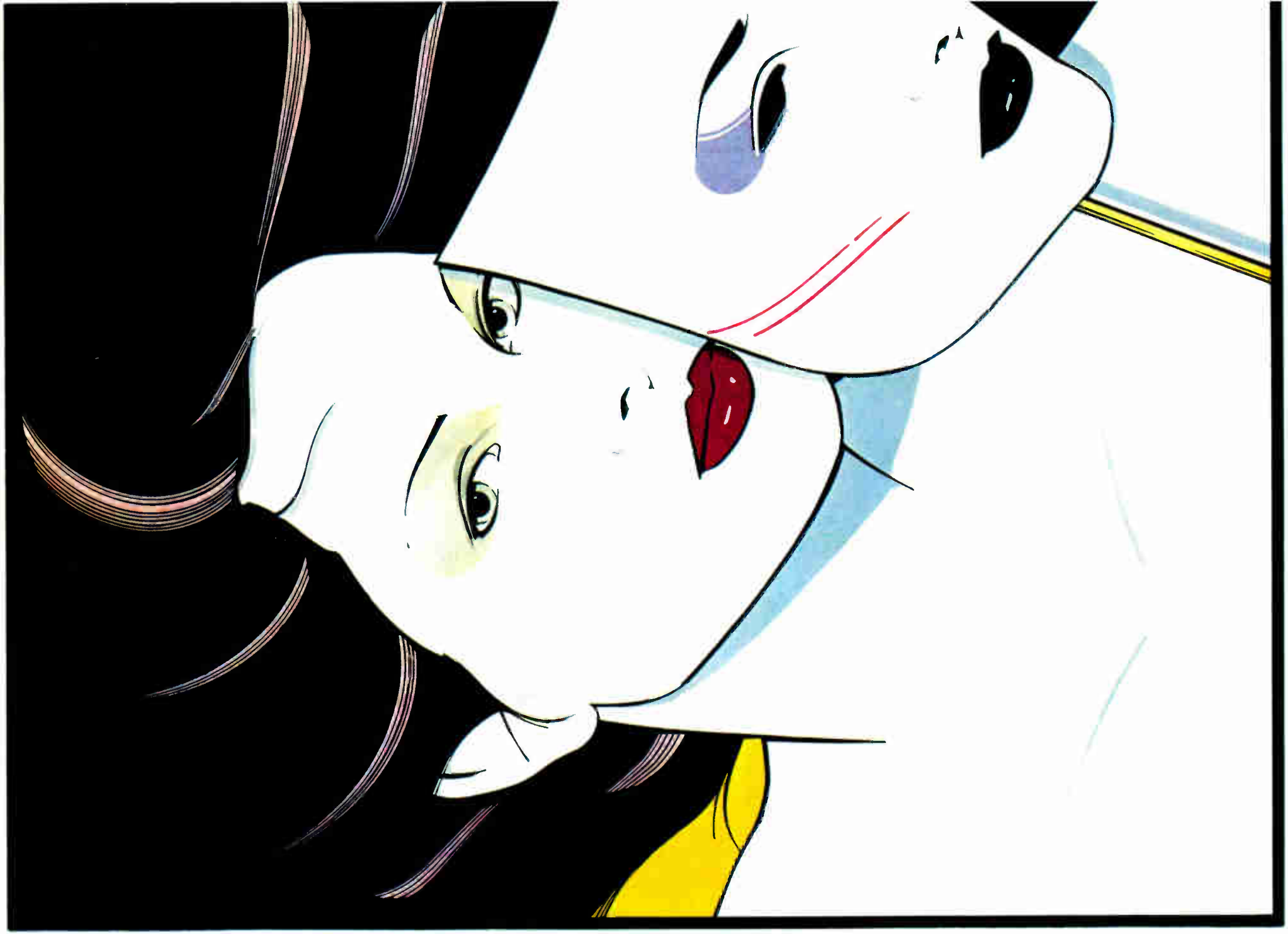

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089/7

Editorial

Good cheer in the Northeast

It was a day that saw the prime interest rate jump to 14.5% and the Dow Jones average plunge 26 points—all in all not the best of times for optimistic prognostications about the future for manufacturers of components, computers, or instruments. But that is what emerged from a panel consisting of a cross section of New England company presidents.

Their consensus was that continuing high demand, strong backlogs, and growing overseas markets will keep electronics strong even in a 1980 recession. The panel included George M. Berman, chairman and president of Unitrode Corp.; Robert Howard, president of Centronics Data Computer Corp.; Andrew C. Knowles III, marketing vice president of Digital Equipment Corp.; and William R. Thurston, president of GenRad Inc.

Perhaps Thurston expressed the consensus, though he was speaking about test and measurement equipment, when he said that strong demand would be spurred by growth in telecommunications, increased use of electronic devices in autos and aircraft, an upswing in defense spending, and IBM Corp.'s emergence as a big customer for semiconductors and manufacturing test equipment. He figures 1980 to look a lot like 1979, with an aggregate growth rate reaching 30%.

Berman agreed with Thurston's demand factors, predicting that high-technology semiconductor companies would fare "reasonably well" in a recession. He foresees an industry growth rate of 11% in 1980. And Knowles said that the computer industry's major problem will be meeting demand.

Howard struck the most somber note when he said that Centronics has already seen evidence of "substantial" inventory adjustments. What's more, he expects the higher interest rates to have a "devastating effect" on large and small companies as they try to develop and market new products.

All things considered, these leaders are painting a bright future. Though no one said it quite in those words, it would appear that the electronics industries are becoming less susceptible to cyclical dips in the economy than some of the nation's other basic industries. It also seems that electronics is becoming an indispensable and omnipresent component of people's day-to-day lives.

Laurels and a lesson for the CAT scanner developers

Speaking of the pervasiveness of electronic technology, another example is the award of the Nobel Prize for physiology and medicine to the two inventors of computerized axial tomography, or the CAT scanner. The X-ray technique enables physicians to look at cross sections of the body. The honor is particularly gratifying for its recognition of technology rather than pure science.

The winners, neither of whom has a doctorate in medicine or anything else, are Allen McLeod Cormack, 55, a physicist at Tufts University, and Godfrey Newbold Hounsfield, 60, an electronics engineer at EMI Ltd. in England.

But the major lesson to be learned from the CAT scanner's evolution is economic. Although prohibitively expensive, the systems were so desirable to U. S. hospitals—each wanting its own—that the Government had to step in with regulations granting subsidies chiefly to large, regional institutions. The result was a slump in sales of the machines and, for developer EMI, financial peril. But now less costly ones are appearing—the classic behavior of a market based on technological advance and demand for the fruits of that progress. Simply put, the technologists will usually manage to shape their product to fit the market.

Meetings

Compsac '79, Computer Software and Applications Conference, IEEE Computer Society, The Palmer House, Chicago, Nov. 6-8.

Midcon/79 Show and Convention, IEEE and Electronic Conventions Inc. (El Segundo, Calif.), O'Hare Exposition Center and Hyatt Regency O'Hare Hotel, Chicago, Nov. 6–8.

Productronica/79—Third International Trade Fair for Manufacturers in Electronics (Postfach 12-10-09, D-8000, Munich 12), Munich Fair Grounds, Nov. 6–10.

Ninth Annual Fall Conference on Consumer Electronics, IEEE, Ramada O'Hare Inn, Des Plaines, Ill., Nov. 12–13.

Concepts and Requirements for Battlefield Interdiction in Europe, Electronic Industries Association *et al.*, Institute for Defense Analysis auditorium, Arlington, Va., Nov. 13–14.

International Technical Symposium, International Society for Hybrid Microelectronics (P. O. Box 3255, Montgomery, Ala. 36109), Bonaventure Hotel, Los Angeles, Nov. 13–15.

International Micro and Mini Computer Conference, IEEE *et al.*, Astro Village, Houston, Nov. 14–16.

Non-Ionizing Radiation Symposium, American Conference of Governmental Industrial Hygienists (2205 South Rd., Cincinnati, Ohio 45238), Capitol Hilton Hotel, Washington, D. C., Nov. 26–28.

Intelec '79—Second International Telecommunications Energy Conference, IEEE, Sheraton Park Hotel, Washington, D. C., Nov. 26–29.

National Telecommunications Conference, IEEE, Shoreham-Americana Hotel, Washington, D. C., Nov. 27–29.

Sixth Data Communications Symposium, Association for Computing

Meetings

Machinery *et al.*, Pacific Grove, Calif., Nov. 27–29.

International Electron Devices Meeting, IEEE, Washington Hilton Hotel, Washington, D. C., Dec. 3–5.

First Electronic Component and Telecommunications Apparatus Industry, Ente Fiera—Mostra di Componenti Elettronici (Viale degli Scaligeri—C.P. 805, 36100 Vicenza, Italy), Vicenza fairgrounds, Dec. 8–10.

Second International Symposium on Mini and Microcomputers in Control, International Society for Mini and Microcomputers (P. O. Box 248, Anaheim, Calif.), Galt Ocean Mile Hotel, Fort Lauderdale, Fla., Dec. 10–11.

Distributed Data Processing, Data Communications and Networks, and Minicomputers Conference, American Institute of Industrial Engineers, (P. O. Box 3727, Santa Monica, Calif. 90403), Jack Tar Hotel, San Francisco, Dec. 10–12.

Winter Consumer Electronics Show, EIA, Convention Center, Hilton and Jockey Club Hotels, Las Vegas, Nev., Jan. 5–8.

Sixth Semiannual ATE Seminar/Exhibit and First Annual Test Instruments Conference, Benwill Publishing Corp. (1050 Commonwealth, Boston, Mass. 02215), Convention Center, Pasadena, Calif., Jan. 7–10.

Second Design and Finishing of Printed Wiring and Hybrid Circuits Symposium, American Electroplaters' Society (Winter Park, Fla.), San Francisco, Hilton, Jan. 15–17.

Short courses

Twelfth Annual Microprogramming Workshop, Nov. 18–21, Hershey, Pa. Write to IEEE Computer Society, Box 639, Silver Spring, Md. 20901

High Power Lasers, Nov. 26–30, Orlando, Fla. Write to the Laser Institute of America, P. O. Box 9000, Waco, Texas 76710

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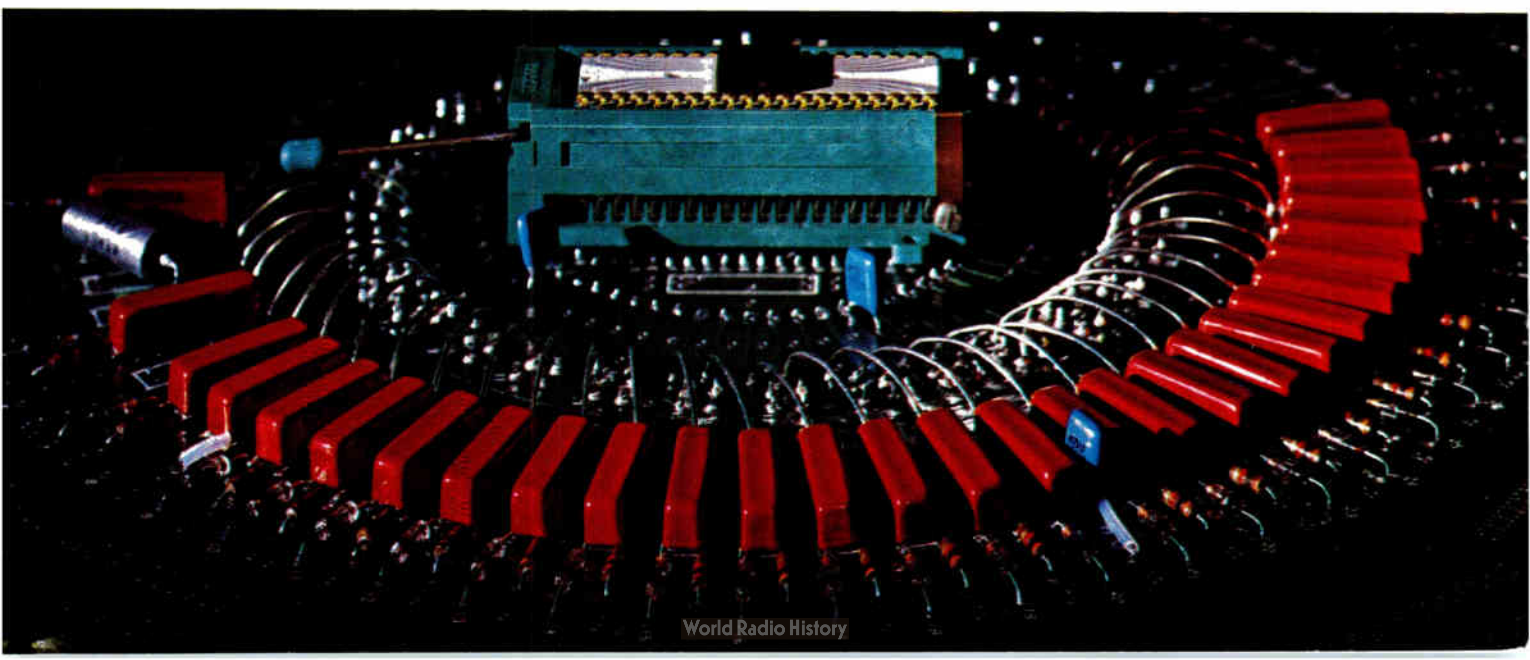
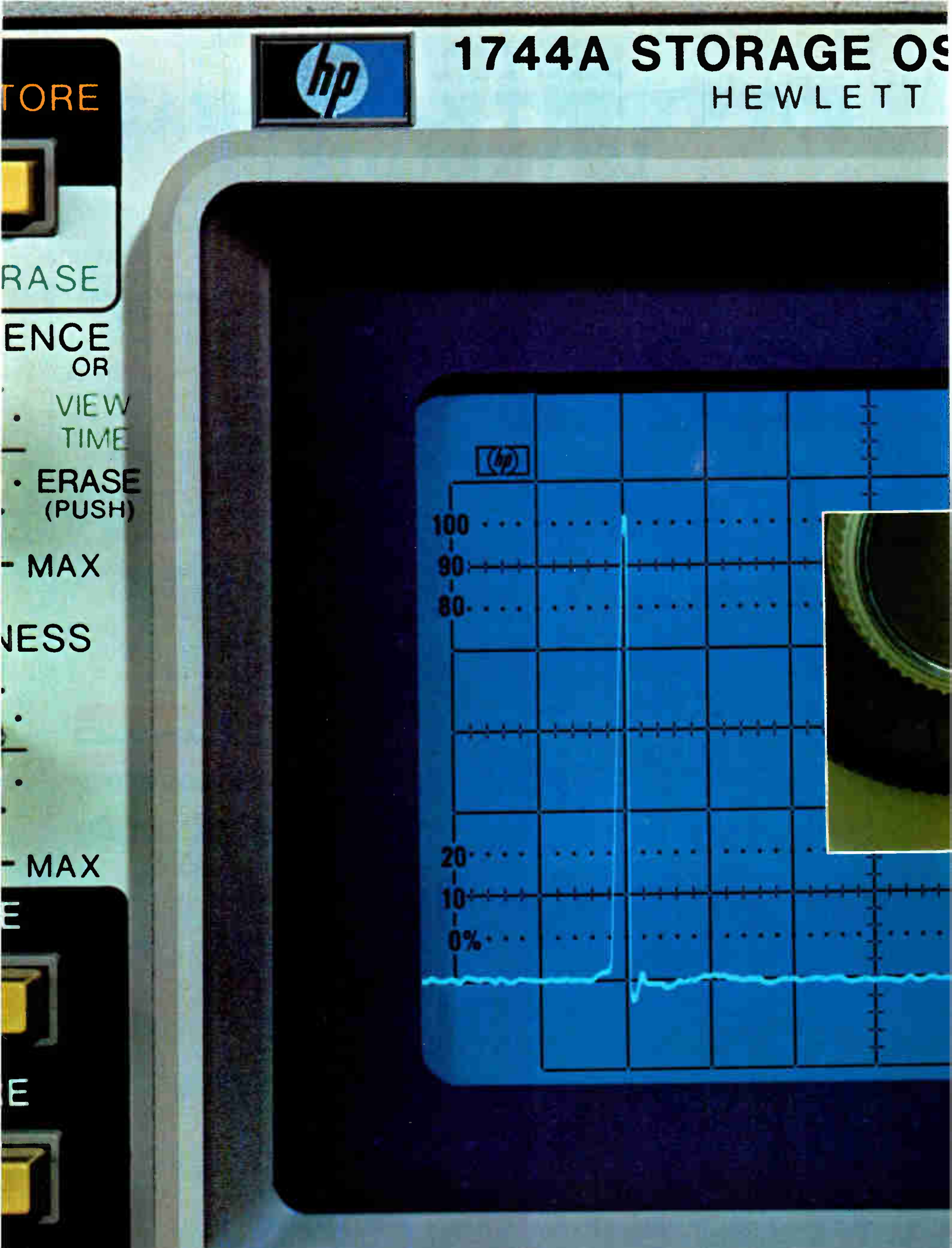
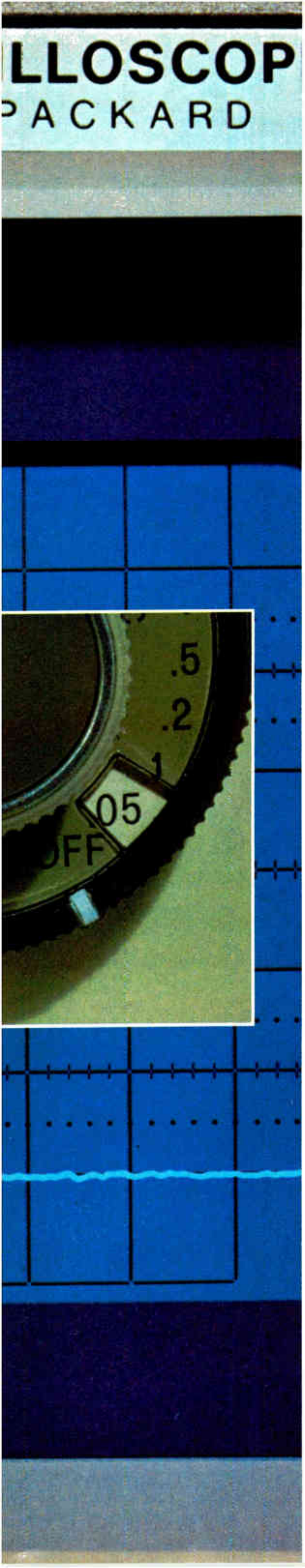




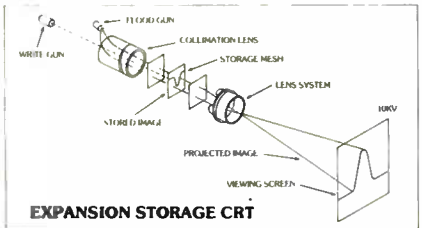
Storage trace as seen using a viewing hood.



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

HP's new 1744A is the Answer.

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



EXPANSION STORAGE CRT

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

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Call your local HP field engineer for further details. And for a lower cost, high quality storage scope where an extremely fast writing speed isn't required, ask him about HP's 1741A 100 MHz storage scope.

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Circle 31 on reader service card

Philips enters electron-beam system market

Saying that it is "totally committed to making a major inroad into the semiconductor equipment business," Philips Electronic Systems Inc. is making its first penetration of the market with a vector-scanning, electron-beam writing system that it calls the Beamwriter. **With a minimum beam diameter said to be one tenth that of other electron-beam production systems,** the $2 million lithography system can write details as small as 0.4 μm and lines as broad as 1.0 μm and can swiftly produce precision masks and reticles.

The Mahwah, N. J., affiliate of the Netherlands' Philips says it is developing a direct-writing version that will be 25 to 50 times faster than the current system. Toward that end, Philips is developing resists—first positive, then negative—that will be matched to the characteristics and performance of the Beamwriter. It is also developing interfaces to popular computer-aided design systems. Philips and several producers of resists and computer-assisted design equipment are discussing commercializing the developments. Meanwhile, Philips Electronic Systems president Dominick M. Protomastro notes that six Beamwriters are currently scheduled for delivery and that other products to be introduced into the semiconductor equipment market may include steppers, wire bonders, and wafer handlers.

TI 16-bit micros get gift of gab

Look for Texas Instruments Inc. soon to add synthetic speech capabilities to its TM990 family of 16-bit microcomputer modules. TI officials in Houston have tabbed the TM990/306 synthetic speech module for fourth-quarter introduction. **The 306 will make use of the solid-state linear predictive coding tehniques** employed in earlier TI consumer products—such as the Speak & Spell electronic learning aid and the 99/4 home computer—but will be aimed at the industrial marketplace and will have a fixed vocabulary of words needed in manufacturing and industrial control.

Motorola prepares own version of Intel's 2147 RAM

Following the announcement by Texas Instruments Inc. that it will supply a second-source version of Intel Corp.'s 2147 fast static random-access memory [*Electronics*, Sept. 27, p. 34], Motorola Inc. has plans for the fourth-quarter introduction of its version of the popular part, organized as 4 K by 1 bit. Motorola's MOS operation in Austin, Texas, has produced the part in limited numbers for the last six months, **but has only recently achieved good yields of devices meeting the 55-ns access-time specification.** With the process now nailed down, Motorola is expected to move ahead with plans for other fast static RAMs [*Electronics*, July 19, p. 34]. Next on the schedule is a second-source version of Intel's 2115A, organized as 1 K by 1 bit.

Boards turn printers into data-entry units

In business to make dumb terminals smart by turning them into complete data-entry systems, Tri-Data of Mountain View, Calif., is about to take the wrappings off 4,000- and 16,000-character buffer-storage boards that fit inside Teletype Corp.'s model 43 and Digital Equipment Corp.'s LA 34 and LA 36 teleprinters. Unlike Tri-Data's earlier 1,000-character board, which provides a one-way store-and-forward buffer, the new 4,000- and 16,000-character subsystems **buffer both outgoing and incoming data for two-way data-communications applications.** They also feature a powerful text-editing package, battery backup, and increased speed by using a Z80 8-bit microprocessor and dynamic random-access memory, instead of the

8080 and static RAMs used in the older board. Priced at $600 and $800, respectively, and available in 60 days, the subsystems are slated to be unveiled at next week's Interface West Conference and Exposition at the Anaheim, Calif., Convention Center.

Computer rivals ready to dissect 4341 from IBM

The computer industry is waiting with bated breath for IBM to begin deliveries of its model 4341 computer—the larger of the two blockbuster 4300 computers introduced last January. **Once deliveries begin, reportedly this week, details of the computer and the new 571-megabyte model 3370 disk drive will be unveiled.** The industry is especially interested in recording specifications for the thin-film head used in the 3370 and what appears to be an innovative dual-actuator scheme.

Army selects burst-data system from Racal

Looking to establish itself in the U. S. military communications market, a division of Britain's Racal Electronics Ltd. has scored the company's second success in as many months with a $3.9 million order from the U. S. Army for its high-speed burst-mode data-communications system. Called Merod, for message entry and readout, it is **designed to provide front-line troops with accurate and secure communications.** Messages of up to 1,000 characters can be keyed in and checked on a 32-character display before transmission—at the touch of a button—over very high frequencies at up 1,300 words per minute. Competition in this fast-growing market is fierce. In the UK, for example, Plessey Avionics and Communications Ltd. in Ilford, Essex, launched a rival product in June. The contracts to subsidiary Racal Datacom Ltd., Salisbury, England, follow a recent $16.5 million order to Racal Communications Inc., Rockville, Md., from the U. S. Air Force and the Canadian armed forces.

Systems to ease process-control networking

Analog Devices of Norwood, Mass., plans to ease networking of process-control systems by boosting the power of its Macsym line. The first in a new series of remote control and measurement systems, the Macsym 20 is being unveiled this week at the Instrument Society of America show in Chicago. **The unit acts as an intelligent front end, conditioning signals from industrial or laboratory transducers and exercising local control, as well as responding and talking to the network's host computer.** Like the earlier Macsym I and II, it also can act as a stand-alone controller. Along with the new unit, the company will introduce a compatible high-level language and development system.

Addenda

Seeking to broaden its base in the U. S., Munich-based Siemens AG intends to purchase the stock of Aerotron Inc., **a small producer of communications equipment in Raleigh, N. C., for $12 million.** Aerotron's management has approved the transaction in principle, but the stockholders still have to vote on it. . . Filling in its product line, **Burroughs Corp. has introduced the third series in its family of word-processing systems.** The Redactron III, compatible with the low-end R-I and the high-end R-III word processors, comes complete, for $9,895, with two single-sided, double-density floppy disks, a cathode-ray-tube display and keyboard, and a 660-word-per-minute printer.

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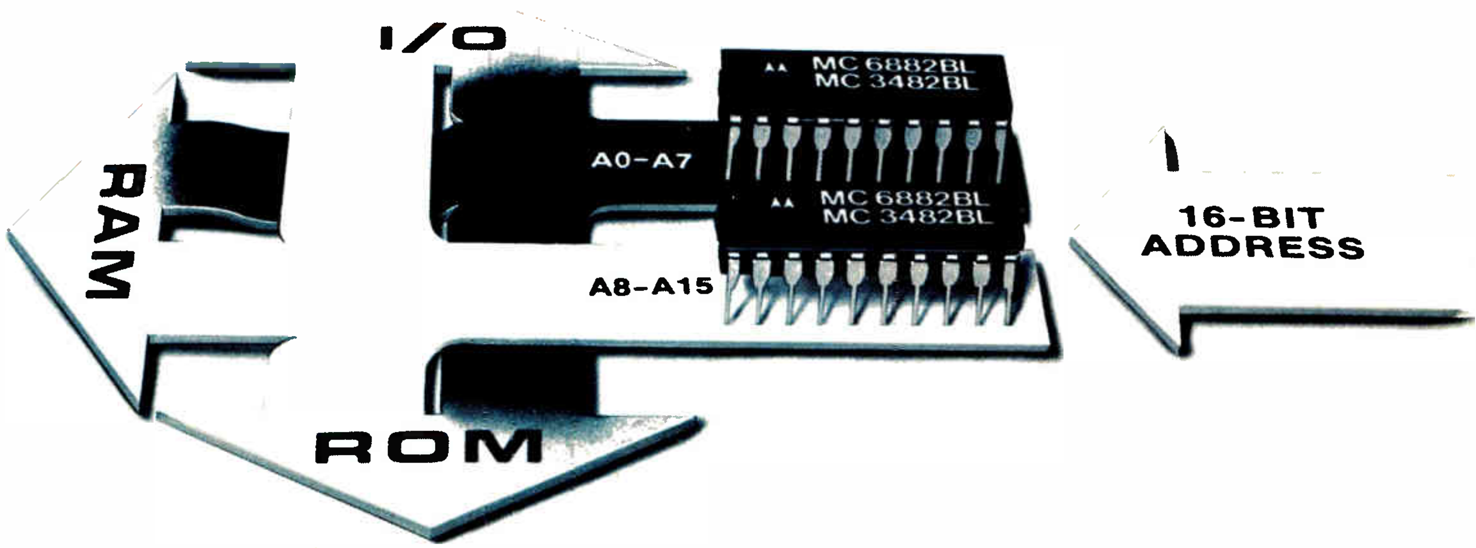

Double your drive, tune out noise with Motorola's 3-state, octal buffer latch.

Despite being around for a while from multiple sources using known LS technology, quantities of octal buffer latches are usually gone by the time you get to the ordering stage. Even if you've been lucky enough to find any lately for MPU memory address bus buffering, chances are they haven't lived up to every performance parameter you could wish for.

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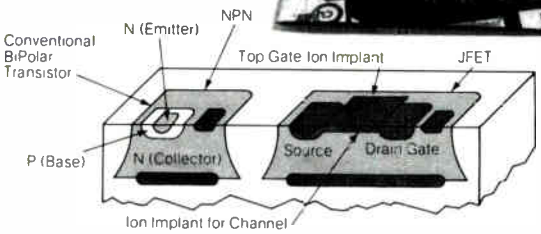

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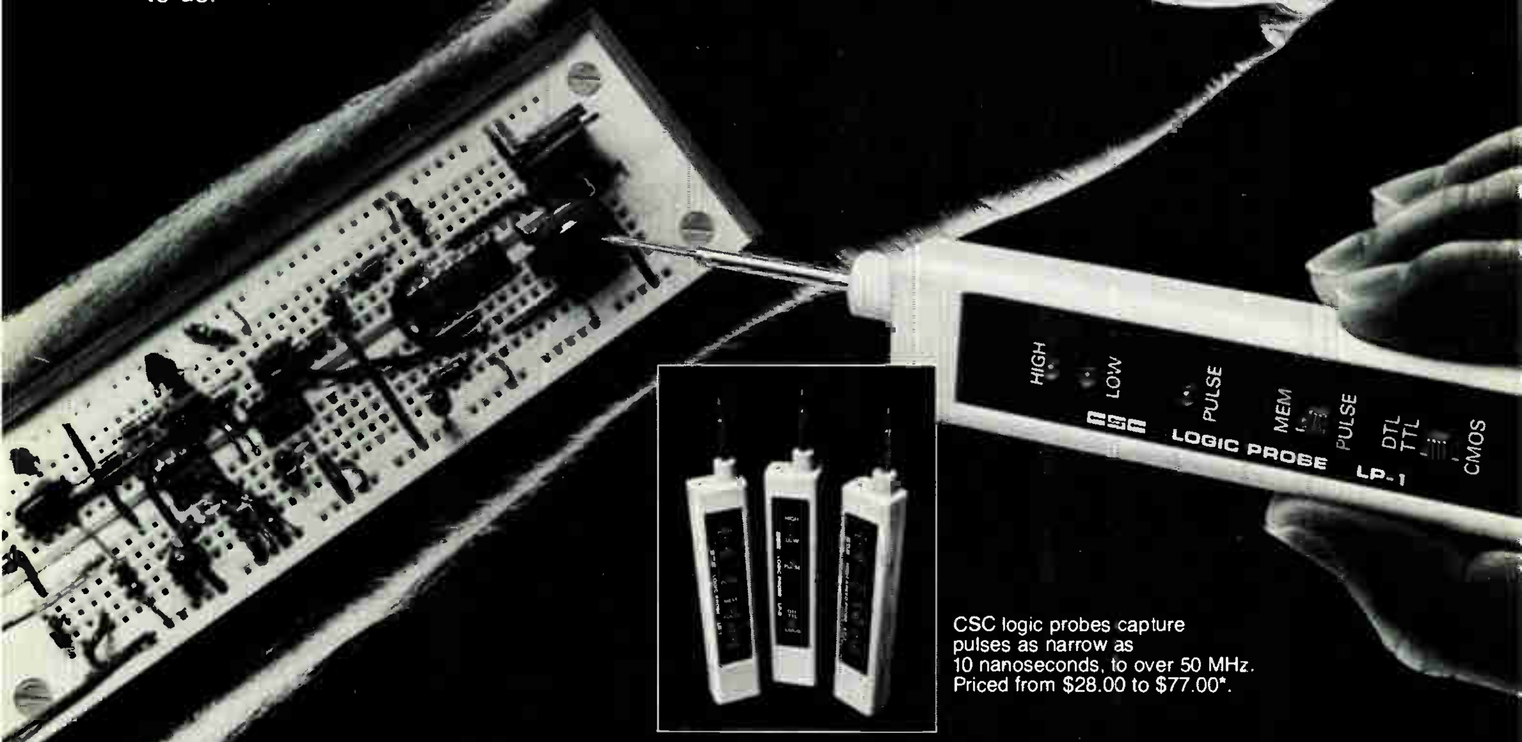

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Circle 38 on reader service card

Distributed processing enlisted by Army's missile command

by Anthony Durniak, Computers & Peripherals Editor

Conference held by R&D center throws spotlight on military's quiet funding of distributed defense processing

The distributed data-processing concept is being widely promoted by the commercial computer industry these days. But the military is quietly funding a significant portion of the research into distributed-processing hardware and software technology.

The extent of the military's interest, particularly that of the Army's Ballistic Missile Defense Advanced Technology Center, came to light at the First International Conference on Distributed Computing Systems held earlier this month in Huntsville, Ala., and sponsored by the Army technology center.

An international conference dedicated to this technology is something of a milestone in the relatively short history of distributed processing. For the Army to host the meeting is an even bigger turning point. As Charles R. Vick, director of the data-processing directorate at the center and general chairman of the conference, points out, an important fallout of the conference will be "a definition and nomenclature" for the concept.

Taking aim. E. Douglas Jensen, a professor of computer science at Carnegie Mellon Unversity, Pittsburgh, Pa., and the conference's program chairman, adds that for the first time "a consensus is emerging on what the problems of distributed processing are."

Among the major difficulties that researchers in both industry and the universities face are: how to program distributed systems, how to decentralize control, how to interconnect distributed computers, and how to distribute the data base as well as the computing. As a result of this meeting the Army's Technology Center made clear its interest in solving these problems.

What are the ballistic missile defense needs in distributed processing? Vick explains that the problem of aiming defensive ballistic missiles to intercept enemy missiles is rather complex because of the need to discriminate rapidly between the multiple warheads expected and the various decoys the Army assumes will be deployed.

Such systems can be either ground based or completely contained in a missile—a previously unavailable alternative.

In addition to the high processing throughput required by such an application, Vick says the Army is especially interested "in increased fault tolerance, reliability, and the ability to expand a system easily." The software development task also becomes less complex because it can be made modular like the hardware.

Such distributed computers will

Making a computer fly

The biggest problem facing the U. S. Army's Ballistic Missile Defense Advanced Technology Center is how to get a computer that can process 50 million instructions per second—some five times the power of a big IBM model 3033 computer—to operate in a missile.

Researchers at Honeywell's System and Research Center in Minneapolis, Minn., and its Avionics division in St. Petersburg, Fla., have tackled that problem for the Army in their design of a modular missile-borne computer.

Obviously large-scale integrated circuits help reduce the size of the computer. But the researchers say a distributed hardware organization is the key to obtaining the processing power from the small package while providing both the fault tolerance and the ease of expansion the Army requires.

The basic element of the design is a general-purpose 16-bit central processing unit that is coupled to three local buses. Also attached to these local buses are between 4,096 and 8,192 words of triple-ported memory, plus adjunct processors with which this general-purpose processing element can perform parallel processing on multiple streams of data or filtering and correlation.

Many of these elements are in turn interconnected by three global buses and a sensor data bus that brings in information from a matrix of optical sensors. Image-processing software running in these processors then discriminates the actual target from the other objects in the missile's field of view.

Prototypes are now being built, the researchers say. The plan is to build the computer by packing the chips on 3-inch square ceramic modules that are in turn mounted on 14.5-in.-diameter circuit cards that are sandwiched into a 29-in.-high pile containing the entire computer and power supply.

-A. D.

be what Vick calls the third generation of computers applied to missile defense work, following the multiprocessors of the 1960s and the large supercomputers used during the 1970s.

On target. Among the first fruits of the Army's funding are the Modular Missile Borne Computers, which were developed by Honeywell Corp.'s Systems and Research Center in Minneapolis and unveiled at the conference (see "Making a computer fly").

This system is apparently only the beginning of the military's backing of distributed processing. The Office of Naval Research is also funding some research because of its application to avionics distributed throughout an aircraft. And the Air Force is said to be examining how distributed processing can be applied to the control of its proposed MX missile project, which would put missiles in a number of underground locations.

Other government funding is coming from the Advanced Research Projects Agency, the National Science Foundation, the Federal Aviation Administration, and the Department of Energy. □

Trade

SIA claims Japanese semiconductor firms are buying into U. S. 16-K RAM market

Japanese manufacturers of 16,384-bit random-access memories captured 42% of the American market at prices 25% to 50% below those prevailing in their home market, a leading U. S. producer has told Congress. Urging it to adopt economic incentives to prevent further erosion of the U. S. semiconductor leadership, Mostek Corp. chairman L. J. Sevin said the growing Japanese share of the American market is far ahead of the 25% target originally identified two years ago by Nippon Electric Co. [*Electronics*, June 9, 1977, p. 103].

"If the 16-K RAM market, or the successor 64-K RAM market, were lost to predatory Japanese competition, the American semiconductor industry would suffer not only in RAMs, but in all integrated-circuit product lines," Sevin told a mid-October hearing of the Joint Economic Committee (JEC).

The U. S. "could become a net importer of state-of-the-art circuits" if deprived of the cash flow from high-volume products like 16-K RAMs that support competitive technology, Sevin warned. He testified on behalf of the Semiconductor Industry Association (SIA) during hearings before JEC chairman Sen. Lloyd Bentsen (D., Texas) concerning a General Accounting Office (GAO) report last month that examined issues and problems of U. S.–Japanese trade.

Alarmed. L. J. Seven, chairman of Mostek, warns congressional hearing that Japanese have captured 42% of U. S. market for 16-K RAMs at prices well below those in Japan.

Price variances. Sevin illustrated the disparity between U. S. and Japanese prices for 16-K RAMs by citing the higher prices obtained by American producers in Japan under five contracts and comparing them with the sharply lower Japanese prices for the same product in the U. S. market (see table). According to Mostek's figures, the Japanese companies lost $500,000 on five contracts for 230,000 units during 1979 by electing to sell in the U. S. rather than in Japan. "We must infer that American prices in Japan are competitive if U. S. companies are selling 16-K RAMs there," explained the SIA's Washington counsel, Peter B. Archie. "But we can't know what Japanese manufacturers charge in their home market. That information is not available to us."

Sevin added that the Japanese loss on all U. S. sales of semiconductors were doubtessly much larger.

Some congressional staff members suspect that the SIA testimony is a prelude to the filing of dumping charges against the Japanese. Archie declined comment on the prospect, but Sevin noted at one point that "three large Japanese companies—Nippon Electric, Hitachi, and Fujitsu—have severely disrupted the U. S. market" for 16-K RAMs. Amer-

SELECTED 16-K RAM UNIT PRICES

Japanese customer*	16-K RAM (type)	Contract quantity	U.S. price	Landed price in Japan	Japanese price in U.S.**
A	4116 N-4	20,000	$5.75	$7.47	$4.85
B	4116 N-4	30,000	5.50	7.16	4.85
C	4116 J-2	60,000	6.75	8.10	5.40
C	4116 J-3	60,000	5.75	6.90	5.10
D	4116 J-3	60,000	5.95	7.14	5.10

*Customers C and D also manufacture semiconductors.
**Not necessarily from companies in first column.
SOURCE: MOSTEK CORP.

ica's semiconductor industry, Sevin said, "stands exposed to the same Japanese target industry strategy that decimated the U.S. color TV and steel industries" earlier.

"Now is the time to anticipate the threat to our high-technology industries," he maintains, "and now is the time for our Government to act. U.S. policy has been reactive, not anticipatory."

Productivity issue. The SIA spokesman shot down several times during the session the contention that declining U.S. productivity is responsible for semiconductor sales losses to imports—an argument advanced by William Tanaka, testifying on behalf of the Electronic Industries Association of Japan and confirmed in part by GAO testimony. Although U.S. productivity overall may be slipping, Sevin countered, semiconductor labor productivity is extremely high.

Sevin also rejected the GAO's proposal that Japanese corporate investment in U.S. semiconductor plants might resolve the trade problem, as it did in the color TV market. Citing the decline in return on color TV sales to 1.5% after Japanese firms began U.S. assembly operations, Sevin declared that forcing such a low rate on the American semiconductor industry would wipe out "its growth potential and its ability to raise capital, all during a period when Japanese banks stand ready to supply capital funds for more Japanese-owned plants." **-Ray Connolly**

Modem diversification spreads market

One result of the trend towards distributed data processing is the increasing diversification of the computer and data-communications companies. This is especially evident in the Response system introduced by Paradyne Corp. at the Information Management Exposition and Conference.

In recent years a number of modem manufacturers have expanded their lines to include front-end communications processors and terminals in an effort to offer distributed-processing customers end-to-end service. Paradyne illustrates this trend with its Analysis network management and control system and its PIX II and Pixnet data-communications equipment that are intended to replace certain data-communications equipment and software provided by IBM.

Now, to compete with IBM's model 8100 and 4300, the Largo, Fla., company is offering its own 32-bit computers and new data-communications–oriented operating system software to support more powerful transaction processing at remote sites while remaining compatible with IBM equipment. The smaller of the two new computers has a 400-nanosecond cycle time, up to 1 megabyte of main memory, a single byte-multiplexer channel, and up to three disk channels. The more powerful 240-nanosecond processor can hold as much as 2 megabytes of memory, two byte-multiplexer channels and five disk channels. Both include an independent Attached Communications Processor that communicates with the network control unit, which is in turn connected with the host IBM System/370 computer.

Demonstrations start in December and product deliveries are scheduled for next August. Response systems can be rented for $3,500 per month while purchase prices start at $125,000. **-A. D.**

Communications

AT&T's Dataphone II offers diagnostics

Those pundits in communications who have been predicting the decay—if not the death—of the modem market in the 1980s, because of the conversion from analog to digital transmission, had better look again. That's the contention of J. Roger Moody, AT&T assistant vice president in charge of the latest Bell System offering, the Dataphone II, introduced last week at the Information Management Exposition & Conference.

The first of what Moody calls Bell's "offering for the 1980s" is a modular data-transmission subsystem, with modems and network controllers for full-duplex synchronous communications at 2,400, 4,800, and 9,600 bits per second. It is available in three hierarchical levels of complexity. These depend on the customer's system and of the diagnostics required.

Do-it-yourself. Dataphone II is compatible with the commonly used binary synchronous, Synchronous Data Link Control, and High-Level Data Link Control protocols. As such it puts AT&T into the thick of the modem competition between microprocessor-based systems (see "Modem diversification spreads market"). But perhaps most important, it represents a recognition by the Bell System that customers of the 1980s will want to do much of their own real-time data-communication system diagnostics.

"The customer can do his own management, control, and system upgrading without getting involved in the data-communications mystique," says Moody. "Customers want such features. An airline reservation system is a good example—it's a disaster when it's down."

Such diagnostics are a valuable feature and save time in isolating problems a good percentage of the time, according to one industry observer. But "a service call is still necessary for a final solution to the problem, especially if it's a line condition." On the other hand, the diagnostics enable the user to do network switching or rerouting to minimize the effect of the trouble.

Stressing service. "It's a stand-alone system," Moody points out. What's more, he notes that it will be fully compatible with, and is complementary to, Bell's Advanced Communication System (ACS) in spite of the fact that ACS is a digital concept [*Electronics*, July 20, 1978, p. 41]. "The world is not going to digital too fast," says Moody, who added that Bell will put the transmissions on satellites if necessary, now that the company has been given permission by the Federal Communications

Commission for such services.

Dataphone II is really two systems in one. The first—the data transmission—uses voice-grade lines with conditioning at 9,600 bits. And, there is a derived second channel for diagnostics that is independent of the data channel and operates at 110 bauds. It is accessible to the telephone company—the data channel is secure—for cooperative diagnostics.

"This is not a product—it's a complete service," Moody emphasises. There is competition among modem manufacturers and others with diagnostic capabilities had been announced before Bell got into the act. "But there is no system with the capabilities of Dataphone II," he notes. "Its hallmark is usability."

The microprocessor-controlled systems are available, for lease only, from all of Bell's operating companies. **-Harvey J. Hindin**

Semiconductors

Motorola redesigns telecommunications subscriber-loop interface chip

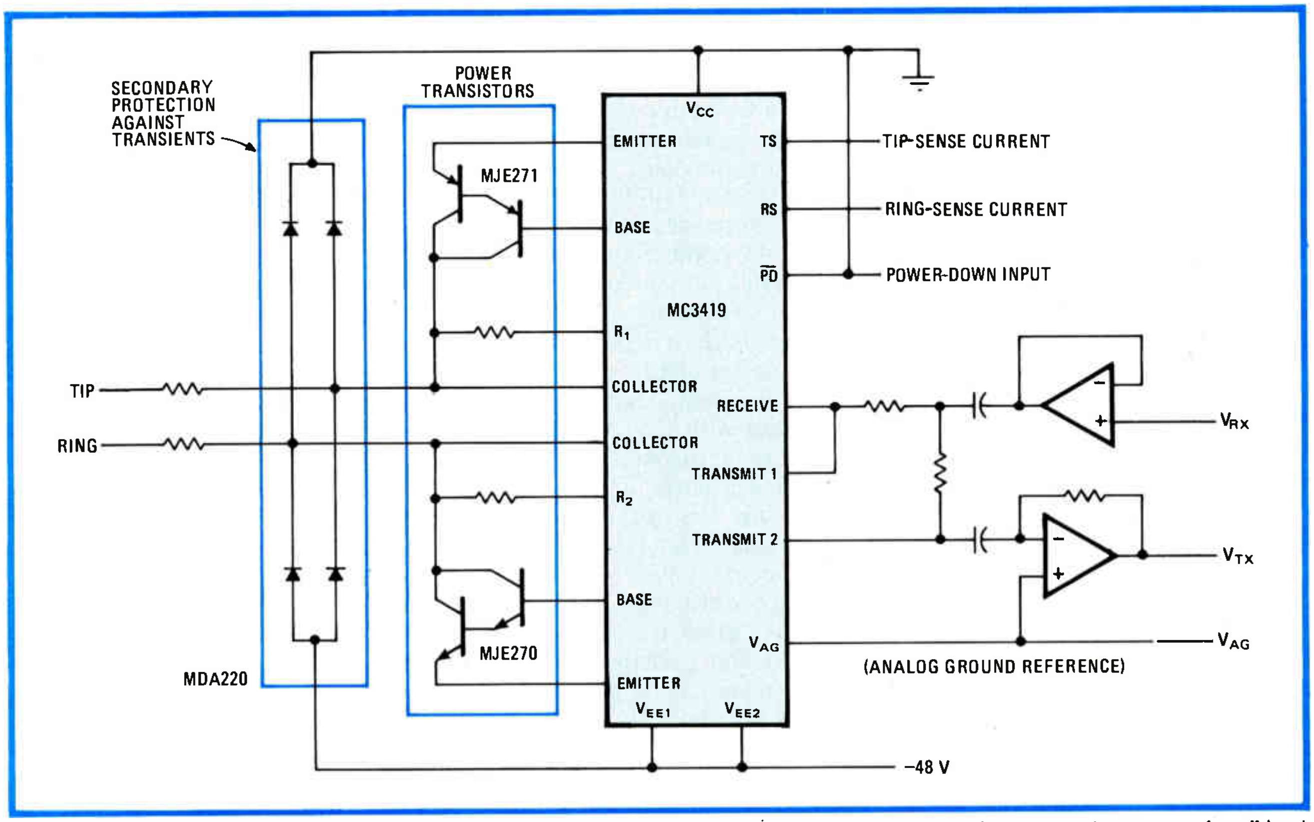
Important links in telephone networks between handsets and branch exchanges are the circuits that condition signals to drive the noisy phone lines. With integrated circuits for digital phone networks coming on strong, chip makers are hard at work on ICs to replace the hybrid transformer that typically performs the conditioning.

Such a chip poses some difficult problems, as the new Motorola subscriber-loop–interface circuit shows. The bipolar MC3419 SLIC [*Electronics*, Sept. 27, p. 33] is a redesign of an earlier IC, and both are based on a patented technique that Signetics Corp. is also implementing.

However, Motorola's Semiconductor Group in Phoenix plans to beat every chip maker to the market with a SLIC. Its 3419 is due to go into production in January. There is also a 3519 with a wider temperature range: −40°C to 85°C, as opposed to 0°C to 70°C.

Tasks. The SLIC's tasks include converting the bilateral two-wire differential signals to the four-wire unidirectional signals necessary for amplification and digital signal handling. Operating from the 48-to-56-volt battery feed supplied at the central office, the chip (see figure) also provides the dc line current powering the phone.

In designing the SLIC and its associated system circuitry, adequate protection must be provided from extreme on-line transients of up to 1,500 V from lightning, as well as from longitudinal signals from short circuits to ground or to 120-V power



Hello there. Motorola's subscriber-loop interface circuit has on-hook power current below 5 milliwatts. Current-sensing outputs for off-hook status come from both tip and ring leads. The SLIC operates from the 48-to-56-volt battery feed supplied at the central office.

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lines. Motorola fabricated devices based on its earlier design [*Electronics*, Sept. 14, 1978, p. 48], but found oscillation problems in the interfaces with the off-chip power devices and difficulty in matching signals at relatively high currents on chip. So the company went into redesign.

Bipolar technology is necessary because MOS cannot withstand the high voltages involved, notes Bill Carns, linear new product planning manager. The 3419 will be fabricated in the company's standard linear high-voltage process, though there are plans to use an advanced high-voltage logic-compatible process that will allow a significantly smaller die size and reduce high-voltage defect density, Carns says.

The Motorola design makes use of a current mirror approach for signal cancellation and matching based on a patent issued to Frank S. Boxall, a Woodside, Calif., telecommunications consultant, who granted an exclusive license to Signetics with provision for a sublicense to Motorola. Each firm has designed its own SLIC but has first refusal on second-sourcing the other's circuit.

At Signetics in Sunnyvale, telecommunications strategic marketing manager Neal Williams says samples of its ST120 SLIC should appear during the second quarter of 1980. He adds that a bipolar coder-decoder, the SI101, is also planned, with samples due in the first quarter.

Difference. The primary difference between the Motorola and Signetics approaches is the latter's decision to integrate the power transistors needed to drive the subscriber line on the SLIC, which Motorola leaves off.

This more conservative approach reduces the die size significantly, says Carns. It also avoids problems associated with on-chip hot spots during power dissipation, which can occur as the line current varies between 20 and 120 milliamperes depending on the length of the loop.

The resulting thermal gradients can play havoc with the matching function, resulting in inadequate separation of the talking and listening channels during two-to-four-wire conversion, asserts Motorola linear marketing manager Ron Campo. "We think that the power devices need to be off the device and that they'll have to remain here for a long time," he says. **-Wesley R. Iversen**

Computers

Honeywell thinks big but 'conservatively'

After two or three years of relative calm, a storm of new products is engulfing mainframe computer makers, carrying them and their technology into the 1980s. The latest company to add to the commotion is Honeywell Information Systems, which has introduced, as expected, four new top-of-the-line computers [*Electronics*, Oct. 11, p. 35].

Included in what is called the new DPS-8 series is the entry-level DPS 8/20 that can have 1 to 4 megabytes of main memory. One step up, the DPS 8/44 is 50% more powerful than the 8/20. And at mid-range is the DPS 8/52, 2.5 times as powerful as the 8/20 and able to support up to 8 megabytes of memory. Almost twice as powerful as any computer previously made by Honeywell and four times more powerful than the 8/20 is the large-scale DPS 8/70, which can hold up to 16 megabytes of main memory and can be ganged in multiprocessor configurations.

Communications, too. To work with the new units the company also announced a communications-oriented operating system, its GCOS 8, that can work in up to eight processing modes simultaneously. In addition, GCOS 8 offers a multiprogramming capability to handle up to 511 concurrent processes, of which 488 can be user processes. Furthermore, it can support multiprocessor configurations of up to four DPS 8/70 computers.

The products are important to Honeywell because of the way they bolster its mid-range mainframes and especially because they expand the product line upwards. Honeywell attempted to expand its line some two years ago with the Level 66 model 85 computer, but problems with its unique current-mode logic chips scuttled the project last year [*Electronics*, March 30, 1978, p. 46].

Conservative. But where several recently announced mainframes—most notably IBM's model 4300 processors and Sperry Univac's 1100/60—were technologically innovative, Honeywell's new processors indicate a more conservative technological attitude. The two smaller members of the line use bit-slice microprocessors to build a

Conservative outfit. Four new DPS 8 computers top out Honeywell Information Systems' mainframe line. The systems are conservative, using standard Schottky TTL.

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microprogrammed execution unit with a four-stage pipeline, but the company declines to reveal details on its proprietary chips.

Apparently leery after being burned by the technology in its large 66/85, Honeywell kept the hardware organization of the two larger DPS 8 machines essentially similar to that of the Level 66. It went to large-scale integrated circuits to reduce the central-processing-unit board count by about 33%, but they are standard Schottky TTL parts.

And where some manufacturers of peripheral equipment are readying the next generation of thin-film head disk drives, Honeywell went with existing head technology and a relatively conventional recording densities of 6,436 bits/inch and 662 tracks/in. for its high-capacity disk drive.

"I suppose you could call the DPS technology conservative," says Dewey F. Manzer, vice president, planning and product management for Honeywell's Large Information systems division in Phoenix, Ariz. "But we feel we made a sound business decision. We chose to achieve our objectives for performance and cost with existing technologies."

To be available in the second quarter of 1980, the systems are priced starting at $400,000 and range up to about $5 million for a fully configured four-processor DPS 8/70 system. **-Anthony Durniak**

Instruments

PROM-like device records rare events

Trying to log rainfall in a desert presents some difficulties. A typical chart recorder could use up an amount of paper out of all proportion to the scarce precipitation. In an attempt to solve this problem, a company in Australia has found what it believes to be a more efficient means of gathering information about infrequent events. Instead of making continuous recordings or even sampling data at fixed intervals, a solid-state recorder logs information only when it is triggered by an event.

The company, Measuring and Control Equipment Co. (MACE), came up with the technique when hired by the Sydney Water Board to provide field recorders for measuring rainfall in remote locations. "They needed a recorder that could run unattended in the Outback," says Lorry Campbell, managing director of the small Epping, New South Wales, firm.

The 10-year-old firm found that traditional recording techniques

Meter eases use of tunable dye lasers

Like Joseph's coat of Bible fame, tunable dye lasers are sources of many colors. Their coherent light output wavelengths are varied by turning dials.

But the dial does not include a direct readout to tell the laser user what the wavelength is. And worse, the complex system of mechanical and electronic instruments needed for the wavelength measurement is often more bulky and complicated to use than the laser itself.

So tunable dye laser operators will welcome a device invented by Renzo Salimbeni and Robert Pole of IBM Corp.'s San Jose, Calif., research laboratory [*Electronics*, Aug. 3, 1978, p. 35]. Their wavemeter is both highly accurate (one part in ten million with a potential for one part in one hundred million) and compact (it fits in a box about 1 foot long by 4 inches square). It will go a long way in improving the convenience of tunable laser experiments. For example, projects studying the properties of the electrons of new materials for electronic applications will become practical and convenient, according to the developers.

In the design of their wavemeter, Salimbeni and Pole (pictured at right) made use of a variation of interferometry. Interferometry involves comparing the phase characteristics of an unknown laser beam with one whose properties are well known. By counting and comparing the "fringes," or interference patterns, that are produced by having the known and unknown beams reflect off moving mirrors, the unknown's wavelength can be determined.

Theoretically, any accuracy can be obtained by counting enough fringes. But this means longer light paths to the moving mirror. In the new device, it is necessary for the mirror to travel only a few centimeters. Earlier interferometer wavemeters needed a meter or so.

To accomplish this feat, Salimbeni and Pole employed a previously known variation known as multiple-beam interferometry. Here the distance traveled by the light beam is effectively increased by making it follow a short course many times over. Specially designed timing and counting circuits are used to keep track of the fringes that are generated and maintain the system accuracy. **-Harvey J. Hindin**

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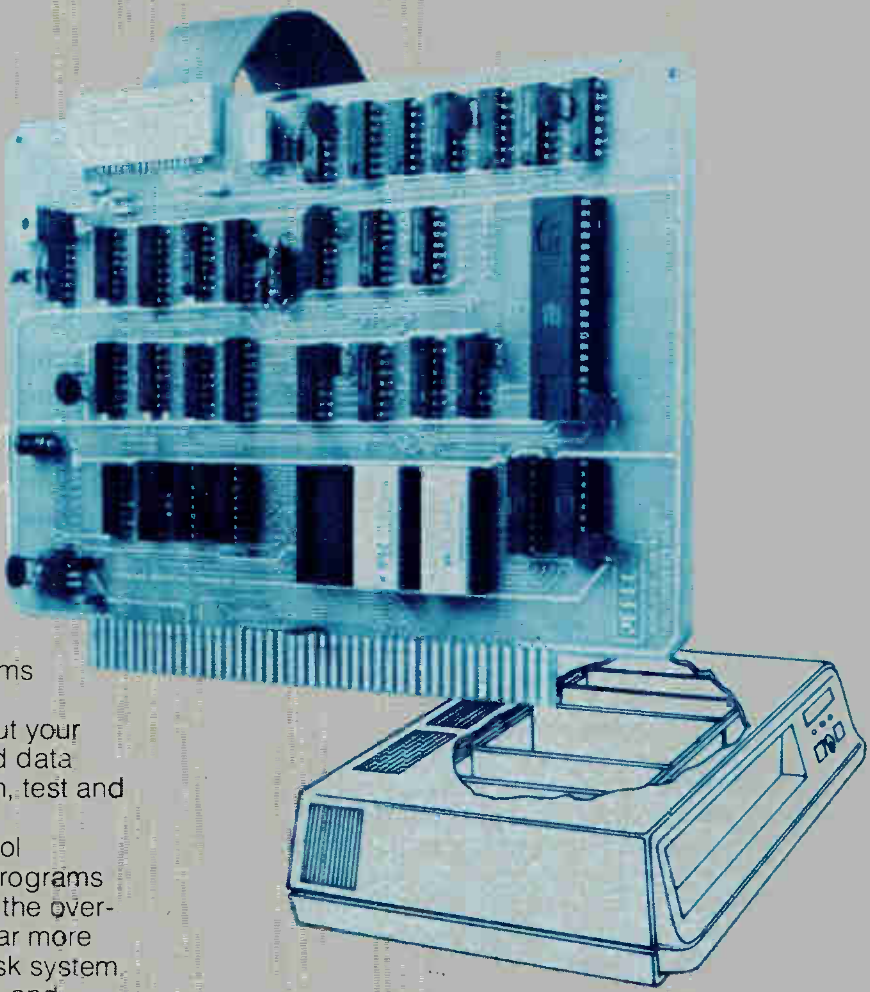

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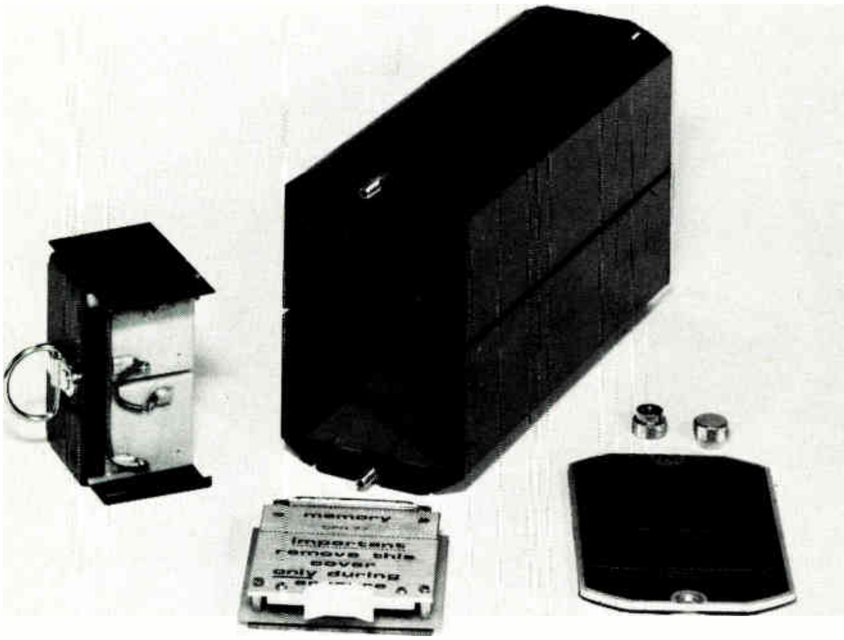

About-face. MACE's solid-state DRF77 records data not as events per unit of time but only during the events. The information is stored in a memory module (bottom, center).

were not practical for precise measurement when several inches of rainfall might be collected per minute but at intervals of several weeks. "Continuous chart recorders with the necessary resolution would generate reams of paper, most of it with no relevant data," Campbell explains. Sampling recorders, on the other hand, could miss the peaks and would still generate waste paper.

MACE's answer to the recording dilemma was the DRF77 event recorder, a device similar to a programmable read-only memory programmer. The 295-by-140-by-93-millimeter unit contains a quartz-crystal oscillator that updates an 8-bit register every minute or two minutes. When the recorder senses an input in the form of a voltage or contact closure (in the case of rainfall, the input is a contact closure generated by the tilting of a cup with an inch of water in it), the binary contents of the register are fed to a dc-dc converter.

The converter raises each logic 1 in the byte to a voltage that burns a 2716 or 2732 erasable PROM. Depending upon which model DRF77 is chosen, up to 4,095 events can be recorded. The standard recording rate is one event every 4 seconds, but the devices can be designed for 20 events per second.

Light maintenance. Aside from the trickle of energy needed to keep updating the complementary-MOS register, the DRF77 needs power only when recording an event. Thus, it works from a 12-volt, 900-milliampere/hour battery and can be equipped with solar cells to keep charge level high. What dictates the need for routine service, then, is memory capacity and timing-register overflow. The latter occurs in 45.5 days with 1-minute resolution or 91 days with 2.

The DRF77's E-PROMs are in a module that plugs into the recorder; the same plug can mate the module to a computer or a plotter interface. Modules can be swapped easily in the field and the whole system can be checked there. An internal test routine started by a front-panel switch lights a lamp when the system is working. After the lamp lights, the same switch can be set to record, thus resetting the register and starting operation. Once the data stored in a module is no longer needed, a cover can be removed and the memories erased with ultraviolet light.

A uniquely Australian aspect of the DRF77 is its color; it is painted black rather than a bright color that could be easily spotted in the wilderness. "If we painted it, say, orange," Campbell jokes, some Outback rancher would use it for target practice." **-Richard Comerford**

Satellites

NASA still expects to fund sat-coms

When all the available slots for placing communications satellites in synchronous orbits are filled by 1990 or 1992 and customer service demands exceed the capacity of C band (4-8 gigahertz) and Ku (12-18 GHz) systems, what will operators do? Move on to a new class of satellites that can handle up to ten times more traffic by using multibeam ground antennas that transmit at 30 GHz and receive at 20 GHz.

That is the answer of the National Aeronautics and Space Administration (NASA) after two years of preliminary study of the concept. But NASA is quick to admit that getting a 30/20 GHz system successfully developed will take at least five more years, much technological innovation, and many millions of dollars—including $8-10 million alone in fiscal 1980.

Challenges. The requirement that a 30/20 system have an end-to-end availability of 0.9999 despite large signal attenuations due to rain is but one of the 30/20 program's big challenges, Robert E. Alexovich, the NASA Lewis Research Center's communications technology branch chief, told the IEEE Electronics and Aerospace Systems Convention (Eascon) in Washington earlier this month.

Another possibility being explored by NASA as part of its return to space communications research and development is direct-to-user communications that bypass terrestrial telecommunications. While the direct-to-user option apears more attractive because of the large costs

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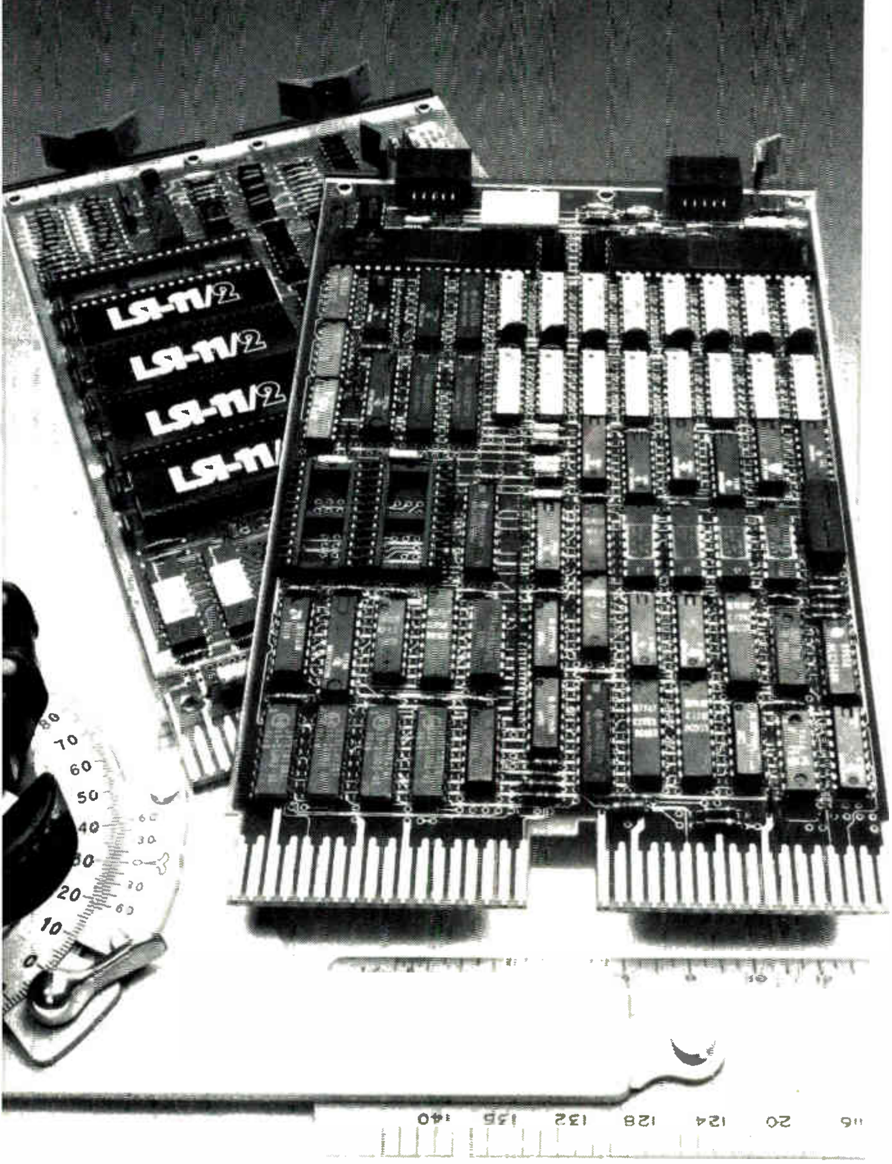

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associated with central offices and their associated access links, NASA has to identify a market that could support the new service because of the high costs per unit of bandwidth, Alexovich explained.

NASA needs. On the technology side, the Lewis communications chief identifies as critical requirements methods for spacecraft data handling and development of low-noise amplifiers, higher-power amplifiers, antennas, and earth terminals. Experimental hardware development in each of these areas is expected to be completed by September, 1982, he said. **-Ray Connolly**

Solid state

Navy eyes VLSI for fault tolerance

The U. S. Navy is set to order full steam ahead on the development of fault-tolerant circuitry to overcome its prime bugaboo—the failure of complex electronics systems caused by unreliable individual parts. It aims at taking advantage of an important benefit of very large-scale integration: on-chip redundancy permitting reconfiguration for backup when failures occur.

Zeroing in on what could be important electronic system improvements, Navy scientists are already revamping architectures to use the advanced devices when they become available in the future. Reliability especially troubles the Navy because increasingly complex shipboard electronics require highly trained personnel and large inventories to keep them working, says Charles E. Holland Jr. As head of the Advanced Applications division at the Naval Ocean Systems Center, San Diego, he spearheads research on how best to exploit VLSI.

Why VLSI? "The ineffectiveness of such classic techniques for achieving system reliability as expensive quality control and extensive parts screening and testing," coupled with spiraling system complexity, gives impetus to the Navy's VLSI effort, says

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News briefs

Transactions made easier by Tandem

Tandem Computers Inc., Cupertino, Calif., has developed a new transaction-processing system software package, called Pathway, that greatly reduces programming requirements and, essentially, makes programs for on-line applications as easy to write as for batch applications. Introduced at Info '79 in New York last week and to be available next February, Pathway provides the necessary procedures, programs, and structures to relieve a programmer of writing time-consuming terminal-handling characteristics. The software package combines a set of special terminal control processes, a new screen-formatting language, a user-controlled application monitor, and an interactive screen-definition facility. Licenses for Pathway are priced at $8,500, plus a $2,000 microcode charge per processor. Also on the way is a new video-display terminal, the TAEEM 6520, that features memory parity and provides data integrity from the display memory for $2,950.

Micropolis aims disk at small end user

Moving to tap another market for its 8-inch fixed-media disk drive, Micropolis Corp., Canoga Park, Calif., plans to sell the drive complete with interfacing, power supply, and the necessary software for plugging it directly into small computer systems. Although the company is not yet delivering the unpackaged drive, introduced at the National Computer Conference earlier this year [*Electronics*, May 24, p. 264], to original-equipment manufacturers in volume, it hopes to have such fully supported versions for end users available within 90 days. The modularized operating software will allow users to interface these drives to microcomputers on the S-100 bus. The smallest 8-in. drive package will sell for under $5,000.

Northern Telecom realigns U. S. operations

In a move that accentuates the convergence of communications and computer technology, Northern Telecom Ltd., the Canadian telecommunications giant, is uniting its U. S. computer products and integrated communications systems sales under the umbrella of Northern Telecom Systems Corp. NTSC was formed last year after Sycor and Data 100 were acquired to direct the Montreal-based parent company's electronic office systems business. Now the two acquired companies fall under the computer systems group, one of five formed at NTSC. The business communications group will be responsible for such products as the Pulse private branch exchange and SL-1 digital business communications system. The remaining three groups are for customer services, international business, and distributor sales. The other U. S. subsidiaries will continue in their present roles—Northern Telecom Inc. serving the common carriers and Northern Telecom Electronics Inc. supplying electronic components for the parent firm's manufacturing operations.

Memorex courted by Storage Technology

While still talking of merging with Amdahl Corp. of Sunnyvale, Calif., Memorex Corp., in nearby Santa Clara, has attracted another suitor—Storage Technology Corp. The producer of computer data-storage subsystems based in Louisville, Colo., proposes to trade between 1.33 and 1.55 shares of its common stock for each of about 8 million Memorex shares. Amdahl's offer is to trade 1.2 shares of its common stock for each Memorex share. Memorex chairman Robert C. Wilson says that when he presents STC's offer to his board of directors, he will recommend against it. Memorex builds computer peripherals that are plug-compatible with those of IBM.

Holland. "We've had to look at new approaches."

Most promising is fault-tolerant computer architecture, in which self-correcting techniques use redundancy to achieve high reliability. The Air Force already has a program to build an airborne computer that can keep operating, without outside help, by detecting and diagnosing faults

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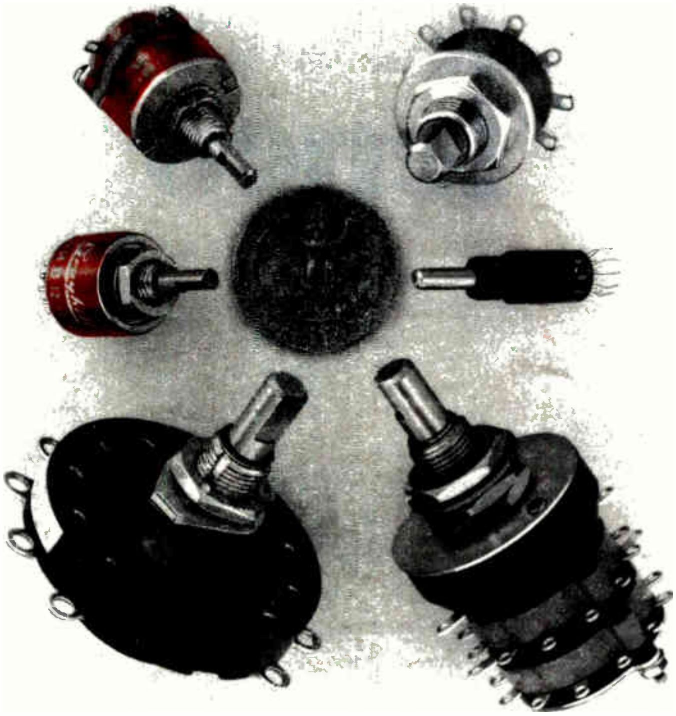

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and taking corrective action [*Electronics*, Sept. 14, 1978, p. 41]. It uses only LSI circuits, however.

Even with LSI, problems of cost, size, weight, and volume can keep fault tolerance out of military systems. "VLSI can remove these impediments," predicts Holland.

To implement the fault-tolerant architecture, the Navy is designing a standard building block called the self-checking computer module. In these modules—which the Jet Propulsion Laboratory, Pasadena, Calif., is helping to develop—will be combinations of commercial VLSI memory and microcomputer logic and four custom VLSI circuits to provide the fault-tolerant features. These are:

- An error-detecting-and-correcting memory interface.
- A programmable bus interface.
- A core computer.
- Input/output circuitry.

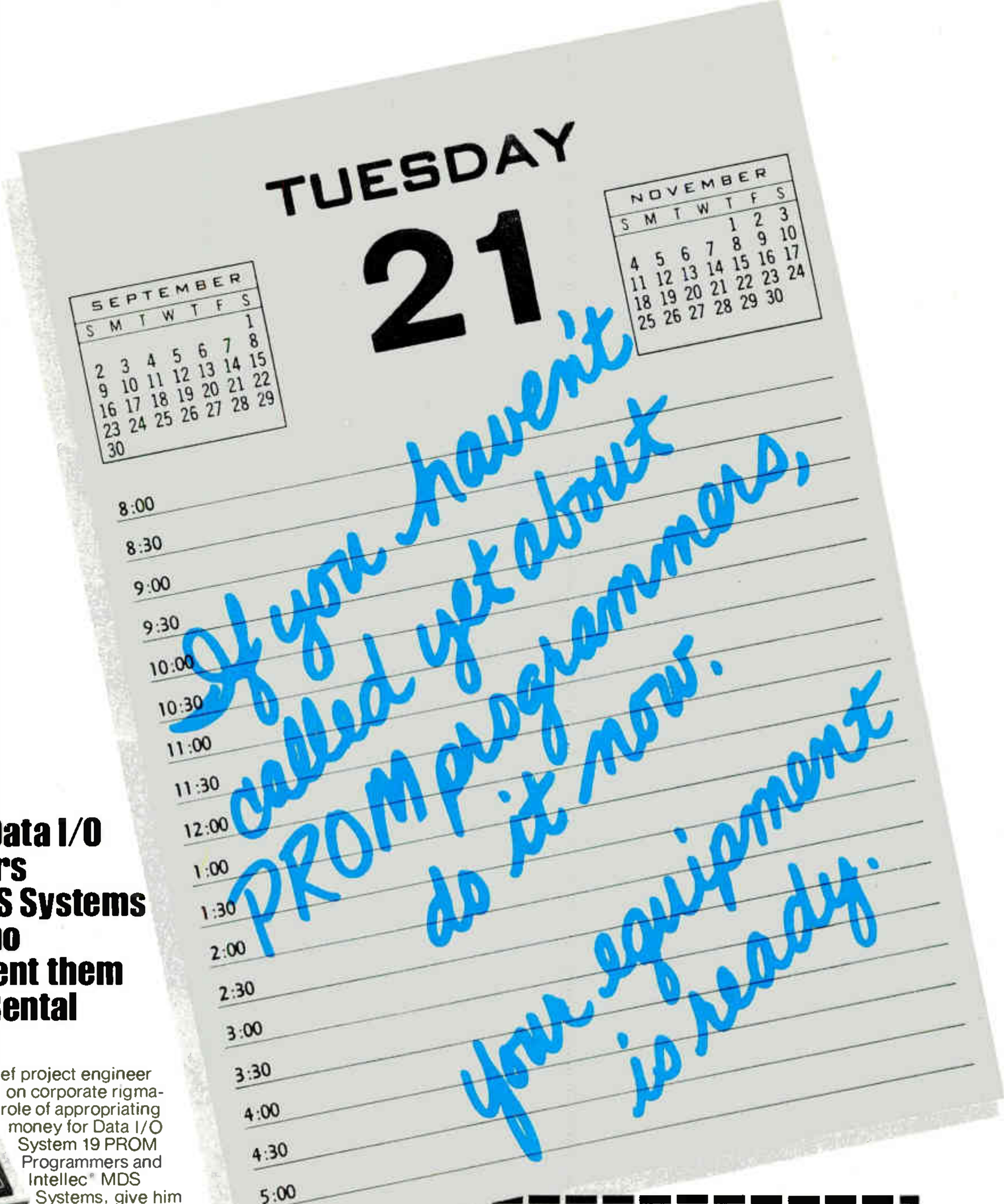
"The first three are being built on circuit boards and will be tested this year," says Holland. The I/O unit will await a specific application to be turned into hardware.

Although the Navy is pushing the self-checking modules for now, the big payoff with VLSI technology is probably still a long way down the road. "This is adaptive wafer-scale integration involving the fabrication of a complete fault-tolerant computer on a single silicon wafer," explains Holland.

Ideal solution. By adding special interfaces to such wafers, commercial VLSI central processing and memory units could easily be designed into fault-tolerant systems.

However, the only serious work on the adaptive wafer concept is by some system firms, and "frankly," Holland says, "not enough resources have been put into it." Semiconductor firms, with the best expertise, show little interest, since they concentrate on high-volume, he asserts.

An industry spokesman points out that the best potential source of funding for adaptive wafers is the Pentagon's VHSIC (Very High Speed Integrated Circuit) program, now stalled by funding debate in Congress. **-Larry Waller**



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Washington newsletter

Justice may open way for AT&T to compete in EDP

The Justice Department is backing away from its rigid opposition to letting American Telephone & Telegraph Co. into the unregulated markets for data-processing services and associated equipment. The softening of the Justice Department's position against modifying the 1956 antitrust consent decree, which limits AT&T to regulated common-carrier services, has stunned the giant company's potential competitors in the computer and telecommunications industries. **They suspect Government lawyers are bending to increasing White House and congressional pressure** to settle the latest antitrust suit, now more than three years old (see p. 58). The disclosure by the department that it is considering modifications of its consent decree came in a late filing of the department's comments to the Federal Communications Commission regarding its Second Computer Inquiry. The Justice Department said that letting AT&T into the market could lead to "more effective competition."

Fubini labels U. S. command and control programs a failure . . .

American military command and control programs have been "a failure" because the commanders who would use the resulting systems have not been obliged to help develop them, so that system architectures have failed to meet their needs, the chairman of the Defense Science Board has charged. As a result, "we have weapons that we do not know how to target," says Eugene G. Fubini, who held various high-ranking posts in the Defense Department before assuming the DSB chairmanship for the second time. He predicts that U. S. military command and control efforts **will continue to fail until participation by the relevant commands in systems design and development is made "compulsory and continuous."** Users must change their thinking that such systems can be procured as if they were "a rocket, a gun, or some other weapon," for successful system decisions "cannot be made by a Fubini sitting behind a Pentagon desk, but by the users." Fubini delivered his criticisms at this month's Electronics and Aerospace Systems Convention (Eascon).

. . . but blasts Congress for killing the TOS battlefield computer

The Eascon audience listened attentively as the Defense Science Board chairman—a confidant of Defense Secretary Harold Brown, who was a Fubini protégé early in his career—took a shot at Congress for its mid-October cutoff of all $37 million in fiscal 1980 Army funds for the troubled Tactical Operations System's battlefield computer being developed by Litton Systems. **"Cancellation is not the way to fix the problem,"** said Fubini, despite the fact that "very competent" congressional military committee staffs "correctly diagnosed" the Army's TOS problems. "The treatment is lousy" for a program evolving for 16 years, he added.

No more freebies for ANSI standards committee members

All members and observers on the computer and office equipment standards committees of the American National Standards Institute will have to pay their own way from now on. That is the word from the Computer and Business Equipment Manufacturers Association, which says it can no longer afford to pick up the tab for the two ANSI committees, whose 1980 budget is expected to exceed $200,000. **CBEMA proposes annual membership charges of $2,500 and $1,500,** respectively, for the X3 (computers and information processing) and X4 (office machines and supplies) committees. Liaison observer fees would be $1,250 and $750 for the respective bodies.

Washington commentary

AT&T's assault on military IR&D records

American Telephone & Telegraph Co.'s antitrust combat brigade has surrounded the Department of the Army's Materiel Development and Readiness Command in a new battle that could win the company's three-year-old war with the Department of Justice. The immediate prize is access to Darcom's 50 file cabinets filled with classified and proprietary corporate data on independent research and development, as well as corporate bid and proposal cost histories and projections.

Pentagon insiders are afraid the Army will lose the battle when it is decided at the end of this month by Judge Harold H. Greene in the U. S. District Court for the District of Columbia. The betting now is that AT&T will gain access to Darcom's IR&D records as part of the company's rights of discovery to prove that other companies have in fact pursued telecommunications research, development, and marketing in areas that AT&T is charged with monopolizing.

The threat to industry

The consequences of a forced Darcom disclosure go far beyond what happens to AT&T, important as that is. The precedent, once established, undoubtedly would be applied throughout the Army, Air Force, Navy, and National Security Agency, as well as to the IR&D records of the Department of Defense. Those records would bare "the financial and technological souls" of the nation's military electronics and aerospace contractors, says Army lawyer Terry J. Kolp, who is arguing the Darcom position. The result of such a disclosure, Kolp contends, would seriously impair the competitive position of companies in future dealings with AT&T despite the telecommunications giant's "vague agreement" with the court last year to protect and not abuse whatever it may turn up in the discovery process.

To combat the AT&T forces on the IR&D access issue, Kolp, working with Justice Department antitrust lawyers, is seeking a protective order for the records from Judge Greene, as well as a ruling that legal privilege can be invoked to prevent disclosures of proprietary corporate information, some of which carries military security classifications. If Judge Greene rules against Kolp and his client Darcom, the Army will find itself entangled in a mess reminiscent of Catch-22.

The IR&D data in Darcom's files is the property of the companies that filed it; Darcom is merely the custodian and trustee. It is a criminal offense subject to severe penalties for anyone with access to the data to reveal it. So what could Darcom do? Kolp responds uneasily, but concedes in answer to specific questions that a company could legitimately request to have its IR&D file returned. The files, he admits, are not so widely scattered that such requests would be impractical.

The national security threat

Requests for file returns are one option being weighed by corporate lawyers and the members of the Council of Defense and Space Industry Associations, who are still developing a plan to cope with this new problem. Among them are the Aerospace Industries Association, the American Electronics Association, the Electronic Industries Association, and the National Security Industrial Association. Some of their lawyers suggest that companies, acting individually or through their associations, could either seek an injunction against disclosure, citing appropriate guarantees of protection in existing law, or register their opposition to disclosure with Judge Greene in briefs filed as a friend of the court (*amicus curiae*).

A number of ranking Pentagon leaders are clearly troubled by the new AT&T assault, convinced that it has serious ramifications for the nation's future security. As one of them explains, "We use IR&D data to guide us in trying to make intelligent decisions on structuring the national defense. Industry cooperates by letting us assess the state of the art in many fields so that we can know what technology is available and what looks promising but needs more support and so we can plan on what systems to buy and get a handle on what they will probably cost. Those files are invaluable. The United States will be chin-deep in trouble if that resource is exposed. Exposing it will destroy it. And we probably could not rebuild it because most companies would never provide us with any proprietary data again."

When that supercharged argument reaches the White House, it is sure to compound the growing political pressure on the Justice Department to settle the AT&T antitrust action as quickly as possible. The other side of the coin, one senior industry lawyer believes, is that "AT&T stands to reap a technological and economic bonanza if it gains even limited access to company IR&D records. The long-term payoff would more than offset their legal fees for this whole case—fees, by the way, that are going to be passed along to consumers in any event."

Either way, it seems AT&T can't lose.

-Ray Connolly

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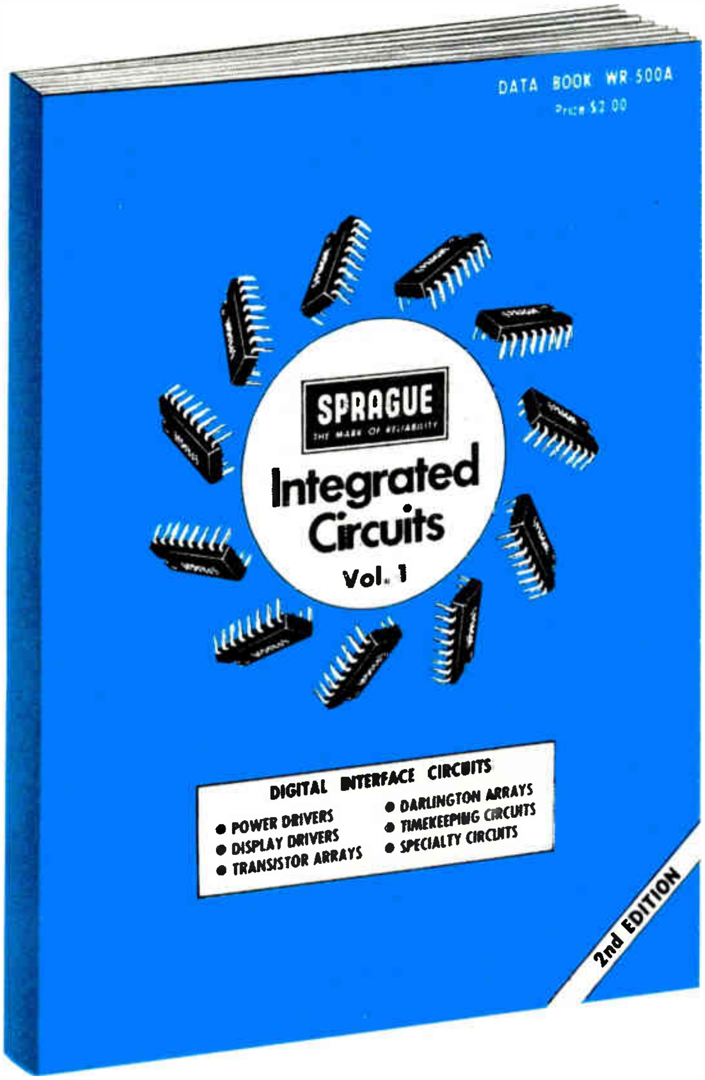

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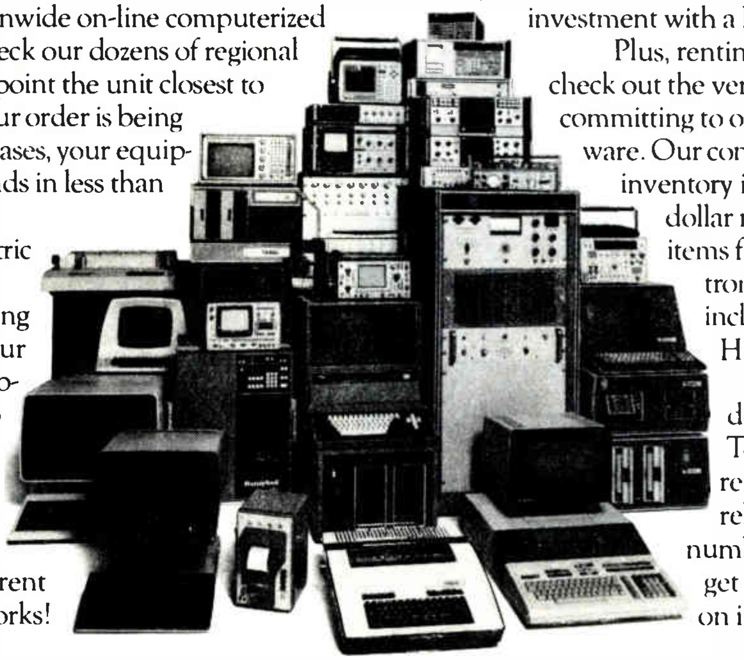

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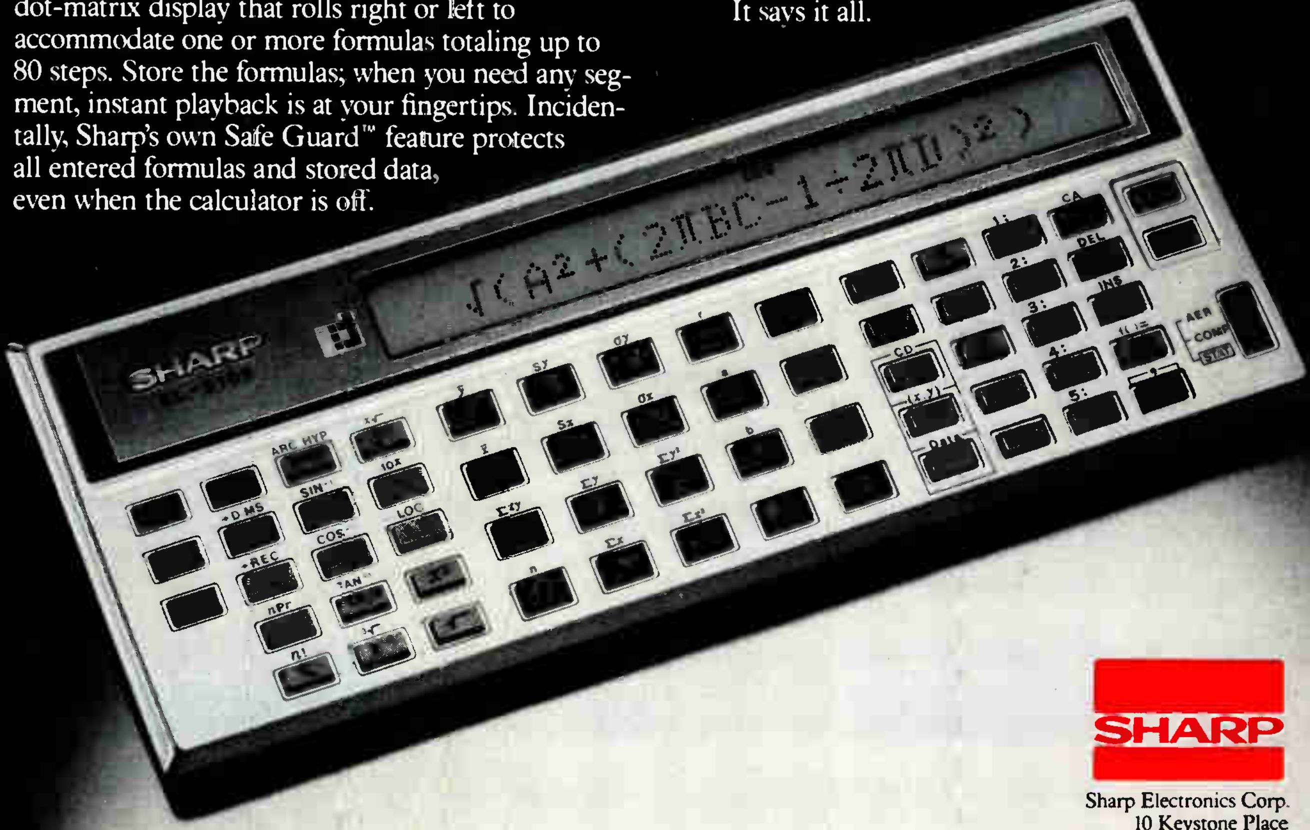

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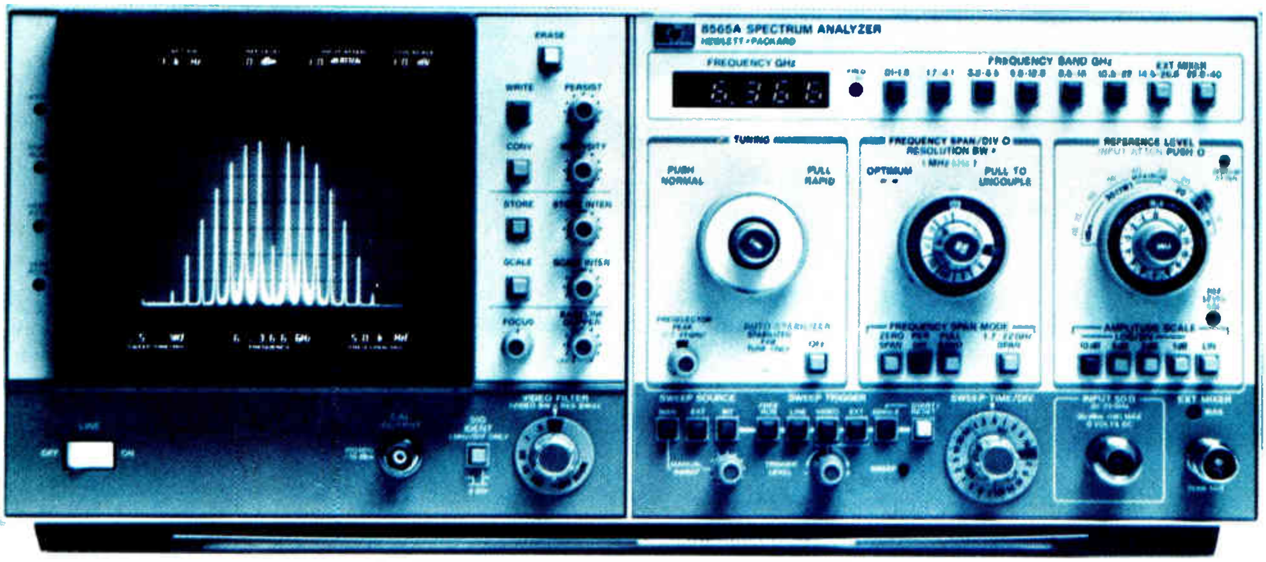

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International newsletter

Japanese commercial speech-synthesizer set being readied

Japan's first commercial speech-synthesizer chip set has been designed jointly by the Yokosuka Electrical Communication Laboratory of Nippon Telegraph and Telephone Public Corp. and Hitachi Ltd. Initial product offerings from Hitachi will include a hand-held unit to read out figures for practice calculations on the soroban—the Japanese version of the abacus—and a clock-radio that announces the time and confirms clock settings by voice announcements. The p-MOS set comprises a digital speech synthesizer chip, a 128-K mask-programmable read-only memory chip, and a 4-bit single-chip microcomputer. All three work from a single −10-V power supply. **Operation is based on the Parcor (partial autocorrelation) principle**—employed earlier by NTT's Musashino Electrical Communication Laboratory [*Electronics*, May 24, p. 69]—which is similar to the linear predictive coding technique used by Texas Instruments. The inclusion in the digital lattice filter of attenuation, as well as multiplication and addition, permits synthesis of a female voice.

UK electronics industry may be in line for major shakeup

Britain's fragmented electronics industry could be heading for a serious restructuring following **a first move by Thorn Electrical Industries Ltd., with nearly $1 billion in sales, which is bidding for troubled EMI Ltd.** EMI, with sales of almost $1 million, has lost over $54 million in the last two years on its computerized axial tomography, or CAT, scanners, and its record-business profits have also taken a nose dive. The move by Thorn could also flush out counterbids by Britain's General Electric Co. and Racal Electronics Ltd. Ferranti Ltd. and Decca Ltd., which is also taking losses, are soon to be sold off by Britain's National Enterprise Board and could also be takeover targets of Racal or GEC. EMI's board of directors has agreed with the logic of the merger but has rejected the $330 million Thorn offer, saying the price should be higher.

Philips to test 103-km continuous fiber-optic cable

Felten & Guilleaume AG, a Cologne-based affiliate of NV Philips Gloeilampenfabrieken in the Netherlands, has installed what it believes to be **the longest optical transmission line yet in place.** The line, with a total length of 103 km (about 64 miles), will be used by Philips for trials and demonstrations in the Dutch town of Huizen, near Hilversum. It is built up from 16 spliced cable sections, each about 1 km long and containing six glass fibers. The gradient-profile fiber, only 0.1 mm thick, has an attenuation of less than 4 dB/km, a value that includes the attenuation of the splices. The line sports a bit rate of 140 Mb/s, allowing the simultaneous transmission of 1,920 telephone channels.

French devise engine-knock sensor for electronic ignition

A sensor to detect engine knock that can be integrated into a fully electronic ignition system has been developed by researchers at the Société pour l'Equipement de Véhicules (SEV), in the Paris suburb of Bagnolet. **The sensor is an accelerometer bolted onto the cylinder head,** with its acceleration mass held by a spring against a piezoceramic button. Engine knock causes the cylinder head to vibrate in the 5-to-10-kHz range. These vibrations result in a voltage of 10 mV plus at the sensor's output terminals. The output signal is processed by a bandpass filter to eliminate frequencies from other sources. It may then be fed to a microprocessor, where it would be combined with data from other sensors to calculate the optimum engine timing advance at any given moment.

Nexos adds three pieces to word-processing jigsaw puzzle

Nexos Ltd., the electronic office-equipment subsidiary of Britain's National Enterprise Board, has bought Ultronic Data Systems Ltd., a British word-processing marketing firm, for $2 million from the Dowty group of companies. The purchase is the latest in a series of moves aimed at assembling a complete range of advanced office equipment integrating voice, text, and data systems. Nexos, based in London, now has agreements with Muirhead Ltd. to market its facsimile equipment; with Logica Ltd., a software systems company, to market its word-processing systems and computer programs; and with Delphi Communications Corp., an Exxon subsidiary based in Los Angeles. The last agreement gives Nexos European marketing rights to the company's Delphi 2 multiprocessor communications system, in which up to 32 processors can be linked by dual data buses running at 120 Mb/s. Ultronic, in Thames, Oxford, markets low-end word processors and fast printers manufactured by Ricoh Co. of Japan, which will complement the top-of-the-line systems marketed by Logica. **Together, Nexos claims the two systems give it a 19% share of the UK word-processing market.**

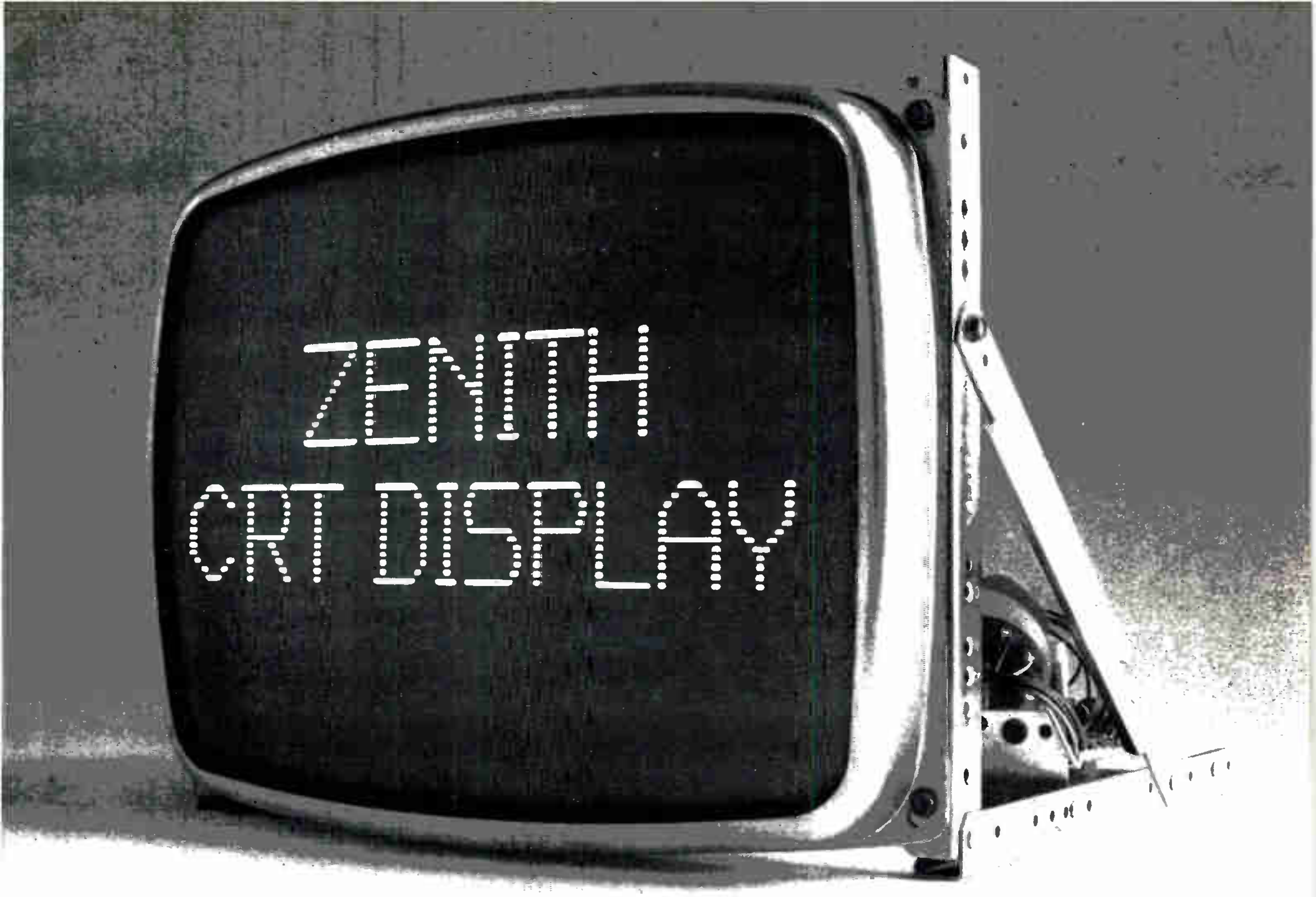
NEC and NEC–Toshiba fill out their response to IBM's 4300 series

Three new ACOS series computers complete the response by Nippon Electric Co. and NEC–Toshiba Information Systems Inc. to the IBM 4331 and 4341 begun in February [*Electronics*, Feb. 15, p. 63; March 1, p. 68] and extend the new lines' capability to midway between the IBM 3031 and 3032. NEC says it is not trying to race ahead of IBM but rather is supplying models that its customers have requested.

The new **computers feature 1,200-gate current-mode-logic chips that are instrumental in reducing logic package area to one twentieth** that of previous computers. Also prominent are extensive firmware replacements for system software and a Japanese-language Information Processing System package. Deliveries of the ACOS system 550 will begin in January and of the ACOS 350 and 450 in July. The purchase price of the system 350, which processes a half million instructions per second, starts at some $383,000; the 1-million-instruction-per-second system 450 starts at about $862,000; and the system 550, handling 1.7 million instructions per second, starts at roughly $1.63 million. These prices include system software, which is mostly unbundled.

Olivetti sets up computer system marketing arm

Original-equipment computer manufacturers will have a new customer to court in Europe. Ing. C. Olivetti & C. quietly formed a new company last month: Olivetti Computers SpA. The subsidiary, like the parent firm to be located in Ivrea, northeast of Turin, has not yet been staffed, nor is it yet operating. Its medium-term objective, says a spokeswoman, is **to market, but not develop, large and medium-scale computer systems.** Olivetti is investigating the possibility of establishing an OEM agreement or joint ventures for marketing these systems throughout Western Europe. Contacts have been made with several suppliers, but no decision has so far been made on the matter. The firm will not be writing its own software, it says. Previously, Olivetti distributed intelligent terminals from Sycor Inc., Ann Arbor, Mich., but phased out the agreement about a year and a half ago.



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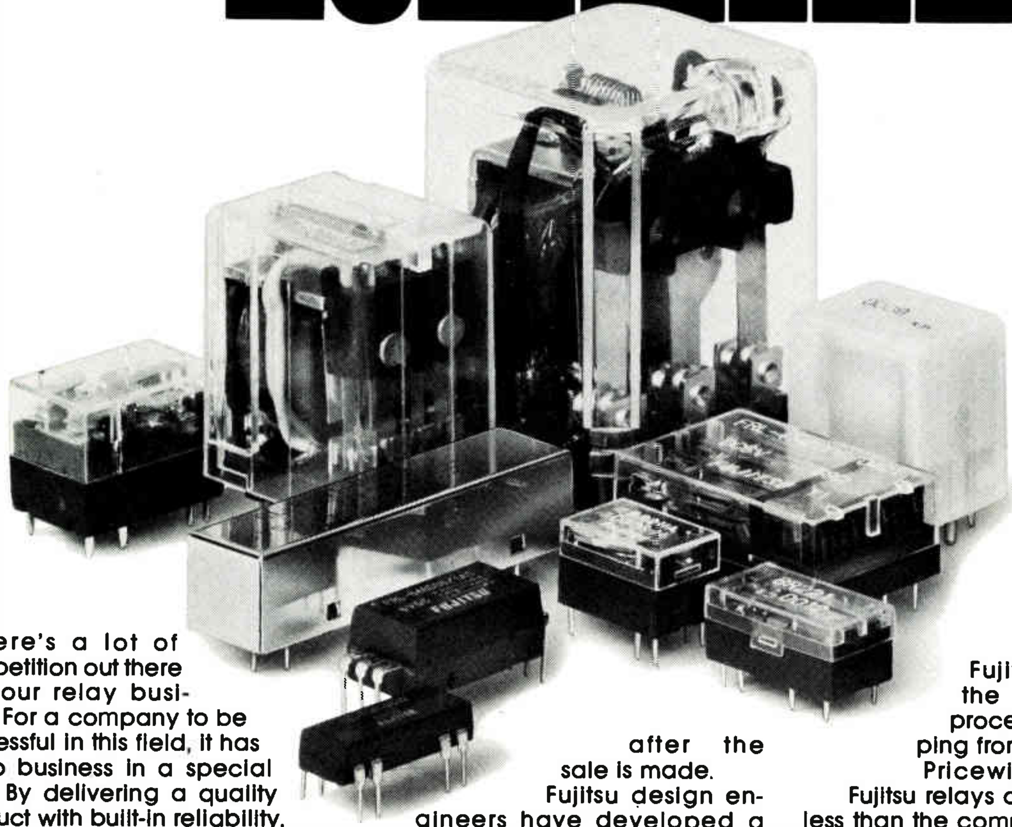

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AND CAPACITORS AND CONNECTORS AN

Nearly all-modular color TV chassis makes repairs simple

by John Gosch, Frankfurt bureau manager

Unit accepts virtually all peripheral TV gear; metal-encased modules withstand rough handling

Figuring that success often breeds success, Grundig AG has made its second major advance in television chassis design. In its Super Color 80 TV sets coming out this fall, the Nuremberg company is using a single-frame chassis with 12 metal-clad modules and a layout that strongly resembles that of a professional piece of equipment. The modules contain the set's entire circuitry except a few big components like the line transformer and the high-voltage cascade.

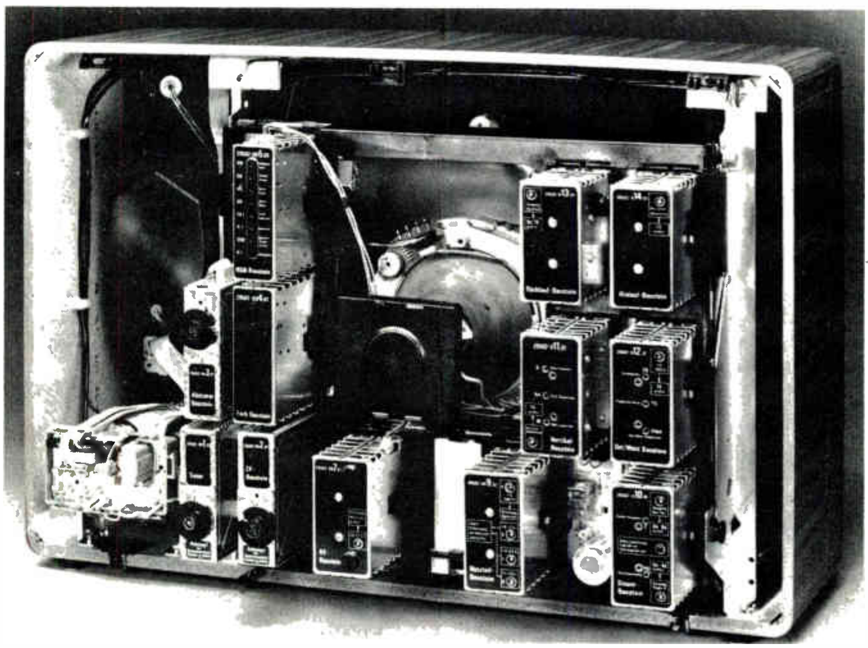
The almost 100% modularized chassis follows a 75% one that Grundig introduced about seven years ago. Because of its service-enhancing modular construction and streamlined design, the earlier chassis has helped the firm maintain its leading position among West Germany's 10-odd makers of television receivers. In subsequent years, color sets using it were continually updated to incorporate innovations such as automatic station search, infrared control, station computer circuitry, and digital channel selection [*Electronics*, Aug. 21, 1975, p. 59].

Accepting. Besides putting the modules in a metal package—unusual in TV engineering—the firm's designers have made receiver versatility a high priority. The Super Color 80 sets, with screen sizes of up to 27 inches, can accept virtually all currently available TV-related peripheral equipment like video recorders, programmable video games, home computers, extra loudspeakers, and black-and-white and color cameras. In addition, they can accommodate videotext decoders and other text-related devices that may come along. The peripherals connect to the set either by way of terminals on the modules or via a slot on the receiver's front panel.

The top-of-the-line series 80 models incorporate a tuning module using phase-locked-loop frequency synthesis. Its memory can store up to 30 station numbers and the frequencies of as many as 100 TV channels. Other models in the series use a tuning module with an automatic search feature for up to 16 station numbers. The frequency synthesis, the automatic search, and the memory are implemented with integrated circuits from Siemens AG and Texas Instruments Inc.

Sturdy. The design of the modules is noteworthy for several reasons. The metal housing of the 10-centimeter-tall modules protects against rough handling that may occur during shipment, set manufacturing, and servicing. Spring-type snap hooks and foolproof plug-in contacts ensure a tight fit and enable the modules to stand up well to shock and vibration.

Still another advantage of the metal package is that it prevents the modules from emitting electromagnetic radiation to the outside and shields them against electrical interference from amateur or citizens'



Modularized. Grundig's new color TV chassis is almost completely modularized for easy repairs. Green and red LEDs on the modules indicate whether the circuits are working.

band radios, electric appliances, and other sources. What's more, with the metal package specially sealed, service men can tell whether or not the set owner has tampered with the module—an important consideration in settling warranty claims.

Moreover, the metal package serves as a heat sink, with air slits in the package providing additional cooling to handle the 110 watts dissipated by the chassis. The cooler operation enhances set reliability and operating life.

Service time is drastically reduced, as a defective module can be easily replaced. Furthermore, the modules are well labeled to identify their function. Red and green light-emitting diodes on the face plate tell which circuits are functioning properly and which are not, allowing a service man to locate troubles at a glance. After a module's rear plate is removed, the circuitry and components are readily accessible.

Japan

Heterojunction emitter multiplies transistor's current gain by 50

Sony Corp. has built silicon npn transistors with the same emitter area as conventional npn transistors but 50 times the current gain. The power transistors are the first active silicon devices to employ a heterojunction emitter, even though the theoretical benefits of such junctions have long been known.

The transistors are fabricated using a highly phosphorus-doped low-resistivity variation of semi-insulating polycrystalline silicon (see figure), which Sony calls Sipos [*Electronics*, May 15, 1975, p. 29].

Energies. Heterojunctions are junctions between two materials having different bandgap energies, as opposed to the homojunctions commonly used, in which bandgap energies are identical. Sony uses Sipos because it has a much wider energy gap than silicon.

Besides the much greater current gain, they can also provide transistors with such advantages as a 90% decrease in base resistance and a fivefold increase in current capacity per unit area over present devices.

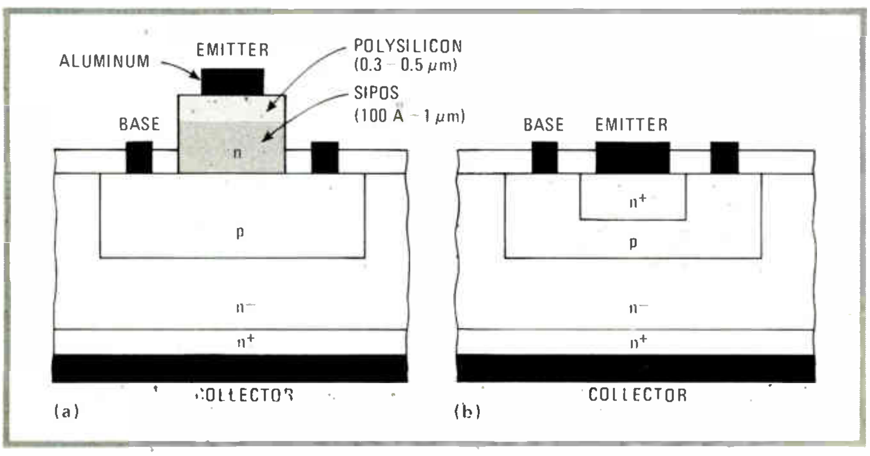
These advantages result because the heterojunction emitter provides a barrier to the injection of carriers from the transistor's base into its emitter and consequently makes it possible to increase the doping in the base region without degrading other characteristics. Higher doping and the ensuing higher conductivity in the base region lower the extrinsic base resistance, a parasitic parameter that decreases frequency response and gives rise to emitter current crowding.

Two other undesirable effects are also greatly reduced. One is the Early effect, in which base layer thickness is modulated by the collector signal and gain is reduced. The other is collector reach-through, which lowers the breakdown voltage.

The barrier to the flow of carriers from the emitter to the base and to the flow from the base to the emitter in a homojunction transistor are identical. Thus the only method of controlling the relative flow of carriers is by controlling the carrier concentration.

Higher. But with a heterojunction, the barrier height is higher for carriers leaving the base, permitting a higher level of doping in the base while maintaining the same emitter efficiency. The additional barrier height is maintained even if there is out-diffusion from the Sipos layer to give an n-n isotype heterojunction transistor.

Sony intends to make such devices as audio power-output, TV horizontal-output, and low-noise audio transistors for various consumer applications. **-Charles Cohen**



Creating a gap. Sony forms a heterojunction emitter in an npn transistor using a semi-insulating polycrystalline silicon, Sipos, that has a wider energy gap than silicon. In a homojunction transistor (b), the bandgap energies are identical.

Great Britain

Researchers discover superfast optic switch

A nonlinear optical effect discovered by a research group headed by Prof. Stanley Smith at the department of physics of Heriot-Watt University, Edinburgh, might one day provide the missing components for an optical computer 1,000 times faster than today's machines. The effect, in which light is made to switch an indium-antimonide crystal into a highly transmissive mode at picosecond speeds, could be exploited to construct bistable optical storage elements and logic gates. A related phenomenon could make possible optical transistors, according to Da-

vid Miller, a member of the team.

The effect was discovered in the laboratory a few months ago, and, says Prof. Smith, reporting at a recent meeting of the British Association for the Advancement of Science, "all the consequences remain to be digested." But the work raises the possibility of an alternative technology to Josephson junctions, seen by IBM as a possible superfast logic of the future.

Running out. The fastest emitter-coupled logic now operates at subnanosecond speeds, but this technology is rapidly running out of steam and further speed improvements will probably require a shift to higher-mobility gallium-arsenide circuits. In contrast, Miller says, optical systems could increase speed by two or three orders of magnitude.

Right now, like Josephson junctions, the indium-antimonide crystal has to be cooled by liquid helium. However, says Miller, their theory indicates that it should be possible to operate at room temperature.

Most optical nonlinearities occur at very high laser power densities on the order of 1 megawatt per square centimeter. Smith's group, though, has discovered variations in the refractive index of indium-antimonide crystals at power levels of 100 watts/cm^2 and achieves switching actions using carbon-monoxide lasers putting out 10 milliwatts.

When operated as a switch, the crystal forms a Fabry-Perot interferometer (an optical resonator). It switches from a blocking to a transmissive mode when the resonating light is reflected from the inner surface, reinforcing the incident wave. Altering the refractive index of the crystal changes the wave velocity through it and thus the wavelength.

Switching. The effect of increasing intensity on optical thickness (in wavelengths) is so large that the resonator can be made resonant with the laser beam simply by altering the latter's intensity. As this occurs, the internal field builds up quickly, thus accelerating the process till the device switches suddenly to a higher transmissive mode. In fact, the group does not have equipment fast enough to measure the transmission speeds, but it believes they are on the order of 10^{-12} second.

On reducing intensity, however, the large internal intensity is already established and therefore can hold longer as the external field is reduced. This, says Smith, "provides a hysteresis effect, or optical bistability" that could be employed for optical data storage.

For the "optical transistor" two light beams are needed. The change in the main beam is far greater than that for the auxiliary, giving useful power gains. Multiple OR gates can be assembled in a similar way by adding beams.

The work is so recent that the group has not yet attempted to build working devices, but Miller believes it should be possible to construct all the components needed for an optical computer. In such a system, an auxiliary beam would bias the crystal components to the required operating point. A system clock, for example, could be formed by feedback between two bistable switches for optical transistors.

In addition, potential applications exist in wideband communication systems, as well. **-Kevin Smith**

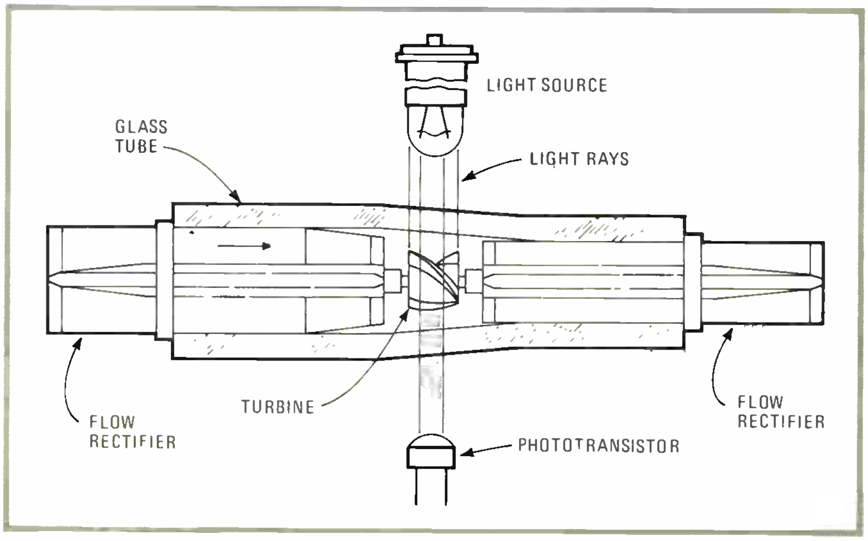
West Germany

Turbine and photosensor determine car's instantaneous fuel-flow rate

A new type of hydroelectronic device that provides data for an indication of a vehicle's instantaneous fuel consumption will be available soon. Coming from VDO Adolf Schindling AG, primarily a maker of dashboard instruments, the engine-mounted device can be a valuable aid in saving fuel, the firm says.

The conventional method for determining fuel consumption per mile or kilometer is to figure out how much fuel was used for the distance driven between two tank fillings, but this scheme yields only an average value. More useful for fuel-efficient driving is knowing the instantaneous value of consumption. Shown on the dashboard display in terms of miles per gallon or liters per 100 km, this indication would serve the driver as a criterion for adjusting his speed or shifting his gears in order to use the least amount of fuel at all times.

Simple. The result of a years-long development effort, the company's



Enlightened. Gas flowing through VDO Adolf Schindling's Turbo-Sensor turns turbine's blades; phototransistor senses blades' rate of revolution, hence fuel flow.

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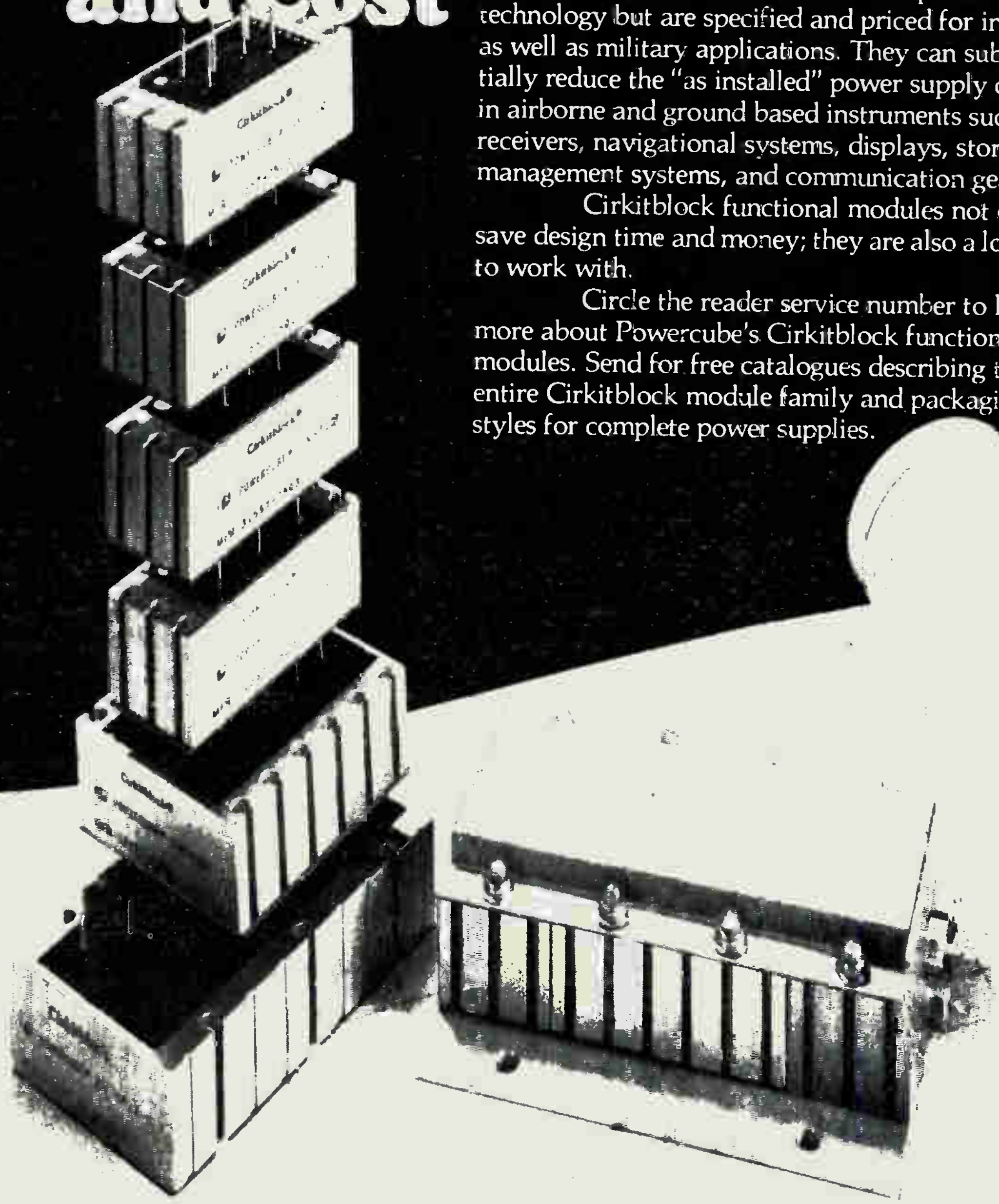

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new device, called the Turbo-Sensor, is based on relatively simple operating principles. It required painstaking engineering, however, to adapt it to the rough environments encountered around the engine and to the different kinds of fuel used in automotive vehicles. Significantly, it can be employed on both fuel-injection and carburetor engines.

Functioning as a volume meter and installed in the vehicle's fuel-supply line, the Turbo-Sensor incorporates a small axial turbine (see figure). Its blades are turned by the fuel flowing through the line, the rotational speed being a measure of the amount of flow.

The turbine is contained in a transparent glass tube and is suspended between two elements that serve as both turbine bearings and flow rectifiers. The latter prevent any liquid turbulences from being set up in the sensor.

The turbine's rotational speed is sensed optoelectronically by a light source and a phototransistor mounted opposite each other and outside the glass tube. The slower (or faster) the turbine blades rotate, the fewer (or more) light pulses are generated and hit the phototransistor. The latter's output therefore corresponds to the fuel flow. The device determines the flow to within ±1 liter of fuel traveling through the supply line in one hour.

The output is fed to a dashboard-mounted instantaneous fuel-consumption indicator or an on-board car computer for calculation of the consumption rate and display. Calibration can be done at either the factory or the service station.

In the U. S., General Motors Corp. last year offered a fuel-consumption indicator as part of an optional trip computer on some Cadillac models and has made it a standard feature on 1980 Eldorados. In this case, the flow-rate sensor is linked to a microprocessor-controlled fuel-injection system to display both instantaneous and average fuel consumption.

A pulse is transmitted as long as an energized injector is open, its length therefore indicating the amount of fuel flowing to an air valve. The car's speed is measured by another sensor connected to the speedometer. The microprocessor then divides the speed by the pulse length to determine the instantaneous fuel consumption. The running total is committed to memory so that, when desired, the processor can calculate the average fuel consumption.

The Turbo-Sensor is still being put through its paces under actual driving conditions. VDO, which is based in Schwalbach, outside of Frankfurt, expects to have the first marketable devices ready early next year. **-John Gosch**

Around the world

Speak & Spell to go to school in Japan

Texas Instruments Inc. is offering its Speak & Spell with 246 English words for the Japanese first-year middle-school curriculum for about $90. It will also offer plug-in modules with 114 words for the second year and 112 words for the third year, each priced at some $19. The word modules were designed at Texas Instruments Asia Ltd., Tokyo, and produced in Japan. The Speak & Spell unit is also produced in Japan and has both an earphone jack and a power-line adapter not included with the U. S. original.

Northern Telecom's digital multiplexer gets European accent

The DMS-1 digital multiplexing system from Northern Telecom Ltd., Montreal, is now available in a configuration meeting Europe's CEPT (Conférence Européenne des Postes et Télégraphes) recommendations and CCITT (Comité Consultatif International Téléphonique et Télégraphique) standards. Up to now, 650 of the systems, which act either as a digital subscriber carrier interfacing with an analog switching machine or as a remote switch to a digital exchange, have been delivered to more than 50 telephone companies. However, these have all followed North American standards.

In the CEPT–CCITT configuration, the DMS-1 can boost the traffic-carrying capacity of an existing cable up to 128 times, eliminating the cost of installing additional cable to a growing community. This development is another step in the ongoing conversion of the world's telephone systems to an all-digital network.

Philips to start general marketing of video-disk system

The Netherlands' NV Philips Gloeilampenfabrieken, encouraged by the success of its Video-Long-Play (VLP) disk system in the Atlanta, Ga., and Seattle, Wash., test markets, has decided to go nationwide in the U. S. by the end of this year. By early 1981, the company will introduce its system in Europe, initially in the United Kingdom because English-language programs from the U. S. will be immediately available. About a year later, marketing will start in Europe's German-speaking areas. The system will probably retail in West Germany for about $1,100. That price, says its West German subsidiary Philips GmbH, will initially not cover the system's cost, but with rising unit sales, will "become acceptable from a profits point of view."

SEL wins tantalum capacitor suit

The ITT subsidiary Standard Elektrik Lorenz AG (SEL) has come out the winner in what it calls a "decisive patent dispute" with the Union Carbide Corp. in Europe over tantalum capacitors. A court in Düsseldorf, West Germany, found Union Carbide guilty of infringing on an SEL patent concerning such capacitors and has ordered the New York–based company to desist from further infringements and to pay damages. SEL is currently fighting Union Carbide in American and British courts, as well, over the same issue. The Stuttgart firm, which has been making tantalum capacitors for years, says it holds basic patents on the device. They are widely applicable miniature components usable, for example, in semiconductor circuits for voltages up to 70 volts and currents of less than 0.3 ampere. Their capacitance range extends from 0.01 to 4,000 microfarads.

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Circle 84 on reader service card

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Zilog's powerful Z8000, the generation-ahead 16-bit microprocessor that delivers big computer performance at microprocessor prices, is on the shelf today at Zilog distributors around the country. Order it as the 40-pin Z8002 with 64KB direct addressing, $107.10* Or, choose the 48-pin Z8001 with 8 MB segmented addressing, $139.30* Supporting it is the versatile PDS 8000 family of development systems.

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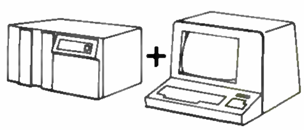
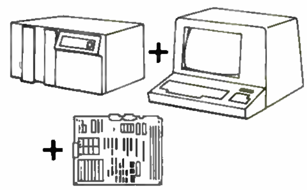
Your most economical entry to Z8000 product development. Everything you need to start your Z8000



software development: a 64K byte microcomputer, CRT, dual floppys, interfaces, 9-slot card cage, power supplies, a Z8000 software development package, operating system, editor, linker and utilities. $10,500*

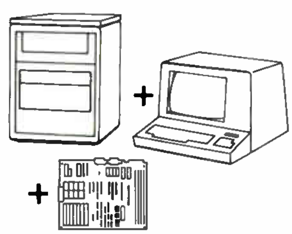
Try it out with the Model 15.

Everything in the PDS 8000 Model 10, plus Zilog's Z8000 Development Module, a Z8000 based computer board with 2K words



of EPROM (expandable to 8K words), 16 K words of dynamic RAM (expandable to 32K words), dual serial interface, 32 programmable I/O lines, four 8-bit programmable counter-timers and a generous wire wrap area. $11,995*

For more complex ideas, Models 25 and 30.



These two PDS 8000 models parallel the capabilities of the Model 10 and 15 but give you the added power of 10 megabytes of rack-mounted hard disc drive. $20,000* and $21,500*

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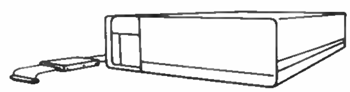

support capability for the Z8000 as well as the Z8.

For more information, write.

We'll send you a complete packet of technical data on the PDS 8000 family and Z8000 Development Module together with the name and location of your nearest Zilog distributor. Address: Zilog, 10460 Bubb Road, Cupertino, CA 95014. Or call (800) 538-9367 toll free. (In California call (408) 446-4666.)

*Suggested Domestic U.S. prices only. Z8001 and Z8002 prices are for quantity 100.

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Matching the test fixture to the PCB and the test system was often time-consuming and costly. Until the Thinline Vacuum Fixture System. With the Thinline System, you can finally achieve flexibility at the interface end of your test system. It's the first fixture system to approach universality.

The basic Thinline Vacuum Fixture System design solves several basic fixture problems. Storage, for example. The Thinline Product Access Unit (PAU) is only 3 inches deep so you can have compact, "bookshelf" storage. And it's made of precision-molded fiberglass and aluminum components for light weight and easy handling.

The PAU is designed for easy access to interface contact probes. Probing to any contact point during test program verification and maintenance can be done while the PCB is in the vacuum-actuated position.

The Thinline Probe Receiver is designed for easy loading, precise fixture alignment and positive locking. The receiver will accommodate more than 2800 points and it can be easily adapted for use with test systems fitted with Virginia Panel or other test system interfaces.

Choose TI's 16-bit 9900 Family. For price. For performance. And because it's production-proven. You'll be in the best of companies.

By the hundreds, companies are staking new product designs on TI's 9900 Family. A wide diversity of products. By companies large and established. By those small and growing. The brief recap on the opposite page lists just a few of the many innovators who have seen the future and chosen the 9900 Family. For a lot of good reasons:

Here-and-now compatible family

Unlike others who plan or promise, the 9900 Family is a fact. Available from your TI distributor today. Microprocessors. Peripherals. Microcomputer modules. Development tools. All compatible to protect your software investment as you move from one product design to another.

From the beginning, TI has been the 16-bit leader. The 9900 Family has grown. Matured. Become second sourced.

We'd like to say it's complete. But that will never be. TI is firmly committed to the Family's expansion according to your needs and as new technologies develop.

Price/performance microprocessor choices

Utilizing the most advanced architecture on the market today, the microprocessors in the Family include the original NMOS TMS9900. The functional I²L equivalent, the SBP9900A, for harsh environments. The lower-cost TMS9980/9981 versions for smaller systems.

Now coming into production: TMS9940, the industry's first 16-bit single-chip microcomputer with on-chip memory and I/O.

In total, an unequalled choice that lets you more easily and quickly match price and performance to your designs.

Low-priced peripherals

At last count, 14 peripherals support these microprocessors. The LSI "nuts and bolts" needed to complete your system. Easily. Economically.

For memory expansion to 16 megabytes there's the new TIM99610 Memory Mapper.

To fill your communication needs: TMS9902 Asynchronous Controller, TMS9903 Synchronous Controller, TMS9911 DMA Controller, and the new TMS9914 GPIB Adapter.

Also of interest: The TMS9927 CRT Controller and the new color graphics TMS9918 Video Display Processor.

Cost-conscious microcomputer modules and minicomputers

For a headstart in systems design, look into the Family's series of 16-bit TM990 microcomputer modules for evaluation, systems prototyping, and OEM applications.

The TM990 series includes standalone CPUs, memory expansion, and I/O expansion modules. And modules for program development. For learning and teaching.

TI's compatible 990 minicomputers extend the 9900 Family's level of integration to packaged host systems for distributed processing and a wide variety of other applications.

End products:

Where the 9900 Family is shining.

Every day, the 9900 Family is proving itself where it counts. In the marketplace. At the core of new products, new designs.

Many major companies, whose large resources and staffs allow them to weigh carefully all considerations and options, have elected to build products around the 9900 Family. Among them are Litton Aero Products, Allen-Bradley, Tektronix, Veeder-Root, Sweda International, John Fluke, Amoco, Fisher Controls, E.I. DuPont, Sun Electric, General Electric, Otis Elevator.

Also, a large number of young, aggressive companies have selected the 9900 Family... companies who cannot afford failure. Among them are Acuity Systems, Optronics Ltd., Harowe Systems, Micor, Cubic, Praxis Ltd., Nicolet, Delta Data.

Texas Instruments, where the bottom line is as important as anywhere else, uses the 9900 Family as the heart of its pacesetting home computer. In its Loran-C receiver. In minicomputers and terminals. In satellite navigation systems. In aircraft tracking and collision avoidance support systems.

The proof is convincing. For performance, economy, versatility, support, your first choice in 16-bits is the 9900 Family. You'll be in the best of companies.

Here-and-now Pascal

Just as many are playing catch up in 16-bit microprocessors, they're working overtime on high-level languages. Particularly Pascal. But TI has had operative Pascal for several years. Long enough to refine it for microprocessor applications.

TI's new Microprocessor Pascal offers the most extensive support available: Editor, compiler, host debugger, configurator, native-code generator, and run-time support.

Also: Compilers for Fortran and interpreters for Power Basic — all available on TI's floppy-based AMPL development system.

Versatile development systems

In addition to a broad family of hardware, you need reliable, available — and economical — development systems. These the 9900 Family has. To boost programmer efficiency while cutting costs.

The AMPL* prototyping lab is a complete set of software and hardware development tools for the entire 9900 Family. It provides real-time emulation and logic-state trace. It can be programmed for complex test and debugging sequences.

With this one versatile unit, you can not only develop software but also check out and verify software and hardware as you go.

Compared on a feature-by-feature, dollar-by-dollar basis, the AMPL lab is the best 16-bit microprocessor development system for your money.

Help is available

Whenever you have a tough question or need another opinion, talk with your nearest TI systems engineer or TI distributor applications engineer. If you want to learn more about the 9900 microprocessors, TM990 modules, Microprocessor Pascal and the AMPL lab, TI training courses are being held weekly. Call your TI field sales office or your authorized TI distributor for details and locations.

For a copy of the new brochure on the 9900 Family, contact your TI distributor. Or write Texas Instruments Incorporated, P.O. Box 1443, M/S 6404, Houston, Texas 77001.

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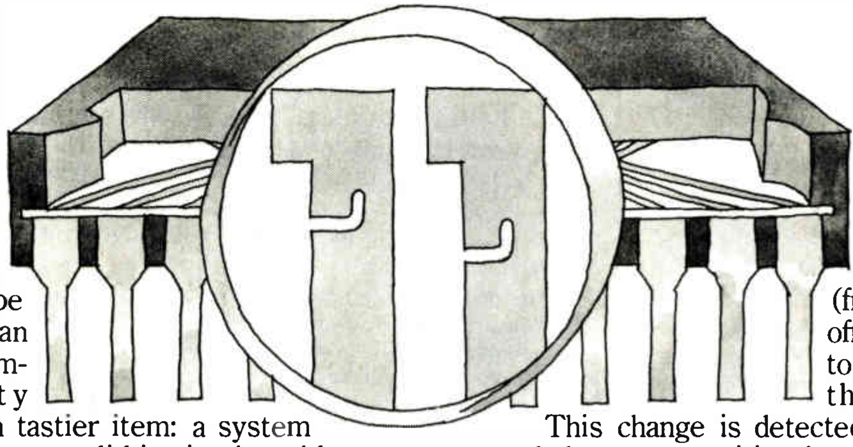
Laser trimming of monolithic circuits

Silicon valleys



No sooner have we swallowed the fact that 86,000 thick-film resistors can be laser-trimmed in an hour than the trimming fraternity serves up an even tastier item: a system capable of trimming monolithic circuits with a laser beam only 6 micrometers in diameter.

Now, to put a spot size of 6 micrometers into focus (so to speak), the new trim system can very easily write your name inside the period at the end of this sentence, with room left over for a troupe of dancing angels.

Producing a spot this small is basically an optical feat, accomplished by lensmanship of the highest order. To be useful in monolithic trimming, however, beam reduction must be accompanied by equally remarkable positioning accuracy, there being no known application for a wandering 6-micrometer laser kerf.

Teradyne's closed-loop galvanometer beam positioner, used for some time on the W411 Laser Trim System, had already wiped out hysteresis and greatly reduced nonlinearity. That left geometry errors in the step-and-repeat table and registration errors from die to die as the principal error sources to be dealt with.

The solution to these problems is a new technique for nondestructive edge sensing, called "Laser Eye." Before the laser beam starts trimming, it is attenuated and brought to the leading edge of the circuit. When it encounters the circuit edge, there is an abrupt change in the amount of laser energy reflected (from high reflection off the light substrate to low reflection off the dark circuit).

This change is detected by a photodiode, and the exact position is passed along to the computer, which adjusts the stored trim coordinates and the focus of the laser beam accordingly. The edge-sensing is typically repeated on every die to ensure positioning accuracy, with focus adjusted every inch or so to compensate for any wafer warp.

As further insurance against positioning errors, the entire mechanism is shock-mounted against the effects of vibration. The trim system is, after all, designed not as a laboratory instrument but as a machine to grind out parts on a factory floor.

The combination of closed-loop galvanometer positioning, Laser Eye, and solid systems engineering yields a bottom-line, no-strings positioning accuracy of 2.5 micrometers. That means that, on any given circuit, the laser beam will be within 2.5 micrometers of where it's supposed to be, period.

Monolithic trimming is currently of principal interest to makers of monolithic 12-bit D to A converters. But now that lasers have broken the IC, who knows what uses may be found for 6-micrometer holes, coming thousands per second, right on the money every time?

The first 12 essays in this series are now available in booklet form. For your copy, write to Teradyne, Department E, 183 Essex Street, Boston, MA 02111.

TERADYNE

IEDM stars bipolar, power, new devices

Attention at electron devices meeting shifts from digital MOS; one addition is high-frequency electron tubes

by John G. Posa, Microsystems & Software Editor, and Roger Allan, Components Editor

This year's International Electron Devices Meeting, which will be held Dec. 3–5, as usual in the Washington (D. C.) Hilton, has turned away from the obvious. Taking a back seat at the IEDM is digital MOS technology, deferring to a greater number of sessions on bipolar integrated circuits, high-power devices, solar cells, displays, detectors, and for the first time this year, high-frequency electron tubes, on which there will be no less than three sessions.

Despite the de-emphasis, one MOS chip maker still a major contributor to the conference is Texas Instruments Inc., Dallas. TI will present almost a dozen papers, including one that discusses a single-supply 16-K random-access memory, elaborating on the technology that allowed it to remove substrate bias from its 64-K dynamic RAM. It will also present several papers on scaling techniques—with an emphasis on bipolar devices.

Several sessions are devoted to new processing techniques like laser annealing. The localized heat generated by a laser is capable of turning polysilicon into near-single-crystal material, actually allowing the fabrication of devices in polysilicon grown over oxides and other insulating material. And because oxides and polysilicon layers can both be grown on one another, the technique may open the door to truly three-dimensional integrated circuits.

More and higher. Banging out more power from smaller junctions at higher speeds has been the historical trend in power devices like transistors, diodes, and thyristors (silicon controlled rectifiers and triacs). Two sessions on this subject attest to its importance. The heavy concentration of papers on power MOS field-effect transistors is an indication of the rapid rise of these devices, which are challenging traditional bipolar power transistors.

In one paper, Siliconix Inc., Santa Clara, Calif., explains how a new family of V-groove MOS power FETs with a unique K-gate structure, made with n-channel enhancement-mode technology, was developed to yield results unattainable by any other technology.

Another interesting power device development involves the static-induction transistor (SIT). Researchers at Tohoku University, Sendai, Japan, have built a device that delivers 3.2 kilowatts of power at 45

HIGHLIGHTS OF THE IEDM

SESSION	PAPER	SOURCE
Day 1		
3.7	A Novel High-Speed Electron Resist	Inomet Co.
4.2	Power Junction-Gate Field-Controlled Devices	General Electric Co.
4.7	A New K-Gate V-MOS Power FET	Siliconix Inc.
Day 2		
8.2	A New Structure for VLSI Bipolar Technology	Institut fur Theoretische Elektrotechnik der RWTH Aachen
8.3	A High-Speed I^2L Compatible with High-Voltage Analog Devices	Toshiba Corp.
8.5	A 1-μm Bipolar VLSI Technology	Texas Instruments Inc.
8.6	Subnanosecond Self-Aligned I^2L-MTL (Merged-Transistor Logic) Circuits	IBM Corp.
9.3	Laser Annealing of Implanted Polysilicon Layers for MOS Process Applications	Texas Instruments Inc.
10.3	2500-V, 600-A Gate-Turn-Off Thyristor (GTO)	Toshiba Corp.
10.4	High-Power Static-Induction Thyristor	Hitachi Ltd.
13.1	Physics underlying Recent Improvements in Silicon Solar Cell Performance	University of Florida
14.1	Schottky Transistor Logic (STL) Technology	Texas Instruments Inc.
14.2	A Super-High-Speed ECL-Compatible I^2L New Technology	Toshiba Corp.
14.3	BEST (Base Emitter Self-Aligned Technology): A New Fabrication Method For Bipolar LSI	Oki Electric Industry Co.
15.1	A High-Performance MOS Technology for 16-K Static RAMs	Intel Corp.
15.2	A Sub-100-ns 16-K-by-1-bit MOS Dynamic RAM using a Grounded Substrate	Texas Instruments Inc.
15.6	High-Density C-MOS Processing for a 16-K RAM	Toshiba Corp.
15.7	Variable Resistance Polysilicon for a High-Density C-MOS RAM	Toshiba Corp.

SOURCE: *ELECTRONICS*

Probing the news

kilohertz with 95% efficiency.

Power advancements have been no less spectacular in rectifiers and thyristors. A paper from Toshiba's R&D Center, Kawasaki, discusses a gate–turn-off (GTO) thyristor capable of handling 600 amperes and 2,500 V. One of the innovative design ideas that make this possible is an annealing process that allows the redeposition of a phosphorus layer onto a previously diffused n-doped emitter surface.

On display. Intense work continues in a number of information-display technologies. All have the common objective of finding a low-cost method of displaying large amounts of alphanumeric data, now the principal domain of the cathode-ray tube.

One of the more promising low-cost technologies is that of liquid-crystal displays. Improvements in contrast ratio and viewing angle are still wanting for this technology, however, although one session on displays includes a paper from Asuag, Neuchatel, Switzerland, on a new dichroic dye-based operation that leads to positive contrast in LCDs without the use of polarizers.

Another paper, from Bell Laboratories, Holmdel, N. J., talks about an extremely important area of LCDs affecting overall costs: supporting drive electronics. The paper discusses a new electrically addressable bistable mode in field-effect nematic LCDs that simplifies multiplexing, previously a stringent limitation for such devices.

As for ac plasma displays, IBM Corp., Kingston, N. Y., gives an overview, presenting technology choices, their yields, and reliabilities.

Under the sun. Silicon and other types of solar cells are the subject of two sessions. In one, several papers treat problems associated with the performance and design of single-crystal solar cells, including the effects of nonuniform illumination on performance and the collection efficiency of vertical multijunction cells.

Alternatives to the single-crystal silicon solar cell are the subject of the other session. It features papers on cast polycrystalline silicon, semiconductor thin films, amorphous silicon, tandem concentrator cells, and electrochemical cells.

One of the most popular semiconductor materials, particularly for high-frequency devices, is gallium arsenide. Judging from the wealth of papers on GaAs circuits in two sessions on solid-state microwave devices, this material looks like the MOS of high-frequency ICs.

MOS proper. With just three papers from Silicon Valley chip makers, who have become more tight-lipped on technology in the face of ever-increasing competition, the conference admittedly de-emphasizes digital MOS devices and fabrication. Those sessions devoted to it come out of universities, U. S. companies with large research budgets, or Japan. The Japanese entries, which number more than two dozen, are especially noteworthy, however.

One example is a quadruply self-aligned MOS approach that eliminates many of the registration problems looming over very large-scale integration. The scheme, out of the Japan Cooperative Laboratories, points the way to a minimum cell size for a RAM of 6 square micrometers that would make possible a single-chip million-bit RAM on a die of less than 55,000 square mils.

Another Japanese entry shows a different approach to self-alignment that allowed Nippon Electric Co. to scale down a design for the 8085 microprocessor to 3-μm rules. Scaling down is also being applied by Toshiba Corp. to complementary-MOS. In two sessions it will disclose several refinements to the low-power technology, including the use of a buried layer to actually vary the resistance of polysilicon load resistors and to minimize die size. The approach has yielded a 2-K-by-8-bit C-MOS static RAM with more than 100,000 devices. □

HIGHLIGHTS OF THE IEDM
(continued)

SESSION	PAPER	SOURCE
Day 3		
20.1	Refractory Silicides for Low-Resistivity Gates and Interconnects	Bell Laboratories
21.1	Some Theoretical Considerations regarding the Maximum Speed of Active Logic Devices, with Special Reference to Josephson Junctions	Mitre Corp.
21.2	Josephson Direct Coupled Logic (DCL)	IBM Corp.
21.3	Superconducting Thin-Film Transformer Design Powering Josephson Logic	IBM Corp.
21.5	Electron-beam-fabricated GaAs Integrated Circuits	Hughes Aircraft Co.
21.6	High-Speed Planar GaAs IC Processing Techniques	Rockwell International Corp.
23.1	AC Plasma-Display Device Technology: An Overview	IBM Corp.
23.3	Configurational Bistability and Nematic Storage Display	Bell Laboratories
23.5	A Fast Silicon Photoconductor-Based Liquid-Crystal Light Valve	Hughes Aircraft Co.
25.1	A Novel Single-Device-Well MOS FET Gate	Bell-Northern Research Ltd.
25.2	A Quadruply Self-Aligned MOS (QSA MOS)	Japan Cooperative Laboratories
25.3	A New Self-Aligned Source-Drain Diffusion Technology from Selectrively Oxidized Polysilicon	Nippon Electric Co.
25.4	Performance of Downward-Scaled C-MOS on Sapphire	Toshiba Corp.
25.6	Compatible V-MOS and n-MOS Technology for Power MOS ICs	University of Toronto
25.7	A New CML Memory Cell for High-Density Memory Devices	NEC-Toshiba Information Systems Inc.
26.2	Virtual-Phase CCD Technology	Texas Instruments Inc.
26.4	An Ultrahigh-Speed GaAs CCD	Rockwell International Corp.
26.6	The Characteristics of Alpha Particle Effects on 64-K CCDs	IBM Corp.

SOURCE: *ELECTRONICS*

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Electronics abroad

Israel sweetens the pot

New law based on its associate membership in European Common Market aimed at drawing American companies

by Howard Wolff, Assistant Managing Editor

When Lambda Electric Corp., the Melville, N. Y., maker of power supplies, opens its new plant in Carmiel, Israel, on Nov. 8, the event will have a significance beyond the mere startup of another manufacturing facility. The reason: Lambda is the first American industrial electronics company to take advantage of Israel's new laws, enacted last year after the country's acceptance as an associate member of the European Common Market made the nation an attractive base for firms selling into the Common Market.

Basically, what the package of laws and inducements does is ease financial restrictions, import duties, and other obstacles. Coupled with other inducements, such as complete plant financing, equipment leasing, training, low-interest loans, grants, and accelerated write-offs, the new measure projects Israel into the picture alongside other common marketeers seeking to attract U. S. industry—particularly Ireland, Scotland, and England.

American firms have operated in Israel almost since the state was born. In fact, Motorola Inc. is one of six companies—the other five are Israeli—that account for 90% of the production and exports. But this new initiative is expected by the government to attract more. And the tiny nation has other things going for it in the fight to keep its economy on an even keel.

Asked why Lambda had chosen Israel as its gateway to Europe, vice president Merrill Simon ticked off

the following advantages:

- A strong technological infrastructure.
- A large pool of trained technologists—there are 4,000 electronics engineers alone produced by three undergraduate and one graduate school.
- An industrial infrastructure.
- A thriving machine-tool industry, important when setting up an industrial electronics facility.
- An internal market for supplies.

"Ireland ran a close second," says Simon, "but we would have been limited there to manufacturing and couldn't do engineering or R&D work because there would be no local university to work with." Another factor that tipped the scale was Israel's Science-Based Industry Law. "This means that if we do R&D, use Israeli engineers, and make what we develop for export, the government pays 50% to 70% of the development cost," says Simon. Not only that, but EEs and technicians earn half of what their counterparts in the U. S. earn. "R&D in Israel costs 25% of what it costs in the United States," Simon says.

Other than industrial firms must have noticed the relatively low cost of research. Two giants of Silicon Valley, National Semiconductor Corp. and Intel Corp., have opened design centers in Israel. Both are designing microprocessors there. National's shop has been open for more than a year—the company will not say how many people it employs or give other details—and Intel's has been in operation since 1974. It has 50 employees and designs central processor and peripheral chips. Intel refuses to comment, but industry observers believe that some of the highest levels of design work for its microprocessor parts have been done entirely or in part at the Israeli facility.

Experience. Giving examples of how Lambda has dipped into this pool of trained personnel, Simon points out that many Israelis have worked for American companies and spent time in the U. S. "Mark Shavit, our general manager in Israel, was one of the founders of Signetics," he says. Some of Lambda's other managers in Israel provide a rather cosmopolitan picture. "Our comptroller is a Dallas CPA who went to Israel on a trip 15 years ago and stayed; a Russian immigrant is manufacturing manager; and the chief engineer, an Israeli, is as good as anyone we could have hired in the States," he adds.

One of the recent developments that could brighten the Israeli electronics picture is the peace treaty signed last summer with Egypt. While the Egyptians are not expected to provide much of a market for Israeli goods, the treaty is expected to have an indirectly beneficial effect. Says Rafi Benvenisti, director of the Israel Government Investment Authority, "There is increased interest in investing in the Israeli industry," while high-placed government officials say that three companies are in the process of negotiating with the government on plans to begin operations in Israel.

Valtec Corp. of West Boylston, Mass., and Elron Electronic Industries Ltd. of Haifa are industrial partners under still another type of arrangement. Together they have an interest in a startup Israeli firm called Fibronics Ltd., whose president, J. Morris Weinberg, is a native New Yorker with a Ph.D. in physics from Ohio State University. Says Weinberg, "In the beginning the know-how went one way, but now it's going two ways: Valtec is bringing Fibronics products into the U. S. under its own label." The product is fiber-optic communications modems.

The current Israeli government's major contribution to smoothing the way for American investment in Israel has been more a matter of style than substance, as explained by Uzia Galil, president of Elron. "The former export rebates were helpful but managerially stultifying. Begin's government has made management simpler and more understandable to prospective investors. Now businessmen can understand the regulations." □

Thaw. Egyptian and Israeli flags fly side by side over Technion City in Haifa as Egyptian President Nasser is welcomed by officials of Elron Electronic Industries, one of whose subsidiary companies is Elbit, a maker of minicomputers 37% owned by Control Data.

Industrial electronics

Smart robots getting smaller

Industrial manipulators that work at higher speeds are competing for small-parts assembly jobs

by Roger Allan, Components Editor

Recent attempts to develop smart industrial robots for the assembly of small parts have had limited success. Historically, most industrial robots have been used for heavy tasks such as welding, paint spraying, and loading and unloading, often in the automotive industry. Looking to break that stereotype, Unimation Inc., Danbury, Conn., will shortly take the wraps off a small industrial robot targeted at the intricate assembly of small parts.

The world's first and largest industrial robot manufacturer will unveil the second-generation PUMA (programmable universal manipulator for assembly) at the Autofact II conference in Detroit's Cobo Hall, scheduled Oct. 30 through Nov. 1. The annual robotics conference is sponsored by the Society of Manufacturing Engineers.

Unimation introduced its first PUMA, the model 500, last year [*Electronics*, Nov. 23, 1978, p. 140]. The new model 250 is also a continuous-path robot but half the size of its big brother and much lighter. Moreover, it is just as "smart," has an additional axis of articulation for a total of six, can repeatedly position a part to within ±0.002 inch, and above all is about 1.5 times as fast (see table of comparisons). Its tip velocity, which includes the gripper, is a maximum of 5 feet/second at maximum load capacity of 3.5 pounds. The gripper, a computer-controlled electrical device, is not available on the older model.

According to Unimation's PUMA product manager Mike McCraley, the model 250 is intended for assembling the small components of appliances and electronic subsystems. One lucrative application is the assembly of electronic components like resistors, capacitors, diodes, and light-emitting diodes on printed-circuit boards. "We'll be going into production in November of this year to fulfill existing orders for the model 250," explains McCraley. "New orders will be filled by May of next year." The robot is at present at a prototype stage.

Like its predecessor, the servomotored model 250 is microprocessor-controlled. Five microprocessors are controlled by a Digital Equipment Corp. LSI-11 master microcomputer system. Four kilobytes of random-access memory is standard, while additional program storage will be possible through optional floppy disks.

Small size. If industrial robots are to compete effectively with other automatic machines in such large component-assembly applications as pc-board parts-stuffing, they must be at least as fast and have at least as high position repeatabilities. Today, many more dedicated programmable machines are available to do this kind of work at economically attractive levels. But for industrial robots, it is easier to get high speed and high repeatability in a smaller machine. However, as Vernon E. Estes, manager of process automation and control systems for General Electric Co., Schenectady, N. Y., observes, "smaller robot size means smaller payload, which has to include the robot's hand. And this hand gets more complex and thus heavier for smaller parts assembly at high speeds, especially where adaptive control is used."

General Electric is one of several large companies using industrial robots for a variety of applications. "We have a major campaign to evaluate robots for small-parts assembly, and we're trying out several different ones from different manufacturers," explains Estes. Robots from Olivetti, Seiko, and Auto-Place as well as Unimation are under investigation. "One of our objectives is to develop robot applications for pc-board stuffing of parts and for mechanical component assembly in small ap-

HOW THE TWO PUMA ROBOTS COMPARE

	Model 250	Model 500
Maximum tip velocity	5 ft/s	3.3 ft/s
Arm length (total reach)	16 in.	34 in.
Number of axes of articulations	6	5
Repeatibility	± 0.002 in.	± 0.004 in.
Maximum load capacity	3.5 lb	5 lb
Arm weight	15 lb	120 lb
Height at shoulder	13 in.	34 in.
Price	$35,000	$35,000

SOURCE: *ELECTRONICS*

pliances," adds Estes, "but we also realize that industrial robots are more cost-effective for small batch assembly involving different tasks."

Richard G. Abraham, programmable automation manager at Westinghouse Electric Corp.'s Research and Development Center, Pittsburgh, Pa., agrees with Estes: "Higher speed is very important, especially for parts assembly. Any time robot speed is increased, more applications open up." He does, however, caution that given his experiences with studying automation of batch manufacturing under a National Science Foundation grant [*Electronics,* Nov. 23, p. 41], robot manufacturers should be making machines with heavier payload capabilities. "Some parts in the small-motor line we're studying are too heavy for some robots we're trying to handle," he adds.

The grant involves funds for a Westinghouse study, now in its second phase, for looking into the feasibility of programmable automation for batch assembly. After studying more than 60 different Westinghouse products, the company concluded that only a few were suitable, and of these, a line of small motors was chosen.

Limited sequence. Many of the simpler pick-and-place robots have been used in the past for intricate parts assembly. Industrial robots from Japan's Seiko Industries Inc. have been assembling watches for many years. Some of them can position a part to within a hair-splitting ±0.0004 in., but they can follow only a limited number of steps.

Some such robots have extra capabilities, like visual adaptive control. Auto-Place Inc. of Troy, Mich., developed the Opto-Sense vision system for use with its robots in collaboration with General Electric Co., which recently installed one at General Motors' Chevrolet division in Flint, Mich., to inspect valve-cover assemblies of V-6 Chevrolet engines for leaks and correctness of assembly.

According to Jerry Kirsch, Auto-Place's president, "We're feverishly working on a continuous-path robot using our Opto-Sense or some other vision system to broaden our markets—it should be ready by the end of next year." One of the applications Auto-Place has in mind for this developmental robot is small parts assembly.

Research into robot vision is being conducted at several locations, including Stanford Research International, the National Bureau of Standards, Wright-Patterson Air Force Base, General Motors' Technical Center, the Jet Propulsion Laboratory, Westinghouse Electric, and the University of Rhode Island.

In addition, work is under way at the Charles Stark Draper Laboratory on tactile sensing, out of which has already come a parts-mating concept currently in use by some industrial robots, the Remote Center Compliance (RCC). The RCC concept employs purely mechanical elements and allows a robot to mate inexactly aligned parts (such as a peg in a hole) at low cost.

The hand. "The biggest problem with using small robots for parts assembly is getting a dexterous enough—and reliable enough—robot hand at low enough cost," explains Ward McClure, manager of vision-aided manufacturing for Texas Instruments, Dallas. McClure's firm has been using a small robot very similar to the Unimation PUMA model 250 to load and unload small calculators, over the last three years. The firm builds its own robots for use in house. "Dedicated parts-stuffing machines are still faster," says McClure, "although for small runs with many changes some of the newer small robots might be just as cost-effective." McClure believes that small robots like the PUMA model 250 from Unimation represent significant progress in robotics for parts assembly since they are easier to fit into a production operation. "It would be great, though, if payload weren't sacrificed to the smaller size," he notes. McClure predicts that within two years small industrial robots will be cost-effective tools for fast parts assembly.

Unlike other automation experts who say that industrial robots are "not quite there," GE's Estes takes the view that "we should take the available technology of robotics, and there is quite a bit of it, and make use of it through more applications engineering." □

Computers

Memory pinch threatens profits

IBM going outside for chips, which should worsen the situation for other manufacturers

by Anthony Durniak, Computers & Peripherals Editor

As the already tight supply of semiconductor memory components becomes tighter, the basic economic laws of supply and demand are superseding the semiconductor learning curve as the basis for determining price. And if recent computer company actions are any indication, the new conditions surrounding the availability of the memory chips may become the limiting factor in the near-term growth of the computer market.

The most dramatic evidence to date was IBM's announcement earlier this month that it would purchase 16-K random-access memories from outside suppliers in an effort to speed deliveries of its model 4341 computer. Announced last January with price and performance that stood the industry on its ear, the model 4341 was so popular that an estimated 2,000 were ordered the first week they were available [*Electronics*, Feb. 15, p. 85].

Highlighted in this new machine was up to 4 megabytes of main memory—some four times the memory capacity of the System/370 model 138, the machine that the model 4341 replaces—consisting of chips made by IBM's General Technology division at its Burlington, Vt., facility.

To meet what an IBM spokesman calls the extremely large demand for the memory chips, the 1.4-million-square-foot Burlington facility is currently being expanded by some 520,000 ft^2. But IBM's move to supplement its internal memory chip production with outside 16-K RAMs is a tacit admission of the bottleneck that memory component supply can become for a manufacturer—the 4341 delivery lead times have stretched out to an unprecedented three years.

IBM maintains that there are no manufacturing problems at either its Burlington plant or in Sindelfingen, West Germany, where the chips are also made. In fact, when the highly automated facility was opened to the public last year, Edward M. Davis, vice president for development and manufacturing at the General Technology division and manager of the Burlington plant, claimed yields exceeded the industry averages.

Equal demand. Instead, IBM apparently miscalculated both the size of the demand and the distribution of orders. According to sources, IBM anticipated that the less expensive model 4331—which uses only a quarter of the memory of the 4341—would outsell the 4341 by 4:1. The number of orders for the two machines actually came in practically equal, throwing IBM's manufacturing schedules awry.

Popular. IBM's Davis finds demand outstripping his division's ability to supply memory.

This is not the first time IBM has been caught short. About two years ago reports circulated that customers ordering top-of-the-line model 3033 mainframes were receiving their machines without the full complement of memory. But at that time the manufacturers of add-on memories were more than willing to step in and sell customers extra memory. And although IBM is probably the most self-sufficient computer manufacturer, it has purchased both logic and memory components externally before, most notably from Texas Instruments Inc.

This time, however, by packaging the entire complement of memory with the computer in a single cabinet, IBM precluded add-on memory boxes. And now the entire industry is feeling the shortage.

For example, NCR Corp., Dayton, Ohio, said last month that the dearth of semiconductor components increased manufacturing costs and resulted in lower than anticipated shipments of finished goods, causing slowed revenue growth and almost flat earnings for the third quarter.

And IBM's needs can only make the situation worse.

"We were already forecasting a shortage of [16-K] devices through 1980, and any increases in demand will obviously exacerbate the situation," says David Ford, MOS memory strategic marketing manager at Motorola Inc.'s Semiconductor Products Group.

Prices may rise. As a result of this tight supply situation, memory prices will not decline as fast as they have in the past and may in fact increase.

"Either supply and demand will cause prices to rise to a demand limiting mechanism or the lead times will go out," or some combination of the two will occur, says Ford. Increases could hurt profit margins at computer companies already committed to a new round of lower memory purchase prices, and longer lead times will limit any growth in product shipments.

Last spring, IBM started buying memory on the outside, apparently for its older computer lines, in order to free up its internal semiconductor facilities to make chips for the new products like the 4341.

But according to a manager at one Texas memory maker, who asked not to be identified, IBM will have a tough time matching the price it got last spring. At that time IBM was said to be able to agree to pay $10 for a 32-K module containing two 16-K chips. Current 16-K prices are $5 to $6 apiece, and industry members say lead times are about 20 to 26 weeks.

And according to Daniel M. Clemson, manager of memory and power supply design at Data General Corp., "it's definitely a seller's market and IBM's move will only aggravate the situation." Even before the IBM announcement, he says, the Westboro, Mass., minicomputer maker found vendors reneging on earlier sales commitments, cutting back on the amount of 16-Ks to be delivered.

Michael S. Gutman, storage systems product manager for Digital Equipment Corp., Maynard, Mass., says he does not expect manufacturers with long-term contracts to be hurt, but does expect price increases on the spot market for chips. In any event, he says everyone is watching IBM and the 16-K memory situation very closely.

What about buffer? An interesting sidelight on the memory question is provided by IBM's buffer. A unique feature of its 64-K random-access memory chips is the independent 8-bit on-chip register that buffers data being read from the chip. Once in this buffer, data can be read out at a 100-nanosecond rate, some three times faster than the access time to the rest of the chip, which is typically 300 ns.

Used in its model 4341 computer, this on-chip buffer is part of a storage hierarchy that also includes a separate 8-kilobyte cache to speed memory accessing. Since 64 of the 64-K memory chips are mounted on a circuit card, up to 64 8-bit bytes can be buffered on the memory card for movement during memory accesses.

In order to use standard 16-K chips, IBM says it has designed the equivalent function into the processor so that operations, timing, and storage are the same as with the IBM memory chips. But spokesmen decline to release details of the redesign. □

Meetings

Midcon hopes for best

Sold-out booths fuel optimism, as do technical sessions that devote much of their time to microprocessor uses

by Roger Allan, Components Editor

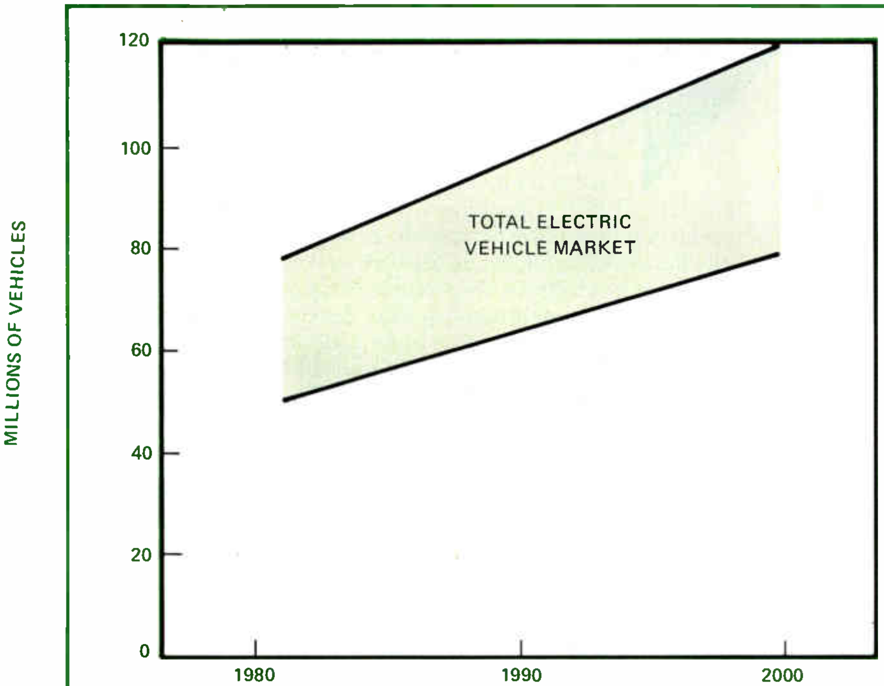
Looking to rebound from last year's unimpressive showing in Dallas, the third Midcon Electronics Convention and Exhibition, which alternates between Dallas and Chicago, will shift to the Windy City Nov. 6–8 for what its producers hope will be the show's best year. And if the number of anticipated exhibitors is any indication, their hopes could come true: Midcon/79's total of 535 exhibit spaces have been sold out as of the first of this month.

Complementing the exhibits, which cover nearly all aspects of the electronics industry from components and subsystems up to large computers and integrated systems, will be a 29-session professional program. Some 111 technical presentations concentrate largely on high-technology electronics disciplines and their applications. But many of the technical papers are from nonelectronics people, indicating a growing cross-fertilization of ideas among technical specialists in all fields. For example, speakers can be found in the program from commercial airlines, automobile makers, mass merchandisers, appliance makers, medical organizations, and large industrial manufacturers.

The microprocessor. Not surprisingly, about one third of the professional program consists of microprocessor-related sessions. Wasting no time, the five papers of session 1 illuminate the advances in monolithic data-converter technology toward complete units capable of interfacing directly with microprocessors. In addition, the rise in monolithic data-converter performance is examined in view of the devices' inherent low prices. Sam Ochi and Brian Gillings of Advanced Micro Devices Inc., Sunnyvale, Calif., describe a high-speed bipolar 8-bit monolithic a-d converter that not only includes all of its components internally but is fast enough (900 nanoseconds) to interface directly with a microprocessor. Jeffrey Riskin of Analog Devices Inc.'s Semiconductor division, Wilmington, Mass., then shows why one of the most significant advances in IC technology is the successful design and mass production of monolithic data converters implementing functions in integrated injection logic. Riskin shows the results of such advances and compares I^2L's merits with those of alternative technologies like n-channel MOS, complementary MOS, and bipolar–C-MOS.

Data converters are gaining speed to the point where video-bandwidth devices in monolithic form have begun to surface. Two such recent devices are the models TDC1007J 8-bit a-d and TDC1016J 10-bit d-a converters, both of which operate over 20 megahertz. The converters are from TRW LSI Products, El Segundo, Calif.; discussing the high-speed bipolar technology that made them possible will be the company's Willard Bucklen.

The microprocessor, because of its low cost, small size, and versatility, has been finding state-of-the-art



ELECTRIC VEHICLE MARKET
(IN MILLIONS)
SOURCE: DEPARTMENT OF ENERGY

applications in many medical disciplines. One of the four papers on this in session 4, "Microcomputer Applications in Medicine," is by Wilbur DeHart of the University of Michigan Hospital, Ann Arbor, and Mel Barclay of Wayne County General Hospital, Westland, Mich. Entitled "Computerizing Human Birth," they look at the case histories of three women whose deliveries were monitored by a microcomputer at bedside.

Electric cars. What is the status of electric vehicle technology? Session 13 gives the answer. Leading it off will be Kendall Wilson of the U. S. Department of Energy, who will discuss the commercialization of electric and hybrid vehicles (see figure, p. 90). He argues that they are only a partial solution to today's transportation energy problems, given available electric-vehicle technology. Present efforts at their commercialization will be aimed at electric vehicles with specific missions, like vans, with general-purpose electric and hybrid vehicles to follow.

In this session, the commercial electric vehicle program of the world's largest automotive company will be spelled out by Frank Swoboda of General Motors Corp.'s Truck and Coach division, Pontiac, Mich. After touching briefly on the advantages of electric vehicles and their cost, Swoboda outlines GM's goals for electric vehicles and its history in the field and looks at some future alternatives. He says that GM will decide whether to introduce an electric vehicle commercially—and, if so, when—as soon as sufficient results are obtained from a large-scale demonstration program now under way with American Telephone & Telegraph Co. That program involves the conversion of AT&T gasoline-powered vans to battery power.

On a more specific level, G. J. Murphy of Northwestern University, Evanston, Ill., takes a close look at the concept of regenerative braking. He concludes that unfortunately its greatest advantages are for vehicles with different operating patterns from those of electric vehicles.

Self-testing. The advent of the microprocessor has made possible such features as self-checking, self-testing, and self-calibration in test and measurement instruments. Session 20 includes three papers with specific examples of where such features have provided economies and confidence in an instrument's operation.

Craig E. Johnston of John Fluke Manufacturing Co., Mountlake Terrace, Wash., shows how the performance of his company's instruments has improved upon that of older instruments at little or no increase in cost, thanks to microprocessor-based automatic self-calibration. The result is reduced costs for owning such an instrument. Johnston also offers design suggestions for minimizing maintenance and calibration costs.

Robert Sullivan, GenRad Inc., Concord, Mass., explores the tradeoff between too much self-checking in an instrument (and subsequent high cost) and no self-checking (and subsequent low measurement confidence), using the firm's model 1688 Digibridge LC bridge as an example. The instrument's firmware-oriented self-checking approach emphasizes the checking of those of its functions that are harder to service or have higher predicted failure rates.

Finally, James W. Griffin, Tektronix Inc., Beaverton, Ore., explores the self-strategies implemented in his firm's model 832 and 833 data-communications testers.

On a lower level of device technology, session 21 reviews the technology of nonvolatile semiconductor memory. One of the more interesting papers in this session concerns a high-speed 16-K electrically erasable programmable read-only memory (EE-PROM) from Hitachi Ltd. of Tokyo. Its authors, I. Uchiumi, T. Kihara, and Y. Itoh, report that the metal-nitride-oxide-semiconductor (MNOS) device features a 200-ns read access time, dissipates 180 milliwatts, and is fabricated on an 18.6-square-millimeter die using 400-square-micrometer cells. The memory has the same 16-pin configuration as industry-standard 16-K EE-PROM. It operates from a single 5-volt power supply (for read operations), is fully static, and is TTL-compatible for input and output. Programming and erasure is achievable by a 25-V dc pulse, typically 1 millisecond wide. □

THE 1979 ACHIEVEMENT AWARD
Inventor of bubble technology opened way to ultradense memories

by John G. Posa, Microsystems & Software Editor, and Howard Wolff, Assistant Managing Editor

"The world could have gone on without bubbles, but bubbles rescued magnetism from complete disaster." That is the self-effacing estimate of the value of his work by Andrew H. Bobeck, and it is typical of the modest 53-year-old Bell Laboratories scientist.

For him there is no blue-sky talk. On the contrary, Andy Bobeck considers his greatest accomplishment the rescue of the science of magnetics from atrophy. "It was static," he says. "Nothing had come along in a while. Now universities teach bubble courses and new companies are being formed" as a result of the emergence of the technology. And bubble memories are finding their way into products such as Bell's repertory dialers. Bobeck's work has made possible memories that have at least four times the capacity of semiconductor types—bubbles have reached 1 megabit, semiconductor random-access memories 64 K.

Bobeck and his co-researchers at Bell Labs in Murray Hill, N. J., made their way into magnetic-bubble domains as the result of a search for a more efficient means of data storage. "A lot of people were doing work on magnetics through the 1940s, '50s, and '60s," he recalls. They played with thin-film approaches—the domain-tip memory ("The problem was bringing data around the loop from the tip") and the waffle-iron memory ("It had a defect called the creep mechanism")—in their quest for the two-dimensional memory.

The bubble problem reduced itself to this, in Bobeck's words: "We had to take magnetization and stand it up"—that is, make it perpendicular to the plane of the device. This need gave birth to the bubble concept, which in turn forced a search for materials. "We tried everything—manganese bismuth, gallium-iron-gallium, garnets. Then we decided to have a meeting to talk about materials. It was conducted by William Shockley, one of the inventors of the transistor. With 80 or so people from all over the labs in the room, Richard Sherwood stood up and said, 'I know what you want: orthoferrites.'" He was right. Thus, the original bubble patent, granted March 3, 1966, bears four Bell Labs names: Bobeck, Shockley, Sherwood, and U. F. Gianola, who provided valuable inputs on use of the domain to make registers.

That original patent actually covers the concept of having an "isolated domain with magnetization running perpendicular to the surface." Although, as Bobeck points out, there are now more than 100 patents relating to magnetic-bubble technology, that 1966 description still covers the case neatly.

A magnetic bubble is a minute, localized reversal of the magnetic field present in a thin sheet of garnet material. This garnet has various elements added to it, principally rare earths, which direct the magnetic field to be normal to its surface. Thus, bubbles may be seen as tiny mobile magnets with one pole at the top surface of the garnet film and the other at the bottom.

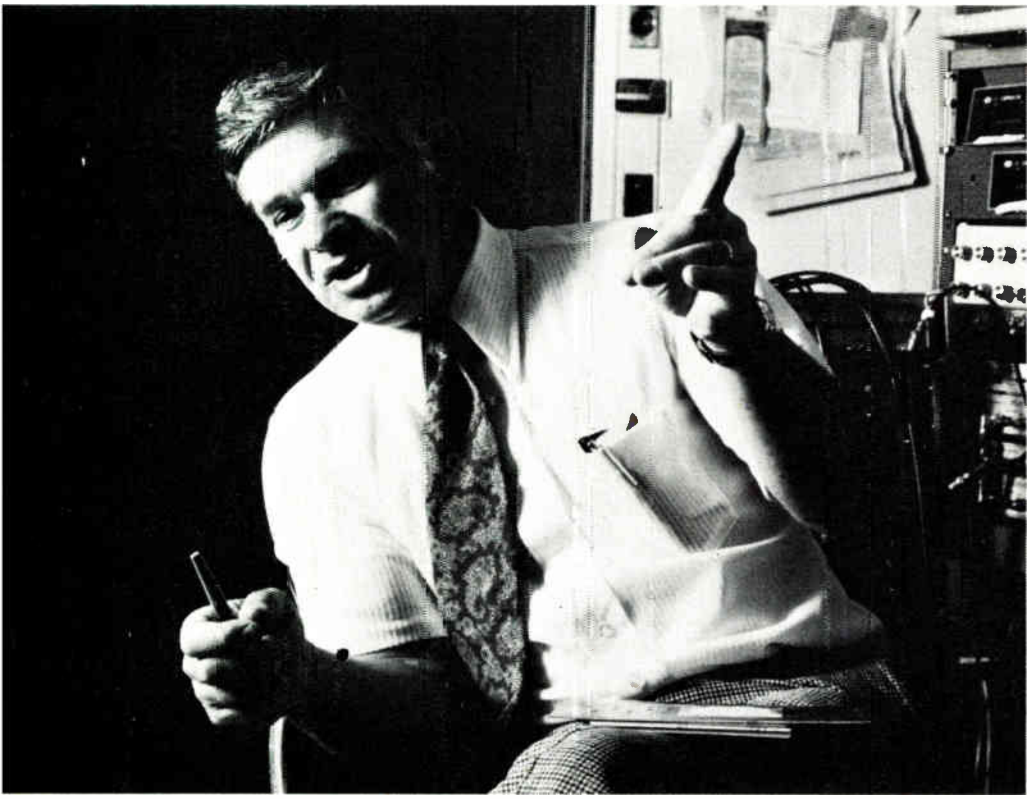
What Bobeck did was make the magnetic vectors perpendicular to the garnet surface. Previous experiments had been conducted with magnetic materials having in-plane magnetization. This field, though parallel to the surface of the material, could also be reversed to form domains and these, like bubbles, could be moved around. But the

The 1979 Achievement Award

For his role in the invention of magnetic-bubble technology and his continuing contributions to the field, Andrew H. Bobeck of Bell Laboratories in Murray Hill, N. J., has been designated by the editors of *Electronics* as the recipient of the magazine's sixth Achievement Award. His feats—his name is on approximately 100 bubble patents, including the first one—have made possible memories many times denser than those made with semiconductor technologies.

Previous winners have been: in 1974, Gordon E. Moore, president of Intel Corp., for his overall accomplishments; in 1975, the four developers of integrated injection logic: Horst Berger and Siegfried Wiedmann of International Business Machines Corp. and Arie Slob and Cornelius Hart of Philips of the Netherlands; Robert C. Dobkin of National Semiconductor Corp., in 1976, for linear-circuit development; in 1977, Charles H. House of Hewlett-Packard Co. and B. J. Moore, president of Biomation Corp., for major instrumentation innovations; and in 1978, Paul Richman, president of Standard Microsystems Corp., for advanced developments in MOS technology.

ANDREW H. BOBECK



When Andrew H. Bobeck started his exploration of magnetic-bubble domains almost 20 years ago, the work was frustrating at times. He would find himself, as have so many other scientists, at the end of a blind alley with "nothing to work on," as he puts it. Many people on his team left because, as Bobeck says, "some people must have a specific assignment," they simply can't cope with the indefinite. "It's nice to be left alone," he says, but the feeling of not knowing whether there is a sure way to success can take its toll. But Bobeck kept on, following his instincts and those of others, and found a way past those dead ends. The result was the magnetic bubble, a memory technology that is relatively young by current standards.

Now Bobeck and others are working on second-generation developments. Though the field-accessing method of bubble propagation is universally used today, another technique is already being talked about among cognoscenti of the art: current or conductor accessing of bubble memories.

To understand it, consider the analogy between the fields taken on by the tiny bars of magnetic Permalloy on the surface of the garnet structure and the fields generated by a slot cut in a sheet

domains had a sloppy shape and a preferred direction of movement. Hence the idea of standing the field on end was the essential idea behind magnetic bubbles.

Assuming it has its negative pole pointing upward, a bubble can be moved by positioning a positive magnetic pole nearby. The two poles attract each other; as the bubble migrates, the magnetic vectors immediately ahead of and behind the bubble reverse their directions so that the diameter of the bubble remains nearly constant.

There are two ways to fashion little magnets on the surface of the garnet and thus two ways to move bubbles. The first is to put tiny bars of magnetic Permalloy on the surface. The chip is then embedded in criss-crossed coils of wire; these produce a spinning magnetic field parallel to the garnet surface. The Permalloy shapes, being easily magnetized and demagnetized, take on the field, and the rotating polarity resulting in each shape can attract bubbles and pull them along. This method, called field accessing, is employed by every bubble device on the market today. The next advance, which Bobeck is working on, is called current or conductor accessing (see above).

Bobeck singles out the practical application of domain work as the contribution made by him and his fellow Bell Labs researchers. "Domain patterns had been studied for years before bubbles came along," he says, "but none of the people involved were interested in devices."

In any event, after the meeting that came up with the orthoferrite solution it took three more months to get real bubbles, with the next milestone being a materials advance. "Bubbles in orthoferrite were very large—a thousandth or five thousandths of an inch," says Bobeck, "and interest would have died except that work went on in optical memories using, for example, garnets. We would slice crystals and look at their structure—garnets were thought to be unsuitable because they had many different magnetization directions. But once in a while we'd discover a garnet with a single preferred direction." Bobeck reasoned that the preferred direction was the result of stresses in the garnet lattice, so it was possible to find a preferred perpendicular direction by stressing the crystal with the right impurities. "So we went to the materials research department."

There, the researchers found "an old work by Shuichi Iida, done while he was at Bell Labs." Based on the earlier efforts of Iida, now a professor at the University of Tokyo, Bobeck tried to balance garnet with rare earths to eliminate the stress sensitivity. "We got a mixture that gave zero stress, so we grew it, polished it, and months later had beautiful domains," says Bobeck.

But that was not the end of his materials problems. "We couldn't slice the material to get the small—micrometer-size—bubbles we needed, so we had to go to epitaxial film growth," explains Bobeck. This was truly a breakthrough, he says. "Growing the first really good epi film—that was the beginning of the first real bubble device."

That occurred in the early part of

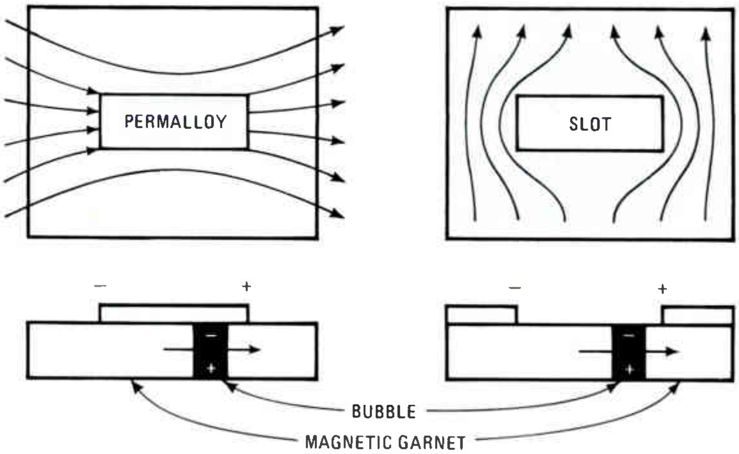
of material conducting an electric current. In both situations, magnetic dipoles are formed that can move bubbles. This analogy is illustrated in the large figure at the right.

Bobeck is presently perfecting that perforated-sheet, or current-accessing, approach to bubble movement. As the diagram shows, while field accessing (a) uses the doughnut hole to form magnetic dipoles, current accessing (b) uses the rest of the doughnut to accomplish the task.

Bubble motion is induced within a current-access device by applying an electric current to the sheet. And Bobeck has found that smoother operation is realized by using more than one sheet. The smaller diagram at the right shows how the currents in two sheets can be reversed to transport a bubble. The shaded apertures correspond to the broken lines representing current flow.

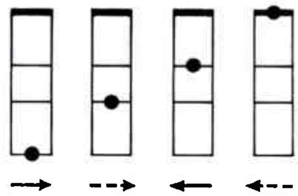
The advantages of current-accessed bubble memories are so many that it is no wonder that Bobeck is captivated by the possibilities. By eliminating the coils of wire that must be used in field-accessed devices, current-accessed units can be operated much faster and at frequencies approaching 1 megahertz. Not only that, but the technique offers the tantalizing possibility of operating at +5 volts only.

Bobeck had been using Permalloy in his field-accessed devices, but only for bubble-detection circuitry. Now he has eliminated this last bit of alloy with a scheme using radio-frequency detection. In his next device, the only magnetic material will be the garnet harboring the bubbles.



(a) FIELD ACCESS

(b) CURRENT ACCESS



BUBBLE PROPAGATION

this decade, and, as Bobeck points out, no replacement for garnet has yet been found. Two-inch wafers are now being produced, with some 3-in. work going on at Bell Labs, says Bobeck.

The trip to honors and recognition has been a relatively direct one for Bobeck. It started in Tower Hill, Pa., a coal-mining town near Pittsburgh. There, his father, who was born in Poland, worked in the mines as an electrician, then opened a grocery store. While Bobeck was still a youngster, the family moved to Youngstown, Ohio, where his father ran a grocery store and then worked in the steel mills. In high school, young Bobeck was being prepared for a good job, that of a sheet-steel layout man, "because I was good at drafting."

But while serving in the Navy during World War II, Bobeck heard about the V-12 program that sent servicemen to college to earn technical degrees. He applied, passed the exam, and spent time at Purdue University, Wabash College, and the University of Illinois. He had to return to Purdue after the war to complete his BSEE and get his MSEE—and that was the end of his formal university training.

One of Bobeck's professors at Purdue had worked at Bell Labs during summer vacations, so he thought he would give the labs a try after graduation. Bobeck was hired in 1949 and has been there since. He got into device work because he had liked his network and filter design courses, and that same professor had worked on filter design at the Labs. Working initially with an apparatus group that was heavily involved with military work, he spent a great deal of time with klystrons, magnetrons, and the like.

Bobeck first felt the pull of magnetics about the same time as the ferrite core emerged from Lincoln Laboratory and what was then called the Radio Corp. of America. Transistors also were new arrivals, and Bobeck was put to work building a core memory for what was to be the first solid-state computer, Tradic (for transistorized airborne digital computer). Bobeck built the first solid-state drive circuitry—"I was the only one who had access to high-power transistors"—and thus was ready for what he calls his first breakthrough: the twistor. By twisting a magnetic line—say, a wire—1s and 0s may be stored as a spiral flux in one direction or the other, meaning that the twistor can be read and written on. "Until a few years ago," says Bobeck, "this was the main nondestructive-readout memory in switching offices."

Bobeck's life is not all magnetics, although some of his best ideas have come to him while relaxing at home, he says. He lives in Chatham, N. J., with his wife and 14-year-old son (he has two married daughters, aged 26 and 24) and relaxes by playing golf at the nearby Fairmont Country Club, using golf clubs he made.

The future for Bobeck includes, he hopes, "coming across at least one more new thing." However, he sadly admits that it is becoming more difficult to find projects. "It's like mining diamonds," he says, "the good big ones are gone and you have to sift harder." □

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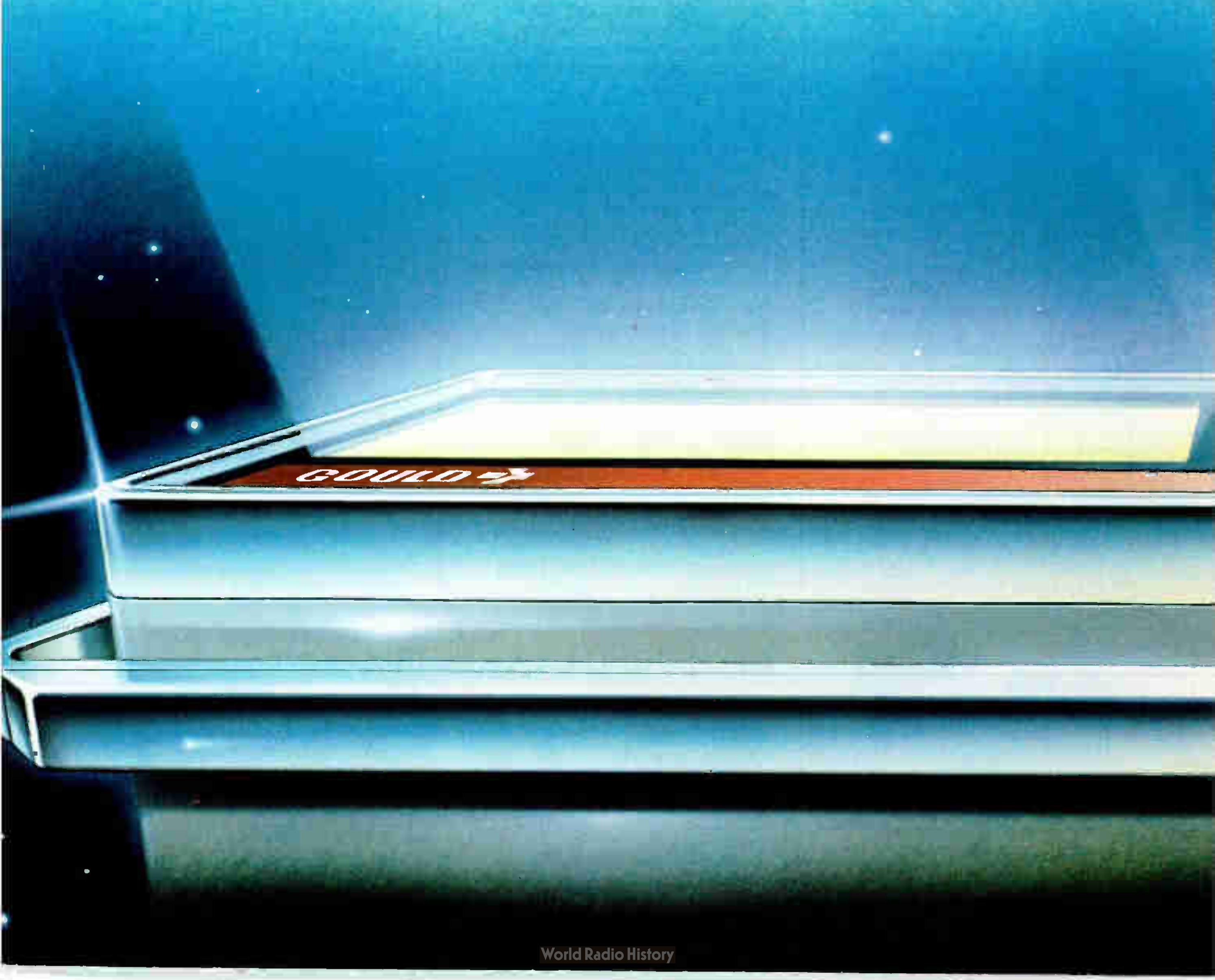

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CDP1859	4 Bit Latch/Decoder
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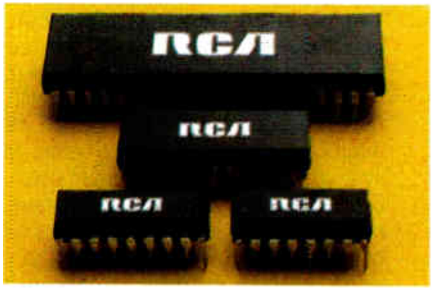
CDP1862	Color Generator Controller
CDP1863	Programmable Frequency Gen.
CDP1864	PAL Compatible Color Interface
CDP1866	1K × 4 Latch/Decoder
CDP1867	4K × 1 Latch/Decoder
CDP1868	4K TV Game Latch/Decoder



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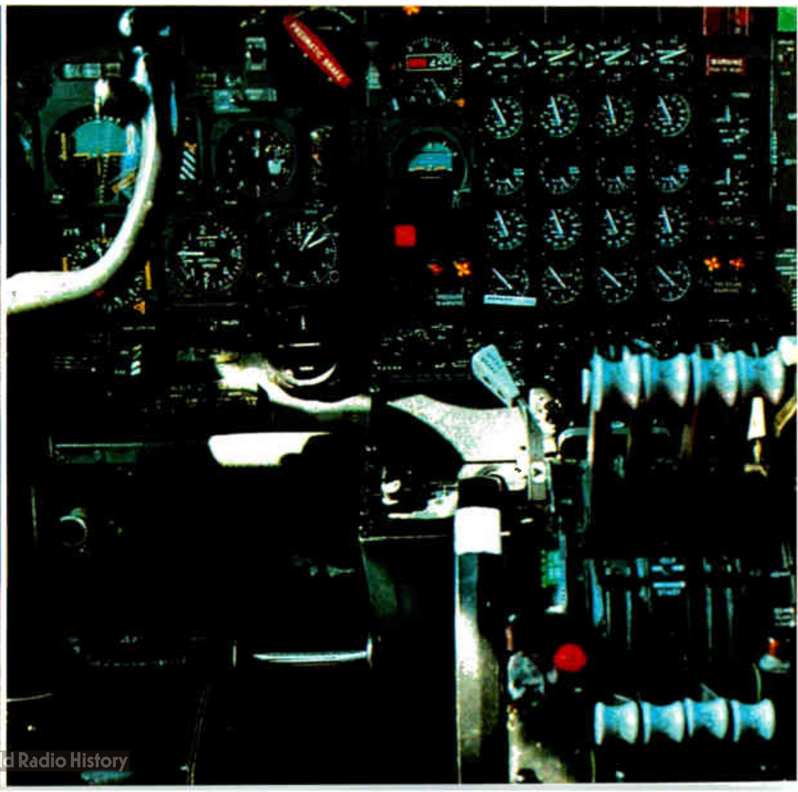
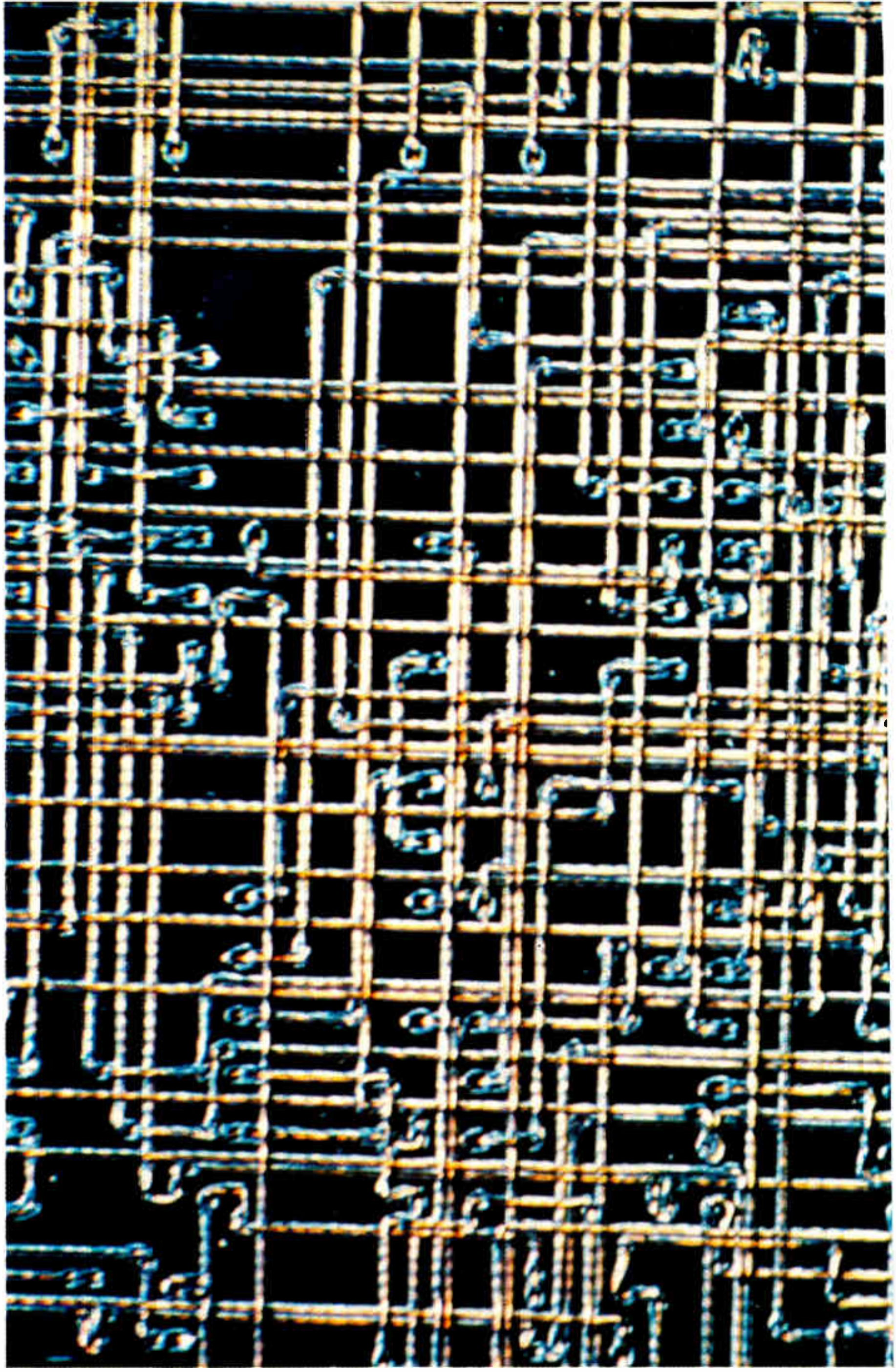


The decade is winding down, but the new Industrial Revolution generated by electronics is just beginning to gain momentum. The year 1979 will be remembered as the one when 16-bit microprocessors began to emerge in system designs, when single-chip microcomputers gained recognition as more than just controllers, when semiconductor memories extended the previous limits of speed and density, and megabit bubble memories became a reality. Accompanying these advances in component development has been commensurate progress in equipment and system capability: new mainframe computers with unprecedented combinations of price and performance, instruments that measure, control, and process signals faster and more accurately than ever before, communications systems that link not only people but computers and data banks anywhere in the world. There is no doubt that the innovative spirit that marked the technology in the 1970s will carry forward into the 1980s, bringing with it even profounder changes in our lives.



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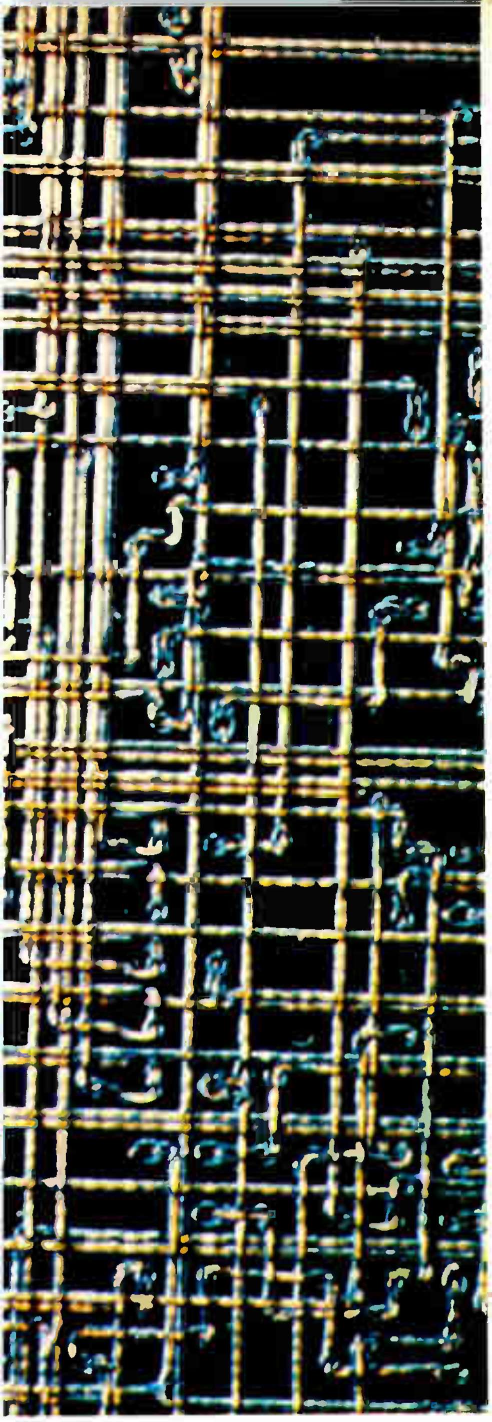
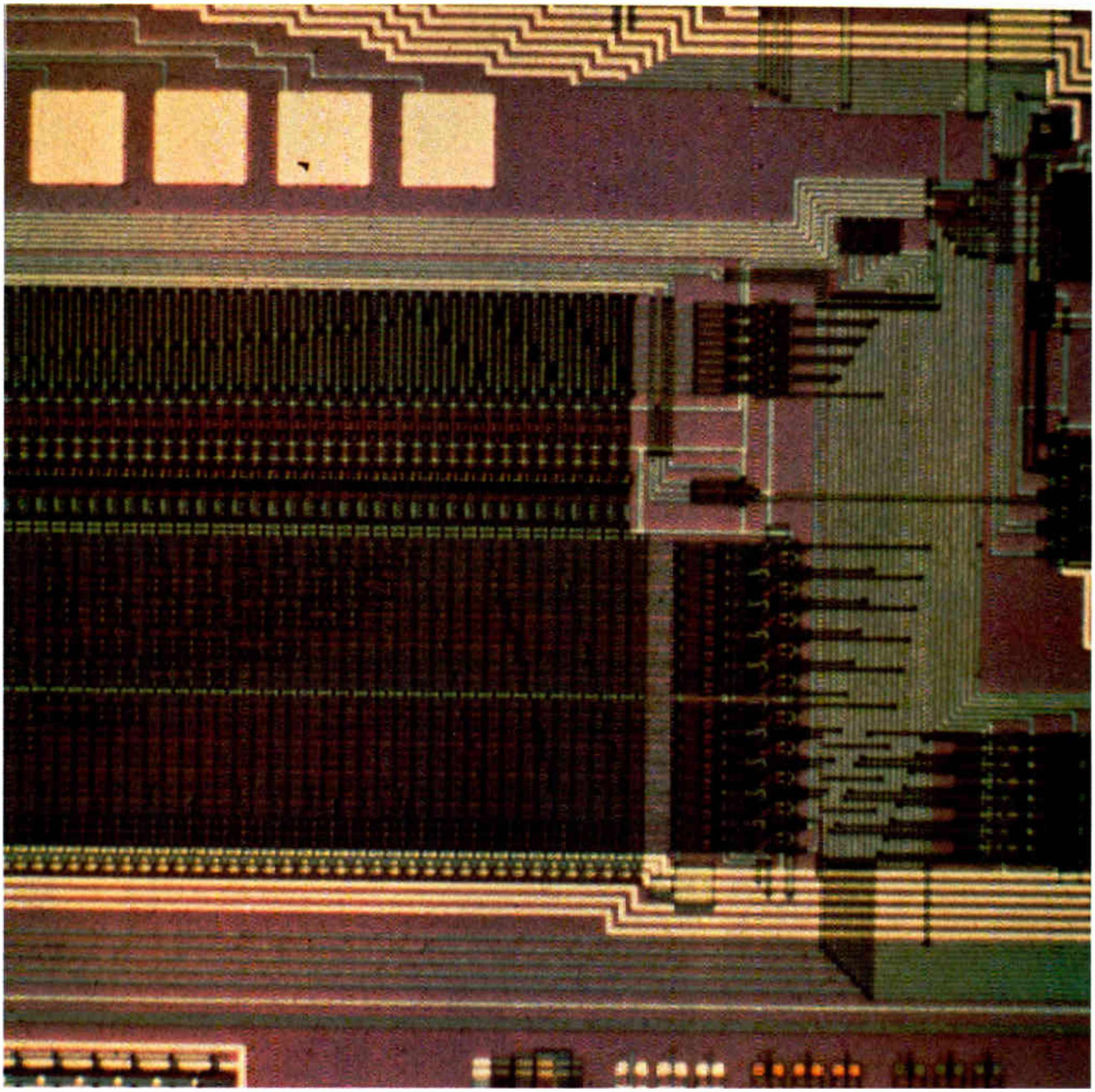


Graduating. Advances in density are attested to by a new Multiwire circuit board (far left), developed by the PCK Technology division of Kollmorgen Corp., that puts 4-mil wires on an 18-mil grid. In communications, boosting channel density is the aim of wideband networks linked by fiber-optic cable (above). The key to dense lithography is electron-beam exposure; at left, Hans Pfeiffer and Edward Weber pose with the system that they developed at IBM.



Semiconductors

by Raymond P. Capece, *Solid State Editor*

☐ *Semiconductor circuit designers are settling into a period of introspection. They have become aware that exotic processes can prove too expensive for commodity-type parts and moderate-speed applications: silicon on sapphire, for example, has been put on the back burner for all but those applications where its cost can be justified by its performance; and V-groove MOS technology, currently enjoying great success in the form of discrete power devices because of unmatched switching characteristics, has recently been shelved by American Microsystems Inc. as a standard memory process. The moral is that designers must choose more carefully than ever before in justifying process expense.*

Proceeding now with caution, they have settled down to the work at hand using the basic tools—oxide, metal, silicon, and polysilicon. They are summoning ingenuity to get more out of the usual n-channel MOS, complementary-MOS, and bipolar processes for analog and digital circuits. Progress continues to be made, however, in the research laboratories, and this year much groundwork has been laid for high-speed technologies of the future. Developments in gallium arsenide, C-MOS on sapphire, and other micrometer-dimension processes continue, proving out the switching speeds needed for the computer and communications applications of the coming decades.

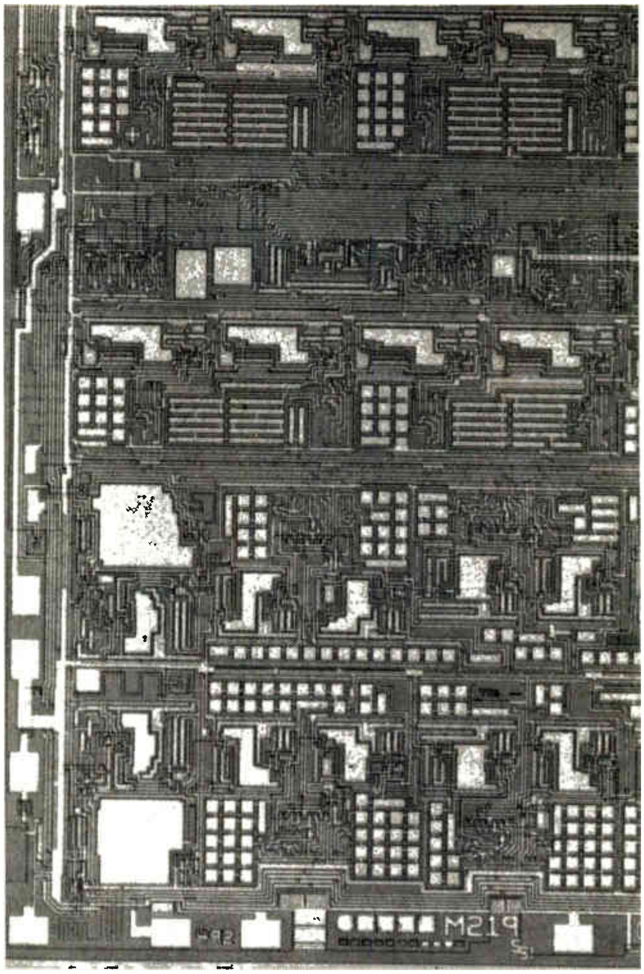
The cruelty of economics stung American Microsystems Inc., Santa Clara, Calif., as it closed down its V-MOS memory-production line. Although the company says the process will still be available for custom circuits, it will no longer be used for static or dynamic random-access memories. AMI, though, will continue production of 64-K V-MOS read-only memories.

The process, which relies on formation of an epitaxial layer and special anisotropic etching to form the walls of the V grooves, was clearly a more expensive one than high-performance n-MOS from the start; estimates put it at a 25% to 35% premium for equal production volumes of a given H-MOS (that is, high-performance MOS) part. But had it yielded well, its density advantage could have justified the cost difference. Whether development of the V-MOS process will continue elsewhere—Texas Instruments Inc. has rights to the process, and Siemens AG has worked on it, going as far as producing a 64-K RAM—remains to be seen.

Starring n-MOS

Alive and well, however, is high-performance n-MOS, which goes under the guise of HMOS at Intel and Motorola, S-MOS at TI, and X-MOS at National Semiconductor. Advanced Micro Devices Inc., Sunnyvale, Calif. has developed PolyPlanar, its name for a scaled-down MOS process that combines positive-resist projection lithography, dry plasma etching, and polysilicon load resistors. The process will first be used to give the 4-K-by-1-bit Am9147 (equivalent to the 2147), a 17,000-square-mil die.

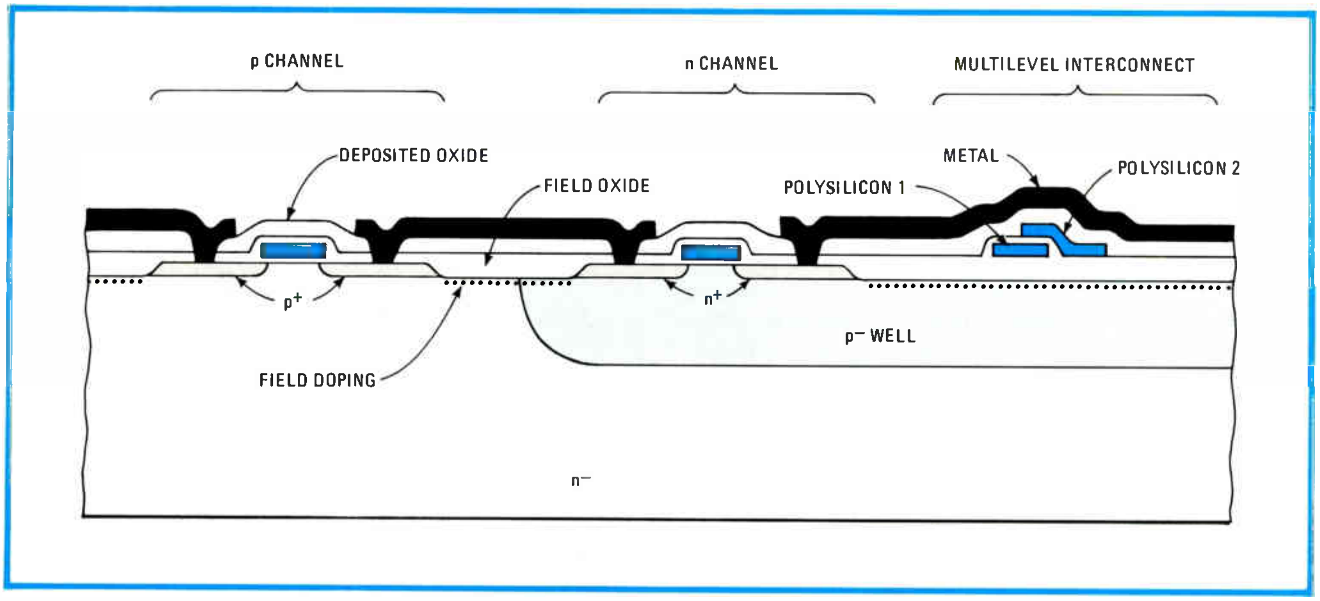
Channel lengths of 3 to 3.5 micrometers are becoming



Dense PLA. Portion of an experimental logic array chip built by IBM uses 1-μm channels to attain gate delays of about 1 ns.

commonplace in critical areas of memories and microprocessors wherever high speed is needed. Intel Corp. squeezed the critical dimension down to 2 μm in its high-speed static RAMs this year to overtake bipolar access times. Calling its process HMOS II, the Santa Clara, Calif., company found that by scaling down certain devices in its depletion-load 1-K and 4-K RAMs to 2-μm channel lengths and 400-angstrom gate-oxide thicknesses and by reworking buffer and other peripheral circuits on the chips, typical access times could be cut in half with only minor changes in its standard HMOS production process. That the HMOS II process was eased gently into its standard HMOS line is evidenced by the minimal changes in layout of the parts: the 2115H 1-K RAM die remained exactly the same size as the previous HMOS 2115A, and the new HMOS II 4-K 2147H was relaid out to 21,240 square mils from the 25,000 square mils of the 2147.

One of the newest sales pitches adopted by Intel for its 1-K and 4-K RAMs was immunity to soft errors caused by alpha particles. Broached this year at several confer-



New-wave logic. C-MOS is out to challenge n-MOS as a microprocessor technology. National Semiconductor's P²C-MOS, a ubiquitous-well process that uses two levels of polysilicon to boost density, will be used in the NSC800, a low-power rival of the Z80 and the 8085.

ences the susceptibility to alpha radiation of static RAMs using high-resistivity polysilicon loads quickly became a cause for concern. The depletion-mode transistor loads used in standard six-transistor static cells (which Intel still uses) show no such susceptibility.

It was determined that sufficient current flowing through the loads (therefore, lower-resistivity polysilicon) could stem the soft-error problem, but that solution meant a limit for the devices on how low the power needed could go, in an industry that is striving to cut power consumption.

Yet some manufacturers' RAMs with multigigohm polysilicon loads showed no soft errors. Apparently, those that use epitaxial processing or reverse-biased junctions in the memory-array area of the chip—such as Hitachi Ltd.'s HM6147 and RAMs used by Bell Laboratories—produced electric fields that shunt away alpha-generated carriers. In any event, the problems of alpha-induced soft errors in static and dynamic RAMs do not seem insurmountable; passivation schemes, like those currently under investigation that use organic materials, could eventually eliminate the problems once and for all.

C-MOS's advantage

Complementary-MOS static RAMs, regardless of whether they are built with full six-transistor cells or n-channel, polysilicon-load arrays, have shown an inherent immunity to alpha particles. That point adds to the attractiveness of these parts, which are already looking better in terms of speed and density. Next year will see samples of 16-K C-MOS RAMs that are by all definitions examples of very large-scale integration: with six transistors per cell, a fully C-MOS 16-K RAM will pack over 100,000 devices on a chip. Indeed, high-density memories will test the mettle of all chip makers; but the prospects of high performance at the lowest possible power have C-MOS manufacturers aggressively chasing down n-MOS speed and density.

Many companies eschewed sapphire for high-performance complementary-MOS designs in favor of bulk C-MOS approaches, which have improved radically in speed and density over the last few years. C-MOS on sapphire may, however, excel at some point in the future, when its much lower power consumption and superior density will be exploited to justify the high substrate cost.

New workhorse

More exciting are the potentials being realized right now for C-MOS. That several manufacturers are building or have announced plans to build popular n-MOS microprocessors and microcomputers in C-MOS evidences the trend toward making C-MOS the workhorse process of the industry. Memories make an even better case for C-MOS—since in most systems the majority of memory components are idle more than they are accessed, the low standby power of C-MOS can pay off in reduced power-supply costs. What's clear is that although C-MOS still has a way to go in achieving speed and density goals, few circuit designs can match it in overall power dissipation and absolutely no other technology can offer its automatic power-down feature.

Redoing in C-MOS

Low-power microprocessors must certainly be in demand, since so many manufacturers have elected to build C-MOS versions of standard devices. Substantial volumes will be produced this year by nearly a half-dozen chip makers: Motorola Inc.'s Semiconductor Group, Phoenix, will produce its 4-bit microcontroller, the MC14100, and its 8-bit microcomputer, the MC146805, in C-MOS and could well begin implementing its high-performance designs in C-MOS this year as

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well. Mitel Semiconductor Inc., Bromont, Ont., announced plans to build Motorola's 8-bit 6802 microprocessor, which should be available by year end. Meanwhile, Intersil Inc., Cupertino, Calif., has offered a C-MOS 12-bit microprocessor, its 6100, for years and now will build Intel's 8-bit single-chip 8748 with on-chip erasable programmable ROM (E-PROM) in C-MOS. Nearby National Semiconductor Corp., in Santa Clara, has ambitiously undertaken a new microprocessor project with its NSC800, an 8-bit microprocessor with a multiplexed-bus architecture like Intel's 8085 (but using the internal architecture and an instruction superset of the Zilog Z80), built with a new double-polysilicon process National calls P²C-MOS.

Taking a rather different tack, RCA Corp. is still plugging away at the 8-bit 1802 in C-MOS on sapphire while readying a pair of parts: a single-chip version called the 1804 and an SOS version of Intel's 8085 microprocessor. Elsewhere, Harris Semiconductor, Melbourne, Fla., which also builds the 12-bit 6100, is settling on which 16-bit design to second-source in C-MOS; and American Microsystems, with a new emphasis on its C-MOS capability, will also build a C-MOS version of a yet undisclosed 16-bit microprocessor.

Not surprisingly, these implementations will cost a premium over their n-MOS models—applications demanding low power usually result in a more expensive end product. But what may be surprising is the fact that the new-generation C-MOS designs are not sacrificing performance. In some cases, the C-MOS product actually outperforms the n-MOS one. For example, Mitel's 6802 will run off a 5-megahertz clock, whereas the original n-MOS part has a maximum clock of 2 MHz. And though the power dissipation of C-MOS does increase with clock speed, the Mitel MD46802 typically dissipates only 15 milliwatts at 1 MHz, whereas Motorola's part dissipates more than 20 times that figure.

Good and dense

As for density, C-MOS may be in a better position than originally anticipated. One reason is that it is fully static; n-MOS microprocessors and other logic devices are relying more heavily than ever on clocked, or dynamic, circuitry to reduce power consumption, and running those clock lines all around the chip eats into density. As a result, today's second-generation C-MOS devices are paying an average density penalty of only about 20% over n-MOS. Again, Mitel's 6802 is about 34,000 mil², which is less than Motorola's first pass on its n-MOS device.

In its implementation of the NSC800, National is using two layers of polysilicon to aid density. As the figure on page 106 shows, the second polysilicon level permits crossovers and, combined with the first level and the metalization, allows more interconnect freedom and hence better circuit density.

The current C-MOS generation has lots of room for improvement as well. Most processes, like those of Mitel, Motorola, and National, are using 5-μm lines and spaces, which is where n-MOS was in its last generation. Still, the performance is respectable: the NSC800 will offer a 1-microsecond instruction cycle time, matching the n-MOS parts. Mitel's Iso-CMOS has performed excellently in gate arrays, where 4-to-5-μm channel-length devices have shown better than 5-nanosecond gate delays operating at 10 volts.

Even though the higher supply voltages needed for greater speed markedly increase power dissipation, the C-MOS master-slice arrays are still relatively low in power. Low-power Schottky TTL gates in their present form could not number 2,000 on an array, as Mitel is achieving with Iso-CMOS.

A further advantage of C-MOS is its wider supply voltage range. Operating from 3 to 12 V, as many of the C-MOS microprocessors do, means inherently greater noise immunity than with n-channel circuits and also permits the use of batteries. Mitel's 6802, in fact, shifts its voltage range from 1 to 7 V, making it the first 1-V microprocessor. And because it powers down to as little as 10 microwatts, it can be operated at slow speed from the same size battery that drives a digital watch.

I²L interjects

Although it does not have the automatic power-down feature of C-MOS, bipolar integrated injection logic (I²L) can have its injection current programmed to trade off speed for power. It can therefore cover a large performance range, and does so in applications today from watch chips to bit-slice microprocessors. At the same high-performance end of the spectrum, where I²L has a respectable following in gate arrays and processors like Texas Instruments' SBP9900 16-bit microprocessor and SBP0400 bit-slice processor and Fairchild Camera and Instrument Corp.'s 16-bit 9440 microprocessor, the effects of scaling down and the introduction of Schottky

NEW TRANSISTOR-TRANSISTOR-LOGIC FAMILIES

Manufacturer	Family	Typical power per gate (mW)	Typical propagation delay per gate (ns) 15-pF load	50-pF load	Typical maximum toggle frequency (MHz)
Fairchild Camera and Instrument	FAST	4	2	3	130
National Semiconductor	LS²	2	5–6	7–8	32
Raytheon	Advanced Schottky (54/74 AS)	20	1.5	2.2	200
Texas Instruments	Advanced Schottky (54/74 AS)	22	1.5	2.8	200
	Advanced low-power Schottky (54/74 ALS)	1	4	6	50

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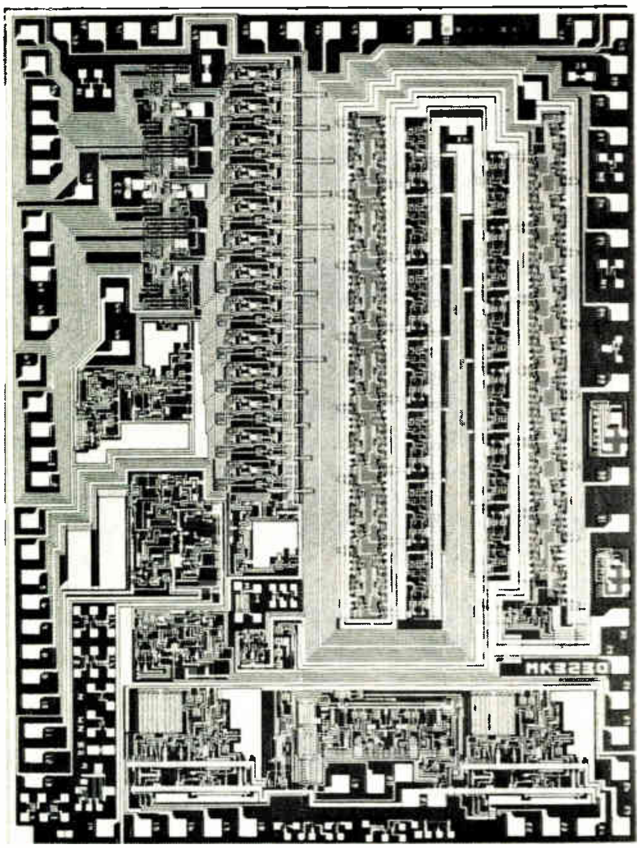

Mixers. This 13-bit analog-to-digital converter from Matsushita, like many other linear devices under development, mixes processes. I^2L builds the logic circuits, p-channel MOS the sample-and-hold, and high-speed bipolar transistors drive outputs.

contacts (rather than ohmic ones) are being investigated. At TI for example, scaling down the active areas of its I^2L bit-slice processor from 3 μm to slightly more than 1 μm has tripled speed, reducing in-circuit gate delays to below 5 ns for a 25-microampere gate-injection current.

Adding Schottky contacts, which quash charge-storage delays, has been shown to double the speed of I^2L circuits. Signetics Corp., Sunnyvale, Calif., is using a Schottky-based injection logic (developed by parent company NV Philips Gloeilampenfabrieken in the Netherlands) called ISL to build gate arrays with typical gate delays of a few nanoseconds for injection currents of 150 μA per gate. In pressing toward extremely fast VLSI circuits, TI is pursuing Schottky transistor logic (STL). Using it, the firm has demonstrated gate delays of less than 1 ns and power-delay products of less than 50 femtojoules. STL is a candidate for electron-beam lithography, since TI has scaled the bipolar process down to 1-μm active regions.

SSI and MSI speed up

LSI chips are not the only bipolar circuits, however, to pick up speed. This year small- and medium-scale integrated logic circuits came under attack by TI, Raytheon Co., Fairchild, and National Semiconductor, all of which decided that fast or lower-power TTL family parts were marketable (see the table shown on p. 109). Though the technology for improving on SSI and MSI logic parts represents no great developmental feats—the use of scaling, Schottky-clamped inputs, and supplanting diffusion with precise ion implantation—the question is whether it can be done profitably. The new parts will cost about 25% more than standard Schottky but will have a far smaller customer base.

If faster logic circuits are the order of the day, faster memories are called for, too. Intel has acknowledged that with its HMOS II RAMs and its bipolar fuse-link programmable ROMs. Having reached at the 8-K density level and fast approaching 16 K, Intel is relying on its polysilicon know-how (rooted in MOS) for fuse-link technology, whereas others, like Harris Semiconductor, are using Nichrome, and still others tout titanium tungsten. Intel's parts are the fastest and densest thus far, however, currently offering a 40-ns access time.

Fairchild, in Mountain View, Calif., is using its new Isoplanar S (for scaling) process to build both faster PROMs and RAMs. Equally applicable to emitter-coupled-logic (ECL) circuits and TTL, Isoplanar S will move eventually to 64-K static density with 1-μm active regions using direct-wafer-stepping equipment.

Turning to polysilicon

It appears that several manufacturers of bipolar integrated circuits are exploring the possibilities for polysilicon as both interconnections and resistors. In Japan, Oki Electric Industry Co. is using polysilicon in its base-emitter self-aligned technology (BEST) to reduce emitter size, lower parasitic capacitances, and provide low power consumption through the use of high-valued polysilicon load resistors.

Nippon Electric Co. too has a polysilicon self-aligned (PSA) process that aims at the same advantages. The goal is denser, lower-power bipolar circuits that will lend themselves to VLSI.

As process familiarity increases, designers have ventured into mixing technologies on a single chip to best take advantage of the strengths of each. Specifically, several different bipolar combinations are being tried. For one, Signetics has produced custom chips comprising ISL, ECL, and low-power Schottky TTL circuits. For another, Japan's Toshiba Corp. is developing a process that mixes I^2L with ECL circuits, with the aim of combining dense I^2L circuits with 4-gigahertz ECL transistors in order to make digital phase-locked–loop television tuners a practical reality.

Other mixes

The growing trend toward LSI circuits that mix analog and digital functions had its start in circuits that mix technologies. The Japanese especially are pursuing technology mixtures.

For instance, Matsushita Electric Industrial Co. has built an analog-to-digital converter that combines three: p-channel MOS for its sample-and-hold circuit, I^2L for

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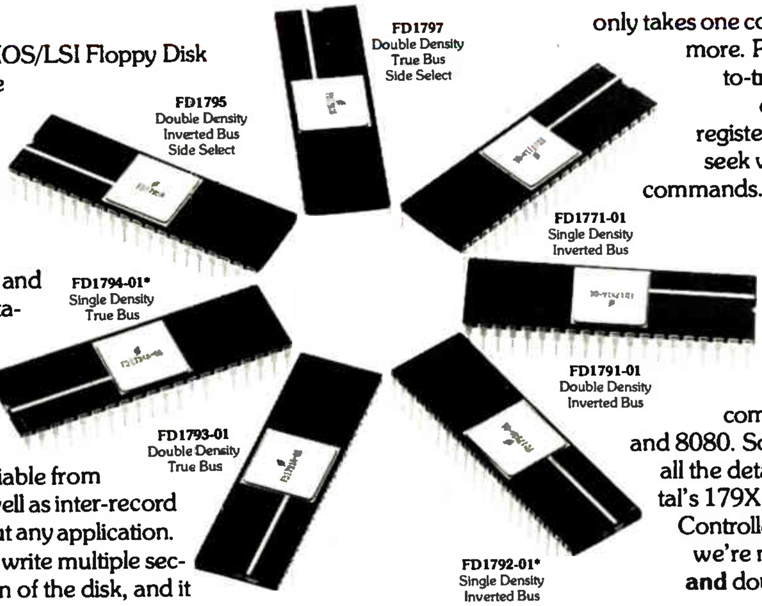

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the comparator and control logic, and ion-implanted npn transistors for output buffering.

Although bipolar technology seems a good candidate for linear-digital LSI, some argue that C-MOS is the most practical. Its low-power operation is a clear advantage, but it was never really regarded as a respectable analog-circuit builder—its noise levels and offset voltages in differential circuits resulted in an inferior operational-amplifier design.

However, circuit developments over the last year may change the C-MOS image. Designs now help skirt the inherent disadvantages and have resulted in op amps with reasonable performance. Intersil introduced a family of C-MOS op amps with various offerings of slew rate and standby current. Although the devices do not quite match bipolar counterparts in noise figures and slewing, the microampere levels of standby current will place the parts into areas where bipolar devices cannot excel, such as hearing aids and other low-power applications.

C-MOS filters

High-gain C-MOS op amps are essential to a new IC technique called switched-capacitor filtering. Extremely accurate audio-band filters with very low drift can be implemented on a chip with the technique that basically assembles standard RC filters but commutates a capacitor to realize the resistor. The result is a filter whose accuracy is dependent solely upon two parameters: capacitor-switching frequency, which is readily established and maintained with a crystal oscillator; and the ratio of on-chip capacitors, which is fixed by the ratio of metal areas during chip layout.

The first commercial product to use the switched-capacitor filter approach was a dual-tone multifrequency (DTMF) receiver chip—commonly called a Touch-Tone decoder—manufactured by Silicon Systems Inc., Irvine, Calif. Many other products will use the technique, which lends itself well to large-volume, fixed-function applications such as filters for coder-decoder (codec) systems.

Data acquisition

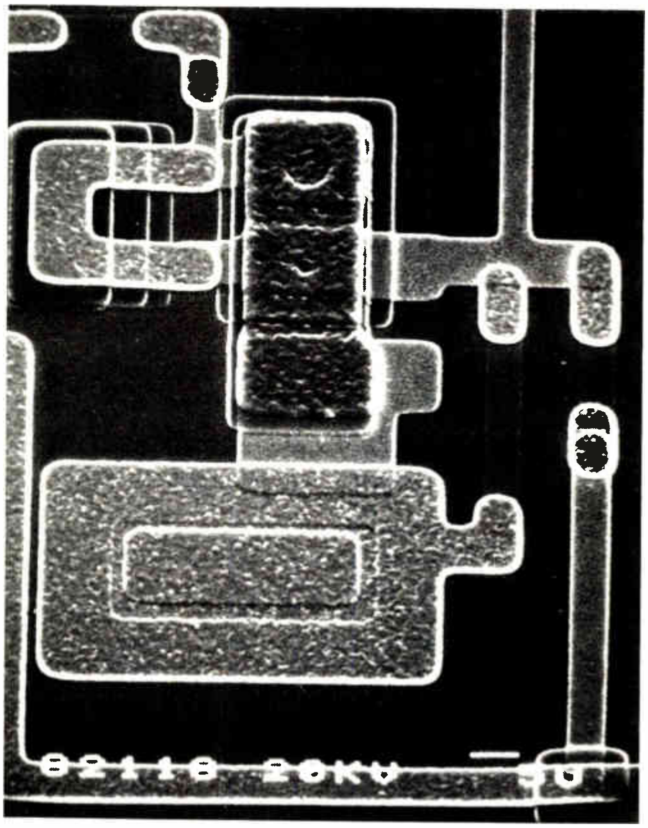
C-MOS is looking strong for data-acquisition systems as well. Intersil, National Semiconductor, and Harris Corp. have the expertise and are expanding to provide full lines of components from the sample-and-hold circuit to the microprocessor interface. Designers are getting more and more out of the process: inherently available in C-MOS is a bipolar transistor, which can be used especially well to provide high output-current drive. Building the npn transistor is simple: the p well serves as a base, an n^+ diffusion as an emitter, and an n-type substrate as the collector. With its collector (substrate) tied to the positive supply, the transistor can only be used as a pull-up device, or as an emitter-follower, but that is certainly no limit for an output-buffering device. The transistor's gain (h_{fe}) can range from 50 to 300 and its breakdown can be as high as 50 V.

Despite their current applicability only to very fast custom designs, circuits fabricated with gallium arsenide are beginning to take somewhat regular logic forms. Until now, no single logic form (like a TTL or an ECL) has emerged. One reason is that the material is difficult to passivate; thus MOS structures could not be readily built. Also, it has not become clear whether depletion-mode (normally off) metal-semiconductor field-effect transistors (MES FETs) will be a better design tool than enhancement-mode (normally on) MES FETs. Also, the voltage levels have not been established, although it appears that swings will be about 1 V.

Progress was made this year in attaining highest performance with what might be the simplest circuits to date. Researchers at Rockwell International Corp.'s science center in Thousand Oaks, Calif. have developed an all-planar process that uses Schottky diodes and depletion-mode MES FETs. The diodes actually carry out the logic functions, with the MES FETs used only for inversion and gain. Rockwell's circuits have shown both the best reported gate delays—136 picoseconds—and the lowest switching energies—16 femtojoules—of any GaAs circuits, regardless of transistor thresholds.

Faster, but . . .

In separate research, IBM Corp. and Rockwell came up with a bottom-line figure for the potential of GaAs. For identical MES FET circuits, at identical lithographic



Cryologic. On the road to superfast central processor applications, Josephson-junction technology realized major goals this year with the development of several types of logic circuits. Built by IBM, the OR gate shown has a switching speed of 13 picoseconds.

dimensions, GaAs should be six times faster than silicon, they say. It might appear that the speed advantage should be greater, since the carrier mobility of the compound semiconductor is many times greater than the mobility of electrons in silicon, but saturation velocities and other speed-limiting effects hold it down. A sixfold increase could almost be considered only a marginal improvement, especially since circuit techniques such as pipelining and parallel processing can boost the throughput of circuits just as well as raw speed can.

Not so limited, however, are the capabilities of Josephson-junction logic circuits, which are resorting to near-absolute-zero temperatures to attain switching speeds of only picoseconds. IBM's Thomas J. Watson Research Center in Yorktown Heights, N. Y., reported earlier this year the fastest circuit to date: an OR gate with a delay of 13 ps. The junctions, each comprising a sandwich of alloys and insulators, actually switch in 7 ps; transit time for the signal makes up the additional 6 ps.

IBM is fabricating larger logic circuits, having established reliable AND and OR circuits. Memories as large as 1,024 bits have also been built. The work is now aimed at reducing geometries from the current dimensions of 2.5-μm line widths and spacings to 1 μm or less. The reduction is aimed not at improving speed, but rather at reducing transit delays between circuits; Josephson junctions already switch as quickly as will ever be practical.

PROFILE

Aitken made a performer out of C-MOS

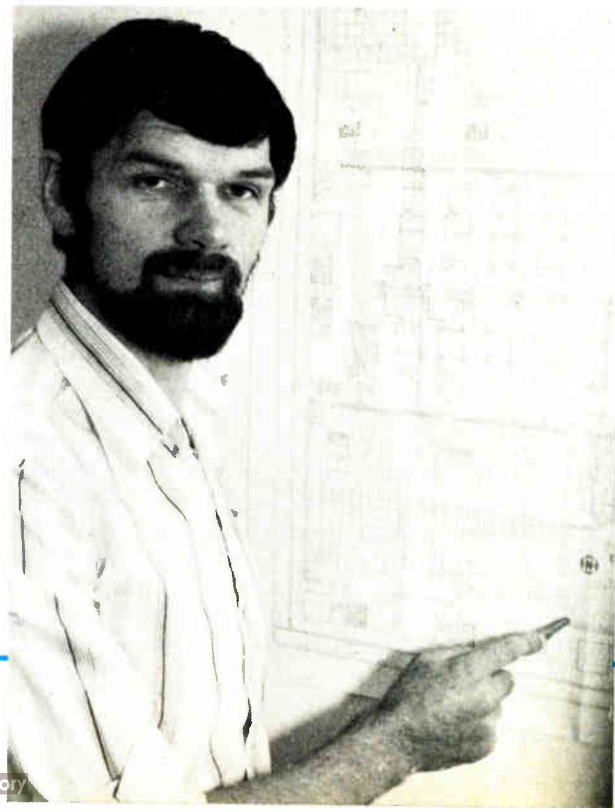
A man who has helped shift attention in the semiconductor industry from sunny Silicon Valley to the cold Canadian north is Alan Aitken, vice president of operations at Mitel Semiconductor Inc. The Bromont, Que., Canada, subsidiary of Mitel Corp., a telecommunications equipment maker, has attracted attention for its high-performance complementary-MOS process it calls Iso-CMOS, which Aitken, 37, was key in developing for Mitel.

Born and educated in Scotland, Aitken received his BSE at the University of Edinburgh and Ph. D. at the University of Strathclyde in Glasgow. His qualifications in semiconductors brought him immediately to Northern Electric Laboratory (now Bell Northern Research Laboratories) in 1969, where he worked on MOS and bipolar circuits. C-MOS—both with bulk silicon and with sapphire substrates—became the focus of Aitken's development effort. But when BNR decided sapphire was needed to meet the company's requirements for fast, low-power telecommunications circuits, Aitken sought alternatives: "When it came time to evaluate the SOS circuits," he says, "bulk-silicon C-MOS test circuits built with 2-micrometer channels showed the potential for equivalent performance."

But it was not until Aitken joined Mitel that he really achieved the kind of performance with his oxide-isolated (or ubiquitous-well) C-MOS process that he knew was possible. There, he and a staff he drew together comprising experienced engineers and new graduates from all across Canada came up with a different approach based on the same concept. The original oxide-isolated process underwent improvements to reduce circuit-slowing capacitances dramatically by profiling junctions and eliminating parasitics. Also, they optimized devices by reducing the active areas to improve speed further.

Although Mitel Semiconductor's original charter was to supply the mother company's telecommunications needs, it soon became clear that the C-MOS expertise brought by Aitken was marketable to the outside world, even beyond telecommunications interests. "There, the emphasis was always on low power, which C-MOS had from the start," he says. "But it was limited in other applications by a lack of speed and density." Aitken now feels he is over that hurdle. "We've got the speed to where it's comparable to n-MOS, and for logic circuits it will be comparable in density as well."

So Mitel has expanded its product line to include C-MOS versions of small- and medium-scale TTL devices, including octal bus transceivers, voltage translators, and display drivers. The most dramatic part, however, will be a C-MOS version of Motorola's 6802 microprocessor, due out later this year, that improves on the n-MOS device. Also, a fully C-MOS 4-K static RAM is on the way with an access time of well below 100 nanoseconds. What's more, drawing from his experience in SOS gate arrays at BNR, Aitken has come up with bulk C-MOS arrays now in production at Mitel with performance at least as good as n-channel MOS: 2,000-gate slices have delays less than 5 ns with 5-micrometer processing, and scaling to 2 μm will, according to Aitken, yield 1-ns gate delays. "The beauty is that we're at a point now where C-MOS is no more difficult to process than n-channel," Aitken explains. "And because it's fully static, it will beat dynamic circuitry in density for logic." **-Raymond P. Capece**



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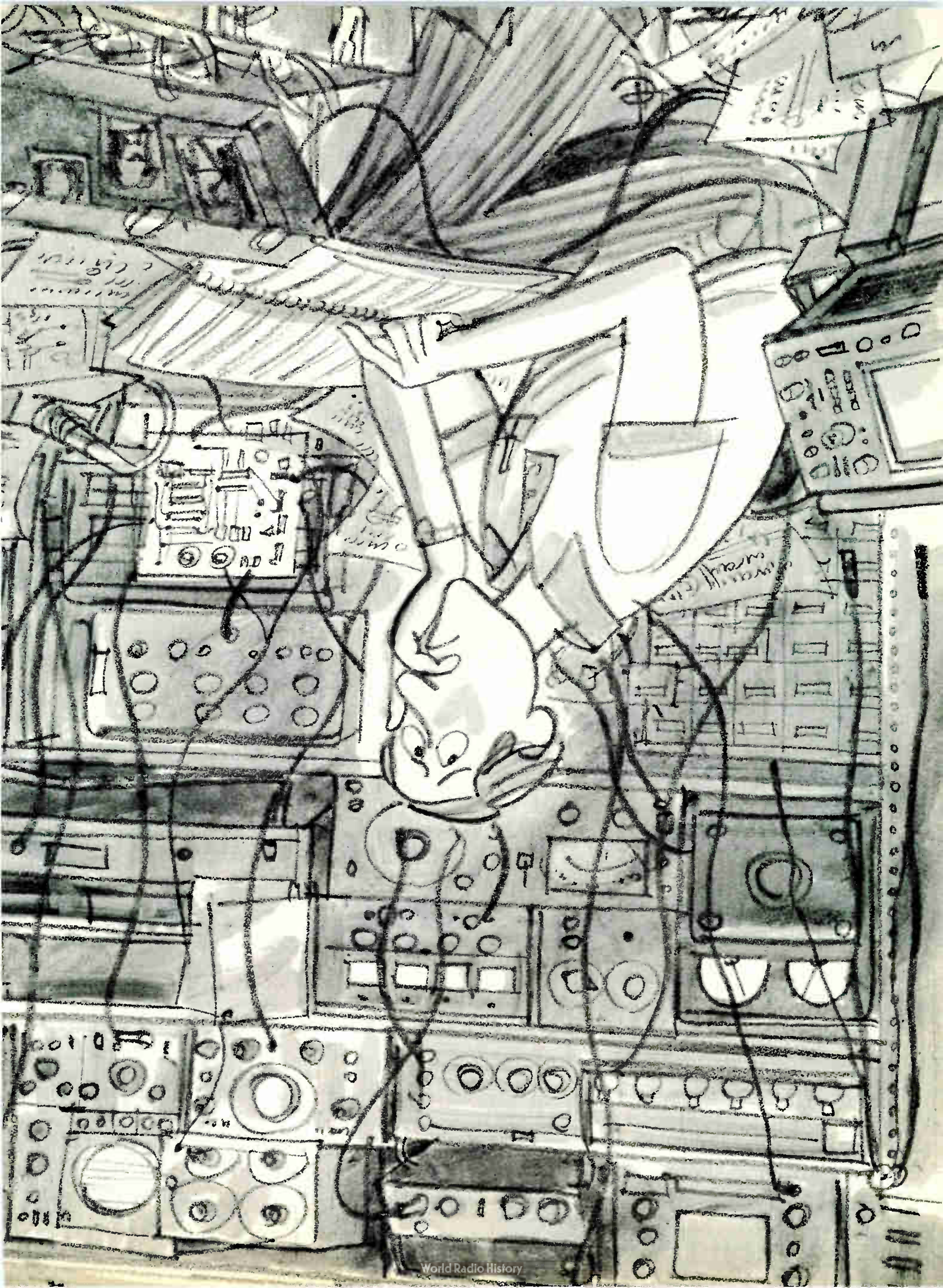

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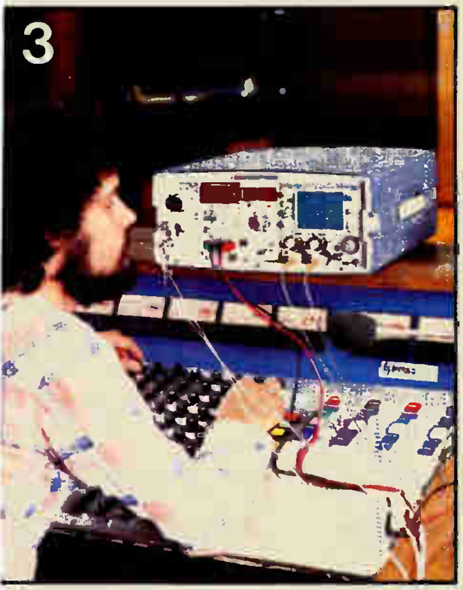

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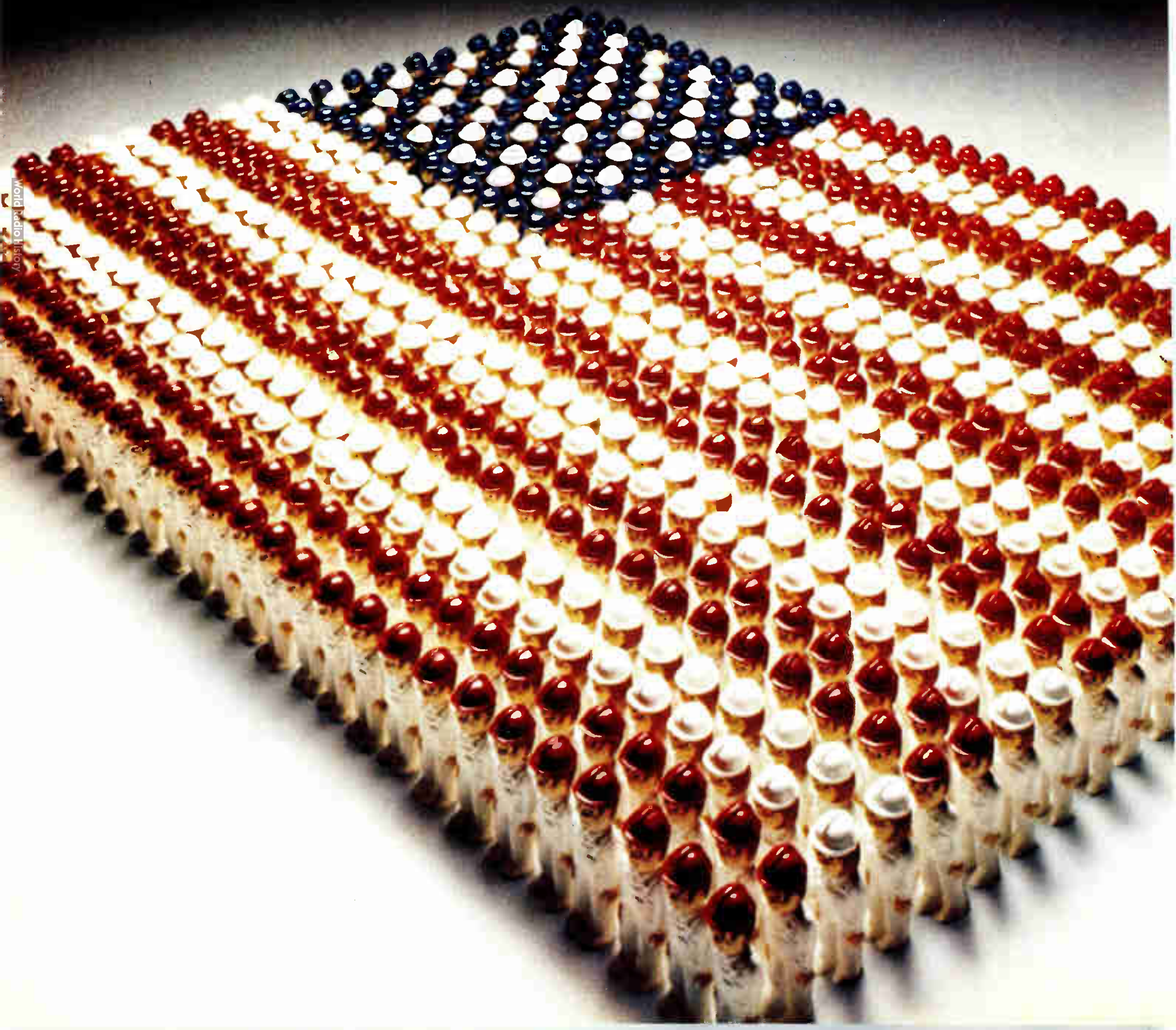

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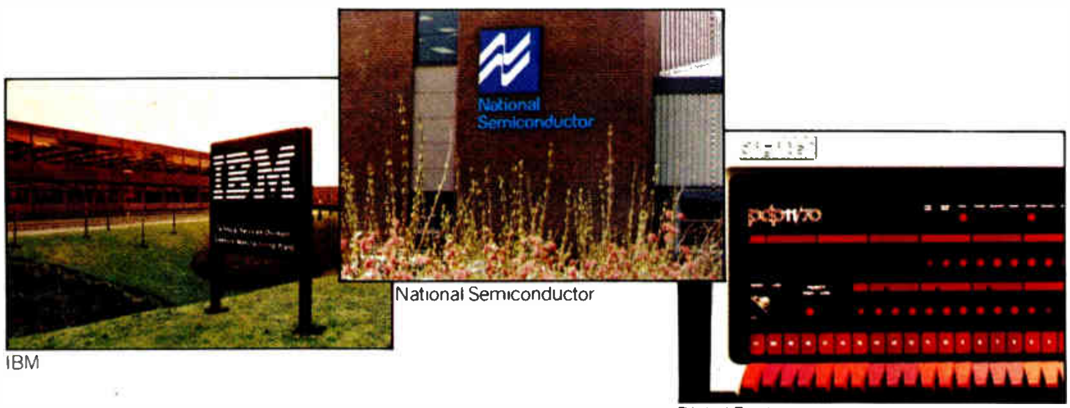

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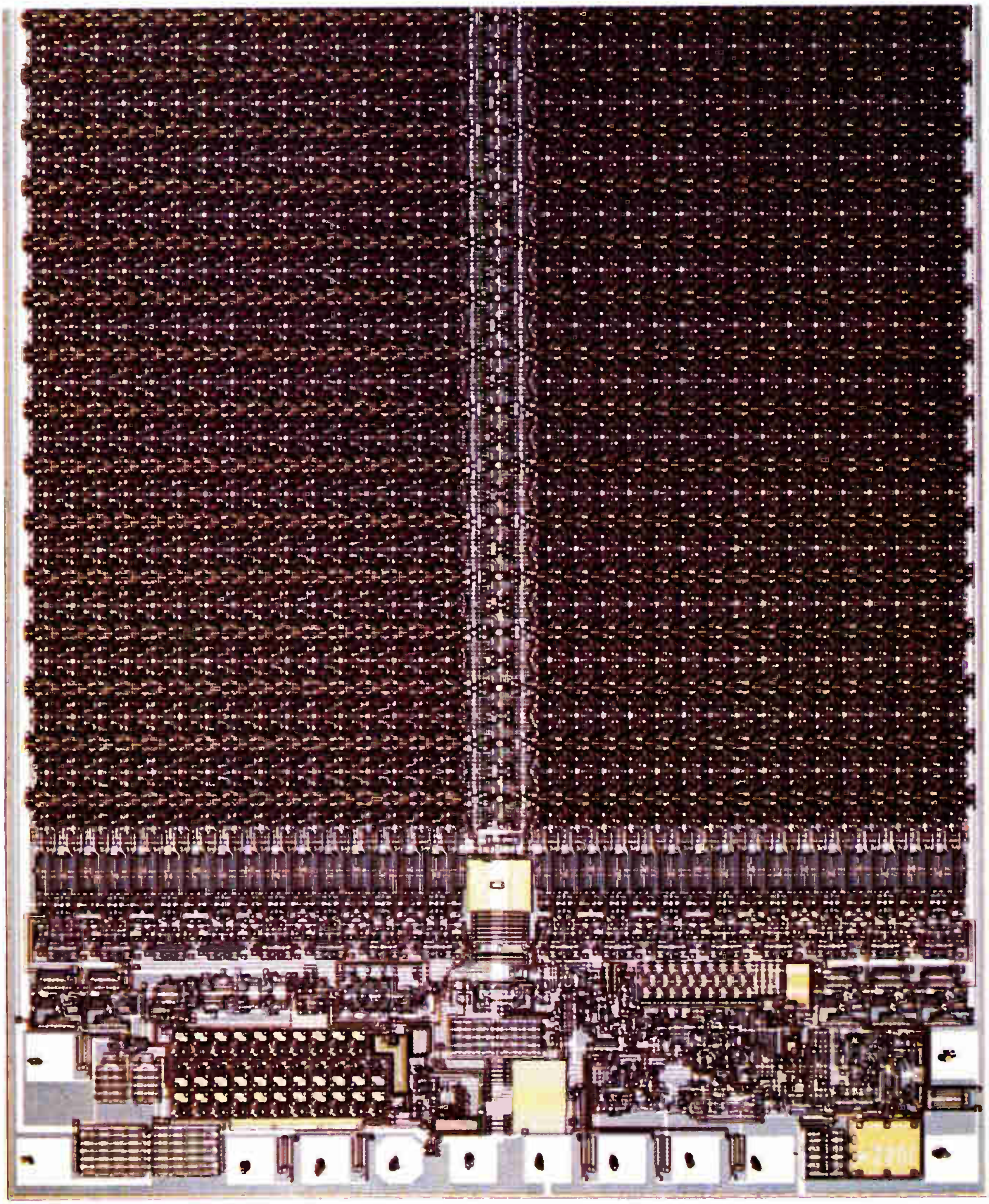


Memories

by Raymond P. Capece, *Solid State Editor*

☐ *Although it might seem that the path of progress in memory-device technology is clear—a beeline route toward higher speed and greater density—it is in fact a jagged one. Along the way in a given technology economic considerations or unanticipated technological phenomena can cause detours—the best example being the alternatives between static and dynamic memories that added to the considerations of cost, performance, and ease of use a recently discovered susceptibility to soft errors.*

Then there are dead ends along the route, as could well be the case with charge-coupled-device memories—lack of a sufficient technological or economic edge for survival. Now, more than ever, development diversions like those have emerged to alter the hierarchy of memory devices to such an extent that predicting a memory-device scenario even a few years hence seems folly.

It can be said: memory densities no longer simply double each year (with the exception of bubble-memory devices, relatively still in infancy); whether caught by cost or technology limits, the life cycles of today's memories have expanded to several years. These denser random-access and read-only memories recently developed—64-K ROMs and dynamic RAMs and 16-K static RAMs—have especially changed the memory utilization picture because of the relation of the storage capacity of the device to the system. For large systems relative to device densities, for example, the use of support circuits is justified. However, when the chip size is large with respect to the system, as it often is in microprocessor-based systems, support chips become prohibitively expensive. Consequently, the situation prompted such developments as pseudostatic memories, which surround a dynamic array with automatic refresh circuitry.

Memory technology in the next few years will find itself at many such crossroads. Processing difficulty when lithography descends below 3 micrometers, alpha-radiation susceptibility, and unforeseen developments like the possibility of storage based on a new phenomenon all complicate the picture. Above all, the determining factor is economics.

The 64-K dynamic RAM

Highlighting the news in memory developments over the past year is the single-supply 65,536-by-1-bit dynamic RAM, eventual heir to the industry-standard throne currently occupied by the 16-K (4116-type) three-supply device. Although dozens of chip makers produce 16-K RAMs all similar in type, design approaches to the 64-K successor took on many forms.

One of the major departures from existing dynamic RAM design was the move to a single-5-volt power supply, which was recognized by all manufacturers as the only route acceptable to the industry. To get there, however, all but one chip maker saw the need to incorporate a charge-pumping circuit on chip to bias the substrate negatively, thereby eliminating problems mainly with signals that dangerously undershoot, but also with speed-hindering body-effect capacitances. In fact, it was the first single-supply 64-K RAM announced—Texas Instruments Inc.'s 4164—that did away with the need for a substrate-bias generator. According to the Dallas company, which has not yet revealed details of its chip design, the 4164 not only suffers no damage upon receiving signal undershoots as extreme as −1.0 V, but moreover, pays no speed penalty for its grounded substrate: if the part had been designed without multiplexing its row- and column-address strobes, it could have achieved an access of 50 nanoseconds, the company claims.

What is known is that the TI part relies on a voltage-reference oscillator and charge-isolation techniques that allow address buffers to endure signal swings of +7 to −2 V. Ideally, all chip manufacturers would prefer to do away with bias and ground the substrate, since providing the current needed with a simple charge pump becomes more difficult for larger memories; if the pump cannot provide enough drive, the substrate potential floats up and down with transients, affecting data integrity.

The right refresher

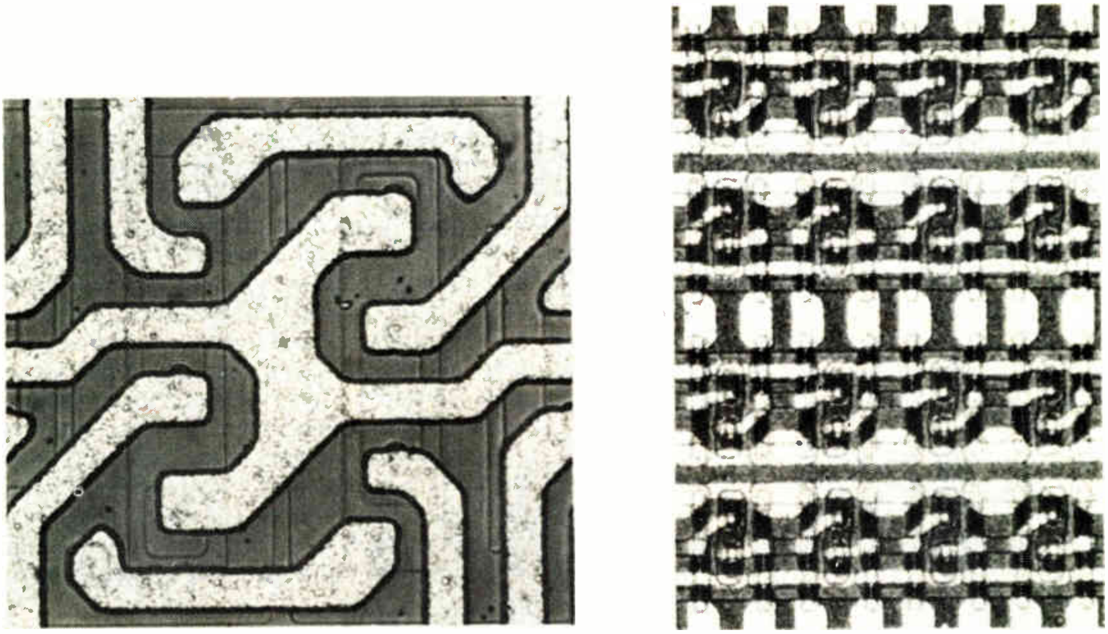
Texas Instruments' 64-K RAM also came forward with a new refresh-timing scheme. Unlike the 4-K and 16-K devices, which require their cells to be refreshed every 2 milliseconds, the 4164 could relax that frequency to once every 4 ms, thanks to a more sensitive sense-amplifier design. National Semiconductor Corp. of Santa Clara, Calif., which is using a triple-polysilicon process to build a 64-K RAM with better storage capacitors, opted for TI's refreshing scheme and therefore must employ improved sense amps. Mitsubishi Electric Co. in Japan has a 64-K device with the same refreshing scheme as well. All other manufacturers planning 64-K RAMs, including Intel, Mostek, and the Japanese contingent comprising Hitachi, Fujitsu, Nippon Electric, Oki, and Toshiba, are relying on a 128-cycle, 2-ms scheme.

Although most manufacturers would defend the 128-cycle, 2-ms scheme, arguing compatibility with 4-K and 16-K RAMs and greater reliability in a cell that only has to hold its charge half as long, their designs actually require twice as many sense amps. They will, in fact, have to redesign for a 4-ms period for the next generation of 256-K RAMs if they are to maintain the same refresh overhead (a figure dependent on the number of cycles per period that relates to memory system efficiency; it holds constant for 128/2 or 256/4). National's, TI's, and Mitsubishi's 64-K parts are therefore the only ones to be upwardly compatible; a 256-K RAM with 1,024 sense amps would be prohibitively large.

Two steps at a time

What chip makers will agree on is that the single-supply 64-K RAM was a double advance. Quadrupling the density of current-generation RAMs is tough enough; redesigning for single-5-V operation doubles the effort. It was therefore the choice of several firms struggling with the power-supply problem to develop a 5-V-only 16-K

Forerunner. The electron-tunneling principle of Xicor's 1-K nonvolatile RAM could be the basis for future nonvolatile memories.



A decade of growth. Bipolar memories, like MOS ones, are on a track to higher density. One cell of Fairchild's 256-bit RAM (left), developed in 1970, occupies the same area as 16 cells of its 93470 4-K RAM (right). Scaled Isoplanar S will boost density another third.

RAM as a stepping stone to the 64-K part.

Ironically, that interim measure could be responsible for pushing back industry acceptance—and the learning-curve experience that goes with volume production—of the 64-K RAM by a year or two. All those chip makers building single-supply 16-K RAMs—National Semiconductor; Intel Corp., Santa Clara, Calif.; Mostek Corp., Carrollton, Texas; and even Motorola Inc.'s semiconductor group in Phoenix, which is one of the few companies with 64-K parts on the market—are taking the same tack. Their parts are almost exactly one quarter of their 64-K designs. Not only do these parts have a much more acceptable yield than the next-generation devices, but in addition they have so much more to offer over the three-supply 16-K RAM—superior access time that might fall as low as 80 ns, lower power, and a scaled-down die size—that customers might be willing to pay a premium price for them.

Though TI and Motorola may lead the RAM density race, Intel clearly holds the MOS speed record with its static RAMs. Way ahead of the competition in producing 55-ns 1-K-by-1-bit and 4-K-by-1-bit parts, it broke into a gallop this year with the introduction of HMOS II RAMs that promise worst-case access times of 35 ns for the 4-K 2147H and a blistering 20 ns for the 1-K 2115H. The MOS competition is eating dust, most having just reached the point of supplying samples of a 55-ns 2147, as TI, National, American Microsystems, Advanced Micro Devices, and a few others are doing. In time, all MOS chip makers involved in memories will build the 2147, doggedly following Intel.

With its new fast RAMs Intel succeeded in its long-term goal of a TTL-compatible RAM access time superior to that of bipolar technology. Indeed, at the time Intel announced its HMOS II products, the RAMs of the leading bipolar supplier, Fairchild Camera and Instrument Corp., were behind—the 1-K 93415A that is pin-compatible with Intel's 2115H had an access time of 30 ns and the 4-K-by-1-bit 93470, which differs in pinout from the 2147, carried a 45-ns worst-case specification. But the culmination of several years' development work has yielded the Isoplanar S (for scaling) process, bringing Fairchild back to life. It has paid off in Fairchild's 93F415 1-K RAM, currently available in sample form and with an access time that matches Intel's 20-ns access. Moreover, the Mountain View, Calif., company expects to drop its 4-K 93F470 that is due out next year to 30 ns, beating the 35-ns 2147H.

Diminishing returns

Marginal advances in the under-55-ns part of the memory spectrum, however, tend to diminishing returns; in fact, at a 30-ns access, the TTL circuits can barely keep up with the memories, and 20 ns is the bottom line for Schottky TTL switching speeds. Beyond 20 ns, only ECL, with its smaller signal swings and lower impedance can take advantage of a faster memory. Fairchild has the lead here in that all its TTL memory designs start out as ECL parts and use ECL levels internally.

For ECL, a 10-ns memory has high utility and is certainly the goal of many bipolar manufacturers. Signetics and AMD have ongoing developments in both TTL and ECL memories; but National and Motorola have chosen to focus their bipolar attention on the sub-10-ns

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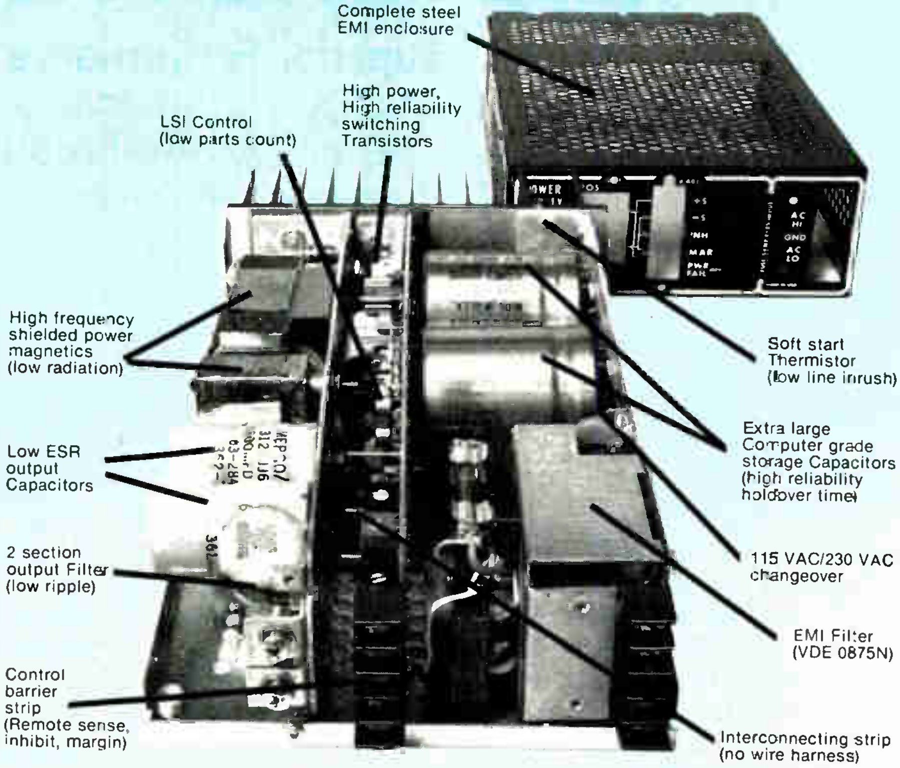

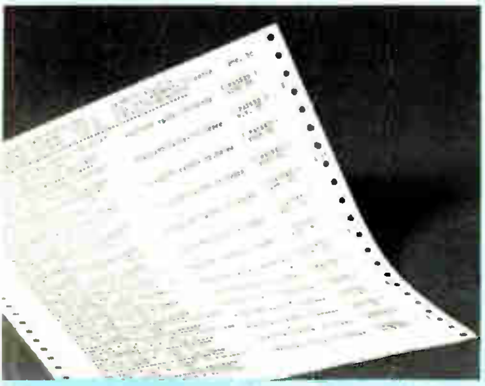

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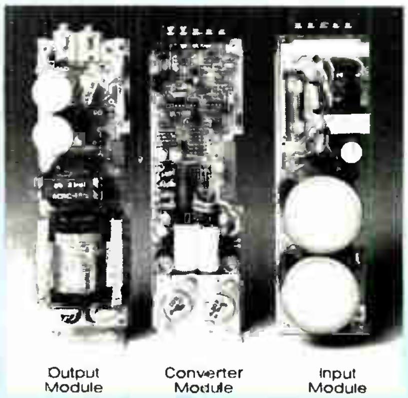

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ECL memory market alone, in anticipation of the needs of next-generation computers.

ECL in general will receive a great deal more attention in the next few years. Not only will memories expand to 16 K, but further, power will diminish. Also, it is not altogether unlikely that, in time, an MOS manufacturer with a high-speed process (like Intel's) will build ECL-compatible MOS RAMs.

Where there is clearly room for development at present in high-speed TTL-compatible RAMs, however, is in density. It looks as though Intel and Fairchild will go head to head on the 16-K-by-1-bit static RAM—the next generation for high-speed cache and control-store memory. Both will incur new expenses as they break into new areas of technology.

The MOS manufacturer will break with its tradition of using depletion-mode transistors for active loads in its cells and switch to denser polysilicon resistor loads. Fairchild, on the other hand, will work at truly exploiting the Isoplanar S process on the 16-K RAM. The part will scale geometries down even further than the 1-K and 4-K RAMs—it will use line and space widths of on average 4 μm (or active regions of 2 μm), and as such it will be processed at first on direct-wafer-stepping lithography equipment. Moreover, it will employ new metalization technology. Both manufacturers are shooting for 45-ns access times, however, and should have samples available by the end of next year.

C-MOS anomaly

Interestingly, one of the first parts to match the 55-ns access time of Intel's 2147 this year was a complementary-MOS static RAM from Japan's Hitachi Ltd. Actually, the HM6147 is not a true C-MOS static part, since its memory array is all n-channel flip-flops. But by using polysilicon load resistors with the extremely high value of 50 gigohms in the cells and by surrounding the array with C-MOS peripheral circuits, Hitachi has built a 55-ns RAM with a worst-case power dissipation of 220 milliwatts—about a quarter that of the n-channel 2147. Where the 6147 really shines is in standby—there, its worst-case power dissipation is a tiny 4.2 mW, and a special low-power version (HM6147P) drops that to only 520 microwatts.

Hitachi calls its process Hi-CMOS, and it has impressed many C-MOS suppliers in the U.S. Whereas initial reaction to the Hitachi design—which even uses a bipolar transistor (inherent in the C-MOS process) as a pull-up to drive the output—was that it required extremely stringent processing, it now looks as though U.S. designers will mimic it. American Microsystems and Motorola, companies with a respectable C-MOS expertise, will go the route of Hitachi. It may well be the memory of the future, for both density and speed.

Indeed, the 6147 has more going for it than meets the eye. Its design is sound: it uses all n-channel devices in the memory array, since true C-MOS static cells could never be as dense; the bipolar output driver has far better current-carrying capability than any MOS transistor for a given size and is free in C-MOS; and, as a result of what seems no more than good fortune, it appears to be immune to alpha particles, which have been found to cause soft errors in static RAMs that use high-value polysilicon loads.

What gives the 6147's 50-GΩ loads their immunity to alpha radiation? Apparently, the grounded p well, in which the n-channel transistors in the array sit and which is sunk into the substrate connected to the positive supply. The electric field produced by the reverse-biased junctions sweeps away the memory-disturbing charge carriers generated by alpha bombardment. Standard n-channel static RAMs with polysilicon loads have no such fields to aid them.

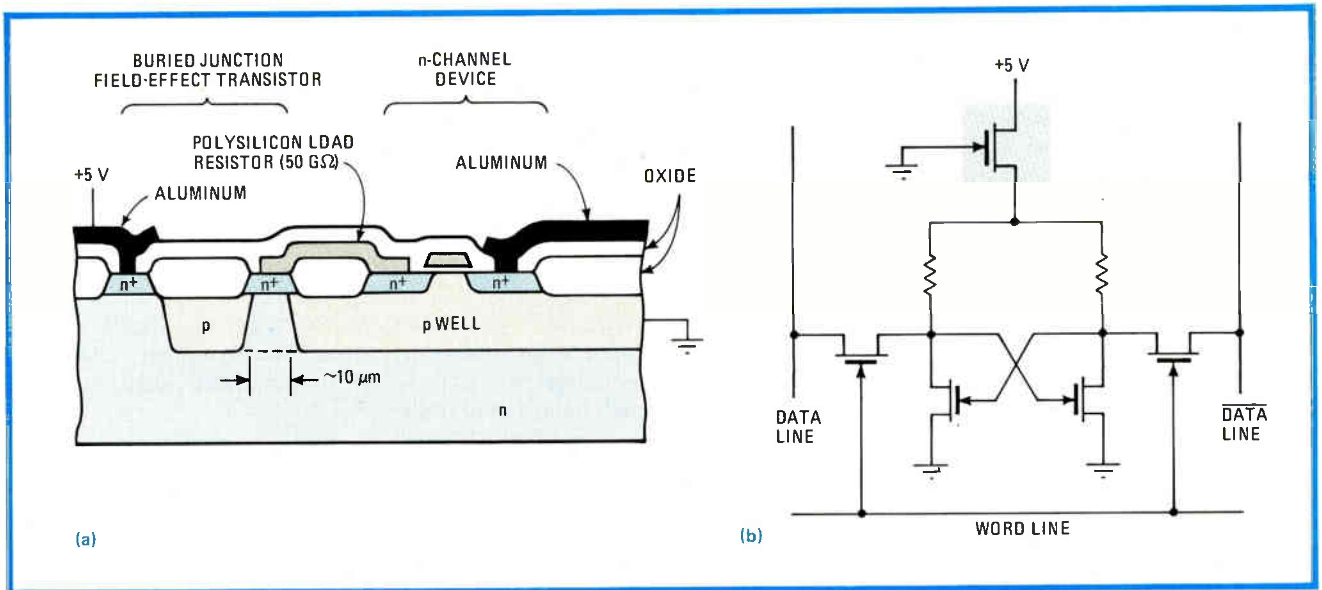
Technology-furthering follows

Hitachi is following the 6147 with a 16-K part, currently under development, that achieves greater density by eliminating the positive-supply contacts to the cells. Ingeniously, the 2-K-by-8-bit device (almost certainly to be followed by a fast 16-K-by-1-bit organization) leaves an n-type island within each cell in the p well and feeds in from the n-type substrate by transistor action—the p-type silicon surrounding each island behaves as the gate of a buried junction field-effect transistor (see figure on p. 130). The current is determined by the size of the island, but it is not critical, since all that is necessary to power the cell is for the resistance of the J-FET to be far less than that of the loads. The power dissipation of the 16-K Hi-CMOS part should range similarly to the 4-K 6147.

Despite the advantages of the Hitachi development, some companies working on high-performance C-MOS processes are aiming to build fast static RAMs using the conventional C-MOS cells that comprise two p- and four n-channel transistors. Harris Semiconductor, Melbourne, Fla., and Mitel Semiconductor Corp., a subsidiary of Mitel Corp. in Bromont, Ont., Canada, are two examples. Both are developing sub-100-ns 4-K static RAMs. Harris has also developed to the prototype stage a 350-ns 16-K (2-K-by-8-bit) C-MOS static RAM that should be available by the end of next year.

The 8-bit-wide organization of so many memories evidences the microprocessor's strong impact. The 2-K-by-8-bit RAMs, for example, are packaged like such 24-pin 16-K erasable programmable ROMs as the 2716. The result is not only good interchangeability of read-only with read/write memory in a microprocessor system, but also a path for upward compatibility that is already cleared by the ROMs up to the current 8-K-by-8-bit density. Thus it is no secret that Mostek's MK-4801 1-K-by-8-bit static RAM, for example, will be followed by a 2-K-by-8-bit version, and so on, clearly up to 8 K by 8 bits, as the technology becomes affordable.

What is not so clear is the future of pseudostatic RAMs, those parts that add refresh circuitry to a dynamic RAM core to achieve high density at a lower cost than fully static parts. Several schemes have emerged: Mostek showed its hand first with the



Toward greater density. Hitachi's 4-K RAM met with success by surrounding an n-channel array with C-MOS periphery. Now the firm is going up to 16 K by adding a buried J-FET (a). Device feeds power to loads (b) while eliminating positive-supply metalization.

MK4816, a 2-K-by-8-bit single-supply part that it announced a year ago but never provided samples of. Since then, it has revised the pinout of the device. Meanwhile, Zilog Inc., Cupertino, Calif., announced plans to build a 4-K-by-8-bit self-refreshing device and later entered an agreement with National for the two to serve as alternative sources of each other.

What alone will prove out a successful pseudostatic scheme, however, is acceptance by users, and currently both approaches have two strikes against them. First, fully static RAMs parts that are easier than ever to use are so near in density level, what with 2-K-by-8-bit samples available from such manufacturers as TI, Hitachi, and Toshiba, that pseudostatics must leapfrog to 32 K or 64 K to be worthwhile. Second, such is the general repugnance in industry toward memory parts with complicated operating schemes that the parts seem likely to catch on only when a refreshing scheme is totally transparent, requiring no more user savvy than a fully static RAM.

ROM advances

Equal to pseudostatic and fully static RAMs in importance for microprocessor-based systems are ROMs, and the developments over the next few years will focus on erasable types. This year saw the introduction by Motorola of a 64-K ultraviolet-light–erasable PROM, and TI and Intel will soon follow.

But a controversy has arisen around higher-density E-PROMs, including both the 32-K, which Intel and TI are currently shipping (Motorola and Mostek are more likely to sell partial 64-K devices than introduce a 32-K design) and the forthcoming 64-K devices. Though the 16-K pinout was agreed upon with the 2716 a model for the standard, 32-K and 64-K designs differ markedly among manufacturers.

Despite their pinout differences, all E-PROM makers are striving for quicker access. The E-PROM process produces the slowest access of all n-MOS memory technologies, typically about 350 to 450 ns. Where problems occur is with the new breed of faster microprocessors, which will lose their speed advantage if the E-PROM program storage cannot meet the 100- to 200-ns cycle times. Thus, chip makers are hard at work getting the access down. TI has the quickest thus far: its single-supply 1-K-by-8-bit 2508 has a 250-ns worst-case specification. Other manufacturers will further pare down that figure next year to 200 ns or better and will do so for their larger E-PROMs as well.

Close at hand: electrical erasability

The parts that will eventually displace UV E-PROMs have already begun to appear: the electrically erasable PROMs, or EE-PROMs. Slow to develop because no forced electrical leakage has proven as reliable as the photon-generated leakage of the UV devices, EE-PROMs are currently under going evaluation in many chip manufacturers' labs. This year saw one commercial announcement of an EE-PROM as an E-PROM replacement, however—a 16-K device from Hitachi that uses a floating-gate sandwich of polysilicon and silicon nitride. Original designs for the part showed much promise, with a quick 250-ns access time potential, fast programming (2 seconds for the entire array), 100-ms erasure time, and a relatively small die size (23,300 mils², as against 30,000 mils² for the 2716 E-PROM).

Still, nitride-based products have yet to prove themselves in the high-volume situations where MOS memories excel. Moreover, the endurance—or maximum number of write-erase cycles—of the nitride parts is not yet proven. The operation of such parts is in fact violent on a molecular scale: charge must be forced to reside at the

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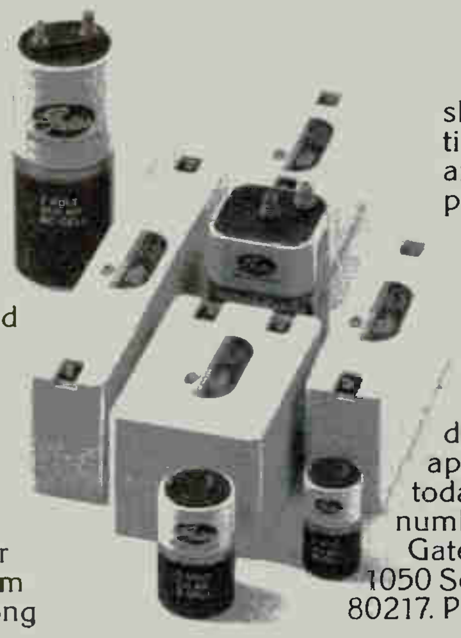

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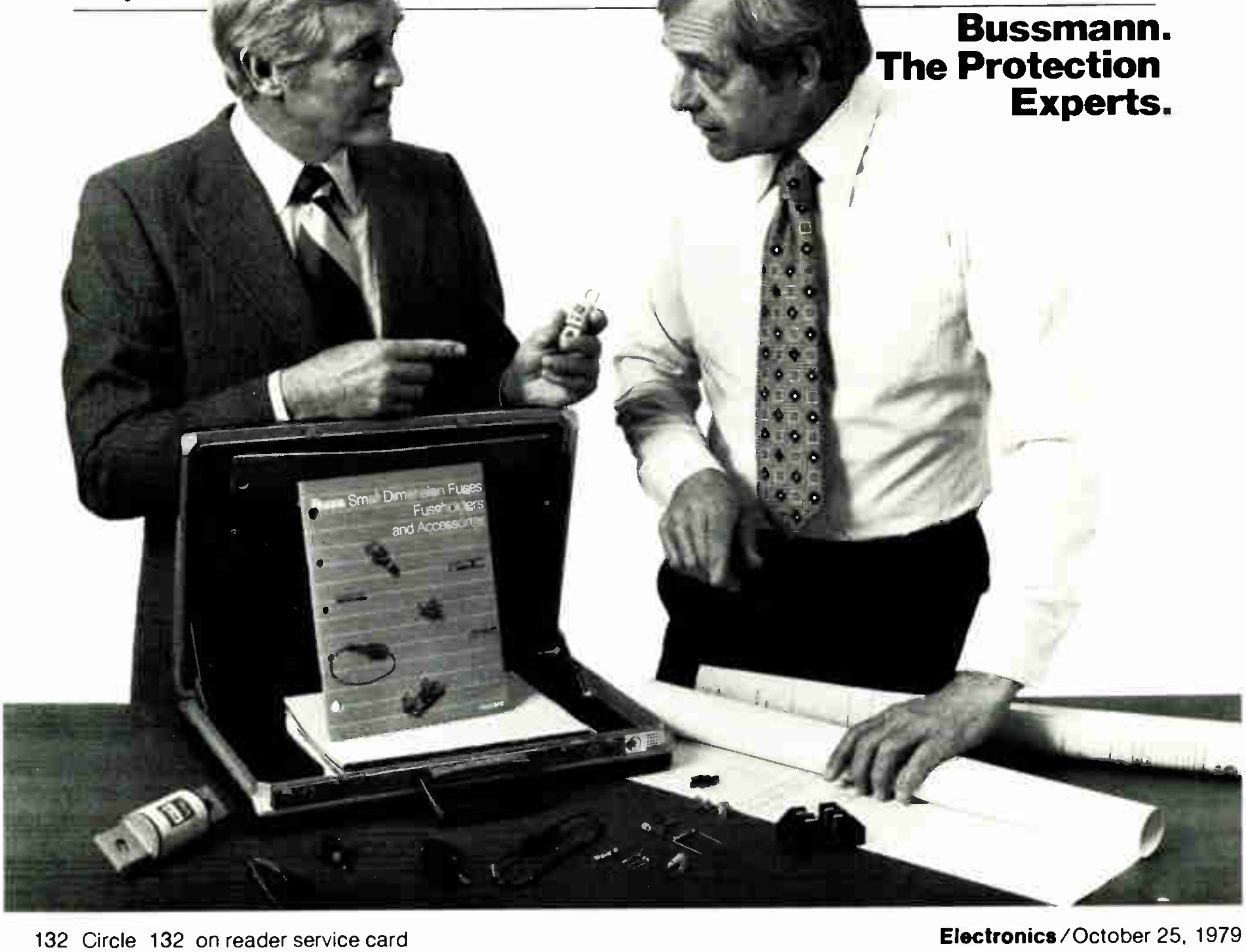


nitride-polysilicon interface, then driven out under avalanche conditions by a high erasure voltage.

A nonvolatile memory that relies on a far more elegant writing and erasing mechanism was developed by Xicor Inc., a new Sunnyvale, Calif., company. Actually, it is intended not as an E-PROM replacement but as a nonvolatile RAM, since it folds EE-PROM elements into static RAM cells. The two 1-K versions, the X2201 and X2202, store and remove charge from floating polysilicon gates by tunneling electrons through oxide. The tunneling phenomenon, harnessed through control over rough-surfaced polysilicon, uses oxides as thick as 1,000 angstroms yet requires a writing and erasing pulse of so low a current that the 30-V potential can be developed on chip with a charge pump. The result is the first 5-V-only RAM with a unique architecture that backs up the static cells with nonvolatility.

Nonvolatiles

In the next few years, a hierarchy of nonvolatile memory products will fall out that will group primarily into three types of parts: ROM types that are rarely reprogrammed but offer high density and relatively quick access times to replace E-PROMs; read-mostly memories that provide a fair amount of endurance (10^5 write-erase cycles) for the daily power-down situations to which cash registers and television tuners are exposed; and nonvolatile RAMs that provide fast program and erasure and, in addition, a superlative endurance of 10^7 cycles or more.

A far less bright future is in store for charge-coupled-device memories. Despite its potential for a niche in the memory hierarchy as a block-oriented storage of high speed and density, the CCD has not outdistanced the dynamic RAM far enough in cost or availability to become successful. Currently, Fairchild is the only manufacturer with definite plans to produce a 256-K device. Further depressing enthusiasm for CCDs, however, is their susceptibility to alpha-particle radiation, which exceeds even that of dynamic RAMs. CCD technology will live on, however, because of the devices' role in imaging and filtering applications.

Bubbles abound

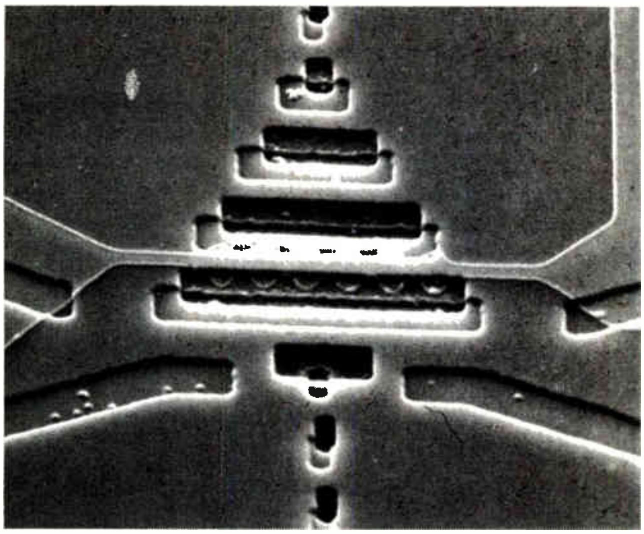
There can no longer be any doubt that bubble-memory systems are a reality—1978 saw the introduction of not one but a pair of million-bit bubble memory chips. Intel Magnetics Inc., Santa Clara, Calif., was first with its 7110 chip, a 4-square-centimeter device organized into 256 4,096-bit loops, which when operated at a 100-kilohertz field frequency provides an average access of about 20 ms. The organization of Texas Instruments' megabit chip is 512 loops of 2,048 bits each; with shorter loops, it has an access of about 10 ns.

What is also certain is that bubble memory chips will follow the semiconductor lead and expand into families. Although Intel is building a 1-megabit device exclusively, National Semiconductor is carrying out plans for its 256-K device, and Rockwell International Corp.'s Electronic Devices division in Anaheim, Calif., which is shipping 256-K bubble chips, will bring out a 1-megabit device in the coming year. The fact is, applications have many different storage needs, and bubbles can be expected to expand not only in range of capacities—from TI's low-end major- and minor-loop 92-K chip to 4- and 8-megabit devices in the next few years—but in specifications such as access time, temperature range, and even loop organization, as well.

Evidence of the family approach showed up best in Texas Instruments' recently announced 0.25-, 0.5-, and 1-megabit designs. Based on a new planar processing technology that allows scaled-down lithography to 2-μm bubble diameters, the 1-cm² megabit chip actually comprises two self-contained 512-K devices side by side. By so designing TI can dice them up as necessary according to yield: two adjacent, fully functioning 512-K dice can be packaged together as a 1-megabit chip or split and packaged as 0.5-megabit devices. Moreover, the 256-K part of the family uses the same 2-μm technology; it differs from the 512-K chip only in that its loops are half as long.

The next generation

Despite the fact that they both store a million bits, Texas Instruments' and Intel's megabit bubble chips are a generation apart in technology. Intel is using 3-μm bubbles to obtain a chip four times the size of TI's. But just who has the better yield is difficult to tell. Intel relaxes lithography requirements because it claims bubble chips are far easier than semiconductors to process and should not be restricted to semiconductor die sizes. TI, meanwhile, gets four times more dice a wafer than Intel does and claims that its planar process, which does not require Permalloy to step over metal lines, is actually easier at 2-μm dimensions than conventional



Detector. Although the original design for its current-access magnetic-bubble device used this Permalloy stretcher to detect bubbles (they enter from the top), Bell Labs' Andrew H. Bobeck is working on an approach for a coilless bubble memory that uses no Permalloy.

processing (which is used by Intel and all the other manufacturers) is at 3 μm.

Both manufacturers will develop 4-megabit chips, however. Although it remains to be seen whether Intel will retain its large chip dimensions and simply scale its bubbles down to 2 μm or less, TI is confident that its planar process could reach, if not to 1-μm bubbles, then to 1.5 μm to build a 4-megabit chip marginally larger than the current 1-cm^2 device.

Bubbles beyond 4 megabits will likely require a change from chevron propagating elements, which every manufacturer currently uses, to a contiguous-disk approach. Proved feasible by Bell Laboratories and IBM Corp., the contiguous-disk propagating structure can support bubble diameters that are in fact smaller than the minimum lithography requirement. Such a memory could therefore use lithography with 1-μm minimum features to produce bubbles 0.25 to 0.5 μm in diameter and densely packed together. If the present impasses in contiguous-disk technology—lack of a suitable replicator, for example—are overcome, the approach's relaxed lithography requirement could make it advantageous to use even for building submegabit arrays to get many more dice per wafer.

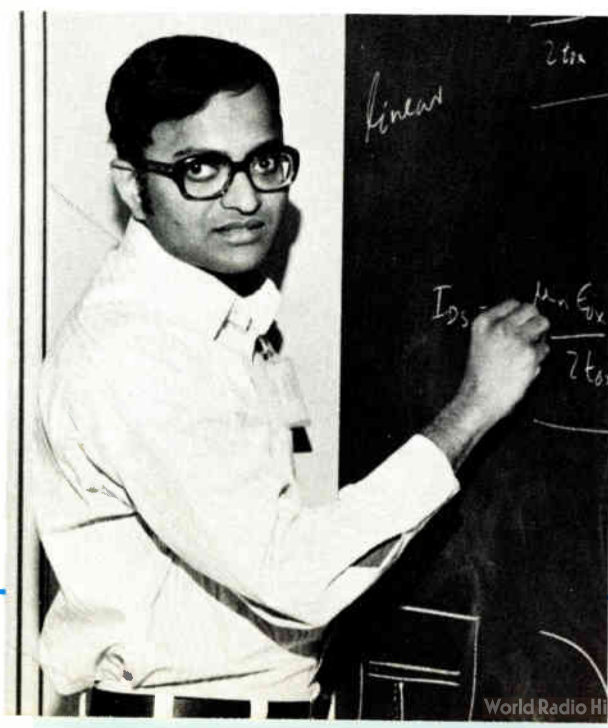
Farther off are bubble devices that will need no field coils, which contribute greatly to device cost. Proposed earlier this year by Andrew H. Bobeck of Bell Laboratories in Murray Hill, N. J., current-access bubbles rely on local magnetic fields generated by currents flowing through conductive sheets to move the bubbles. Though its feasibility has been proven, there are many hitches in the technology so far: too great a current requirement, and a not-so-simple process of insulating between two or three conductive layers. Still, in the next decade devices should emerge that are easy to use and interface well with the 5-V supplies of semiconductor devices.

PROFILE

Rao raised the performance of TI's 64-K RAM

Scholarship offers from 23 U. S. universities provided G. R. Mohan Rao with a wide range of choices when he left his native India in 1968 to pursue additional education. For Rao, who had aleady obtained a bachelors' degree in physics, a masters' degree in electrical engineering, and a Ph. D. in electronics from Andhra University in India, the question ultimately came down to a choice between the University of Cincinnati and Southern Methodist University in Dallas.

Rao settled upon SMU in part because of the school's close ties with Dallas-based Texas Instruments Inc., as well as for the presence of several faculty members whom Rao admired for their work in solid-state research. By the time he received his Ph. D. in electrical engineering in 1972, he was convinced of a significant future for metal-oxide-semiconductor devices. And knowing of TI's plans to invest heavily in MOS, Rao accepted a job as process engineer for TI's MOS operation in Houston.



Eleven years later, neither TI nor Rao is unhappy with the move. Rao, 34, was recently named a TI fellow—a designation that the company reserves for its top technology contributors. He is the holder of four U. S. patents for work at TI, including the development of the n-channel process that was used in the company's TMS4060 dynamic random-access memory. He has also done significant work involving static RAMs and is the principal inventor of the polysilicon load resistor in wide use across the industry today.

In addition, Rao's name appears with others on a number of pending patents that resulted from the development of the TMS4164, TI's 64-K RAM. The 4164 was significant not only because it was the first such RAM device to require only a single 5-volt power supply for operation, but also because it uses no negative substrate bias and thus eliminates the need for performance-reducing on-chip charge pumps of the type used on other single-supply RAM parts [*Electronics*, Sept. 14, 1978, p. 39].

Conventional single-supply RAMs require the reverse substrate bias in order to accept input signals that can sometimes undershoot to as low as −1 V. Rao, who was tapped by TI in early 1977 to head up the 4164 design team, still refuses to release the details of the technique used to make the part operate without a substrate bias. But he does note that it involves a filtering approach in which the ground is precharged to a positive potential on some nodes whenever a negative undershoot is expected on an input. The approach can best be described as a "unique filtering technique employed through circuitry in the 4164's input buffers," says Rao. "The inputs that we get externally are isolated from the inputs that are internal to the part," he adds.

Rao is quick to point out that the 4164 project was a team effort, noting that a number of individuals made significant contributions to the part's final design. And neither does he consider the device to be the zenith of his still young career. "This is only the beginning," Rao promises. "My interests are very wide." **-Wesley R. Iversen**

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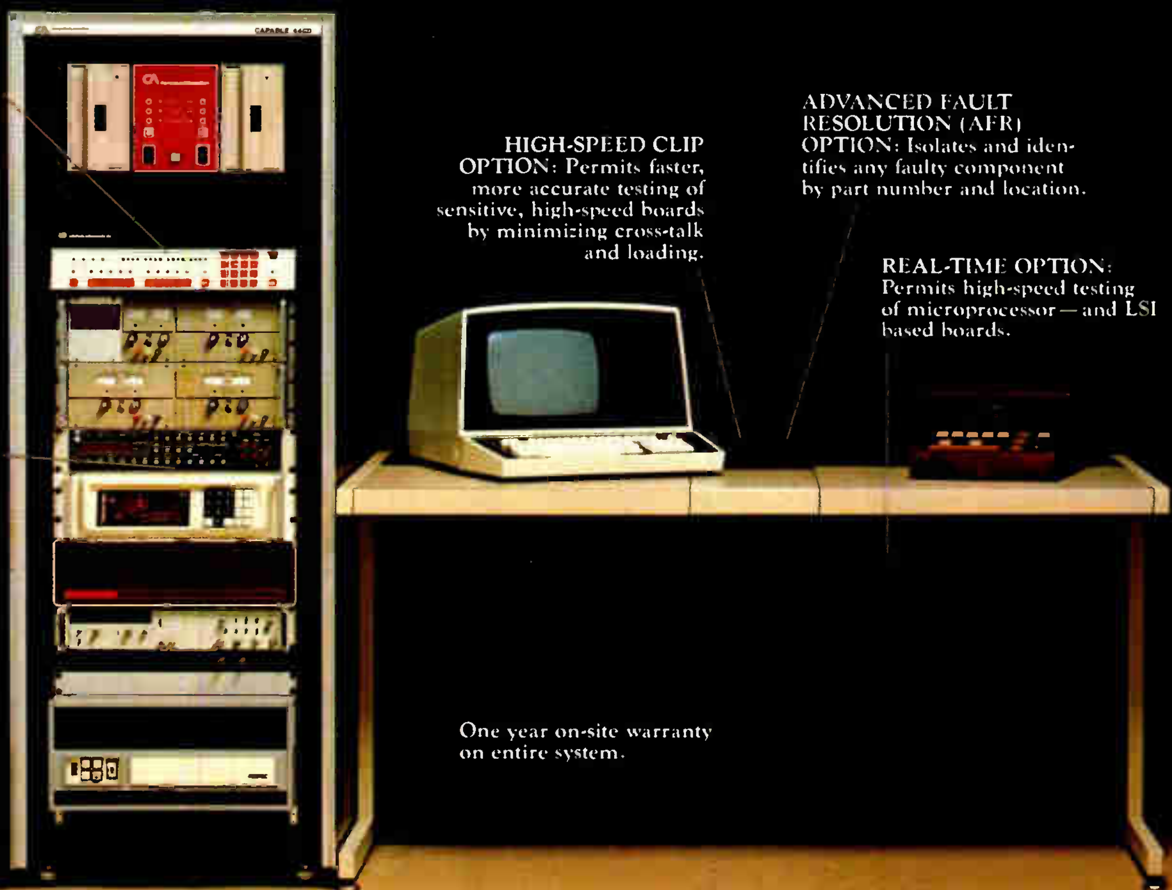

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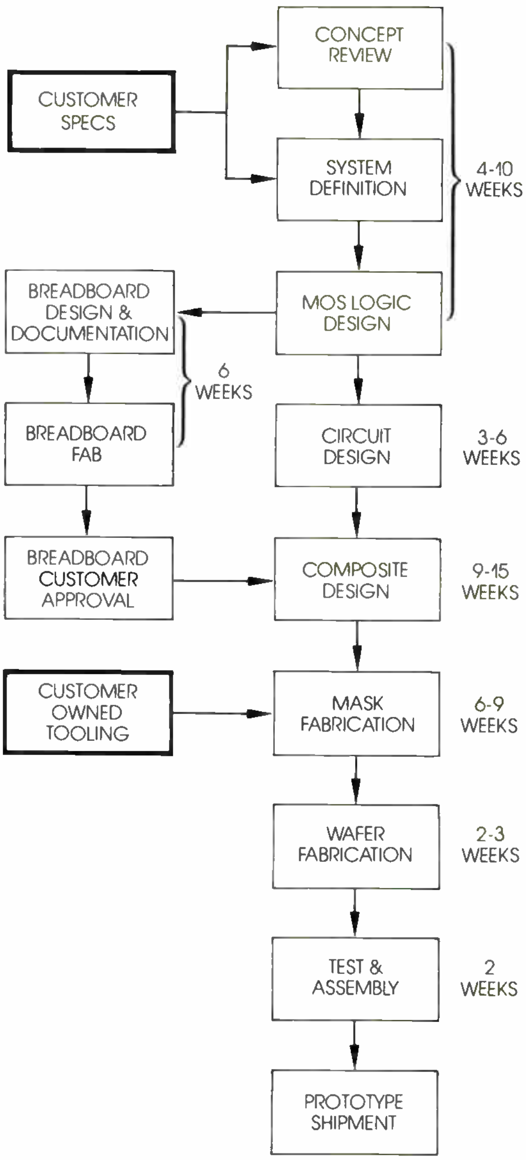

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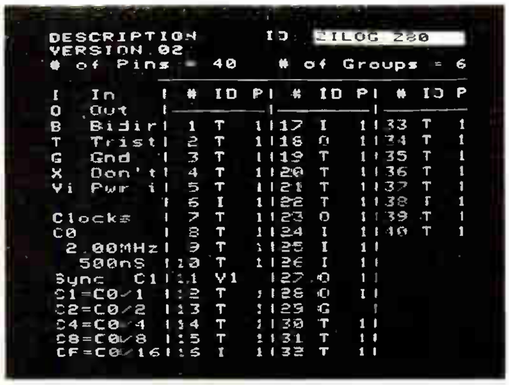

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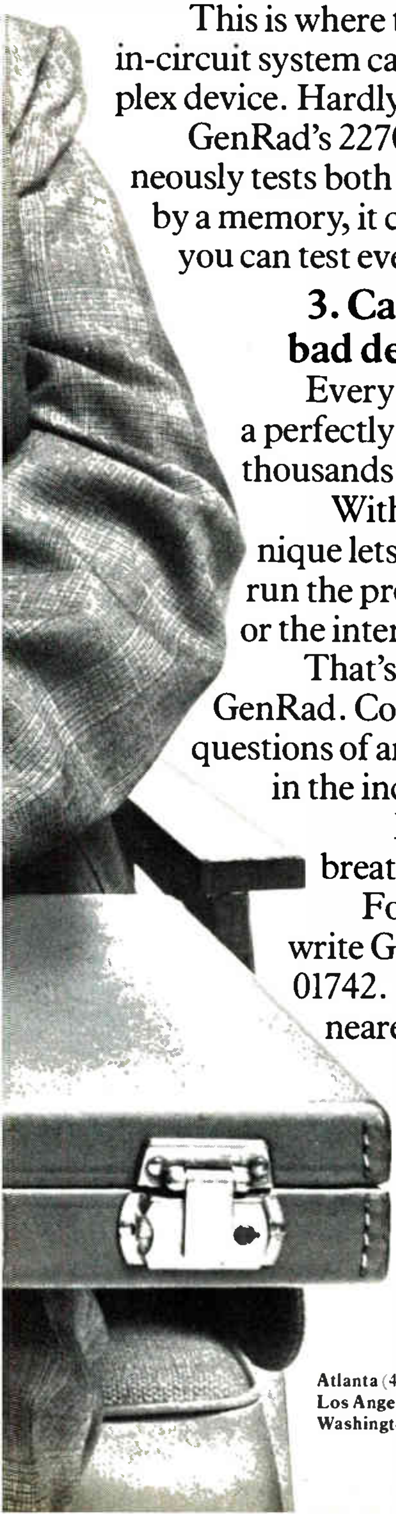

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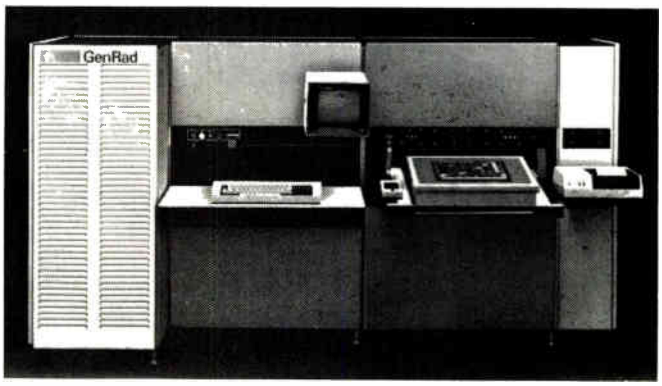

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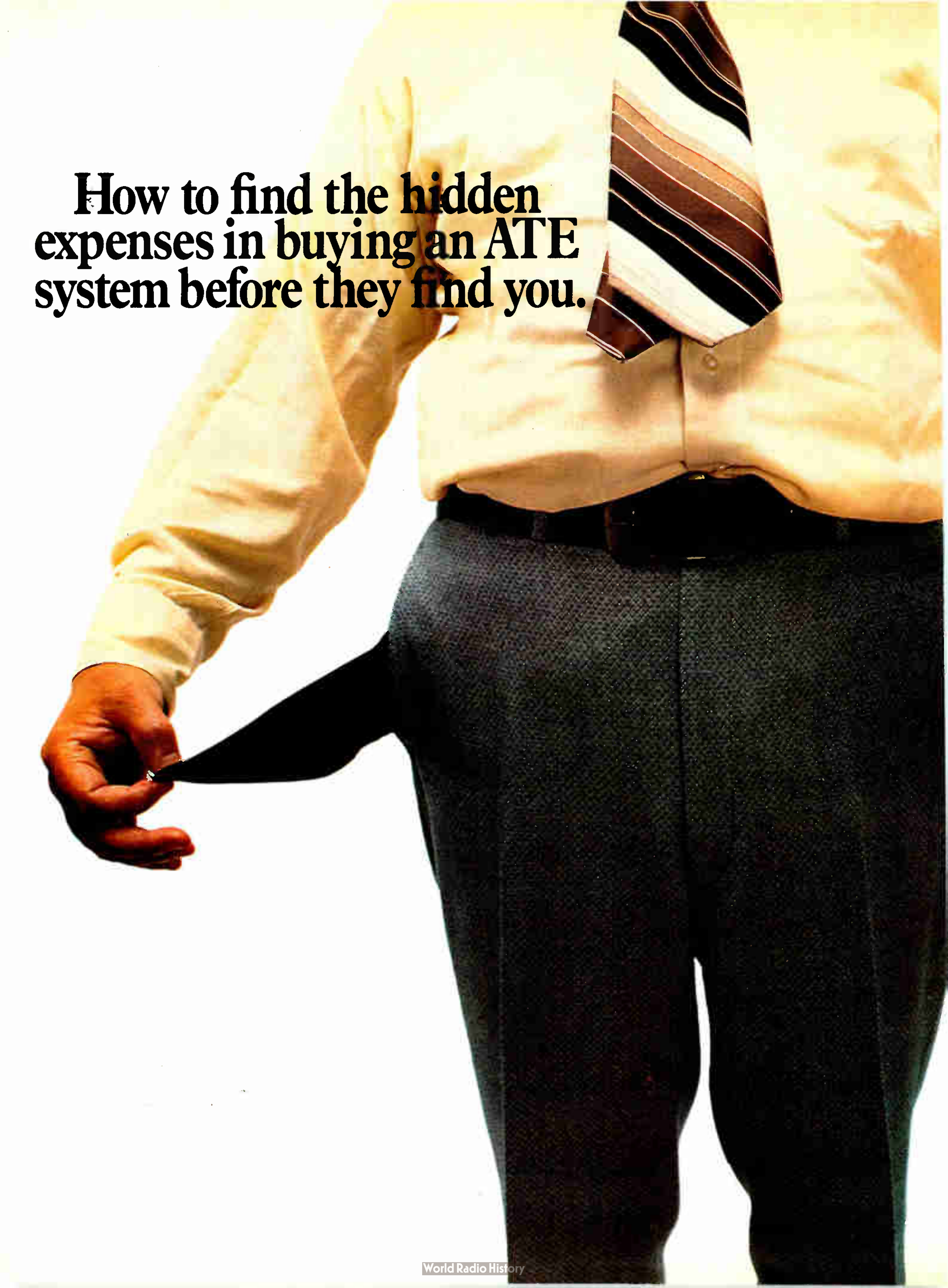
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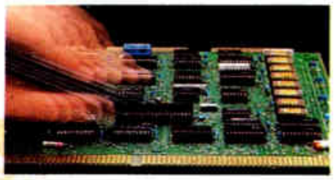

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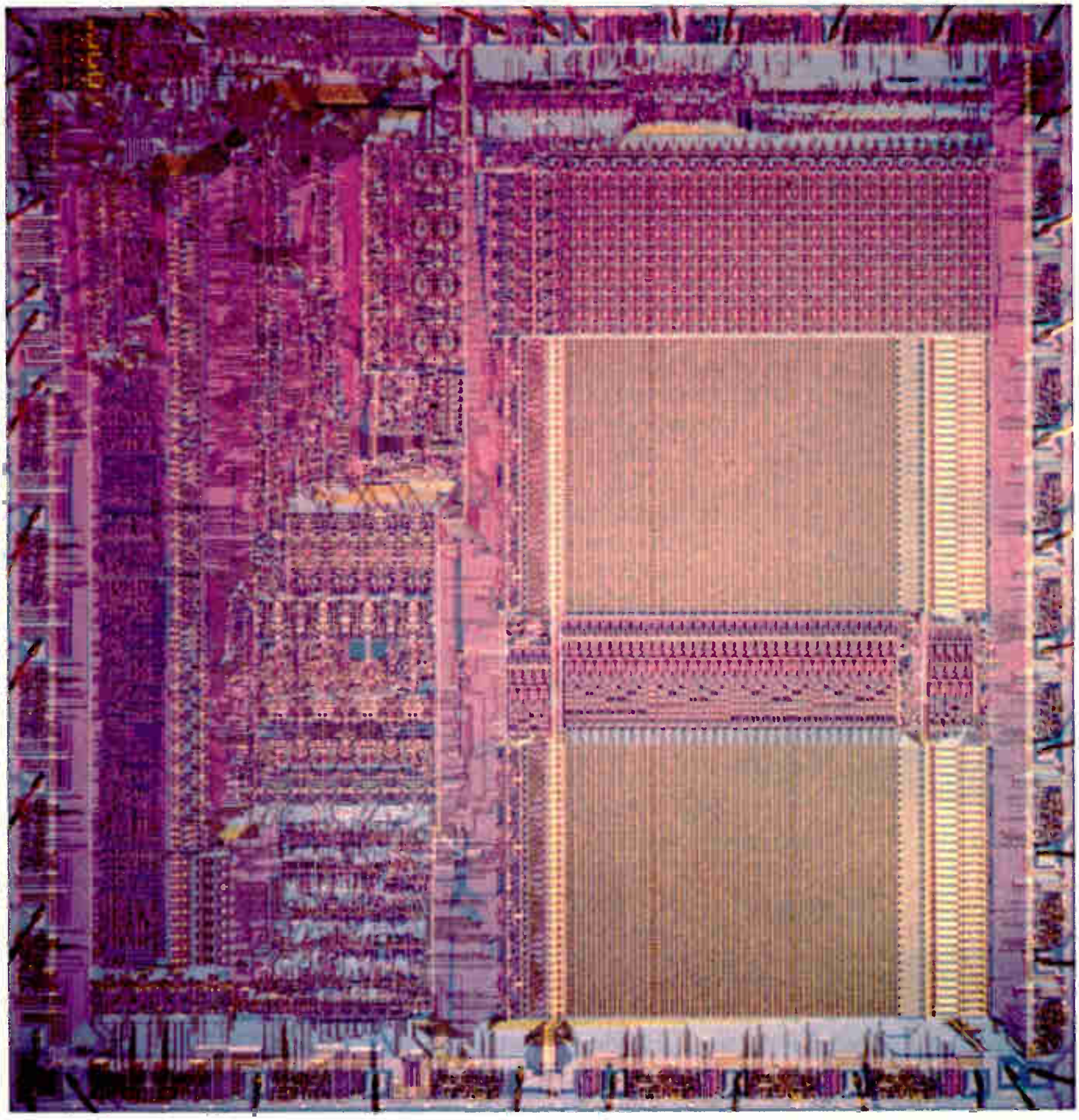


Microprocessors and Microcomputers

by John G. Posa, *Microsystems & Software Editor*

☐ *With higher levels of performance, larger amounts of on-chip memory, and high-level languages, things are looking up for microprocessors and single-chip microcomputers.*

For their general-purpose architectures, semiconductor manufacturers have provided 16-bit machines, the most recent of which have many 32-bit attributes. Also, it has become economically attractive to market specialized microprocessors and microcomputers; these are helping to further soften the blow of software and increase system throughput.

Single-chip microcomputers are getting more memory and different kinds as well. Computer-aided design and manufacturing equipment is being exploited to allow users to select their own complement of memory and input/output. In addition, microcomputers are finally being designed with the right bus structures and handshaking control signals so they can act as smart slaves instead of always being masters. This will allow the chips to leave behind their reputation for being solely for stand-alone control and to assume a more important role in distributed-processing networks.

The latest generation of microprocessors, those termed the 16-bit units, are clearly more powerful than their older counterparts. They address much larger spaces and have speedier clocks. In fact, the simple term "16-bit," though it applies to the instruction word width and external data bus, is somewhat of a misnomer.

It is important to look beyond the width of the processor's external data bus and into its architecture. Here, in the latest and forthcoming machines, the ability to operate on bits, bytes, 16-bit words, 32-bit long words, and long data strings is to be found. Indeed, many of the so-called 16-bit microprocessors are actually hybrid machines in the sense that Motorola's 6809 is: they can operate on data that is double the width of their external data bus.

Modern microprocessors employ prefetching of instructions and parallel pipelining to gain processing advantages. Also, the control sections (at least those of the 68000 from Motorola Inc.'s Semiconductor Group in Austin, Texas, and the 8086 from Intel Corp. of Santa Clara, Calif.) are highly microcoded. The microcode helps to speed up some operations, but more importantly, it makes for untangled future enhancements.

Motorola's 68000 takes microcoding the furthest thus far; it uses a two-level microcoded structure, with one tier feeding the other. The first level contains "vertical" microinstructions that address wide "horizontal" microinstructions—which Motorola is calling nanoinstructions—in the second level. With such a philosophy, future circuit size reductions and instruction set modifications can be done in parallel. Indeed, the company has plans to add floating-point and string operations with the presently unused operation-code map.

The Z8000 from Zilog Inc., Cupertino, Calif., in contrast, is made almost entirely with random logic, having even less microcode than the company's 8-bit single-chip Z8 microcomputer. Though the design makes for a relatively small die size and higher yield now, it may cause snags later. The figure on p. 146 compares the die of the Z8000 with that of the INS8070, a microcomputer due from National next year that has practically no random logic.

The dice of the newer machines are partitioned for a division of labor. Intel's 8086, for example, is sectioned into an execution unit and a bus-interface unit. The latter fills a six-instruction queue with words and the execution unit pulls them out fast enough to eliminate lengthy idle periods. Intel went through a long, involved process to come up with this form of prefetching.

The Z8000 can be configured in two ways: through hardware and through software. Physically, two versions of the Z8000 are offered. The Z8001 has 48 pins, accesses a segmented memory, and is intended to mate with the Z8010 memory-management unit; the Z8002 has 40 pins and directly addresses one 64-kilobyte segment. With software, both can be directed into system and normal modes, each with its own stack pointer. The current mode is signaled to the outside world through a mode pin.

Power saver. The C-MOS IM87C48 microprocessor from Intersil (left) features E-PROM programmability and low power consumption.

Privileged modes

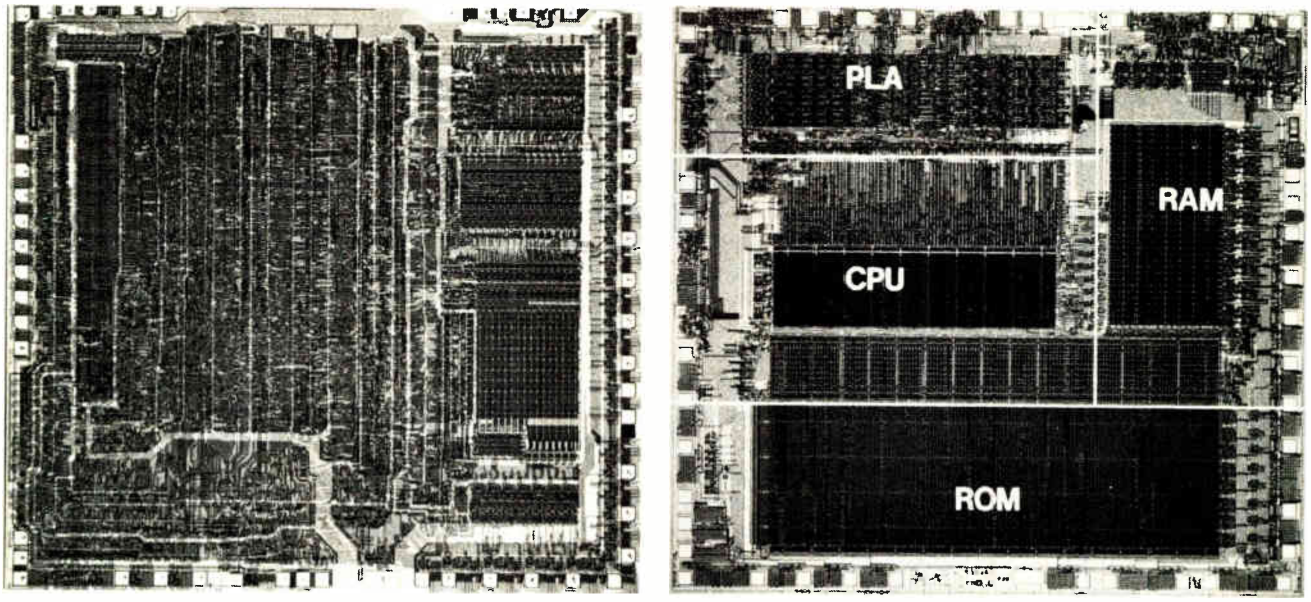
Not unlike the Z8000, the 68000 has user and supervisor modes, chosen by a bit in its status register. In the supervisor mode, the programmer enjoys privileged instructions such as halts, as well as the ability to update Motorola's proposed memory-management unit.

National Semiconductor Corp. of Santa Clara, Calif., has its NS16000 microprocessor family in mask-preparation stages and scheduled for production in sample quantities by mid-1980. Like Zilog, National will introduce more than one central processing unit for optimal market penetration. But National plans three CPUs instead of two. All of them are basically 16-bit machines: the 16008 will have an 8-bit multiplexed bus, the 16016 will have a 16-bit bus, and the 16032 will have a 32-bit arithmetic and logic unit and register set.

Even more notable is that the two lower-end devices will have two instruction sets, selectable by a single software command. One will be a superset of the 8080's assembly language; its purpose is to take advantage of the software already written for the large installed base of 8080 and Z80 microprocessors. The other, available on all three devices, will be 20 times more powerful than the 8080's instruction set, says National. The two instruction sets can also be intermixed.

In addition, National plans what it calls slave processors for the 16000 family. One will be a floating-point math circuit that will be introduced around the same time as the CPUs. Another will be a memory-management unit, able to extend the 16032's proposed 16-megabyte direct-addressing range.

From the existence of user and supervisor modes, it is clear that microcomputers are gearing up to be useful in different environments from their past ones. The devices are being prepared for advanced operating systems, multiple users, and high-level languages. High-level



Random vs regular. The Z8000 (left) uses random logic for high performance at a small die size. If this method makes future architecture alterations difficult, one solution is to microcode the processor's control unit. National has done this with the INS8070 (right).

languages are, in fact, seen as one key to circumventing skyrocketing software costs. Although the new machines may seem like overkill for some projects, if they are able to untangle programming, they will catch on for that reason alone.

Avoiding intimidation

It is interesting to note that even the chip makers are concerned about the possibility that the new microprocessors will intimidate some potential buyers. Why else would Intel turn right around and offer an 8-bit version of its 8086 (the 8088)? Texas Instruments Inc. of Dallas did the same with its 9980, and in that light it becomes obvious why National's 16000 family is tied to the 8-bit 8080. Zilog and Motorola may make similar aboutfaces, but it is doubtful. They seem to be heading directly into the systems business, and they are stoking their intentions with support chips like memory-management units. Intel claims it is still in the logic-replacement business but, for some reason, it has purchased a database software company: MRI Systems Corp. in Austin, Texas.

Some of the ways microprocessors can be more conducive to high-level programming are by exhibiting a regular (or consistent, or orthogonal) architecture and by having a large number of addressing modes, a very powerful instruction repertoire, and a complement of intelligent peripheral chips that off-load the processing burden and reduce the coding requirements.

The 8086's register file exhibits a slight degree of nonuniformity in that particular addressing modes require the use of specific registers. This makes object-code generation difficult for a compiler because when a register is tied down to a function, data must be swapped in and out of it for use. This added data manipulation of course results in fatter programs.

The Z8000 and the 68000 exhibit one of the advantages of being introduced later in the game: the idea of orthogonality has been carried further in these devices. The Z8000 has 16 16-bit general-purpose registers, and they all can serve as accumulators for byte, 16-bit word, or 32-bit long-word operations; except for register 0, they can also function as index registers or base or stack pointers. Now that is a regular register file.

As an easy-to-comprehend bank of registers does, addressing modes and instruction types help compilers and humans generate code. Motorola's 68000, for example, has postincrement and predecrement addressing modes that will add or subtract, respectively, bytes, words or long words from 8-, 16-, or 32-bit register arrangements, allowing very straightforward stack and queue manipulation.

For an instruction set, it is not the size but the power contained within it that counts. Some of the instructions in newer machines are able to do so much they could almost be considered high-level. And this is where things are headed. The 68000's set has two instructions, link and unlink, that allocate and deallocate, respectively, local storage on a stack so that procedures can be executed. (Procedures are basic blocks of code—the Pascal language, for one, is based on their use.) The 68000 has other instructions to store and recall multiple registers before and after a procedure call.

Built for Pascal

Pascal was in fact the star high-level language of 1979, and it will continue to be popular for some time to come. Machines like the 68000 and 16000 were engineered with this language in mind, and the Pascal Microengine from Western Digital Corp. of Newport Beach, Calif., was made to execute Pascal exclusively.

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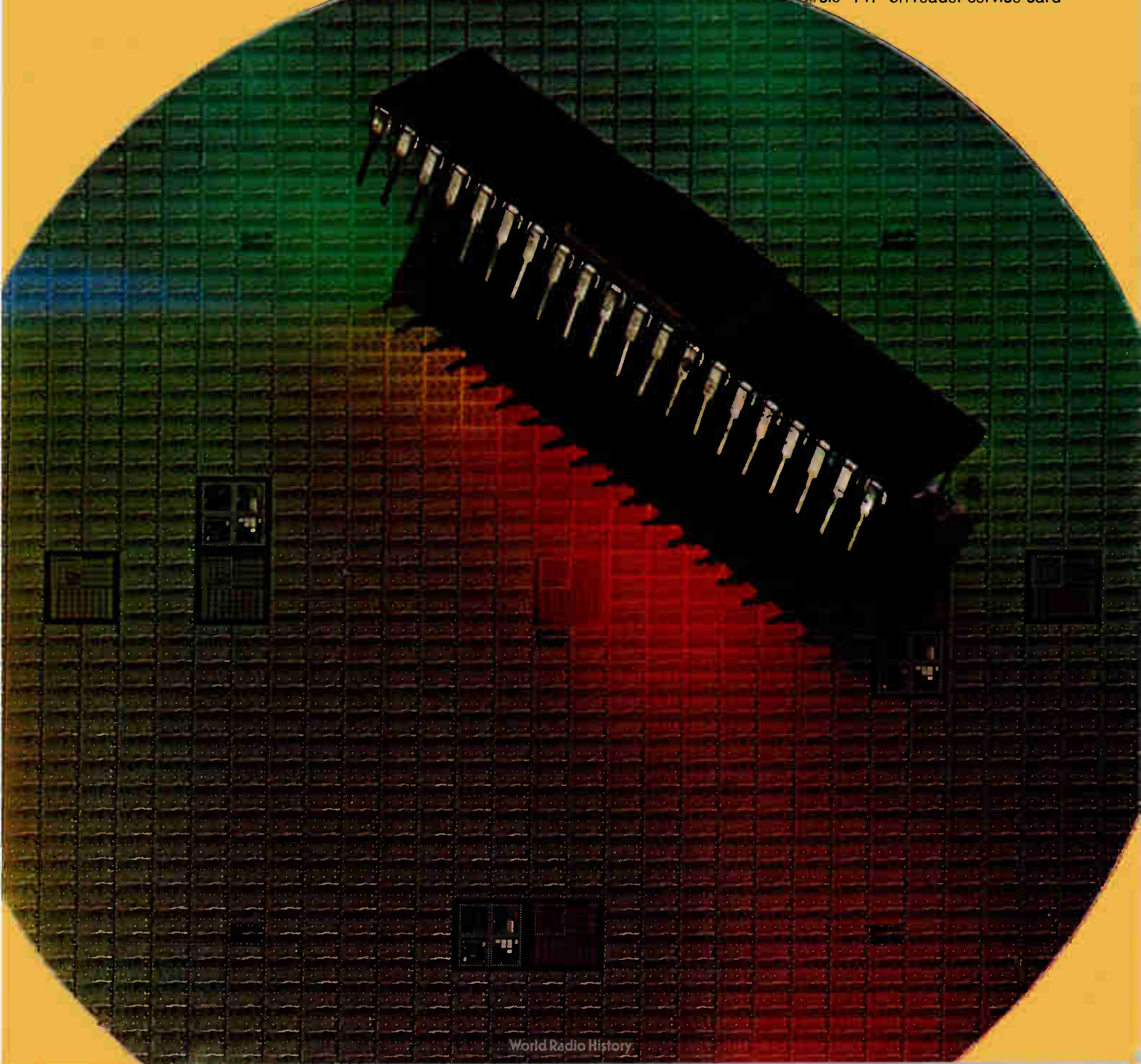

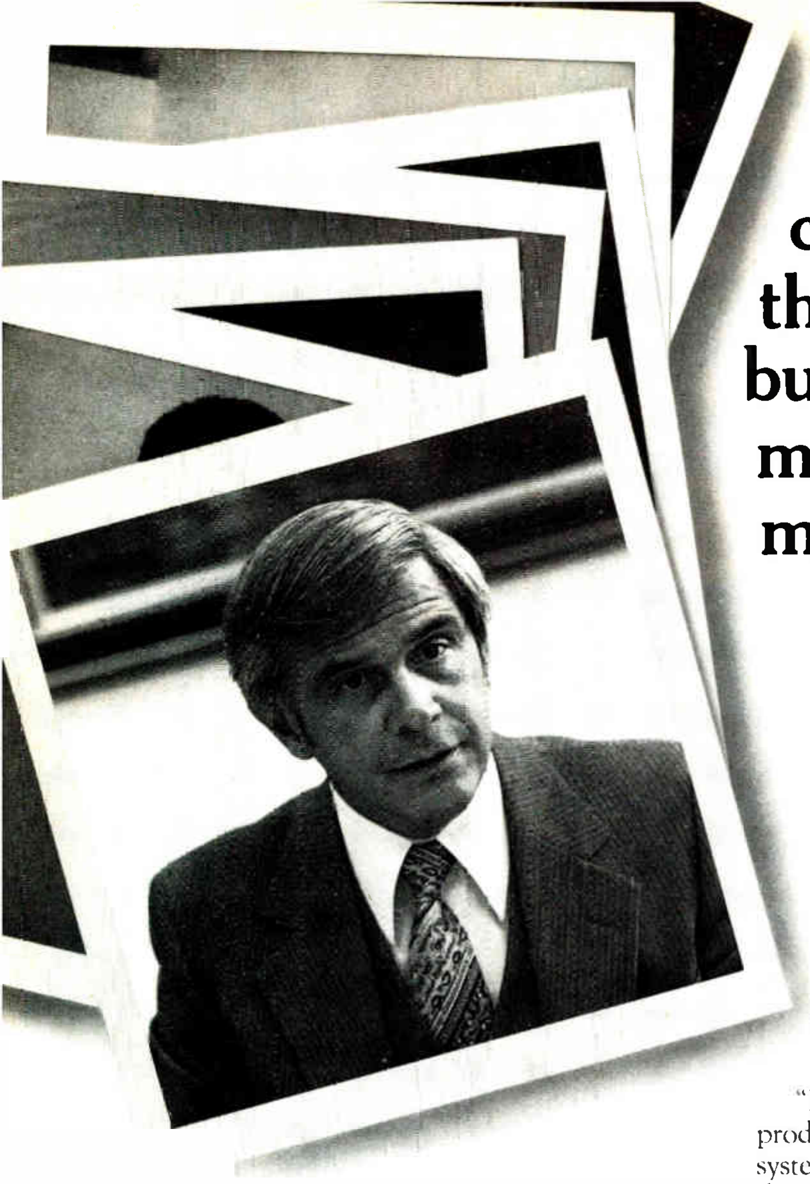

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"This is a tough, competitive industry. Getting a product to market first can make all the difference. Any company that doesn't move fast to take advantage of new technology will simply get left behind. So at Hazeltine, a key part of our strategy is to work closely with technology leaders — such as Intel. They introduced the microcomputer, and have continued to innovate with developments such as the 16-bit 8086 microcomputer. Taking advantage of their new products has enabled us to consistently give our customers higher performance and greater reliability.

"Intel makes it easy for us to apply their new products. An example is the Intellec® development system. Frankly, I don't see how any company can design a product that uses microcomputers without a system such as the Intellec system. The Intellec system features such as in-circuit emulation (ICE) and PL/M programming language are essential timesavers. With our Intellec systems we can convert our existing programs for the 8080 microcomputer to Intel's new 16-bit microcomputer, the 8086, quickly, and increase throughput ten times. That's flexibility."

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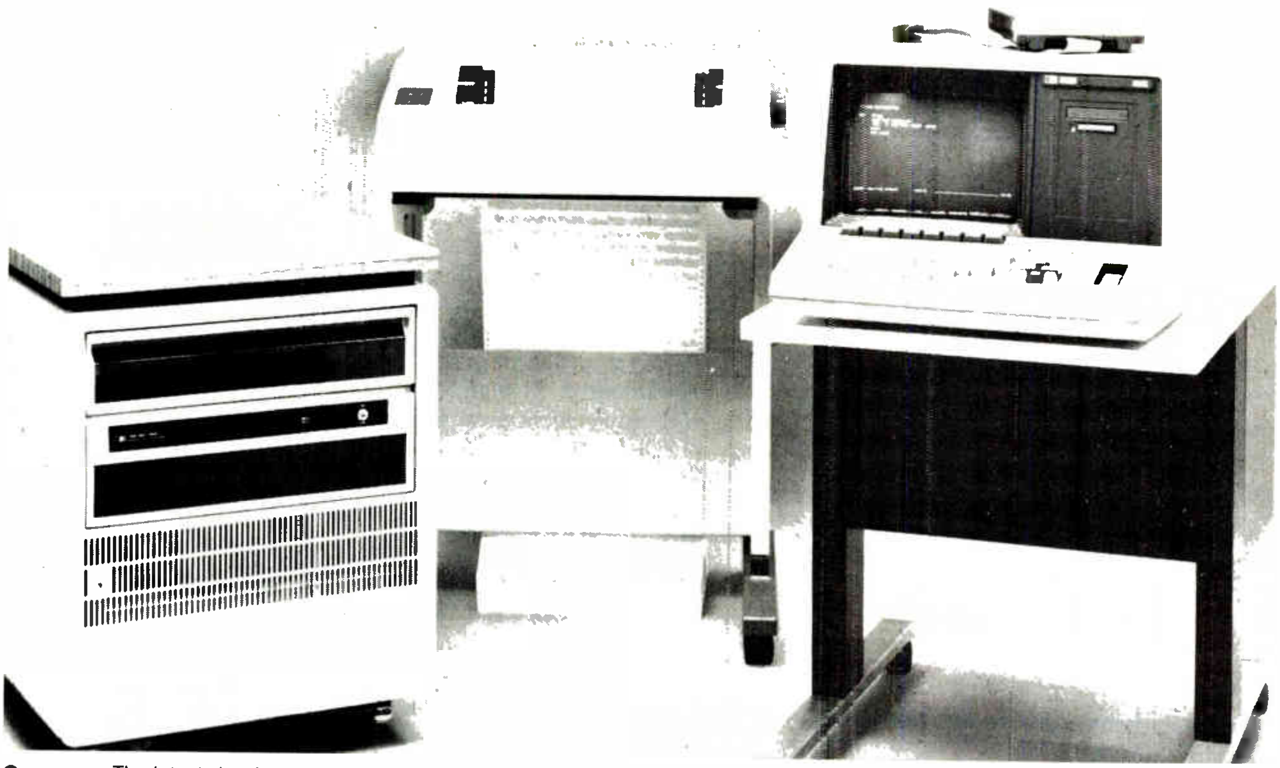


Generous. The latest development system from GenRad/Futuredata and the model 64000 from Hewlett Packard Co. (shown above) share the expensive disk and printer among several development stations. HP provides hard-disk storage, as do Intel and Zilog. Others will follow.

comes from a newly formed company called Mikros Systems Corp. of Albany, N. Y. The company, a spinoff from General Electric Co.'s Corporate Research Center in Schenectady, has designed a microprogrammable 16-bit microcomputer called the Mk-16. Presently available from Mikros is a bipolar bit-slice version of the machine, but the company is designing a complementary-MOS-on-sapphire version of the architecture to be marketed next year. Like Western Digital's Microengine, the Mk-16 executes P-code, the intermediate interpretive language generated by some Pascal compilers, such as the one Softech Microsystems Inc. in San Diego, Calif. acquired from the University of California branch in the same city.

Other reasons

High-level–language execution is not the only reason for a specialized processor design. High-speed mathematics is another. So far, Advanced Micro Devices Inc. of Sunnyvale, Calif., has two such parts, the 9511 and 9512, and Intel has signed on to second-source them. Intel is also hinting at its own 8087 math processor for the 8086 family, and National says it will offer a fast-math slave processor to be mated with its 16000 family.

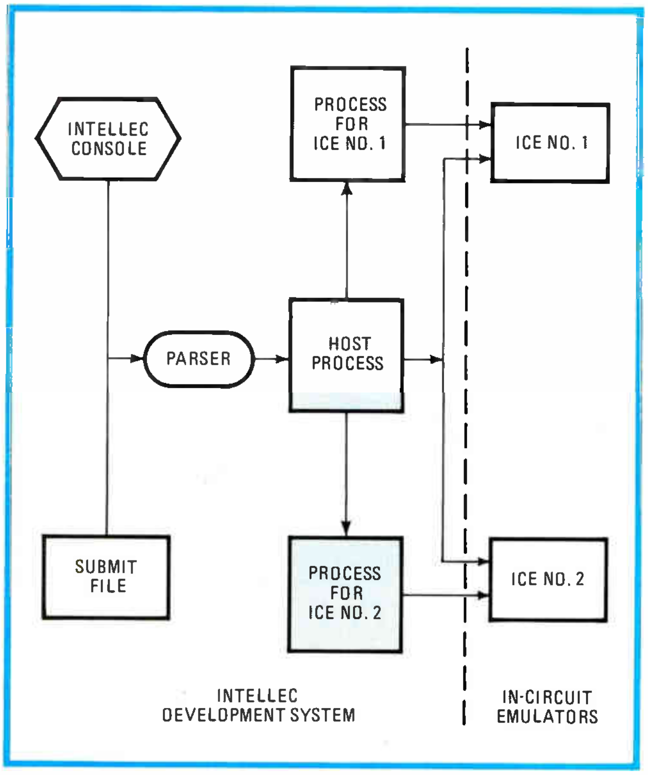
These chips illustrate their makers' priorities; they are after scientific and mathematical markets. Also, the 9512 meets the IEEE's proposed standard for floating-point mathematics. Intel's 8087 will adhere to the draft, and it is likely that National's device will too. The existence of the standard gives chip designers a base to work from and encourages the future proliferation of floating-point processors from other companies.

Input and output have long been a bottleneck in microcomputer systems, and silicon is being dedicated to doing something about that, too. Intel's 8089 I/O processor is a case in point. Essentially a very high-class direct-memory-access controller, the 8089 is designed to mimic the function of IBM's channel processor. It has two independent channels that can be time-shared by slower peripheral devices. The clock speed for the 8089 is currently at 5 megahertz to achieve a data-transfer rate of 1.25 megabytes per second, but Intel has also been picking out some chips that can handle an 8-MHz clock and 2 megabytes/s. And to make design with the processor easier, Intel recently introduced an assembler called the ASM 89.

Other device makers are eyeing the progress of the Intel device to ascertain if proprietary designs are warranted. If nothing else, such parts allow existing 8-bit peripheral devices to be easily married to new 16-bit processors.

Analog MOS

The world is full of analog signals, so to sense and drive external transducers, microprocessors eventually have to deal with analog input and output. The two most notable examples are the Intel 2920 analog microcomputer and the S2811 signal-processing peripheral from



Multi-ICE. Up to three separate software processes, one for each in-circuit emulator and a third for the host, can be active at any one time using Intel's Multi-ICE development system package. This enables the user to design and debug multiprocessor systems.

American Microsystems Inc., Santa Clara, Calif.

The 2811 and 2920 are both in 28-pin packages and both are intended to act in analog environments. But that is about where the similarities end. AMI's device is built using the company's V-groove MOS process; Intel's device is made in n-channel MOS. Intel's chip contains on-chip analog-to-digital and digital-to-analog converters and AMI's 2811 has an internal pipelined multiplier that can perform a 16-bit multiplication in 300 nanoseconds. For program development, Intel has a software simulator; AMI will furnish a real-time emulator.

Another special-purpose microprocessor worth noting is the new MAC-4 from Bell Laboratories. R. L. Townsend, a member of the technical staff in Murray Hill, N. J., described the device at Compcon in September. Townsend said that a search was made of existing microprocessors, but they were all about the same and none had the versatility Bell was after. The MAC-4, with its special bit-manipulation capabilities, is made in C-MOS and consumes a low 200 milliwatts of power. And, with a special halt instruction, most of the chip is shut off and power consumption heads down into the microwatt region. Thus, according to Townsend, a charged 1- or 2-microfarad capacitor could keep a telephone number alive in the chip for several days.

Before leaving the subject of specialized processors, it should be noted that some peripheral chips are getting so intelligent that they have become specialized processors in their own right, even if their manufacturers do not bill them as such. And in time, the difference between a peripheral chip and a specialized microprocessor will be less apparent. Consideration of what a very capable support device needs—a multitude of internal registers, ROM, and control logic—soon leads to the conclusion that a microprocessor will best fill those needs.

Single chippers

While some microprocessors are becoming more specialized, single-chip microcomputers are becoming increasingly versatile because of density advances in large-scale integration processing. For one thing, the new microcomputers are being designed in a block-oriented fashion, so that RAM, ROM, I/O and CPU requirements can grow as applications demand. Also, of the I/O functions to choose from, analog converters are now included, and instead of just masked ROM, E-PROM and, in one design from General Instrument Corp., EE-PROM have appeared on the die.

With higher density and computer-aided design and manufacturing, single-chip microcomputer production has almost become a custom business. Just about every single-chip microcomputer family has members with varying complements of RAM, ROM, and I/O. Some of the companies are going so far as to let the user specify the size of his memory and the type of I/O; then the blocks are chosen and the masks are made. Fairchild Camera and Instrument Corp., Mountain View, Calif., is doing this now with the 3870 family, and others like AMI are headed in that direction.

Motorola's new 6805 microprocessor, which tests its own I/O, RAM, and ROM, has its memory border the edge of the chip for future expansion. A future C-MOS version called the MC146805 will have more RAM and no ROM, for instance. The 68705 will have E-PROM instead of masked ROM, and finally, the 6805R2 will have 2 kilobytes of ROM and a four-channel a-d converter.

Many single-chip microcomputers contain or will be designed to have a-d converters, including members of the S2000 family from AMI, the 8021 family from Intel, the TMS1000 family from Texas Instruments, and the 3870 family from Mostek and Fairchild. AMI also plans an S3000 C-MOS microcomputer family. Besides having interrupts and counters for time-keeping, the basic S3000 will feature an on-chip voltage doubler or tripler to drive liquid-crystal displays directly.

It is clear that microcomputers are being geared for independence, to do more on their own with fewer peripheral circuits, fewer commands, and, with C-MOS, less power. It is ironic that one drawback with some single-chip microcomputers is that they can only act alone; that is, their bus lines can only drive peripheral devices and not accept instructions from a host in a distributed-processing environment. But this situation is also changing. Following Intel's lead with its 8041 slave microcomputer, other semiconductor companies are turning the buses around on some of their single-chip microcomputers so that they can interface a host proces-

An important tip for PDP-11 users

Play the blue-chip cards from Able.

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INSTALLS IN: All PDP-11's; in less than one half the space of DH11. **DATA RATES:** All 14 standard baud rates plus 19.2K baud and one user programmable data rate (16 baud rates). **PROCESSING ADVANTAGES:** Word transfers (in lieu of byte DMA) cut processing overhead by half! **OPERATING MODES:** Full or half duplex with full modem control via DM/16 option. **CAPACITY:** Up to 256 lines on a single PDP-11.

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INSTALLS IN: All PDP-11's; 4-lines per SPC slot at one unit load to Unibus. **DATA RATES:** 7 independently selectable baud rates for each of 4 channels (150-9600). **ELECTRICAL:** EIA standard RS232C (Modem control not supported). **VECTOR/ADDRESS SELECTION:** Vector and address values to be set on boundaries of 00$_8$ or 40$_8$. 16 continuous word address for Vector or Address.

QUADRASYNC/C™
(4-LINE DL11 REPLACEMENT/CL)

INSTALLS IN: All PDP-11's; 4-lines per SPC slot at one unit load to Unibus. **DATA RATES:** 7 independently selectable baud rates for each of 4 channels (150-9600). **ELECTRICAL:** 20MA current loop (Send : Receive). **VECTOR/ADDRESS SELECTION:** Vector and address values to be set on boundaries of 00$_8$ or 40$_8$. 16 continuous word address for Vector or Address.

QUADRASYNC/E™
(4-LINE DL11-E REPLACEMENT)

INSTALLS IN: All PDP-11's; 4-lines per SPC slot at one unit load to Unibus. **DATA RATES:** 7 independently selectable baud rates for each of 4 channels (150-9600). **ELECTRICAL:** EIA standard RS232C – with modem control. **VECTOR/ADDRESS SELECTION:** 16 continuous word address for Vector or Address – starting values selected on any boundary.

QUADRASYNC/LSI™
(4-LINE DLV11 REPLACEMENT)

INSTALLS IN: LSI-11 and PDP-11/03; 4-lines/card at one unit load to Unibus. **DATA RATES:** 8 independently selectable baud rates for each of 4-channels (110-9600). **ELECTRICAL:** 20MA active/passive current loop (Send : Receive) – also supports EIA standard RS232C. **VECTOR/ADDRESS SELECTION:** Like DLV-11 – 3-channels must have contiguous addresses and 1-channel may be set to any address including console address.

QUADRACALL™
(4-LINE DN11 REPLACEMENT)

INSTALLS IN: All PDP-11's; 4-lines per SPC slot at one unit load to Unibus. **PERFORMANCE:** Interfaces up to 4 Bell 801 ACU's with Unibus enabling any PDP-11 to dial any DDD network number to establish data link. **INPUT/OUTPUT:** 5-input signals from ACU are handled by EIA RS232 receivers. 6-output signals are transmitted using EIA RS232 drivers. **VECTOR/ADDRESS SELECTION:** Allows selection of device address and vector by use of pencil switches.

DV/16
(16-LINE DV11 REPLACEMENT)

INSTALLS IN: All PDP-11's; in less than one half the space of DV11. **DATA RATES:** 16-line throughput of up to 76,800 char/sec (19.2K baud full duplex for each line) total. **PROCESSING ADVANTAGE:** Word transfers (in lieu of byte DMA) permit user to operate within one half the DV11 bandwidth for data transfers. **OPERATING ADVANTAGE:** User may mix sync and async lines in combinations of 4 or 8 lines with modem control and full system software compatibility with all DV11 performance features.

MEMORY PRODUCTS

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INSTALLS IN: PDP-11/45, -11/50 and -11/55. **EXPANDS IN:** 32K word increments/board. One-half of the available Fastbus space will accept full 124K word complement. **ADDRESSES ON:** Any 4096 word boundary across entire 124K word range. User has full memory complement at 330 nsec cycle-time memory instead of 32K word limitation imposed by the computer manufacturer.

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(CACHE BUFFER MEMORY)

INSTALLS IN: PDP-11/45, -11/50 and -11/55. **CAPACITY:** 2048 byte (1K word). **ENHANCEMENT FACTOR:** Run time reductions to 50% (100% speed improvement) are achievable. **CACHE PARITY:** Automatically goes off-line in event of any data error. **RANGE SELECTION:** User may optimize hit ratio by upper/lower limit switch settings. **SPECIAL FEATURE:** Cache/45 can be enabled via software or console switches.

CACHE/434™
(4K WORD CACHE MEMORY)

INSTALLS IN: PDP-11/34 and -11/34A **without** using any additional backplane space! **CAPACITY:** 8192 byte (4K word). **ENHANCEMENT FACTOR:** Run time reductions to 40% (70% speed improvement) are achievable. **CACHE PARITY:** Automatically goes off-line in event of any data or address error. **RANGE SELECTION:** User may optimize hit ratio by upper/lower limit switch settings. Cache action monitor indicates hit rate.

CACHE/440™
(4K WORD CACHE MEMORY)

INSTALLS IN: PDP-11/35 and -11/40 **without** using any additional backplane space! **CAPACITY:** 8192 byte (4K word). **ENHANCEMENT FACTOR:** Run time reductions to 40% (70% speed improvement) are achievable **CACHE PARITY:** Automatically goes off-line in event of any data or address error. **RANGE SELECTION:** User may optimize hit ratio by upper/lower limit switch settings. Cache action monitor indicates hit rate.

EMULOADER™
(ODT/BOOTSTRAP LOADER REPLACEMENT)

INSTALLS IN: PDP-11/05, -11/10, -11/35, -11/40, -11/45, -11/50 and -11/55. **MECHANICAL:** Dual width card replaces standard Unibus termination; requires no additional backplane space. **OPERATING ADVANTAGE:** Provides fixed console emulator (ODT) and bootstrap loaders for DL11, PC11, RF11, RK06, RK11, RP04/05/06, RP11, RS03/04, RX11, TC-11, TM11 and TU16. **SPECIAL FEATURE:** Performs memory diagnostic each time a boot operation is done from ODT.

GENERAL PURPOSE PRODUCTS

QNIVERTER™
(Q-BUS TO UNIBUS CONVERTER OR UNIBUS TO Q-BUS CONVERTER)

INSTALLS IN: LSI-11, LSI-11/23, PDP-11/03 and PDP-11/23 via quad-width card. **APPLICATIONS:** Allows Unibus-compatible controllers and memories to be used with LSI computer systems, or LSI-based peripherals to be used with PDP-11 computer systems. **FEATURES:** Supports features of LSI-11/23 including the full 128K address capability.

REBUS™
(BUS REPEATER – DB11 REPLACEMENT)

INSTALLS IN: All PDP-11's; **without** using any additional backplane space. **MECHANICAL:** One dual-width card plugs into the same pair of connectors as the Unibus extension cable which is then plugged into the REBUS connectors. **COMPATIBILITY:** Allows for 18 additional bus loads and 50 foot bus extension. Requires no software changes. Bus cycle time unaffected for devices on CPU side of REBUS – increased by 250 nsec max. for devices on outboard side.

DUAL I/O™
(GENERAL INTERFACE-DR11-C REPLACEMENT)

INSTALLS IN: All PDP-11's; in any SPC slot via quad-width card. **APPLICATION:** Dual I/O is equivalent to two (2) DR11-C's and provides the logic for program-controlled parallel transfer of 16-bit data between two (2) external user devices and a Unibus system. **OPERATING ADVANTAGE:** Provides user the hardware/software equal to a dual DR11-C in one-half the space and one-half the bus loading of DR11-C's.

UNIFACE™
(UNIBUS-COMPATIBLE, GENERAL-PURPOSE IOP)

INSTALLS IN: All PDP-11's in any SPC slot via hex-width card. **APPLICATION(S):** Limited only by user's ingenuity: can form additional intelligent Unibus I/O channel(s), communications preprocessor(s), efficient KMC11 equivalent(s), or user-proprietary device(s). **OPERATING ADVANTAGE:** To PDP-11's, UNIFACE looks like a standard controller at one bus load; to devices served, UNIFACE acts as a powerful CPU.

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INSTALLS IN: All PDP-11's and/or LSI-11's via pairs of hex-width, hex/quad-width or quad-width cards and supplied cables. **APPLICATION:** Provides full DA11-B (Unibus or Q-bus link) compatibility on single cards. BUSLINK operates at DA11-B transfer rates over distances of up to 50 feet. **OPERATING ADVANTAGE:** Requires only one card per CPU to effect link at minimal bus loading vs. full system unit per computer.

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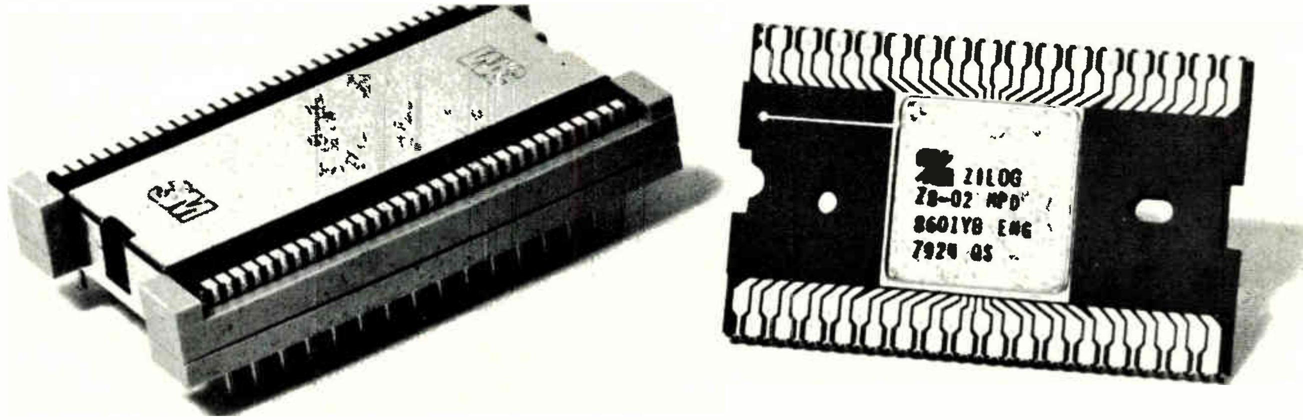


Prototyping. For program development, Zilog offers a 64-pin version of its 8-bit single-chip microcomputer, the Z8, with the read-only memory missing. After the user's code is checked out using external memory, it can be mask-programmed into standard 40-pin Z8.

sor with peripheral equipment. Zilog is doing this with its Z8, turning it into a universal peripheral controller for the 16-bit Z8000 family. And Motorola is doing the same with the 6801 for the MC68000 family. The 6801 UPC will have a basic 6801 CPU but with a dual-ported RAM and 8 extra data-bus lines, resulting in a 48-pin package. The on-chip ROM will be preprogrammed to transfer blocks of data between a host and a peripheral.

For ultimate versatility in some applications, a microcomputer needs nonvolatile storage that can be changed on the fly. E-PROM is a step in the right direction, but of course it needs ultraviolet light for erasure. This situation is leading General Instrument Corp.'s Microelectronics division in Hicksville, N. Y., to design a microcomputer with on-chip metal-nitride-oxide-semiconductor (MNOS) nonvolatile backup memory.

GI's PIC 1657, still perhaps a year from volume production, has been specified to have 512 13-bit words of microcode, 48 bytes of RAM, and 16 general-purpose registers. Both the RAM and the register set will be backed up with nonvolatile MNOS EE-PROM to save data when power fails. The next part with that technology will be the 1677, which will double the amount of ROM.

Microprocessor support

Support equipment comes out of the woodwork like clockwork, not long after a microprocessor is introduced. Chip makers usually start off with so-called evaluation boards. These star the CPU and surround it with RAM, ROM sockets, and I/O. These days the boards have some ROM precoded with monitoring and debugging routines so the buyer can hook up a terminal and begin evaluating a device more quickly.

Evaluation boards are usually purchased in small quantities and taken home by engineers when the full-blown development systems for serious development work surface. But they are handy in the beginning, mostly because the first CPU samples are only offered on such boards.

All the 16-bit microprocessors now have their own evaluation boards. Intel introduced one for the 8086 some time ago, and more recently AMD and Zilog built their own versions separately for the Z8000, Motorola for the 68000, and TI for the 9900. TI also introduced a 9980-based board, the TM990/189M, which has a keyboard and three holes punched in it so students can put it in their three-ringed binders.

Millennium Systems Inc., Cupertino, Calif., has taken the evaluation board idea further with its MicroSystem Designer. The Designer is a sort of universal evaluator, able to be configured for several 8- and 16-bit processors. Millennium also recently introduced an emulation terminal called the MicroSystem Emulator, which connects to a computer or dedicated development system through a serial line for emulation of many processor types at speeds up to 6 megahertz. It has 8 kilobytes of user RAM and real-time tracing.

Development systems swell

Recent additions to the latest development systems can be traced in a logical manner, beginning with the new microprocessors themselves. They support high-level languages and address megabytes of memory directly. This calls for more expansive, faster mass storage, so Intel, Hewlett-Packard, and Zilog tacked hard disks onto their development systems. It is likely that other companies like Motorola, National, and Advanced Micro Computers Inc. of Santa Clara, Calif., will be forced to do the same.

Hard disks cost a lot, however, so now development system manufacturers are working out networking schemes so that several users can share the expensive components like the disk drives and printers. But to share resources this way, the systems need multiple-user operating systems, so these too are being developed.

Building a distributed development system architecture demands more than simply lacing together dumb terminals and a host with serial communication lines, however. The less traffic on the communications paths and the less contention for system resources, the more successful the distributed architecture will be. So if the terminals in the architecture are dumb and the users want to edit programs and emulate processors, the data paths will be jam-packed and response to system requests will be long.

GenRad/Futuredata, Concord, Mass., and Hewlett-Packard Co., Palo Alto, Calif., have lowered resource-bus traffic by having multiple buses and by putting more intelligence into the development stations (see figure on p. 149). In both systems, a development station is given enough memory to allow a user to write, edit, and debug programs as well as emulate a processor without too much communication with the host. Once a program is checked out, or if a user needs a file on disk, blocks of data are transmitted between host and station in batch fashion, after which independent station operation may resume.

Intel's Multi-ICE package is another new idea in microcomputer development whose time has come. It facilitates the design of multi-microprocessor systems by coordinating control of two simultaneous emulation processes in a single Intellec development system. At present, two ICE-85s or an -85 and a -49 can be paired for concurrent execution with Multi-ICE, and Intel plans other combinations.

A block diagram of Multi-ICE is shown in the figure on p. 150. Up to three software processes can be active in the system at one time. These include the host process and one for each of the two hardware ICE units. An ICE process can be activated, suspended, killed, or continued. The user can create an off-line test file with any other Intellec software tools and synchronize the three processes later for check-out.

The emulation of single-chip microcomputers can often be difficult, even impossible, if access to internal memories is not provided via external pins. To deal with this particular problem, some semiconductor manufacturers are offering prototyping versions of their microcomputers. An example is the Z8-02 MPD from Zilog (see photo on p. 153). The chip, housed in a 3M 64-pin

PROFILE

Hoff has high hopes for his 'analog' microcomputer

As Intel Corp. employee number 12, Marcian E. "Ted" Hoff has been intimately involved with many of the 11-year-old company's major developments, including the landmark progression of the 4004, 8008, and industry standard 8080 microprocessors.

The latest addition to his portfolio of integrated circuits is the 2920 analog microcomputer. With internal analog-to-digital and digital-to-analog converters, the 2920 accepts stimuli from the outside world, digitally processes the information in real time, and reconverts the results into analog form. And because analog signals are omnipresent, Hoff's latest creation has an much nicer fit with the real world of communications than the results of his digital microprocessor projects did.

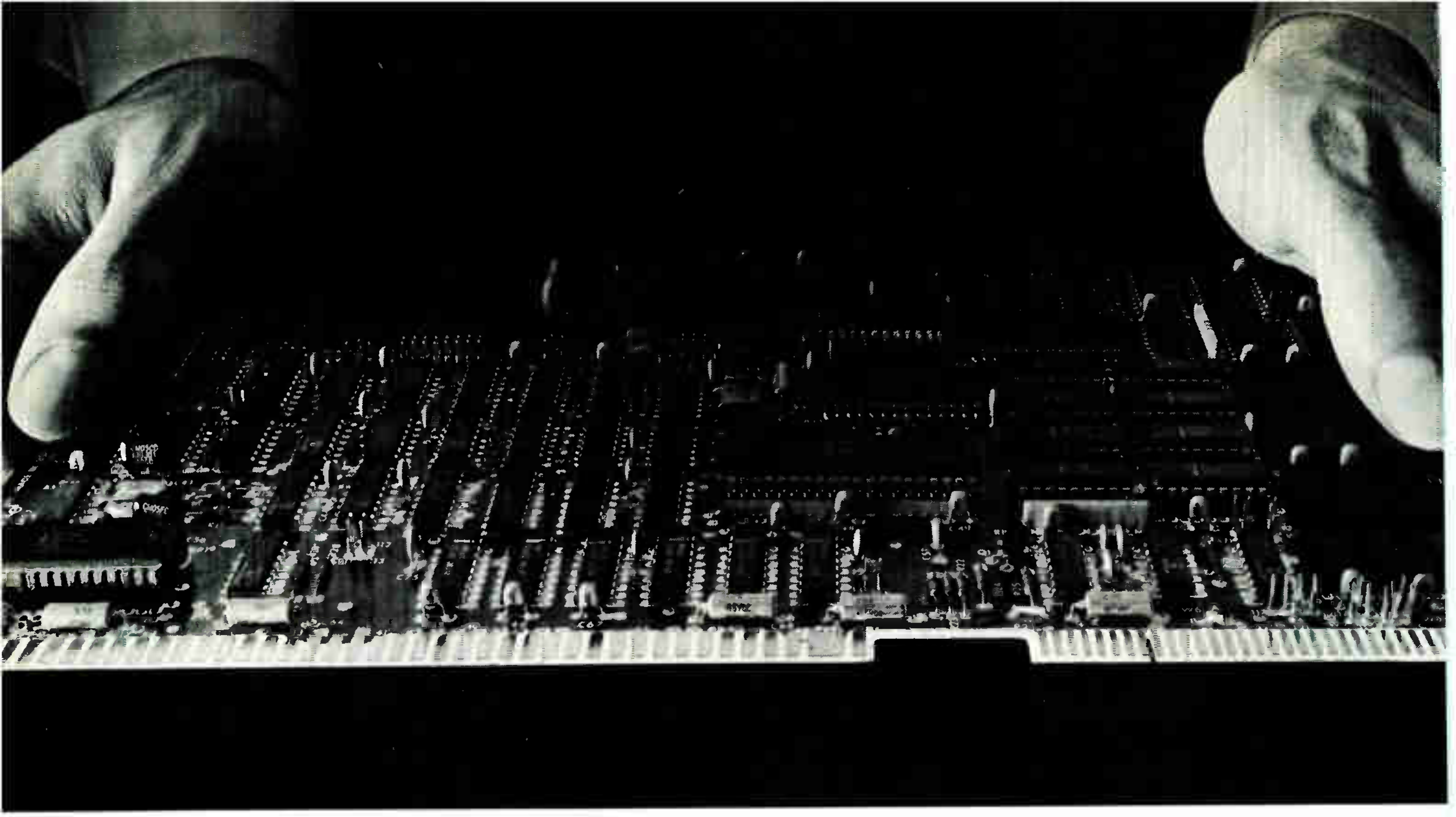
For Hoff has been involved with telecommunications programs at Intel since 1975. Indeed, he says the 2920 concept began to emerge when existing telephone systems were found not to justify developing custom chips for the various functions. During this same 1975–76 period, "the technology had gotten to where digital processing of analog information was possible," Hoff says, since an a-d and d-a capability could be included along with an n-channel processor on the same chip. This was important because "analog interfaces were necessary to work with existing [telecommunications] equipment," and as luck would have it, most microprocessor data rates were high enough to sample analog inputs.

Now Hoff feels the 2920 will open the door to an exciting new wave of analog computing. "With the 2920, you have a new kind of microprocessor with a different kind of intelligent engine for analog applications," he explains. The upshot for Hoff is that "digital processing of analog signals has finally arrived and will soon be practical and available to everybody."

The applications for such a device are overwhelming because the concept of analog processing is still in its infancy. In fact, Hoff likens analog computation with the 2920 to digital processing with the 4004. But, he adds confidently, "as users get used to the 2920's features, the applications will grow and other analog-signal–processing products will emerge." Just guessing at a few of those applications, architect Hoff and designer Matt Townsend foresee analog subsystems such as filters, mixers, modems, and tone receivers, and the device might even play a role in applications such as process control.

Perhaps the biggest problem for Hoff and Townsend in the 2920's design "was to get all that stuff on one chip." For besides the analog converters and the pipelined digital processor, the microcomputer packs in a random-access memory and an erasable programmable read-only memory for the user's instructions. It was therefore a challenge to "implement a reasonable number of functions without making the chip impossible to build," says Hoff. But as it turned out, the 2920 uses less die area than typical E-PROM–based microcomputers.

When Hoff arrived in 1968 for his first day at Intel, it was also the company's first day at its first facility in Mountain View, Calif. He had been working for six years on hardware-adaptive filters as a research associate at Stanford University when Robert Noyce called and offered him a job at a new company called Intel. Hoff, holder of a 1958 BSEE degree from Rensselaer Polytechnic Institute, Troy, N. Y., received his MSEE and Ph.D. at Stanford in 1959 and 1962. **-William F. Arnold**



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quad in-line package, has no internal ROM but instead provides 12 address lines, 8 data lines, and control signals to develop programs in external PROM, E-PROM, or RAM. As single-chip microcomputers have attained more power, other firms have been forced to make similar packaging arrangements.

Suppliers other than those responsible for the development systems have been creative in devising hardware and software products to improve the performance or applicability of the existing equipment. One such company is Processor Innovations Corp., Red Bank, N. J. This outfit sells a software package called Pivot 9900 that allows 9900 microprocessor programs to run on an Intellec system. PI Corp. followed this software with a hardware adapter that allows the 9900 code to be downloaded into a Texas Instruments 990 CPU module.

Pascal is quickly finding its way into development system equipment. GenRad/Futuredata has Pascal up and running on its equipment, as do Zilog and Texas Instruments. TI has gone beyond the proposed IEEE Pascal standard to add facilities for concurrent process execution.

Software will become much easier to use in the future, not only because of high-level languages like Pascal, but because of bigger ROMs. With microprocessors able to execute position-independent programs, more and more software will be put into ROM to become firmware. TI will provide many such modules, and already has versions of its Power Basic and an executive package called Timber. National also has Basic in ROM, and Motorola plans a floating-point package for the 6809 called FP09. Plug-in firmware modules will proliferate because they take that much more pain out of system design. The firmware will be supplied by major semiconductor companies and cottage industries; even compilers may one day come in dual in-line packages.

PROFILE

Wirth works to better Pascal

"Our contribution to the development of computer languages was rather small compared to what remains to be done." That's how Niklaus Wirth, the man behind the development of Pascal programming language, sees his creation in retrospect.

But for all his modesty, Wirth, a professor with the computer science department of the prestigious Swiss Federal Institute of Technology in Zurich, is gratified "that the methodology for which we have fought so long is now being recognized as a valuable tool in data processing." It is not so much Pascal *per se* that counts, he adds; of far greater importance is achieving a disciplined and structured approach to program design. "Pascal, I hope, will bring the programmer one step closer to that goal."

Wirth's work on Pascal dates back to 1965 when the International Federation of Information Processing Societies invited him to cooperate in the development of a successor to Algol 60. In 1966 a language called Algol W was implemented at Stanford University where Wirth held a position as assistant professor in the newly established computer science department.

After returning to Switzerland in 1967, Wirth freed himself from committee compromises and devised a successor to Algol W. He called that language Pascal, in honor of the 17th-century French mathematician and physicist Blaise Pascal, who is credited with having built a computing machine in 1642 to help his father in his tax-collecting chores. "Besides, the word Pascal has a certain melodious ring to it," Wirth says.

Wirth feels that many equipment makers think too much in terms of machinery and not enough in terms of a language. "The *raison d'être* of a high-level language is that it enables the user to formulate his programs on a higher level of abstraction to better solve a problem. It is not intended to enhance computer design."

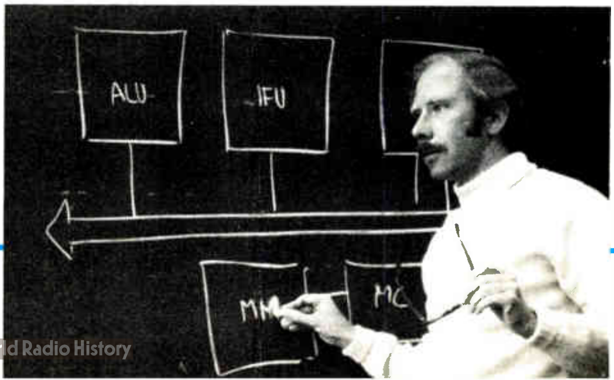
Wirth wrapped up his work on Pascal in 1974. He has since turned his attention to Modula, a language intended mainly for the programming of dedicated systems, including small computers. Although not a direct successor to Pascal, it uses many of the latter's elements. In addition to the conventional block structure, Modula has a "module" structure, each module constituting a scope of visibility of names that enables the programmer to hide information about some program parts from others.

The initial version, Modula I, was "never considered a full-fledged systems programming language," Wirth emphasizes. What does constitute such a language, however, is Modula II, a variation for a personal computer now being developed at the Zurich institute. The big advantage of Modula II over Pascal, Wirth explains, is that it uses "the concept of the module; a concept that will become absolutely essential in the future."

Speaking in his office overlooking Zurich, Wirth comments that a language should not be made a standard "unless it has proven itself in actual practice for several years." As regards his own creation, he thinks that the revised Pascal Report (Pascal User Manual, 1975) could well be considered a standard definition. "An official standard document would, in essence, limit itself to the clarification of insufficiently defined points and to language representation in terms of standard character sets."

Wirth, a soft-spoken and amiable man who does not look his 45 years, enjoys his work immensely. What little leisure time it leaves him, he spends with his family (which includes two girls and a boy), often hiking with them in the rolling hills of northern Switzerland. He holds a bachelor of science degree from the Swiss Federal Institute of Technology, where he now works, later receiving his master of science degree at the University of Quebec in 1962 and a Ph.D. from the University of California at Berkeley the following year.

-John Gosch



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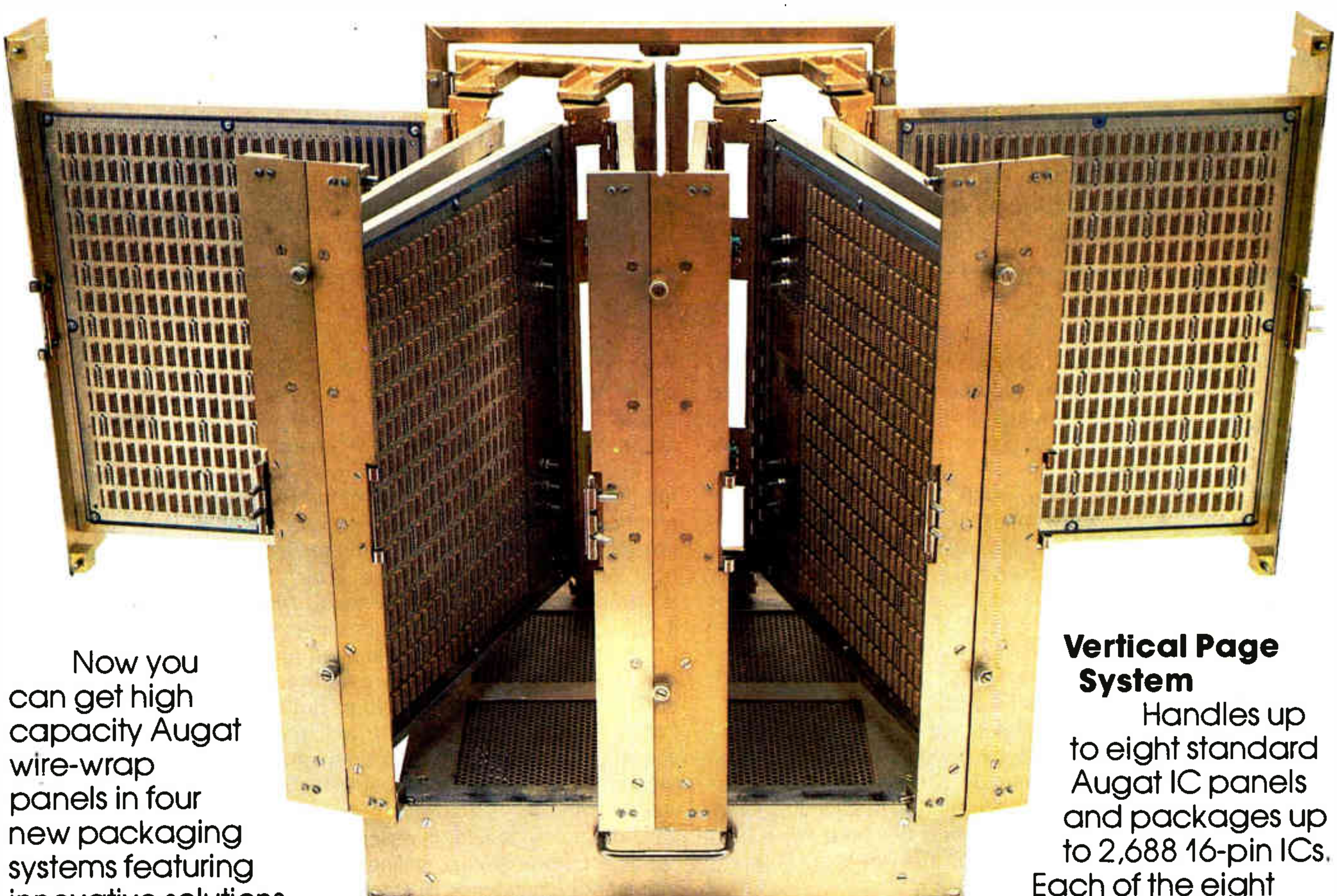

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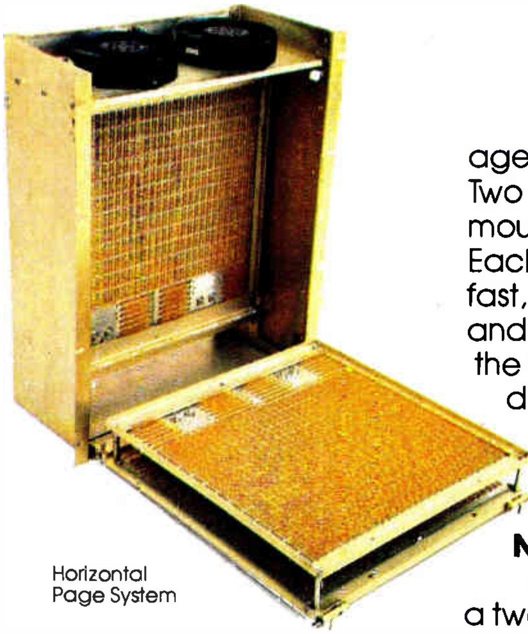

Horizontal Page System

stitch-weld; and single, double and triple width boards in the same enclosure. Choose either a continuous backplane or three separate backplanes to provide the different voltages and grounds needed to mix analog and digital boards. All are assembled with 96-pin I/O connectors. Flexible spacing lets you use up to four wire-wrap boards (1.2" spacing) or 7 stitch-weld boards (.6" spacing) or a combination of the two. Guide separators let you mix different width boards. Fans are optional.

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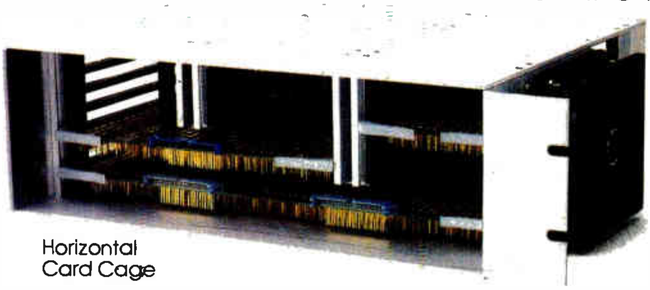

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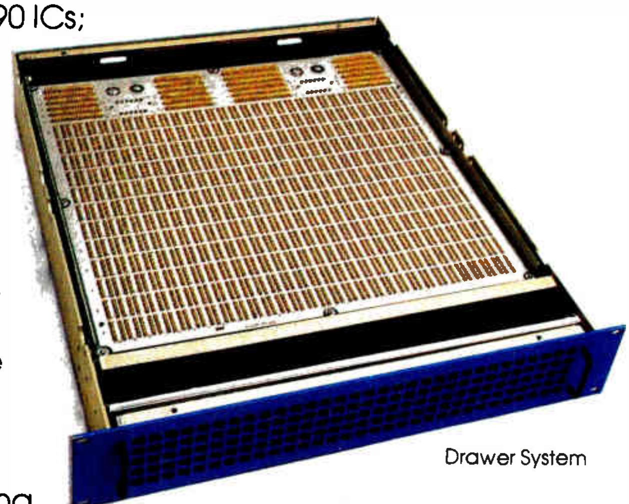

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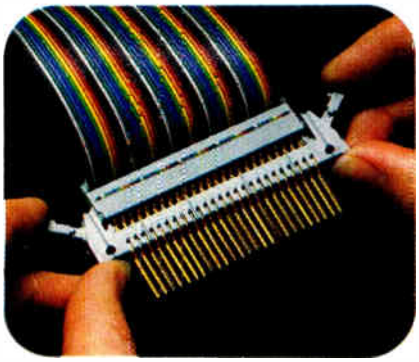

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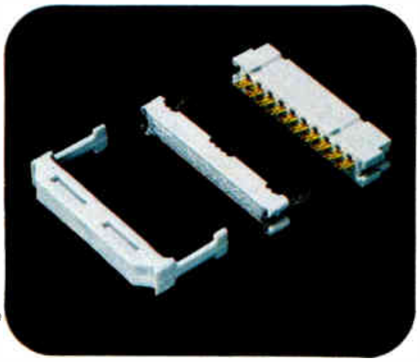
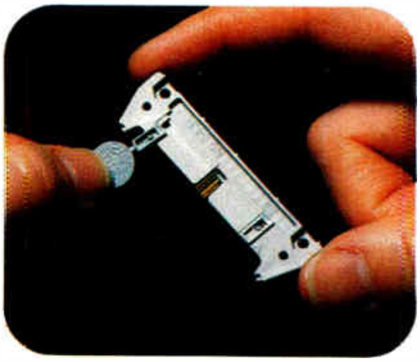


Mating socket connectors have been redesigned with metal spring clips that lock cover to body tightly, providing greatly increased cover retention. And a new one-piece strain relief clip now reduces parts inventory and cuts assembly labor time.



An improved keying system permits positive polarization without pin loss, helps reduce equipment damage and field maintenance. Connectors snap into polarized headers to insure positive mating and provide increased retention.

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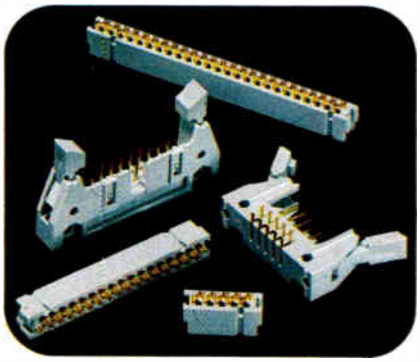

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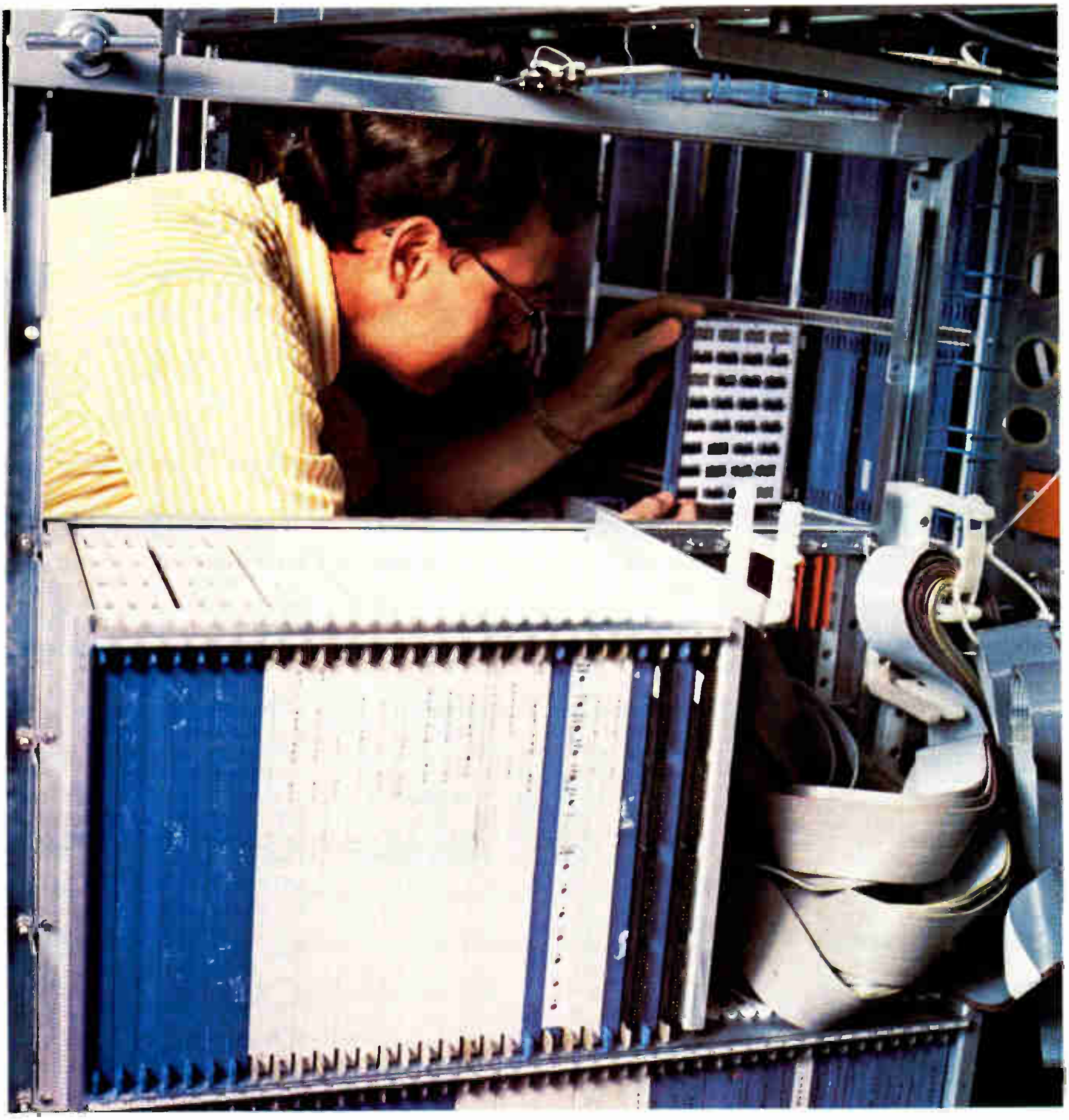

Computers

by Anthony Durniak, *Computers & Peripherals Editor*

☐ *The stored-program electronic digital computer marked its 30th anniversary this year and the industry celebrated by unleashing a torrent of products that not only encompass a wealth of new technology but also indicate the direction computers will take in the 1980s. What makes the last 12 months particularly significant is the sheer number of innovations in every hardware and software area. As a group, the new machines are setting new standards for performance, price, ease of use, reliability, and maintainability.*

Most obvious were the new computer hardware architectures and their innovative use of semiconductors. IBM led the way by introducing several products that not only offered new architectural features, but also used new 64-K random-access memory and logic chips—the first new semiconductor technology from the industry leader in almost nine years. Univac made unusual use of bit-slice microprocessors by building the industry's first microprocessor-based mainframe computer. NCR reminded the world it is serious about large-scale mainframes with its unique bus-oriented 8600. A new architecture, called micromodular concurrent, was unveiled by Burroughs in its 900 series of computers. But the biggest machine in the past few months was Control Data's Cyber 200 supercomputer.

In addition to the new mainframes, a fresh crop of minicomputers was cultivated by Univac, Data General, Texas Instruments, and Computer Automation. Further blurring the distinction between the minicomputers and mainframes were new 32-bit computers from Perkin-Elmer Data Systems Group.

Capturing the peripheral spotlight were Winchester-type disk drives—especially in the new compact 8-inch version. And nonimpact printers were scaled down for the office environment.

Significantly, much of the new equipment is aimed at making the concept of distributed processing a reality, lending still more momentum to that new wave of the data-processing world.

IBM sets the pace

IBM remained the dominant force in the marketplace this year by announcing a dazzling array of new products that made unusually aggressive use of new technology. The 8100 Information System from IBM's Data Processing division, White Plains, N. Y., started the ball rolling early last October. Besides being the medium for the corporation's dramatic new 64-K random-access memory chips, it signified IBM's recognition of distributed processing. Packaged with the Distributed Processing Programming Executive operating system software, the 8100 has a configuration flexibility and stand-alone processing capability IBM never before offered.

Later that month IBM's General Systems division of Atlanta, Ga., unveiled an ambitious new architecture—IBM's first in almost 15 years—in its System/38. A replacement for the 10-year-old System/3, System/38 illustrates not only the direction in which IBM's future systems will move but also the problems new technology poses for the industry.

Rapprochement. Technician assembles Sperry Univac's 1100/60, the first large mainframe to be built from bit-slice microprocessors.

Take the current industry dilemma of how to exploit large-scale integrated circuits without loss of design freedom or control over the architecture. IBM's answer is to use gate arrays. One division developed a master-slice chip containing arrays of 704 Schottky TTL gates that is customized by the addition of the last three layers of metalization—a step that involves a computer-aided design system and an electron-beam system that writes directly on the wafers. The new chips made it possible to fit the System/38's entire central processing unit onto a single 10-by-15-inch board.

This new hardware serves a new architecture that offers more functionality—for instance, the ability to address up to 280 trillion bytes of virtual memory—and in general an easier-to-use machine. In its dramatic break with the past the new architecture will force users to convert any existing software to the System/38's needs, but it is intended to prevent such dislocations in the future. "It capitalizes on the rapid evolution of technology and yet minimizes the impact of hardware changes on the user's software," explains System/38 project manager Brian Utley.

Software's impact

In fact, the System/38 also demonstrates how software is changing the rules of the computer development game. Its new operating system promises the user greater ease of use and easier memory reference techniques. To do so, the skills of the design team had to change: the System/38 team had five to six software people for every two hardware designers. More significantly, the software is at present being blamed for a six-to-nine-month delay in product deliveries. Just as shipments were to start this August, IBM announced that more time was needed to "integrate and test the systems programming elements to achieve planned performance levels." Utley and IBM are unwilling to discuss the problem further. But as Steve Gaal, Data General's director of software development, points out, "there's no question that systems software gets more complex as more of the utility of the system is made available to less sophisticated users." And the trend to having separate software components handle memory management communications, programming languages, and the like makes putting the final product together even harder.

Such product development and scheduling problems will continue to plague the industry for the near future because, points out Nicholas M. DiCianni, director of strategic planning for Sperry Univac, Blue Bell, Pa., "we don't have the tools for software that we have for hardware and we're not making advances in the way of tools." Those attractive new software techniques—structured programming, top-down design, and the like—help but are not the cure. "Only 20% of the software development job is coding, so things like structured programming will only help a little," DiCianni notes. "We don't

Future directions. IBM Corp. views master-slice chips containing arrays of 704 gates as the best way for it to employ large-scale integrated circuits in future computers. Shown here are the new logic elements being installed in the new 4300 computers.

yet know the optimum way to program, but it's a high-priority item for all of us in the industry."

IBM's Data Processing division let it be known in January that it also intended to bring new hardware technology to its mainframe computer line—the first component update since the System/370 was introduced in 1970. The showcases for the new technology are the 4331 and 4341 computers, which used the same master-slice gate arrays as the System/38 and offer four times the performance of the 370/115 and 3.5 times the performance of the 370/138 respectively.

The bottom line

One result of employing the new technology was dramatically lower prices: the 4331 starts at $64,000 and the basic 4341 sells for $245,000, an estimated three to five times improvement in price/performance ratio. And memory is priced at an industry low $15,000 a megabyte—a fifth of what IBM charges for memory for the rest of its mainframes even after last year's 30% price reduction. Long discussed in industry circles under the code-name E-Series, the new 4300 computers are seen as harbingers of the direction the price and performance of IBM computers will take in the future, specifically in the top-of-the line H-Series expected in 1980.

IBM made it clear that it agrees with others in the industry who say it is almost impossible to change a widely used computer architecture today because such a change would make so much software obsolete—software estimated to be worth over $200 billion in the case of IBM's System/370. So instead of changing over to an entirely new architecture, the 4300 supports the existing one with newly designed hardware, made faster by additions such as an 8-kilobyte cache memory, eight (instead of four) byte-wide data paths, and a new arithmetic and logic unit.

Blazing a trail

Humberto Cordero, manager of processor development for IBM's Systems Product division in Endicott, N. Y., where the 4341 was developed and both models will be made, says the new unit reflects design techniques that the entire industry's next generation of computers will employ (see "Cordero journeyed from computer to chip and back").

The gate arrays used in the 4300, for example, represent a compromise solution to how best to use large-scale integration and still retain architectural flexibility. But making that decision when the 4300's design was started was not easy because such semiconductor technology had not yet been proven. And making such decisions will get harder, Cordero says.

"The advent of a technology menu so rich in price and performance capabilities and alternatives makes planning a product harder," he says. As a result, products will have "to put a structure in place that can take advantage of new chips as they become available."

Leaving no stone—or industry trend—unturned, IBM also went to great lengths to improve the reliability, testability, and maintainability of its new computers. The logic chips used in both the System/38 and 4300 incorporate the company's level-sensitive scan design. This allows the state of the various gates in the chip—many otherwise inaccessible—to be captured and read out for interpretation by another new feature, a separate diagnostic service processor.

IBM has also made a major commitment to remote diagnostics—for software as well as hardware. Both the 4300 and System/38 can be tested over telephone lines so that if the failure is found in hardware, the service technician can be dispatched with the proper spare parts. And through a series of special software support centers, programming problems can be discovered and often can also be corrected.

For all its technical significance, the ultimate test of any computer is customer acceptance in the marketplace. In that test the 4300 passed with flying colors. Although IBM will not release figures, demand for the 4300 outstripped IBM's capacity, so that delivery times have stretched out over three years. And the 4300

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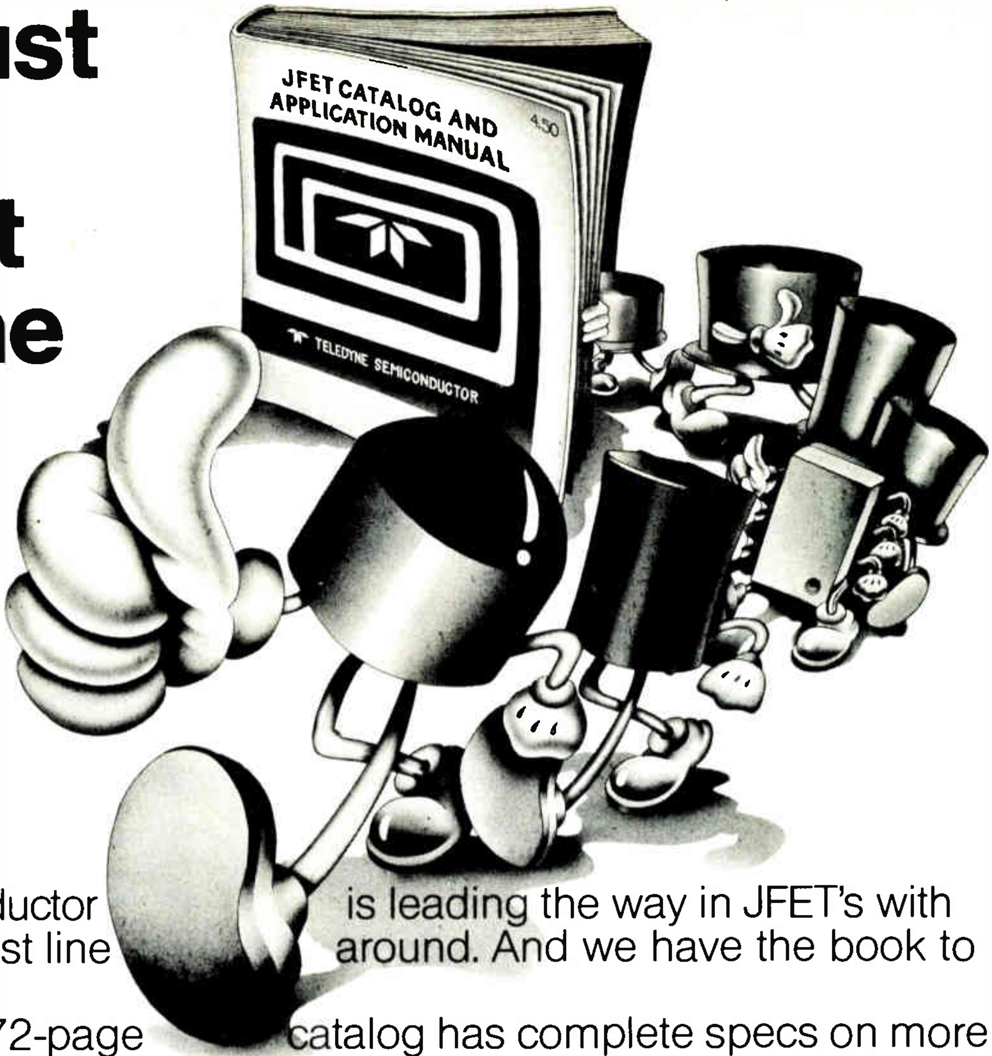

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encouraged such strong speculation about similar dramatic price/performance improvements in the rumored H-Series that customers began postponing their purchases. As a result a series of economic ripples ripped through the market, affecting both IBM and IBM-compatible machines.

The economic problems preoccupied many of the IBM-compatible makers, most of whom reported drops in their second quarter earnings. Itel, the most severely hit with a $60 million loss, sold its computer business to National Semiconductor Corp., and Amdahl and Memorex initiated merger discussions.

But they did launch a retaliatory attack of new machines. Itel brought out an AS 3/5, while Magnuson Systems unveiled its M80/42 and M80/43. A notable casualty of the 4300, however, was National Semiconductor's System 400, a bus-oriented design that was initially withdrawn from market for redesign and eventually scrapped. And Amdahl Corp., apparently believing that the best defense against the forthcoming H series was a good offense, introduced its 470 V/8 as well as the 470 V/7A, which outperforms IBM's top-of-the-line 3033 and sells for 27% less. Control Data Corp., aiming at users of the IBM's older model 138 and 148 machines replaced by the 4300, expanded its line with the Omega 480-III.

Meanwhile, in the rest of the industry . . .

Although IBM succeeded in capturing much of the industry's attention in the past several months, the other mainframe and minicomputer vendors also announced a number of new machines.

Probably the most significant of these was the 1100/60 that came in June from Sperry Univac, Blue Bell, Pa. Also solving the dilemma of how to use new semiconductors and yet maintain architectural flexibility, Univac chose to build it with Motorola 10800 high-speed emitter-coupled-logic 4-bit-slice microprocessors—68 of them—the first use of such parts in mainframe design. And although the so-called macro-architecture that the programmer sees remains the same as in other 36-bit 1100 series computers, the 1100/60 uses an innovative arithmetic and logic unit design. Two identical ALUs—each built from nine microprocessors—operate in parallel for speed, and a redundant set of ALUs match their operations in lock step, comparing results at the end as a check to increase reliability.

Univac also plans to "use a completely different maintenance philosophy" with its new 1100/60, says Ronald H. Wandersee, director of 1100-series worldwide marketing and services. A separate microprocessor-based System Support Processor, interrogating the CPU through Univac's Scan-Set technique, can be used to remotely diagnose the processor. Also, because of the redundancy built into the machine, failing portions can be disconnected allowing the rest of the machine to operate until the repair is made.

NCR Corp., Dayton, Ohio, contributed to the year's technical fireworks at the end of November with its V-8600 family, which also established it as a serious contender in the large-scale mainframe market.

Implemented with ECL also and based on a hardware architecture that employs instruction pipelining and cache memory, the machine operates with a cycle time of 28 nanoseconds, half that of previous NCR units and among the fastest for a commercial mainframe. Especially interesting about the V-8600 is its bus-oriented design, centering on a 32-bit-wide internal transfer bus that operates at 72 megabytes per second. Although such bus-oriented designs are common in minicomputers and were used by NCR in other medium-scale computers, such designs are unusual among large-scale mainframes. In fact, some others in the industry predict that bus-oriented designs may become more common because of the upgrade flexibility they offer.

NCR wasted no time in responding to IBM's 4300 either, unveiling new V-8500 models in the spring. The V-8555M, V-8565M, V-8575M, and V-8585M offered up to 67% more performance at prices as much as 37% less than previous V-8500 systems. Also using a bus-oriented design, the new V-8555M has a starting price of $88,035 and offers an estimated 47% better performance than IBM's 4331 at only a 28% higher price. The largest of the new systems, the V-8585M outperforms IBM's 4341 by 39% at only a 27% higher price.

Burroughs Corp. revamped its mid-line with the new 900 series having a building-block architecture. Dubbed a micromodular concurrent architecture by the Detroit firm, the new computers consist of eight basic elements each dedicated to performing a single task—such as fetching and decoding the instructions, executing the operations, or transfering data to and from memory. Interconnected by separate control and data lines, these elements can operate concurrently and run three to four times faster than the older machines at the same clock rate. In fact, the first two members of the 900 family, the 2900 and 3900, offer up to five times the overall performance of the 2800 and 3800 computers they replace, yet sell for only 27% more. More computers with this architecture are expected from Burroughs.

More responses

Honeywell Information Systems, Waltham, Mass., responded to the 4300 later in the spring with four of what it calls its Distributed Processing Systems computers: the DPS-320 and DPS-350 in its medium-scale Level 64 line and the DPS-440 and DPS-520 in its large-scale Level 66 family. As for the high-end of its computer line, the firm is introducing its DPS-8 series, the largest member of which, the DPS 8/70, is twice as powerful as any previous computer from the company.

Control Data Corp., of Minneapolis, replaced five models in its Cyber 170 series with four new processors. More dramatic, however, was CDC's introduction of a new supercomputer—that elite class of giant machines intended for only the biggest number-crunching scientific applications. Called the Cyber 200, the new machine is an upgrade of CDC's Star supercomputer and

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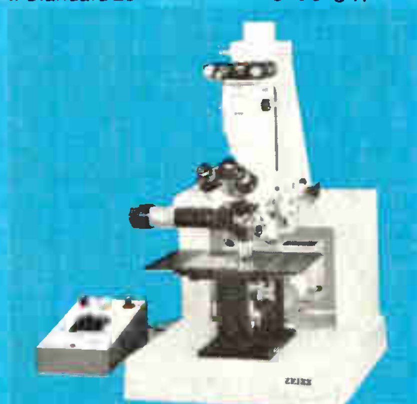

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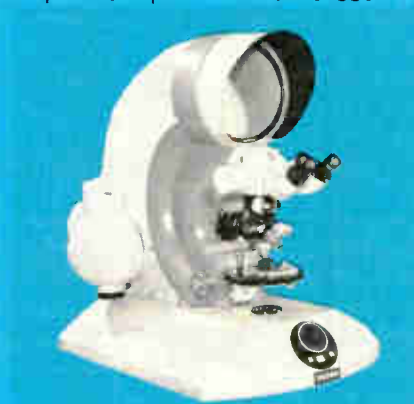

5. Ultraphot. Circle 349

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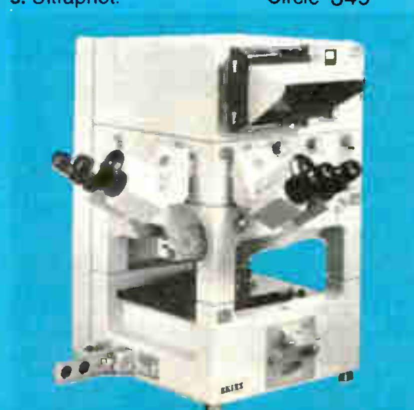

8. Axiomat. Circle 348

at the end of the summer. Based on the faster Schottky TTL, they not only surpass the price/performance ratio of the company's own older 8/32 line of computers but challenged the VAX 11/780 as well. And competition is expected to increase in the next few months as DEC makes good on its commitment to expand the VAX family with bigger and smaller units and Data General finally brings out its long-awaited 32-bit machine.

In addition to more powerful general-purpose minicomputers, increasing attention is being given to specialized processors—especially those dedicated to performing arithmetic. Known as array processors, these units handle floating-point number crunching at speeds unattainable by more general-purpose computers.

Analogic Corp., Wakefield, Mass., introduced its AP400, capable of 10 million floating-point operations per second last January. In April, Floating Point Systems Inc., Beaverton, Ore., introduced its FPS-100, which performs some 8 million such operations and was designed with the configuration and programming needs of the original-equipment manufacturer in mind. Offering twice the precision is the 64-bit MAP-6400 from CSP Inc., Burlington, Mass., unveiled in June.

Internationally

Overseas, the computer companies were also rather active, in some cases expanding existing product lines and in others answering IBM's challenge.

Siemens AG of West Germany bolstered its mainframe computer line last November with four models in the 7700 series, which offers performance up to 4 million operations per second—about that of an IBM 3032—and is among the first of the mainframe series designed to use 64-K memory chips. Even more powerful are the four 7800 models that Siemens will market as a result of a product and technology exchange agreement with Japan's Fujitsu Ltd. They range from 2.4 million to 9 million operations per second, well over IBM's current top of the line.

Just last month CII Honeywell Bull, the French company which is 47% owned by America's Honeywell and often markets its machines in Europe, introduced two mainframes developed in France. Both bus-oriented machines, the single processor DPS 7/80 falls between IBM's 3031 and 3032 in performance while the dual processor DPS 7/82 is between the IBM 3032 and 3033.

In England the most notable activity is the innovative Distributed Array Processor, being developed by International Computers Ltd.'s Advanced Development Centre in Stevenage, England. This new architecture links each small processor with its own memory, and then arranges these processor/memory elements into an array as large as 64 by 64, providing improved performance because of the parallel processing.

Other than the U.S., the most active country in computer technology today is Japan, led by computer makers Fujitsu, Hitachi, Mitsubishi, and Nippon Electric Co. This activity is likely to increase, as indicated by the new association formed by these four, several other electronics firms, and the Japanese government to fund and coordinate research into Japanese language software and peripheral products.

Of new product introductions, the most extensive list was compiled by NEC. In November the company introduced its microprocessor-based System 100 small business machine, and in December it expanded its NEAC minicomputer line with the MS10. NEC fleshed out its Distributed Information Processing Network Architecture with its N4700 computers, which are similar to IBM's 8100 and designed to work with NEC's Acos 77 series mainframes. The Acos system 250 models 40 and 60 increased the power of the low end of its mainframe line and answered IBM's 4300 and System/38.

Last September Hitachi introduced a new top-of-the-line mainframe, the M200H, said to be some 30% more powerful than IBM's biggest 3033 computer. In January it bolstered its distributed-processing scheme with introduction of the Hitac L-320/60 remote processor. Answering IBM's 4300 at the beginning of the summer were the Hitac M-140H, M-150M, and M-160H computers that will use 64-K memory chips.

Hitachi's partner Fujitsu used its versions of the machines, the Facom M-1305, M-140F, M-150F, and M-160F to counter the IBM machine also. Mitsubishi

Quality copy. By combining a xerographic copier with a cathode-ray-tube display, Wang Laboratories succeeded in producing a nonimpact printer that can produce output of correspondence quality at rates of up to 18 pages a minute.

offered its Melcom 700s and 700 III against IBM.

Supporting all this processing power is an equally dazzling array of new peripheral products—primarily memories. The new products indicate that despite all the speculation regarding solid-state replacements, electromechanical memories will remain in widespread use for some time to come.

Popular peripherals

The most popular storage device is disk memory, and of these the so-called Winchester type represents the leading edge of technology. By integrating both the heads and disks into a hermetically sealed module, they lock out contaminants and remove the alignment problems that reduced the reliability of older schemes.

Used in mainframes for some time now, they have been made available to small-systems builders in the past 12 months through the advent of economy-priced 14-inch models from makers such as Shugart, Control Data, CalComp, Ampex, Memorex, Kennedy, and Storage Technology Corp. But the latest craze is 8-inch versions of the Winchester drives designed to fit into the same cabinet opening as the standard floppy-disk drive. Deliveries of most of the 8-inch disks will start only in 1980 and they stand to be with us for at least the next five years. International Memories Inc., Sunnyvale, Calif., led the 8-in. way last year with its 11-megabyte model 7710. But only when IBM unveiled its so-called Piccolo disk—first in its System/34, and later in the 8100, System/38, and 4300 computers—did the rest of the industry feel the concept had received a seal of approval.

Quick then to join the race at the beginning of the summer were disk-drive makers Micropolis Corp., Canoga Park, Calif.; Pertec Computer Corp., Chatsworth, Calif.; BASF Systems of Bedford, Mass.; and Kennedy Co. of Altadena, Calif., with Memorex Corp., Santa Clara, Calif., and Shugart, Sunnyvale, Calif., close behind. Among the most unusual entries was one from Microcomputer Systems Corp., Sunnyvale, Calif., which incorporates a rotary head tape drive and 8-inch Winchester disk on the same spindle. This provides a tape backup to the disk to copy data and programs for safekeeping away from the computer system.

An alternative that surfaced this year for providing the backup is the so-called streaming tape drive that costs about the same as conventional small tape drives but can transfer large batches of data at four to five times the regular rate—hence their name. Units from Cipher Data Products, San Diego, Calif., and Data Electronics Inc., Pasadena, Calif., were first in this area.

Even before the new 8-in. units are shipped, new forms of Winchester disks are already being predicted. To begin with, several manufacturers see some sort of removable 8-inch disk as a better solution to the backup problem. Control Data, for instance, is hinting that its 8-inch entry, expected later in 1979, will offer this.

Among the larger disk drives used predominantly in mainframe systems, manufacturers are trying to extend the capabilities of the current Winchester technology while also preparing the next generation of disk drives.

The most sophisticated form of Winchester technology is incorporated into IBM's 3350 317.5-megabyte disk drive and the legion of 3350-compatible products from vendors such as Memorex, Storage Technology Corp., Louisville, Colo., and Control Data. In recent months these IBM-compatible vendors outdid IBM by doubling the track density of their drives, thereby offering 635 megabytes of storage.

This is just a stopgap, however, pending the arrival of the next generation of drives, probably in the next year, using thin-film read/write heads and new plated media. The new read/write heads are manufactured with a semiconductor-like batch masking and etching process instead of the labor-intensive hard grinding and coil winding used to make today's ferrite heads. In addition to being cheaper to make, the new heads offer smaller recording gaps and hence higher recording densities.

Although all the drive manufacturers and a number of specialized head manufacturers have thin-film heads under development, they are once again waiting to see what IBM has up its sleeve. When it unveiled the 4300, IBM introduced the 571-megabyte 3370, which it says uses a recording head manufactured with a "semiconductor process." But the company will release no details of the new drive until shipments start later this month.

Solid-state substitutes falter

As the electromechanical disks are being improved their newer semiconductor replacements are experiencing a bumpy start that might preclude their acceptance in the marketplace for the near future. Memorex and STC, which both announced products based on charge-coupled devices, found CCD suppliers unable to meet their demand and CCD prices dropping more slowly than expected. This forced them also to design versions of their units capable of employing conventional 16-K random-access memory chips. Intel joined the fray with its FAST 16-K RAM-based replacement for a fixed-head disk, but with the shortage of 16-K chips even these products may have problems.

Looking further into the future, peripheral researchers see optical storage replacing magnetic tape for archival data storage. Using the laser recording and reading schemes similar to these being perfected for video disks, companies such as Philips, Hitachi, and Toshiba have already developed prototype systems.

Another concept reaching the prototype stage is one form of intelligent peripheral—the content-addressable memory. Instead of referencing data by its location address, such memories contain decision-making logic for searching a series of records and only select those whose contents match the desired criteria. Such a technique, already being built by England's ICL for the British Post Office telephone directory service, will be especially useful for managing the contents of the large data bases now being amassed by computer users.

Among the other input/output peripherals, nonimpact

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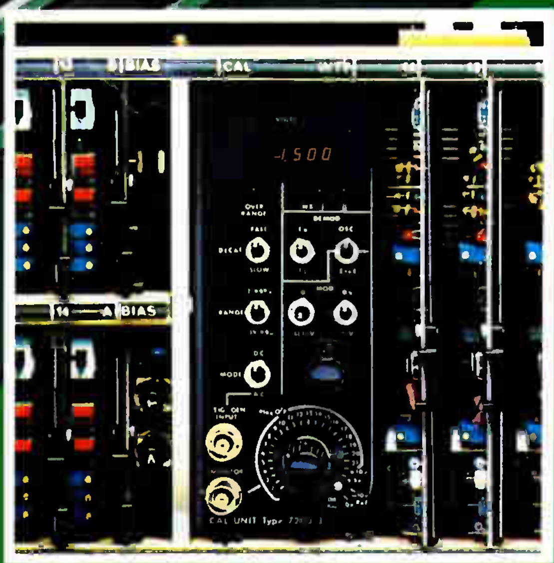

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Thermalloy's new solderable heat sinks cut assembly steps in half.

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2. Wave soldered, cleaned and trimmed.
3. Inspected once.

Conventional Method

1. Board components to be wave soldered are pre-assembled.
2. Wave soldered, cleaned and trimmed.
3. Inspected first time.
4. Heat sink mounted with loose hardware.
5. Hand soldered, cleaned and trimmed.
6. Inspected again.

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printers caught the most attention in the past several months. Previously large, expensive machines restricted to high-volume applications where their 20,000-lines-per-minute output could be appreciated, these printers are now becoming available as smaller and cheaper units designed for offices and other small computer sites. They offer high-speed, high-quality printing and quiet operation, and some models can double as a convenience copier as well. Wang Laboratories Inc., Lowell, Mass., captured the spotlight in December with an announcement that it had combined a xerographic copier with a CRT unit to create a nonimpact computer-output printer that produced correspondence-quality printing at a rate of 18 pages a minute. In March IBM's Office Products division introduced the laser-based model 6670 that prints 36 pages a minute yet sells for $75,000—more than twice the price of Wang's unit. And at the National Computer Conference in June, Japan's Canon showed a unit employing semiconductor lasers, while Konishiroku demonstrated a CRT-based unit.

Many of these recent advances in computer and peripheral technology are intended to make computers less expensive and easier to use, thereby encouraging their application to a variety of new tasks. Many users, especially businesses, also desire to maintain some sort of communication with these small computers that are being sprinkled throughout their organization. To this end, the manufacturers are promoting the distributed-data-processing concept, which lets geographically dispersed computers not only communicate, but also share data and the workload. Although discussed over the past three to four years, only recently have the product offerings tied the concepts down in useful form.

Distributed processing advances

IBM was once again a prime example. Although just about the first to formalize its distributed processing approach, IBM's Systems Network Architecture was severely limited because control was centered in one host computer and all other terminals were relatively subservient. But the new 8100s and 4300s can be attached to SNA networks, bringing stand-alone processing power to the remote site. And with a new SNA software release this summer, IBM made the network configuration rules more flexible and provided one of the most sophisticated network test and reconfiguration techniques around.

PROFILE

Cordero journeyed from computer to chip and back

"You have to anticipate technology changes, what the semiconductor process ground rules—the diffusion and isolation techniques, the possible line widths—will permit in the future."

This lesson was really driven home to him, says Humberto Cordero Jr. of International Business Machines Corp. by his experiences over the last several years in directing the development of one of the year's dramatic new computers, the model 4341.

In fact, computer engineers will have to become even more aggressive planners, predicts the manager of processor development at the System Products division in Endicott, N. Y., for "the technology is changing so fast, you have to look at it in the light of your computer's performance, cost, architectural, and scheduling objectives and try to select the most advantageous approach possible, even if it's not here today."

Computer engineers can therefore expect to work more closely with the semiconductor designers than ever before. "You have to convince your technology designers they should commit to giving you the technology you need and yet make sure the risk is manageable. If your objectives were aggressive to begin with, they can be adjusted if problems arise later."

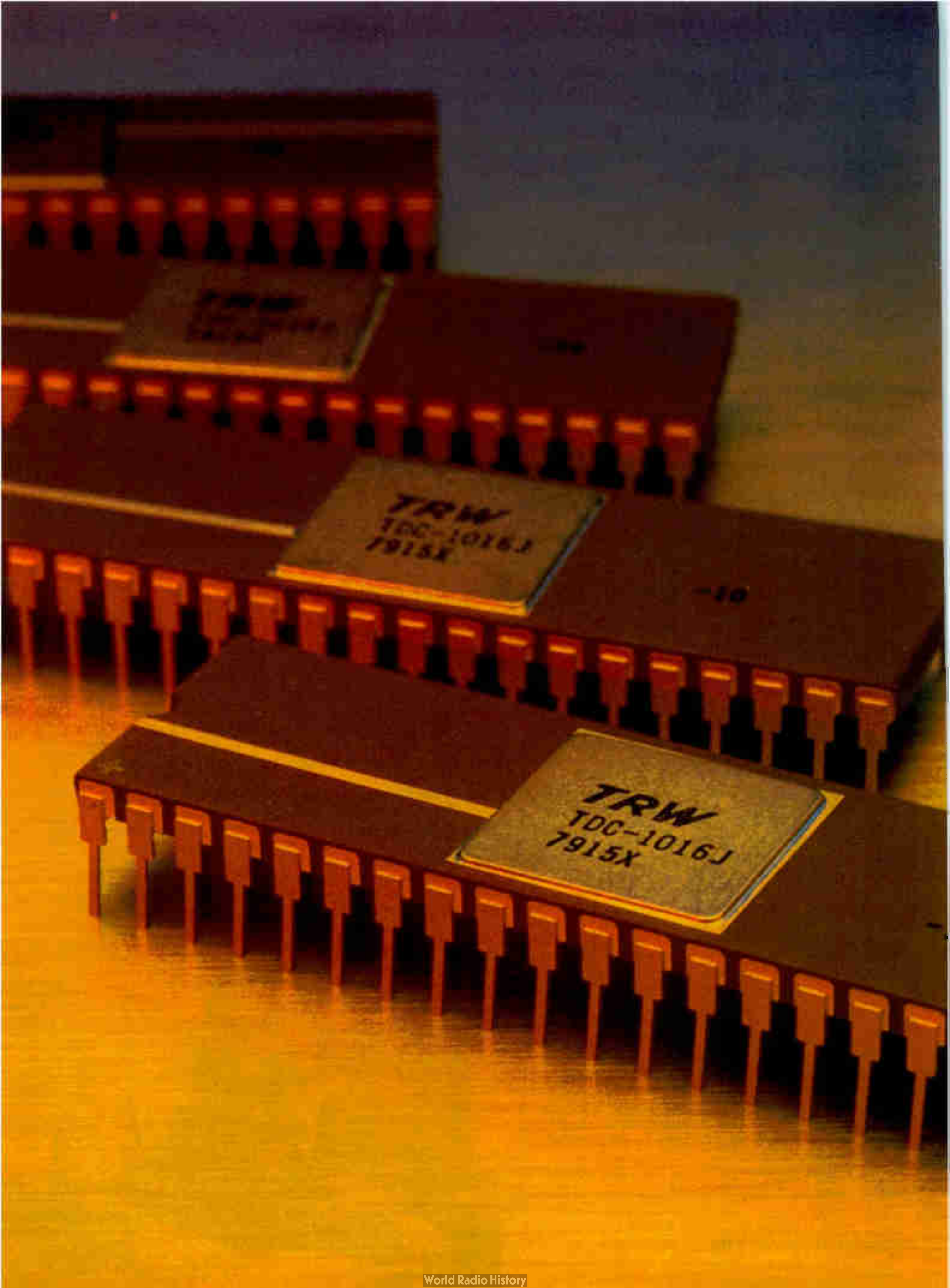
The 4341 is a good example of this growing interrelationship, since its use of a master-slice chip, containing an array of 704 TTL gates, was a major contributor to its low price and high performance. But Cordero admits such decisions are rough ones. "The 4331 and 4341 had to be cognizant of future technology," he recalls, "but it wasn't easy because [when design started] people thought 500 gates on a gate array was too much to comprehend and to design with."

The 40-year-old native of Puerto Rico, who won bachelor's and master's degrees in electrical engineering from Cornell University, says things were different when he started with IBM in 1963 doing logic design on the System/360 model 30. "Process technology wasn't even talked about then—it was the technologists' alone."

The way engineers do their job is also different. "Another significant preoccupation today is design tools and computer-assisted design," Cordero says. "Those are important because they will pace your development costs and schedules."

A new humility may be required of the engineers as well. "As LSI matures there are a lot of building blocks around, and you have to ask: should I design my function [from scratch], or should I give up some design pride and use a part that's already designed? In the next system we design we'll have to face up to that," Cordero says, "but in any case it'll be a brand-new approach and we'll design it completely differently."

-Anthony Durniak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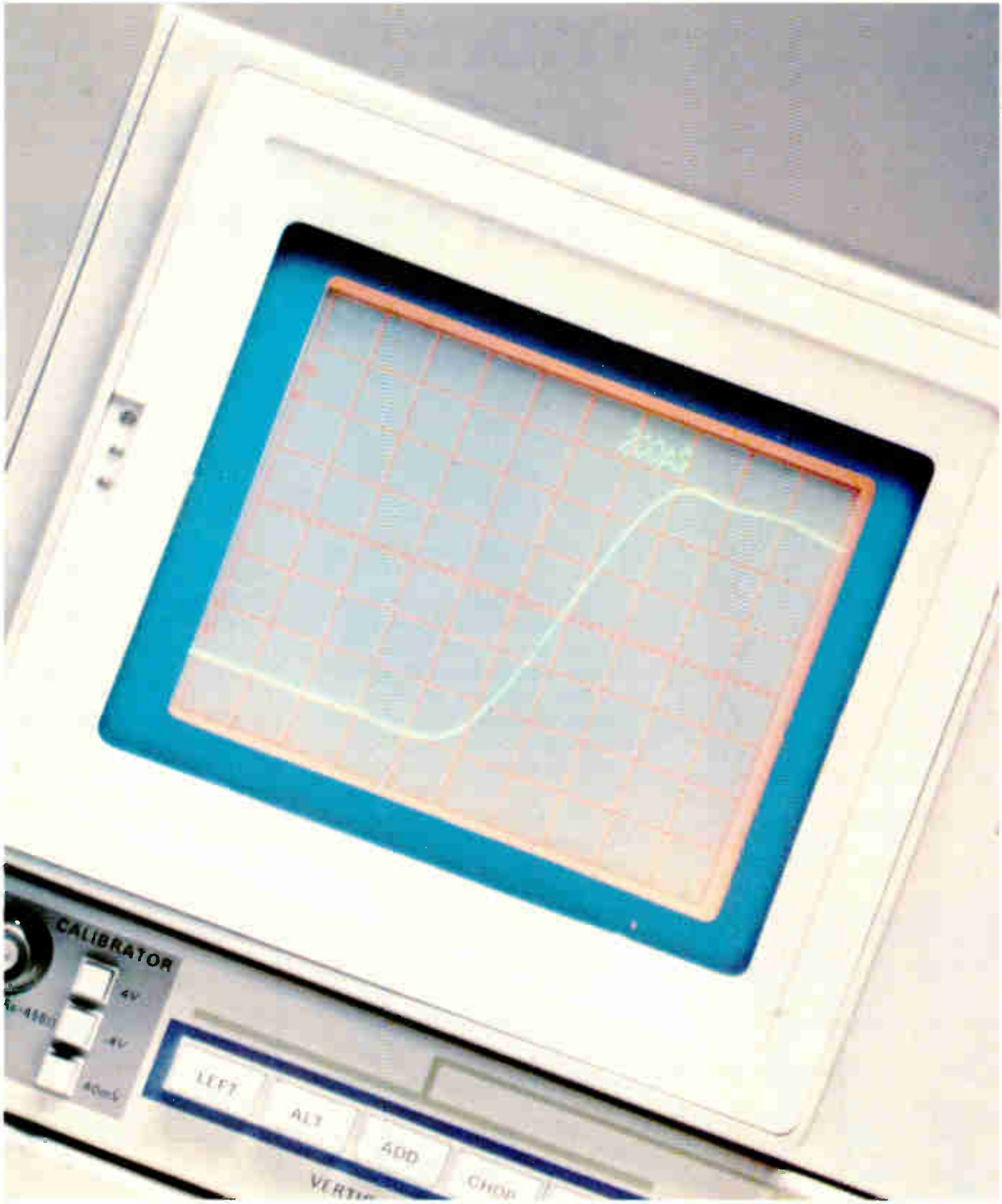


Instruments

by Richard W. Comerford, *Test, Measurement & Control Editor*

☐ *As the 1980s dawn, instrument manufacturers face unprecedented challenges: measurement speed and accuracy must grow at an even faster rate as semiconductor learning curves get steeper and steeper; logic analysis must keep apace of widening bus structures; doubling circuit densities threaten to create testing nightmares at not only the board but chip level as well; magnetic-bubble devices, with their complex voltage parameters, will move off the production line onto boards. And as they confront this ever more intricate testing environment, meter makers must also contend with thinning ranks of service personnel and intense foreign competition.*

An example of how they will go about meeting them next year was provided this year by Tektronix Inc., Beaverton, Ore. In what must be regarded as a significant engineering achievement by any criteria, the company produced the first portable conventional oscilloscope with a bandwidth of 1 gigahertz, the model 7104. In so doing, it produced an instrument that will serve the technological community in advancing the operational speed of semiconductor devices made during the next decade, whether they use emitter-coupled logic, gallium arsenide, or other, emerging processes.

Details of the design

To manufacture such a scope at a reasonable price was not merely a matter of replacing parts in the company's earlier 500-megahertz model with faster devices. Achieving the 7104's 200-picosecond-per-division sweep speed and 10-millivolt-per-division sensitivity required that its cathode-ray tube be built with a distributed horizontal-deflection system, a meshless expansion lens for full-scale waveform projection, and an electron-multiplying microchannel-plate to enhance brightness. Then, to ensure that the displayed signal exactly represented that at the scope's 50-ohm input, Tek engineers grappled with the intricacies of microwave design and in so doing developed: a new packaging technique called Hypcon (for hybrid-to-printed-circuit-board contact) to permit easier amplifier replacement; a new circuit technique, called feed-beside, to ensure linearity across the scope's full bandwidth; and a new integrated-circuit process called Super High Frequency III (SHFIII) to give a cascode circuit a high transition frequency.

Undoubtedly, this design sets a standard that is being carefully studied by other high-end oscilloscope companies such as Hewlett-Packard Co., B&H Electronics Co., Schlumberger Ltd., and Thomson-CSF.

Also bringing to the bench measurement levels previously attainable only in the laboratory was Keithley Instruments Inc., Cleveland, Ohio, designer of the 642 electrometer. Capable of measuring charge at a level of 10^{-12} coulomb, the instrument was designed with thorough consideration of the possible sources of error and the application of state-of-the-art electronic and mechanical technology. It, too, will advance semiconductor technology by accurately characterizing the low currents and high resistances now being encountered.

Tomorrow today. Tektronix' nonsampling 7104 oscilloscope will let engineers view the ever faster operation of tomorrow's systems.

The U. S. benchtop logic analyzer market was invaded by instruments from Germany, England, and the Netherlands. From Dolch Logic Instruments GmbH in Germany came the Kontron/Dolch model LAM4850 state and timing analyzer aimed squarely at the wider bus structures of 16-bit microprocessors. With 48 channels each backed by 1,024 bits of memory, the unit can sample at three different clock rates. Priced at $9,850 with seven active probes, the LAM4850 can also be configured for the IEEE-488 bus.

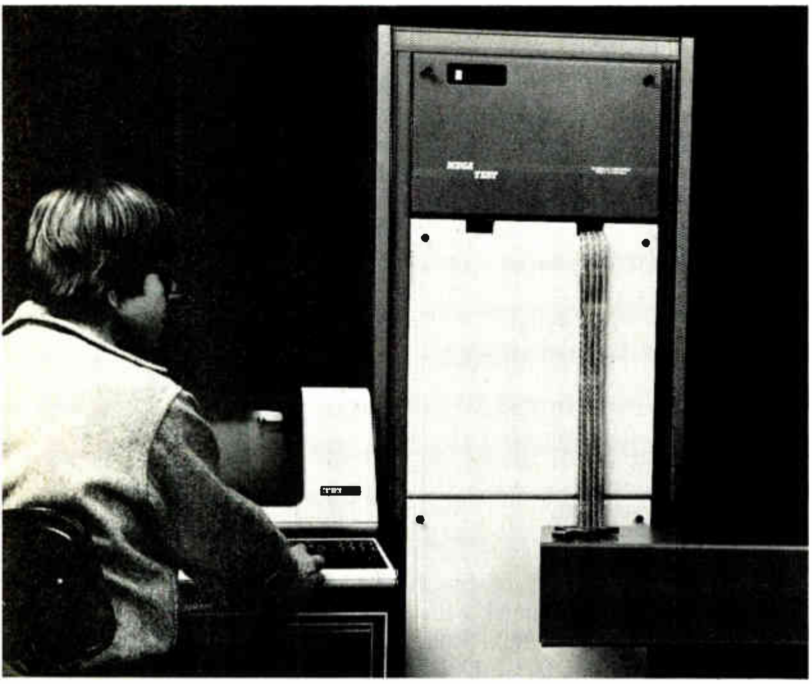
Noting the increased clocking capability that microprocessor systems are requiring, Hewlett-Packard Co., Palo Alto, Calif., improved the 1610A state analyzer, turning it into the B version by adding multiphased, qualified clocks that permit three capture modes: 32-bit, 16- and 16-bit, and 16-, 8-, and 8-bit. The $12,500 unit also offered an IEEE-488 bus option.

Aiming to gain more of the market (in which it is already strongly positioned with the K100-D) with a lower price tag, Gould Inc., Rolling Meadows, Ill., last month brought to the U. S. the LA5000 originated by its English division. Introduced in Europe last June, the $6,300 state-timing analyzer allows easy setup of its 16 channels with a menu display and simple keyboard. In a four-channel configuration, it can work at 50 MHz.

The long-awaited entry of Philips Test and Measurement Instruments Inc. became a bifurcated reality at Electro79, where the Eindhoven-headquartered company unveiled two units. Its 100-MHz, 16-channel PM3500, which can split its memory to display two sets of 249-bit data for each of its channels and can capture 3-ns-long glitches, is priced for laboratory use at $8,295. A companion unit for the field, the $3,975 PM3540 combines the capabilities of a 10-MHz analyzer with those of a 25-MHz oscilloscope and a 64-bit-deep memory that can also be split.

Testing bubbles

This year has seen the development of not one but four test systems for magnetic-bubble memories where before there was none. First announced was the Megatest Corp.'s system, christened simply the bubble-memory test system. The approach of the Santa Clara, Calif., company was to build a tester that could be used both for engineering characterization of the new devices and later for on-line production testing. Built around a PDP 11/V03, the system offers an extended Pascal for programming tests on either wafers or packaged memories. Following quickly was a bubble test system from Fairchild Camera and Instrument Corp.'s Xincom Systems division in Chatsworth, Calif. Introduced at May's Semicon West, it can operate as a stand-alone system or with a host computer of a large Xincom test system. And in June, Watkins-Johnson Co. of Palo Alto, Calif., doubled the number of test systems by introducing both the Adate 1450 for development labs and the 1475 for production testing. All systems that are now on



Magnetic provinces. The magnetic-bubble memory testing world was divided into three parts with the introduction of commercial test systems from Fairchild Camera and Instruments' Xincom division, Megatest (whose system is shown above), and Watkins-Johnson.

the market sell for a price of around $100,000.

Undoubtedly, these systems will become the workhorses of the early bubble lines, and those who must stay in the forefront of technology will find their investment in them rewarded: they can handle any foreseeable growth in memory size. But developments in this relatively young field keep bubbling up; many will stand on the sidelines for as long as they can to see what is coming round the corner before joining the parade.

With current-access techniques promising to simplify bubble operating parameters and hence the systems that test them, many automatic-test-equipment (ATE) companies may adopt such a posture. Thus, those with systems already on the market may find they have the field to themselves for a while. Undoubtedly, they will want to consolidate their lead and devote some of their attention to providing in-circuit board testers for these bubble-memory systems. Once users have developed tests that characterize proper operation using the device testers, they will undoubtedly want to be able to use those tests for both device and board production. So tester manufacturers will provide such things as board fixtures that will let device testers work with other semiconductor testers to check the boards. Indeed, the Xincom system can already be used with a host computer that runs other testers too.

Also of interest in the development of these test systems is the way in which each tester manufacturer worked closely with a bubble-device manufacturer in developing the system. As devices grow more complex because of improvements in magnetic and semiconductor technology, closer cooperation is needed to bring both device and system to market within a reasonable time.

Instrument manufacturers will therefore find themselves working more closely with both part producers and the end user. As pointed out this month at the annual test conference at Cherry Hill, chip designers will have to add testability attributes to their circuits if they expect them to be used. And, as one test system manufacturer has observed, the fact that companies such as IBM, Sperry Univac, and Nippon Electric are pushing for these attributes will ensure that they do appear, particularly since this will guarantee a degree of economic stability in what might be an unsettling period.

Scanned heat

What is being presented to semiconductor and test system houses alike by these giant chip consumers are latching techniques called level-sensitive scan design, scan/latch, and scan/set. Which one the designer chooses to employ will be determined by how much chip real estate he can afford to surrender and whether the particular device must be tested with or without stopping operation. What both the tester and the end-user must know, in addition to the particular technique employed in a part, is what the information present on these latches tells him.

The inclusion of such information on chip is indicative of another trend in testing, visible at this past year's National Computer Conference. In the System/38 and the 4300 introduced by IBM Corp. and in Univac's latest mainframe, testing can be performed by exercising the computer from a remote location. Analysis of the diagnostic procedure performed from that location can isolate problems to the board level. Thus, the computer user with a supply of boards can be told which one to replace, and, once the bad card is removed, it can be shipped to a central location for further troubleshooting and repair. Computer Automation Inc. of Irvine, Calif., has even taken this concept a step further with its Scout model 4/04, suggesting that, as the cost to diagnose a board and repair it climbs, it is cheaper simply to throw away a defective $200 board and replace it.

While these concepts will undoubtedly continue to be part of products introduced in the coming year, dealing with the installed base of equipment will provide continued growth for the third-party maintenance companies such as Sorbus Inc. and PCC Service, a division of Pertec Computer Corp. As skilled technicians become harder to find, more companies will recognize the profit to be gained from their field service and repair organizations. Such companies as General Electric Co., which recently adopted Varian's CT scanner maintenance, and Westinghouse Electric Corp., already capitalizing on its expertise in the heavy equipment industries, are certainly aware of the dollars to be gleaned in this service area also.

One trend in field-service instrumentation definitely underscored this year was that toward hand-held (or pocket-sized) quality digital multimeters. Whereas John Fluke Manufacturing Co. stood alone in the low-priced,

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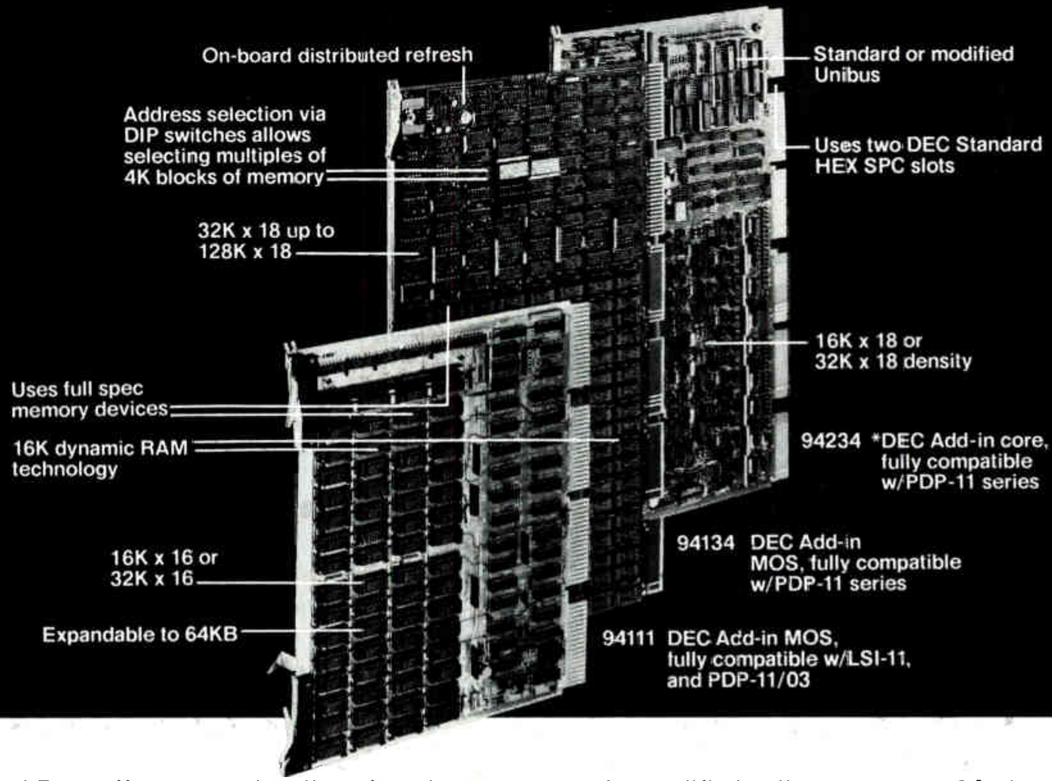

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CANNON ITT

high-accuracy mini-DMM market as the new year began, entries from Data Precision Corp., Danvers, Mass., and Beckman Instruments Inc., Fullerton, Calif., early in the year gave the company stiff competition, making it quickly improve the accuracy of its 8020A.

Hand-to-hand combat

Data Precision's February unveiling of the model 935 undercut its competition by offering a 3½-digit meter with dc voltage uncertainty of ±(0.1% of input + 1 count) for just $149. Responding rapidly, Fluke not only matched the 935's accuracy in its 8020A but also lowered the price of a pocket DMM to $129 with its model 8022A. Next, Data Precision extended the hand-held concept by introducing a similar meter for measuring capacitance, the model 938. Beckman Instruments entered the competition with three such instruments, including a $130 basic unit and a $190 model able to give true rms readings. The rotary dial units are all covered by a one-year "no-fault" warranty. Before 1979 is over, a fourth manufacturer is bound to introduce such a meter with a different switching scheme and a price of under $100.

Like the early pocket calculators, which they also resemble physically, the new meters are bound for lower prices in the coming year. And as the year progresses, it is likely that other common measurements will find themselves well in hand. Furthermore, even higher accuracy, connoted by 4½-digit resolution, will be in the offing in the not-too-distant future.

In favor of busing

More than ever before in instrumentation, the message being transmitted by the Bell System ads is proving true: "The system is the solution." Fewer engineering measurements are being approached as readings to be taken on one piece of gear and manually transferred to another for processing. Microprocessors now are both communicating readings and shaping them automatically.

Witness the continued growth in popularity of the IEEE-488 general-purpose interface bus. There has been a host of recent introductions not only by the GPIB's creator, Hewlett-Packard, but by Keithley, Wiltron, John Fluke, Racal-Dana, EIP Microwave, Ailtech, Dolch/Kontron, Wavetek, and others.

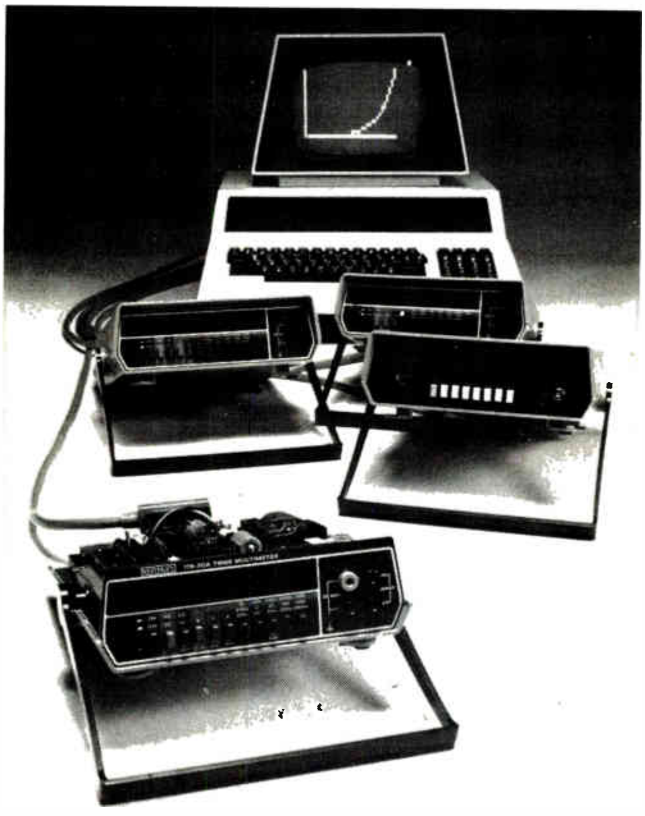
Keithley widened bus use this year by offering a field- or factory-installable bus option. When added to its line of low-cost digital multimeters, it made talk-only or addressable instruments available for a mere $600 to $700. Semiconductor manufacturers like Philips and Motorola, quick to note the growing bus popularity, introduced chips that implemented the interface protocol. And the bus itself even grew longer as Hewlett-Packard and National Instruments of Austin, Texas, introduced systems that let instruments communicate at distances of about 1,000 feet.

Such a vote of popularity, then, cannot help but produce a raft of bus-related products. One such unit, introduced this month by Racal-Dana Instruments Inc., Irvine, Calif., is a bus-compatible switching matrix that will allow users to route stimulus and response signals at the command of an IEEE-488 controller. Controllers will become more sophisticated in 1980, letting users talk to instruments on the bus without having to learn the strange jargon of the standard itself.

When introduced, a new standard from the Institute of Electrical and Electronics Engineers dealing with codes and formats will permit manufacturers to design instruments that are addressed and answer in the same way, regardless of who built them. The result, according to one manufacturer, is that he will be able to compete head on with larger competitors, offering total systems while continuing to build individual instruments in the particular discipline in which he specializes.

Bringing the system concept inside the instrument itself was Paratronics Inc. of San Jose, Calif. Its System 5000 will let users build their own instruments by changing a probe and plugging in a card with front-end electronics and program memory.

Another place in which systems are providing the needed solutions is the ATE market, where several examples exist. Paving the way for widespread implementation of coder-decoder chips in the coming year are complex analog test systems from Fairchild Test



Talk is cheaper. Keithley's IEEE-488 bus option, which turns its low-cost DMM line into talk-only instruments or addressable talkers, lowers overall system costs. The bus is changing test instruments into universally interchangeable system modules.

Systems Group, Teradyne Inc.'s Industrial-Consumer division in Boston, Mass., and GenRad. Next year, the mix of analog-digital tester functionality considered ideal for those devices, as well as that for the high-speed a-d and d-a converters, will become apparent. What seems certain now, for converters at least, is that systems will offer a choice of high-speed testing at lower accuracy and slower testing to define parameters more closely.

Entering the market created late in 1977 by Megatest and by Adar Associates Inc. of Burlington, Mass., with the introduction of benchtop testers of large-scale integrated circuits, GenRad brought forth the 1732 digital IC tester for $44,000. The 1732 can test 48-pin parts using its growing test library, which at last look covered more than 150 devices, and it will also work from larger GenRad systems. The digital tester was a logical follow-on to the 1731 analog test system with which it shares much of its hardware design. The 1731 surprised the Concord, Mass., firm with its success; company figures indicate it has captured 80% of the market.

But the originators of the market are not standing still. Megatest, first formed to produce the Q8000, introduced the Q-II system that has the capability of working from tapes generated on other larger systems. And Adar Associates plans to announce a programmable signal-assigning matrix for its MX-17 early in 1980.

PROFILE

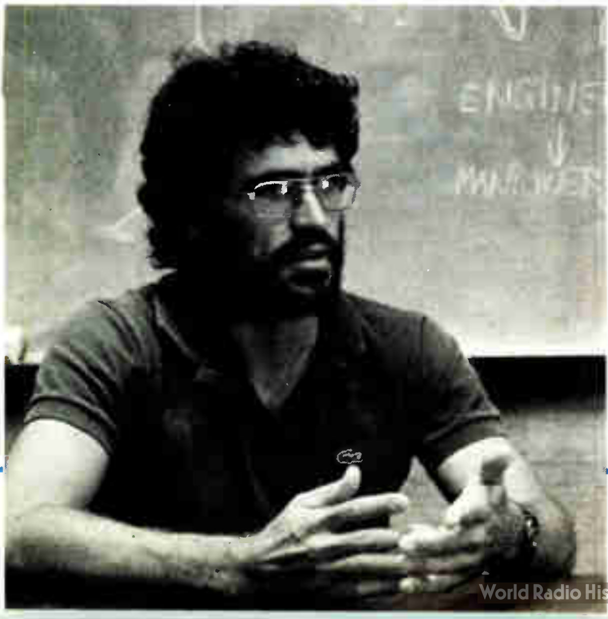
Bisset slashed the cost of LSI testing

Starting a business with one's life's savings is the stuff of short stories. But in the case of Megatest Corp. it is not fiction nor is it likely to be short. The four-year-old company is prospering, a fact its president and cofounder Steve Bisset attributes to spotting and being the first into a growing market niche: low-cost, high-throughput testers for microprocessors, peripheral chips, and memories.

"One of our motives for starting up was that tester companies in the area weren't interested in the low-cost approach—they weren't meeting the requirements for high-volume microprocessors," the 29-year-old Australian says. To him, it was obvious that although sample microprocessors were still going for $300 apiece when the company started, the price would drop with high volume. And high volume would mean a customer base seeking low-price but high-performance testers to handle that volume. So he and cofounder Howard Marshall quit their jobs ("You can't keep a job and start a business," Bisset declares) and "lived on beans" to develop their tester.

The result: a powerful benchtop tester, the 08000, with a base price of only $29,000—a mere fraction of the cost of larger, engineering-oriented units, which Bisset characterizes as then being "too slow, too expensive, and too clumsy."

But the Q8000 is only part of the Sunnyvale, Calif., company's success story. "The principal key to our success is focus," Bisset says, by which he means being a "small company focused on limited problems, applications, and number of customers." Part of the focusing process is "identifying customers whose needs mate with areas you're ahead in," he observes. Megatest's market base contains microprocessor manufacturers who need a cost-effective high-volume production tester—and Bisset claims "the Q8000 tests more microprocessors in production than any other test equipment does by far."



With the Q8000 under its wing, Megatest, now at a $5 million to $10 million yearly sales rate, broadened out this year with two new products: a versatile tester in the $100,000 range for the emerging market in magnetic-bubble memories, and the Q-II, a modular test system family in the $70,000-to-$100,000 range aimed at both engineering and production testing.

These new products reflect Bisset's drive to move Megatest from its present niche in low-cost production testing to a larger one in cost-effective general-purpose LSI test solutions. Up to now, he believes, the LSI makers and users faced an expensive dilemma: to get a break on the cost of production testers, they had to relinquish software compatibility with the large engineering systems. Bisset thinks that what they really need is a modular family, with some members providing programmability and software power for development needs and others to transfer developed tests to the production line.

Having found a niche that is lucrative, he now naturally has competition. But Bisset says that "competition isn't new," and besides, "the testing business is so vast and so complex that relationships between the vendor and the customer are tighter than in other businesses, such as the computer business." Moreover, "there's such a broad body of knowledge in testing and there's no such thing as a best," he continues. "The only way you get the knowledge is to get a job—you learn by experience and are taught by the testing companies."

Bisset himself was taught on the device side. After graduating with a BSEE from the California Institute of Technology, he joined Hewlett-Packard's Santa Clara (Calif.) division where he worked with an in-house bipolar design group and met Marshall. Six months later, he joined Intel's Corp.'s microprocessor-design group where he worked for 18 months before leaving to form Megatest. While at Intel, he got his first exposure to testing when he worked on an in-house 8080 tester. —**William F. Arnold**

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A comprehensive study of power line disturbances which affect sensitive computerized equipment was conducted by two IBM researchers. They concluded that such disturbances occur on an average of 128 times each month.[2] For users of computer-based equipment, power disturbances can and do create a variety of costly problems.

Effects upon data processing computers.

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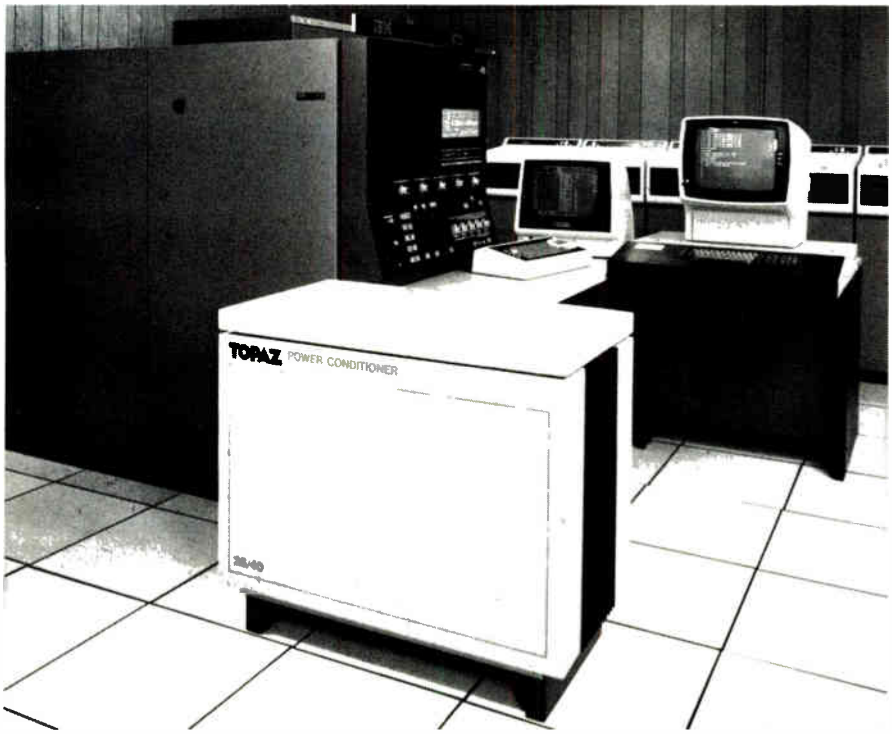
References:

1. *U.S. Department of Commerce, "The Effects of Electrical Power Variation Upon Computers: an Overview."*
2. *George W. Allen and Donald Segall, IBM Systems Development Div., "Monitoring of Computer Installations for Power Line Disturbances," presented to the IEEE Power Engineering Society.*



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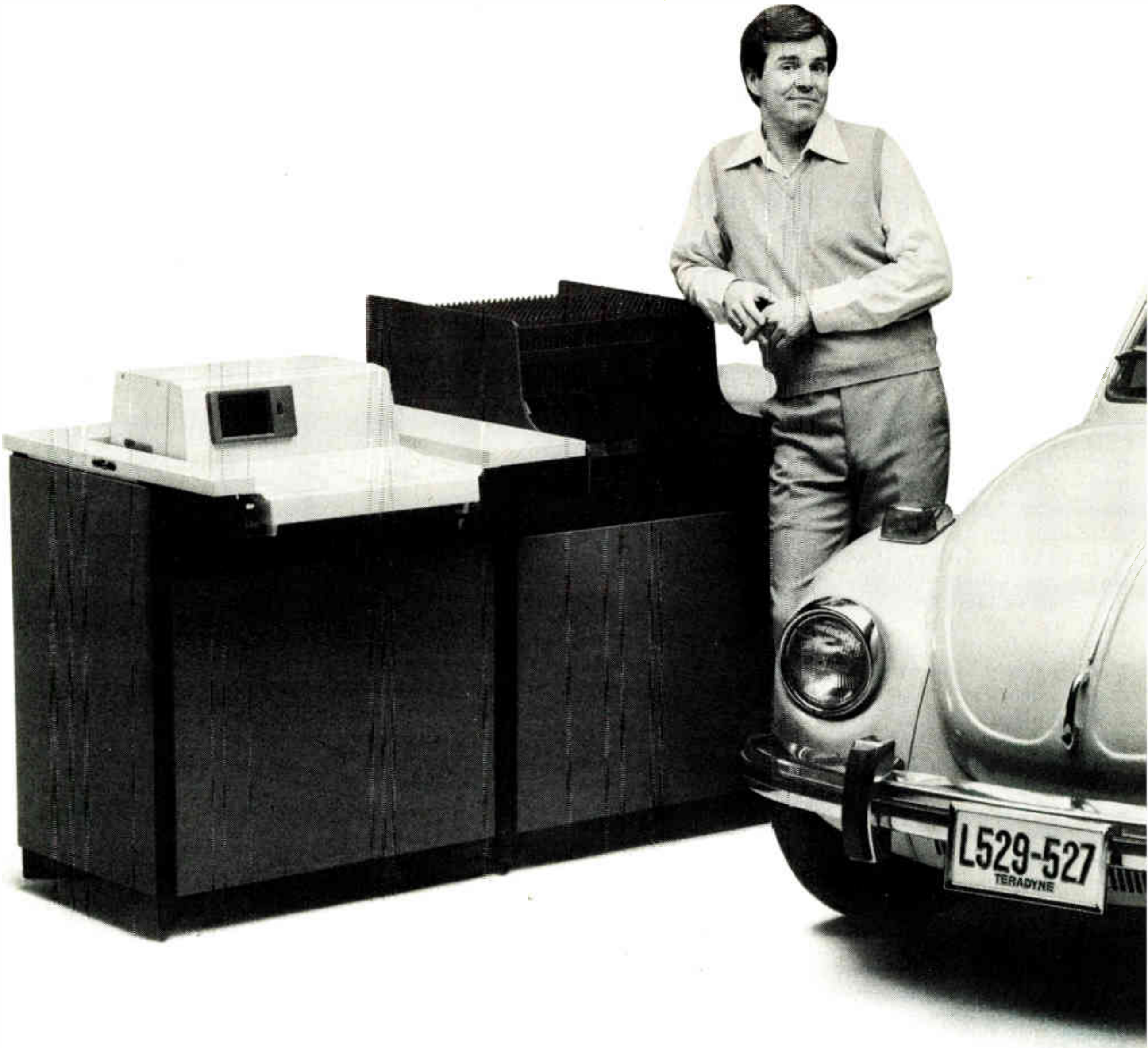

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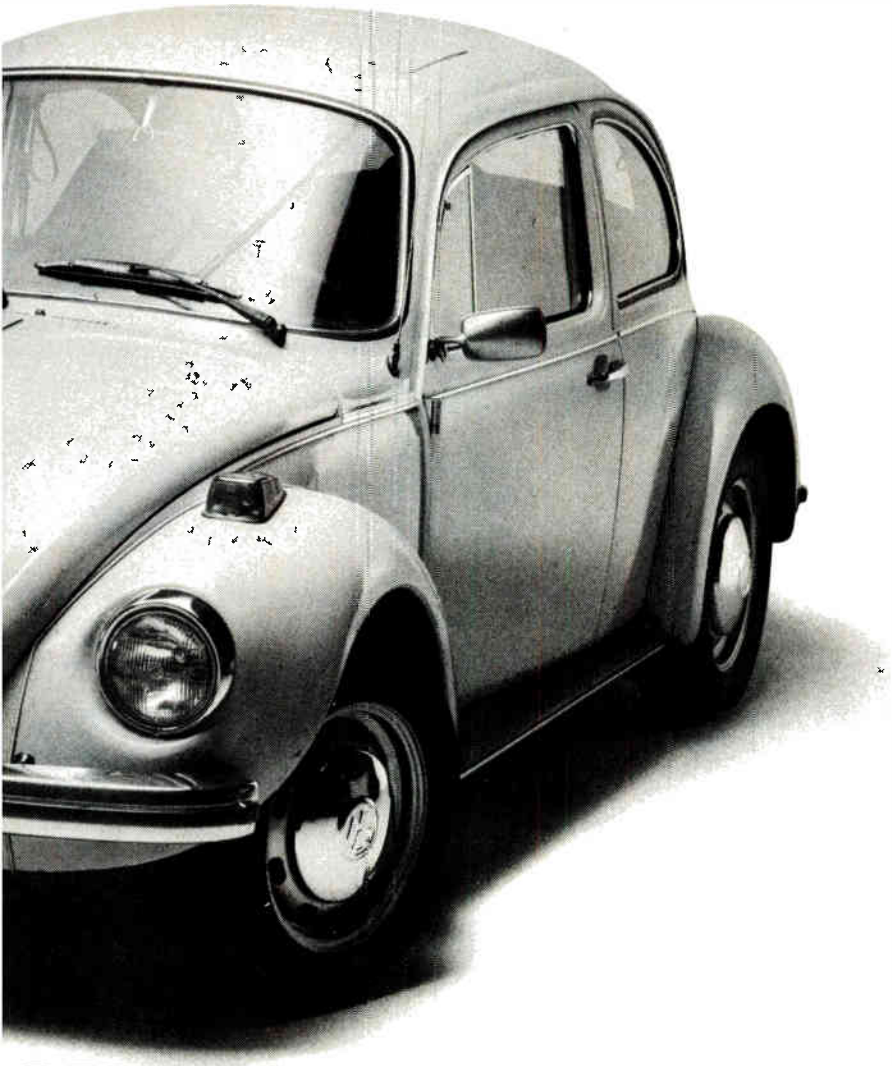

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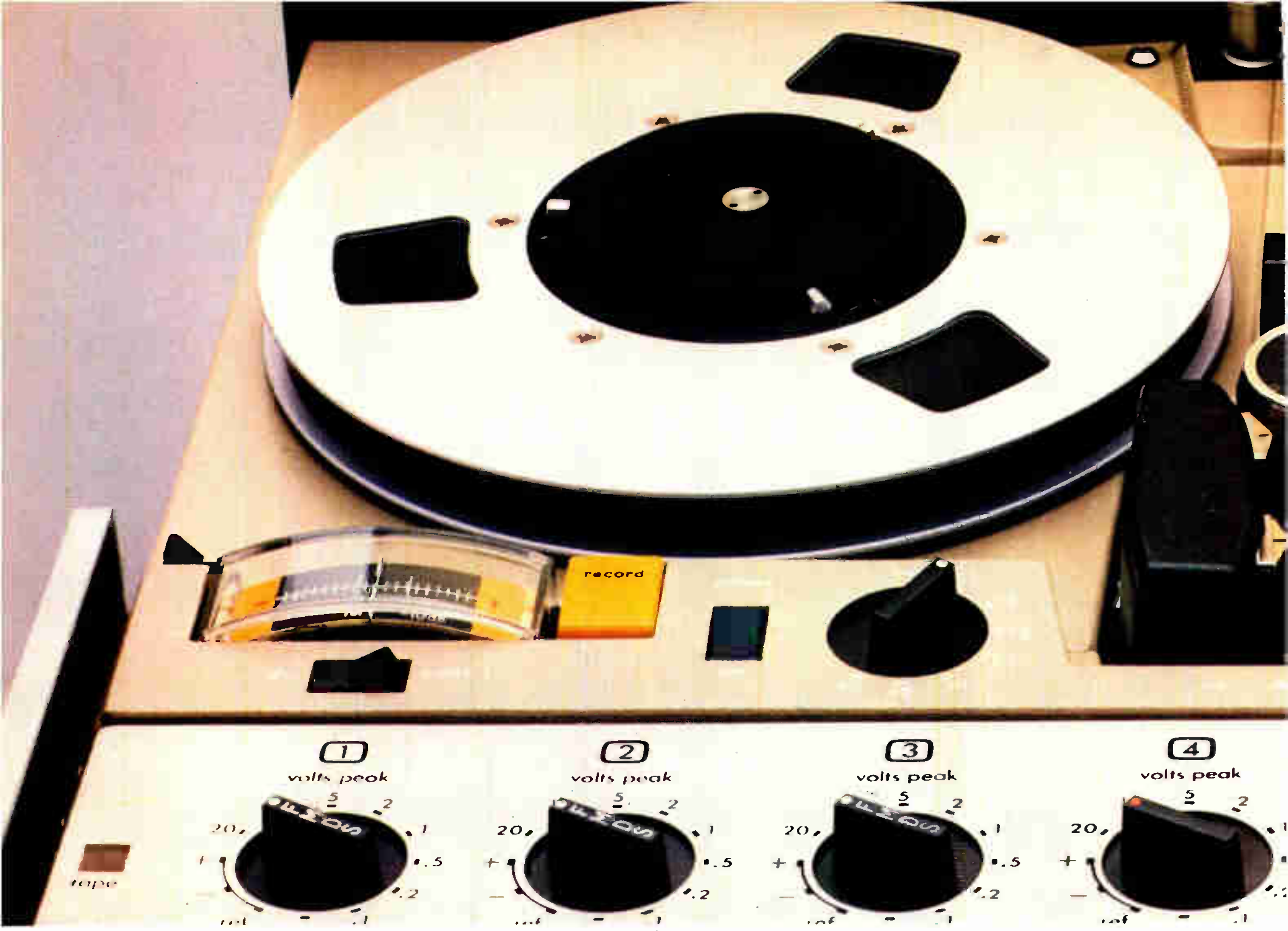

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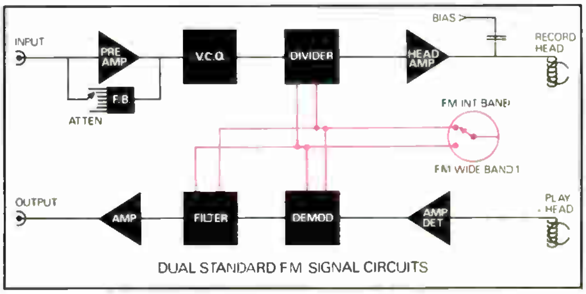

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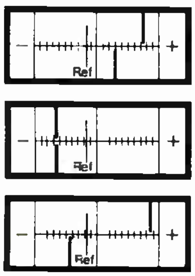

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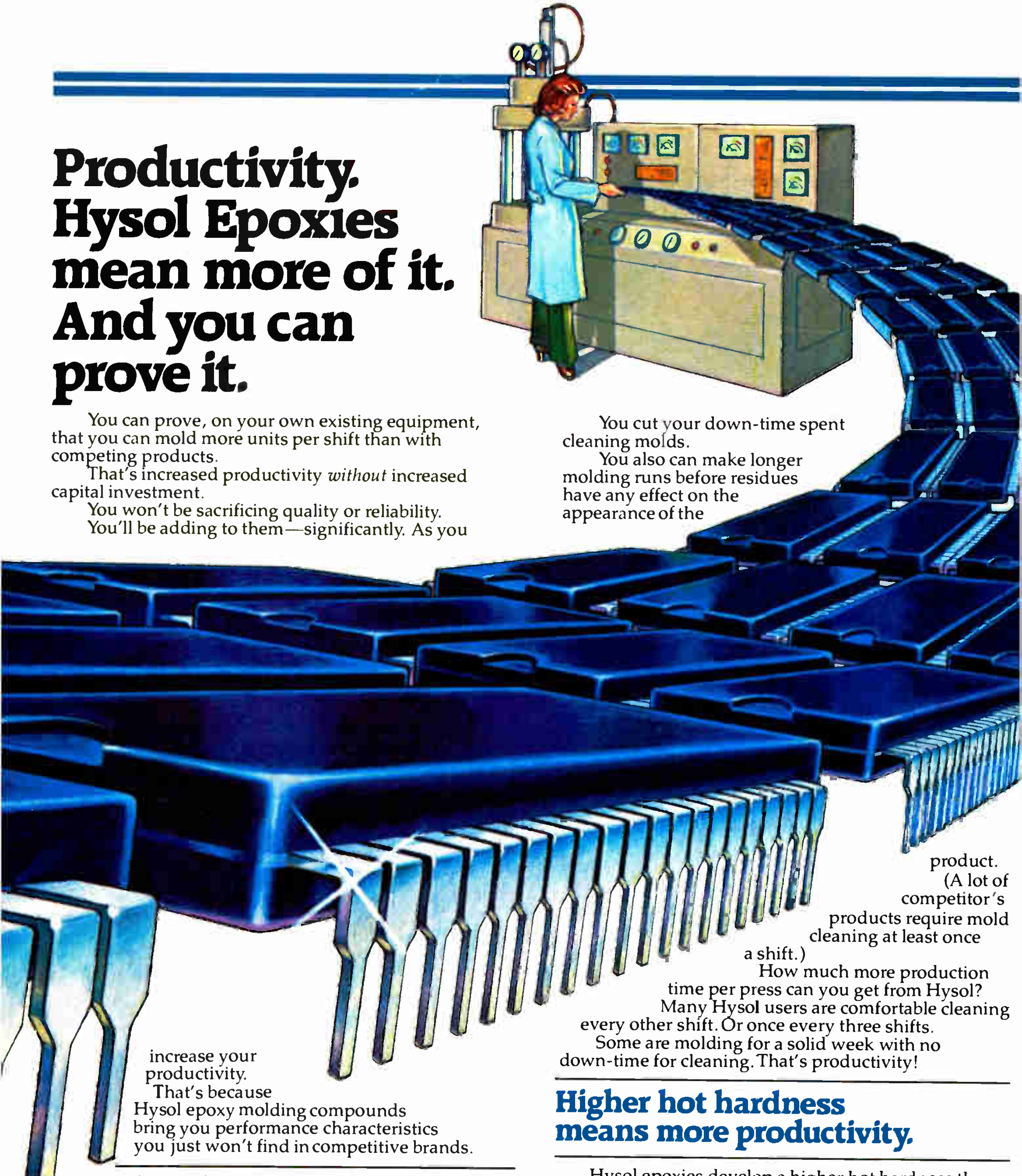

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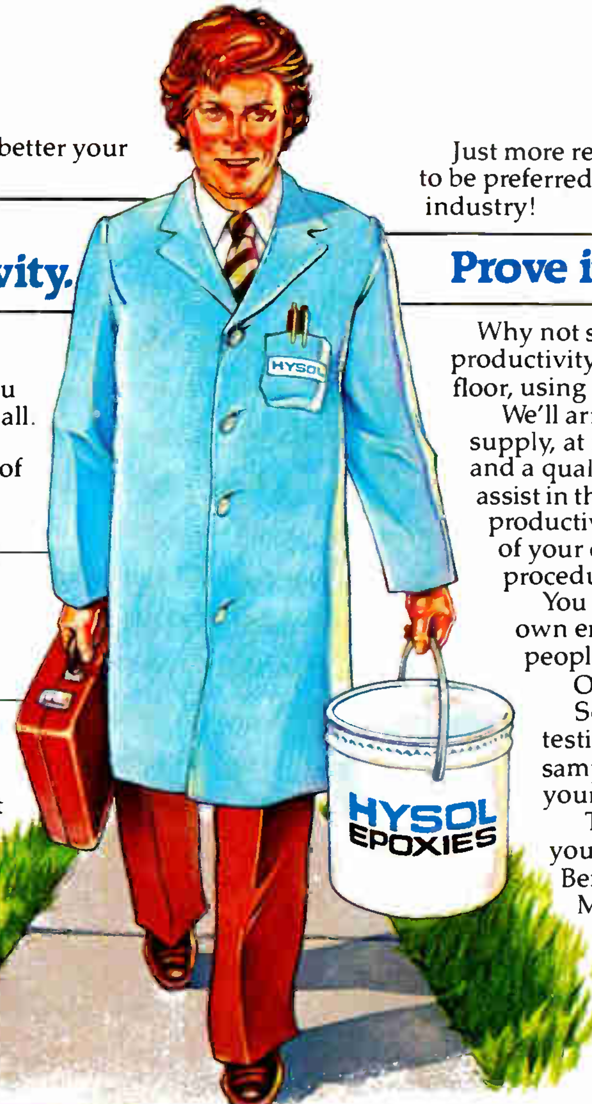

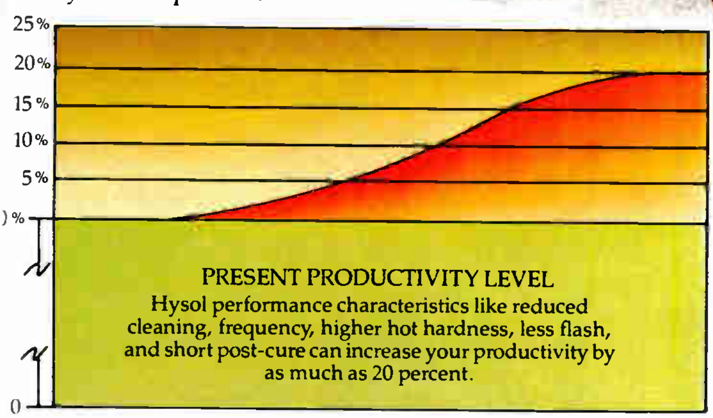

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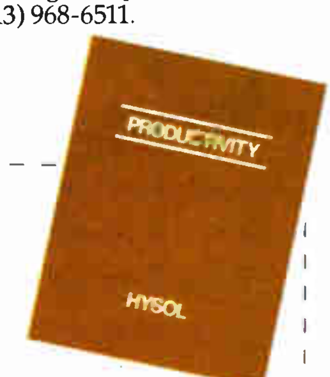

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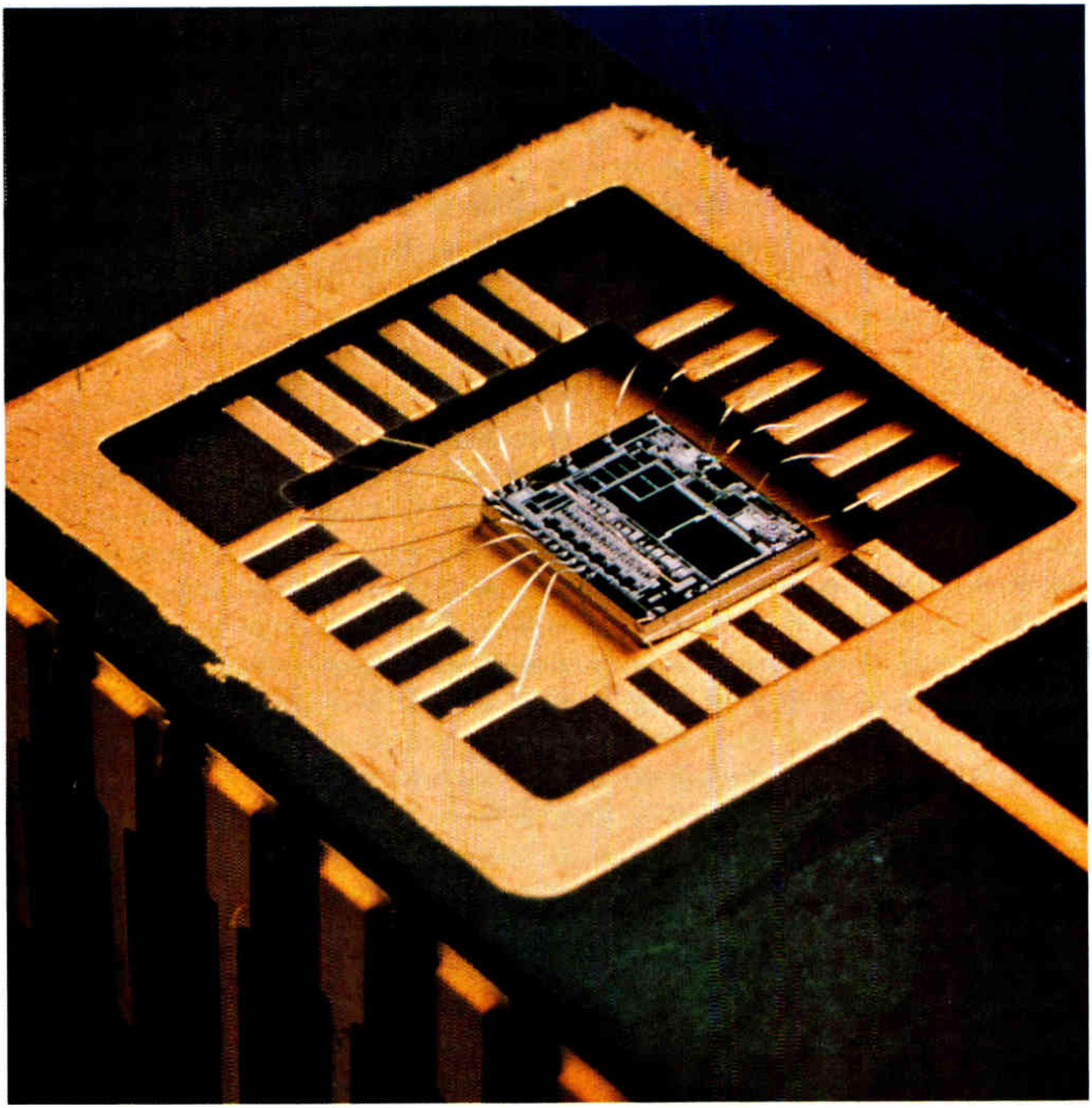

Components

by Vincent Biancomano, *Circuit Design Editor,* and Roger Allan, *Components Editor*

□ *Monolithic integrated-circuit technology continues to drive component development, particularly in linear ICs and data-conversion products. Designers are also using a variety of processes—complementary-MOS, bipolar, and mixtures like bipolar-MOS and bipolar-field-effect transistors, to name a few—to integrate components upwards into subsystems and systems and make them microprocessor-compatible. As a result, many components really resemble small systems, containing greater numbers of functions in ever smaller real estate. Many analog-to-digital converters, for example, are evolving into miniature data-acquisition systems, complete with sensor interfaces, data latches, and microprocessor input/output lines. Similarly, discrete displays are beginning to incorporate on the same chip not only driver/decoder electronics but also microprocessors for improved programming flexibility.*

As expected, data-conversion activity has led the way with developments in 12- and 16-bit units taking center stage. While monolithic data-converter manufacturers look for new ways to standardize converter processing and thus reduce their costs even further for the same or better performance, hybrid and modular (discrete-component) converter makers are busy adding value to monolithic units. Nevertheless, the performance gap between monolithic and hybrid and modular a-d and d-a converters is narrowing. And the gap is even smaller between hybrid and modular converters.

The invention of the commutating automatic zeroing circuit promises to eliminate the errors inherent in operational amplifier offset voltages. Laser trimming is increasingly used to eliminate the offset errors associated with bi-FET amplifiers. Bi-MOS has become a popular process. In the discrete area, V-MOS devices are continuing to improve, and the gain-bandwidth product of linear bipolar circuits has increased.

Gearing up for the anticipated demand for small-scale data links, manufacturers are directing more of their efforts toward fiber optics. The efficiency of light sources and cable has been improved, and now low-cost data systems are available.

Manufacturers are racing to develop low-cost transmit-receive links. And extremely low-loss fibers are being developed and made available at reasonable prices.

In the display area, light-emitting diodes are more efficient. Liquid-crystal displays have been improved, and there is an indication that programmable and complete-system displays are coming into their own.

12 bits and beyond

Monolithic data converters are making inroads into many domains previously exclusive to hybrid and modular approaches. Improvements in processing and circuit designs are the main reasons. Better ladder-network and comparator designs are emerging not only to simplify but to improve monolithic converter performance and at the same time reduce their manufacturing costs. MOS technology is gaining in converter popularity as a viable process. It offers low cost, inherently high packing density, and memory and microprocessor compatibility, yet improvements in its performance are such that traditionally the highest-performance bipolar monolithic data converters have been encroached upon. Several MOS 12-bit d-a and a-d converters with excellent performance levels have emerged to prove this point. Nevertheless, bipolar units still hold sway when it comes to high-speed, high-accuracy performance. Motorola's MC-10318 8-bit d-a converter with just 10 nanoseconds of settling time is an excellent example.

The performance of monolithic converters has improved to the point where most 8-bit d-a and a-d converters are accurate to 8 bits, not just capable of 8-bit resolution. The fact that accuracy is catching up to resolution in monolithic data converters has strong overtones for the market, where emerging 16- and 18-bit chips with only 12 to 13 bits of accuracy can be priced at low enough cost to compete with hybrid and modular units.

The cost for a stand-alone converter has dropped to about $10 for a 12-bit monolithic integrating a-d unit, to about $12 for a 12-bit C-MOS d-a device, to about $16 for a bipolar 12-bit d-a converter, and to about $30 for a 12-bit bipolar successive-approximation a-d device. Manufacturers have also been coming a step closer to the development of truly universal microprocessor-compatible converters.

Catching up. Approaching hybrid and modular performance, Analog Devices' 12-bit AD566 d-a device settles in 200 ns.

The vanguard

Leading the way in 12-bit hybrids, Hybrid Systems Corp., Bedford, Mass., late last year introduced a d-a unit having accuracy to within ±½ least significant bit and a settling time of 750 ns for a step input. It retails for a price of about $25. The company's successive-approximation ADC 594-12, announced at about the same time, resolves 12 bits in a maximum of 2 microseconds. Hybrid's use of emitter-coupled logic for its 12-bit d-a unit, the DAC397B, makes the unit the fastest in the industry—capable of performing a conversion typically in 50 ns with accuracy to within 0.99%.

Analog Devices Inc., Norwood, Mass., stormed the 12-bit arena with four models: a competitive version of the DAC85 d-a module; a complete a-d converter, the AD574; and two high-speed bipolar d-a converters, the AD565 and 566. The chip count in the DAC85 was reduced to two (and to three in voltage-output models), thereby improving reliability while also lowering cost. The bipolar AD574 includes control logic for interfacing to microprocessors, an internal clock and reference, a successive-approximation register, and three-state output buffers. Performing a successive-approximation conversion to ±0.01% in 25 μs, the unit is priced at around $35. The AD565, pin-compatible with the AD563, settles to ±½ LSB in 200 ns. Containing 12 precision current switches, a highly stable voltage reference, a control amplifier, and a laser-trimmed thin-film resistor network, it costs $16. The AD566, similar to the

AD565 but minus a reference, sells for $15. In other bipolar developments, American Microsystems Inc., Santa Clara, Calif., announced the first bipolar inherently monotonic d-a converter with a diffused-resistor ladder affording ±½-LSB linearity without trimming.

Datel Systems Inc., Mansfield, Mass.; Rockwell International Corp.'s Microelectronic Device division, Anaheim, Calif.; Beckman Instruments Inc., Fullerton, Calif.; NEC Microcomputers Inc., Wellesley, Mass.; and Intersil Inc., Cupertino, Calif., have introduced 12-bit C-MOS a-d units to provide accuracy at moderate cost, though at the expense of some speed. Datel's ADC-ET 12-bit a-d devices, with a conversion time of 24 milliseconds and a standby current of 200 microamperes, cost as little as $13 each. Now that Datel has merged with Intersil, a leader in C-MOS technology, it appears that the group will have the inside track on future developments in this area.

Beckman's bus-compatible 7555 and 7556 units do provide ±½ LSB performance in only 5 μs for a 2-byte conversion, however, because of the devices' successive-approximation schemes. The cost is naturally higher, $27 for the 7555, which includes clocking circuitry and a thin-film ladder; for the 7556, which includes a high-speed comparator and precision reference, it is $55.

A significant improvement in conversion speed was claimed by Rockwell. Its research into C-MOS-on-sapphire a-d converters revealed that 12-bit precision can be obtained in 2.5 μs, at the low power of standard C-MOS devices. Surely this is one area that will see much activity in the coming year.

NEC introduced the first microprocessor-oriented a-d converter with an on-board multiplexer for accommodating four analog inputs, the μPD7002.

Onward and upward

Burr-Brown Research Corp., Tucson; Analog Devices Inc., Norwood, Mass.; Zeltex Inc., Concord, Calif.; and Intersil have all plunged into the 16-bit market, using various technologies to achieve their ends. Burr-Brown's hybrid DAC-71 d-a unit does a conversion in 10 μs and has a maximum linearity error of ±0.003%; it sells for about $40. Zeltex's ZAD7200/7400 a-d module, on the other hand, provides 16-bit accuracy for $750 apiece. Analog Devices already has 16-bit d-a modules with 16-bit accuracy. Intersil's C-MOS (ICL7104) and bi-FET (ICL8068) a-d devices provide true 16-bit performance at three conversions per second for about $30. The biggest challenge in the next few years, obviously, is to provide 16-bit accuracy at high speed, at the same time reducing the cost to under $100.

The bit parade does not end here, though; several 18-bit devices are available, including one from Zeltex, the 1137 (16-bit accuracy) and 1138 (18-bit accuracy) from Analog Devices, and a hybrid unit (DAC374-18) from Hybrid Systems, so that 16-bit accuracy has now

OVERVIEW OF RECENT HIGH-BIT CONVERTER PRODUCTS

Manufacturer	Device	Type	Technology	Resolution	Accuracy	Speed	Price	Other
Hybrid Systems	DAC336C-12	d-a	hybrid	12 bits	1 LSB max	5 μs	$89	Has internal reference, control amp, output amp; is microprocessor-compatible, relatively low-power
Burr-Brown	DAC862		bipolar		± ½ LSB	3.5 μs	$24/100s	Is two-chip converter
Analog Devices	AD565		bipolar		± ½ LSB	200 ns	$16/100s	Has internal reference and control amp
Intersil	ICL7112		C-MOS		0.01 %	n.s.	$12/100s	Is pin-compatible with AD7521, AD7541
Teledyne Semiconductor	8641		C-MOS		0.01 %	n.s.	$18/100s	Is pin-compatible with AD7521, AD7541
Beckman	7556		C-MOS		½ LSB	50 μs	$55/100s	Offers 2-byte conversion with serial or parallel output available; is bus-compatible
Hybrid Systems	DAC394		module		0.025 %	50 ns	$475	
Hybrid Systems	DAC397		ECL		0.01 %	50 ns max	≈$370	
NEC	μPD7002	a-d	C-MOS		0.05 %	5 ms typ	$12/100s	Has on-board multiplexer for accommodating four analog inputs
Analog Devices	AD574		bipolar		0.01 %	25 μs	$35/100s	Is microprocessor-compatible
Hybrid Systems	ADC594-12		hybrid		± ½ LSB	1.8 μs typ	$299	
Burr-Brown	DAC72	d-a	hybrid	16 bits	14 bits	10 μs	$47/100s	
Zeltex	ZDA1600	d-a	module		14 bits	2.5 μs	$275/100s	ZDA1800, having 18-bit resolution, is available for $775
Zeltex	ZAD7200	a-d	module		16 bits	20 μs	$750/100s	ZAD7400, having 10-μs conversion time, is available at higher cost
Intersil	ICL7104	a-d	C-MOS		16 bits	3 conv/s	$29/100s	

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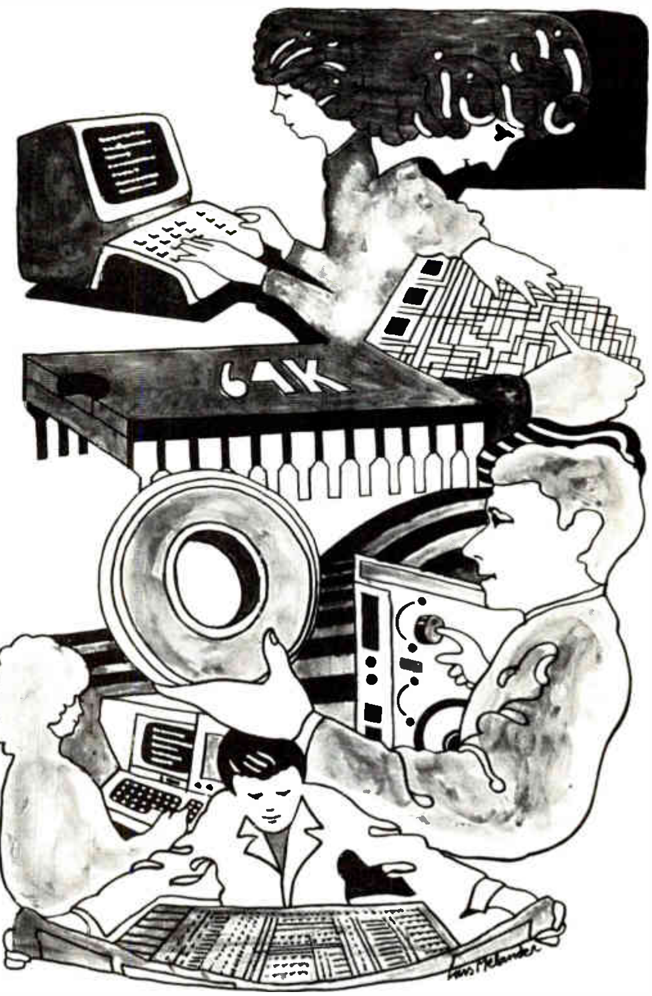

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SY2332	4Kx8	450nsec
SY2332-3	4Kx8	300nsec
SY2333	4Kx8	450nsec
SY2333-3	4Kx8	300nsec
SY2364	8Kx8	450nsec
SY2364-3	8Kx8	300nsec

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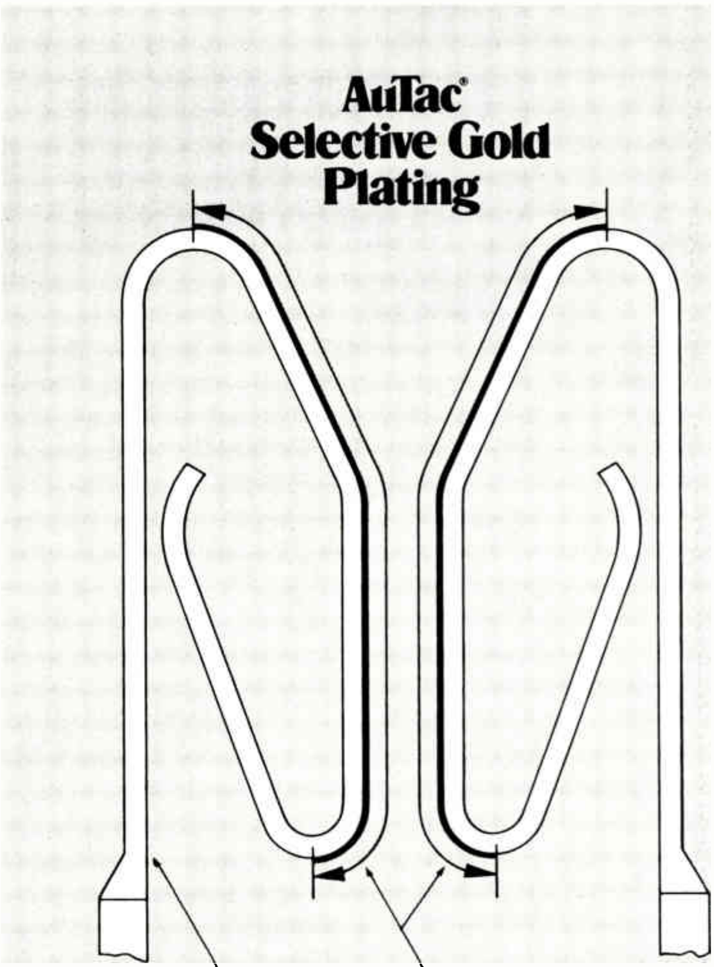
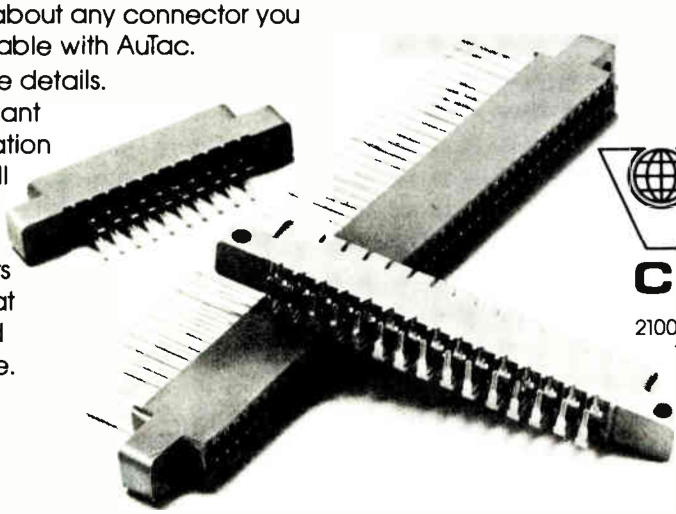


.000010 Gold flash over nickel undercoat, or tin plating

.000030 Heavy gold plating over nickel undercoat on the mating surfaces



Viking CONNECTORS

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been reached or even exceeded at high data rates.

Occupying center stage in the operational-amplifier developmental area during 1979 were C-MOS and bi-FET technologies. Most of the excitement in that arena during the past few years had been generated around C-MOS and its conversion from a strictly digital process into one for use in analog applications. This year the byword characterizing C-MOS advances was CAZ—Intersil's commutating auto-zero method for eliminating an op amp's input offset errors internally by utilizing a continuous sampling technique. Present work is concentrated on improving the scheme so that the amplifier, which at present operates at under 100 hertz, can be made to work at higher frequencies.

Mixed processes benefit op amps

Improvements in mixed-process bi-FET operational amplifiers were also made, as demand grew for low-cost (about $2), low-noise (around 25 nanovolts/$Hz^{1/2}$), high-performance (5-MHz gain-bandwidth) op amps with input bias currents of a few picoamperes. Precision Monolithics Inc., Santa Clara, Calif., and Harris Semiconductor, Melbourne, Fla., pushed to manufacture precision bi-FETs, using laser trimming to reduce offset voltages to around 500 microvolts—a capability that Motorola Inc., Phoenix, also has. Analog Devices has also taken an active interest in the process because of its work in high-performance a-d converters.

But holding fast to its belief that bi-MOS devices (with either MOS-FET input and bipolar output or MOS-FET input, bipolar midsection, and C-MOS output) technology offers the greatest potential for high-performance, low-cost op amps, RCA introduced the CA3290 in early 1979, the industry's first dual bi-MOS comparator. Similar to the National LM393 bipolar device, the CA3290 costs less than $1, within pennies of the LM393. RCA will second-source the Texas Instruments Inc., Dallas, TL080 series later this year, but in bi-MOS, not in bi-FET, showing that it is as viable a technology.

Its only apparent drawback is higher noise levels below 1 kilohertz. Next year, RCA will introduce its line of precision bi-MOS op amps for under $2 that have only 5 μV/°C input offset drift and 500 μV input-voltage offset.

The year's advances were not confined merely to C-MOS or bi-MOS technology, however. International Telephone & Telegraph Corp., New York, first announced in December of 1978 that it would market its V-groove FETs for nearly the same price as compatible bipolar transistors, and Siliconix Inc., Santa Clara, Calif., followed suit. Employing silicon gates and a flattened-bottom groove in its IVN-5000 series, Intersil was able to attain a new order of stability, reliability, and increased voltage-breakdown properties with its V-MOS devices. Its dielectrically isolated, dual-matched junction field-effect transistor (di-FET) device was introduced, too, providing wideband (100-megahertz) performance at extremely low bias currents for only a few dollars per unit. Analog Devices fabricated high-speed (18 MHz gain-bandwidth product) monolithic op amps, AD542/AD544, with implanted FET inputs to reduce bias currents to 25 picoamperes. Using bipolar, J-FET, and laser-trimming technologies, the input offset voltage was reduced to a matter of only 0.5 millivolt and noise to 2 microvolts peak to peak at 10 hertz (and 16 nanovolts/$Hz^{1/2}$ at 10 kHz). Signetics also used an ion-implantion technique in its monolithic bipolar sample-and-hold (NE5537) for improving accuracy and decreasing the droop rate.

Harris introduced a monolithic bipolar op amp having a gain-bandwidth product of 150 MHz (HA-5190) and a settling time of 100 ns for a 5-V step resolved to 0.01%. Its HA4950 resolved a 100-μV differential voltage in 100 ns—fast enough to work with 12-bit a-d converters. Signetics' entry into the high-frequency op amp market was the NE5539, a device having a 2-GHz gain-bandwidth product at a gain of 100 and selling for $10.

In January of 1979, National Semiconductor took the lead in the low-power area, introducing the LM10 bipolar op amp that worked off a 1.2-V supply. Later, Intersil and RCA claimed an improvement to 1.0 V and there may still be a little room left for bettering that value.

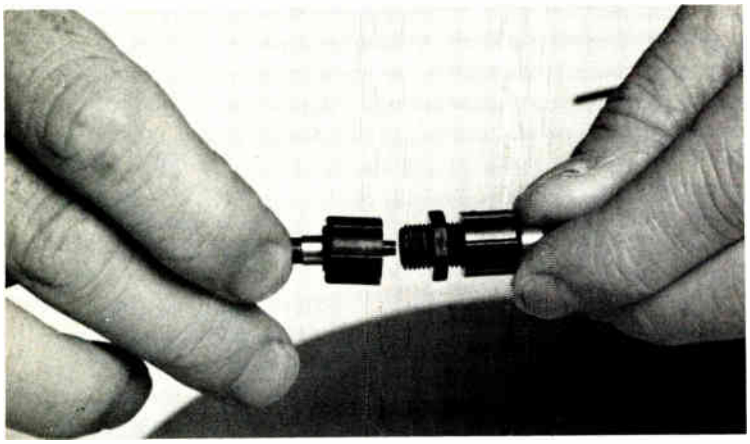
Higher MOS-FET power levels

Besides ongoing advances in power devices like silicon controlled rectifiers and triacs, developments in power MOS FETs, in the form of V-MOS and HEX FETs, are leading the power device field. Since Siliconix introduced it about two years ago, V-MOS has been adopted as a technology for power products by TI, Intersil, and General Electric's Solid State division, Auburn, N.Y. V-MOS power FET ratings are now up to 600 V. Current ratings are also impressive—up to 10 amperes for some low-voltage V-MOS FETs. These have been made possible by the constant chipping away of the V-MOS transistor on resistance, which is now down to about 0.2 ohm.

Meanwhile, the technology of the hexagonal-geometry FET has become the newest and most talked about MOS power technology on the block. A development of International Rectifier's Semiconductor division, El Segundo, Calif., it is being billed as a head-to-head challenger of V-MOS power FETs, and with good reason. HEX FETs boast a resistance of as little as 0.05 Ω that makes possible even higher current ratings than V-MOS FETs. They can also switch currents at speeds 10 to 100 times those of the fastest power devices, bipolar transistors. The company recently brought out its model IRF350 HEX FET, a higher-voltage version of its earlier model IRF150 transistors. The IRF350 can switch an impressive 4.4 kilowatts continuously. Continuous ratings are 400 V and 11 A.

In thyristors, Teccor Electronics Inc., Irving, Texas, cut dielectric isolation on its Thermotab line of SCRs to 2.5 kV (up to 4 kV in screened parts) for stand-alone TO-220 packages. The firm also introduced what it calls a sidac, a four-layer bidirectional voltage-triggered switch that switches ±120 V in less than 1 μs.

Cognizant of the increasing demand for optical



Easy fibers. Easy-strip Pifax cable manufactured by Du Pont enables the user to make connections in as little as 5 minutes with a 10-step technique. Using any of a variety of connectors readily available from several sources, connection loss is only 1.5 dB.

communications systems at affordable prices, several manufacturers have concentrated on development of low-cost transmitter-receiver combinations for various applications. Spectronics Inc., Richardson, Texas, designed the SPX 4140 and SPX 4141 combination for handling 10 megabits/s of Manchester-encoded data over a 2-kilometer path, each unit of which sells for as little as $50. Burr-Brown's 3713T-3713R forms the nucleus of a link that handles data rates at 250 kilobauds out to distances to 1.7 km. Burr-Brown now offers such an introductory kit, complete with optical cables, for $125. Motorola has a similar kit, although the user is required to perform some wiring in order to build a working system. The HFBR-0010 system from Hewlett-Packard Co., Palo Alto, Calif., gives virtually error-free data transmission to 10 megabits/s over distances to 100 meters. Prices start at $570 for a 10-meter system.

Light-beam links

Of equal importance in the performance of these optical links is the quality of the fiber and its associated connectors, and significant improvements in both have been made in the past year. Corning, long a leader in low-loss optical waveguides, has introduced fibers having a maximum attenuation of 4 dB/km at bandwidths to 1,500 MHz for handling energies at 820 nanometers, plus 2-dB/km fiber with a bandwidth of 400 MHz, specified at 900 nm. The prices are $2.50/meter and $1.75/m, respectively, for 1-to-10-km lengths. Corning Glass Works, Corning, N. Y., also designed an improved spool for storing and shipping optical fiber so that the thermal expansion coefficients of spool and fiber are matched, thus virtually eliminating fatigue degradation. In related work, Du Pont, Wilmington, Del., was able to improve its PFX (Pifax) line of silica-core cable, making it more immune to electromagnetic interference and gamma radiation. Du Pont forecasts a great demand for its PFX cable from military and nuclear power plant concerns. Siecor Optical Cables Inc., Horseheads, N. Y. also was able to strengthen its cable against hard pulls and increase its resistance to oil, solvents, and acids by using a central core of steel and a chemically and mechanically non-aging fluoropolymer.

Fiber (and cable) costs are expected to drop through 1980, although the decline will not approach the 70% achieved in the last two years.

In a major development, a coordinated effort by Motorola and AMP Inc., Harrisburg, Pa., produced an electro-optics package that greatly increased coupling efficiency, improved serviceability, and reduced cost. Combined with Motorola's new MFO line of light-emitting-diode sources (and transistor detectors) that are packaged in a resilient plastic ferrule and mounted on a sturdy header, AMP's Optimate fiber-optic connector is designed for direct mating, thereby providing up to 50 times the energy transfer between source and fiber than can be expected with so-called standard systems.

As for the light sources themselves, Japan's Hitachi Ltd. introduced gallium-aluminum-arsenide infrared LEDs capable of an output power of 60 mW and 18% efficiency at bandwidths to 40 MHz. General Optronics Corp., South Plainfield, N. J., announced its GaAs-GaAlAs laser diode, the GOLS-1, having a projected lifetime of 100,000 hours. More long-life devices are anticipated in 1980. The cost will be high, though—the company's asking price for the GOLS-1 is $1,000.

In anticipation of the increase in the number of fiber-optic systems expected in the next few years, several manufacturers have become aware of the user's need to measure electro-optical parameters. The most notable test equipment introduced in 1979 was the FPM-1 from Radiation Devices Co., Baltimore, Md., a $500 meter for quantifying average optical power over the 20-nW-to-2-mW range.

Hewlett-Packard, along with General Instrument Corp.'s Optoelectronics division, Palo Alto, Calif. (previously Monsanto), a major researcher in the LED display area, was very active in product development. HP introduced high-efficiency red, yellow, and green LEDs (HL1300–HL1500), light-bar modules (HLMP-2300—HLMP-2500), and rectangular modules that have been designed for various applications requiring a large, bright light source.

The Datascreen Corp., Mountain View, Calif., confident that the most promising of the technologies suited for large displays lies with liquid crystals, introduced a 40-character alphanumeric unit using a 5-by-10-dot matrix. Datascreen improved the LCD's viewing angle and contrast ratio, two areas that are in need of further improvement.

Beckman made the largest inroad into the planar-gas-discharge display area, introducing an improved 40-character, five-by-seven dot matrix display with an on-board microcomputer (8041A system) for programmability of character brightness and representation (flashing display, etc.). Although not inexpensive ($475 in single lots), it is expected to take a bite into the alphanumeric display area long dominated by cathode-ray tubes.

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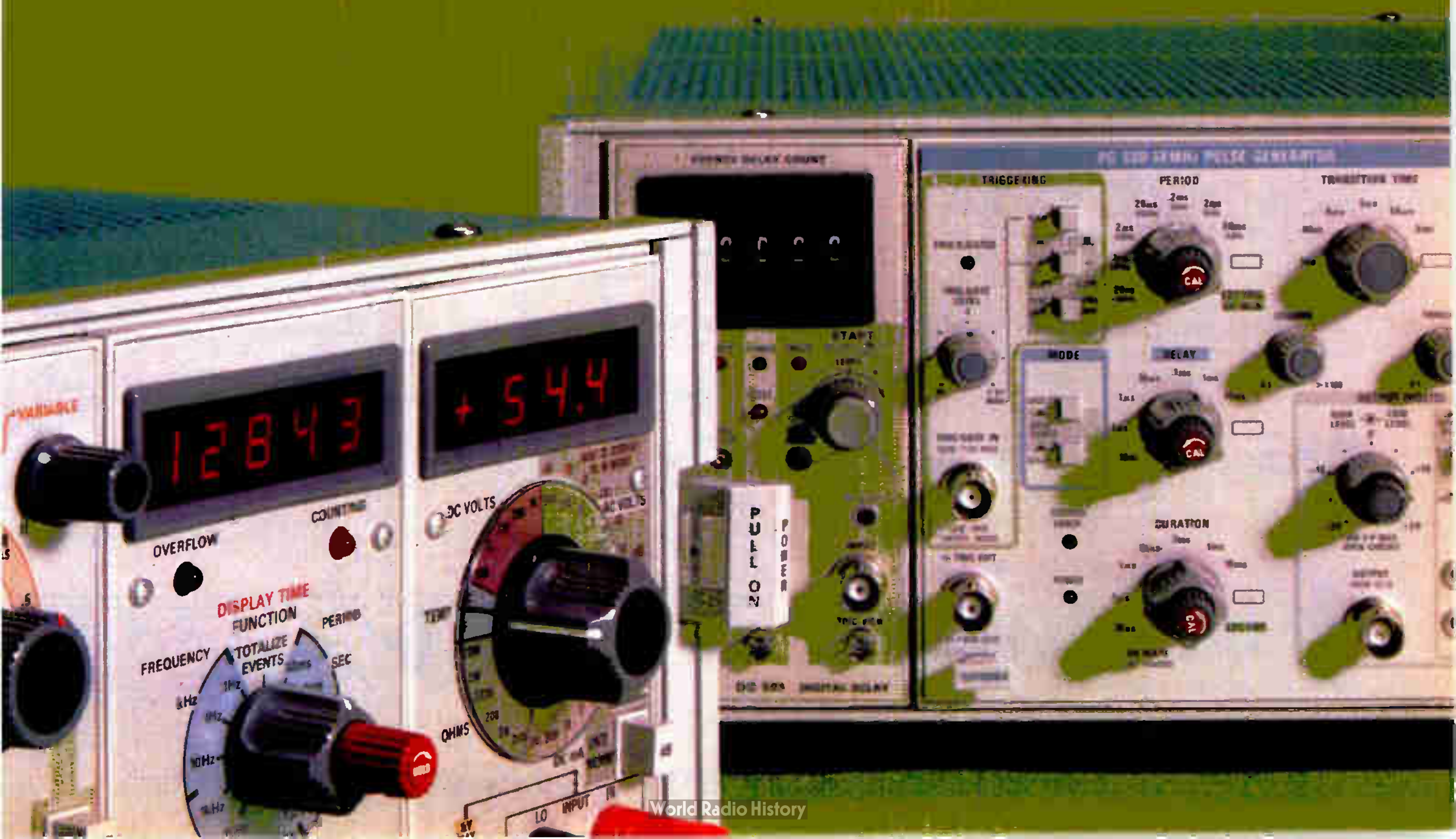


As for the other exotic types of displays—incandescent, fluorescent, and so on—the greatest progress was made by Sharp, with electroluminescent units. Its yellow-orange alphanumeric display, complete with drivers and character generator, has a total viewing area of about 17 square inches, a contrast ratio of 25:1, and an astronomical price—more than $2,000. But the electroluminescent types might move in on the LED and LCD market in a few years, once their prices become competitive.

Despite the work carried on by the Japanese with electrochromic and electrophoretic displays, both of which are similar to the LCD, no significant product developments appeared during the year and it is not likely that these displays will become practical until several years from now. For the foreseeable future, CRT technology will still be dominant for the low-cost display of large amounts of alphanumeric data. No other technology trying to compete with the CRT can do so at present. This is because the cost of supporting electronics for non-CRT displays makes them too expensive.

PROFILE

The CAZ amp was Bingham's brainwave

David Bingham has a reputation amongst his colleagues at Intersil Inc. for coming up with simple but elegant solutions to knotty problems. And during his almost 10 years with the company in Cupertino, Calif., he has earned it with such designs as the first high-frequency watch and clock chips to incorporate dynamic counters, the first on-chip light-emitting-diode drivers, the first 3½-digit voltmeter on a chip, and a complementary-MOS version of the popular 555 precision timer.

But with the CAZ amp—short for commutating automatic zeroing amplifier [*Electronics*, Jan. 18, p. 39]—the British-born Bingham may have surpassed himself. Simplicity itself, the CAZ amp attacks the offset voltage problem common to operational amplifiers by achieving a maximum of 5 microvolts for frequencies from dc to 10 hertz. To do it, Bingham puts two op amp circuits on one chip so that as one of them processes the signal, the other stores the offset errors on an external capacitor. The two continuously switch roles and the error on the capacitor is in series with the second op amp's input, canceling the offset error.

Bingham recounts that he came across the idea while "thinking about another type of circuit [a peak detector for a tape recorder] that required continuous sampling of the input signal while having the error of that signal very low." Suddenly he thought, "Why have only one amp? Why not have two, one to process the signal and the other to correct it, and then switch the two very quickly?"

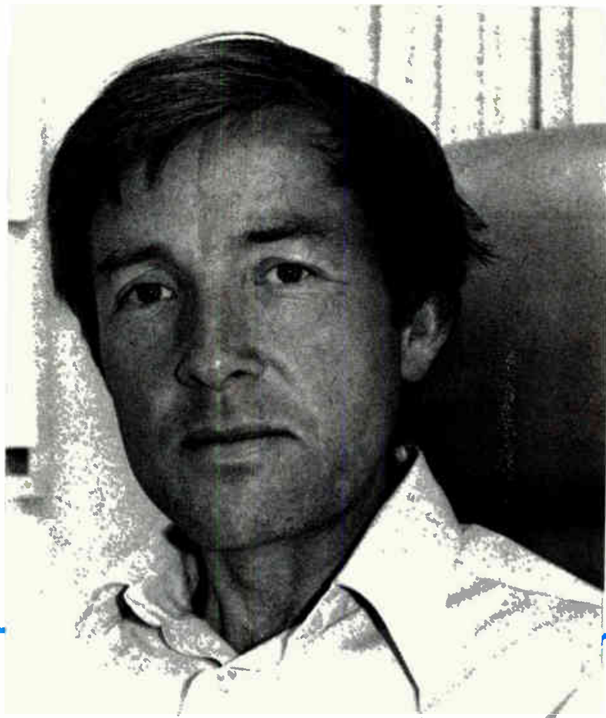
Executing the concept was more difficult, however. For one thing, the CAZ amp was going to be in MOS, an inherently noisy technology given to offset error. For another, it needed an op amp with 100 decibels of gain that was reasonably quiet and gave good performance. But there were no C-MOS op amps available then. Bingham's solution: "I came up with a unique output stage to the op amp that provided higher gain than expected." His colleagues are quick to add that the C-MOS op amp he developed for the CAZ amp also became Intersil's basis for a successful family of C-MOS op amps.

The resulting CAZ amp, or ICL7600, consists of two op amps, a series of low-charge–injecting analog switches, and a section that digitally controls the analog switches, Bingham explains. He neatly solved the problem of merging all that on one chip by integrating analog and digital power supplies. This allowed the digital section its own stabilized power supply so it would not interfere with the functioning of the analog supply.

Since then, he has further investigated commingling analog and digital power supplies and has come up with the ICL7660, a C-MOS voltage converter for a low-power data-acquisition system that can convert input supply voltages with nearly perfect efficiency.

Bingham thinks he has been lucky in his career because he started off in the analog world, designing circuits for television sets, and then moved into watch and calculator circuits, which are "highly digital by nature and use C-MOS." So he thinks it fortuitous that the Intersil industrial low-power products section was set up in 1976 where, as engineering manager, he could "work on C-MOS circuits and bring them into the analog industrial world." Bingham believes that the advantage of C-MOS is low power and that, therefore, "the future of analog is largely C-MOS because it serves a demand not served by bipolar techniques."

After receiving his electronics degree in 1959 from Imperial College, London, England, Bingham worked for the SGS-Fairchild joint venture then in existence in Milan, Italy, before coming over to join Fairchild Camera and Instrument Corp. in Mountain View, Calif. He stayed there for about three years. He then joined neighboring Cermetek, where he remained for two years before beginning his career at Intersil. **-William F. Arnold**



Facts from Fluke on low-

cost digital multimeters.

When you're looking for genuine value in a low-cost DMM you have a lot more to consider than price. You need information about ruggedness, reliability and ease of operation. Accuracy is important. And so are special measurement capabilities. But above all, you must consider the source, and that company's reputation for service and support.

Fact is, as electronics become more a part of our daily lives, dozens of new manufacturers are rushing to market their "new" DMM's. In theory, this is healthy; but in practice, crowding is confusion.

To help you deal with this flood of new products, here are some facts you should know about low-cost DMM's.

The economics of endurance.

Even the least expensive DMM isn't disposable. Accidents happen, and test instruments should be built to take the abuses of life as we live it.

Look for a DMM with a low parts count for reliability, and rugged internal construction protected by a high-impact shell. Make sure the unit meets severe military tests for shock and vibration.

Another feature to check out is protection against overloading, whether from unexpected inputs, transients, or human errors.

Just for the record, all Fluke low-cost DMM's meet or exceed military specs, and feature extensive overload protection.

The importance of being honest.

Just because a multimeter is digital doesn't mean it's automatically more *accurate* than a VOM – even though the LCD might give you that impression. The benchmark for accuracy in DMM's is *basic dc accuracy*. The specs will list it as a percentage of the reading for various dc voltage ranges.

Of course accuracy is more critical in some applications than others, and increasing precision and resolution in a DMM usually means increasing price. In the Fluke line, you can choose a model with a basic accuracy of 0.25% (the 8022A), others rated at 0.1%, or the new 8050A bench/portable at 0.03%.

Special measurements: getting more from your DMM.

Actually, for all the variations in size, shape and semantics, most DMM's perform five basic measurements: ac and dc voltage and current, and resistance. Prices vary according to the number of ranges and functions a DMM delivers.

	Product	Functions	Ranges	Digits	Basic DC Accuracy	Conductance	Other Special Features	Price
HANDHELD MODELS	8022A	6	24	3½	0.25%		Basic six-function DMM; lowest-priced	$129
	8020A	7	26	3½	0.1%	X	High accuracy ; pioneer in conductance; exclusive two year warranty.	$169
	8024A	9	26	3½	0.1%	X	Direct temperature readings; continuity/input level detector with selectable audible signal; peak hold capability.	Available soon
BENCH/PORTABLES	8010A	7	31	3½	0.1%	X	True RMS; extra 10A range.	$239
	8012A	7	31	3½	0.1%	X	True RMS; two extra low resistance ranges.	$299
	8050A	9	39	4½	0.03%	X	True RMS; selectable reference impedances with direct readouts in dBm; offset feature.	$329

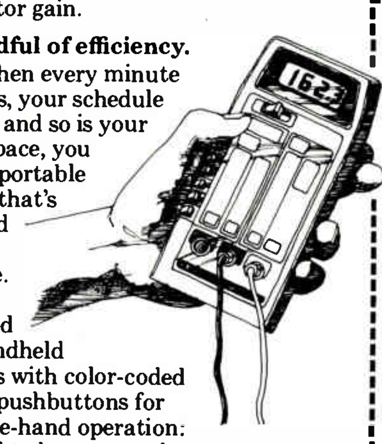
The Fluke line includes DMM's with from 24 to 39 ranges, 3½ and 4½-digit resolution, and some unique functions you won't find in any other DMM. Additional measurement capabilities like temperature, dB, conductance and circuit level detection.

If your work involves temperature measurements, the new 8024A delivers direct temperature readings via any K-type thermocouple. This is especially useful in testing component heat rise and checking refrigeration systems.

Another talented instrument is our new 8050A bench/portable. The microprocessor-based 8050A features a self-calculating dB mode in which dBm readings are displayed automatically referenced to one of 16 selectable impedance ranges – a real timesaver when servicing audio equipment.

And of course no discussion of DMM's is complete without considering conductance – a Fluke exclusive featured on five of our low-cost DMM's – which allows you to make accurate resistance measurements to 100,000 Megohms. You can't do that with any ordinary multimeter, but it's a must for checking leakage in capacitors and measuring transistor gain.

A handful of efficiency.



When every minute matters, your schedule is tight and so is your work space, you need a portable DMM that's fast and easy to operate. We designed our handheld DMM's with color-coded in-line pushbuttons for true one-hand operation: no need to hang onto the meter with one hand while twisting a rotary dial with the other.

But there's more to convenience than fingertip control. The 8024A, for example, is also designed to function as an instant continuity tester, with a selectable audio tone to indicate shorts or opens. It also has a peak hold feature to capture transients.

A word about warranties.

Last but not least, look closely at the company that manufactures a low-cost DMM. Their service is just as important as their product. Look for no-nonsense warranties, a large family of accessories, an established network of service centers and technical experts you can rely on.

That's how you'll recognize a knowledgeable supplier of low-cost DMM's, a company with experience, resources and a commitment to leadership in the industry.

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Look for more facts from Fluke in future issues of this publication. Or call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

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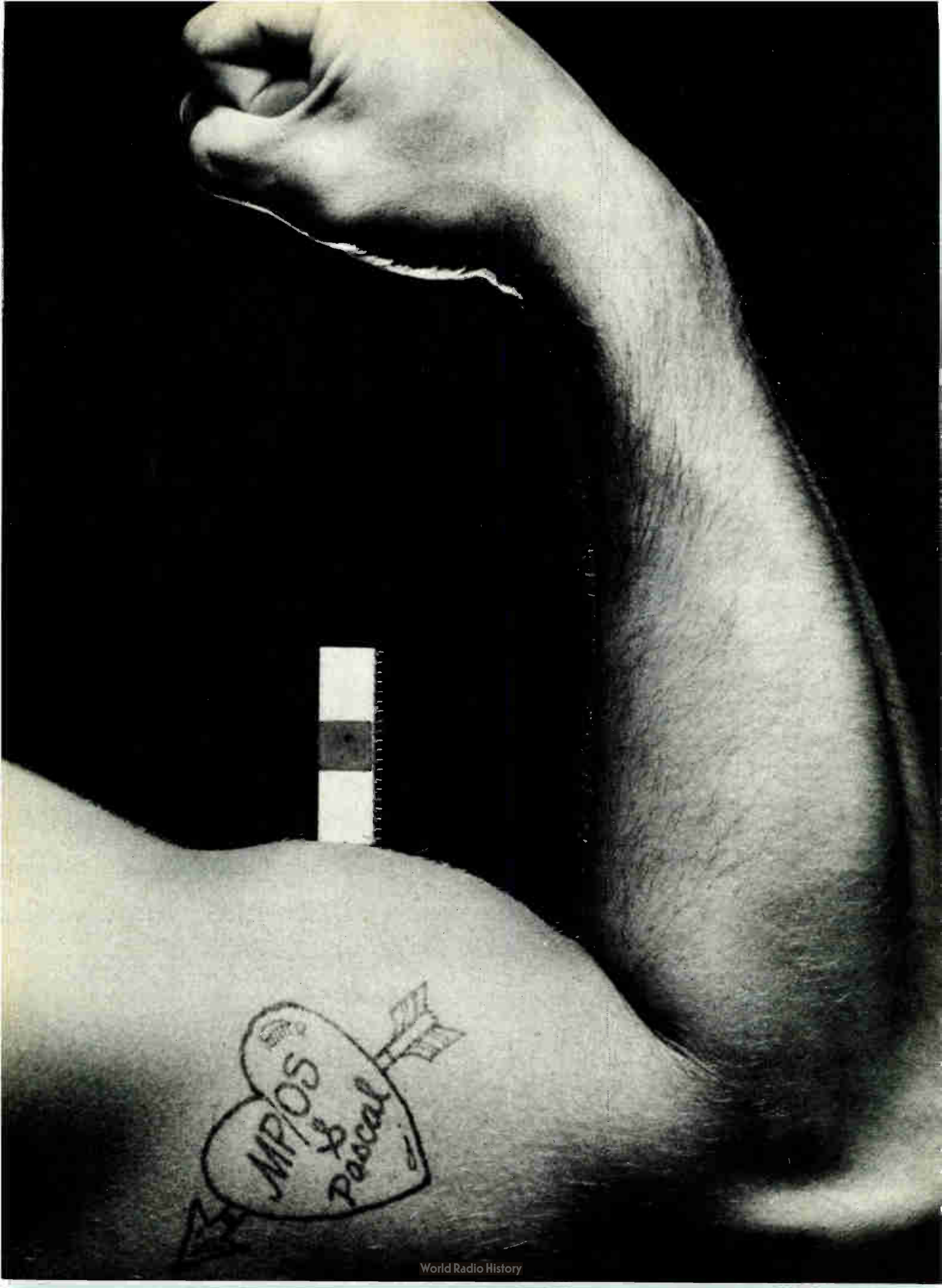
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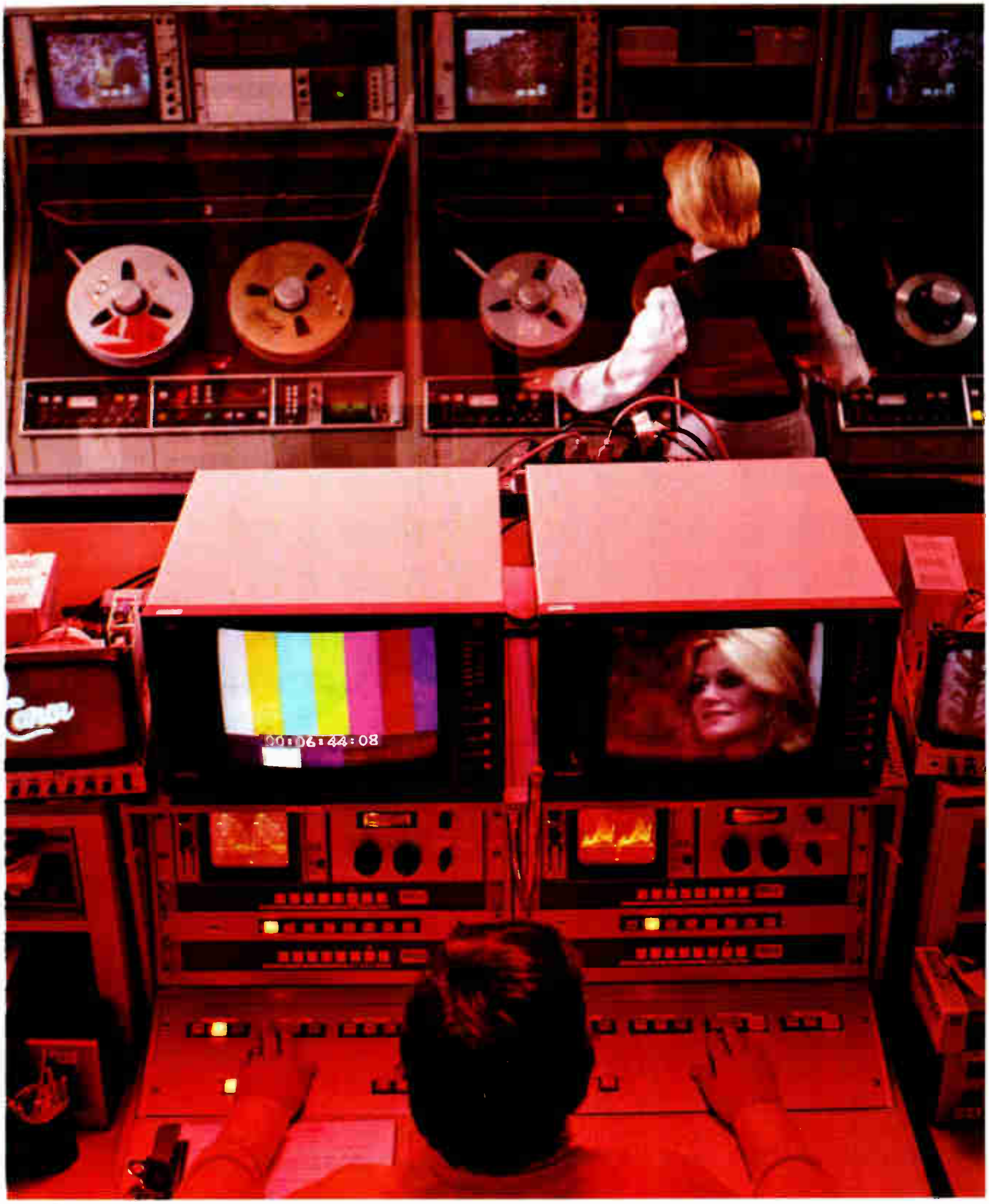


Consumer

by Howard Wolff, *Assistant Managing Editor*

☐ *After a period of relative somnolence in which the emphasis was on improvement rather than innovation, the past year for the consumer electronics industry was one of exciting development in technology as well as marketing initiatives. Consider, for example, the long-range effect on the television community of the development of a single-gun, single-beam color picture tube by Matsushita Electric Industrial Co. or of the entry into the video-disk picture this fall of International Business Machines Corp.*

The past 12 months also have seen a small object on the electronic horizon called videotext begin to cast a longer shadow as interest in televised home delivery of information, carried either on phone lines or during TV blanking intervals, perked up around the world. Information handling in the home is also growing more electronic in nature through the continued introduction of new personal computers, as well as ambitious marketing plans for the machines. For example, Sears, Roebuck and Co. recently announced that it will sell the just introduced Atari home computers and plans to move at least 100,000 of them annually in its stores and through catalog sales.

In other areas, the pace was slower. Audio engineers continued their work with digital recording techniques, originally derived from video cassette recording methods, as records from Japan and Europe that have benefited from digital and laser techniques began to become more common in retail stores. As for VCRs themselves, NV Philips Gloeilampenfabrieken of the Netherlands and West Germany's Grundig AG jointly developed a system using a reversible cassette that plays for four hours on a side. And West Germany's BASF AG and Japan's Toshiba Corp. came up with mechanically simpler units that play longitudinally rather than helically.

Aside from straight over-the-air television and stereo, the most common electronic entertainment device in the home continued to be the game, both video and nonvideo. While the days of explosive development appear to be over, growth remains healthy. National Semiconductor Corp. delivered its millionth game chip to Mattel Inc. this year and hand-held, calculator-like language translators made their first impression on the buying public.

It started with Lexicon Corp., a self-described "tiny, tiny, small company" in Miami, Fla., and the LK-3000. The translator uses the 8-bit 3870 microcomputer from Mostek Corp., Carrollton, Texas, and a 64-kilobyte read-only memory, also from Mostek, to store 1,500 words of English and another language. But unable to put together all the resources needed to stay in the business, Lexicon in September announced that it had licensed a subsidiary of Nixdorf Computer Corp. of Burlington, Mass., to manufacture and market the 3000. The subsidiary, Nixdorf Computer Personal Systems Inc., paid $2.5 million plus a royalty on sales.

The market has already become crowded. Craig Corp. of Compton, Calif., came along with its M-100, which also uses the 3870, and then some giants entered: Texas Instruments Inc. of Dallas, Texas; Japan's Sharp Corp.; and Matsushita Electric Industrial Co., whose translator bearing the Panasonic label is merely the forerunner of a slew of consumer products that will rely on plug-in modules.

TI broke new ground, showing the direction future translators will take by incorporating its one-chip speech synthesizer, the same one used in the Speak & Spell children's learning aid. And Sharp added a new wrinkle by coming up with a translator that displays English and Japanese as an aid to Japanese learning English.

Words and pictures. Scientist works with encoder that sends test data along with television picture to receiver in background.

TV moves into advanced display areas

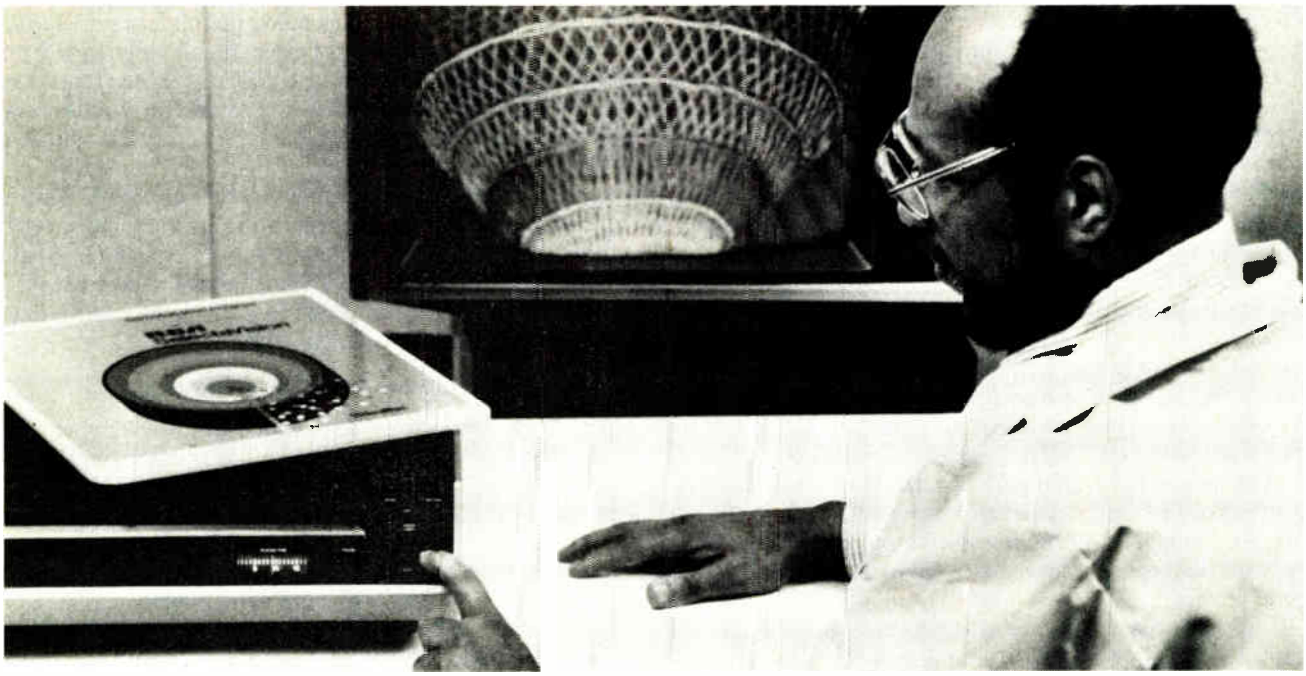
Two developments in Japan brought the day of the take-it-anywhere TV set closer. Matsushita's single-gun TV set opens the way to the long-awaited battery-powered portable color receiver. The new tube needs less power than conventional three-gun versions—only 7 watts in a 4.5-inch-diagonal size—thus making it possible to power a set with batteries. Matsushita has replaced the power-hungry shadowmask system with a luminescent index material that emits ultraviolet light when excited by an electron beam. The emitted light is detected by a photomultiplier tube and converted into an electric signal that controls the beam.

Another TV receiver type, one that has been done before—the so-called pocket size—has been developed by Matsushita, only this time using a liquid-crystal display. The display consists of an array of 240 by 240 picture elements made by layering liquid-crystal material on an integrated-circuit array. Each picture element has its own MOS field-effect transistor and condenser. Drive circuits are all complementary-MOS, and the display can be driven by low-power batteries.

In the U. S., microprocessors made more inroads in consumer electronics, and probably will go on doing so. RCA Corp., New York, marked the 25th anniversay of color television with a set that can be programmed to turn different channels on and off at selected times over a seven-day period. A microprocessor is the brain behind the new feature. Also introduced in the new line was a sound system that simulates stereophonic sound by separating the incoming audio portion and driving two separated speakers with the two signals.

As for projection TV, the industry is still waiting for someone to produce a set that can offer high quality for less than $2,000. The man who started it all, Henry Kloss, president of Kloss Video Corp. and founder of Advent Corp., promises a new model of the usual three-tube, two-piece variety but with a brighter and sharper picture that will cost less, at under $2,500, than any other projection TV system now on the market.

The greening of the television receiver as an all-purpose information-delivery terminal threatens to continue apace as various videotext systems are tested in North America. The technology has branched into two techniques: viewdata, which is a link to a computer via phone lines, and teletext, the broadcasting of special



Look of the future. By the end of the year, RCA will tell the world its plans for production and marketing of its video-disk player. Here, RCA scientist Paul Mitnaul demonstrates a prototype of the machine, which uses a grooved disk played with a diamond stylus.

information along with the normal TV signal during vertical blanking periods. The British-developed Prestel viewdata system is being tested in the U. S. by General Telephone and Electronics Corp., the CBS/Broadcast Group of CBS Inc., and RCA; it is also being tested in Sweden and West Germany. At the same time, the French government's teletext system, called Antiope, is getting a workout at station KMOX in St. Louis. Prestel is being given a test run cheek by jowl with Antiope in St. Louis. Prestel is also being looked at via Salt Lake City's KSL. Videotext systems also are being tested in the U. S. in Philadelphia and Lexington, Ky., and in Canada.

Computers that go home—sometimes

As computer stores proliferate, operators say that most of their customers are owners of small businesses and most of the rest are computer freaks. Still missing from the equation is the ordinary consumer buying a computer to operate lighting and heating at home, balance the check book, and keep a recipe file. Makers of the systems are undeterred, even though the market-defining line between a personal or home computer and a small-business system is hard to discern.

The most noticeable arrivals in the past year were from Texas Instruments, Radio Shack (a subsidiary of Tandy Corp., Forth Worth, Texas), and the first models from Atari Inc. of Sunnyvale, Calif., formerly a maker of games only. Now, more than 80 companies make machines that can be classified as personal or home computers. The biggest noise was from TI's long-awaited announcement, but the noise turned out to be a sigh of relief from competitors as the Texas giant chimed in with its 99/4, which, with keyboard and monitor, sells for $1,150—hardly providing the price break that other makers had feared. However, considering what TI did to the calculator market, those other companies cannot feel completely safe yet.

But before the Texans rode into town at the Consumer Electronics Show in Chicago, there were introductions by Atari, with its 400 and 800 models—the machines now being retailed by Sears—and several others at the June National Computer Conference in New York. One, the Apple II Plus made by Apple Computers Inc., Cupertino, Calif., with its on-board read-only memory containing Basic and an automatic start-up mode, is aimed specifically at small businesses. And an old name in the consumer business, RCA, announced its VIP II, an under-$400 seller using RCA's 1802 microprocessor, a basic 8 kilobits of random-access memory, 12 kilobits of ROM, and side-by-side ASCII and hexadecimal keyboards. Finally, also at the New York show, Radio Shack introduced its TRS-80 model II. This machine is really too big to be called a personal computer: it has at its heart a Z80A microprocessor, which is driven at 4 megahertz, giving it twice the speed of the original TRS-80, now called the model I.

Several companies are looking for a niche between those big machines and the hand-held calculator with a portable hand-held personal computer. Hewlett-Packard Co. of Corvallis, Ore., even as it refused to comment on reports that it was working on a $2,500 personal computer, showed its versatile $295 programmable calculator. It looks much like other calculators, but has four data ports to handle an optional $350 printer, $195 memory card reader, and $75 memory modules. At about the same time, Matsushita told the world it was developing a

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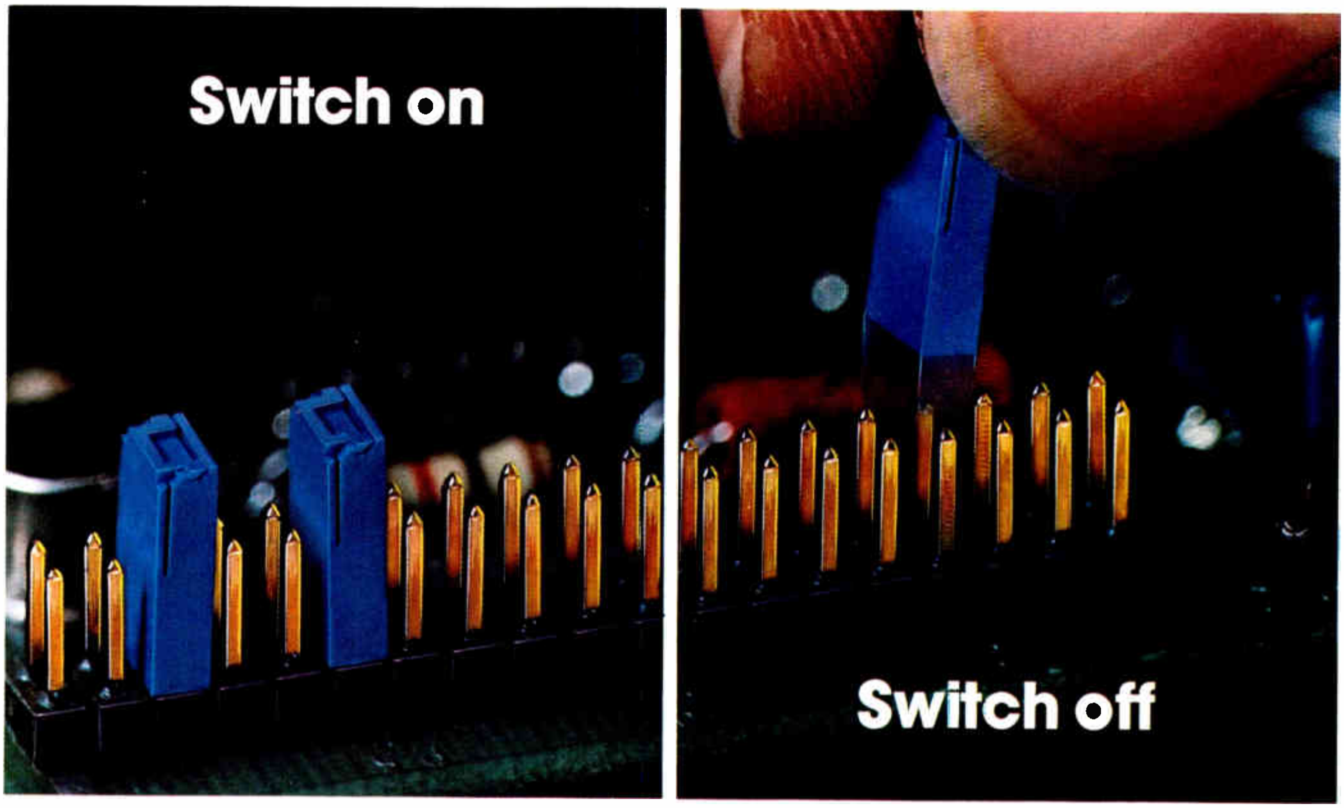

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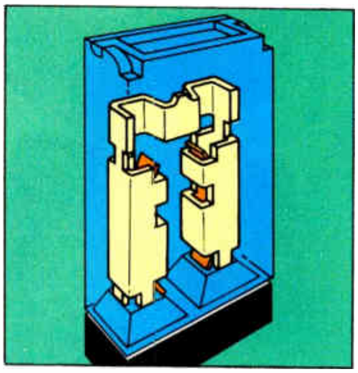

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hand-held personal machine with software by Friends/Amis Inc. of Redwood City, Calif., the outfit that worked up the software for Craig's translator.

Electronics reaches out from under the hood

Now that the Government has forced Detroit's engineers to place electronic controls in the automobile engine compartment, the Big Three are trying to spin out dashboard options to push in ads.

Ford Motor Co. and General Motors Corp. are busily mining the options lode this fall. Ford is offering a digital speedometer and fuel gage using vacuum fluorescent displays. And the top-of-the-line Lincolns can be delivered with an industry first: an alphanumeric display indicating the condition of automotive systems, a trip computer, and other functions. While Chrysler Corp. too will have a "message center" in the next model year, no one has plans to duplicate Ford's other marketer's delight: a five-button panel on the driver's door to lock or unlock it when the right combination is punched in.

Ford has the lead in dashboard displays, but GM has advanced the art of self-diagnosis. The engine-control module in the Cadillac Seville SS is linked via a serial interface to the light-emitting-diode display of the electronic climate control to indicate, with a two-digit code, up to 25 failure modes.

The result of this is that the typical car of the future will have at least one microprocessor each in the engine control module, the radio, climate-control system, load-leveler, and at least two in the instrument display.

PROFILE

Fedida's idea spawned the videotext industry

One engineer working alone at the British post office's Marlesham Research Center in Ipswich in the late 1960s dreamed up a system from which has sprung a whole new industry. The system is Prestel, a viewdata technique (it links television terminal to remote computer data bank by telephone), and it has become the predecessor of countless viewdata services now in the works. The opening of a new $4.4 million computer center in England, where transmissions have been broadcast for several years, affirms Prestel's ascendancy. Trying to catch up are three rival systems developed elsewhere and an assortment of videotext services that are undergoing trials in almost every developed country.

But when he joined the post office in 1968 after an already long and successful research career, Sam Fedida's only assignment was to stimulate the use of computers in telecommunications. Says Fedida, "I was the only member of my department at that time, which was very nice because I had time to think." He used the time to good effect and within only a matter of months had formulated the entire concept and strategy for the development of a viewdata system.

Fedida realized that the uses for a computer data base, instantly updatable and accessible to the public and business at large, were legion. The problem was getting the costs right and making the system so easy to operate that it could be operated by a first-time user with no experience in computer technology.

Getting a computer to display a few pages of information on the screen was easy. The real problems came when planning a system that could work on a national scale. Engineering decisions had to be made on the likely traffic levels the computers would be required to support; comprehensive housekeeping software had to be developed to look after the behind-the-scenes bookkeeping, to take care of customer billing, to provide information suppliers with editing facilities, and to log messages when making purchases via viewdata.

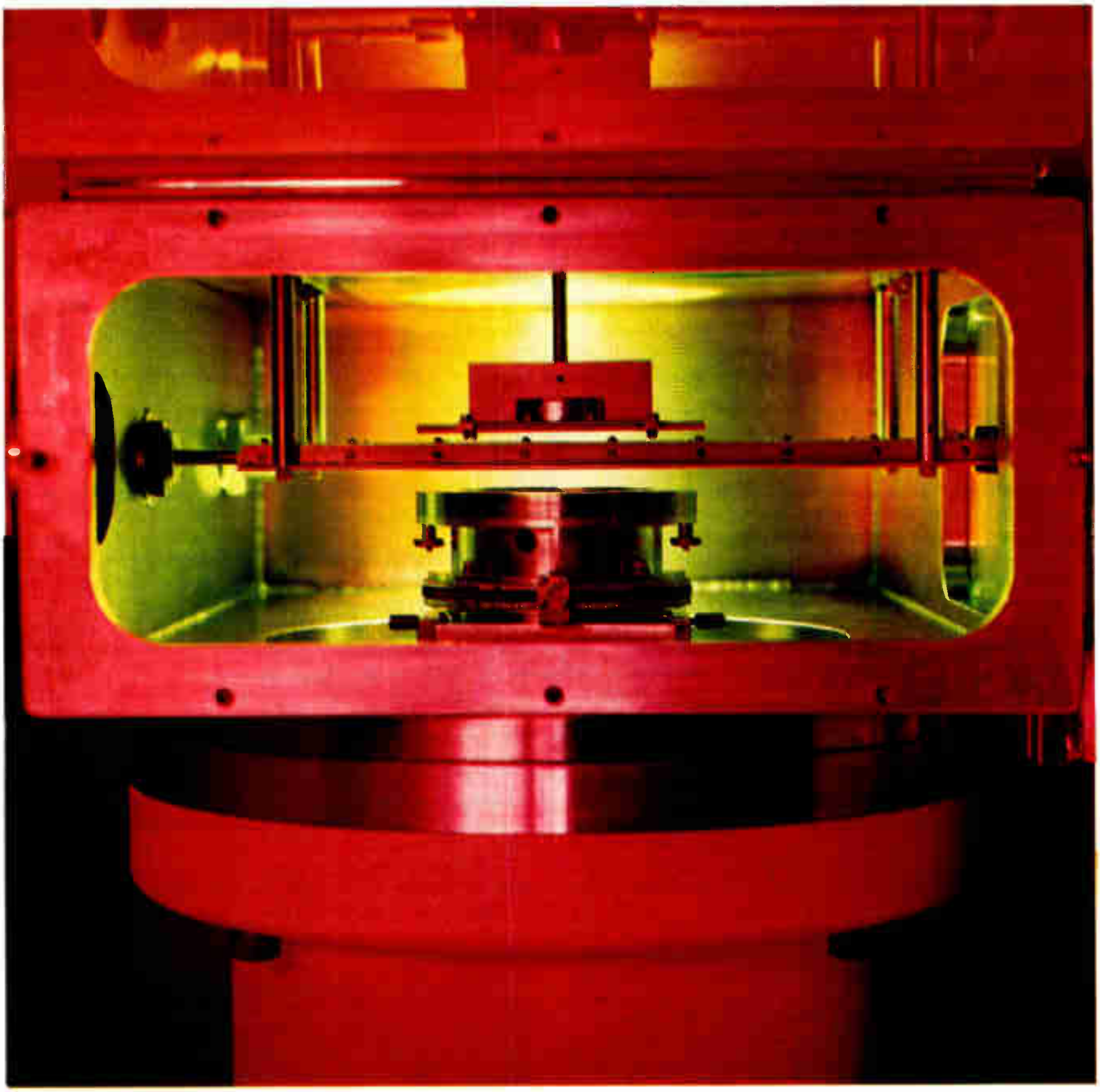
Fedida decided on a decentralized system replicating computer data bases throughout the country. This spread the traffic load and, when operational, meant that a customer could dial into the computer to obtain data for only the cost of a local call.

Fedida's involvement with viewdata was a case of the right person being in the right place at the right time. His training as a professional engineer began at Imperial College, London, where he took an honors degree in telecommunications. Later in his career he added a master of science degree in computer science.

After the war, which he spent in the Royal Air Force, he joined Marconi Ltd., Chelmsford, as a research engineer and by 1960 was manager in charge of communications development. By 1968 he had become assistant director of research of English Electric Marconi Ltd., but the takeover of English Electric by General Electric Co. Ltd. caused Fedida to rethink his career, and he left to work briefly as a consultant.

So he arrived at the post office with the right experience and the right background. Perhaps just as significantly, he knew the then research director personally.

Says Fedida, "He knew that any proposal I made would have substance. Additionally, he had the persuasiveness to sell a new idea calling for a big investment to his superiors." **-Kevin Smith**



Packaging and Production

by Jerry Lyman, *Packaging & Production Editor*

☐ *The story of the incredible vanishing chip continues. From integrated-circuit processing to interconnection at the board level, all phases of electronics are now being driven by the exigencies of large-scale and very large-scale integration. This year saw researchers investigating a new lithographic method, using ion beams rather than X rays or electron beams, that potentially can both expose submicrometer circuit details and aid in other wafer-processing steps.*

Other engineers, also prodded by LSI's shrinking of chips, have developed methods using either lasers or pulsed electron beams to anneal out defects in wafers without causing distortion, in order to maintain the yield of devices with submicrometer geometries. At the board level, a new, fully automatic wiring method was introduced this year that achieves even higher interconnection density for printed-circuit boards carrying arrays of chip-carriers.

Today, VLSI chips like 64-K RAMs with geometries of 2 to 3 μm are in full production, and prototypes of VLSI chips with geometries of 1 to 2 μm are being evaluated at many IC facilities worldwide. For devices with submicrometer details, companies such as Hughes Research Laboratories, Malibu, Calif., have already turned out experimental devices using either scanning-electron-beam or X-ray lithography. However, both of these techniques have inherent limitations. In an electron-beam system, electron scattering in the resist and substrate seriously limits the minimum line width achievable. An X-ray system, with its theoretically finer line widths, is subject to penumbral distortion due to the lack of a collimated source.

LITHOGRAPHY LIMITS ON RESOLUTION

	Ultraviolet (mask)	X-ray (mask)	Electron beam (spot)	Ion-beam (spot)	Ion-beam (mask)
Wavelength	2,000–4,000 Å	1–100 Å	0.2–5 Å	0.1–1 Å	0.01–0.2 Å
Diffraction	XX	X			
Electron diffusion		X	XX	XX	
Backscatter			X		
Depth of focus	X				
Geometric effects		X			
Mask scattering					XX
Overall minimum resolution (with ideal resist)	≈ 1.6 μm for 4,000 Å; ≈ 0.8 μm for 2,000 Å	> 0.1 μm	> 0.3 μm	> 0.02 μm	> 0.3 μm

XX = dominant factor
X = influences final resolution

SOURCE: BELL TELEPHONE LABORATORIES

Ion beaming

During the past year, researchers at Hughes Research and at the National Research and Resource Facility for Submicron Structures at Cornell University, Ithaca, N. Y., have reported on successful experiments with a new technique—ion-beam lithography (IBL)—that shows great promise for submicrometer structures. Ion beams do not scatter as much as electron beams and, unlike X rays, there are collimated sources available.

IBL has shown submicrometer (0.5-μm) resolution and is capable of a large throughput. Potentially, IBL can handle many different IC processing steps—ion-implantation, milling, and mask and wafer lithography.

So far, Hughes and Cornell have done most of their laboratory experiments with ion-transparent mask substrates in a system that resembles an X-ray lithographic system, with its masks on their X-ray-transparent substrates placed in proximity to a resist-covered wafer. The source of the beam is a modified ion-beam implanter. (Better resolution is theoretically possible by using a scanning, or focused, ion-beam source, but this approach is still on paper.)

A pattern is produced in a thin resist film after exposing it to radiation through a mask. As with X rays, the use of high-energy protons may eliminate wavelength diffraction problems that limit photolithography. The two mask technologies are somewhat similar. Both rely on heavy-metal absorber patterns put down on a thin transmissive membrane.

Ions have an advantage over X rays, however. They avoid penumbral distortion because ion sources will produce highly collimated beams using ion-optical techniques. Focusing lenses cannot be applied to X rays; instead, using a distant point source is the only feasible scheme for collimating them.

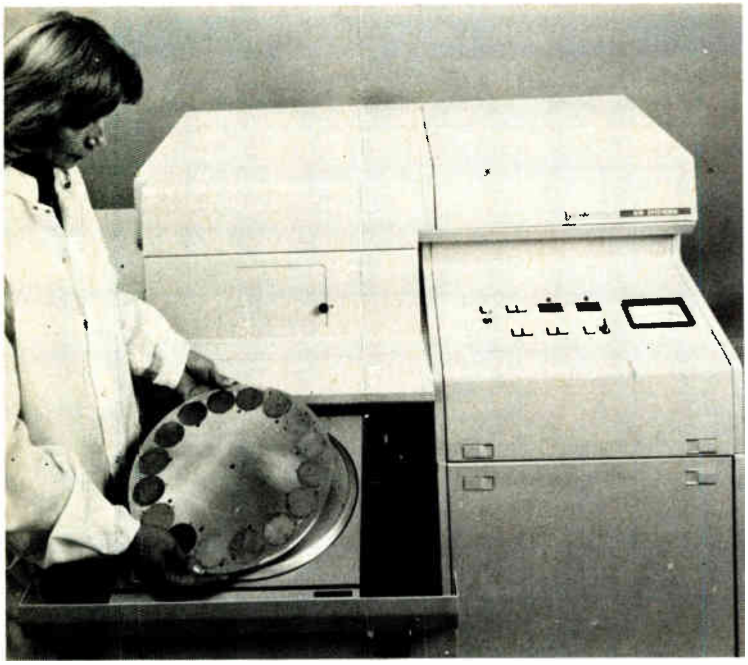
In the Hughes experimental ion-beam lithography setup, a collimated beam approximately 1 cm² in area irradiates the mask. The proton-beam energy is typically 150 to 250 kiloelectronvolts; the beam current is on the order of a microampere. A gold ion-absorber pattern on the mask may be 0.5 to 1.0 μm thick, and the mask membrane may be an amorphous thin film or a somewhat thicker single-crystal film.

Since the resist is very sensitive to proton radiation, the wafer throughput can be large. A beam current considerably below the state of the art for collimated proton beams can expose PMMA (polymethyl methacrylate, a popular electron-beam and X-ray resist) in a fraction of a second. So wafer throughput depends mostly on other factors, such as the time it takes for wafer loading, aligning, and stepping.

IBL is not plagued by diffraction and proximity effects. The protons are less affected than electron beams by stray electromagnetic fields, and secondary electrons generated in the resist have very low energy and will travel less than 100 Å. All of these features contribute to IBL's inherently high resolution. Submicrometer patterns have been created with PMMA at Hughes Research using an open mask and 150 keV protons. The patterns have 0.5-μm openings in a 1-μm-thick resist.

According to a recent paper by Hughes Research scientists, "IBL has passed through several stages of maturity rather rapidly in that many basic issues tradi-

Electron-beam annealer. In this chamber of Spire's processor, a submicrosecond energy pulse thermally anneals a silicon wafer.



Laser annealing. Quantronix' model 610 Epitherm is the first commercially available laser annealer. Its first application will mostly be in repairing wafer damage from ion implantation and in activation of dopants. Another possible use is laser assisted diffusion.

tionally raised for submicrometer lithographies and beam technologies have been investigated and have yielded positive results." Two key components of an IBL system already exist: the ion source and the resist. The masks must be improved to reduce mechanical distortions and scattering. As in other projection-type lithographies, an automated high-speed aligner is also required for high throughput submicrometer IC fabrication. Hughes is building its first complete ion-beam system under a Government contract. The table compares all of the presently employed submicrometer lithography methods along with the theoretical specifications of a scanned ion-beam system.

Correcting the wafer damage caused by ion implantation is the direct cause of two important new advances this year in IC processing—namely laser and electron-beam annealing. Both new methods improve yield. They do a more efficient job of repairing damage caused in the silicon-crystal lattice during ion implantation than older high-temperature thermal annealing. In addition, both techniques show promise of taking the place of other IC processing steps. For instance, a laser system can be used for diffusion, epitaxial growth, and gettering, and a pulsed electron beam can also diffuse dopants, sinter contacts, and be used for epitaxial growth.

Laser annealing

The concept of laser annealing to replace thermal annealing first surfaced in 1977. In this method, a pulsed continuous-wave laser is aimed at a particular damaged site. On a wafer the heating is transient and localized while the rest of the wafer remains at room temperature. This transient heating and recrystallization of the material reduces defect densities and increases carrier densities. In the future, it could be used to produce structures and geometries not otherwise available. Until recently, laser annealing was confined to research and development with machines developed in house. Now Quantronix Corp., Smithtown, N. Y., will shortly deliver a commercial unit of this type, opening up new possibilities in IC processing.

The new laser processor, shown in the photo to the left and called the Epitherm model 610, uses a 6-watt neodymium–yttrium-aluminum-garnet CW Q-switched laser. The throughput of the new machine will be 200 wafers per hour. Quantronix says it has orders for four machines from various IC firms. According to Martin G. Cohen of Quantronix, "There already is a significant level of interest in this technique, and it is beginning to build." For the last year Quantronix has been processing wafers with this machine for various companies, on a contract basis, to evaluate its potential.

Pulsed electron beams for annealing wafers have been under development at Spire Corp., Bedford, Mass., since 1974. Rather than heating a spot like the laser-based unit, the system heats the surface of a silicon wafer to a high temperature in a single submicrosecond pulse. Only about a 1 μm depth is heated keeping the overall wafer at a low temperature. This low-temperature processing provides low thermal distortion of the wafer (vital in submicrometer lithography) and does not redistribute implanted dopants. In addition, a high throughput is possible with this method.

As in the laser method, Spire is introducing hardware for research and development purposes. The SPI-Pulse 300 was shown for the first time at Semicon/East trade show in Boston. This machine can process an area covering from 5 to 25 cm^2 with a 20-joule pulse and with a throughput of 120 wafers per hour. Four of these machines have been sold so far and Spire is developing a production version with even higher throughput.

Shrinking board wiring

Another of this year's VLSI/LSI-related developments is the design and production of a new version of Multiwire by PCK Technology division of Kollmorgen Corp., Glen Cove, N. Y., that has two to two and one half times the wiring density of the original Multiwire.

Multiwire is an automated wiring system where insulated wires are ultrasonically bonded to an adhesive-coated epoxy-glass board. Terminations are formed by drilling through wires and board and then plating the walls of holes. The result is a highly dense wired interconnection that competes with multilayer pc boards. The newer versions write the wire in a tighter grid and in some cases use even smaller wire than originally.

In the 1980s new board designs will use chip-carriers rather than dual in-line packages to accommodate the new multilead LSI chips. This process will necessitate denser wiring. For instance, the wiring density for pc boards loaded with DIPs containing small- and medium-

scale integrated circuits is about 50 inches of wire per in.[2] A board carrying chip-carriers can have as much as 200 in. of wiring per in.[2] Under these conditions, an array of chip-carriers might require an 11-layer pc board. The new versions of Multiwire can compress this to two to three layers of wiring. By redesigning Multiwire's original wiring stylus and wire-feeding mechanism, and by relating ultrasonic bonding power level to table motion, the new system is capable of writing a small grid of fine wires.

The original Multiwire put down 40 in. of wire per in.[2] using 6.3-mil wire on a 50-mil grid. The newer system, in its production version, writes the same wire size in a 25-mil grid, doubling the density of the wiring. A modified form of the new system can put down 4-mil wires onto an 18-mil grid, which results in a wiring density of 110 wires per in.[2]

This is the first automatic wiring system modified to meet the demands for interconnecting chip-carriers. The next few years should see still more systems that have been designed specifically for wiring on tighter circuit-board grids with finer wires.

PROFILE

Tobey made a winner out of the wafer stepper

By next year, the search for even finer chip geometries will bring new competition for the 1:1 optical-projection lithography systems that pattern the circuits of most large-scale integration wafers currently produced. Stepping onto the production floor of many major integrated-circuit facilities will be the step-and-repeat reduction projection system popularly know as a wafer stepper or direct-step-on-wafer. One of the men most responsible for bringing the wafer stepper out of the relative obscurity of research and development and into the limelight of the production state is Aubrey "Bill" Tobey, who is currently director of marketing for GCA Corp.'s IC Systems Group in Bedford, Mass.

Since 1976, Bill Tobey has promoted step-and-repeat lithography by delivering papers and talks at symposiums sponsored by the Semiconductor Equipment and Materials Institute and the Society of Photo-Optical Instrumentation Engineers. In his enthusiasm, he has visited every major IC facility to sell the idea of DSW. "At the beginning people wouldn't believe in this concept," Tobey points out. But, he proudly adds, "after our first prototype was built in 1977, the system proved itself out." Tobey says that, in those days, potential users used to bring their own wafers, resists, and reticles to GCA and end up proving to themselves what a DSW could do.

Tobey came into the lithography business indirectly. In 1965 he left a research position at Arthur D. Little Inc. to take a marketing position at GCA in space and military projects. Within a week or so, he was asked to assist GCA's David W. Mann division (since renamed GCA/Burlington). Within the year, he became director of marketing of this division, which both produced photorepeaters used to make masks in the semiconductor industry and designed instrumentation for Government projects.

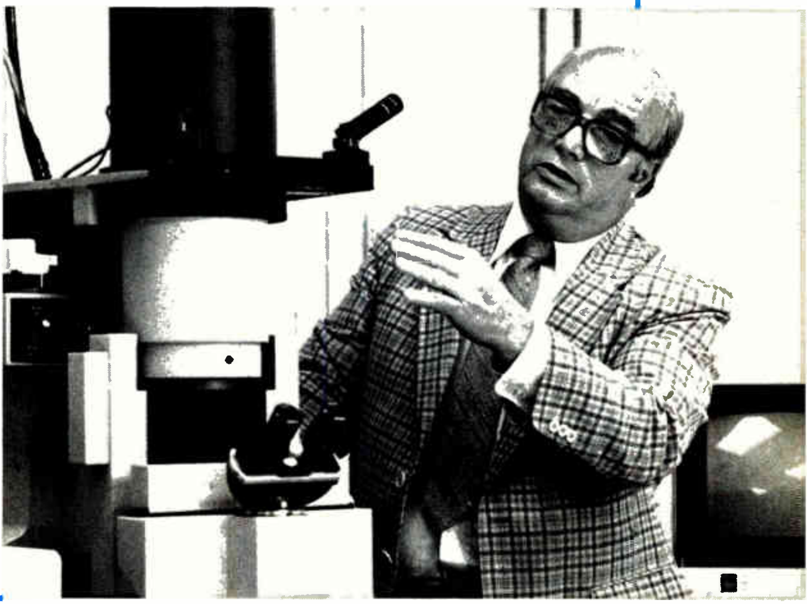
The work on the masking equipment—which rapidly became the division's main product—led to investigations of X-ray and electron-beam lithography between 1969 and 1970. At the time, GCA's researchers doubted that these sophisticated machines could be ready for production roles in the near future. Instead, a reasonably priced alternative with a good throughput and resolution approaching that of an electron-beam system was proposed. This was the direct-step-on-wafer concept.

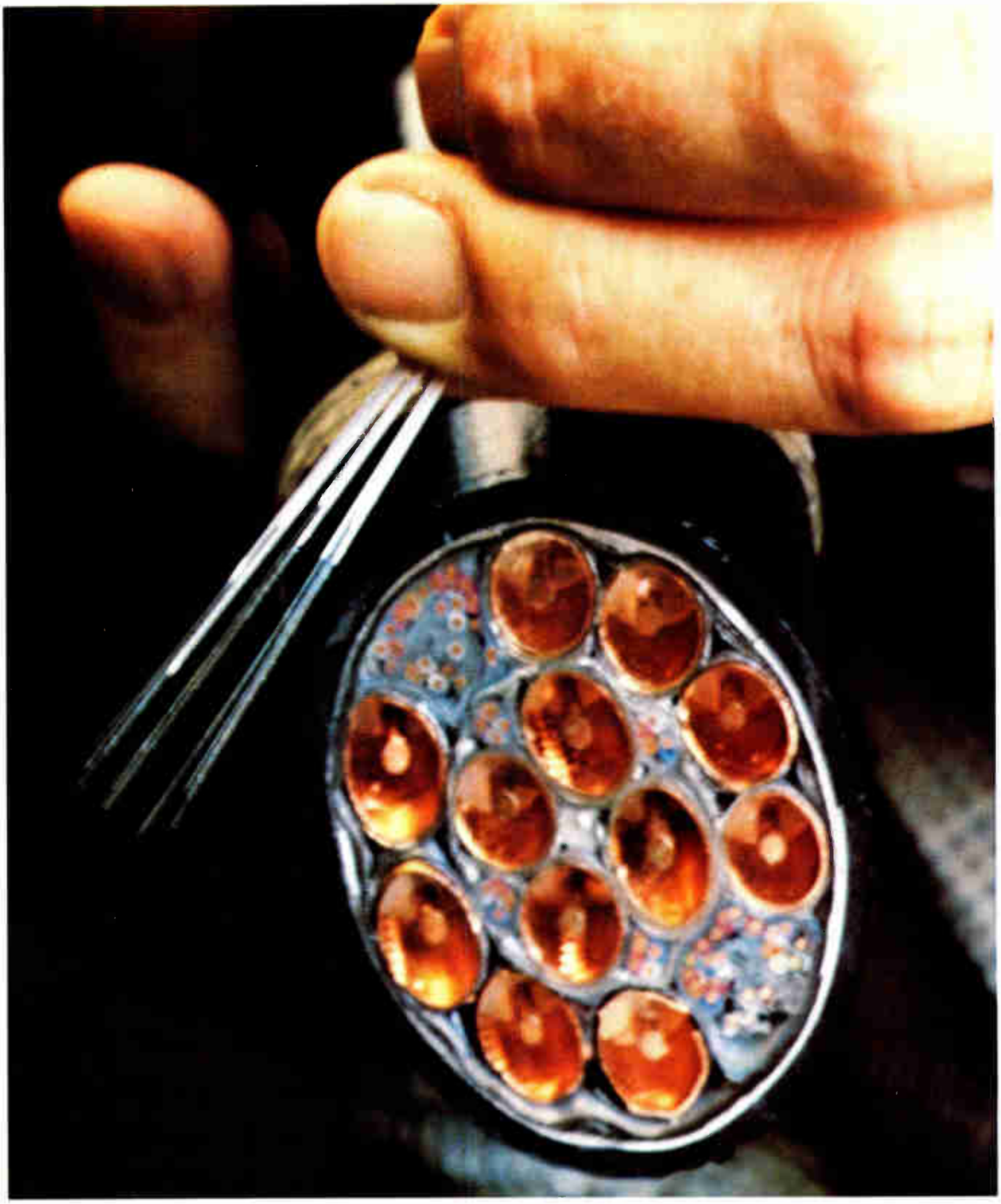
The design began in 1975. The stepper used much of the hardware and software derived from an earlier step-and-repeat photomasking system. The prototype was finished around August 1977 and proved an outstanding success—the company sold over 150 steppers. "Today most of our machines are installed on pilot production lines," says Tobey. "Next year these machines should take on a production role."

Bill believes that the wafer stepper will dominate in that role until 1985, at which time electron-beam systems should take over in the process. Long range, he sees a step-and-repeat system with an X-ray source as a production machine for submicrometer geometries.

Meanwhile, GCA is looking at possible automatic alignment schemes for its wafer stepper. It is also looking into second-generation steppers with new optics and different mechanical configurations to handle even smaller geometries than its present machine. Tobey points out that GCA is interested in all forms of IC lithography, as evident in its full-scale in-house project to develop a scanning-electron-beam machine.

Since his recent promotion to head of overall marketing for the GCA divisions that sell capital equipment to the semiconductor industry, Tobey's job has been to see that the company develops the links that will tie together all of the firm's ion implanters, in-line IC processors, and lithography equipment into an automated production line. By the time he accomplishes this task, he will have seen the wafer-stepper concept through from its inception to its natural conclusion—as an integral part of a future GCA automated wafer-processing system. **-Jerry Lyman**





Communications

by Harvey J. Hindin, *Communications & Microwave Editor*

☐ *If there is one new communications technology that has been generating lots of attention this year, as it did last year, it is fiber optics. The feasibility of transmitting messages as light waves through long glass fibers began to be tested in several different information systems both for the home and for the public telephone network. Just how well such systems operate could influence how fiber optics will be applied for a long time to come.*

Also attracting its share of effort has been the application and technology of satellites. For example, Canada transmitted pages of a weekly newspaper from Europe to Montreal by satellite, and the U. S. Bell system developed a new integrated circuit to remove speech-disrupting echos from telephone conversations carried via satellite.

Satellite orbits were one issue among many to be debated in September by the World Administrative Radio Conference. This U. S.-sponsored meeting occurs every 20 years, and its goal is to divide up the electromagnetic spectrum so that all the available frequencies can be used in a cost-effective way without interference.

Controversy also continues in the U. S. over how to regulate the communications industry. But the 1978 proposed revision of the Communications Act of 1934 (which established the Federal Communications Commission and policies of regulation in the U. S.) died in Congress from lack of support. And, as expected, the battle between AT&T, IBM, and Xerox Corp. over how the office-of-the-future market should be tapped continues, with no end in sight.

Home interactive television has continued to attract attention. More tests have been announced and more services experimented with. Yet no one seems sure what to do with the new service or how to sell it. But U. S. Bell finally got into the act this year, though Europe, England, and Canada have publicly experimented with their Antiope, Teletext, and Telidon systems for years. Bell is also continuing experiments on the light-powered telephone it announced in 1978.

And finally, 1979 has seen an upswing in interest in keeping communications safe from unauthorized parties. Products for coding and decoding transmissions have been introduced, but exactly how to do the encoding and decoding remains controversial.

Spotlight on fiber optics

Fiber optics has attracted more fanfare this year than ever before. Some predict the thin hairlike strands will soon provide all the communications pathways the world will need. Still, "Don't sell your copper-wire stocks yet," says one industry observer. So far, fiber has not moved on to high-volume applications, and sales of components amount to little more than prototyping quantities. One reason is that, despite falling prices, fiber is still less cost-effective than copper wire except when its freedom from electromagnetic interference or when its wide bandwidth is needed.

In the home. Bell Canada uses fiber instead of coaxial cables for wiring in their tests for the home of the future.

In fiber technology, one critical parameter is the fiber's attenuation—its decibel loss per kilometer of length. The lower this figure can be kept the better, because fewer costly amplifiers must be used to remove the effects of attenuation.

In March, Nippon Telegraph and Telephone Public Co. announced it had developed a silicon-based optical fiber with a loss of only 0.20 dB/km. The previous record, set by NTT only last year, was 0.66 dB/km. Only a dozen or so years ago, 20 dB/km was considered top-notch.

Extremely careful processing of the raw fiber-optic materials is the key, with silicon purity kept to an unheard-of 99.9999%.

Also making progress in the field, Bell Laboratories scientists have used a similar kind of single-mode low-loss fiber to demonstrate digital information transmission at a record-setting rate of up to 200 gigabits per second. The system is strictly for demonstrating and experimenting with the fantastic bandwidths possible with glass fibers. The bandwidth is far in excess of what is currently needed by any practical communications system. It is, for example, 2,000 times wider than the one that was used by Bell in its telephone fiber-optics test in Chicago in 1978.

New lasers emerge

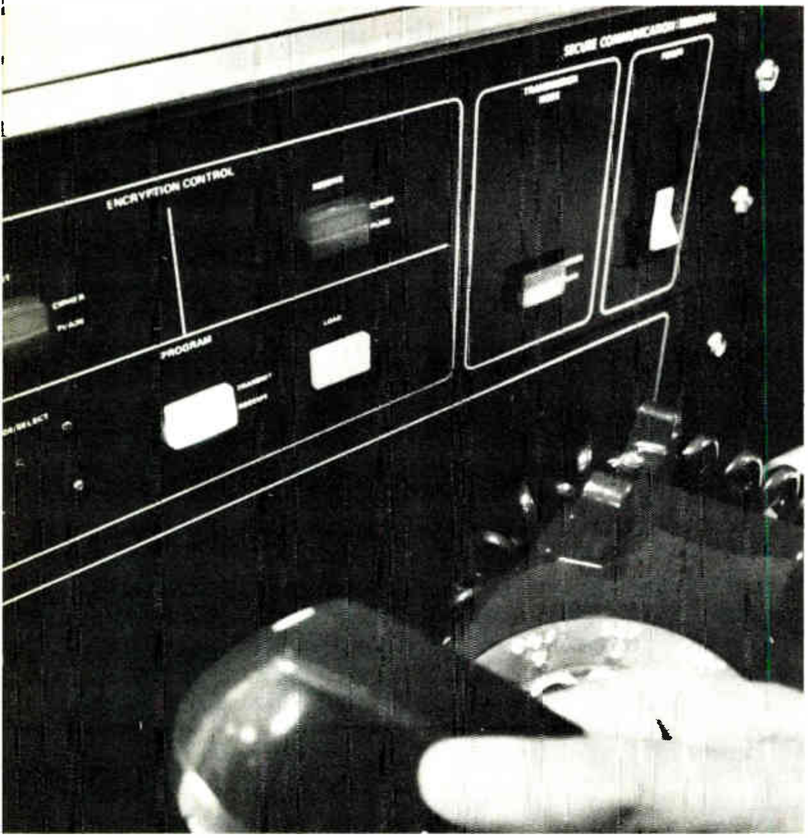
Along with the progress in fiber optics, 1979 is seeing new laser diodes developed to act as the source of the light that carries information along the fiber. RCA's still-developmental planar laser diode is one of the most important new developments. Since it is planar, it could be mass-produced by standard integrated-circuit fabrication techniques. And RCA claims such a device could eventually provide a cheap and reliable light source for a fiber-optic system—something that up until now has been a major problem.

Another plus for the gallium-arsenide device is that it operates stably, no matter how much information it carries or how hard its modulation. (Work in combining these characteristics has been going on as well all over the world, most notably in Japan.) The unit is able to generate light in the infrared region of the spectrum, where fiber losses are lowest.

Another kind of laser with communications applications was developed in 1979. One of the world's first electronically tunable high-power sources of light, it was developed by researchers at Columbia University's Plasma Physics Laboratory in New York in collaboration with scientists at the Naval Research Laboratory in Washington, D. C.

The new laser uses light emitted by energetic free electrons in a high-temperature plasma. It emits in the region of the spectrum between the millimeter and infrared ranges and offers power, efficiency (80% to 90%), and tunability (10% or more) never before achieved in one instrument.

Not only does the device offer new frequencies for communications system use, but its high power gives it



What did you say? Interest in secure telephone conversations has led to encryption of voice signals during transmission. In the Harris equipment shown, coded bursts, even if intercepted, cannot be decrypted without effort beyond the resources of most interlopers.

military potential as well. It can already deliver 1 megawatt of peak power for a fraction of a microsecond. While this is hardly the death ray of science fiction, the laser's developers say higher power lasting milliseconds may be possible.

Light in Atlanta

The Bell System has announced that next year it will install its first standard light-wave communications system to handle both voice and data transmission in Atlanta, Georgia. The system will be very similar to the one successfully tested for the year 1977–78 in Chicago. That fiber system linked two telephone company switching offices, and a voice, data, and television side-link was set up to an office building.

Initially, the Atlanta system will connect three central offices. It is similar to those Bell has also announced for Florida and Arizona, which are near electrical-power–generating stations and whose fiber cables are immune to the severe electrical interference that the stations produce.

In the world's first field trial of a fiber-optic system for home telephones, Bell Canada has started a two-year test of a voice, video, and data service to 35 homes in Toronto, Ontario. The $1.75 million installation has 1.2 km of fiber cable. Light-emitting diodes send the information on fibers running under city streets much like conventional cable. In this installation, unlike Bell's in Atlanta, the fiber is actually directly connected to the customer's telephone.

Eager to begin

The fiber-optic components are all off the shelf. This illustrates well just how much has been developed in fiber technology in recent years. While better components may come along in the future, Bell Canada does not want to wait, nor does it have to. It preferred to get information early on the operation of the cable system, as well as on customer reaction.

The experimental system in Toronto provides not only basic telephone service but conference television, remote video surveillance, and access to a library. Later on, interactive graphics such as a viewdata system will also be available.

Undaunted by Bell Canada's announcement of a test in Toronto, Manitoba Telephone Co.—independently of Bell—is going to fiber-wire 150 homes in the rural town of Elie in Manitoba. The $6.1 million effort will offer multichannel television and fm radio, along with a variety of other services.

The idea here is to solve the communications problems of rural Canadians, but the results of the test are expected to be applicable elsewhere. By using fiber cable with its superwide bandwidth, many different kinds of services can be brought into the home on one connection. The cost may be distributed over a large supplier base, and services impossible to deliver by separate wires can be made available.

Light-powered telephone

Late last year, Bell Laboratories scientists demonstrated a highly efficient light detector and transmitter that can power a telephone solely with light transmitted over glass fibers from the telephone switching office to a home or office location. The detector changes more than half the light into electrical energy, converting the limited energy available to operate all the telephone's functions. The phone has a strong potential impact on the future, but further development is needed before it will be practical for home use.

Fiber-optic cable could handle all the bandwidth for communications during the foreseeable future. Thus, the new phone could establish AT&T as the No. 1 provider of wideband services to home and industry such as color television, data and computer services, and electronic mail. And, of course, the data-handling capabilities of Bell's recently announced Advanced Communications System (ACS) are also immeasurably enhanced by fiber-linked telephones.

Bringing modern electronic technology into the office is the dream of AT&T, which hopes to accomplish this task through its phone-based Advanced Communications System. It is also the goal of the IBM- and Comsat-backed Satellite Broadcasting System, with its satellite-transmission–based technology, and Xerox Corp., with

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V_{CEV} (V_{BE}=-1.5V)	600V min	700V min
I_C continuous	8A max	8A max
Power dissipation (T_C=25°C)	80W max	80W max
$V_{CE(sat)}$ @ 5A/1A	1.5V max	1.5V max
t_f @ 5A/1A	0.5μs max	0.5μs max

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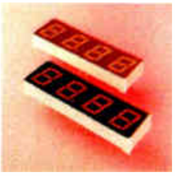

Here's bright news.

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Encapsulated digits				
Part No.	Size	Package	Color	Price per Digit per 1000
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DLO-4770	.27"	4 digits	high-bright orange	1.80

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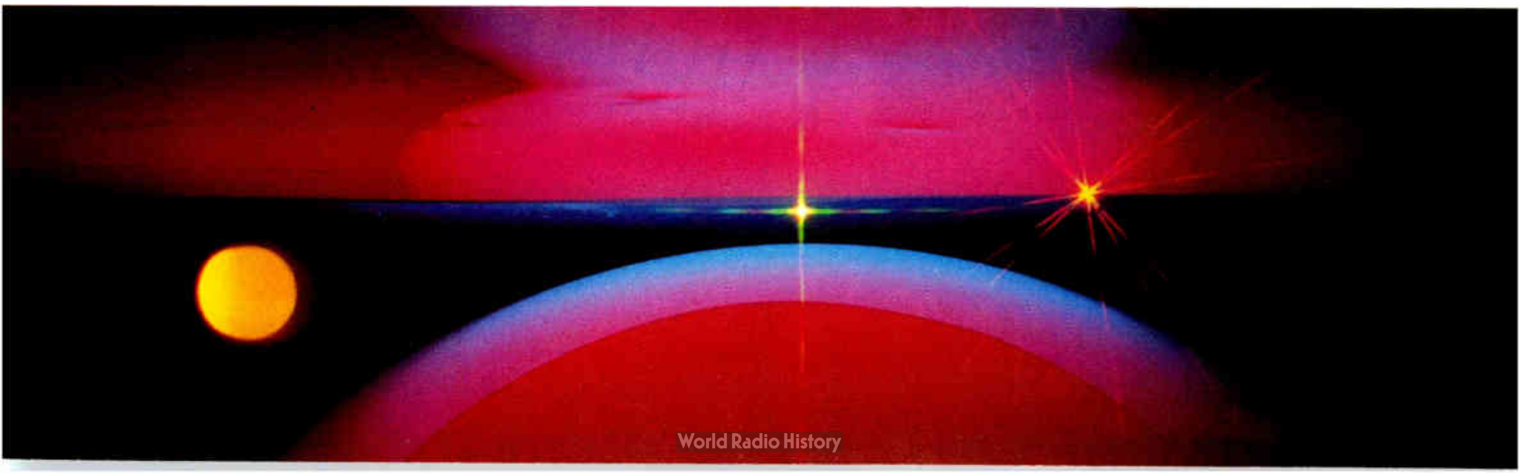
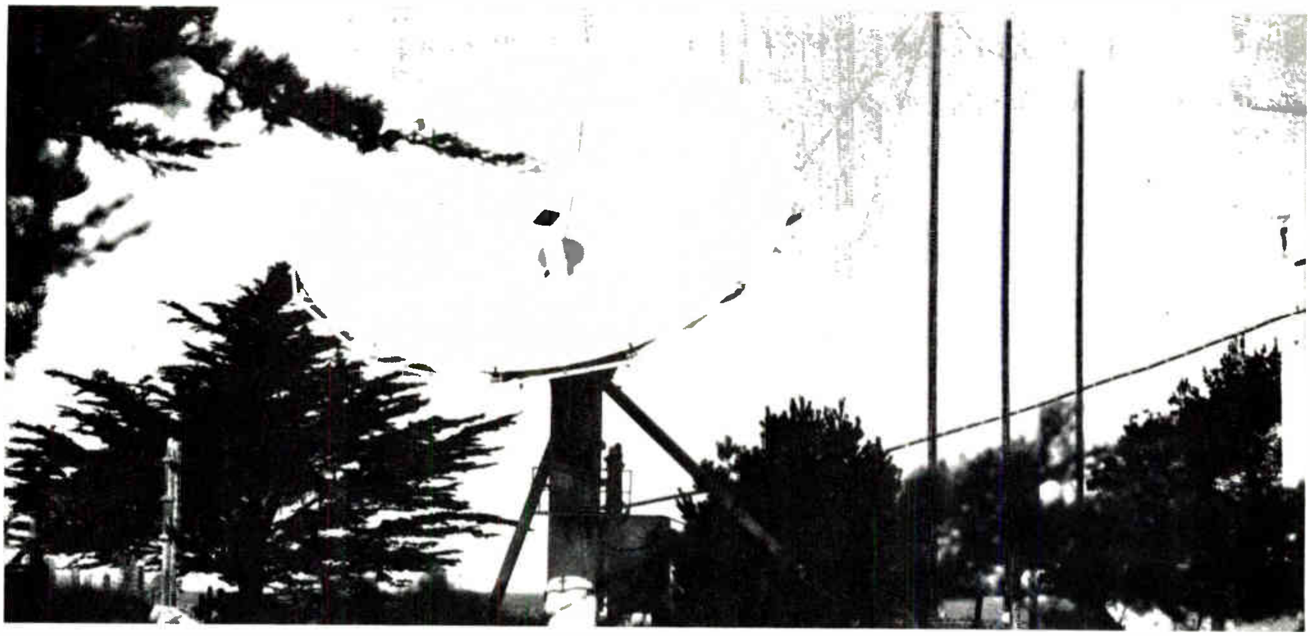




On the ground. As more satellites are launched, more ground stations like this one are needed for tuning into the myriad of new services that are being offered. The use of higher frequencies will ultimately mean antennas with smaller diameters.

its system based on satellites and terrestrial microwave circuits.

Both Xerox and IBM are unregulated and do not operate any of their divisions as monopoly structures. This is not the case with the telephone company. Controversy continues over whether Bell should engage in computerlike data-processing activities. Competitors claim Bell could subsidize its service with artificially low prices from its standard telephone business unless strong measures are taken to prevent such a ploy.

A trend toward competition

The FCC has begun to grapple with the problem this year. It has indicated that it wants to let the telephone company provide any kind of service, as long as it sets up a separate operation with entirely separate accounting procedures. For example, a decision was made to let the telephone company use satellites, beginning in July, for private special services such as television transmission. Bell had been prohibited up until then from using the birds for anything but standard telephone voice conversations, so that competitors could get well established. The FCC seemed to indicate a trend toward a more competitive, less regulated communications industry by this and other acts.

Meanwhile, Bell has continued its active quest for permission from the FCC to test its ACS. It has filed 350 pages of answers to a list of questions from the FCC as to just how the company would implement the system. Yet even all these answers were not specific enough for Bell's competitors and the Federal government. who asked the company to reveal even more. Perhaps overwhelmed by the enormous size of the project, both from the technical and the paperwork points of view, Bell has slipped from its schedule. Up to one year more than originally planned would be required for the filing of tariffs, or rate structures, to tell just exactly what Bell would offer and for what price.

Skylab's fall . . .

In July, Skylab—an orbiting U. S. space satellite—reentered the earth's atmosphere years earlier than the National Aeronautics and Space Administration thought it would because sunspot intensity was higher than NASA had expected it to be. By causing particles in the atmosphere to rise, sunspots increased the drag, or resistance of the spacecraft to free flight, so that it slowed down and shifted orbit.

NASA had hoped to rescue Skylab with the space shuttle, slated to serve as a reusable vehicle for space construction and launching of spacecraft such as the Satellite Broadcasting System's first satellite, but because of one construction delay after another the agency fell hopelessly behind schedule. Luckily, Skylab fell harmlessly in western Australia, amid sighs of relief from NASA and other agencies of the U. S. government, which felt liable for any damages.

. . . with more to come

Skylab, which became a large and dangerous piece of space junk, was only one example of a problem that the satellite community has only begun to worry about this year. Investigations have shown that the innumerable bits and pieces of satellites and rockets in orbit, lost when satellites break up or the remains of purposely jettisoned parts of rockets and satellites, have probably already knocked parts of a European satellite out of commission by damaging its solar panels. According to some authorities, if the current rate of launchings continues, it is only a matter of time before a major collision occurs, possibly wrecking a multimillion dollar space effort. So a 1979 proposal is to use the space shuttle (when it is ready) as a celestial garbage collector to pick up the pieces and bring them back to earth.

Satellite newspapers

Canada continues its experiments with satellites to provide services otherwise unavailable to its far-flung populations. The one set up by Teleglobe Canada—the quasi-government agency responsible for international Canadian satellite communications—was typical.

A satellite over the Atlantic relayed European newspapers to Montreal for the large French and Italian communities there. At the European newspaper site, a standard reproduction proof was made of a page of the newspaper and was converted into an electronic facsimile processed by digital data compression.

The data was sent by the Intelsat 4 satellite to Nova Scotia, where it was picked up by the Teleglobe antenna and transmitted to Montreal. There it controlled a laser in a facsimile recorder, exposing a sheet of photographic film to produce a plate for printing.

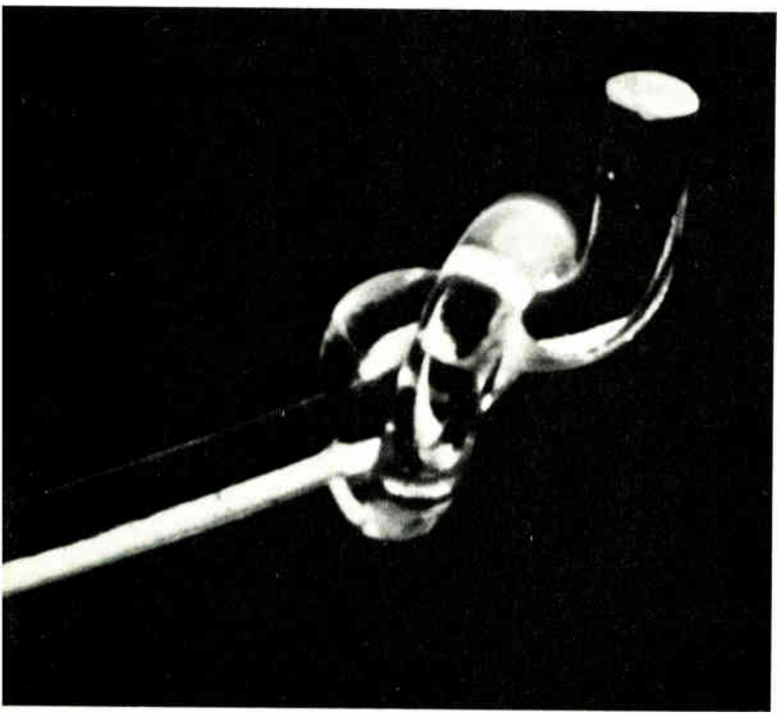
No more echos

By the beginning of 1980, telephone communications by satellite will have undergone a drastic technical change. The voice-garbling echoes that occur along the 45,000-mile-long satellite paths will be just about eliminated by a new integrated circuit that was developed by researchers at Bell Laboratories.

The chip—dubbed an echo canceler—could by itself double the number of satellite circuits used by AT&T in its telephone network. So far, because of echo problems, the company transmits transcontinental telephone calls only one way by satellite.

The echo for one-way transmission is controllable by the present echo suppressors, which open the transmission paths when the echo's amplitude becomes too high. But these devices do not meet high enough two-way transmission standards for AT&T. The new digital device removes an echo signal from a circuit by sampling it electronically as it occurs, making a replica of it, and adding the replica to the original signal so that the two cancel each other. It is ideal for connection to Bell's all-digital telephone network, which will be completed over the next 20 years.

Twist. Most fiber-optic systems use the flexibility of fiber to good advantage in simplifying cable route layout. This Du Pont silica fiber, which can bend to a 1.5-millimeter radius, is shown here in a configuration that is unusually complicated.



Coding countermeasures

As society becomes ever more dependent on electronic communication of data, crime associated with tapping communications is increasing, resulting in the loss of millions of dollars. Communications encryption codes the transmission so that information is useless to the interloper even if he manages to obtain it.

Interest in this procedure has grown this year among computer and communication system users as practical coding and decoding products have become available. These products use the data encryption standard (DES) developed by the National Bureau of Standards.

If everyone can agree on the method and it can still be secure, then coding equipment can be made inexpensively because of economies of scale. But although the DES algorithm guarantees that 70 quintillion attempts and the use of the exhaustion method—keep trying until you get it—would be required to crack any DES coding, some authorities claim it is unsafe because it can be broken by specially designed machines.

For their parts, both NBS and IBM Corp., which did the original work on the DES, deny it can be broken in any reasonable amount of time. They also deny that the National Security Agency had any hand in the development of the code, as claimed by observers who also said the agency had thereby gained special insight into how it would be possible to break it.

The DES requires both the sender and the receiver of a message to know the particular code key chosen out of the 70 quintillion choices. To some authorities this is a weakness and presents key-management problems.

Ways around the code key problem have been further developed this year. Chief among them was the so-called public-key system. This approach has a coding key that is different from the decoding key but related to it by a mathematical equation. Theory says it is impossible to solve the equation even with the most advanced computer technology.

Private companies and users can still choose to use proprietary coding algorithms—a route followed this year by Cryptext Inc., a small company in Seattle,

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Circle #231 for Additional information

Wash., when it offered a device for safeguarding the communications of home computers.

In the area of radio communications, delegates from around the world convene every 20 years to decide how to divide the electromagnetic spectrum and what services to provide on what frequencies. This is the year that will decide the next 20 for the U. S. and 154 other countries, developed and developing.

Scrambling for frequencies

The question on the minds of the U. S. communications industry early in 1979 is whether the U. S. is adequately prepared to defend its interests at the World Administrative Radio Conference. Glen O. Robinson, chairman of the delegation, answering in the affirmative, told critics that their criticism of his committee was ill-founded and WARC would be governed mostly by technical issues, not politics.

Everyone is worried about the attitude of the developing nations, who have announced they want a bigger share of the frequencies available. And, given the one-nation, one-vote concept by which WARC will be governed, the developing nations could in fact put a lot of pressure on the industrialized nations.

A typical point of contention is the limited number of orbits in which communications satellites can work efficiently. Too close together, the satellites interfere with each other electrically. For instance, when RCA launches the fourth in its series of communications satellites, it will have to be stationed so far east in longitude that it cannot put a beam on Hawaii—whereas its three predecessors in the Satcom series have been able to link Hawaii with the Continental U. S.

Although some developing nations claim to "own" the orbital slots above their countries, it seems that the real problems are more likely to come from conflicts among the developed nations, who can make practical use of the orbit slots and spectrum space made available by new electronic technology. For example, Canada and the U. S. both have a prime interest in geostationary slots over this hemisphere for microwave transmissions at about 3,000 MHz. □

PROFILE

De Loach built the fiber-optic phone

The world's first telephone powered by light carried on a fiber-optic cable could probably only have come from a place with the resources of Bell Laboratories. Barney De Loach Jr., the 49-year-old head of the lightwave sources department that developed the phone, certainly feels that way.

"The phone could have been developed by a number of people here, given the facilities and the caliber of talent," says De Loach, a fellow of the Institute of Electrical and Electronics Engineers. "Here at the Murray Hill, N. J., facility, I was lucky to be able to work with Richard C. Miller and Richard B. Lowry."

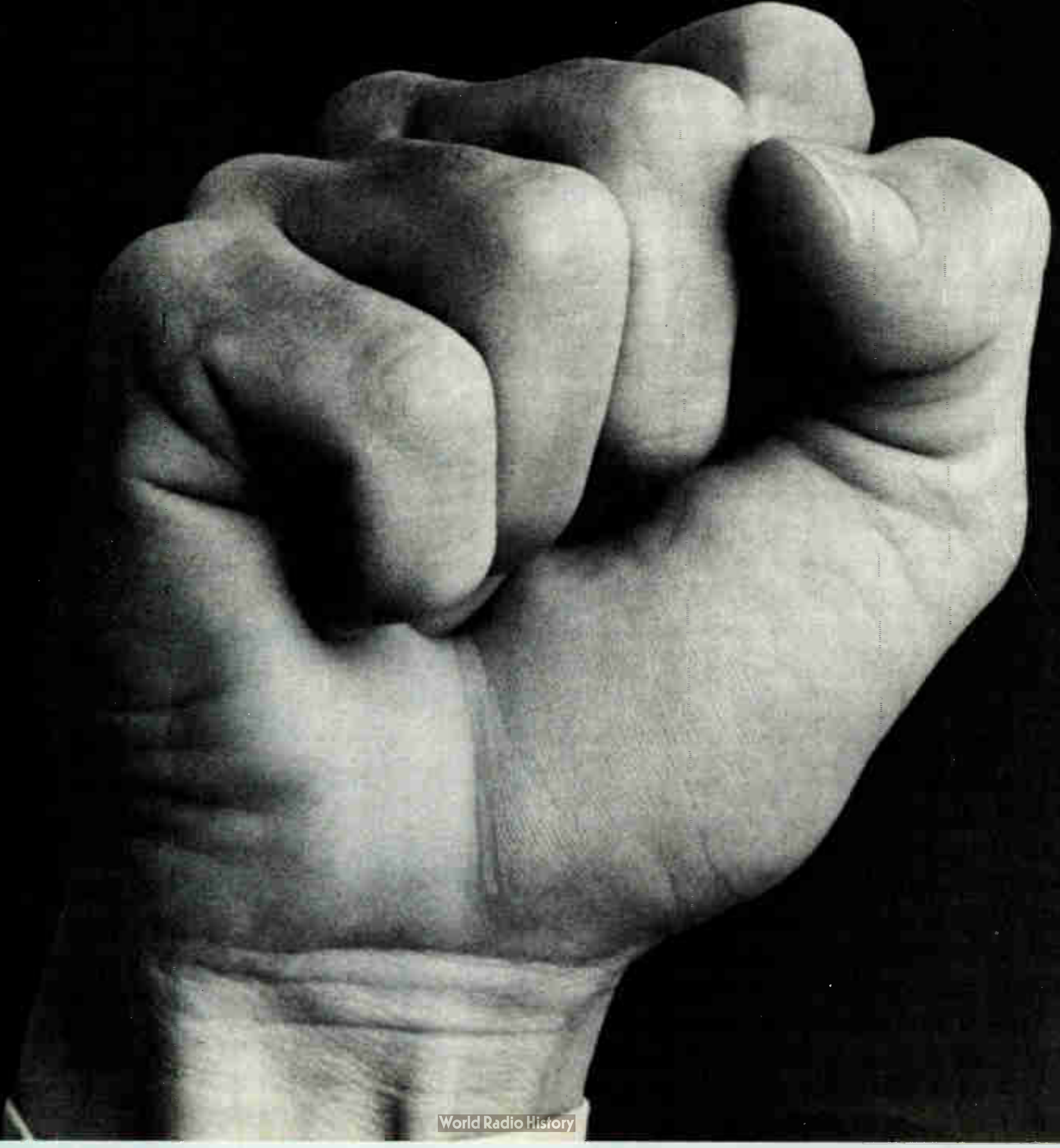
Such modesty is typical of De Loach, who is quick to give credit to other individuals and departments. In his 23 years at Bell he has built an impressive background in the area of solid-state microwave and optical sources. His experience equipped him for work on the phone's photodetector-transmitter combination. For their parts, Miller (right in photo) put the optics and electronics together with the aid of Lowry, a circuitry expert (left in photo).

De Loach has an almost casual approach to the new phone, speaking conservatively about his project as telephone-system people tend to do. What intrigues him particularly is what he sees for the future. "Color television and data and computer services could come into everybody's home or office via the telephone—the bandwidth is so broad," he says. He would certainly like such a phone in his own home right now—but only if the price were right, he is quick to add.

De Loach has a doctorate in physics from Ohio State University. But he considers himself something of electrical engineer and physicist combined. In fact, he has done some basic work in microwave theory. His earliest job at Bell dealt with variable-bandwidth waveguide filters and earned him the first of 12 patents.

Perhaps the high point of his microwave engineering career at Bell and his "favorite project" was the invention of the Impatt diode oscillator. For this effort, he and Bell co-worker Ralph Johnson received not only a patent but also prizes from both the Franklin Institute and IEEE for contributions to the theoretical understanding of the device. De Loach has also had various supervisory roles in studies of light-emitting and avalanche diodes as well as high-frequency and transient charge flow in switching diodes at Bell since 1963. These gave him the background to "demonstrate the technical feasibility of the fiber phone. What is left is the economic feasibility question."

Conveniently, De Loach lives right in Murray Hill, which makes it easier for him to head up several Bell projects. Besides the development of the light-powered phone, the projects include work on long-wavelength indium-gallium-arsenide-phosphide lasers for use with low-loss fibers in long-distance communications. **-Harvey J. Hindin**

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Imagine being able to pack all the complex memory and logic capabilities of a room-size mainframe into a desk-size minicomputer. Or increasing your mainframe's capability many times over without increasing its existing space and power requirements.

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As we shrink into the future, we'll offer you both ECL and TTL LSI with 16 times the density and four times the performance. That's an incredible increase in speed and density, along with a major decrease in system power and cooling requirements. Just look at what the potential of 1 micron can mean to you. This is the kind of progress that continues to make Fairchild a major force in the future of computer technology.

ISOPLANAR-S PRODUCT EVOLUTION

	4μ	1μ
RAM	4K x 1 35ns	1K x 4 10ns
PROM	1K x 8 50ns	8K x 8 45ns
LOGIC	200 GATE ARRAY 0.7ns	2000 GATE ARRAY 0.5ns

Isoplanar-S. It makes HMOS look like peat moss.

Once you've seen Isoplanar-S, you won't be interested in any other high-speed technology. That's because, along with superior performance, it offers high reliability and radiation tolerance. And most important, as we scale down, nothing is compromised.

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HMOS? Use it on your asparagus.

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To prove how totally committed we are to the future of computer technology, we've done what very few other companies in our business could afford to do. We've made major investments toward the advancement of Isoplanar-S and high-volume production. All because of our goal to meet your volume requirements with the fastest and densest LSI devices available. With them, you'll be able to make the best computers in the world.

Isoplanar-S-based devices are now in production. Watch for our announcements.

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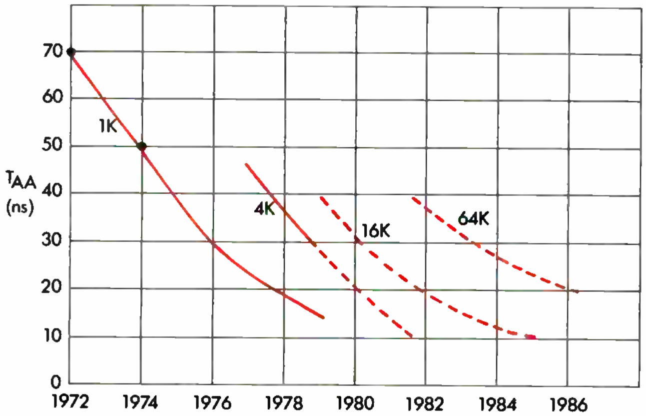
Fairchild is lengths ahead of the field.

For the past seven years, Fairchild has had the fastest RAMs in the industry. Now, thanks to Isoplanar-S, this new family offers increased density while still maintaining its leadership performance position.

The TTL member of the family, the 93475, has a maximum T_{AA} of 45 ns, and features standard 2114 pinout.

The two ECL members, the 10474 and the 100474, have 24-pin separate I/O pinout, which enables them to offer a 25 ns maximum T_{AA}.

BIPOLAR RAM PERFORMANCE EVOLUTION



Isoplanar-S. It will keep us way out in front.

Within the next few years, we're planning to scale down geometries from 4μ to 1μ through Isoplanar-S. This will give us devices that are four times faster, with 16 times the density and much lower power requirements.

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We'll leave the rest of the field at the starting gate.

Right now, we're way ahead of the pack on the learning curve. We already have one of the lowest speed-power products in the industry, with one of the highest-volume production capabilities. And things can only get better with Isoplanar-S in the saddle. For us and for you.

Now that Fairchild's gone 4-wide and fast, there's no reason to horse around with anyone else's RAMs. For more information, call or write Bipolar RAM at Fairchild Semiconductor Products Group, P.O. Box 880A, Mountain View, California 94042.
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Now high speed at half power is a piece of cake.

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Isoplanar-S. The pièce de resistance.

Isoplanar-S is Fairchild's evolutionary new process for scaling down bipolar LSI geometries. With it, we'll be able to reduce dimensions of bipolar products from their current 4-micron geometry all the way down to 1 micron. That will mean incredible increases in speed and density, with substantial decreases in system power and cooling requirements. All of which translates into superior performance for your computer system.

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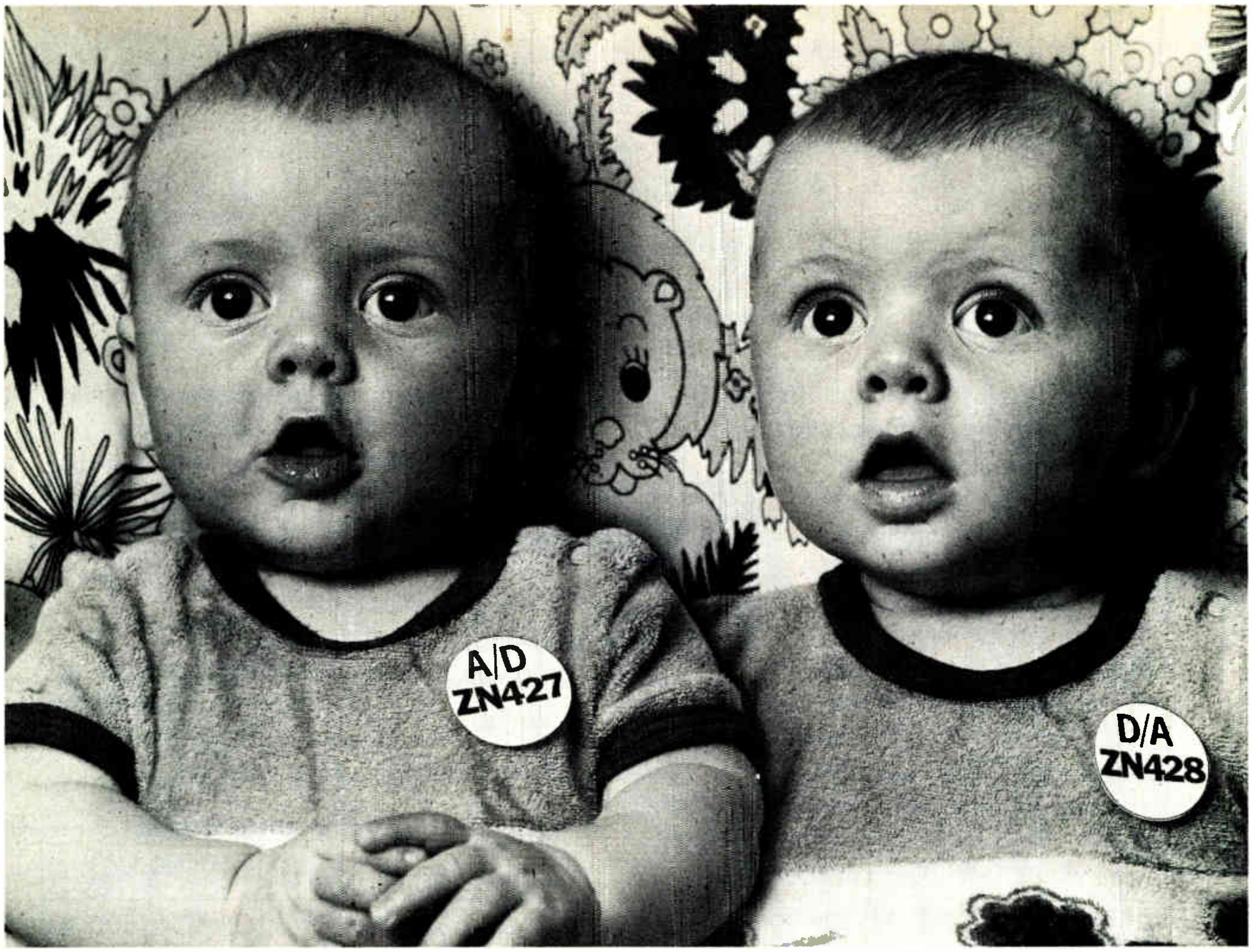
COMPARISON WITH OTHER 8K PROMS

MANUFACTURER	PART #	T_{AA} MAX 0-75°C	I_{CC} MAX 0-75°C
FAIRCHILD	93450/51	55 ns	175 mA
HARRIS	7680/81	60 ns	170 mA
SIGNETICS	82S180/81	70 ns	175 mA
INTEL	3608/28	80 ns	190 mA
MMI	6380/81-1	90 ns	180 mA
FAIRCHILD	93L450/51	70 ns	85 mA
SIGNETICS	82LS181	175 ns	85 mA

FAIRCHILD

Shaping the future of LSI technology.



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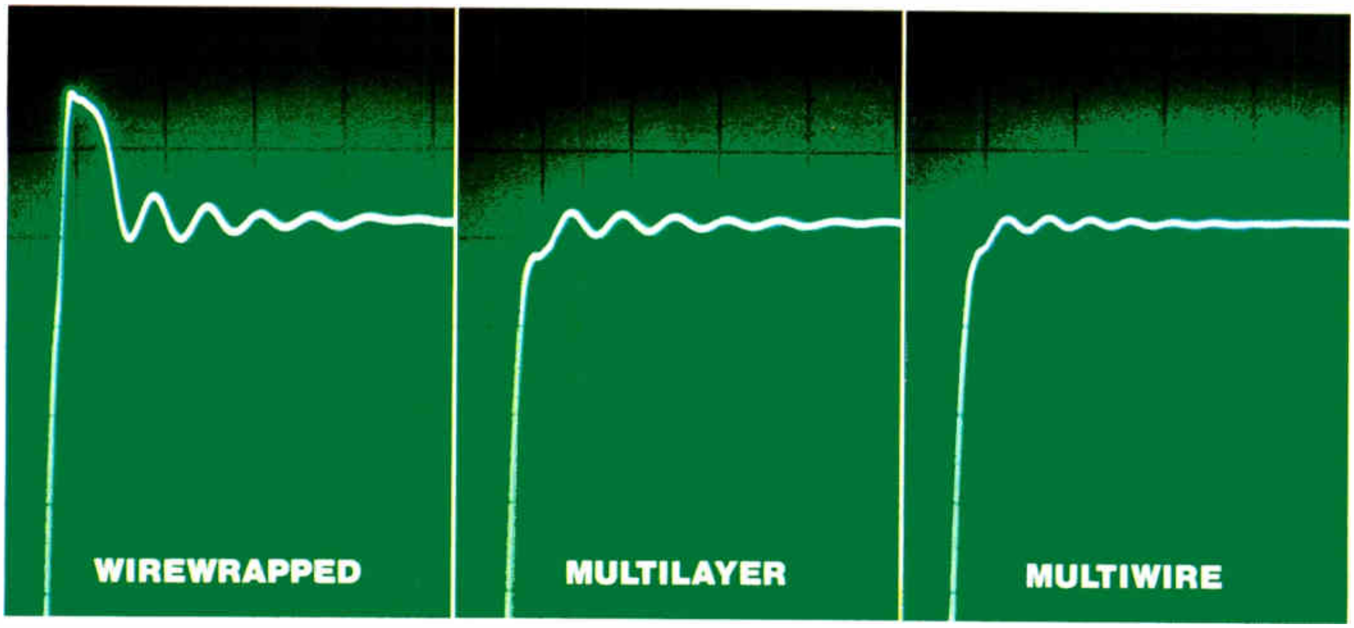

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MULTIWIRE

Chronology

October 1978	● Canstar Communications of Ontario, Canada, develops directional coupler for light waves whose performance can be predicted in advance. *Oct. 26, p.40* ● Hitachi introduces the C-MOS version of the industry-standard 2147 4-K-by-1-bit RAM. New RAM dissipates lowest power in industry—75 mW typical, 220 mW maximum, at a 55-ns access time. *Oct. 26, p.63* ● IBM endorses the distributed-processing concept with the introduction of its 8100 processor. *Oct. 26, p.88* ● NTT produces a single-mode fiber-optic cable having the lowest attenuation ever—0.66 dB/km (later improved to 0.31 dB/km by ITT). *Oct. 26, p.184*
November 1978	● IBM announces first 64-K dynamic RAM. *Nov. 9, p.39* ● Philips unveils optical recorder that packs 10 billion bits onto a 12-in. disk. *Nov. 9, p.64* ● Bell Labs develops first telephone powered by light waves. *Nov. 23, p.39* ● Philips Labs in Redhill, England, designs an electron-beam projector for IC lithography that overcomes the low throughput of conventional scanning systems. *Nov. 23, p.63*
December 1978	● Columbia University scientists develop a high-power plasma laser that can be electrically tuned over a wide range of frequencies. *Dec. 7, p.43* ● Thomson-CSF develops a LED-photodiode chip that doubles as both a transmitter and receiver. *Dec. 7, p.70* ● Xerox proposes a satellite-based data-processing network to be called XTEN, challenging earlier suggestions from IBM and AT&T. *Dec. 7, p.84* ● Texas Instruments develops taper-isolated memory cell that stores charge without a capacitor, pointing the way to dynamic RAMs of greater density. *Dec. 21, p.31*
January 1979	● NTT fleshes out the Japanese version of distributed processing with the introduction of its N4700 processor. *Jan. 4, p.70* ● Intersil introduces commutating auto-zeroing (CAZ) technique for eliminating offset errors in operational amplifiers. *Jan. 18, p.39* ● Bell Canada initiates world's first fiber-optics field trial, providing voice, video and data services to homes in Toronto. *Jan 18, p.41* ● Prime Computer joins the 32-bit computer race with the introduction of four new models in its series 50 line. *Jan. 18, p.174*
February 1979	● Control Data introduces one of the world's most powerful computers, its Cyber 200, successor to its number-crunching Star. *Feb. 1, p.42* ● Tektronix presents the first mass-producible conventional (nonsampling) oscilloscope having a 1-GHz bandwidth. *Feb. 1, p.79* ● IBM announces its 517-megabyte disk drive, the 3370, the first to use a thin-film recording head. *Feb. 15, p.85* ● First single-chip Touch-tone decoder is built by Silicon Systems using switched-capacitor filters. *Feb. 15, p.105*
March 1979	● Single-chip 2920 microcomputer from Intel is first to process analog signals in real time, easing the software design of filters, oscillators, and other analog circuit elements. *March 1, p.105* ● Fairchild Camera's Xincom division announces the first commercial system for engineering and production testing of magnetic-bubble memories. *March 15, p.33* ● Bell Labs attains transmission rates of 200 gigabits/s in fiber-optics systems. *March 29, p.49* ● Bell Labs describes coil-less current-access approach to bubble memories. *March 29, p.80* ● Intel introduces its 8089, the first single-chip I/O processor to implement IBM/360 mainframe-computer channel. *March 29, p.127*

April 1979

- New multiwire technique developed by PCK Technology doubles density of standard automatic-wiring systems. *April 12, p.39*
- Thomson-CSF shows experimental liquid-crystal display that uses three molecular states to produce TV pictures. *April 26, p.70*
- Intel announces first commercial million-bit bubble memory complete with supporting LSI circuits. *April 26, p.105*

May 1979

- Researchers at Siemens AG develop experimental blue light-emitting diodes that use silicon carbide. *May 10, p.64*
- Corning develops new mask substrates for deep UV lithography that allow fabrication of even finer lines. *May 24, p.29*
- Bell Labs announces a method of conditioning (predistorting) an information-bearing optical signal so that errors generated along the transmission link due to path distortion are minimized. *May 24, p.42*
- Dialog Systems introduces speaker-independent voice-recognition system. *May 24, p.55*
- First of a wave of 8-inch Winchester (hard) disk drives surface from Pertec and Micropolis. *May 24, pp.194, 264.*

June 1979

- The FCC, in a landmark decision, concludes that AT&T may engage in data-processing endeavors if it establishes a separate subsidiary for that purpose. *June 7, p.92*
- Offering double the precision of 32-bit units, CSP introduces industry's first 64-bit array processor. *June 7, p.161*
- Univac introduces its 1100/60, the first large-scale mainframe to incorporate bit-slice microprocessors. *June 21, p.42*

July 1979

- Siemens produces a communications-type helium-neon laser that can be modulated to a full 100%, making possible reception of pictures of heretofore unattained quality at greatly reduced cost. *July 19, p.63*
- Thomson-CSF announces a method for making real-time holograms using bismuth silicate crystals. *July 19, p.72*
- Data General introduces two terminals that offer simultaneous voice and data transmission for remote diagnosis of its computers. *July 19, p.172*

August 1979

- Bell Labs develops an n-MOS chip that cancels echoes in satellite telephone communications. *Aug. 2, p.41*
- FCC removes moratorium on the leasing of satellite channels to non-government users, leaving AT&T free to compete in the burgeoning market. *Aug. 2, p.50*
- Fairchild introduces first 8-bit byte slice parts in emitter-coupled logic. *Aug. 2, p.120*
- Advanced Micro Devices announces first 16-bit microprocessor in ECL. *Aug. 16, p.42*

September 1979

- Xicor introduces nonvolatile 1-K RAM that works on the electron tunneling principle and as a bonus operates from a 5-V supply. *Sept. 13, p.39*
- AT&T announces small-scale test of its Electronic Information Service, a phone-based videotext system, in Albany, N. Y. *Sept. 13, p.40*
- Siemens develops prototype ink-jet printer that can produce characters of seven different colors. *Sept. 13, p.71*
- Texas Instruments announces commercial quarter-, half- and 1-megabit bubble-memory chips that use 2-μm bubbles. *Sept 27, p.42*
- Motorola introduces first 64-K E-PROM. *Sept. 27, p.176*

MOTOROLA HAS DEVELOPED A

It isn't as if we had invented the wheel, but at Motorola we appreciate some of the feelings of the person who did. Because we have developed a new microprocessor—the 16-bit MC68000—of such exceptional speed and capacity that, quite frankly, we don't know all the uses that equipment designers will find for it.

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We developed the MC68000 to handle jobs that benefit from more speed and efficiency than even the best available microprocessors could supply. For instance, the additional electronic horsepower of the MC68000 can more cost-effectively turn a typewriter work-station into a complete desktop computer, one with a capacity available only in a room-size computer just a few years ago.

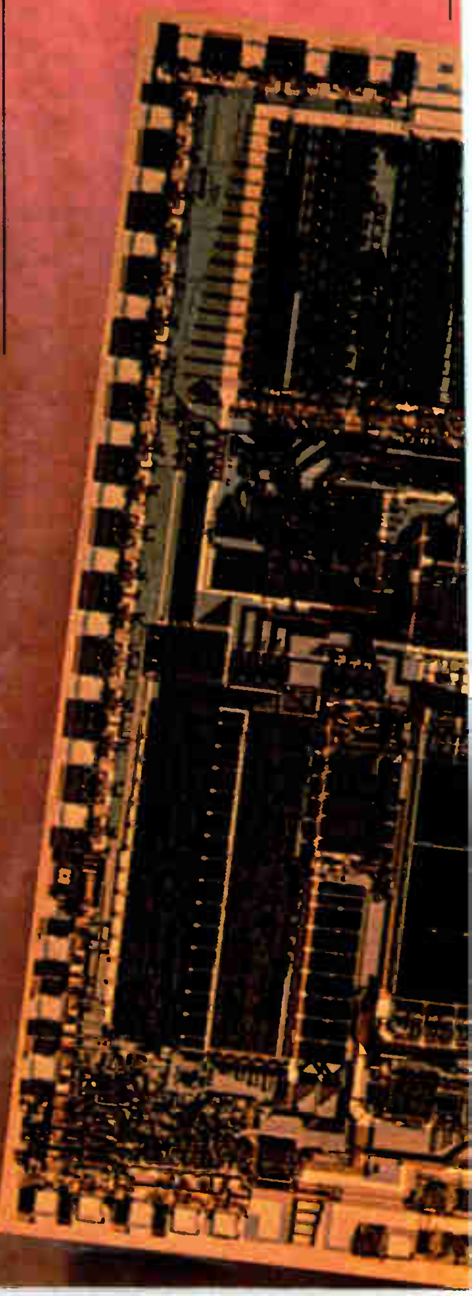
It can give a telephone switchboard the discretion to direct many thousands of phone calls simultaneously, each by the cheapest route.

It can give the auto industry an important increase in the ability to control engine efficiency by giving engines the ability to respond to measurements of such minutiae as air temperature, barometric pressure, altitude, even changes in the chemical composition of gasoline.

It can give the utility industries the ability to distribute electricity in response to second-by-second changes in customer demand.

It can sleeplessly tend scores of patients in intensive care, automatically and instantly responding to critical signs (it can cope with two million instructions per second) with all the relevant corrections.

Even more exciting, however, are the applications we know nothing about.



PROBLEM-SOLVER FOR THE '80s.

ELECTRONIC HISTORY IN THE MAKING.

What are the applications of a superchip that measures only one-quarter inch square, but has the ability to control a memory containing 128 million bits of data, and can complete a job in microseconds instead of minutes? The mind flies.

Perhaps a worldwide medical diagnostic network that recognizes the symptoms and knows the prescribed treatment for every identified disease on earth. Perhaps computerized machinery to disassemble a space satellite automatically the moment its orbit begins to decay.

Perhaps an industrial computer that can handle everything, from extraction of raw materials, to packing and shipping to retail outlets. Or an automated national allocation system for home heating fuel, with computers in every city and town to regulate fuel distribution by local temperature fluctuations.

PUSHING THE LIMITS OF MICROELECTRONICS.

Motorola, of course, makes only the microprocessor. But the MC68000 is a tool of enormous sophistication. In a very legitimate sense, it is a tool for expanding minds, extending possibilities, exciting exactly that sense of practical wonderment that is the real source of all progress.

Motorola's MC68000 is a giant stride even for a company that systematically explores the very limits of microelectronics technology; that has become a foremost producer of semiconductors; that has become one of the world's largest manufacturers devoted exclusively to electronics.

We have been making electronics history since 1928. With the MC68000, we have outdone ourselves.

For further information, write Public Affairs Office, Corporate Offices, Motorola, Inc., 1303 E. Algonquin Road, Schaumburg Illinois 60196.

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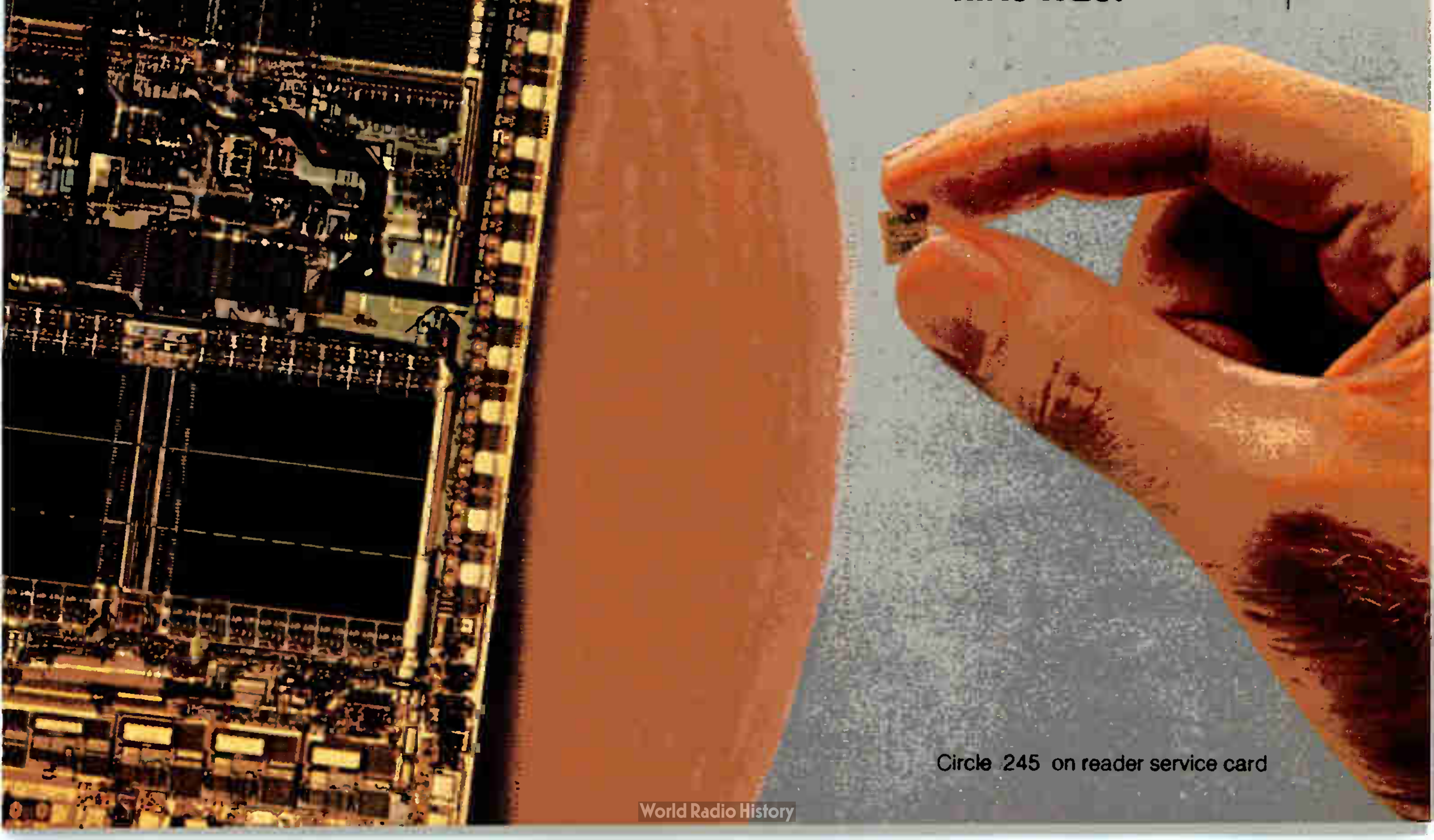
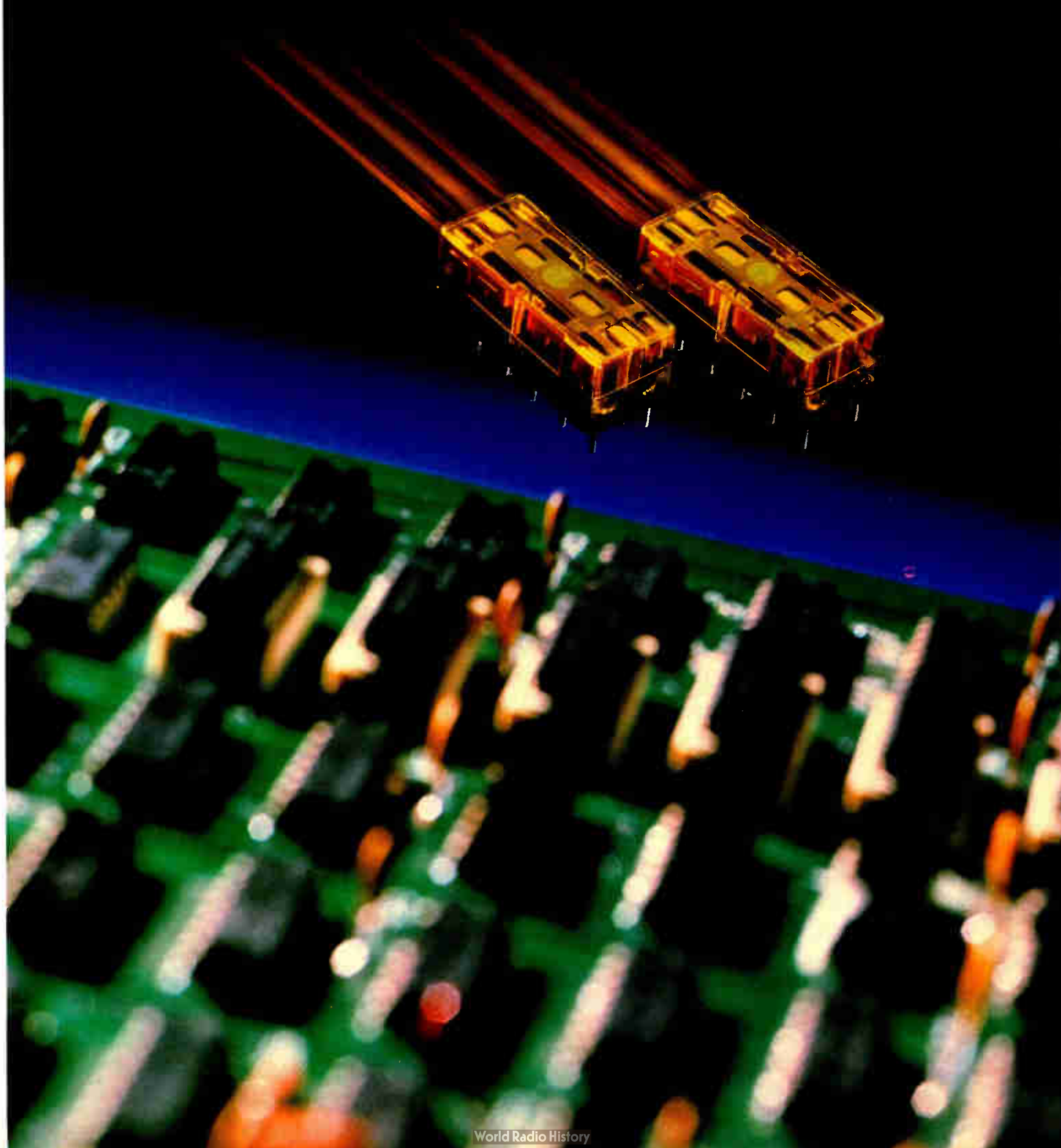


Circle 245 on reader service card

Aromat SE Amber Relays... a pure product of "relay efficiency."

$$\text{Relay efficiency}(\eta) = \frac{\text{The sum of all contacts' switching capacity (VA)}}{\text{Operating power(W)} \times \text{Volume(cm}^3\text{)}}$$



A breakthrough in relay efficiency.

The SE Amber relay's key to higher efficiency lies in greater miniaturization coupled with high reliability and greater switching capacity.

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  [Operating power (W) x Volume(cm^3)]
  The SE Amber relay's 4-gap balanced armature delivers a highly efficient polarized magnetic circuit—sensitive enough to be driven directly by an IC, in a space 28L x 12W x 10H mm.

Sensitivity

Pick-up power	100 mW
Nominal operating power	200 mW

Dimensions

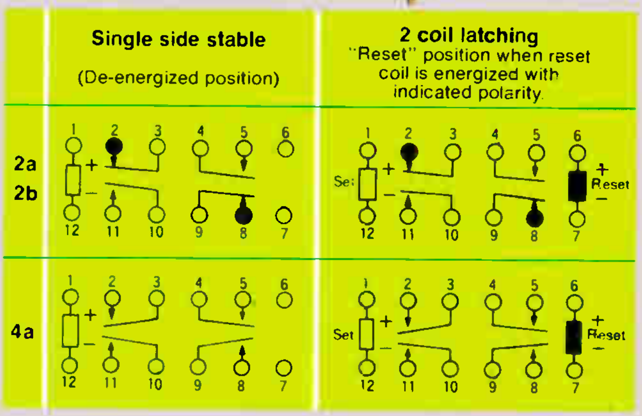
Volume	28L x 12W x 10H mm	1.102 x .472 x .394 inch
Header area	336mm²	.521 inch²
Height	10mm	.394 inch

- **Wide switching range.**
  [The sum of all contacts' switching capacity (VA)]
  Switching is possible from 100μA 100mV DC to 4A 250V AC, thanks to the 4-gap balanced armature system and special multi-layer clad contacts. A single SE relay can handle maximum and minimum switching simultaneously.

- **High reliability and long life.**
  The balanced armature system with permanent magnets gives larger contact pressure. Bifurcated contacts and lower contact bounce add to contact reliability and expected contact life.

- **Amber design and construction.**
  Designed for automatic wave soldering and cleaning, the sealed SE Amber relay performs reliably under conditions where hydrogen sulfide, silicone and ammonia fumes prevail.

- **High vibration/shock resistance.**
  The balanced rotating armature provides great resistance to shock and vibration. Vibration resistance: 10 to 55G (amplitude: 3mm) Shock resistance: 50G (11msec.).



- **Varied contact arrangement.**
  SE relays are available with bifurcated contacts in 2a2b and 4a contact arrangements.

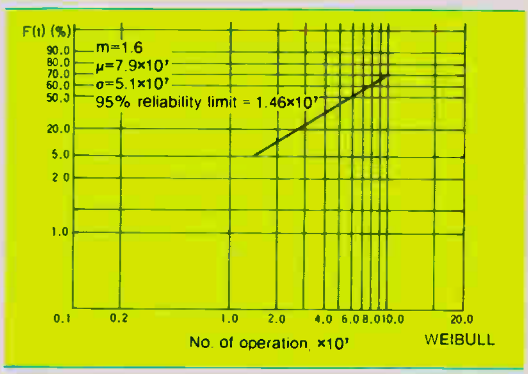
- **Multiple latching.**
  2-coil latching types are available, in addition to single side stable types.

Since SE relays have a latching capability with multiple contacts, one contact can control the circuit while the other can switch the load simultaneously.

- **Low thermal electromotive force.**
  Because the SE relay has completely separate coil and contact chamber areas, extremely low thermal electromotive forces are possible.

- **Dual in-line package arrangement.**
  This 2-track terminal arrangement allows easier component insertion, easier layout and identification of terminal locations, and simpler in-line checking.

Contact reliability Test condition: DC1V/1mA, 4 contacts in series Detection level 10Ω Sample: S4E-24V Q'ty = 10



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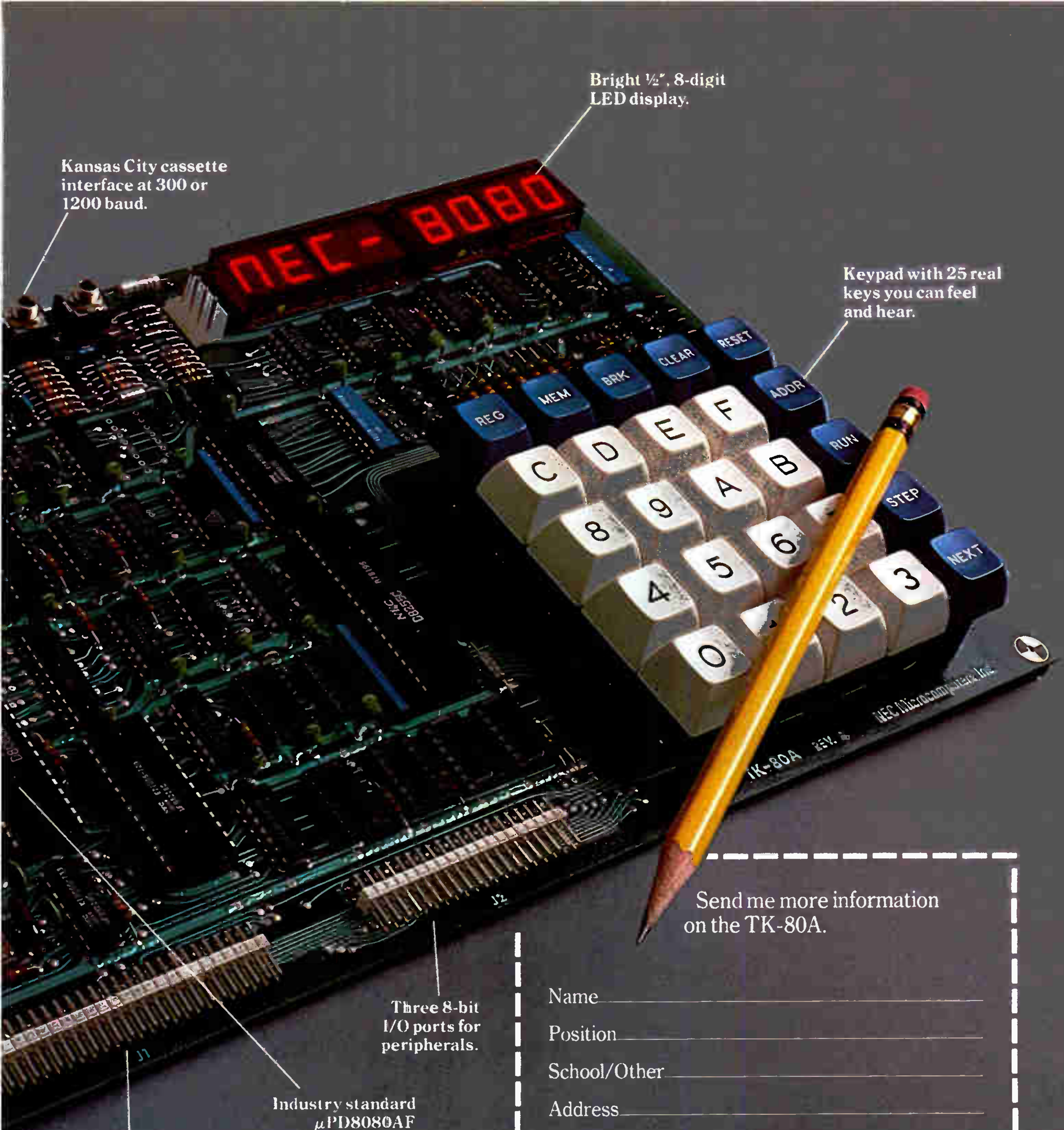
Circle 247 on reader service card



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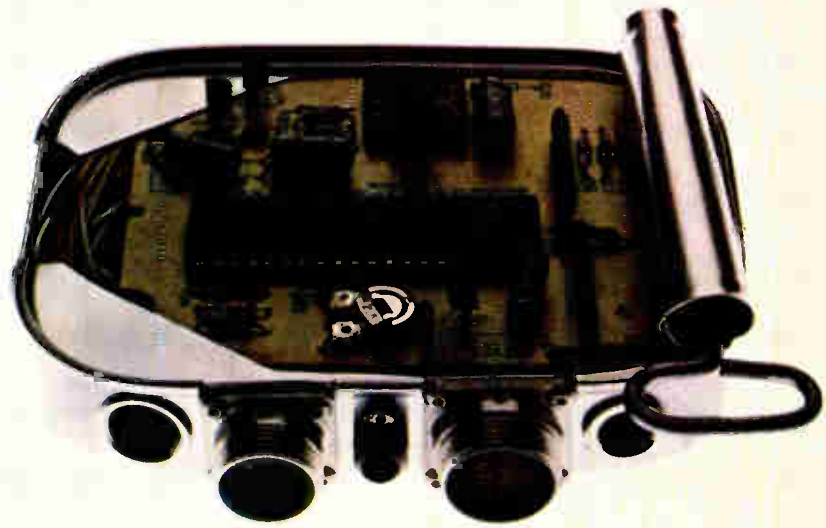

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CANNON ITT

Six decades on the leading edge of interconnect technology.

Logic analyzer sells for $750

Portable instrument for production and field use can sample data at 10 MHz, format digital information for oscilloscope display

by Bruce LeBoss, West Coast Editor, Computers & Instruments

Although there is a wide range of expensive logic analyzer products available to satisfy the needs of the research and development user, no low-cost systems exist that have been designed specifically for production and field use. That situation will soon change with the introduction of a $750 portable digital troubleshooting instrument at next month's Midcon '79 exhibition in Chicago.

The logic analysis display instrument, called LADY by its developers at Practical Technology, formats an 8-by-16 section of digital information into a timing diagram display on an ordinary oscilloscope. "LADY addresses the needs of technicians who continue to test and troubleshoot digital products long after the R&D is over," observes Keith Rosburg, 39-year-old president of the fledgling company.

Available from stock to 30 days and housed in an 8.5-by-2.5-by-9-in. package that fits under most oscilloscopes, LADY samples signals on eight input channels at rates to 10 MHz. Sampling may be synchronized with an external clock or operated asynchronously using the instrument's internal 10-MHz clock. The 3-lb troubleshooting tool is triggered either with an external trigger signal or by recognition of a selected input combination.

Front-panel settings let the instrument show various combinations of samples before and after the trigger point. By hooking a scope's input probe to LADY's output, the operator sees a timing diagram picture of the eight input channels. On each display line, the 16 sample fields are marked, as is the trigger position; a low-level reference is provided to make logic information easy to read and analyze. LADY is intended mainly for state analysis.

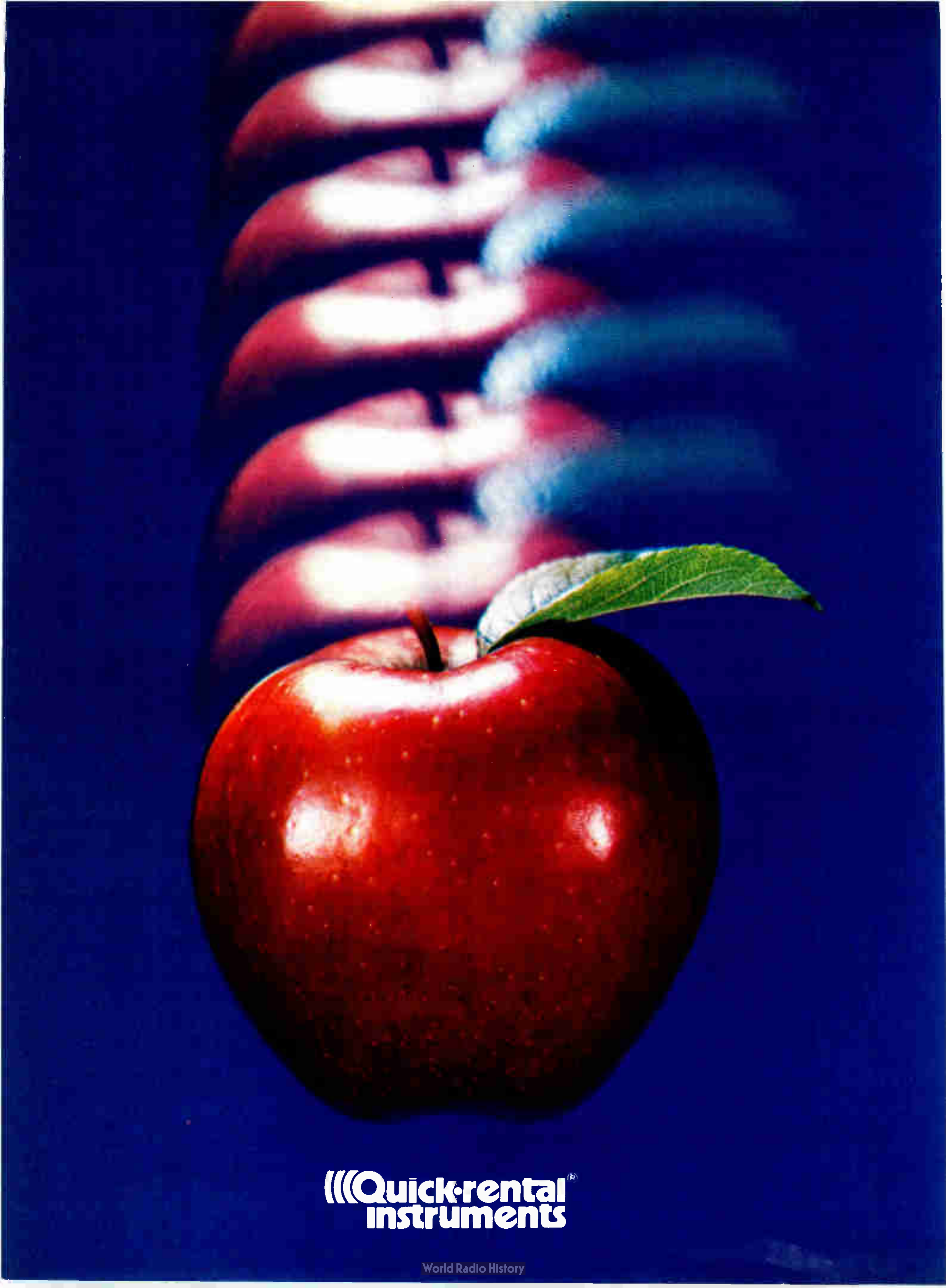
According to Rosburg, LADY has many attractive, practical features that can improve the efficiency of the troubleshooter and reduce the cost of making and servicing digital products. He adds, "it should recover its cost within a few months use." For example, the test connections allow easy access to signals. The user can plug LADY directly into integrated-circuit test clips or wire-wrapped pins. Furthermore, the input circuits are designed to accept logic signals of different levels and let the troubleshooter follow faults through different types of logic—TTL, MOS and complementary-MOS, among others—without special settings or adjustments.

Although the 10-MHz sampling rate of the LADY may not be as high as the level found in more expensive logic analyzers, "it is adequate for most digital systems," Rosburg claims, except for those that use emitter-coupled logic (ECL).

LADY is designed for a knowledgeable user, one who understands the problems he is working on, according to Rosburg. Many of the newer digital debugging instruments are microprocessor- or bus-oriented; he says they are "fairly limited in terms of testing flexibility—field servicemen are maintaining seven-year-old equipment with TTL, five-year-old systems with 4004 microprocessors, and new products with Z80s, and next year there will be some other new device in the systems they're servicing."

With microprocessor- or bus-oriented testing devices, the operator needs a different instrument or personality for each processor he is troubleshooting, Rosburg notes. But with LADY, the operator can adapt to the configuration he is after by using his knowledge and different hookups. "Sometimes," Rosburg concludes, "you have to get off the bus to see what's going on."

Practical Technology, 25 Village Sq., P. O. Box 449, Carmel Valley, Calif. 93924. Phone (408) 659-3128 [338]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GENERAL ELECTRIC

Microcomputer does it all

6800-based machine with dual floppy disks and 48 kilobytes of RAM supports Basic, C, UCSD Pascal, and PL/W high-level languages

by John G. Posa, Microsystems & Software Editor

The Sprint 68 system from Wintek is a rugged, reliable microcomputer that can function both as a dedicated, real-time turnkey computer and as a software development system. Its impressive list of standard and optional hardware and software tools is so comprehensive that an unfulfilled designer must indeed be a very hard person to please.

The basic $3,995 Sprint comes equipped with the 6800 microprocessor, dual 8-in. floppy-disk drives, 48 kilobytes of random-access memory, an RS-232 serial input/output port, a multitasking disk operating system (DOS) called Wizrd, an editor, an assembler, and a 12-kilobyte version of Basic in read-only memory.

If this basic system cannot handle it, any of Wintek's micromodules can be added to the backplane for extra serial, parallel, or analog I/O, an erasable-programmable-ROM programmer, or an interface for the IEEE-488 bus. Similarly, if other high-level languages are needed, the system supports optional compilers for C, UCSD Pascal, and PL/W, Wintek's version of IBM's PL/1 for the 6800 microprocessor. Finally, additional firmware can be installed, including a monitor and debugger called Fantom-II, a floating-point package called Math-1, and a 4-kilobyte version of industrial Basic.

The Wizrd DOS is unique in that each task can be allocated a share of the microprocessor's resources as these become available or as demanded by conditions outside the computer via interrupts. Its multitasking feature allows the overall system software design to be partitioned into smaller, more managable modules, each of which can be executed as an individual program.

Wizrd is unlike many microcomputer disk operating systems in that it has many features normally associated with minicomputers. This includes true device-independent (virtual) I/O, sophisticated heap management for efficient memory allocation for I/O buffers, and command indirection. Command indirection, which allows computer commands to be read from files with no operator intervention, is essential for systems used by untrained operators; it can also reduce the time required to develop such systems by an order of magnitude.

Recent advances in computer science have resulted in features that greatly enhance the productivity of a programmer. Included are structured high-level languages, separate compilation of individual subroutines, selective loading from subroutine libraries, and language standardization. The editor, assembler, and programming languages available for Sprint incorporate these modern concepts.

The text editor is a general-purpose line- and character-string oriented program having powerful content-oriented conditional editing commands that include insert, replace, delete, edit, print, tab, purge, save, and restore.

The assembler generates an object code file and a listing file for 6800 microprocessors. It features conditional assembly, all standard pseudo-operation codes, plus title and subtitle, pre- and post-radix, programmer flagged errors, efficient error handling, and automatic memory management through a label table. A Wizrd utility allows the object code to be loaded into RAM and executed.

While much is said about Basic, Pascal, and PL/1-like languages, not enough time has been allotted for the virtues of C. This is a very modern, structured language and very effective in expressing both system and application algorithms. It is also ideal for microprocessor programming because its low-level constructs allow manipulation of characters, numbers, and addresses on a completely individual basis.

C blends together a fine complement of decision-making, looping, and case-selection control features, which combine for well-structured, efficient programs. Variables may be internal to a program block, external to one, or global to all, and the functions of a C program may be compiled separately.

After the software has been developed using Sprint, the same system can be configured for various data-acquisition, process- and power-control applications by simply installing the proper mix of RAM, ROM, and serial and parallel I/O modules.

For heavy loads, driver sensor and relay micromodules can be used for optically isolated inputs and for driving motors, lamps, and so on. The IEEE 488 module allows Sprint 68 to be used as a powerful general-purpose interface bus controller. Finally, Sprint 68 can also be supplied with Wintek's power-failure detect/power-on reset power supply for applications that require advance knowledge of an imminent power failure.

Wintek Corp., 902 N. 9th St., Lafayette, Ind. 47904. Phone (317) 742-6802 [339]

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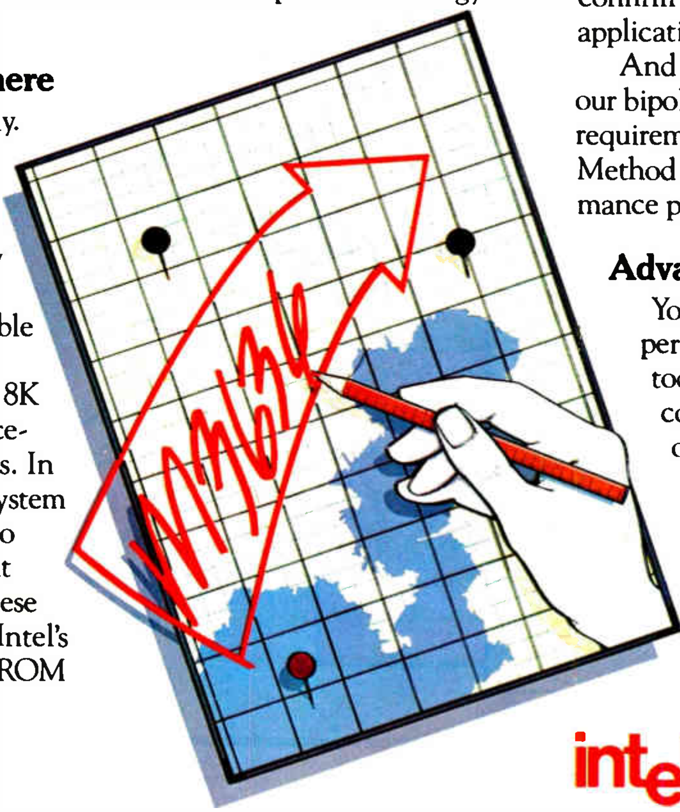

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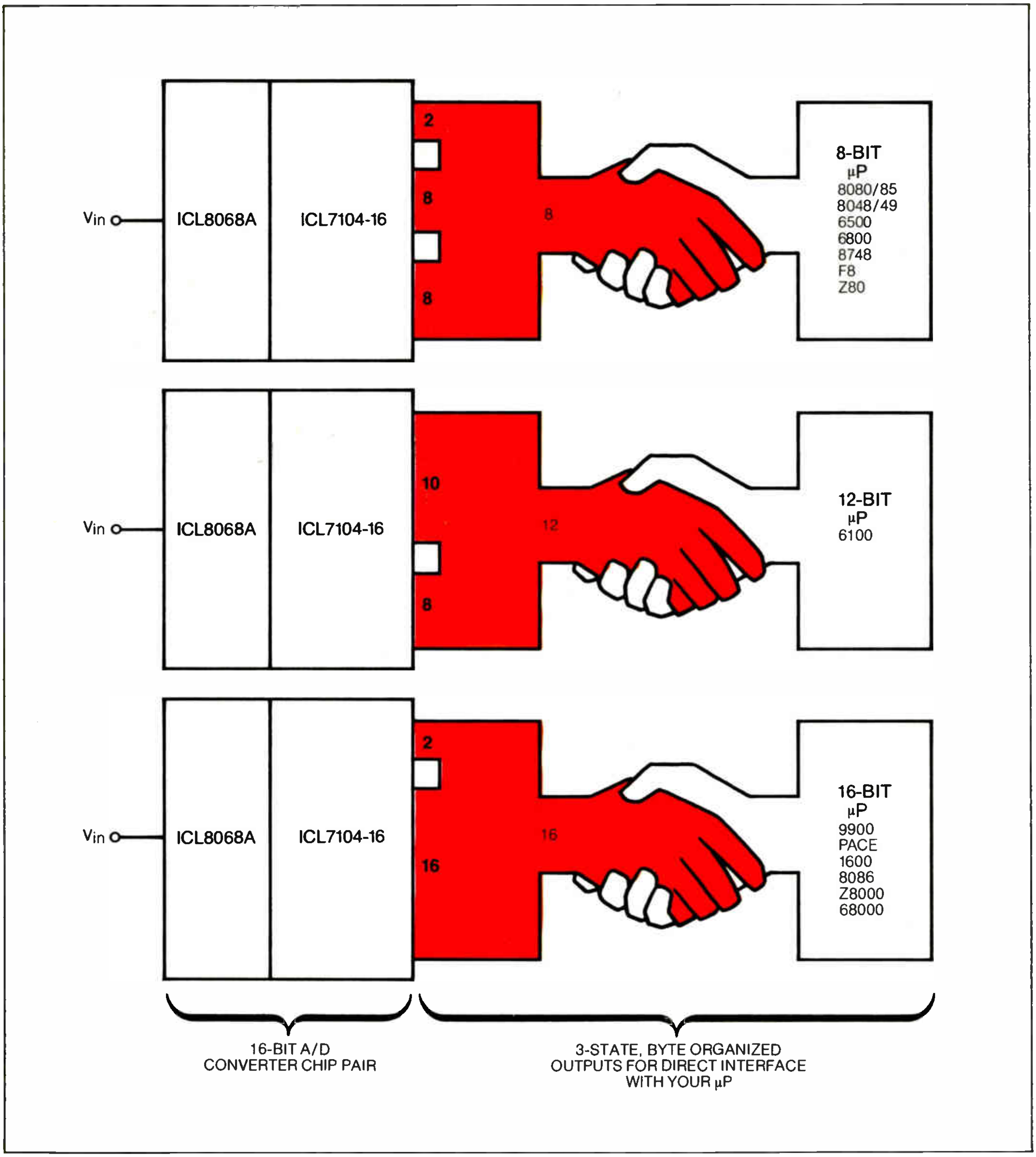

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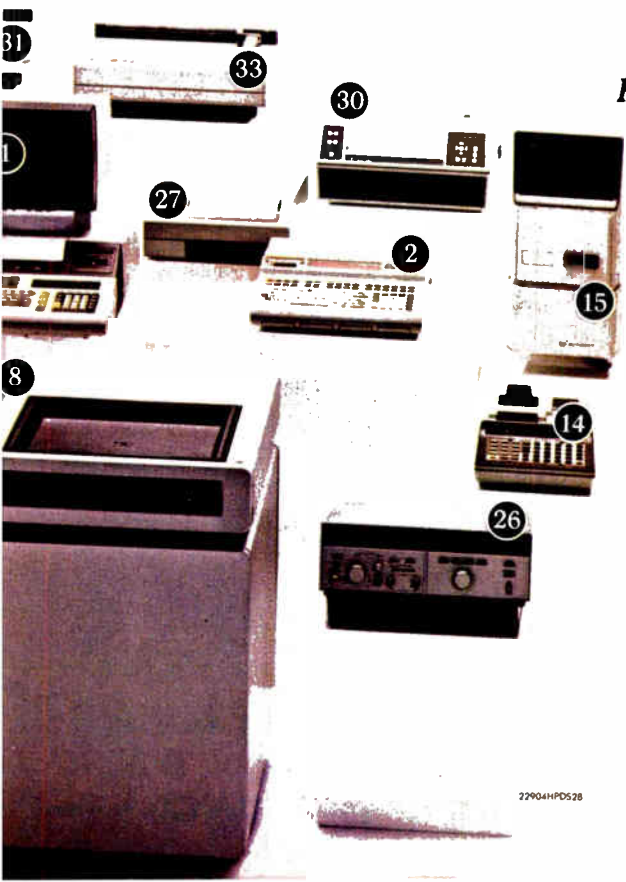

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Supplies for international use offer ±3% regulation over 10:1 load range

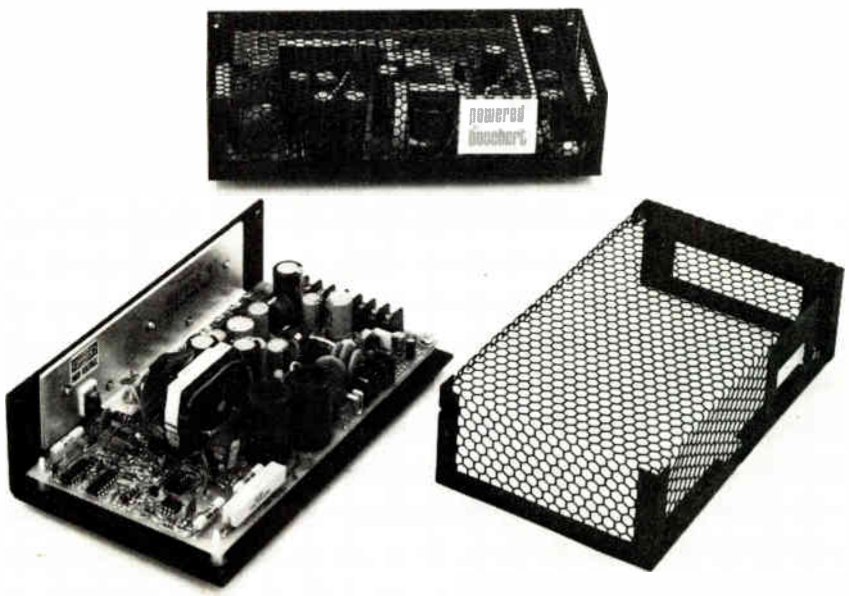
Automobile manufacturers and operators are concerned about anything that affects the price, performance, and availability of car batteries, and manufacturers and users of computers, peripherals, and other electronic systems share the same concerns about power supplies. And when some development favorably affects all three of these factors, as does a new family of standard switching power supplies from Boschert Inc., it is of particular interest.

Called the XL series, the new line can be tailored to meet the wide-ranging needs of original-equipment manufacturers and end users in both domestic and international markets without reliance on higher-cost custom-made supplies. What's more, the XL supplies feature a high degree of regulation over a wide load-current range, as well as a wide input-load range that enables them to satisfy user needs in the U.S., Japan, European countries, and the British Commonwealth.

According to Stephen C. Johnson, Boschert's marketing vice president, power-supply companies must build in high volumes to keep costs down and pass along the savings, if any, to OEMs and users. "The degree to which each customer's load range changes affects the quality of the regulation we can provide. And sometimes," he notes, "the regulation hasn't been good enough for certain digital applications. Therefore, if the load-current range were significantly different, we would have to tailor the power supplies and, in effect, would be building custom units."

Unlike Boschert's earlier OL series of switching power supplies, which provided regulation over a 2:1 load range, the XL series supplies provide regulation of ±3% on the auxiliary outputs over a 10:1 load range. "Now there is no tailoring of power supplies for a given range of output voltages," Johnson says. "The XL series covers the waterfront," he continues, "and allows us to get into a high-volume situation."

To achieve this performance, Boschert relies on novel power-control



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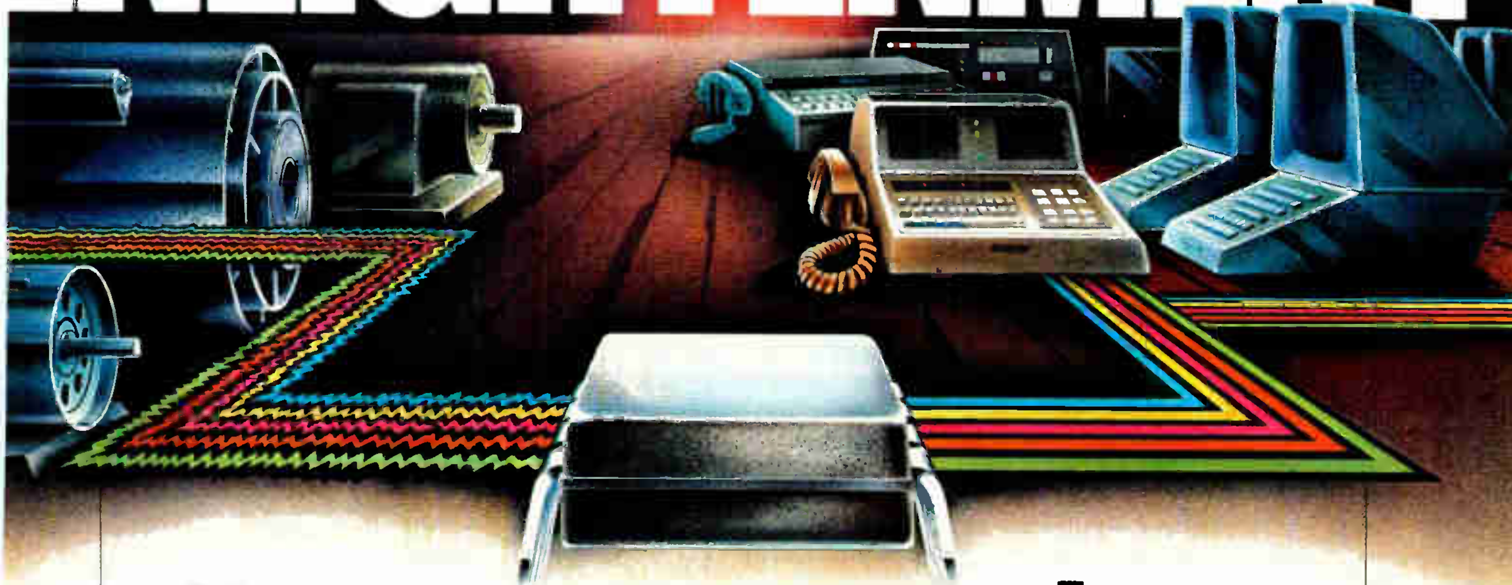


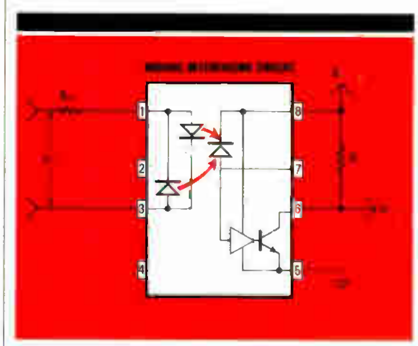
Now, a power to logic optical interface that monitors AC line status

General Instrument's MID400. It's the first optically isolated interface to have direct operation from an AC line current and direct compatibility to TTL and microprocessor systems. Not only do you get a device with direct interface from line voltages ranging from 24V to 240V, but one with externally adjustable time delay and AC voltage sensing. Add to that . . . logic level compatibility and high isolation between input and output.

A system sentry with motor to logic capability. The MID400 is the perfect answer to monitoring AC "line down" conditions. When the power goes, the MID400 can activate auxiliary power control. In industrial control applications, the MID400 is an ideal "closed loop" interface between electromechanical elements such as solenoids, relay contacts, small motors and microprocessors. This closed loop capability may also be utilized in emergency shut down or fail safe applications. And if your system needs an AC current status monitor, a 2 or 3-phase power line status monitor, telephone ring detector or a low speed, high gain optocoupler interface, there's no better device than the MID400.

Low power . . . low current. AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A very high gain detector circuit senses the photodiode current and drives an open collector transistor to a logic low condition.

With a low threshold input current, the MID400 provides energy savings and less heat in your system. Packaged in a UL recognized 8-lead plastic mini-DIP, it's also a space saver.



It's another first from the new name in optoelectronics. For more information on our new MID400, contact General Instrument Optoelectronics, 3400 Hillview Avenue, Palo Alto, California 94304.
Telephone: (415) 493-0400.

GENERAL INSTRUMENT

Circle 261 on reader service card

New products

methods, among them a proprietary opto-isolator design, a means of characterizing switching components over a wide frequency range, and the use of a high-efficiency ac linear regulator on the output, Johnson explains. The units also use what he calls flyback design, which minimizes the costs of magnetic and semiconductor components by applying greater stress to fewer components, for use in low- and medium-power applications.

The new series initially includes the 25-W XL25, the 75-W XL75, and the 130-W XL130, each with four outputs: +5 V, −5 V, +12 V, and −12 V. Their input-line range goes from 90 V on the low side—"to get you into the Japanese market"—up to 265 V—"good for the British Commonwealth countries"—on the high side, says Johnson. The input ranges of 90 to 130 V and 180 to 265 V are strap-selectable. The supplies also feature overvoltage and short-circuit protection and automatic short-circuit recovery.

"Previously, we were filling 80% of the market's needs with about 50 products," says Johnson. "Now, we intend to do that with about 10 to 12 products." By not having a large proliferation of products, Boschert also can automate several of its power-supply manufacturing processes. "If we didn't do all these things, costs would rise. But because we are," Johnson adds, "our yields rise dramatically, and we are able to hold our costs level or slightly decrease them." The prices of the XL supplies, therefore, will be about the same as, or slightly less than, the older OL series—"but with better regulation," Johnson points out. In quantities of 100, for example, the XL130 will list for about $207. For the XL75 and XL25, the prices are $147 and $97, respectively.

Furthermore, because Boschert is building the XL series in high volumes, it will be able to stock an inventory of the standard supplies. "Previously, a customer typically waited 18 weeks before receiving initial quantities of a custom supply. Now," Johnson continues, "we can deliver limited quantities to him out of our stock of standard units."

Boschert Inc., 384 Santa Trinita Ave., Sunnyvale, Calif. 94086. Phone (408) 732-2440 [381]

Photodetector bias power supply goes to 600 V

Featuring very low noise, a high-voltage power supply has been designed specifically for photodetector biasing and similar applications. With an internal precision reference, the AM/DPS series of modules provides output voltages from 0 to 600 V programmable by external fixed or variable resistors or under the control of a 0-to-5-V source. Negative-output models are also available.

At maximum output voltage, the typical peak output ripple is ±0.008% with a typical output drift of ±0.3% from 0° to 70°C. Input voltage may be either 12 or 24/28 V

dc, with a maximum input voltage 20% beyond that. Reverse-polarity protection is provided, as is a two-stage input filter. A two-stage output filter, a magnetically enclosed transformer, and electrostatic screening ensure low levels of electromagnetic interference.

Hermetically sealed in small (2.05-by-0.55-by-1.0-in.) packages, the power supplies are available in a commercial version—operating temperature range from 0° to 70°C—or in a military one—temperature range from −55° to +85°C. The standard model is priced at $85 in quantities of 26 to 100 and the mili-

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tary at $103 in similar quantities.

Analog Modules, 603 Majorca Ave., Altamonte Springs, Fla. 32701. Phone Hazel Crawford at (305) 862-5061 [383]

Unit delivers 30 mA at 250 V to drive plasma displays

Plasma displays demand high voltage, and the CM 1.250.30 power supply provides 250 V at 30 mA to drive them. Line and load regulation of this power supply is ±2%, with noise (ripple) held to 1 V rms. The unit has a drift temperature coefficient of ±0.05%/°C and accepts a voltage of 115 V ac, ±10% (100 and 230 V ac versions are also available).

With a full five-year warranty, the

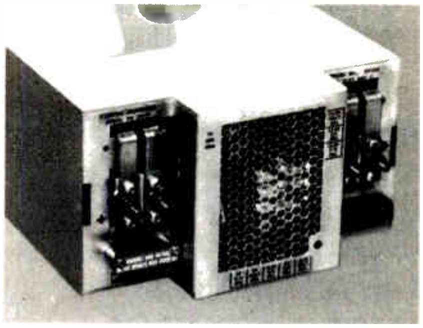
module is encapsulated in epoxy and easily installed with a screwdriver. Foldback current limiting protects the power supply against accidental overloading.

In quantities of one to nine, the power supply sells for $69. Delivery is from stock to four weeks.

Calex Manufacturing Co., 3355 Vincent Rd., Pleasant Hill, Calif. 94523. Phone Ron Kreps at (415) 932-3911 [384]

260-V ac switching units regulate with 166 V rms dips

Practically brownout-proof, a line of multiple-output switching power



supplies is well suited for generating power for add-on memories, mainframe computers, process-control systems, communications equipment, and test equipment. The PM2809 is a three-channel switcher featuring two high-power output channels with output-voltage selections of 2, 3, 5, 12, 15, 18, 21, 24, 28, and 48 V dc. The maximum total output for the unit is 800 W, which includes 400 W maximum on the main channel and 400 W maximum on the second channel, less the power on the third channel—up to 15 V at 10 A.

Available with single-phase 47-to-63-Hz inputs ranging from 184 to 260 V ac, the units will regulate through line dips to 166 V root mean square. When operating at full load and nominal line, the unit has a minimum 30-ms power-loss holdup time. Other standard features include protection against overshoot, overload, overvoltage, excessive temperatures, and reverse voltage. The unit also has remote sensing and provision for connecting two or more supplies in parallel.

Options for the supply include: logic inhibit, true inhibit, overvoltage crowbar, remote programming, output power good, an additional hold up to 50 ms, undervoltage detection, and current limiting delay.

The unit will operate at 100% of rated power from 0° to 50°C, which derates linearly to 80% of rated power at 70°C.

The PM2809 sells for $1,075 in quantities of 1 to 10, with delivery within 16 weeks.

Pioneer Magnetics, 1745 Berkeley St., Santa Monica, Calif. 90404. Phone Bob Friedman at (213) 829-6751 [386]

New products

Microcomputers & systems

Graphics unit rides STD bus

256-by-256-dot controller fits on one 4.5-by-6-in. card, sells for $495

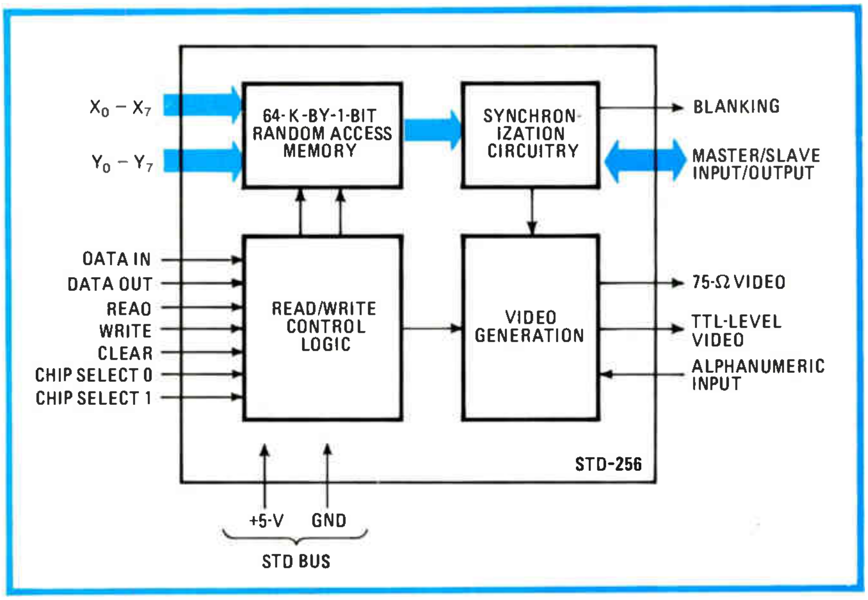
The STD or standard bus—a 56-line structure developed jointly by Mostek Corp. and Pro-Log Corp.—has gained wide acceptance since its introduction some 14 months ago. Users are especially fond of the small format of its cards (4.5-by-6-in.), and numerous companies have supported the idea with their own module designs [*Electronics*, April 26, p. 86]. One of those companies is Matrox Electronics Systems Ltd. Earlier this year it brought out a cathode-ray-tube controller board to generate an alphanumeric display, and now it has followed that up with a 256-by-256-dot graphics controller—a first for the STD bus.

The STD-256 card contains a 65,536-by-1-bit refresh memory, all refresh and read/write control circuitry, and a composite-video signal generator. It produces a square display. The position of each dot is specified by two 8-bit coordinates, X and Y, and the dot intensity (on or off) is controlled by a third coordinate, Z. To read or write a dot, the X, Y, and Z values are latched at the appropriate inputs and a strobe is generated on the read or write lines.

While the STD-256 is powered from the STD bus, commands are entered through a single ribbon-cable interconnection. This cable, which attaches to the edge of the board opposite the STD bus, is driven by a parallel interface card like the MDX-PIO from Mostek or the 7601 from Pro-Log. Besides the commands for writing dots to the screen, video on/off and clear screen controls have also been included.

A system can easily be upgraded to increase horizontal or vertical resolution or the number of bits per pixel (dot). This is done by cascading or stacking additional cards; for example, a 6-bit, 64-color (or gray-level) display can be generated from six STD-256 cards, where one acts as a master and the rest function as slaves. The TTL-level video outputs from each card are fed to the Matrox ENC-1 color/gray scale encoder card to display composite monochrome or color video on any standard monitor. Only one parallel interface card is required, as it can support up to six STD-256 cards.

For applications that require a combined alphanumeric and graphic



The Clare cloned DIP relay eliminates identity crises.

Last = first.

When you're into high-volume production, installing the same relay in great numbers, there's one absolutely essential relay requirement — identity. If your relays aren't spec twins, you've got to have QC crises. To prevent such crises, we cloned our high-volume PRMA DIP relay.

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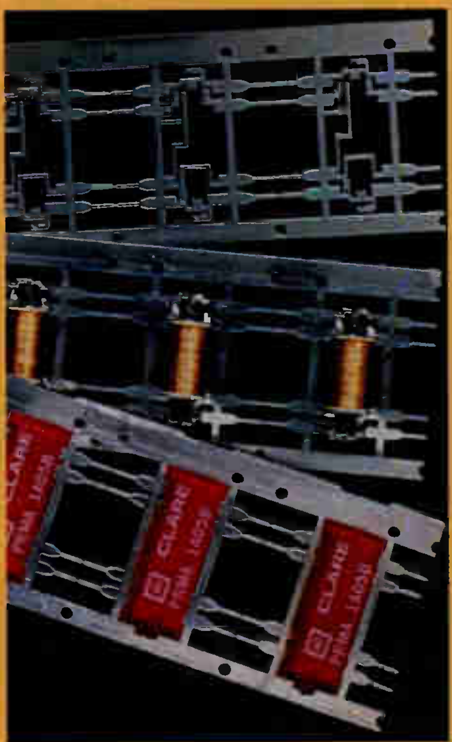

Same size.

Picoreeds have rhodium contacts. They operate 100-million times at low level and signal loads; 5-million times at 10 VA. Consistently. Their 10-year record attests to it.

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Second. We use a thermoplastic bobbin — non-corrosive, resilient, strong — ideal protection for the reed switch and magnet wire through encapsulation and for life.

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Fourth. We do it all with high-speed, precision machinery that turns out totally consistent relay packages in the types you want. PRMAs are available in 1 Form A, 2 Form A, 1 Form B, 1 Form C and Alt. Form C types with nominal 5, 12, and 24 DC voltages. The 5 V 1 Form A is TTL compatible. Every relay is indexed for automatic insertion equipment and coil terminations are on each side of the relay for versatility of connection.

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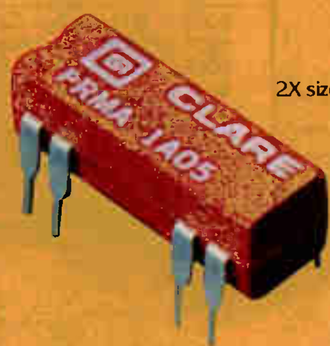
Free PRMA. If you'd like a free sample, write to Tom Fox, product manager, on your letterhead.



2X size.

GENERAL INSTRUMENT

Circle 267 on reader service card

display, one or more graphics cards are stacked with the Matrox STD-2480 alphanumeric display controller mentioned earlier for 24-line-by-80 character alphanumeric overlay. The price for one STD-256 board is $495.00.

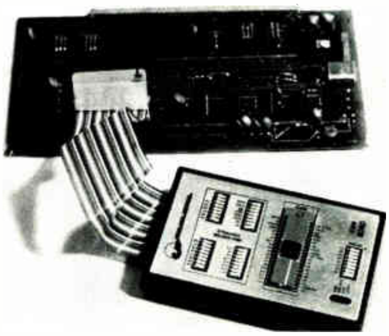
Matrox Electronic Systems Ltd., 5800 Andover Ave., Montreal, Que., H4T 1H4, Canada. Phone (514) 735-1182 [371]

ICE system gives signature analysis for microprocessors

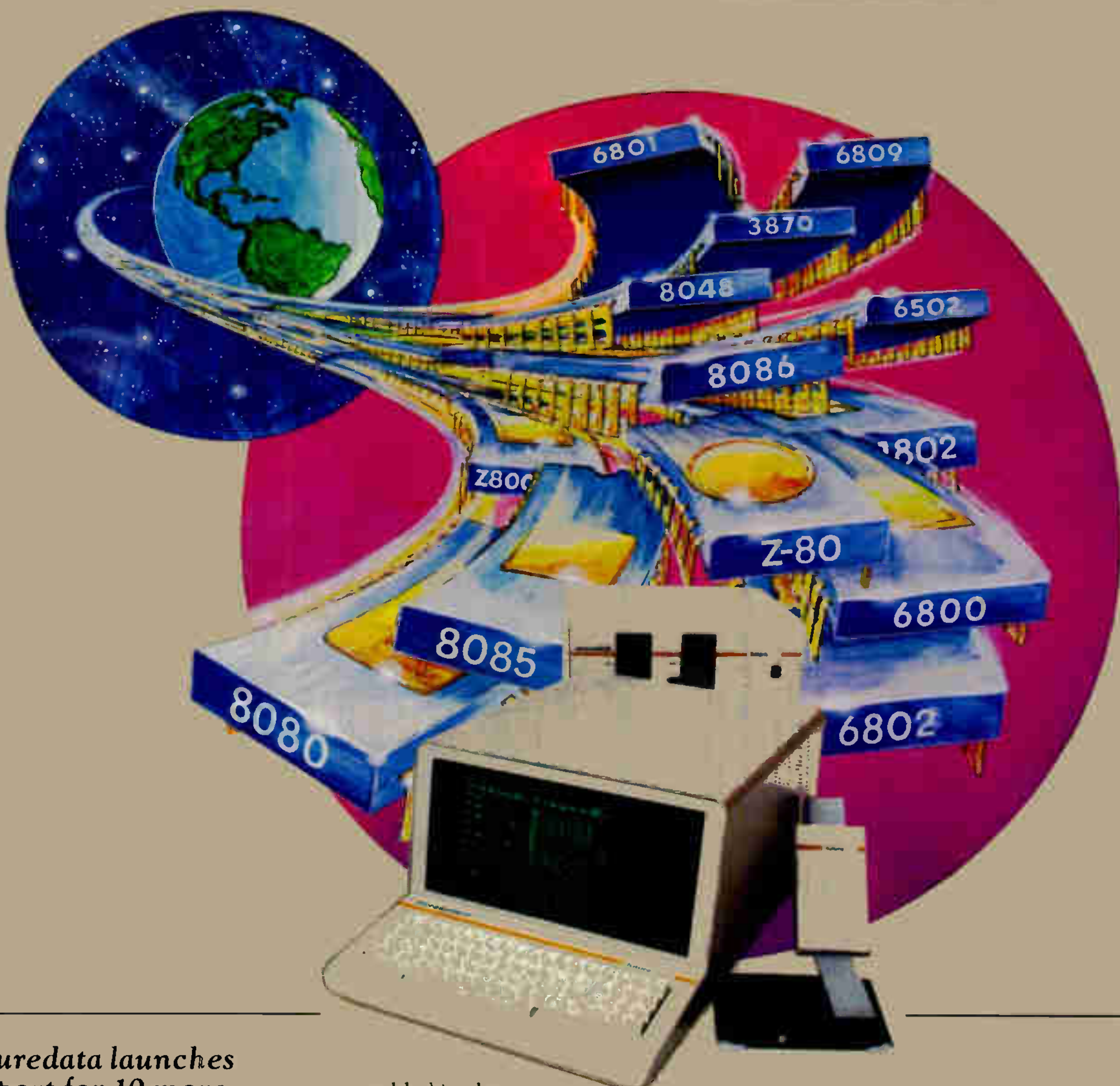
A newly announced in-circuit emulation (ICE) system provides simplified signature-analysis diagnostics of bus, microprocessor, and system fault problems. The SSM (for signature stimulus module) uses a forced-operation-code technique for microprocessor stimulation and free-run generation.

By removing the microprocessor from the system under test, placing it in the SSM socket, and opening all address, data, and control lines with the appropriate eight-position bit switches, the user may take signatures from the microprocessor to verify its correct full-speed operation and clocking.

When the LS 100, 120, or 140 signature analyzers are used in conjunction with the SSM, full testing of all address, data, and control lines is possible. The SSM can perform signature analysis testing for over 50% of the system without external stimulus software. If the LS 140 is used, data bus operation and memory contents may also be checked. And by closing the address lines to the system under test, the



How to put µP with the mad, mad world of product development.



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SSM can stimulate the microcomputer system.

SSMs for the 6800, Z80, 8080, 6500, 6802, 6502, and 6512 are available now, with others under development. SSM prices start at $216.50; delivery is within 30 days.

Phoenix Digital Corp., 3027 N. 33rd Dr., Phoenix, Ariz. 85017. Phone Gerald Trussell at (602) 278-3591 [377]

Memory-mapping ICs expand 16-bit processor abilities

A series of single-chip memory-mapper integrated circuits has been designed to expand the amount of memory addressable by a 16-bit microprocessor. The SN54LS/-74LS610, 611, 612, and 613 function with the system memory address bus to expand a microprocessor's memory address capability by 8 address lines. Using 4 of the CPU's 16 lines to generate 12 memory address lines, the memory mapper ICs increase the number of memory address lines by 8.

Each IC contains a 4-to-16-line decoder, a 16-word-by-12-bit random-access memory, 16 channels of 2-to-1-line multiplexers, 12 latches, and other circuitry. All of this is contained on a single chip.

The 4 most significant microprocessor address bits are used to select 1 of the 16 mapping registers, each with 12 bits. The content of the selected register is driven to the system through output latches or buffers. The remaining least significant microprocessor bits are applied directly to the system's address bus.

Both the 610 and 611 models have output latches; the 612 and 613 do not. The 610 and 612 have a three-state output, and the 611 and 613 have open-collector outputs. The SN54LS models operate from −55° to +125° C, and are available in ceramic 40-pin, dual in-line packages. The 74 models operate from 0° to 70° C, and come in either ceramic or plastic DIPs.

Available in sample quantities in the final quarter of 1979, these devices will sell for about $55 each in the plastic packages, in 100-piece quantities.

Texas Instruments Inc., P. O. Box 225012, M/S 308, Dallas, Texas 75265 [378]

4-bit microcomputer family has on-chip ROM, uses +5 V

Operating from a single, +5-V dc power supply, a recently announced series of 4-bit microcomputers from Panasonic includes four single-chip microcomputers, an evaluator chip (MN1599), and an I/O expander chip (MN1591). Two of the microcomputers—the MN1542 and MN1544—come in 40-pin, plastic dual in-line packages, while the MN1562 is in a 64-pin plastic DIP, and the MN1564, a 64-pin ceramic DIP.

Using byte-sized (8-bit) instruction words, the devices have an instruction speed of 2 μs. A large on-chip read-only memory, which may be either 2-K or 4-K, increases the performance of the MN1500 family. Other features include: 6 or 12 bidirectional I/O ports for greater flexibility in assigning inputs and outputs; four levels of priority interrupt; indirect jump instructions; table lookup; an 8-bit on-chip counter and timer; and an 8-bit serial shift register.

The devices will also operate in a powered-down mode, in which only the random-access memory is powered so that data is not lost.

Applications for the MN1500 family include computer peripherals, high-level calculators, industrial controllers, high-grade consumer appliances, and instrumentation.

Delivery times for the microcomputers depend on the overall mask development cycle, but are usually within six weeks after receipt of order. Each device is expected to sell for under $7.50 in large quantities.

Panasonic Co., One Panasonic Way, Secaucus, N. J. 07094. Phone Bill Bottari at (201) 348-7276 [375]

Lab computer unites desktop features, minicomputer power

Combining true minicomputer power with the ease of use and low cost of conventional desktop computers, the MiniMINC is a desktop analytical tool for use in scientific, engineering, and management problem solving, as well as for the reduction of laboratory data. The system provides for up to three serial I/O lines, which may be connected and coupled to selected instruments and peripherals like printers and plotters. MiniMINC may be used as a full development-level system operating under MINC Basic allowing users to create and save their own application programs. A communications capability permits the computer to operate as part of a distributed processing system as necessary in some applications.

Using an LSI version of Digital Equipment Corp.'s PDP-11 computer and an enhanced version of Basic, the computer boasts 64-K bytes of random-access memory and a dual floppy-disk storage system with a capacity of 512-K bytes. The system also has a communications port with modem control for either synchronous or asynchronous information transfer, and a serial printer port—both ports will transfer data at rates up to 9,600 baud.

The MiniMINC system, part of the larger MINC family, will sell for $9,900 with deliveries scheduled to begin this month.

Digital Equipment Corp., Maynard, Mass. 01754. Phone (617) 481-9511 [376]

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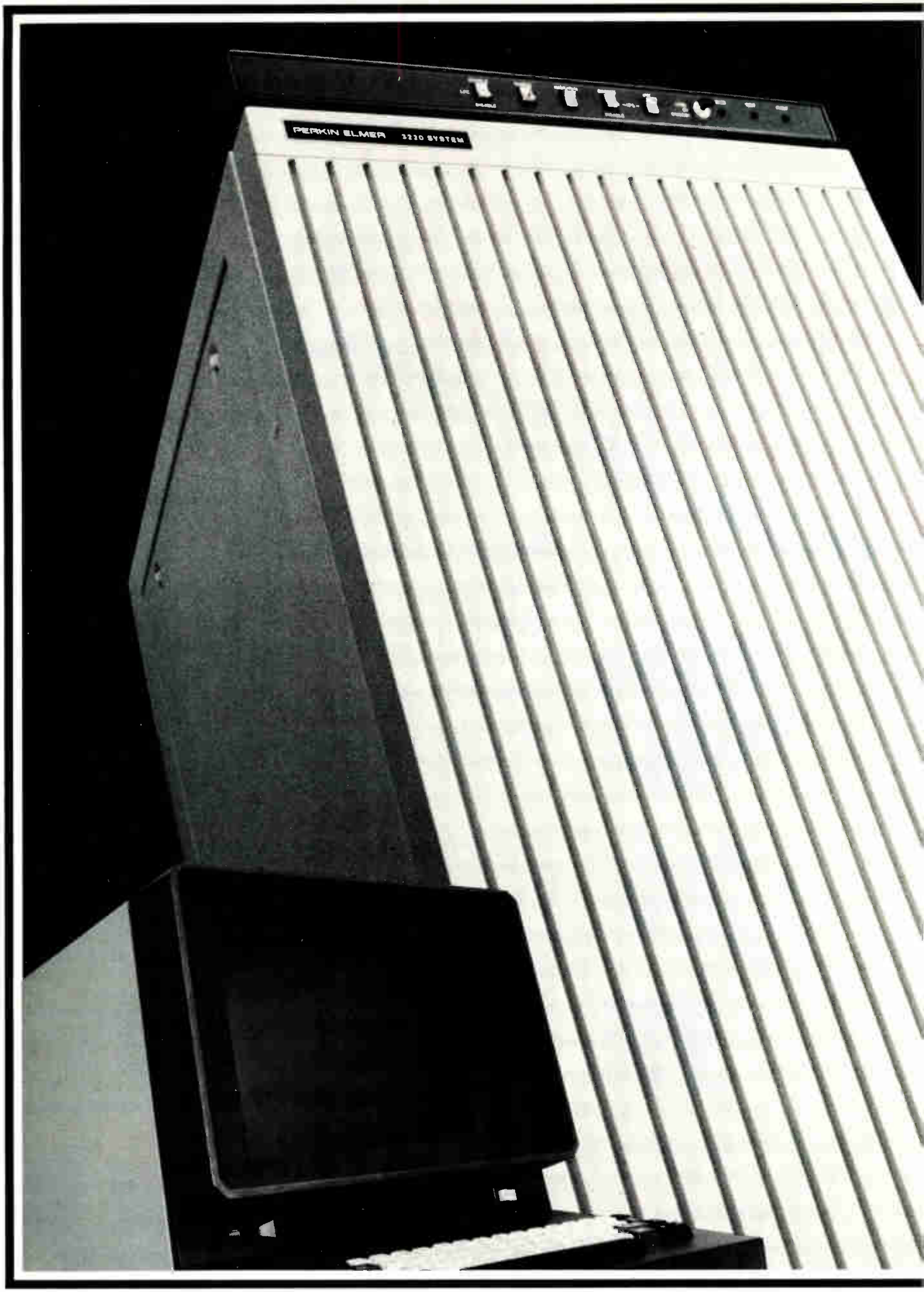
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3220 SYSTEM

The new 3220 from Perkin-Elmer. A 32-bit supermini so fast, so powerful, so advanced, it may not be for everyone.

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Please send me your fact file on the 3220.

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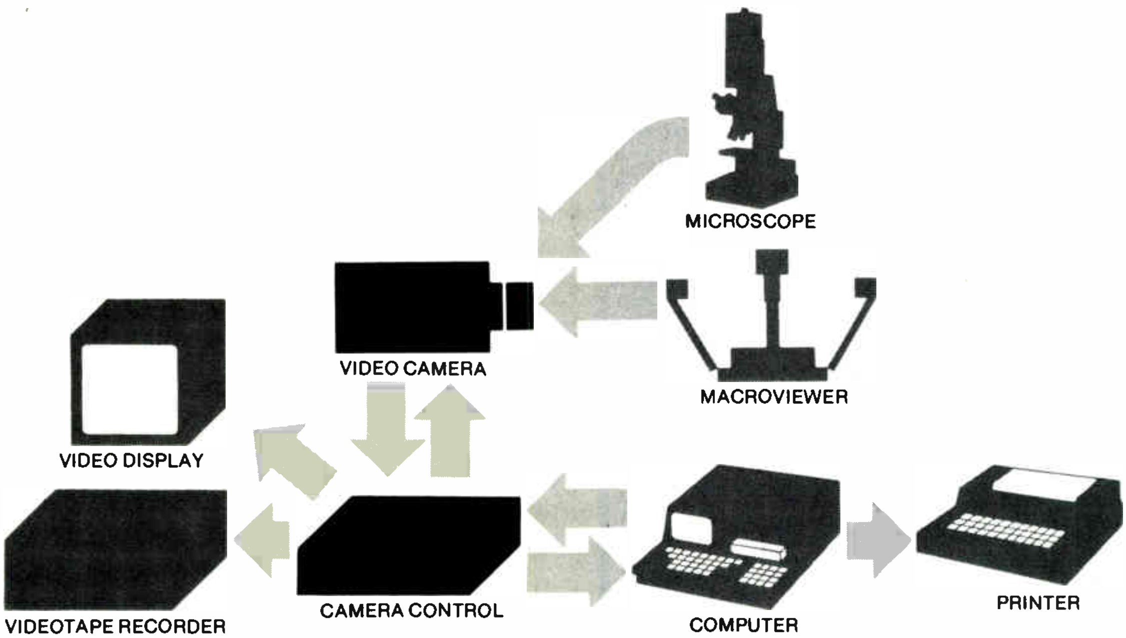

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The C-1000 Camera solves the problem of converting visual images into digital data for image processing and analysis. Video data generated by the Camera is converted into a digital signal within the C-1000 control module. This signal then is transferred directly into your computer through a plug compatible interface.

Standard interfaces are now available for most widely used minicomputers manufactured by Digital Equipment, Data General and Hewlett-Packard, plus personal computers, the IEEE 488 GPIB and others. One million data points and 256 gray levels provide your computer with precise video data automatically, directly.

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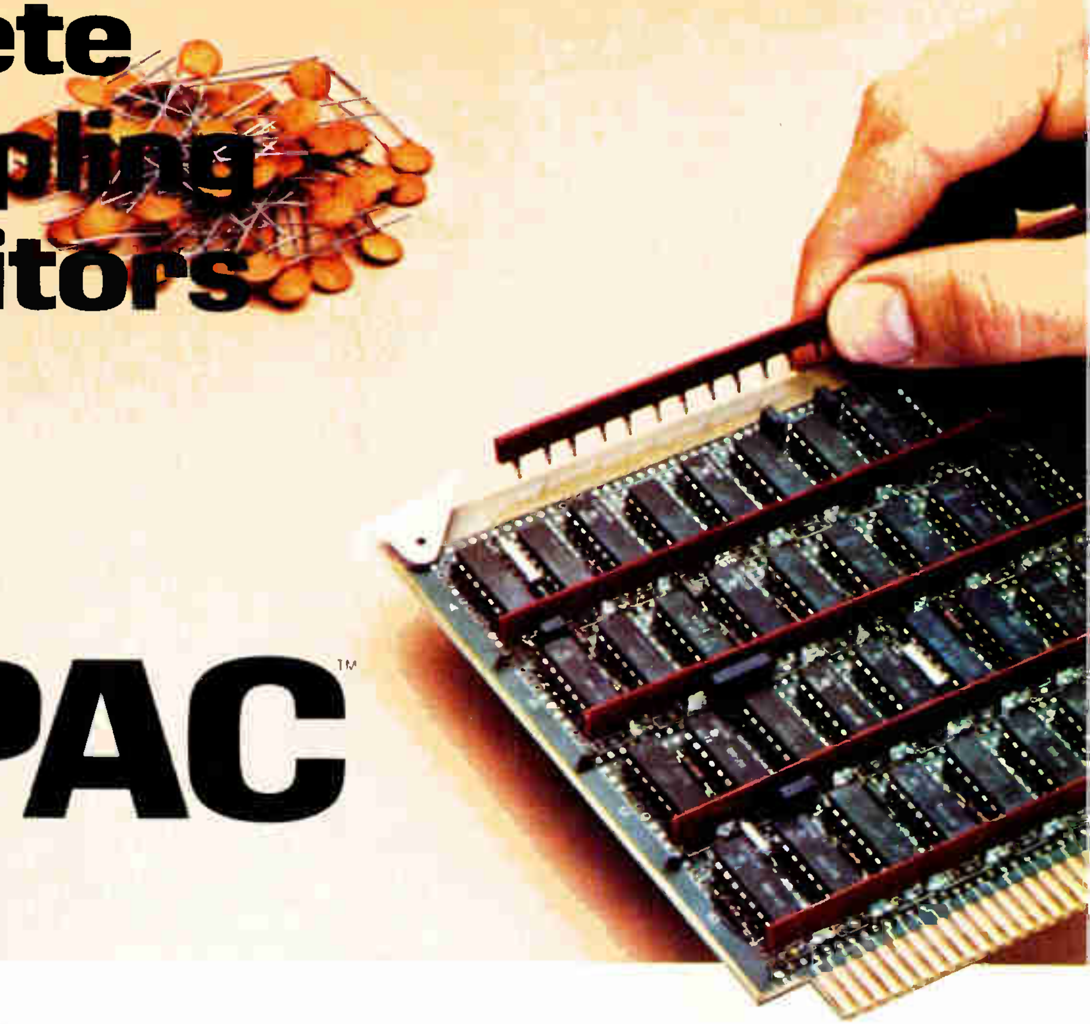

New, high capacitance Q/PAC* power distribution elements are the exciting, revolutionary way to eliminate decoupling capacitors from printed circuit boards. Rugged Q/PAC elements are easy to install and increase system reliability through reduced part count.

Q/PAC elements are available in capacitance values up to 0.05μf per inch in lengths up to 16 inches. Configurations allow for either vertical mounting or horizontal installation under DIP packages.

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Q/PAC elements feature a low dissipation factor, low inductance and low impedance.

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Data acquisition

D-a converters catch the bus

Monolithic 10-bit units have all logic needed for direct connection to Microbus

Monolithic 10-bit digital-to-analog converters with on-board circuitry for interfacing with microcomputer buses have been around only a relatively short time, yet the price and performance competition is already getting fierce. The latest entry into the field is a line of 12 converters from National Semiconductor Corp., which Al Tremain, product marketing manager, data-acquisition and -conversion products, claims are the first truly bus-compatible converters of this type because, in addition to double-buffered latches, they contain the control and other logic needed for direct microprocessor hookup. "They're Microbus-compatible," he boasts, "no one else on the market has done it."

Trademarked Micro Dac, the series comprises six basic parts: three 24-pin models with linearities of 8, 9, and 10 bits; and three similar models in 20-pin packages. The 24-pin units give the user a choice of left- or right-hand justification for the second, 2-bit, byte making up each digital input word to the converter. (The first part of each 10-bit word is, of course, a full 8-bit byte.)

All the plastic-packaged converters are guaranteed linear to within half a least significant bit over their operating-temperature range of 0° to 70°C. Six other devices, packaged in ceramic, have identical specifications, except that they operate from −40° to +85°C.

Key specifications of the new National parts include a current settling time to within 0.05% of full scale of 500 ns, a gain temperature coefficient of 0.0003% of full scale per °C, a total power dissipation of only 20 mW, and compatibility with transistor-transistor logic.

The Micro Dacs will operate from supply voltages between 5 and 15 V dc. The units also require an external voltage reference, which, of course, largely determines their absolute accuracy and drift.

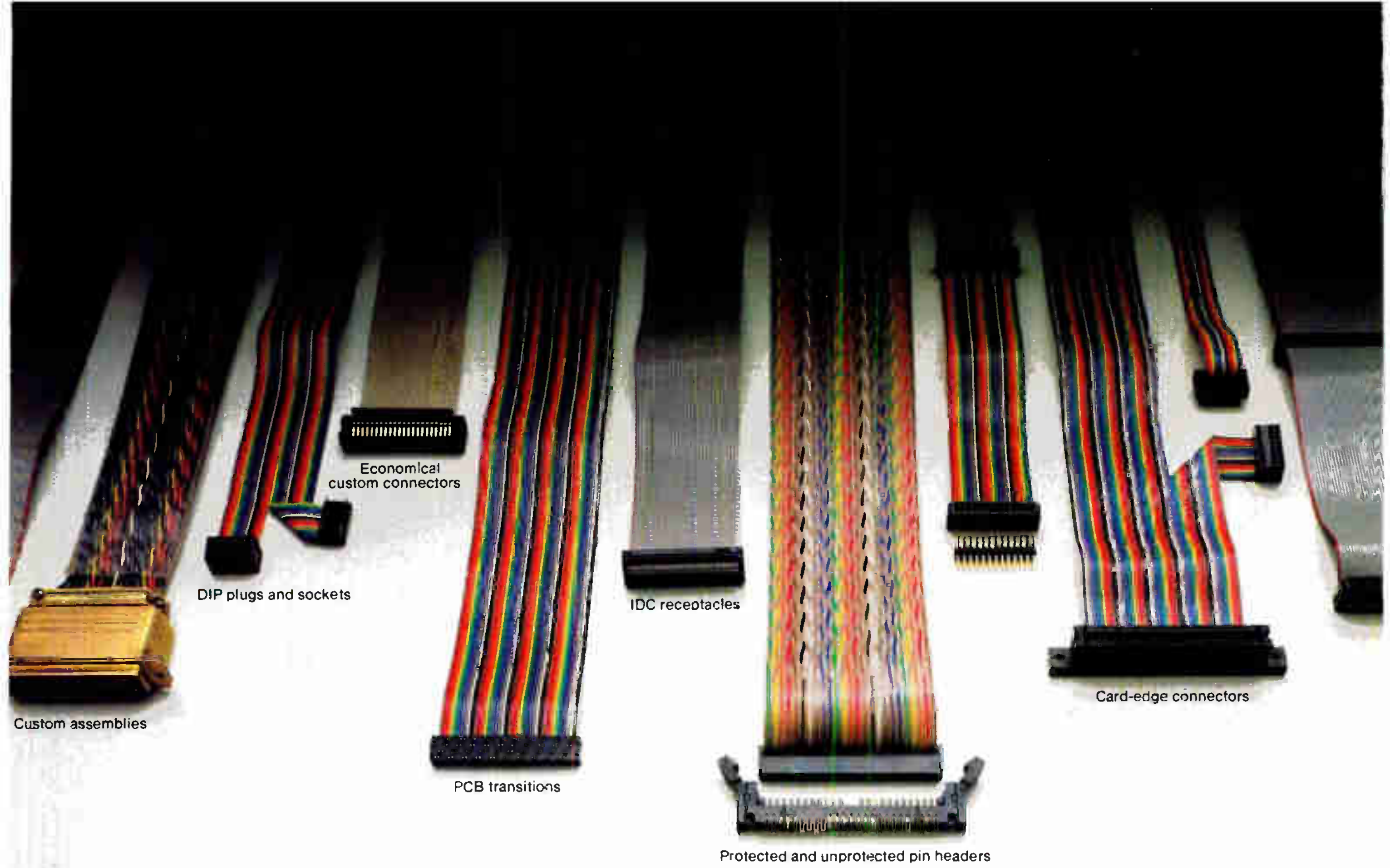
For the 24-pin plastic parts, 100-piece prices range from $9.70 for the 10-bit DAC1000 to $7.50 for the 8-bit DAC1002. For the 20-pin devices, the respective prices are $8.80 for the 10-bit DAC1006 and $6.65 for the 8-bit DAC1008. The converters are available now in sample quantities. They are scheduled to be in distributor stock in November.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 737-5000 [391]

1-MHz V-f converter has ±25 ppm/°C drift

Featuring a maximum nonlinearity of 0.02% of full scale, the latest voltage-to-frequency converter from Teledyne Philbrick also offers a low drift—±25 parts per million/°C. The 1-MHz 4719 V-f converter further expands the company's offerings in this area [*Electronics*, April 12, 1979, p. 188].

Applications for the device include



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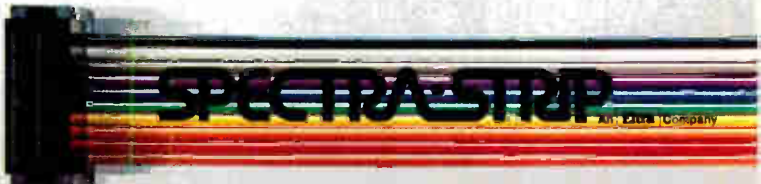
For the name and number of our nearest distributor or rep, write Spectra-Strip, an Eltra Company, 7100 Lampson Avenue, Garden Grove, CA 92642. Or call (714) 892-3361 today.



When you're down to the wire

Circle 18 on reader service card

high-resolution data links, phase-locked loops, high-voltage isolation, and two-wire digital transmission. Operating from 1 Hz to 1 MHz, the 4719 has a guaranteed common-mode rejection ratio (for output frequencies between 100 Hz and 1 MHz) of 60 dB. The common-mode voltage rating is ±10 V. The unit has a maximum zero offset input voltage (initial untrimmed) of ±5 mV which is trimmable to zero. Maximum drift of the zero offset voltage is specified at ±25μV/°C (from −25° to +85°C).

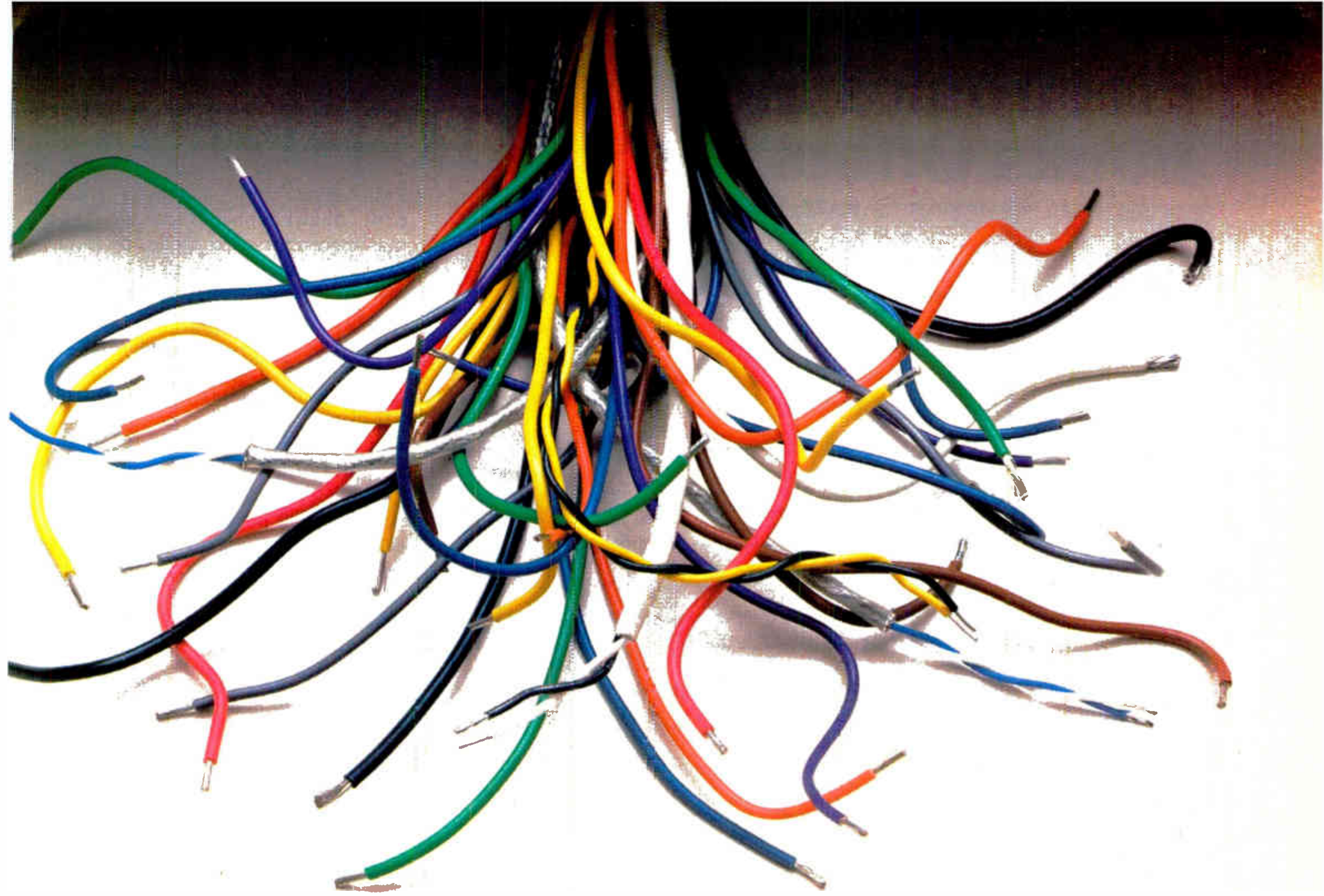
The output waveform is TTL-compatible pulses that are adaptable to C-MOS and HNIL circuits. The 4719 has a settling time to 0.01% for a full-scale input step of one to two pulses of the new frequency plus 5 μs.

Priced at $90 in single quantities, the 4719 is available from stock.

Teledyne Philbrick, Allied Drive at Route 128, Dedham, Mass. 02026. Phone (617) 329-1699 [394]

Waveform recorder uses master-slave combo

Providing a different approach to the task of simultaneous, multichannel data recording, the model 2805 is a dual-channel waveform recorder. The system consists of the 2805 master unit, which offers full performance dual-channel recordings and provides an 8-bit word per sample (with a maximum of 2,048 words per channel memory capacity) operating at up to 5 MHz, and the



We'll take it from here.

Let's face it, interconnections can really leave you at loose ends.

So we're offering to take total responsibility for solving your mass termination problems.

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When you're down to the wire

Circle 22 on reader service card

2805 slave unit—a master-dependent dual-channel recorder. The master can be used alone, or interfaced with up to three slave units, to provide up to eight channels of synchronous recording.

Pretrigger and delayed trigger recording modes allow information to be captured before a selected trigger event, around a trigger event, or at a selected interval after the event. Samples are stored in solid-state memory. Sample rates vary between 0.2 μs to 100 ms per sample and are selectable through an internal time base or derived from an external clock input to the 2805. The unit features an input impedance of 1 MΩ in parallel with 25 pF, which causes little loading to external circuits. Input bandwidth per channel is 1.25 MHz.

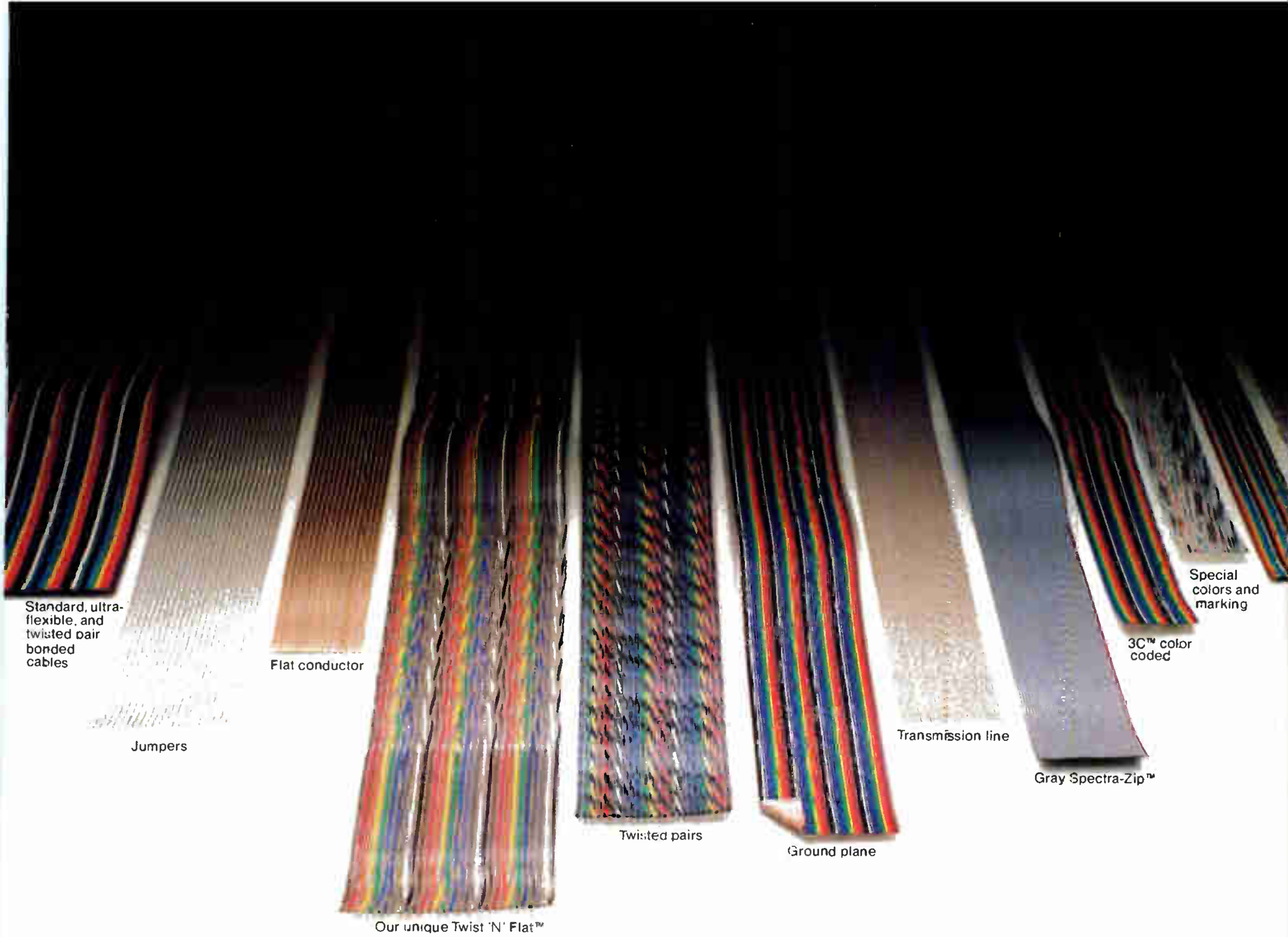
After the data is stored, it may be displayed on a number of CRT monitors or oscilloscopes. The 2805 reconstructs stored data through a digital-to-analog converter at a rate of 1 MHz. Data may be transferred to a digital memory, to a calculator, or to a computer by digital access to the 2805's memory through a bit-parallel word-serial handshake data exchange.

Designed for high-speed, high-resolution transient-event signal capture, the 2805 master unit sells for $5,250; the slave unit is priced at $4,200. Both units are available within 90 days.

Gould Inc., Biomation Division, 4600 Old Ironsides Dr., Santa Clara, Calif. 95050. Phone (408) 988-6800 [393]

Synchro-to-digital converters track at 129,600°/s

Designed to provide a low-cost solution to the growing requirements for higher velocities in industrial applications, the 168L series of synchro/resolver-to-digital converters accepts frequencies of up to 10 kHz. Available in 10-, 12-, and 14-bit versions (with resolutions of 0.352°, 0.088°, and 0.022°, respectively), the converters offer maximum tracking rates from 10,800° to 129,600°/s at a



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SPECTRA-STRIP An Eltra Company

When you're down to the wire

Circle 30 on reader service card

reference frequency of 2,600 Hz.

These units can accelerate at rates ranging from 22,000° to 3,159,000°/s² (at a 1-least-significant-bit lag) with a K_A from 1,000,000 to 9,000,000 s^{-2}. Accuracies vary according to the resolution selected: ±4 minutes (±0.9 LSB) for a 14-bit converter, ±30 minutes for a 10-bit converter. The 168L will accept inputs of 11.8 or 90 V rms.

The devices are priced at $215 to $395 in small quantities. Initial delivery is two weeks after receipt of order.

Control Sciences Inc. 8399 Topanga Canyon Blvd., Suite 303, Canoga Park, Calif. 91304. Phone (213) 887-7344 [395]

Units transmit and receive data for microprocessors

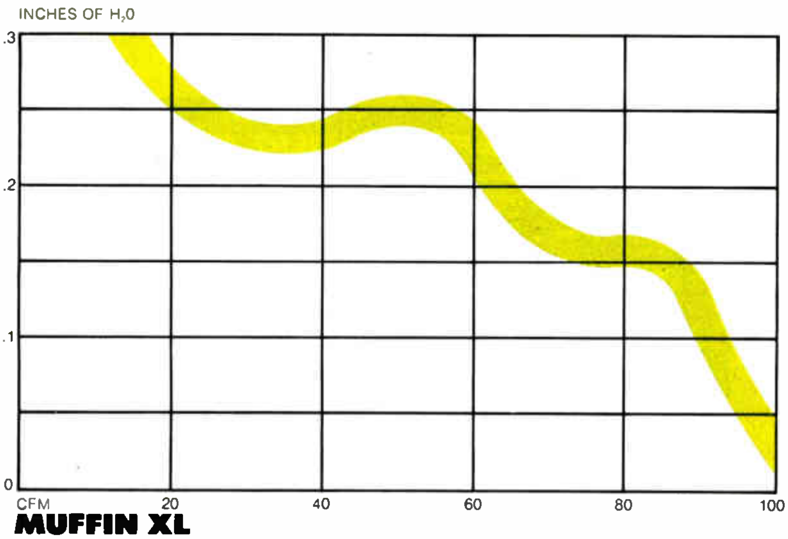
Consisting of an eight-channel analog data transmitter and a combination receiver and computer interface, the ADS100 is a data-acquisition system intended for use with the 8080, 6800, and 6502 microprocessor systems. The data transmitter converts the multiplexed analog inputs into a serial data train by means of a precision voltage-to-frequency converter. The serial data is then sent to the receiver over a two-wire transmission line. Control pulses from the computer interface are sent along this same line back to the data transmitter to control the selection of the analog input channels.

The data transmitter is available with an input from 10 mV to 5 V or 10 mV to 10 V, with output frequencies of 0 to 15 kHz, or 0 to 100 kHz. The receiver-computer interface uses a line or crystal time base counter and is expandable to eight data transmitters by means of a relay accessory card. It provides an 8-, 11-, or 12-bit counter with respective read-in times (for eight channels) of 226 ms, 100 ms, and 200 ms.

Prices for the data transmitter start at $27.95 and for the receiver interface at $47.95. Delivery is from stock to six weeks.

Mauro Engineering, Route 1, Box 133, Mount Shasta, Calif. 96067 [397]

ROTRON PROUDLY INTRODUCES ITS NEW IMPROVED LINE.



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Write to: Commercial Products Div., Rotron Inc., Woodstock, N.Y. 12498, (914) 679-2401.

Rotron B.V., Oosterhout, Netherlands, Tel: 1620-32920.

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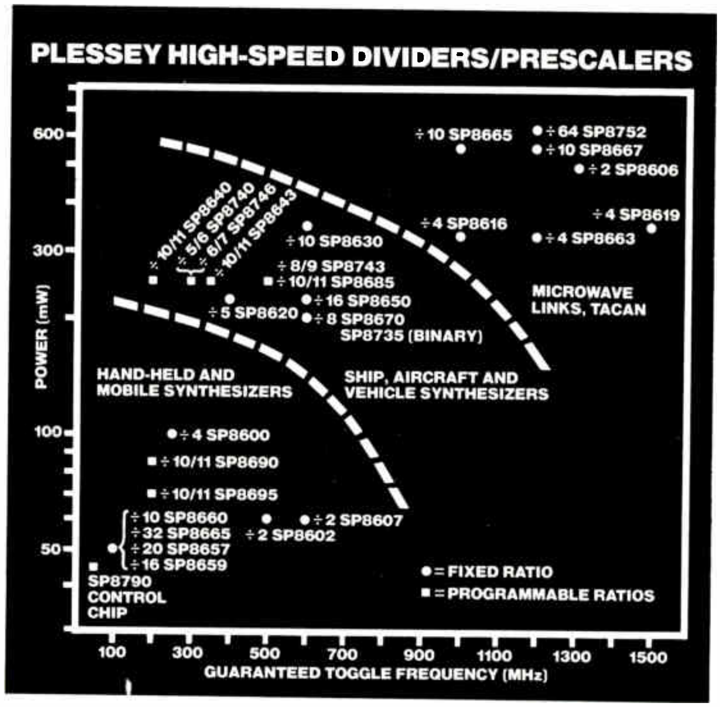

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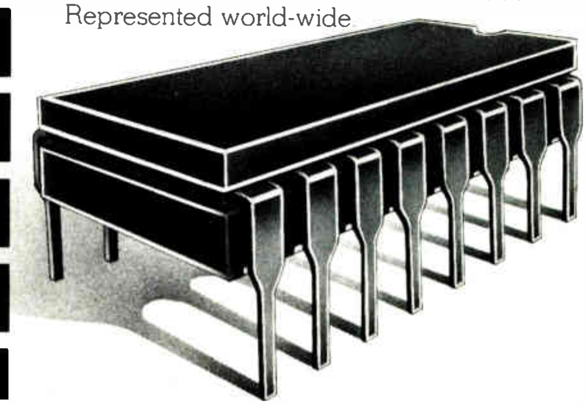

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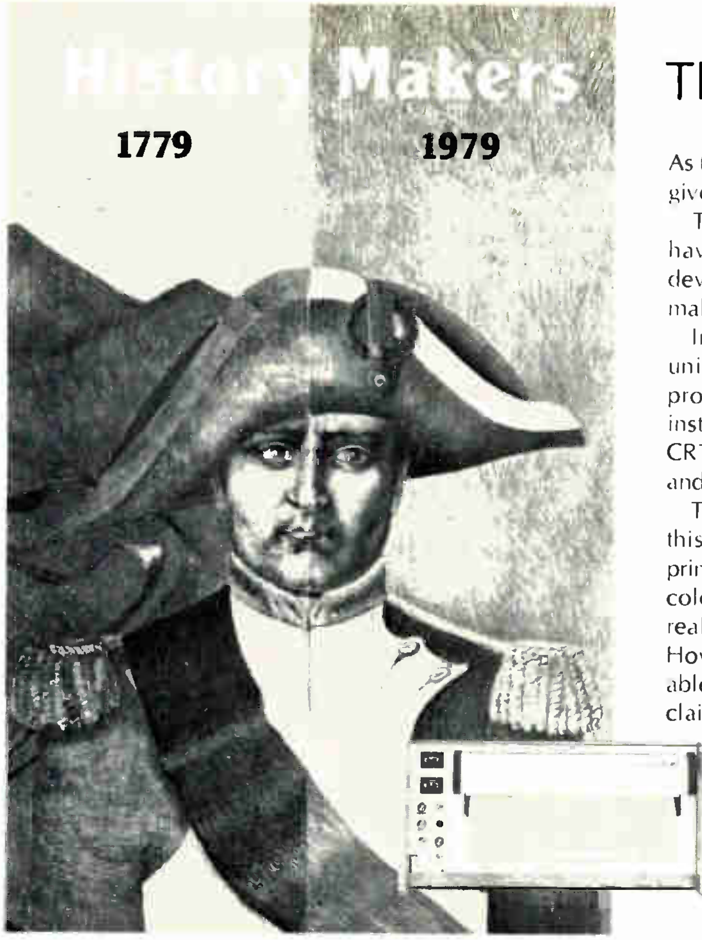

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sepic

Circle 46 on reader service card

Instruments

Unit measures fiber attenuation

Rugged optical instrument works over 8 decades from 0 to −80 dBm

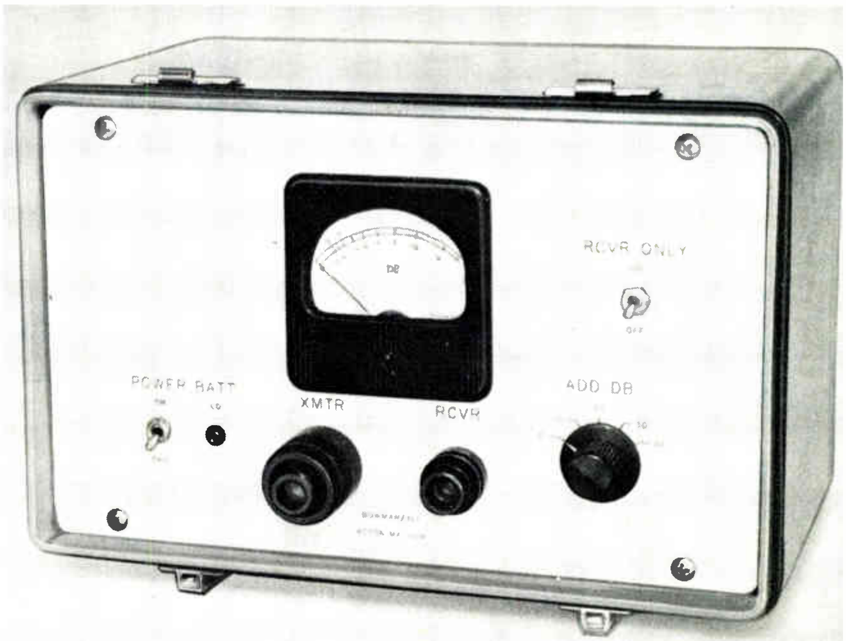
Much laboratory equipment is available for measuring the performance of optical fibers, but there is little gear for the person who has to service fiber-optic systems in the field. One of the few units is the model 650 from Bowmar/Ali Inc.

The model 650 is a fully self-contained measurement system capable of making receive-only or transmit-receive measurements of attenuation in optical transmission systems. Because of some innovative design tricks, it is nearly as accurate as lab systems, despite its rugged exterior.

According to Robert Livingston, the 650's design engineer, the unit presents an optical fiber with a wave front perpendicular to the fiber's axis. Since the light wave and the fiber meet face to face, the light propagates down the optical waveguide in single-mode form. This contrasts with most available measurement systems, which present a curved wavefront to the face of the fiber. Livingston notes the present industry controversy about whether and how such multimode propagation degrades measurement accuracy, but says it really should not matter to users of the 650.

The device measures attenuation in decibels over an eight-decade range from dBm to −80 dBm. Operation is simple: the user just attaches the ends of the fiber to be measured (in the case of a closed-loop measurement), turns on the 650, and adjusts the range switch until the system's analog meter yields a mid-range reading. Measuring the performance of fibers equipped with connectors is simply a matter of plugging in the fibers and flipping switches. But with the 650, it is also easy to work with bare fibers, without loss of measurement accuracy.

Bowmar is offering a clamp-equipped connector with the 650 to grasp the outer covering of the fiber, making a tight fit around the fiber itself. The fit is so accurate that an almost perfectly flat face is obtained when the fiber is scribed with the supplied carbide blade and then broken. The whole operation, from fiber preparation and connector at-



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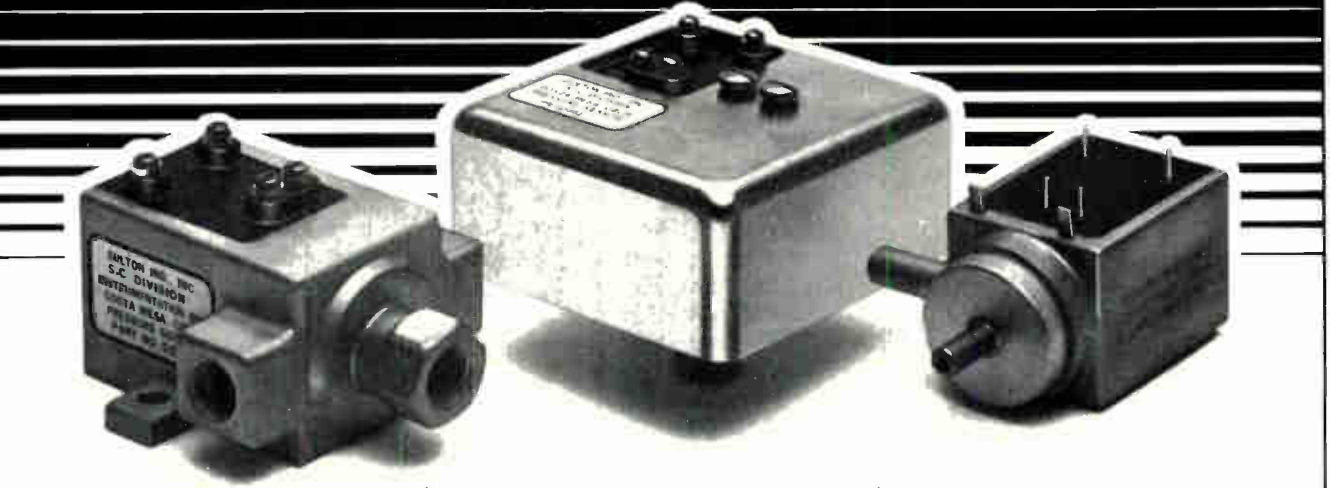

"Anywhere" means just that! Whether you have a new application or an existing design that needs a more accurate and reliable pressure transducer, Gulton's GS Series has the special features that combine for optimum system performance:

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- Input power of less than 1/2 watt from any 9-12 VDC source.
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"Now" means you won't have to wait to verify the GS Series' price/performance advantages. Gulton's in-factory stock gives you 12 pressure ranges to choose from so that we can ship your urgently-needed 'first-article' pressure transducer anywhere — now.

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S•C Division

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Standard pressure ranges:

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☐ 0 to 20 psi ☐ 0 to 1000 psi
☐ 0 to 30 psi ☐ 0 to 2000 psi
☐ 0 to 50 psi ☐ 0 to 3000 psi
☐ 0 to 100 psi ☐ 0 to 5000 psi

☐ Absolute ☐ Gage ☐ Differential

My ☐ Visa ☐ Master Charge card number is: ____________

NUMBER EXPIRATION DATE

Please send my GS Series transducer to:

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tachment to cleaving, takes 10 to 15 minutes. In contrast, the epoxied connectors normally used for optical fibers take a minimum of 5 to 20 minutes longer to attach. It may take much longer if the epoxy cannot be cured with a heat gun—and a technician may not have a heat gun atop a telephone pole.

The calibrated LED transmitter in the 650 operates at a wave-length of 900 nm; Bowmar claims that LEDs in different 650s are less than 1% apart in output amplitude. Thus, two 650s can be used at opposite ends of fiber-optic links and the readings will be meaningful, which is not always the case with some uncalibrated instruments.

Measurement repeatability is better than 1%, according to the firm, with resolution down to 0.1 dB. Absolute accuracy is well within ±0.5 dB in all except the −80-dB range, where Bowmar specifies ±1 dB.

The 15-lb device measures 11 by 7 by 10 in.; it includes a built-in battery pack and charger as standard. Wavelengths other than 900 nm are available on special order, as are adapters for a variety of fiber sizes.

The model 650 is priced at $850; deliveries will begin in the first quarter of 1980.

Bowmar/Ali Inc., 531 Main St., Acton, Mass. 01720. Phone Hajo Koester at (617) 263-8365 [351]

System allows analog, digital switching for GPIB designs

Offering a practical method of analog and digital switching within an IEEE-488-bus-based system, the series 1200 universal switching system from Racal-Dana Instruments allows the analog inputs and outputs of off-the-shelf instruments to be interfaced as easily as the general-purpose interface bus (GPIB) allows their digital programming inputs and data outputs to be interfaced.

The 1202 is a microprocessor-based mainframe that uses a 6802 microprocessor to provide a GPIB interface, built-in diagnostics, self-test, and master control of switching modules. There are six different modules that may be mixed and matched into the mainframe to handle a variety of analog signals.

The 1212 is a power-switching module designed for switching the outputs of dc power supplies and for ac-line-voltage switching. The 1213, a low-level switching unit, is designed for signals up to 50 V rms, whereas the 1214 is a high-voltage device guaranteed for dynamic operation up to 750 V dc. Both of these models feature less than 1 μV of error due to thermocouple action and also offer extremely low contact resistance, even at low current levels.

The 1215 is a high-impedance radio-frequency switching module with a 100-MHz bandpass, whereas the 50-Ω 1216 provides microwave and fast-pulse switching up to 18 GHz. Both may be used to switch frequencies at the dc level.

The 1211 TTL-switching unit may be used as a GPIB-to-parallel converter for programming binary-coded-decimal and other parallel programmable instruments. The module also contains power sinks capable of driving external relays, lamps, and other components.

The 1202 mainframe unit accepts up to five of these individual modules of any type or mix. If the user requires additional units, a 1203 slave chassis is offered.

The 1202 mainframe sells for $1,195, while the 1211 and 1212 are priced at $250, the 1213 at $350, the 1214 and 1215 at $600, and the 1216 at $750. Delivery on these items is within 30 days.

Racal Dana Instruments Inc., 18912 Von Karman Ave., Irvine, Calif. 92714. Phone (714) 833-1234 [352]

Tester for RAMs, ROMs and PROMs has 0.5-ns accuracy

Designed for use by manufacturers and users of semiconductor memory components in production testing, incoming inspection, and device characterization and evaluation, the

Our 3-terminal switching regulator gets OEMs over the toughest hurdle.

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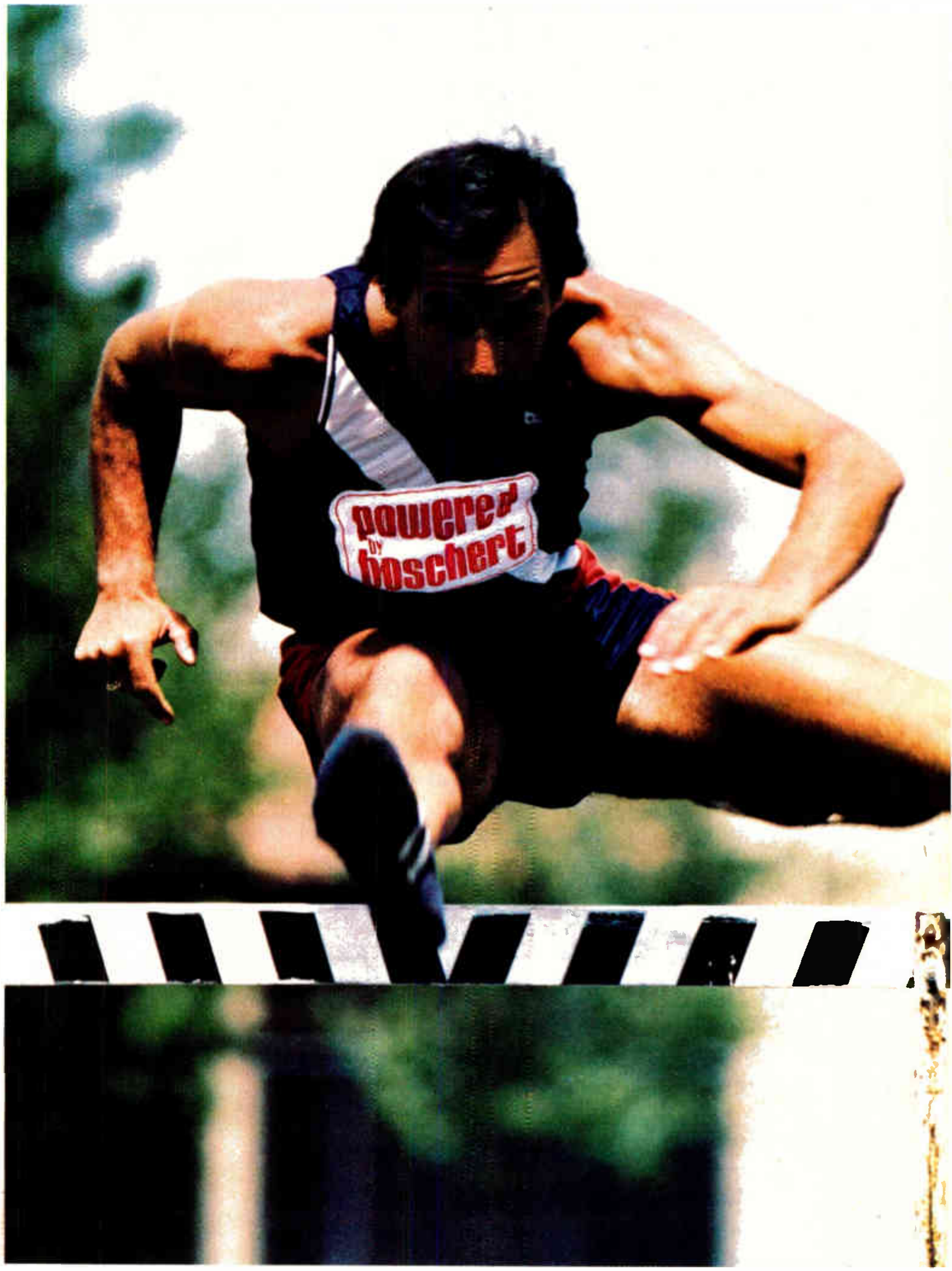
Manufacturing your own switching power supply can be a big money saver. But designing it can be risky and time-consuming.

Today Boschert solves the most difficult problem of building your own hybrid switching power supplies with our new low cost 3-terminal switching regulator. It gives you a perfectly matched set of magnetics, logic and power circuits to 12 amps—all on a single 4" x 5" board. The 3T switching regulator is bound to save you design time and production cost. It will get your systems to market sooner—without the risk.

For designers working with microprocessor systems or battery backups, this regulator is ideal. (See specs left) If needed, DC voltage can be distributed to various 3T submodules throughout a system to eliminate voltage drop problems. And since hybrid power supplies have built-in isolation and low leakage, the 3T regulator is perfect for medical equipment, too.

At Boschert, we've been building off-line switching power supplies for nearly a decade. Over 100,000 of our multiple output power systems are now in operation. For any power requirement between 25-400 watts, at any volume level between 1 and 1000 a month, Boschert sticks with you. Today Boschert also sticks with OEMs who want to produce their own.



For more information on how our new 3T Switching Regulator takes the guesswork out of hybrid switching power supplies, contact your local Boschert representative. Or write Boschert, Inc., 384 Santa Trinita Avenue, Sunnyvale, CA 94086. Or call (408) 732-2440.

boschert SWITCHING POWER SUPPLIES

New products

J387A memory test system tests dynamic and static random-access memories of up to 64 kilobits, read-only memories, and programmable read-only memories. The system is available as an upgrade of the J387 (through additional software and hardware) or may be acquired as a new system.

The J387A features 0.5-ns accuracy at the pins of the memory under test. The cycle times and clock delays in the J387A derive from a 62.5-MHz, crystal-controlled oscillator; precision delay lines divide the 16-ns oscillator period into 1-ns increments with an accuracy of better than 0.5 ns.

The system also offers a pattern generator to test dynamic RAMs at an unrestricted 20 MHz (40 MHz for static RAMs, using software controlled OR-tying of clocks) and 16 independent timing sets for testing 5-V address-multiplex, page-mode memories.

The computing controller (M365CX), an 18-bit processor that regulates the system's instrumentation, is used for test-program preparation and analysis of test results. It is supplied with a 16-kilobit memory that can be expanded in 16-K increments to a maximum of 256-K. The mainframe contains the pattern generator, digital-to-analog converters, a precision measurement system, and the power supplies for the system. A real-time-bit mapping (RTBM) option may be added to the pattern generator to identify the memory cells that fail during a functional test. And finally, each individual test station contains 11 timing circuits to provide clock pulses to the memory under test as well as the internal system timing.

In a typical configuration, the J387A sells for about $155,000. If the system incorporates the full

Data Integrity Control with just one chip.

Signetics' new 2653 brings you Bisync in firmware...fast!

Here's high-speed intelligence to distinguish control characters from data. All on one chip. Our new 2653 data integrity controller. Since it supports transparency, the 2653 tells you when DLE is not DLE. *So your CPU can do other work.*

Fully programmable, it packs a 128-character-class RAM for complete format control. And that makes it easy to tell the difference between control and data characters—in EBCDIC, ASCII or six-bit codes.

Riding atop your microprocessor's data bus, the 2653 speeds data checking with throughput of 4 million bits/second. It also shrinks design time while it cuts development costs. Use it and save a half-board of standard logic plus about 100 lines of programming.

Need high-speed error detection via CRC? It's a breeze with the 2653—the only IC that computes and checks CRC *intelligently and in parallel.*

This versatile part simplifies error checking and detection in almost any mode: block-check, single-character, two-character sequence, or parity generation and checking. The 2653 does it all.

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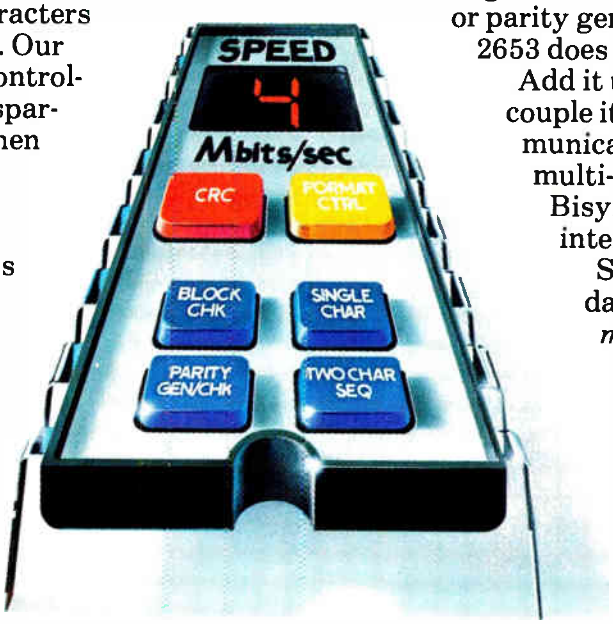
So when your design calls for data transfer, *even within magnetic media controllers,* specify our one-chip simplifier. Write us today.

Or contact your nearby Signetics sales office or authorized distributor for full information.



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I want to cut design costs immediately. Please have an applications specialist phone me at:

(   )__________ ext._____

range of options, including an RTBM, the price will be about $230,000. Every system is supplied with operating, utility, applications, and maintenance software. The delivery time is between 24 and 26 weeks.

Teradyne Inc., 21255 Califa St., Woodland Hills, Calif. 91367. Phone (213) 888-4850 [354]

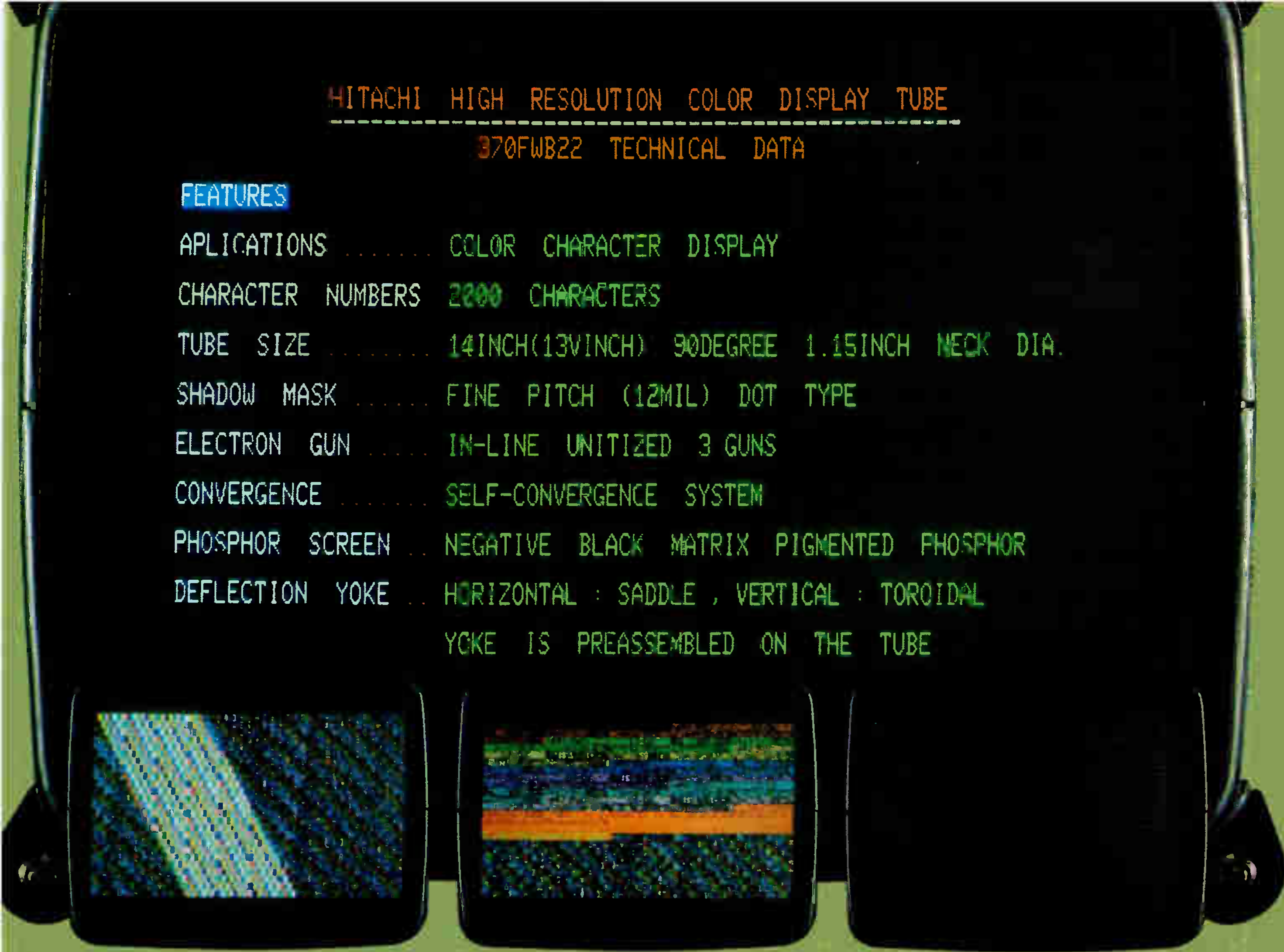
4½-digit DMM features 39 ranges, 7 functions for $299

The 8050A is a 4½-digit multimeter that can function both in the lab and in the field. The instrument has 39 ranges and seven functions, as well as a large high-contrast liquid-crystal display, and optional rechargeable-battery operation. It provides accurate true-rms measurement of non-sinusoidal waveforms to beyond 50 kHz.

Two ranges of conductance measurement extend the resistance measuring capabilities of the unit to 10,000 MΩ, allowing measurement of such parameters as capacitor leakage and leakage of printed-circuit boards, cables, and insulators, as well as measurement of transistor beta and leakage directly using a test adapter. The 8050A has the capability to measure ac volts in decibels across any one of 16 user-selectable impedances. The unit can also memorize any measurable level and use it as the 0-dB reference point.

Low-power, ohms, and diode tests allow testing of silicon diodes and transistor junctions using one of three marked resistance ranges. The resistances of in-circuit components other than semiconductors may be found with one of the three other ranges. Maximum common-mode voltage (low terminal potential with respect to power-line ground) is 500 V dc or peak ac. The optional battery pack uses nickel-cadmium batteries, with a six-hour minimum operating time and a recharge time of 14 hours. The basic bench instrument sells for $299.

John Fluke Manufacturing Co., P. O. Box 43210, Mountlake Terrace, Wash. 98043. Phone (206) 774-2211 [353]



Hitachi's 370FWB22 Speaks for Itself...Beautifully

The Hitachi 13V-inch High Resolution Color Display Tube 370FWB22 is an integral tube component system. That means the yoke and all other components are preassembled, and adjustments for purity and convergence are not required.

Obviously, it's not just another computer display terminal. It gives both character and graphic display, with the following colorful features:

- 13V-inch (335.4 mm) visual screen diagonal
- 90° deflection and 29.1 mm diameter neck—lower power consumption
- 2000 alpha-numeric characters displayed
- Inherent self-converging system with saddle-toroidal yoke—dynamic convergence not required
- Unitized in-line, high-resolution electron gun—bi-potential focus type
- Internal magnetic shield
- Dot type black matrix screen—improved contrast and high resolution
- Temperature-compensated shadow mask assembly—stable color purity
- Banded type implosion protection with mounting lugs
- Quick-start cathodes

What's more, it has an optional non-glare, anti-reflection treatment screen, and red, green and white type phosphors are also available. And our 20-inch model, No. 510VFB22, comes with a fine-pitch dot type shadow mask for the black matrix screen.

If you prefer, there are Monochrome CRTs available in sizes of 5.5, 7.5, 9, 12, and 14 inches to match your needs.

For more information, contact Hitachi:

HITACHI

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Hitachi, Ltd.
Electronic Devices Group
6-2, Otemachi 2-chome, Chiyoda-ku,
Tokyo 100, Japan
Telephone: Tokyo (03) 270-2111
Cable: "HITACHY" TOKYO
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P.I.E. Building, 2 Rubastic Road, Southall, Middlesex UB2 5LF

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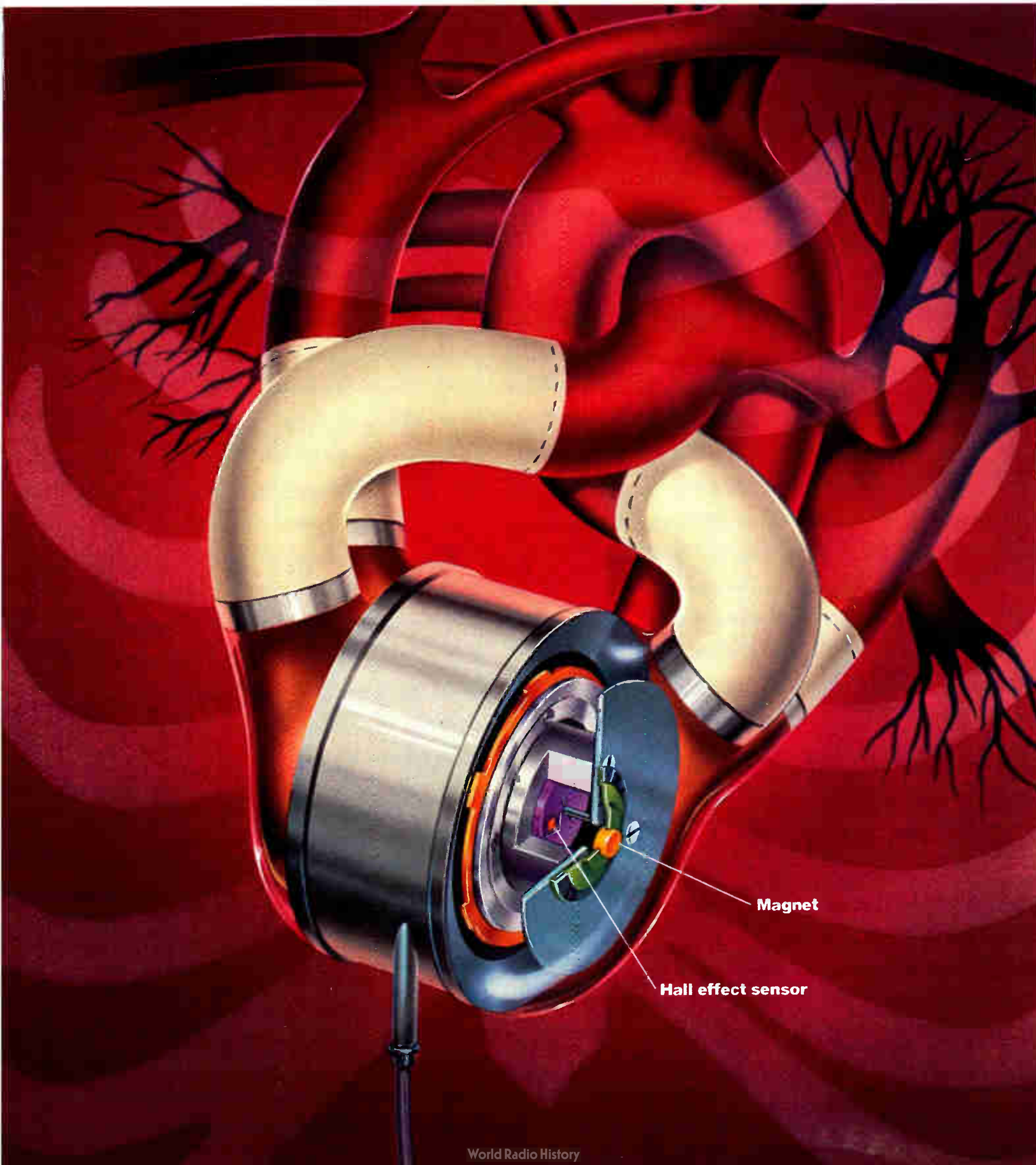
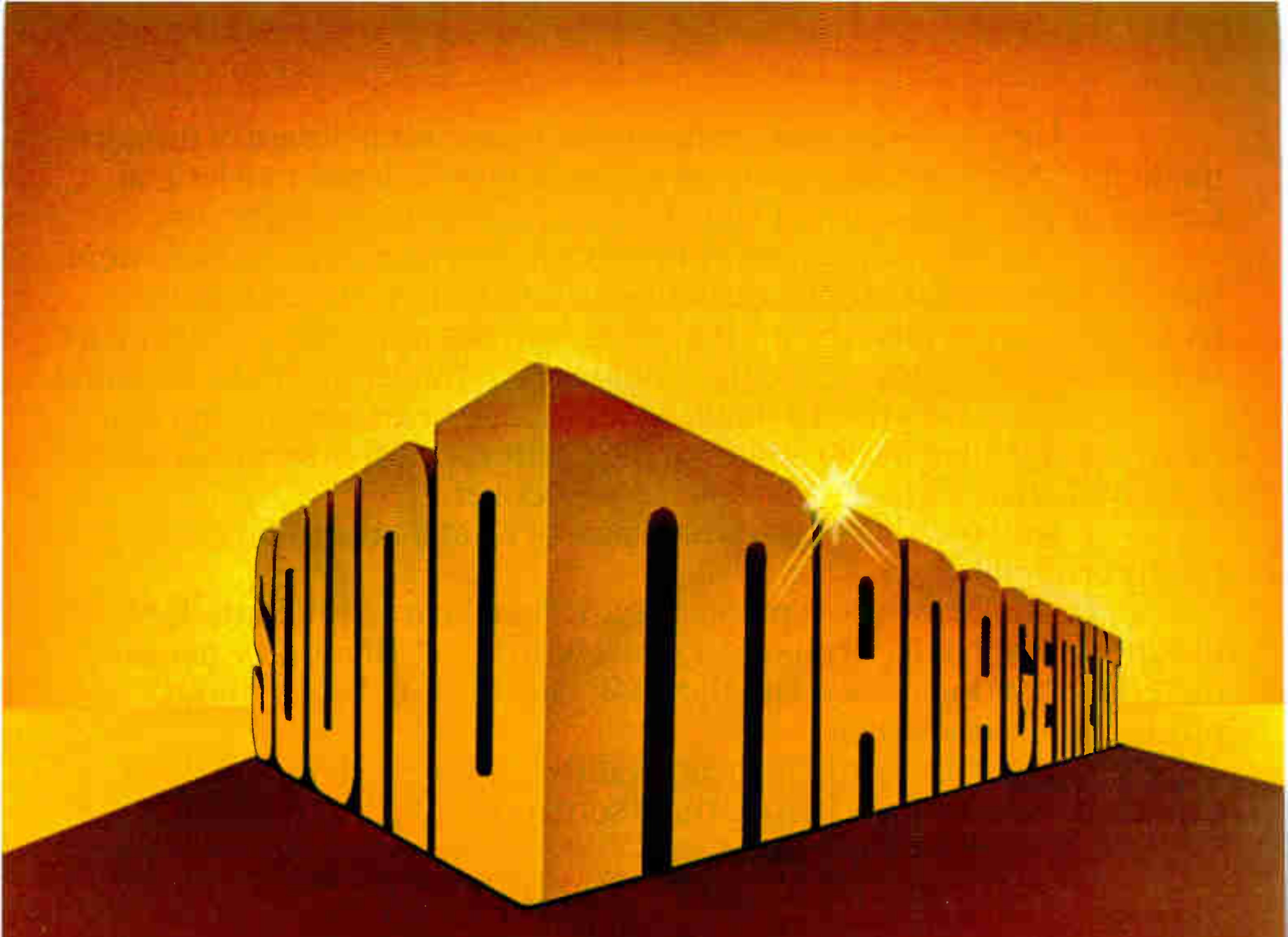
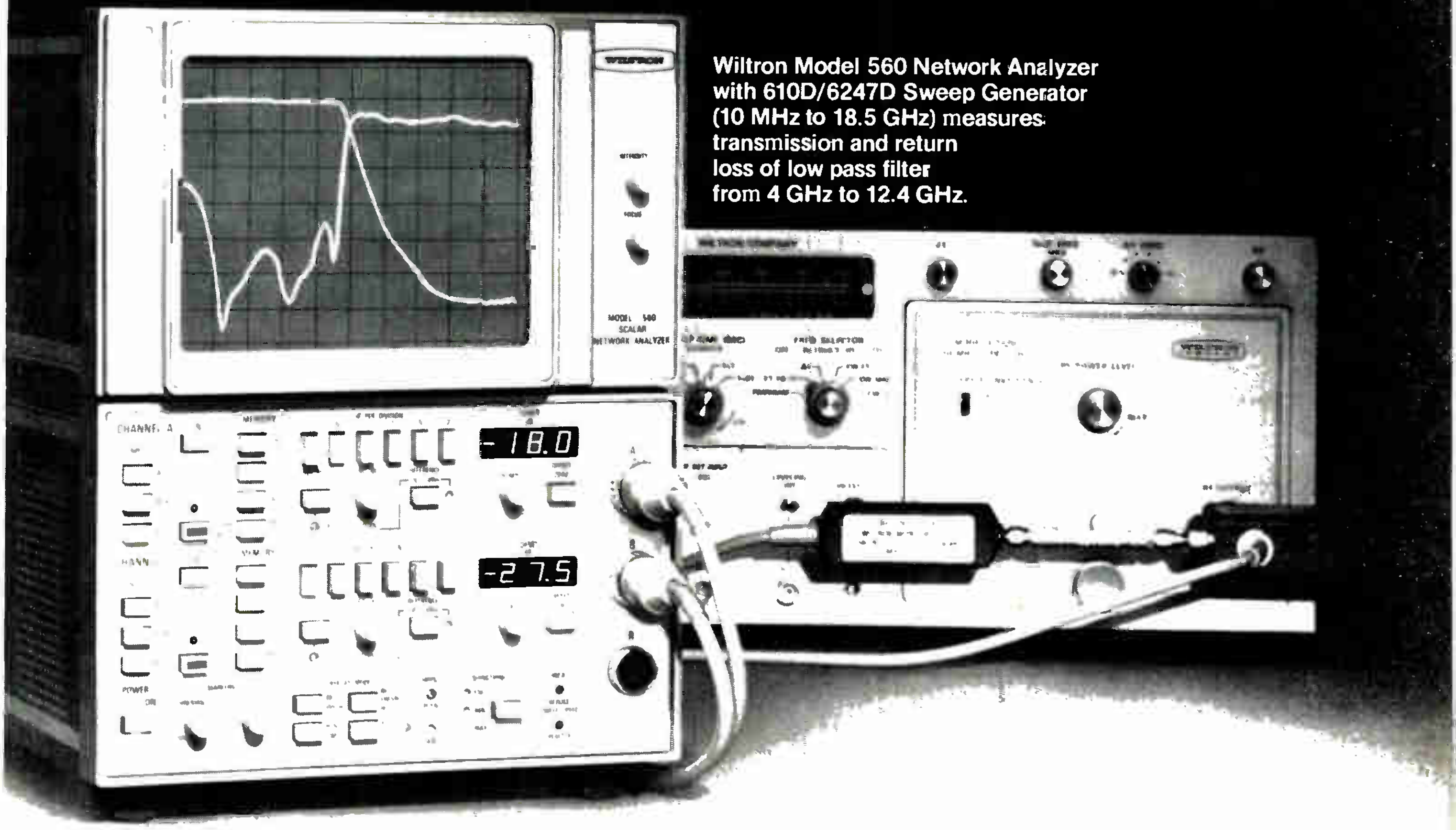
Circle 92 on reader service card

At Penn State's Hershey Medical Center, they needed a sensor that would last a lifetime.




SOUND MANAGEMENT



A new era Network Analyzer. 10 MHz to 34 GHz. It's a Wiltron.

There's a better network analyzer out now. It's the new Wiltron 560 Scalar Network Analyzer for the 10 MHz to 34 GHz range. It's GPIB compatible so you can make both automatic and manual measurements of transmission loss or gain, return loss (SWR) and absolute power. It has a superb dynamic range of 66 dB (+16 dBm to −50 dBm).

Error proof and so easy to use.

We've done a lot to stop errors and simplify measurements. For instance, there's a display mode for every application. Look at events in Real Time or in the Refresh display mode. In Refresh, data is digitized and updated each sweep for a steady flicker-free display, regardless of the external sweep speed. You can also freeze the display for analysis or photography. Press the X-Y Plot button for a 30-sec. sweep to drive a recorder.

There's memory in the new 560. System residuals, including test-port mismatch errors, are stored and subtracted automatically from test data. Throw away your grease pencil. Memory also automatically averages open/short reflections, eliminating cumbersome and inaccurate estimates of the 0dB return loss reference.

Better in a system, better alone.

Wiltron's 560 offers GPIB programmability and 0.01 dB resolution. With 40 dB directivity from a 10 MHz to 18 GHz SWR Autotester, you get unmatched accuracy. Broadband components let you make uninterrupted measurements over more than 10 octaves. A new WSMA (SMA compatible) detector has an upper frequency limit of 34 GHz.

Prices begin at $5900.

At $5900 for the manual unit or $7250 with GPIB, the 560 is an exceptional value in microwave instrumentation. A fully automated turnkey system (Model 5610) is available too.

For an early demonstration or more data, phone Walt Baxter, (415) 969-6500 or write Wiltron, 825 East Middlefield Road, Mountain View, CA 94043.

WILTRON

Circle 95 on reader service card

±0.15dB transmission measuring accuracy.

ME447A

ME446A

Absolutely first-class performance...

And just the type you can expect time and again from Anritsu's Transmission Measuring Sets. These sets come in two configurations. The ME447A consists of the Synthesized Level Generator MG442A, the Level Meter ML424A and the Level Comparator MN415A. This set offers the advantage of effortless gain and loss measurement, complemented by a convenient digital readout. The ML424A in particular can readily accommodate an optional psophometer for measuring the noise levels of telephone and sound program circuits. The weighting filters used meet the requirements of CCITT recommendations (P-53, J-16). Also available is the ME446A Transmission Measuring Set, which consists of the MG442A and ML424A, for more modest requirements. The MG442A and ML424A offer frequency characteristics of ±0.1dB, enabling the set to perform end-to-end measurement of carrier system with great accuracy.

ME447A

Frequency range	10Hz to 20MHz
Transmission measuring accuracy	±0.15dB (0 to 30dB) ±0.3dB (30 to 75dB)
Level measuring range	−60 to +20dBm
Impedance	75Ω unbalanced (10Hz to 20MHz) 75Ω/150Ω balanced (4 to 650kHz) 600Ω balanced (30Hz to 150kHz)

For comprehensive literature on the Transmission Measuring Sets, contact—

Anritsu

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Circle 104 on reader service card

Communications

Filter measures phone line noise

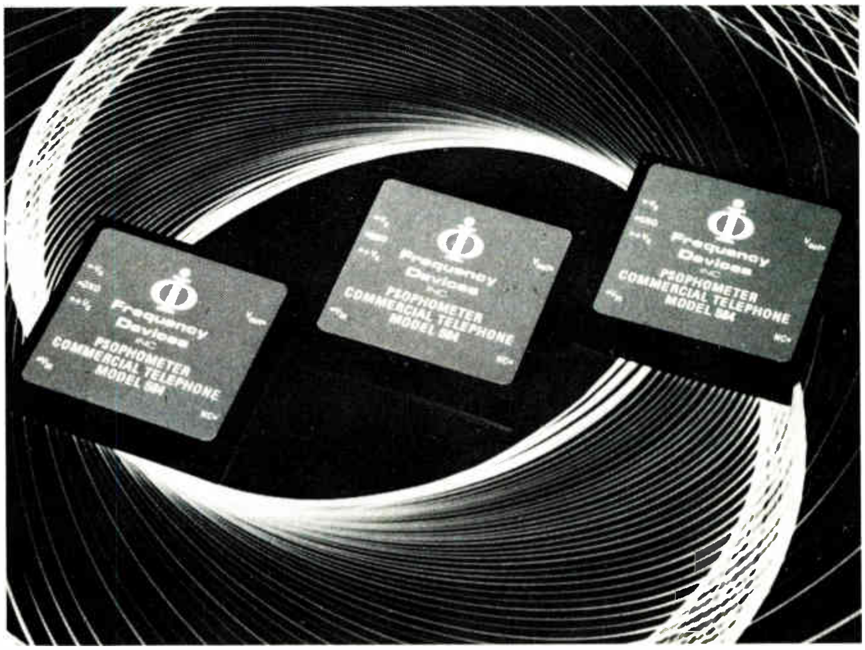
Psophometric unit has 1-dB gain at 1,000 Hz, sells for $55 in small lots

A quick way to determine if the noise in a telephone system is too great for the signal is to measure the signal-to-noise ratio with a psophometer. At the heart of this type of instrument is a psophometric filter. Frequency Devices Inc. is now offering active psophometric filters, which, when used in a psophometer, allow the noise power that they pass to be compared with an 800-Hz reference tone.

The International Consultative Committee for Telephony and Telegraphy (CCITT) came up with the psophometric curve as a noise-weighing tool. Similar to the C-message noise measurement system in the U.S., the psophometric approach is a simulation of the ear's response to noise degradation in speech transmission over 300-to-3,400-Hz telephone lines.

The center frequency of the CCITT curve is 1,000 Hz, the rolloffs on either side of which are a nightmare for active-filter designers. But Frequency Devices' filter makes such design work easier. The filter has a 1-dB gain at 1,000 Hz and unity gain at 800 and 1,200 Hz. Above 1,000 Hz, rolloff begins at 3 dB per octave, but above about 3,000 Hz, it plummets downward at more than 50 dB per octave. Below 1,000 Hz, there is an initial 3-dB-per-octave rolloff to about 450 Hz, then a 12-dB-per-octave rolloff below that to about 300 Hz, where there is another knee, and rolloff proceeds at 21 dB per octave. Attenuation is 85 dB at 16.66 Hz and 43 dB at 6,000 Hz.

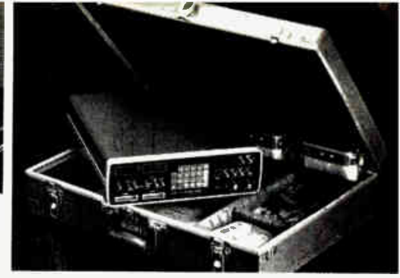
Despite its internal complexity, this filter should fit easily into any psophometer. It can operate from impedances as low as 600 Ω, a standard in most telephone systems. Its ports are short-circuit–protected and can withstand ±18 V without damage. Output impedance is less than 1 Ω; rated output is ±10 V. Supply requirements are simple; any bipolar supply with voltages between 5 and 18 V will suffice, and current demands are typically about 1.5 mA and 4.5 mA at most. The filter's own noise is low, being specified at 50 mV root mean square, which is well below masking thresholds typical of



Use our 532 stand-alone.

Or with a scope.

Operate it from a terminal.



It's portable.

The best way to troubleshoot a microcomputer is with another microcomputer. Ours.

The Paratronics Model 532 looks like a logic state analyzer. But it's more. It's really a powerful microcomputer programmed to perform logic analysis functions.

With 32 channels, 21 triggering modes, and a deep, high-speed trace memory, you can debug systems based on 8-bit or the latest breed of 16-bit microprocessors.

Since the Model 532 is a microcomputer, it's smart and easy to use. For example, you can store your tests in RAM or a set of UV PROMS for automatic playback. Our analyzer even remembers front panel settings so you don't have to.

But that's not all. Software signature analysis on 32 channels is a standard feature. Options include RS-232 and IEEE-488 interfaces, a serial communication test probe, and additional program space for defining special functions.

Our Model 532 will solve your design, production test, and servicing problems. Contact us for a no-obligation evaluation unit from one of our local sales offices. Or write for our free, illustrated booklet, "Check It Again, Sam." See for yourself how our microcomputer can help yours.

Paratronics Inc., 122 Charcot Ave., San Jose, CA 95131
(408) 263-2252/TWX: 910-338-0201
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PARATRONICS INC.

DEBUGGING MICROCOMPUTERS?

It takes one to know one.

The Model 532 Logic State Analyzer, a full blown microcomputer for only $1950. (plus probes and options)*
**U.S. price only*

PARATRONICS

For additional information 105

For a demonstration 106

phone systems.

The price of the filter is attractive: \$55 in lots of 1 to 10 and \$18 in thousands. Delivery takes two to four weeks.

Frequency Devices Inc., 26 Locust St., Haverhill, Mass. 01830. Phone (617) 374-0761 [401]

Frequency counter covers 10 Hz to 26.5 GHz for \$5,200

Priced at \$5,200, the 5343A microwave frequency counter combines keyboard control with a microprocessor to cover the 10-Hz-to-26.5-GHz range. Measuring these frequencies with a resolution of 1 Hz on an 11-digit LED display, the instrument will be useful for newer satellite and terrestrial communications bands, as well as many K-band radar applications.

The unit has a guaranteed sensitivity of: −33 dBm from 500 MHz to 12.4 GHz; −28 dBm from 12.4 to 18 GHz; and −23 dBm from 18 to 26.5 GHz. Fm tolerance is selected by a rear panel switch; in worst-case situations, the 5343 can tolerate up to 50 MHz peak-to-peak.

With a digital-to-analog converter option, any three consecutive digits on the display can be converted into an analog voltage. Frequency drift may thus be monitored with a strip chart recorder. The analog output voltage varies from 0 V with a 000 display, to 9.99 V with a 999 display.

With the IEEE-488 (HP-IB) option, remote programming of the front- and rear-panel controls may be accomplished. Measurements may be fed to HP-IB-compatible instruments, computing controllers,

or computers. Up to 89 readings per second may be taken when making these frequency measurements.

The digital-to-analog converter adds $250 to the $5,200 base price. The interface option is an additional $350.

Hewlett-Packard Co., 1507 Page Mill Rd., Palo Alto, Calif. 94304 [403]

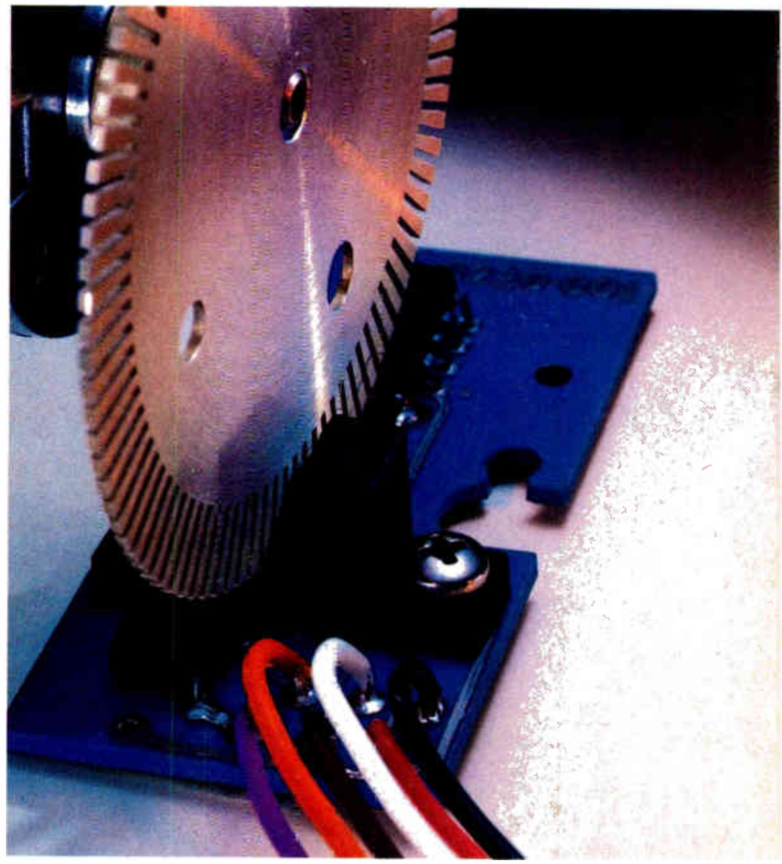
Modem races at 4 megabits/s with digital algorithms

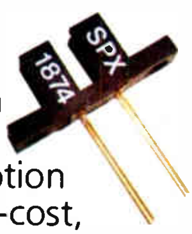
Instead of implementing analog building blocks for such functions as transmit filtering, carrier tracking, bit timing and agc, the LM46 modem uses newly developed digital signal-processing algorithms. A full-duplex digital modulator-demodulator that can work at rates of up to 4 megabits/s, this modem should prove interesting to designers and users of digital communications systems.

The unit is controlled from the front panel on which are displayed various modem and channel parameters; the panel has push buttons and a digital keyboard for entering commands and establishing operating parameters. A general-purpose microprocessor controls the operation of the front panel and monitors such functions as remote data interfacing, modem input/output, and redundancy control.

Noteworthy features of the LM46 include: operation at rates from 32 kilobits/s to 4 megabits/s; frequency selection from 52 MHz to 88 MHz in 5-kHz steps, with self-contained transmit and receive frequency synthesizers; built-in, on-line fault monitor and off-line self-test with the capability to loop back at several levels for fault isolation; control and monitoring from the front panel or

THE INTERRUPTION YOU'VE BEEN WAITING FOR.





Most design engineers don't mind an interruption that offers a low-cost, high-volume design alternative. Like Spectronics' line of optical interrupter switches.

In fact, our SPX 1870 series has been so successful as a replacement for mechanical switch headaches like corrosion, contact bounce, and fatigue, that it's become the industry standard optical sensor.

And we're one of the largest volume producers, offering a variety of types and package designs. All microprocessor compatible with -55°C to 100°C operation and switching speeds as fast as 10 microseconds.

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We also provide the industry's leading opto isolators, infra-red components, and fiber optic products.

So if you're into optoelectronics, give us a call. That's one interruption that could save you time and money.

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Circle 116 on reader service card

When you need rockers & toggles or more than rockers & toggles...

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This new Dialight family of switches, which comes in a full range of sizes is, we're proud to point out, all-American made.

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Circle 118 on reader service card

through a remote interface port; energy per bit to noise ratio (E_b/N_o) performance within 0.5 dB of theoretical, in uncoded two- or four-phase shift—keying (BPSK/QPSK) mode at a bit error rate of 10^{-5}; and the ability to acquire and demodulate at E_b/N_o down to −2.0 dB.

The LM46 will sell for $15,000 to $23,000 depending on options with delivery in approximately six months.

Linkabit Corp., 10453 Roselle St., San Diego, Calif. 92121. Phone Sharon Allen at (714) 453-7007 [405]

Unit displays modem, terminal faults to ease repair work

Displaying signals visually from any RS-232-C communications line will help unskilled operators locate and isolate modem or terminal problems. The hand-held model 40 locates such faults in data-communications networks and displays them. The unit derives its power from the signal line and features constant-current drivers for each of its eight visual displays—each display requires only 3 mA over the EIA range of 3 to 25 V.

The model 40 also features 25 test points that break out the data communications cable. These test points allow a user to implement a loopback function when trying to isolate a hardware malfunction in the network. One display, which is unassigned, may be programmed to any signal in the network by patching it to one of the 25 test points.

When it is installed in a communications path, this communications line analyzer is transparent and displays the seven key signals of the data path. The unit uses one 25-pin male connector and one 25-pin female connector. A complete discription of the EIA RS-232-C/CCITT modem terminal interface is attached to the back cover of the unit. Priced at $85 each, the units are available within two weeks after receipt of order.

Remark International, 4 Sycamore Dr., Woodbury, N. Y. 11797. Phone (516) 367-3806 [407]

This is the most technically advanced Electron Beam Lithography System you can buy.

The Varian Ee⁻BES-40 etches patterns so fine you can fabricate 15,000 circuits on a 4-inch wafer. It is the only fully automated machine of its kind designed for production. With a 40 MHz data rate, it writes masks twice as fast as previous machines and 10 times faster than optical systems. It can handle 7-inch masks.

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Circle 122 on reader service card

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We're in the process of expanding our facilities and enhancing our capabilities to supply you with the thick films you need . . . when you need them . . . with the properties to match your requirements.

Our 43,000 sq. ft. construction program, now underway in East Newark, N.J. will house laboratories, production and warehousing facilities. It will virtually double our present capacity.

WHAT DOES IT MEAN TO YOU?

Simply, that Engelhard will continue to be your most reliable single source for total film materials. These include precious metal powders (electronic grade platinum, palladium, gold, silver and their alloys); metallo-organics and resinates (noble and base metals); resistor inks (like our well known, low drift, high stability Rely-Ohm® ink); multilayer dielectrics; protective coatings (overglazes and organic types).

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For the past several years Engelhard has been producing more kinds of film materials than anyone else in the world. These new facilities reflect our dedication to keep pace with the industry's growth and its future. At Engelhard we're building today so we can be ready for you, tomorrow. For information write or call:

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Currently, we offer our 3081 and 3082 Subscriber Line Interface Circuits in production quantities. These circuits meet the stringent requirements for Central Office line applications.

They are the best you buy today. And when your specifications change, you can be sure ITT North will be there to meet those specifications tomorrow.

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For more information, write or call: ITT North Microsystems Division, 700 Hillsboro Plaza, Deerfield Beach, Florida 33441. Phone (305) 421-8450, TELEX & TWX: 510-953-7523.

ITT North
Microsystems Division

Circle 142 on reader service card

Computers & peripherals

Printer has two-wire input

Panel-mounted alphanumeric unit may be placed up to 1,000 feet from computer

When a panel-mounted printer is used with a computer, the two devices may normally not be separated by more than about 25 feet. The reason: available printers of this type are parallel-input units that must be driven from parallel-output TTL computer ports, with as many as 18 lines (usually a flat flexible-ribbon cable). Now Datel-Intersil's panel-mounted model APP-20A2, a serial-input version of the model APP-20 [[*Electronics*, Aug. 31, 1978, p. 190], solves this problem. It includes all serial-data drive electronics as well as the power supply to simplify user wiring. Any two-wire line, even electrical power-line cord, may be used to connect the printer with a computer located hundreds of feet away.

The microprocessor-based 20-column printer will be unveiled at this year's Midcon. It uses a thermal printhead and features two inputs: a 100-MΩ optically isolated (up to 300 V root mean square) RS-232-C port and a 20-mA current-loop port. The RS-232-C input allows the printer to be placed up to about 100 feet from the computer. The current-loop input extends this distance up to 1,000 feet.

The printer has a universal asynchronous receiver/transmitter (UART) that includes a one-line 20-character buffer. The internal microprocessor allows several programming features (through a rear-panel connector) that include pin-selection of the RS-232-C or current-loop input, software-programmable tall characters, pin-selectable inverted printing, and single-character printing. Printer rate may be set from 50 to 9,600 bauds by programming pins on the rear-panel connector. Word lengths of 10 or 11 bits are also pin-selectable in this manner.

The 4.25-lb printer operates at a speed of 1.2 lines/sec (72 lines/minute) and accepts the full upper- and lower-case 96-character ASCII set. It is 8.00 inches long by 2.76 in. high by 4.44 in. wide (203 by 70 by 113

mm). It prints on 150-ft rolls of paper with five-by-seven-dot-matrix characters that are 0.11 in. (2.8 mm) high. The printer is rated for 30 million lines (600 million characters) of operating life and has operating and storage temperature ranges of 0° to 50°C.

The model APP-20A2 operates from 115/230 V at 47 to 440 Hz. A European version (model APP-20E2) is also available.

Applications for the model APP-20A2 panel printer include serial interfacing for factory data loggers and industrial data-acquisition systems, where an operator station may typically be located at a distance from a hazardous process. Other applications include medical systems, analytical instruments, diagnostic testers, and multiple-station daisy-chained message repeaters.

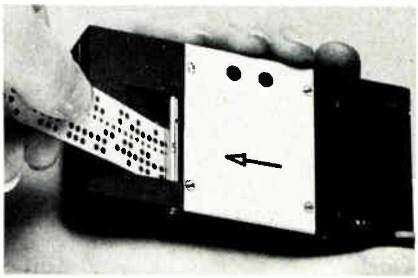
Single-quantity pricing for the printer is $880. Delivery takes two to eight weeks.

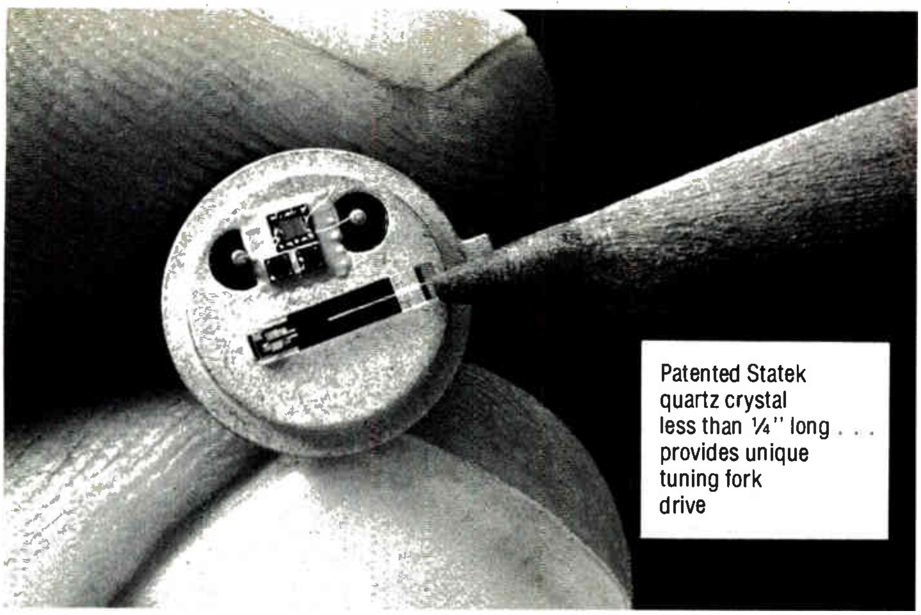
Datel-Intersil, 11 Cabot Blvd., Mansfield, Mass. 02048 [361]

Small paper-tape reader aimed at data processors

At first glance, the device looks like a pocket camera or a film cassette. But on closer examination it turns out to be a tape reader, one not much larger than a pack of cigarettes. Claimed by its developer, AEG-Telefunken, to be the smallest tape reader ever built, the unit measures only 10 by 5 by 2 cm (roughly 4 by 2 by 0.8 in.) and thus easily fits the palm of a hand.

A plaything? Not so, the West German company insists. Spawned by the firm's activities in enciphering and deciphering equipment and oth-

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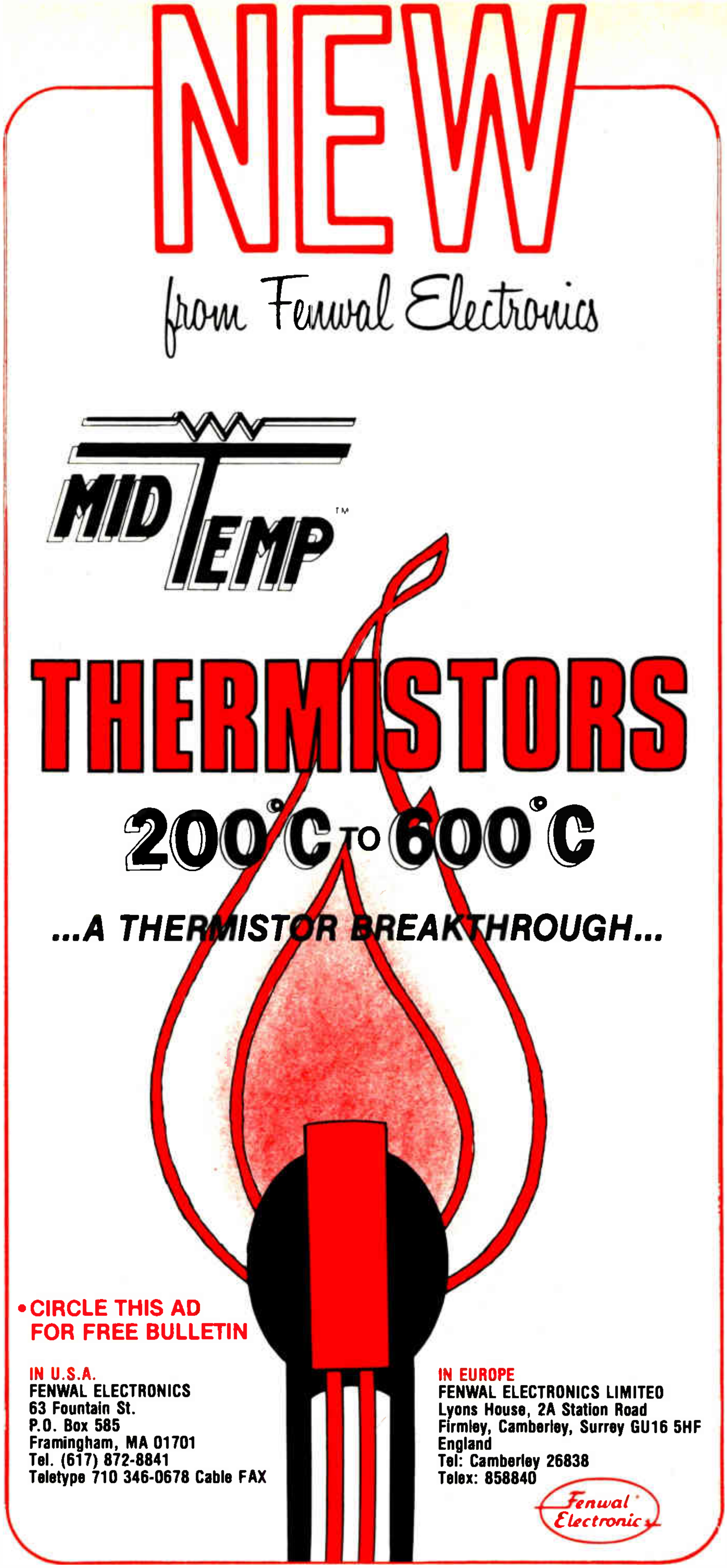

er electronic security devices, the tape reader is designed mainly for feeding information into data-processing systems. "Specifically, microprocessor engineers may find it a valuable tool for loading read-only memories or programmable ROMs," says Hans-Peter Baumann, sales manager for communications security devices at AEG-Telefunken's Backnang facilities.

The unit's small size is due to the use of special miniaturized circuits based on thick-film technology and (more importantly) to the absence of any moving parts such as drives or wheels, required for feeding the tape through the unit. That makes the reader a truly electronic device.

The operator's hand replaces the tape advance mechanism. For reading, the user simply inserts the tape into a guide slot and pulls it through the reader at anywhere between a rather slow 1 mm/s and a fast 5 m/s, corresponding to a maximum reading speed of 200 characters/s.

The device can handle either 5- or 8-bit tape, regardless of the code used. An array of photoelectric elements reads out the data and feeds it to a 16-pin plug on the unit's rear side. The mechanical as well as electrical interface is such that the reader can easily be adapted to different kinds of processing equipment. The output signals can be applied to complementary-MOS circuits (with a fanout of 10) or TTL circuits (with a fanout of 1).

The reader is powered by the voltage of the equipment to which it is connected. That voltage may be between 4.5 V and 12 V dc. At 5 V, the current consumption is from 60 mA to 160 mA depending on whether the control lamps are off or on. No special skills are needed to operate the device.

In small quantities the reader is available as an off-the-shelf item with short delivery times. Larger orders take about six months, Baumann says. The unit costs "around $500" depending on quantity. Sound high? "Not if you consider its mechanical sturdiness combined with the precision that's required for accurate tape guidance and hence

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the right environment for electronics.

There is already a thriving electronics industry in Strathclyde. Many international companies have established large plants in the region as a base for their European operations. Firms like IBM, Honeywell, Digital, National Semiconductor and Motorola.

The attractions for these companies include good labour relations and high productivity records. The region has a clean atmosphere and chemically stable freshwater supplies ideally suited to the manufacture of silicon micro-processor chips. There is also an ample pool of high quality and adaptable labour throughout the region, and several institutions within the central belt of Scotland with international reputations for research and development work in micro-electronics engineering. There are two international airports linking Strathclyde with the rest of Europe and the U.S.A. The region has excellent rail and motorway connections to the U.K. network.

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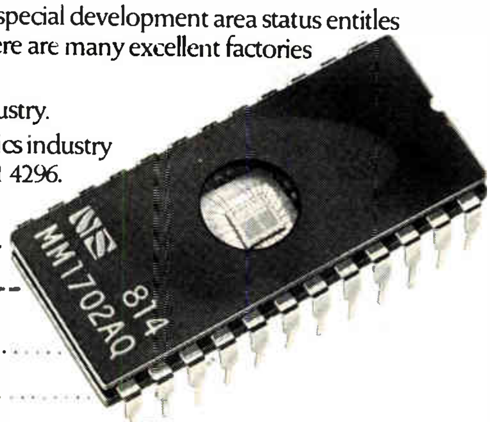

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Strathclyde Regional Council

Industrial Development Department, 21 Bothwell St., Glasgow G2 6NJ. Tel.041 221 4296

The silicon chip illustrated (type MM 1702 AQ) is manufactured in the Strathclyde Region by National Semiconductor (UK) Ltd.

Circle 150 on reader service card

for reliable character reading," Baumann notes.

AEG-Telefunken Corp., Route 22/Orr Drive, P. O. Box 3800, Somerville, N. J. 08876 [362]
AEG-Telefunken (N26V32), 7150 Backnang, Gerberstr. 33, West Germany [363]

CAD system for students sells for under $10,000

Priced at less than $10,000, a stand-alone computer-aided design (CAD) system was recently developed by Texas A & M University. System software is written in Basic for easy transfer, and the hardware is configured to offer a low-cost CAD system for student training.

A part in the design may be entered into the system through a digitizer, a Lear-Siegler ADM-3 cathode-ray-tube monitor that has been modified for graphics, or through the system keyboard. This part may then be manipulated through system instructions and displayed on a digital plotter. Both the digitizer and digital plotter are made by Houston Instruments.

The user may also choose isometric, axonometric, perspective, oblique, and orthographic representations of the part together with axial rotation, different size scaling, and multiple views. Graphing routines and limited manufacturing costs analysis, as well as limited linkage analysis, are also supported.

A microcomputer with 48 K of random-access memory and two minifloppy disks provides the basis for the system. Almost any microcomputer with this amount of memory and capable of supporting multiple RS-232 ports may be used. In addition to the CRT, digitizer, and plotter peripherals, a serial printer is included with the system. Total hardware cost is under $9,000 , with software available from the university under license agreement for $300 per year.

Engineering Design Graphics Department, Texas A & M University, College Station, Texas 77843. Phone John T. Demel at (713) 845-1633 [364]

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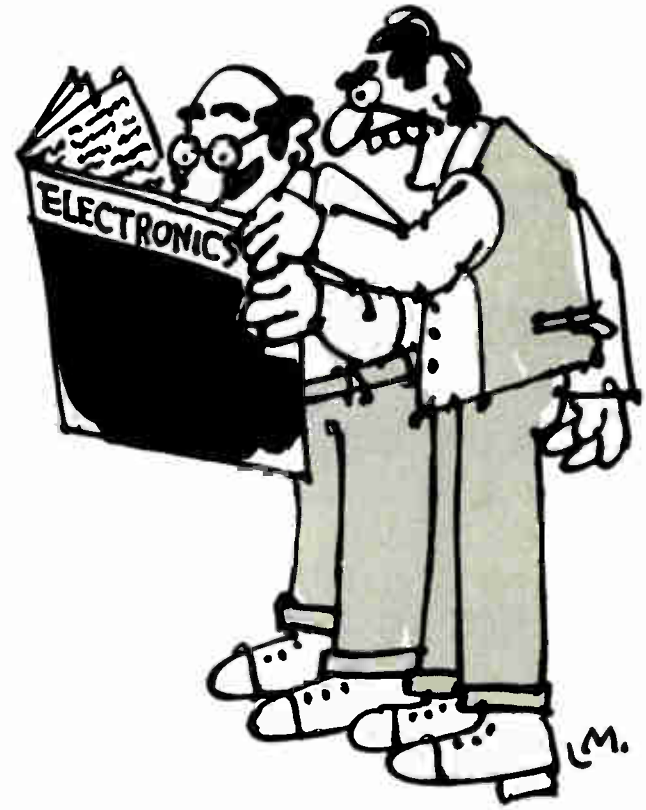

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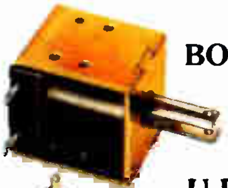

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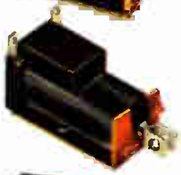

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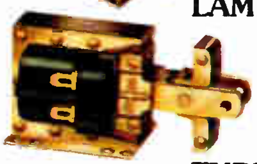

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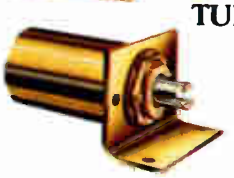

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Semiconductors

Chips sound off at TI

Sound-generation devices go to mass distribution for toys, games, and home computers

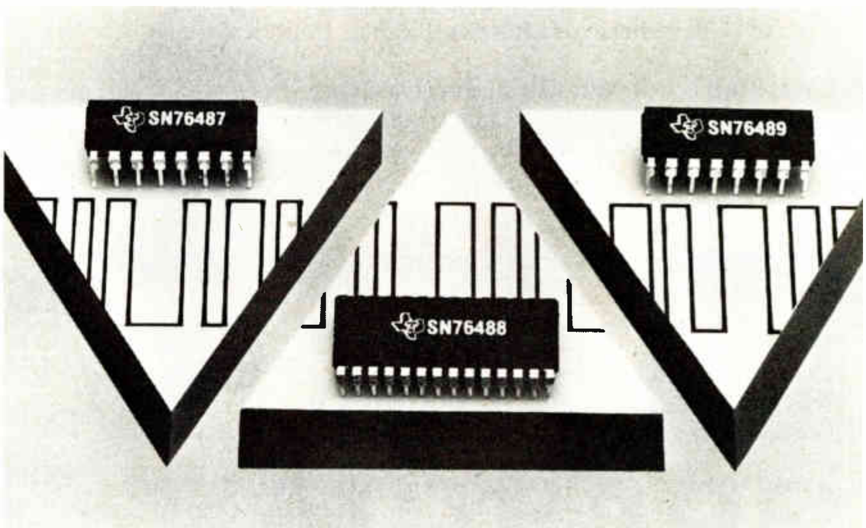
Electronic bells, whistles, and a multitude of other sounds are emanating from more and more products these days, thanks to the emergence of integrated circuits capable of generating complex sounds that it once took an entire card of discrete circuitry to produce. Indeed, until now, the demand for such circuits, for applications ranging from toys and arcade games to home computers, has been so strong that a family of sound-generation chips—manufactured by Texas Instruments Inc. since April—has been gobbled up entirely by a few large-volume customers.

But as this year's toy- and game-production season winds down, TI says it is ready to stock distributors with its SN76477N/488N/489N family of complex-sound–generation devices. Therefore the chips will generally be available through normal distribution channels by December, says Ray Griffin, TI product marketing engineer for the chips. In addition, Griffin notes, a new IC known as the SN76489AN will go into production during the first quarter of next year as a lower-cost and more versatile replacement for the 489N.

Like the 489N, the 489AN will be fabricated in bipolar integrated-injection-logic technology. Both chips include three programmable tone generators, a programmable white-noise generator, and four programmable attenuators, all of which are controlled by eight internal registers for generating complex sounds under microprocessor direction. The microprocessor interface is via eight data lines and three control lines.

Unlike the 489N, however, the 489AN will provide a musical-output range from about 200 Hz to 15 kHz, using clock inputs as low as 500 kHz. The 489AN will also handle the higher clock frequencies—2 MHz to 3.579 MHz—accepted by the 489N and commonly used with high-speed 8-bit and 16-bit microprocessors. The broader range of acceptable clock-input speeds will make the 489AN easier to use in low-end applications with 4-bit microprocessors and slower 8-bit machines, TI sources say.

The ability of the 489AN to accept the slower as well as the faster clock inputs was made possible by eliminating some of the input dividing circuitry included in the 489N design, Griffin says. In addi-



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Both the OS4000 and the new OS4100 combine the capabilities of semi-conductor memory with a bright, stable, flicker-free display. This technique allows analysis of signal build-up and decay characteristics through pre- and post-trigger viewing. Expansion of the display after storage permits detailed study of specific areas of the trace.

The new model—OS4100—also offers you stored X-Y displays, channel sum or difference and a maximum of 100 V per cm sensitivity with noise suppression. A unique trigger window circuit assures capture of transients of unknown polarity.

Other outstanding features include automatic operation, display of stored and real time traces simultaneously and hard copy memory output in digital or analog form. And IEEE488 is available for compatible interfacing.

And, remember that Gould scopes are backed by a two-year warranty of parts and labor, exclusive of fuses, minor maintenance and calibration. For further information, contact Gould Inc., Instruments Division, 3631 Perkins Ave., Cleveland, Ohio 44114. Or Call (216) 361-3315, Ext. 395, for a demonstration.

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tion, an on-chip audio amplifier found on the 489N will be eliminated on the 489AN. The result will be a much smaller die that will help lower the 489AN's price to $5.07 each in 100-unit quantities, compared to the 489N's current $6.27 price tag.

Designs making use of the 489AN will require an off-chip audio amp that might typically cost between 50¢ and $1.00 each, depending on volume, Griffin concedes. But he notes that most applications for the earlier 489N design require a discrete audio amp anyway in order to boost the 489N's output of 25 mw per tone generator to higher levels typically required for higher-end applications such as home computers. Both the 489N and its 489AN successor are fully digital, bus-oriented devices housed in 16-pin packages. They are TTL-compatible and require only a single 5-V power supply.

For lower-end applications such as alarm systems and toys and games that do not require the complex sounds possible with the 489N and 489AN devices, TI's 487N or 488N may fill the bill. These chips contain both digital and analog circuitry and use a 9-V power supply. Unlike the 489 devices, which need microprocessor control, the 487N and 488N can stand alone, with programming by user-defined external devices such as capacitors and resistors.

Priced at $1.69 per unit in 100-piece quantities, the 487N is housed in a 16-pin package and offers less sound complexity than the 488N, which is housed in a 28-pin package and priced at $2.78 in lots of 100.

Texas Instruments Inc., P. O. Box 226325, Mail Station 812, Dallas, Texas 75266. Phone Ray Griffin at (214) 892-7111 [411]

Communications circuit offers binary serial interface

A programmable communications interface circuit, designed to amplify and expand the capability of microcomputer-controlled data-communications systems, has recently been

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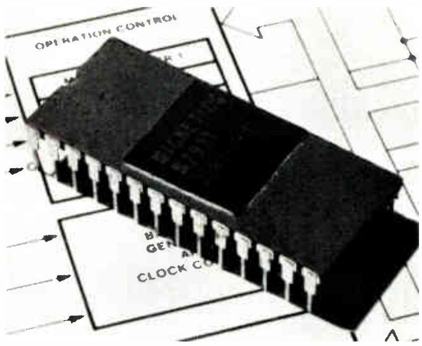
introduced by Signetics. The 2661 EPCI (for enhanced programmable communications interface), pin- and register-compatible with the earlier 2651 PCI, provides a binary serial interface for the asynchronous or character-oriented synchronous data systems that are based on such data-link control procedures as Bisync, ANSI 3.28, and ISO 1745. Interfacing directly with all 8-bit microprocessors, this communications interface circuit can be used in polled or interrupt-driven system environments.

The Bisync features of the 2661 eliminate the programming usually needed for interactive communication data tasks. By doing some of what is otherwise accomplished by software, the 2661 greatly enhances the performance and memory availa-



bility of the microcomputer systems.

Programmed selection of the internal clock provides a choice of 16 crystal-controlled baud rates for each of three versions of the device. Rates range from 45.5 to 38,400 bauds. If clocked externally, the 2661 can operate at speeds of up to 1,000,000 bits/s—fast enough to enable a direct-memory-access interface to handle character transfers without CPU intervention.

The 2661 also includes double-buffered independent transmitter and receiver logic; dynamic character-length switching; and also a single 5-V power supply requirement. Packaged in a 28-pin ceramic case, the 2661 EPCI is priced at $14.50 in quantities of 100 to 999.

Signetics, 811 East Arques Ave., P. O. Box 9052, Sunnyvale, Calif. 94086. Phone (408) 739-7700 [415]

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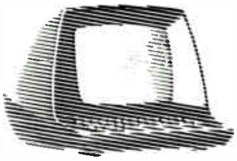

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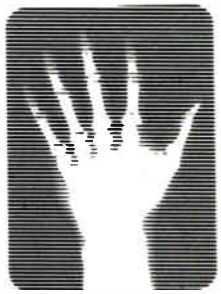

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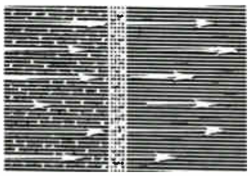

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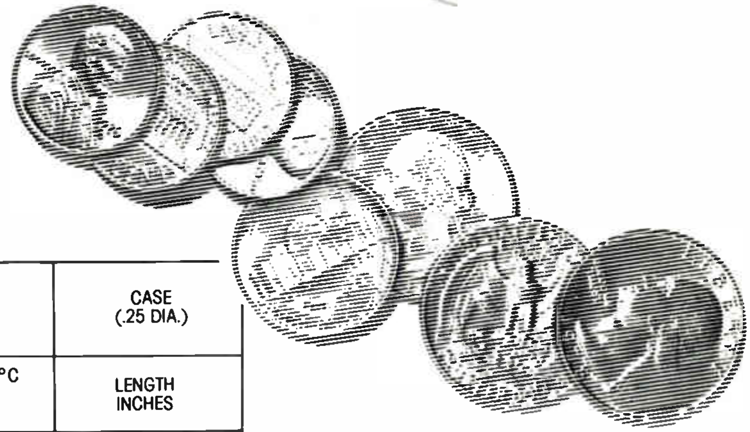

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Cheap data-acquisition system to bow by year's end

A low-cost 16-channel hybrid data-acquisition system will be introduced by Analog Devices Semiconductor, Wilmington, Mass.—a division of Analog Devices Inc., Norwood, Mass.—by the end of this year. **The AD364 consists of two parts: one dual in-line package contains the input circuitry and the other DIP houses a 12-bit analog-to-digital converter—the AD574 introduced last year.** The system is directly compatible with the 6800 microcomputer, plugging into it without additional interface circuitry and will sell for less than $100 in 100-piece quantities.

Fluke readies nine-function hand-held DMM

In the near future, John Fluke Manufacturing Co. plans to unveil what it believes will be the industry's first nine-function digital multimeter. Dubbed the 8024A, the $199 instrument from the Mountlake Terrace, Wash., firm, is a hand-held 3½-digit meter with the usual five functions of ac and dc voltage and current plus resistance measurement, as well as the conductance feature offered in its predecessor, the 8020A. However, **the unit has three new features:** it will measure temperature from −20° to +350°C directly using a K-type thermocouple; it will act as a continuity tester with both visible and audible indicators (the audible one may be shut off, when desired); and it has a short-term memory for capturing the peak values of transient signals.

Qantex will make printers, too

Up to now a manufacturer of cartridge-tape drives for data storage, the Qantex division of North Atlantic Industries is branching out to printing peripherals as well. **The Hauppage, N. Y.–based company will soon unveil a medium-speed, microprocessor-controlled, bidirectional matrix printer that can print as many as 150 characters per second.** Priced at under $1,000 in large quantities, the unit will compete with a number of low-priced printers introduced in recent months.

Optical coupler handles 600 V at 0.5 A

Enlarging its family of optical couplers, Theta-J Corp., Woburn, Mass., is introducing the H11CM. This coupler, which uses a pair of LEDs as an emitter and a high-voltage, glass-passivated silicon controlled rectifier chip to provide output, is similar to another relay the company unveiled earlier this year [*Electronics*, Feb. 15, p. 209]. **Handling 600 V at 0.5 A, the H11CM has a pulse capability of 50 A, with lag times of 1 to 10 ms and minimum isolation of 4,000 V ac.** A possible replacement for pulse transformers used to drive 1,000-A SCRs in capacitor-discharge ignition systems, the device has a price tag of $4.25 in quantities of 1 to 99, which drops to $2.50 in quantities over 1,000.

10-A-h battery provides 1 A for volatile memories

Adding to its lines of 2.5-A-h and 5.0-A-h D- and X-cell batteries, General Electric's Battery Business department, Gainesville, Fla., is now offering a 10-A-h sealed lead battery. **Priced at $5.50 per 2-V cell in 10,000-piece quantities, the battery can maintain a 1-A discharge rate for 10 hours** suitable for powering computers and related systems with volatile memories. Other applications include portable and standby power for communications and instrumentation systems. GE has plans to introduce a 6-V 10-A-h battery as a standard configuration early next year.

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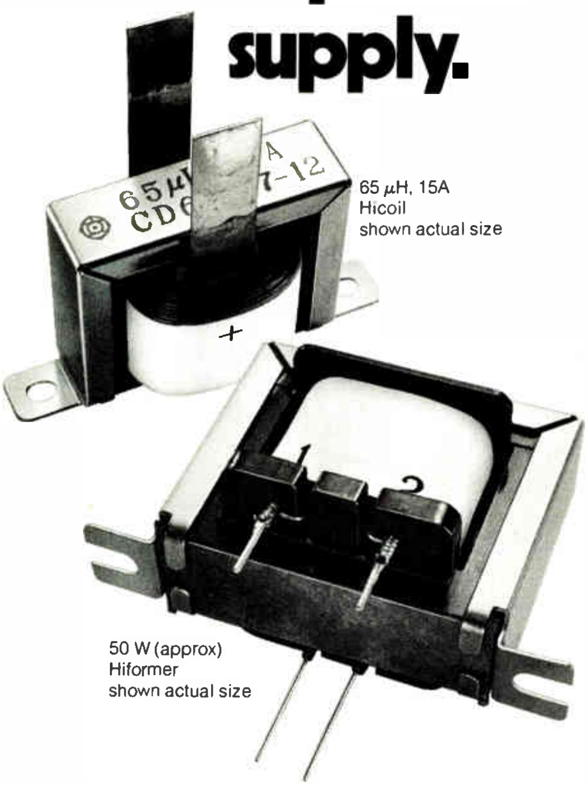

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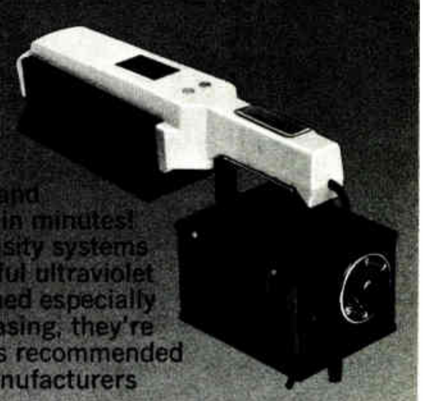

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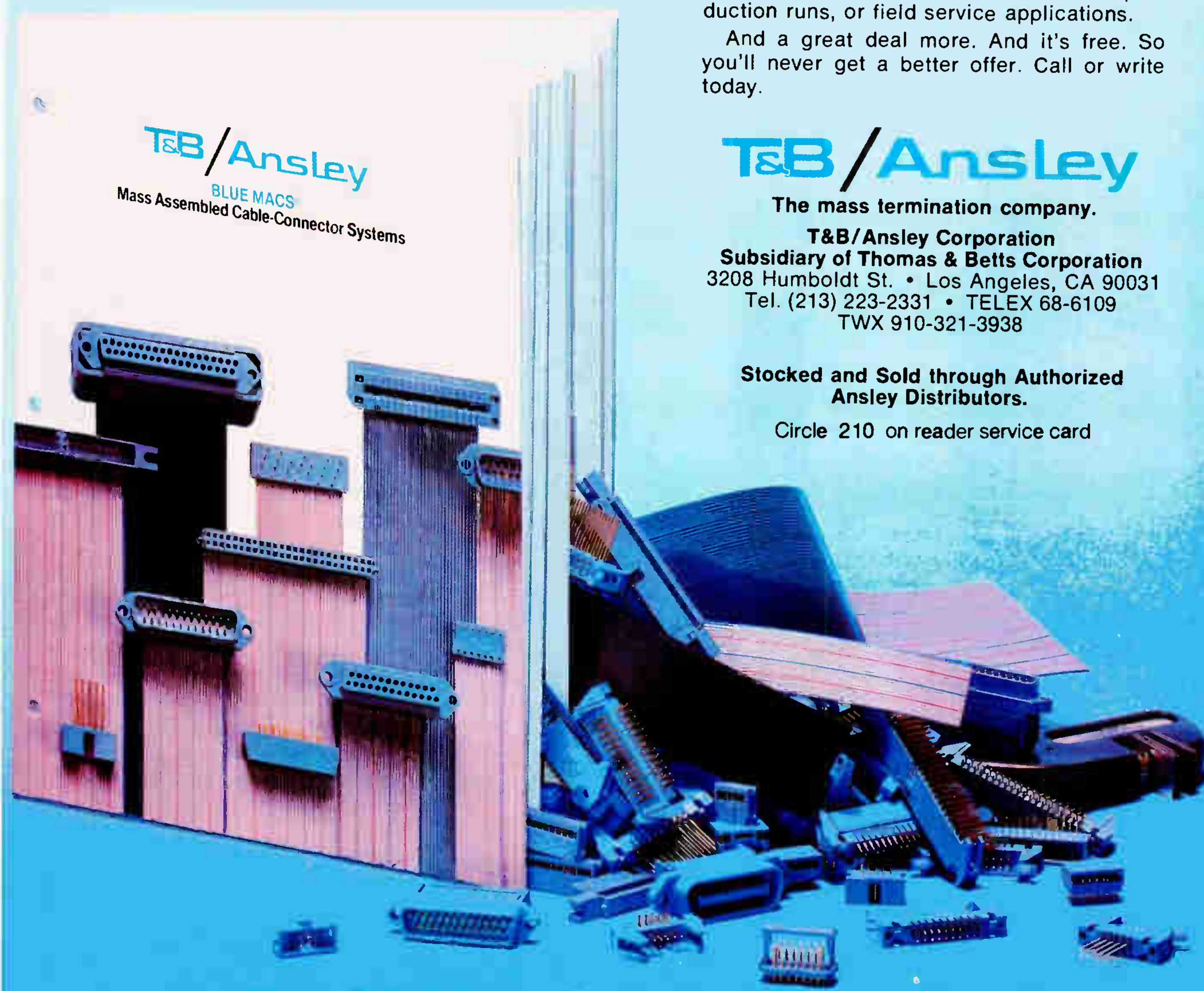

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New products/materials

An adhesive-coated foil, Arclad S-5795, applied to the interior of electronic equipment housings, can reduce errors in data entry, malfunctions due to static buildup, and electromagnetic interference in general. It is impervious to changes in temperature. The foil has applications in computer terminals, radios, power tools, and electronic control

systems. Available in sheets or rolls, Arclad S-5795 is easy to die-cut.

Adhesives Research Inc., Box 245EA, Glen Rock, Pa. 17327. Phone (717) 235-4860 [476]

Broadband microwave absorbers, Eccosorb HT, operate in the temperature range of −70° to +750°F. They are particularly useful for lining the metal housings that cap radiating antennas. Eccosorb HT is available as lightweight unicellular foamed ceramic bricks, 12 by 18 in., with thicknesses of 2 or 3 in., dependent upon frequency coverage. The ceramic bricks have an array of conical holes drilled into them. The base of each hollow cone is at the back surface; the tip is close to the front surface. Lossy films, which constitute the microwave-absorbing element, are applied to the surfaces of the cones, making heat transfer from the film to the air effective.

Emerson & Cuming Microwave Products, Dewey and Almy Chemical Division/W. R. Grace & Co., Canton, Mass. 02021. Phone (617) 828-3300 [478]

Silicone coating resin, CR-3912, operates in the temperature range of −80° to +300°C. It has been designed to be used as a moisture-barrier coating for capacitors, a protective coating for electronic as-

New products/materials

semblies and components, and a paint coating.

CR-3912 withstands water, bad weather, and chemicals. It resists corrosion due to 16 hours exposure to 50% sulfuric, hydrochloric, and nitric acids and 20% sodium hydroxide solutions. It can be cured to a high-gloss enamel-like finish at room temperature in 24 hours or in one to two hours at 150°C or at 100°C when 10% CR-3912 catalyst is added. An important feature of this resin is that it offers the same physical, thermal, and electrical insulation properties as the conventional silicone coating resins without the need for a high-temperature bake.

CR-3912 is available from stock in a range of container sizes and prices.

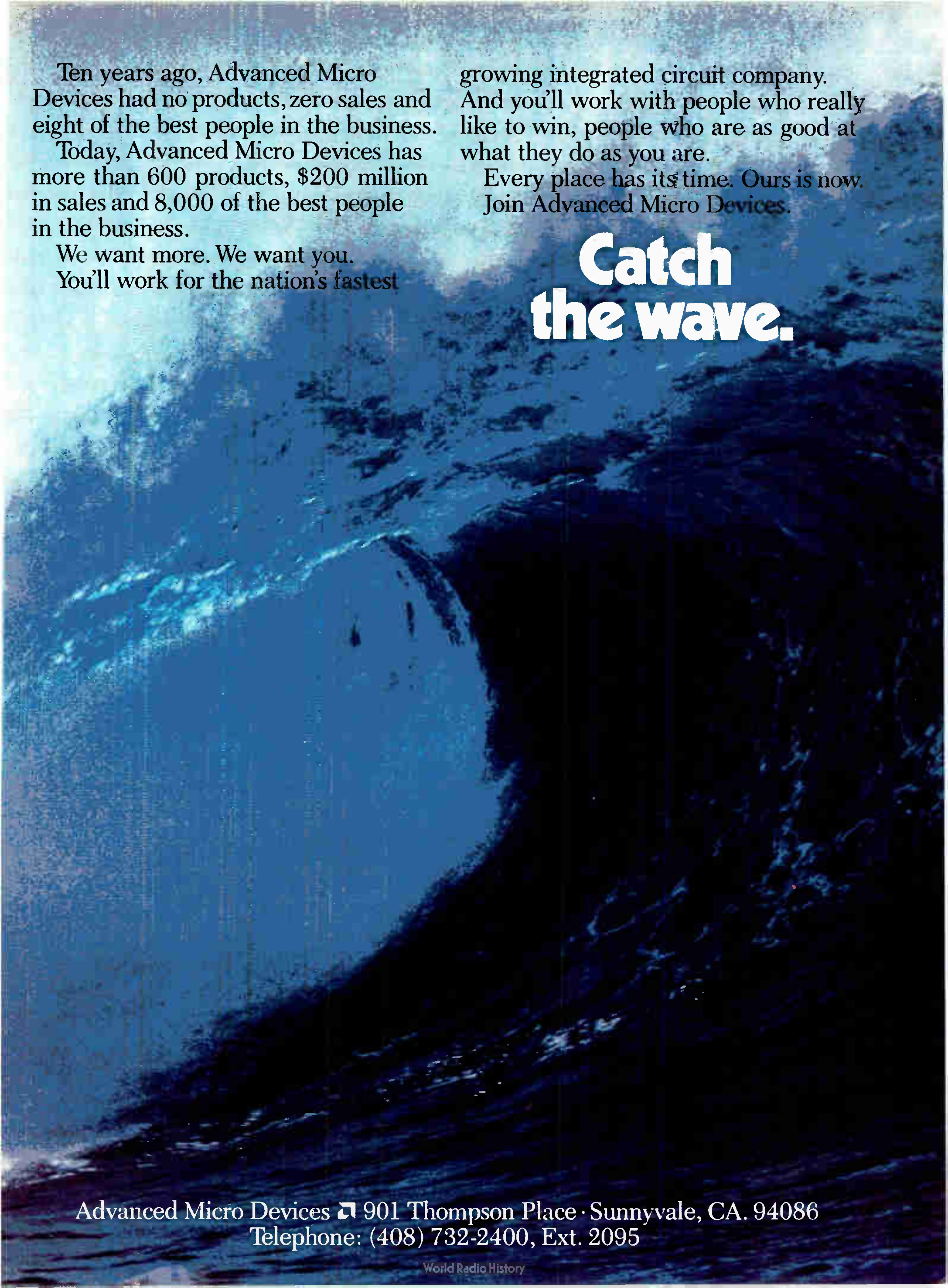
Formulated Resins Inc., P. O. Box 508, Greenville, R. I. 02828. Phone (401) 949-2060 [477]

An alumina-based adhesive, Cerama-Dip 538, is used as an end-seal material for cartridge heaters and other high-temperature devices such as feed throughs and thermocouples. The material can be applied by injection, brushing, or dipping. After air drying, a low-temperature bake-out of 180°F will cure the seal making it resistant to temperatures

up to 3,200°F. The material has a thermal expansion coefficient of 14 ppm/°F, which is higher than that of most metals, such as stainless steel.

Cerama-Dip 538 is available from stock at $40 per quart. A thinner, 538-T, is offered at $20 per quart.

Aremco Products Inc., P. O. Box 429, Ossining, N.Y. 10562. Phone (914) 762-0685 [479]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obtained from Ball Computer Products, 860 East Arques Ave., Sunnyvale, Calif. 94086 [424]

Spectrophotometers. "Infrared Accessories for Infrared Spectroscopy" lists the accessories for the 580, 28X, X99, X98, and 7XX series of Perkin-Elmer infrared spectrophotometers. Window materials, data-handling equipment, cells and accessories for liquid and gas cells, and beam condensors are among the devices described in this illustrated catalog. Catalog Order No. L-396A can be obtained from Perkin-Elmer Corp., Instrument Division, Main Avenue, Mail Station 12, Norwalk, Conn. 06856 [425]

Data acquisition. "Principles of Data Acquisition and Conversion," edited by Eugene L. Zuck, manager of market planning at Datel-Intersil, provides information on the theory and application of data conversion circuits and systems. It contains 35 technical articles, 312 illustrations, 40 tables, and a glossary of the 200 most commonly used data-acquisition terms. The handbook contains sections on principles of data acquisition and conversion, a-d and d-a converters, data-conversion systems, sample-and-hold circuits, high-speed op amps, and voltage-to-frequency converters. The handbook is available at $3.95 plus 5% sales tax in Massachusetts; outside the U. S. and Canada add $2.75 for shipping and handling. Datel-Intersil Inc., 11 Cabot Blvd., Mansfield, Mass. 02048.

Resins. "Noryl Resin Injection Molding" gives the performance, economics, specifications, design considerations, assembly methods, and secondary operations for each of the 12 injection moldable grades of Noryl resins. The 36-page brochure contains the typical processing ranges of each resin, a typical properties chart, and a trouble-shooting guide. Also included is a section on the services available from the Noryl products department team of specialists who have backgrounds in mold design, the injection molding process, and decorating and finishing

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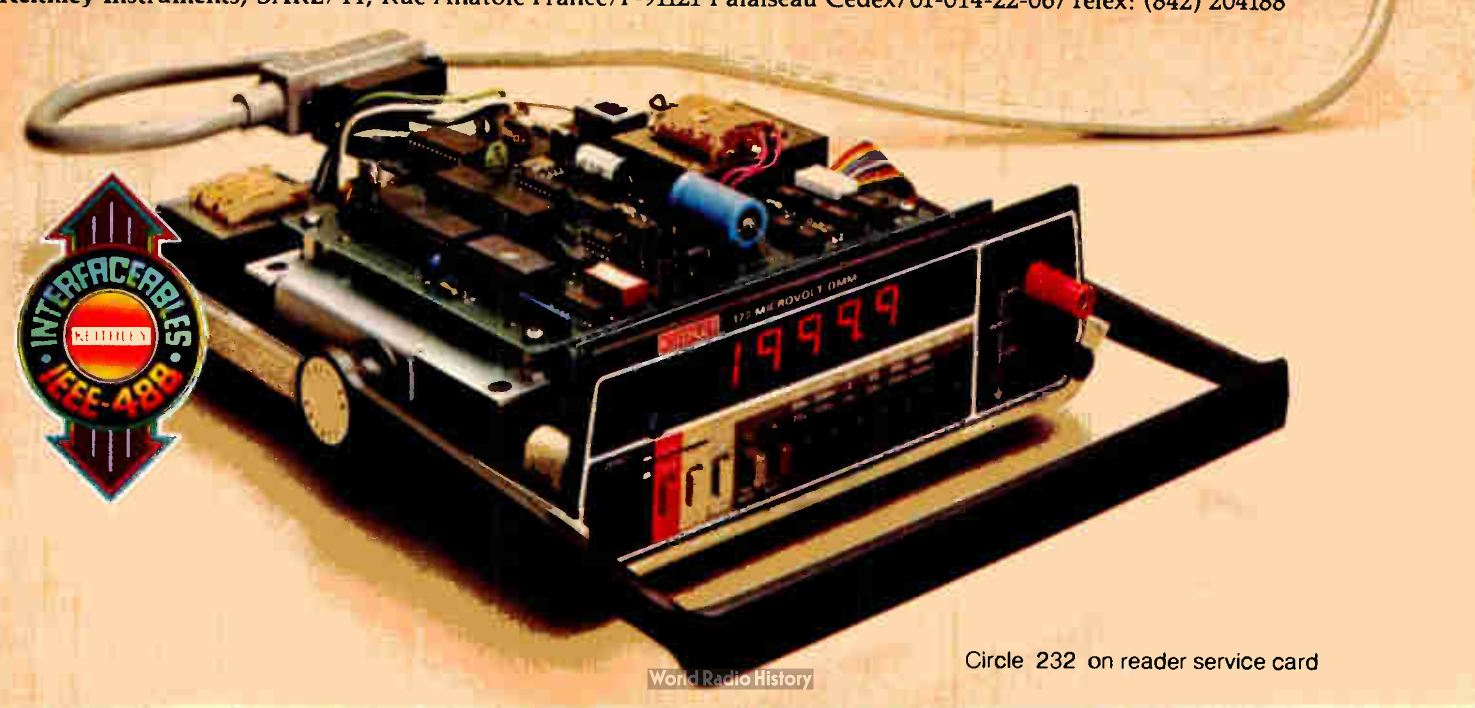

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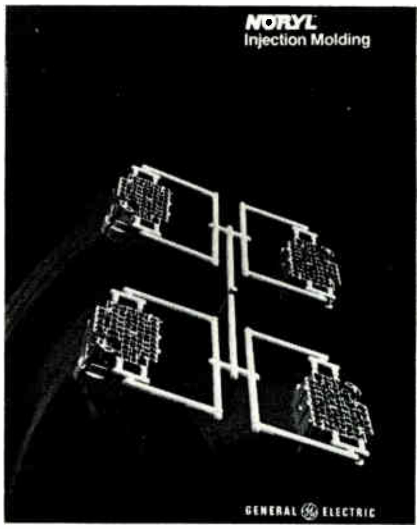
New literature



operations. A copy of the catalog can be obtained from General Electric Co., Plastics Division, Noryl Products Department, Noryl Avenue, Selkirk, N. Y. 12158 [428]

Optical communications. Technical data and application recommendations for communications system designers is provided in "Everything You Need in Optical Communications." This information kit describes Valtec's systems capabilities in telephone, community-antenna television systems (CATV), data transmission, and monitoring installations. It also discusses various components, such as fiber-optic cables, low-loss optical fibers, RS-232-

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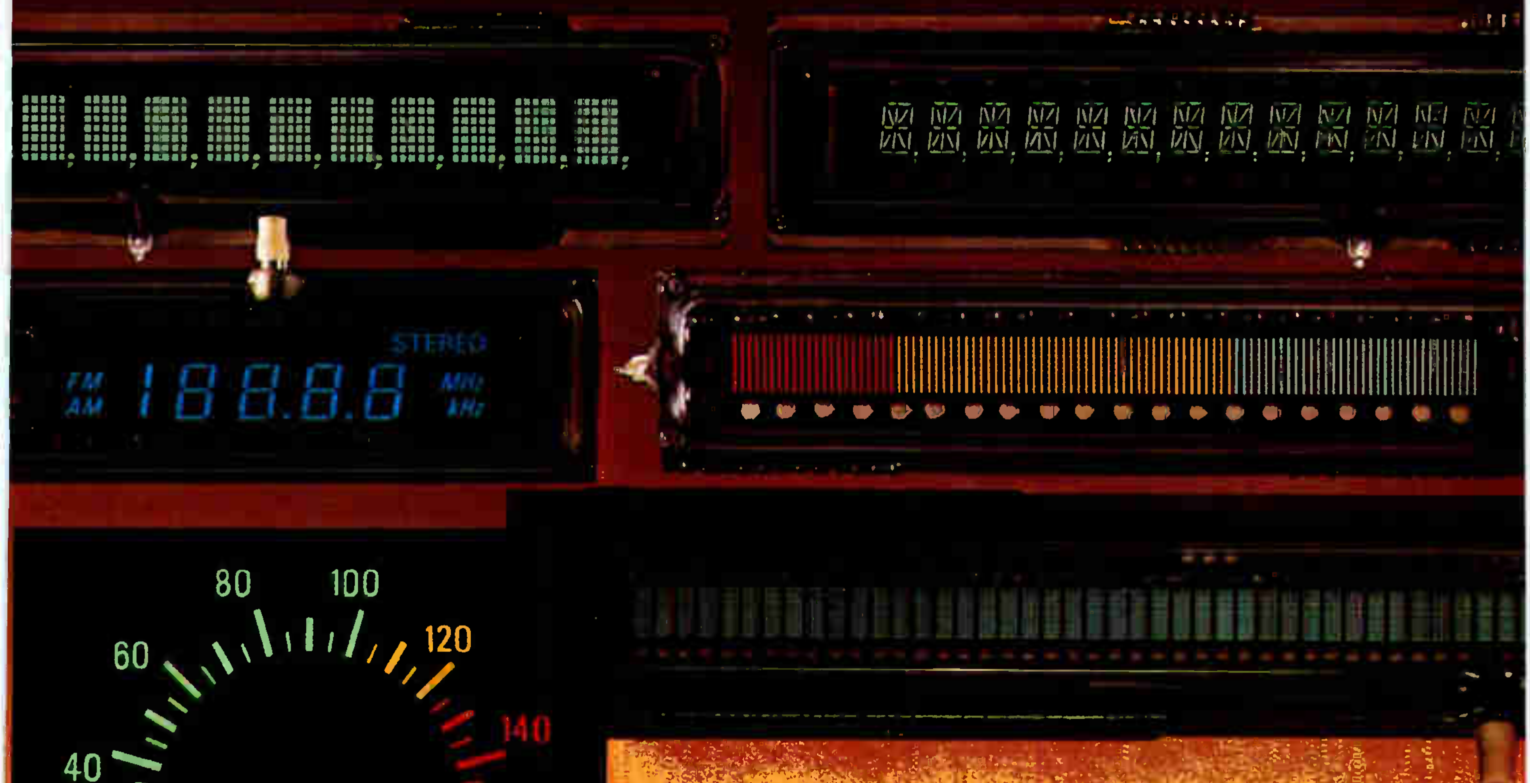

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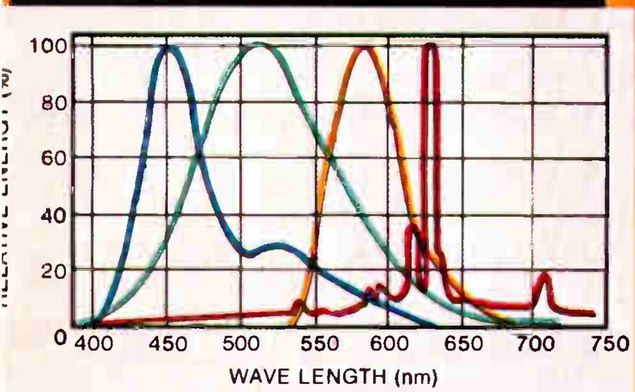

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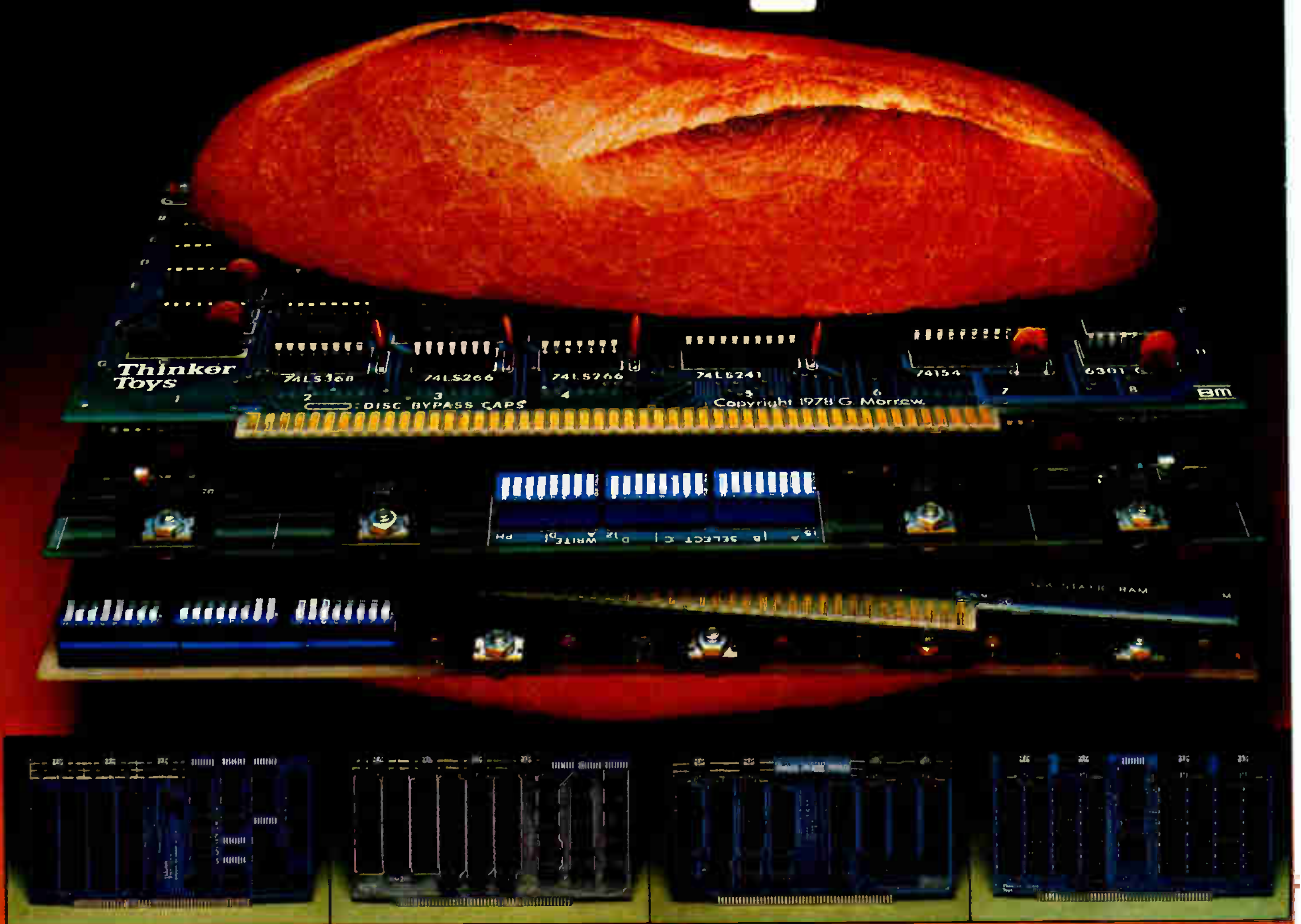

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New literature

C fiber-optic modems, TTL-compatible fiber-optic interfaces, and the VS-100 baseband video link. A copy of the kit can be obtained from Valtec Corp., Communication Fiberoptics, 99 Hartwell St., West Boylston, Mass. 01583 [429]

Counters. Electromechanical, elapsed-time, and mechanical counters are discussed in a short-form catalog. The six-page catalog lists the standard models available. Additional devices such as electromechanical impulse counters, small non-reset counters, and small reset counters are also available. TMI Industries Inc., Digital Instruments Division, 7333 W. Harrison St., Forest Park, Ill. 60130 [430]

Electronic kits. The latest in Heathkit's electronic equipment is described in a fall 1979 catalog. The 104-page catalog features products such as a remote coax switch for amateur-radio antennas; an economy hand-held portable digital multimeter; a 12-V digital thermometer for recreational vehicles, boats, and cars; self-instruction programs in mathematics; and computer concepts for small businesses. Product categories in the catalog include color television, stereo components, test instruments, digital clocks, personal computer systems, auto, and marine and aircraft accessories, among others. Heath Co., Benton Harbor, Mich. 49022 [431]

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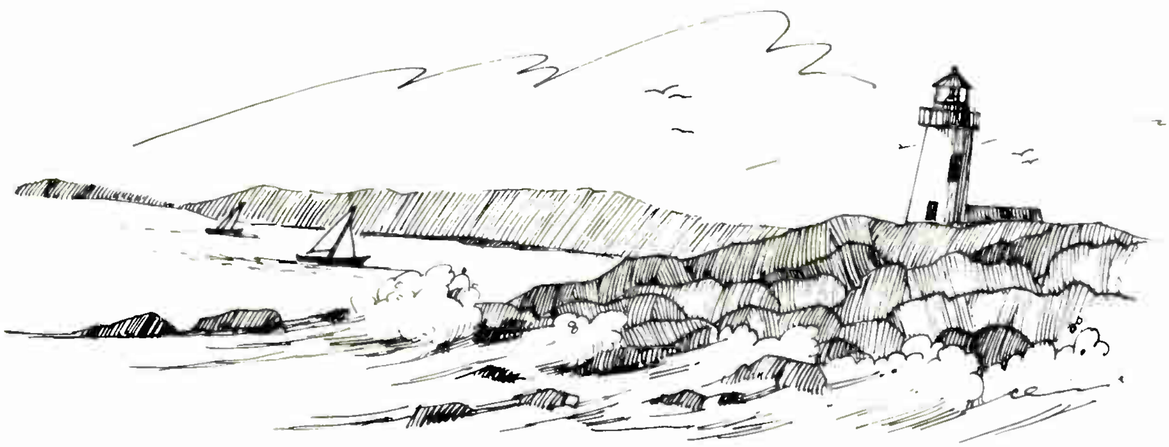

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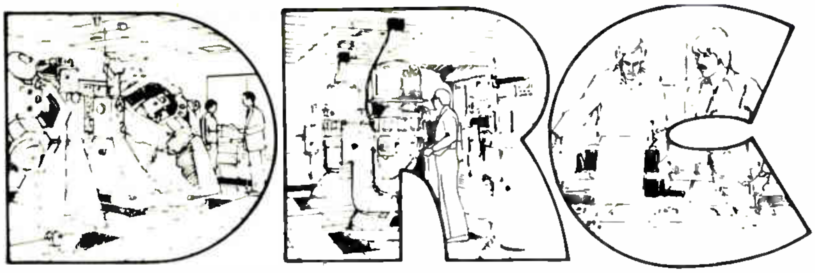

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- BS, plus at least 5 years Life Cycle Cost experience with Army or Navy systems preferred.

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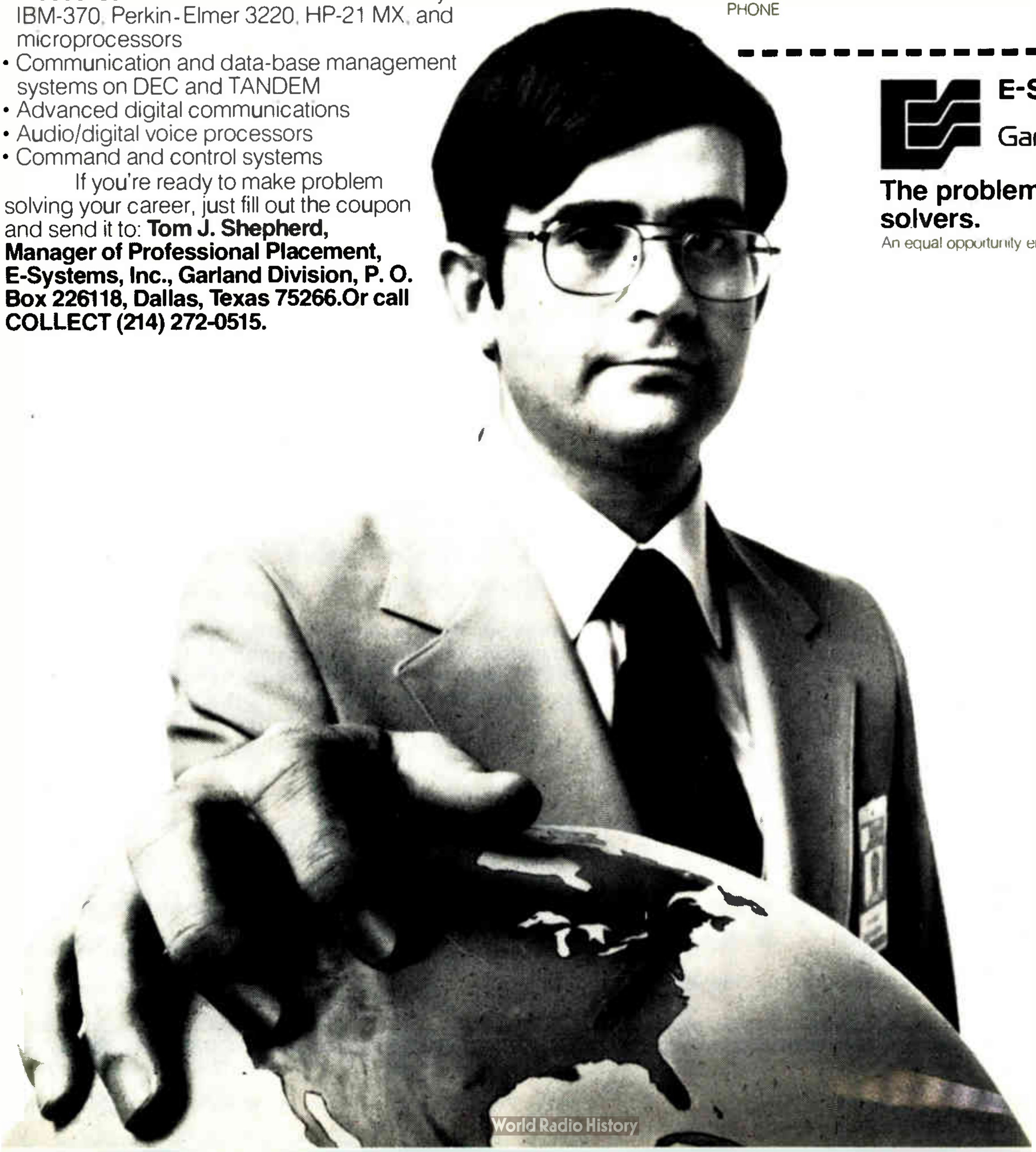

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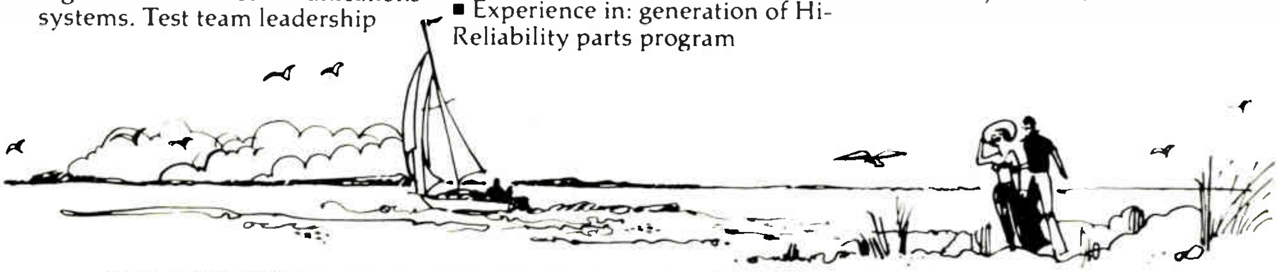

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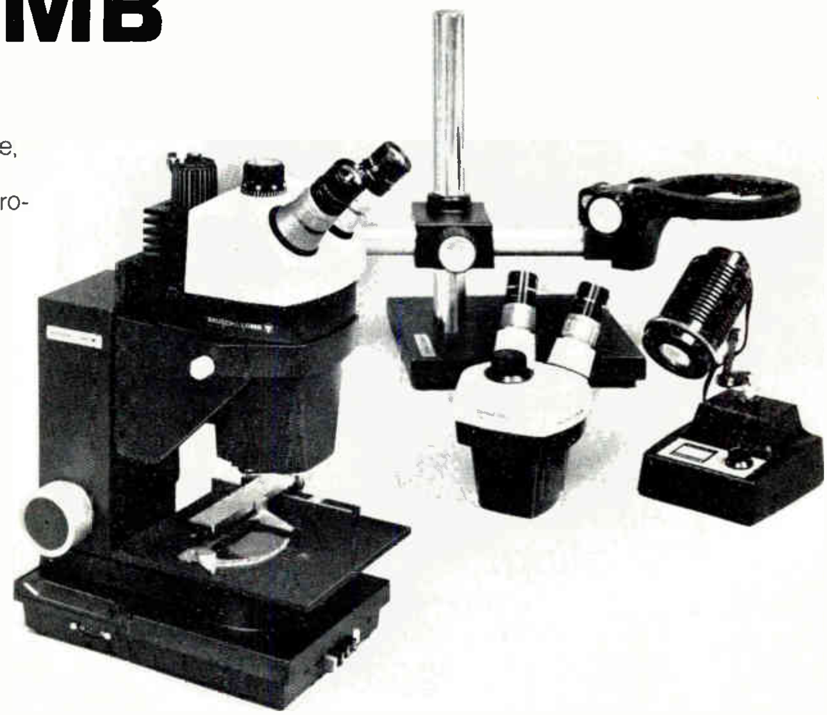

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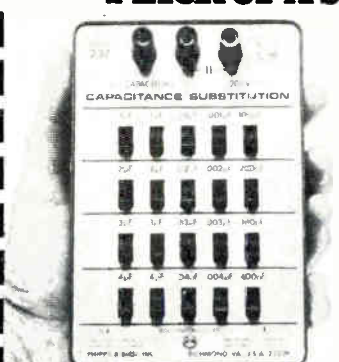

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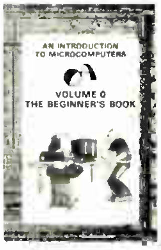

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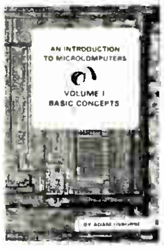

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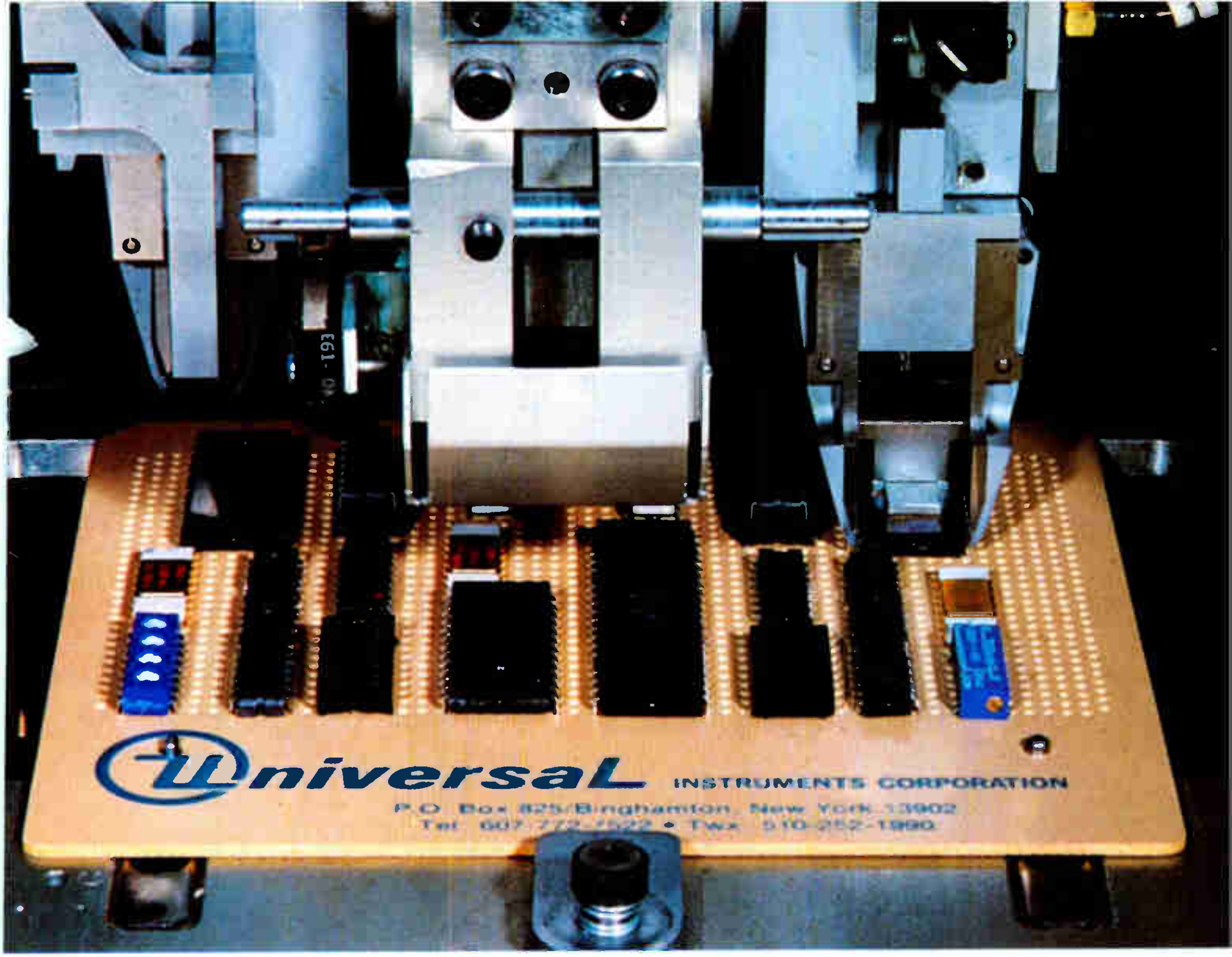

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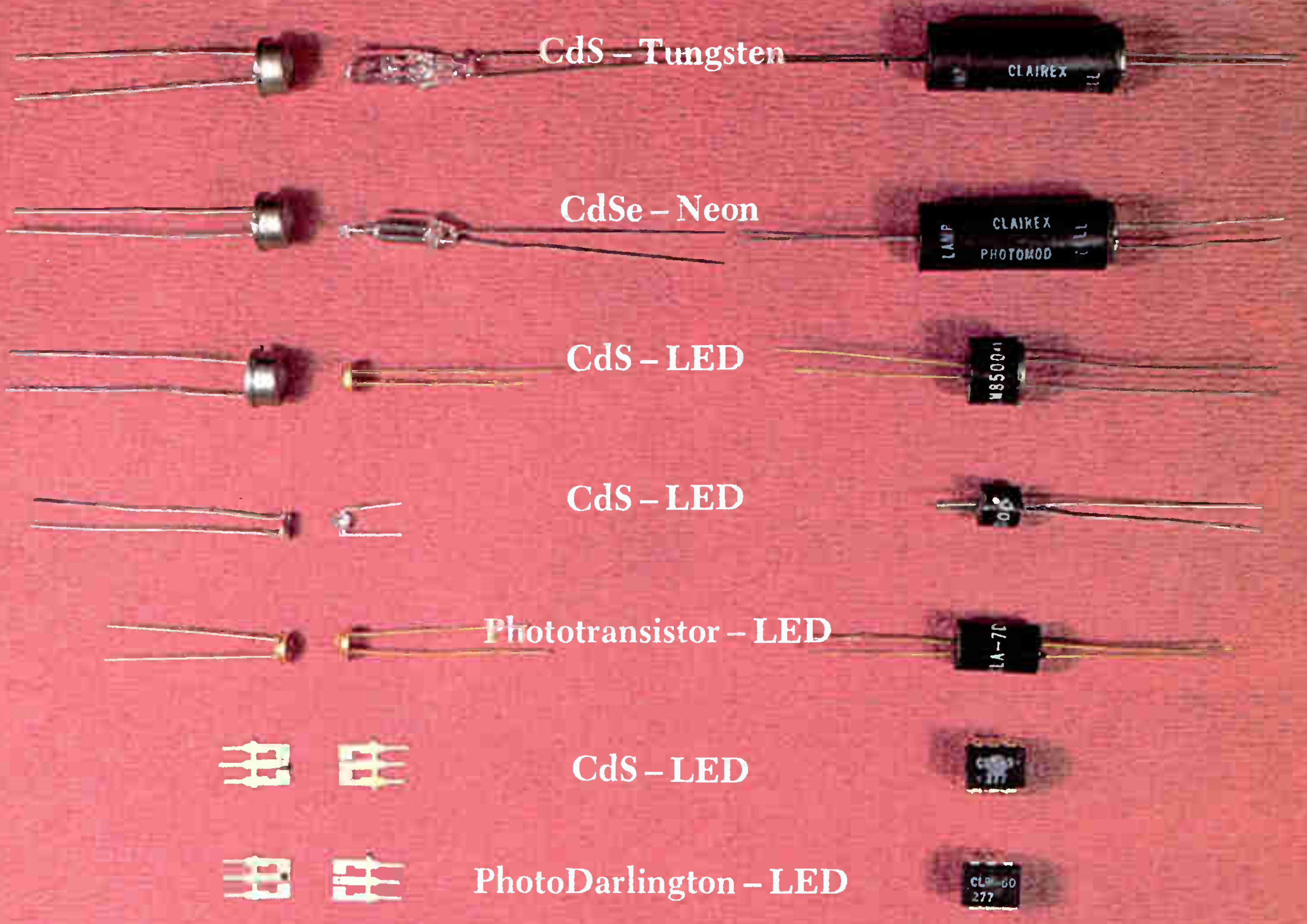

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