APRIL 21, 1983

AMERICAN BELL'S ELUSIVE STRATEGY: AN INTERVIEW WITH ARCHIE McGILL/105

Batch-processed IC package exceeds military specifications/155

Touch-sensitive screen makes logic analyzer friendly/144

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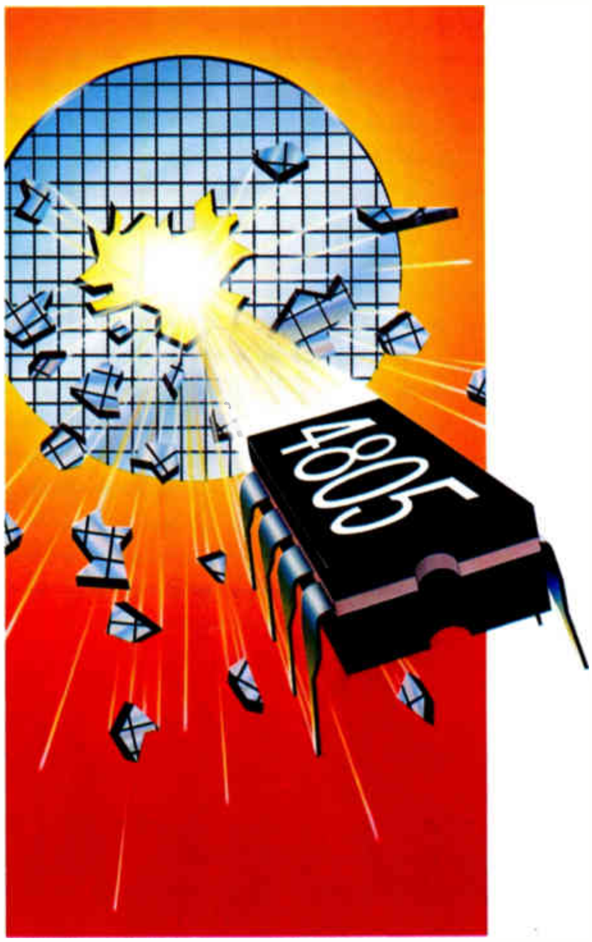

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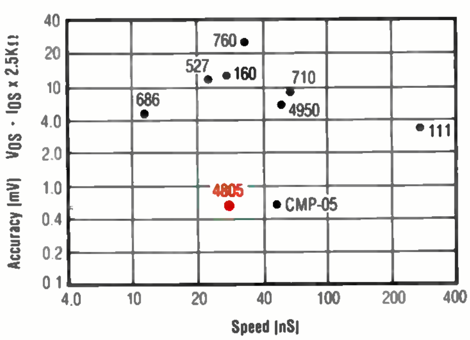

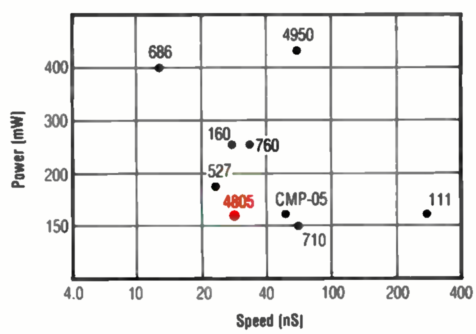

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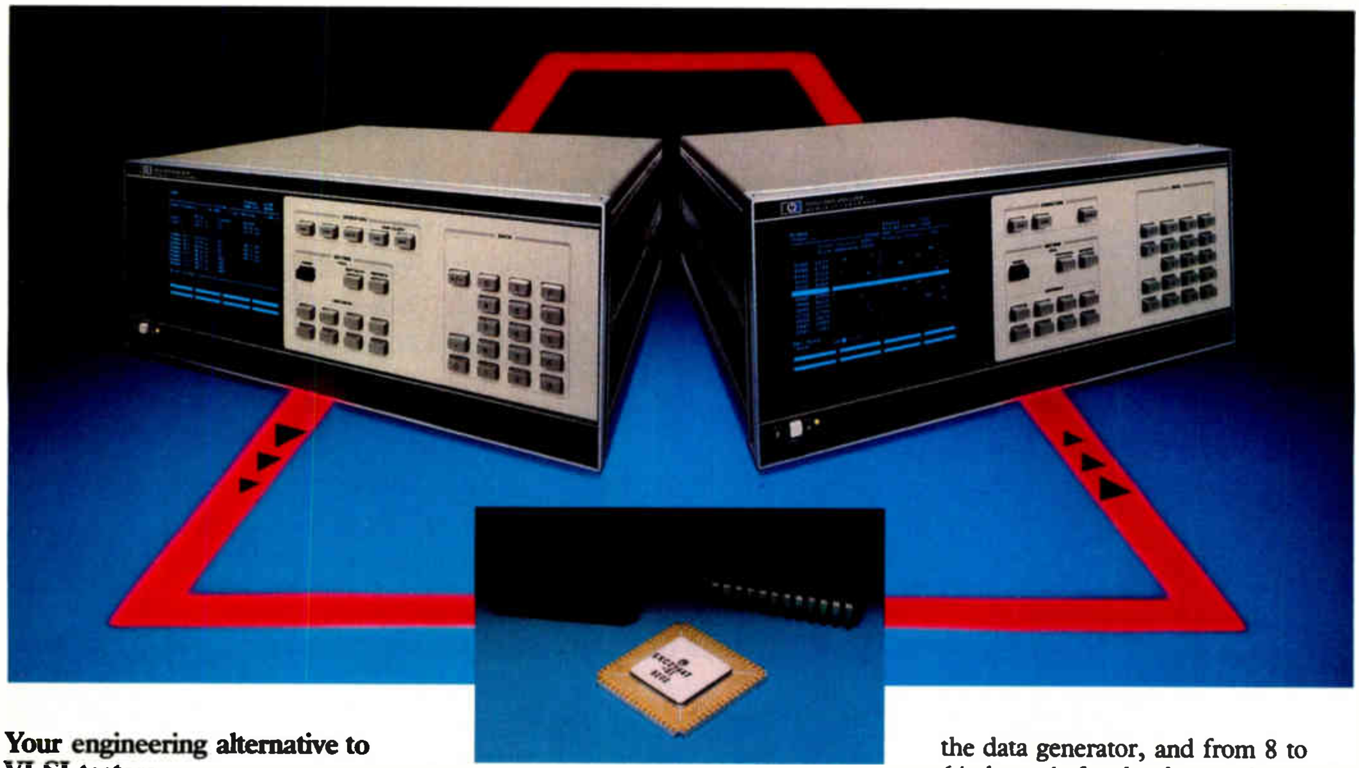

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Highlights

Cover: Voice technology advances to new highs, 126

A combination of technological advances and market forces are stimulating developments in such voice technology applications as speech recognition and synthesis and voice mail. Better speech-processing algorithms and very large-scale integrated circuits are combining with the explosion in personal computers and office automation to spur the advances reported in this package of three articles, plus an overview.

Voice input/output for small computers, 128. A single-chip 32-bit microcomputer designed for fast signal processing is the heart of a board that brings voice technology to small computers. This system can both synthesize speech and recognize voice (a much harder task), as well as perform other voice-processing functions: the desired program is downloaded from the host.

Text into voice from a two-processor board, 133. Turning ASCII code into high-quality speech is the boast of a board that combines a general-purpose microprocessor with a signal-processing microcomputer (the same chip featured in the previous article). The real secret, however, is the highly sophisticated software, which unites a phonemic dictionary, translation rules, and transition smoothing.

Voice mail in a PABX, 139. Voice store-and-forward systems can do a fine job of storing digitized messages, and, when combined with a private automated branch exchange, they can also answer telephones and perform other phone-related tasks. Such a unit, of course, makes it possible to send a message without actually calling the recipient.

SID meeting to focus on big displays, 114

Large-area electronic displays will be the central topic at next month's meeting of the Society for Information Display. Moreover, many of the papers will discuss developments that are close to implementation.

Adaptable logic analyzer answers many needs, 144

Accessible to users with varying degrees of skill, a new logic analyzer also covers a broad spectrum of applications and includes such easy-to-use features as a touch-sensitive screen and display-scrolling knob. Its dual-clocking scheme simplifies hardware-software integration.

Mass-produced compact package holds dense ICs reliably, 155

With package patterns etched on a large substrate, much as integrated circuits are lithographed onto a wafer, a new package type can be mass-produced. What's more, it can hold dense ICs in a small space and has a thermal coefficient of expansion that matches that of printed-circuit boards.

In the next issue . . .

The National Computer Conference: a special advance report . . . inside the 80186 . . . a 10-bit monolithic analog-to-digital conversion subsystem.

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Publisher's letter

Ever since Texas Instruments divulged details about its amazing Speak 'n' Spell learning aid in 1978, we have listened attentively to developments in electronic speech. And there has been much to hear as integrated-circuit makers shrunk what were dedicated computers into single boards that have turned up in applications as diverse as talking elevators and university-level computer-aided instruction systems.

Now the state of the art has moved well beyond simple speech output systems like Speak 'n' Spell's. "There has been a transition to fully integrated voice input and output," says Roger Godin, our communications and microwave editor. Furthermore, he points out, many of the new systems are designed as inexpensive add-ons to personal computers. This burgeoning market, Roger feels, will accelerate the growth of voice technology: having cost-effective hardware to work with, independent software makers will generate the application packages lacking till now.

For our cover-story package (starting on p. 126), Roger put together articles on three electronic voice systems. "In the special report, I tried to convey the excitement I feel as a potential user of voice technology," he says. "By combining the three systems presented, it will be possible to ask a personal computer to read you files, tell you the time, dial phone calls, take messages, and do many other tasks of an executive secretary. Both the executive and his secretary could share the same system, doubly enhancing productivity."

In Roger's view, the report is special for another reason as well: the companies involved bring a solid ring to a market that has been mostly promises for a long time. For starters, TI, with its reputation for driving prices down ahead of the learning curve, discusses a Multibus version of its recently introduced one-board system. DEC, famous for interactive computers, presents a simple hardware module that allows spoken output of any text file. Rounding out the report is Rolm, the first company to produce a voice store-and-forward capability distributed between a telephone switch and a dedicated computer. All told, so much is going on in the field that, Roger says, "the difficult part of doing this report was keeping it below 100 pages."

In the winter of 1777, local legend has it, George Washington supped and slept at Arnold's Tavern on one corner of the town green in Morristown, N. J. If tavernkeeper Arnold were around today, he might well play host to a different sort of commander and his troops, for catty-corner to the site are the still incomplete headquarter buildings of American Bell Inc.'s Advanced Information Systems division, presided over by Archie J. McGill. *Electronics* staff reporter Marilyn Harris and editor Godin trooped out there recently to interview McGill. Along with the question and answer session reported on page 105, they came back with a tale or two to tell.

"Morristown isn't the sleepy burg it used to be," comments Marilyn, "but it's hardly a metropolis. Therefore, American Bell's three 10- and 12-story buildings, which would pass unnoticed in Manhattan, tend to dominate the green, drawing the eye to that corner. You know something big is in town.

"We found our way through the construction along a maze of snow fencing and were whisked up to McGill's top-floor office past hallways still being plastered and wired. Sky-blue and ivory within, a view of the Appalachian foothills without, the executive suite radiates the power, the utter assurance that comes from having a mother like Ma Bell.

"Many have called Baby Bell a gamble, but McGill, the consummate marketeer, is probably quite adept at poker. He kept his cards close to his chest during our interview, but one thing was clear: he's playing for keeps."

Readers' comments

Straight from the source

To the Editor: We at Source III read your special report on very large-scale integration, "Advances in customization free VLSI system designers" [Feb. 10, p. 134], with great interest. Being in a position to appreciate the magnitude of your efforts, we thought the article was well-written, timely, and incisive. In addition, we thank you for giving us credit for the data used to generate your chart on page 141, which was drawn from our 650-page report "Gate Arrays Implementing LSI Technology."

Over a man-year was spent writing, compiling, and editing the manuscript, and we believe strongly that the information contained in the report is invaluable to many of your readers who are about to embark on their first semicustom venture.

Copies of the report may be obtained for $1,250 each by contacting Electronic Trend Publications, 10080 N. Wolfe Rd, Cupertino, Calif.

Michael Magranet
Source III Inc.
San Jose, Calif.

Double vision

To the Editor: The article entitled "Vision unit can be programmed on site" in the Electronics review section of the Feb. 24 issue [p. 52] made a misleading cost-versus-price comparison between machine-vision systems of Chesebrough-Ponds Inc. and Octek Inc

When discussing Chesebrough's vision system, you stated "the unit cost to the company is between $15,000 and $20,000," whereas the 20/20 Vision Development System "starts at $49,800 plus an extra $19,000 for each satellite module." Such a comparison is erroneous as it implies that the 20/20 costs twice as much as the other, similar equipment. However, as the Chesebrough unit "is not available commercially," costs for research and development, standard profit margin, and vendor maintenance are not allocated directly to the price of the equipment.

It must also be understood that the typical company will not build its own machine-vision system. Ideally, a company wishing to incorporate automated inspection or robotic vision would opt for many fully functional, stand-alone machine-vision modules capable of being programmed off line from an integrated machine-vision work station. As mentioned, Octek has accomplished this with the 20/20 VDS and its satellite approach.

Chuck Hitchcock
Octek Inc.
Burlington, Mass.

Staff reporter Harris replies: *Mr. Hitchcock's attention to our recent article was appreciated. However, I wish he had been more scrupulous in his presentation of the facts. The text explicitly states "The cost estimate [of Chesebrough's vision system] includes no markup, for the unit is not available commercially." Further, Octek's system—which, like Chesebrough's, has a development capability—is in fact more directly compared with a slightly less expensive commercial product from another maker that has four times as many gray levels but no development capability.*

Unix redux

To the Editor: On page 56 of the Feb. 10 issue you published an article entitled "Bell, DEC announce support for Unix" in which reference is made to Unix-based operating systems developed by the University of California at Berkeley. Although the article states that "the Berkeley software is in the public domain," this is not correct. The software developed by Berkeley may only be furnished to American Telegraph & Telephone Co.'s licensees for Unix operating systems.

W. R. Guffey
AT&T
Greensboro, N. C.

Correction

Inadvertently omitted from "Statistical analysis proves good subject" (April 7, p. 52) was the location of the firm that gives the seminars on that topic. Dialogue Systems Inc. is in Los Altos, Calif., and its phone number is (415) 960-0555.

There's a Z8001 in Commodore's future.

Commodore is about to prove that Zilog's high-performance CPU's are as ideal for consumer products as they are for business and industrial applications. Because soon the Z8001 will appear in Commodore's new 16-bit personal computers! So why did they select the Z8001 over all other CPU's?

Consider size. Compared to other 16-bit CPU's, only the Z8001 delivers exceptionally high performance in a standard 48-pin package. It doesn't take much board space, so it's a natural, cost-effective solution for personal computers.

The Z8001 is also the most reliable. Its transistor count is one-fourth that of other popular CPU's, contributing to higher reliability and clock speeds greater than competitive products. What's more, its advanced, large-computer architecture provides smooth, fast memory-management—with no wait states. It requires 30% less code to run C language than other 16-bit CPU's. Plus, the Z8001 gives Commodore access to a remarkably broad software base—operating systems, languages and applications programs.

Now consider the migration path. The Z8001 guarantees Commodore upward migration to Zilog's new-32-bit processor.

Finally, Commodore has access to Zilog's family of peripherals: MMU's, FIFO's, SCC's, CIO's, ASCC's, UPC's, BEP's, DCP's and many others. All compatible.

Commodore selected the Z8001 for all the right reasons. Just like many other successful companies have: Ferranti, Beckman Instruments, Litton Data Systems, Olivetti, Teletype, Sweda, Boeing, Ratheon, Printronix, Lear Siegler, and Coleco, to name a few.

Shouldn't you find out what they already know? Call Zilog at 800/252-6560. Or write: Zilog, Inc., Technical Publications, MS 1-4, 1315 Dell Avenue, Campbell, CA 95008.

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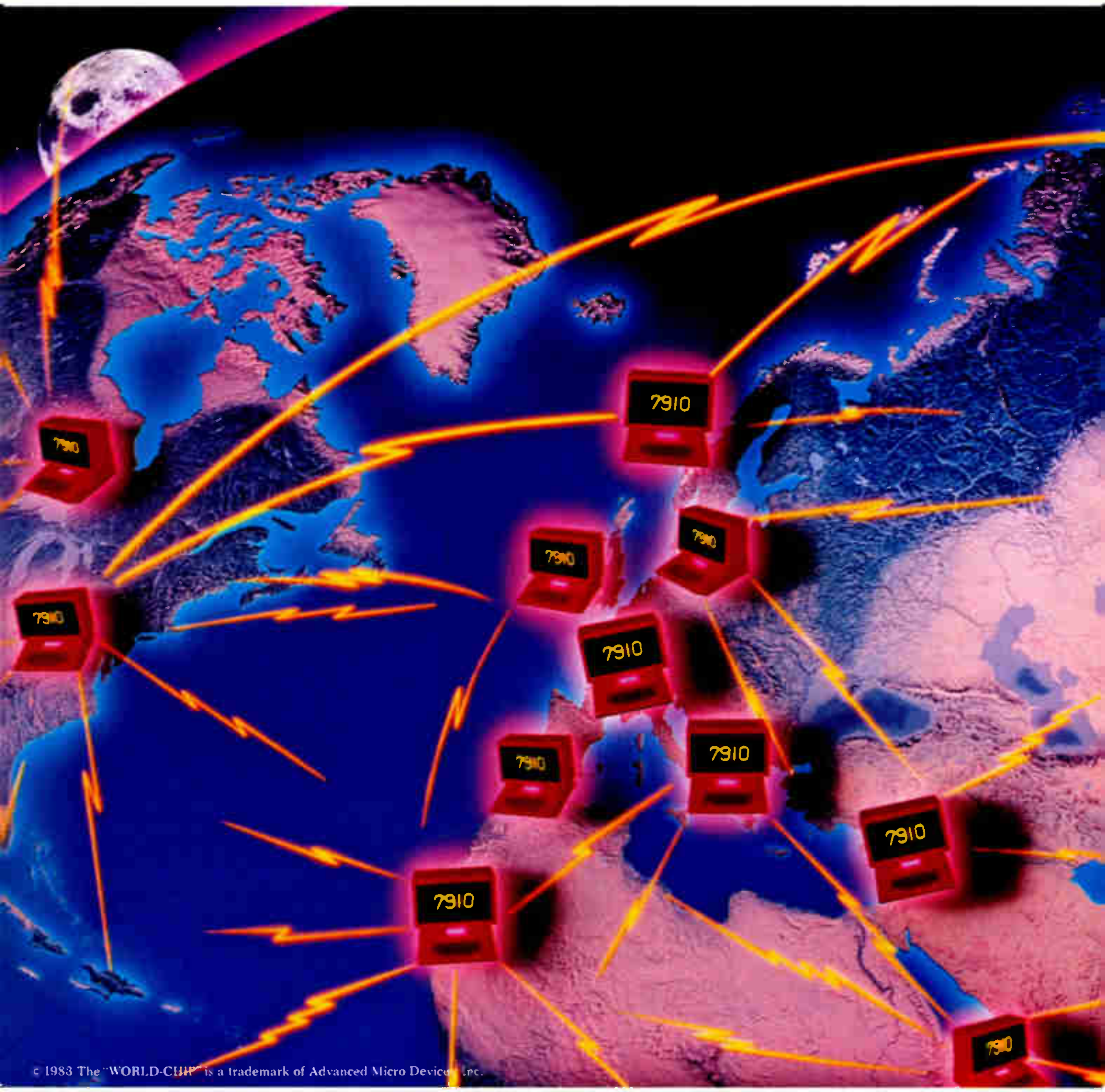

The IRS takes a nearsighted look at software

Although April 15 has passed, for at least some members of the electronics industries the regulations of the Internal Revenue Service remain far more than just an unpleasant memory. For the IRS, in its infinite wisdom, has decided to take what the Wall Street Journal characterizes as a "hard line on software" and in so doing has software and computer firms and a good portion of the accounting industry up in arms.

Briefly, the IRS has proposed that the 25% research-incentive credit as permitted under the 1981 tax act would apply only if a program were "new or significantly improved." It wants to reject credit for one whose "operational feasibility" was not "seriously in doubt." In other words, there must be a serious risk that the program cannot be written. This, say critics, distorts the intention of the Congress in approving the incentive credit.

The potential for damage is best expressed by G. Steven Burrill, who heads the high-technology group at Arthur Young & Co., the international accounting firm with headquarters in New York. Says Burrill, "We believe that the proposals are a blow to technology businesses and to entrepreneurs across the country. The scope of these regulations is especially inadequate for software, electronics, and aerospace companies, and for start-up enterprises in a number of industries." The accounting firm also points out that the "significantly improved" stipulation would mean that adaptations of previously developed programs, such as tailoring one to specific customer needs or translating an existing program for use with other equipment, would not qualify for the credit unless the programming itself involved significant risk that it could not be done.

We agree that the proposed change is short-sighted, potentially damaging, and unduly discriminatory. It is not clear on what evidence the IRS acted, or even how it will decide the relative risk involved in developing different software. Hearings on the proposed rules were scheduled for April 19. It would behoove the tax people to drop the whole matter and get on with their business.

Think what they could do if they had enough engineers!

On a recent visit to Japan, *Electronics* editors were told by several Japanese executives that they were concerned about a developing shortage of electronics engineers. Despite the fact that Japanese universities turn out many more engineers than those in the U. S., it seems that industry's demands have outstripped the supply. Unlike for U. S. companies, the only source of additions to the staffs of Japanese companies is the latest crop of graduates, since hiring away engineers from competitors simply is not done. What's more, the number of engineering students in Japan does not rise and fall with demand, as it seems to in the U. S., since the number of places in the schools is relatively fixed. As a result, the major electronics companies in Japan are more or less on allocation for the available supply.

What are the Japanese doing about it? The same as the Americans—they are going all out to make their engineers more productive with computer-aided design and other types of computer-enhanced engineering tools. It looks as if the competitive edge of the future in the electronics business will belong to whoever has the best engineering hardware and software.

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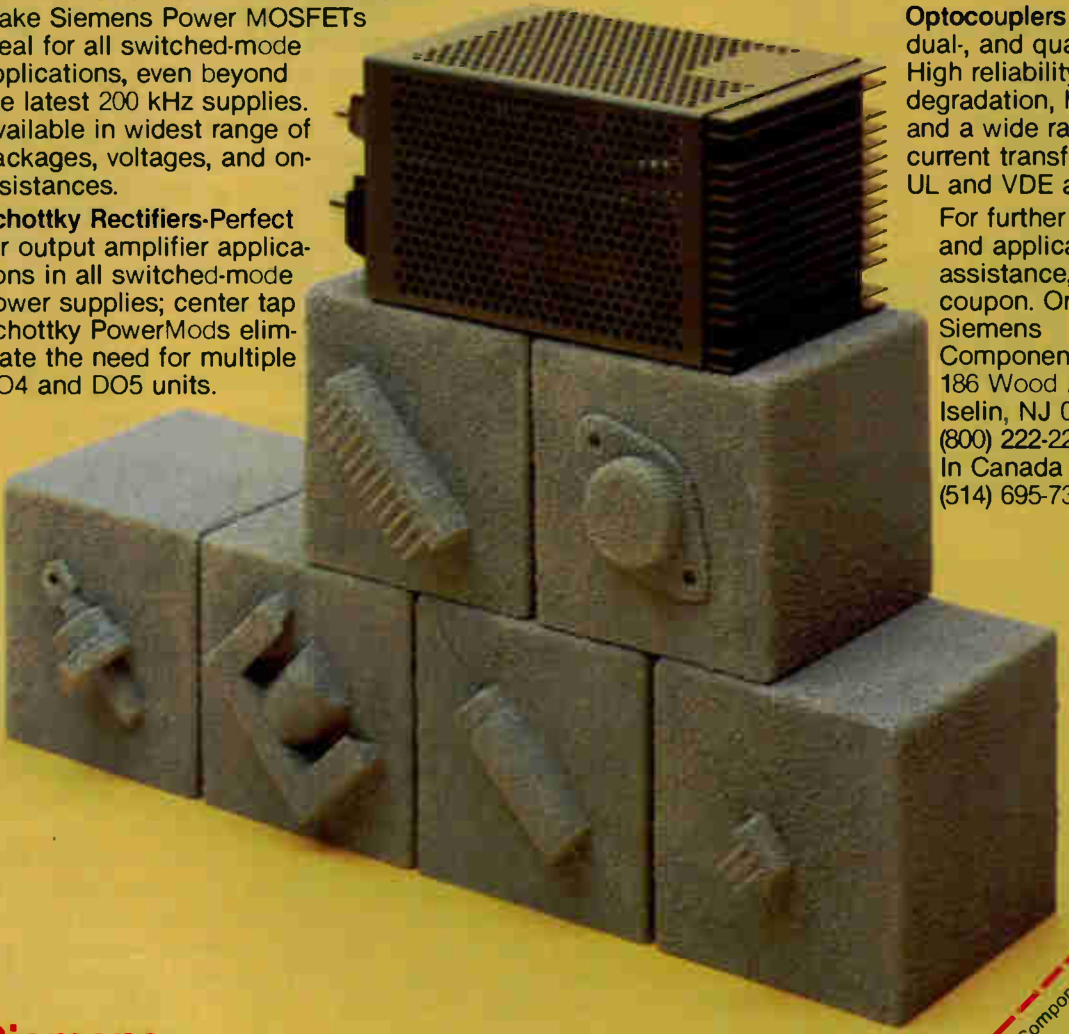

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People

Snow sees quick updates as key to Vector's success

Straight talk about the small-computer business from insiders is hard to come by; most executives still hold—in public, at least—that never-ending demand offers everyone a chance to grow large, given a solid product to sell. Challenging this complacent view, however, is Frederick A. Snow, a 46-year-old native Briton, who has spent nearly a year as president of Vector Graphic Inc., Thousand Oaks, Calif., started in 1976 to help pioneer small computers.

No mirrors. Frederick Snow has Vector Graphic using "next generation of wizardry" to gain lead time.

"Everything has changed in the last 12 to 15 months; the competition has become unbelievable," he says. Not only has IBM Corp. moved to dominate the fray, but Texas Instruments Inc. and other heavyweights have stepped up the action and the long-predicted Japanese entries are beginning to show up. And there is the product-identity dilemma—observes Snow, "We're all selling virtually the same thing."

There are two survival choices, he says. A company can opt either to specialize in a narrow vertical market—"nichemanship"—or to take advantage of the quick-decision mobility of small companies to rapidly plug in advanced technology.

Vector Graphic is going the second route, trying to put the "next generation of wizardry" into its new machines and gain a six-to-nine-month lead that could prove critical against stiff competition. First examples introduced in late 1982 are a local interactive network, called LINC, that connects a multiuser system over a telephone wire, and the Vector 4 intelligent work station to plug into it. Snow says that IBM and TI, for example, still have these only in the planning stage.

Snow, who has bachelor's degrees in nuclear physics from the University of London and in electrical engineering from the University of Salford, joined Vector Graphic in mid-1982 as chief operating officer. Before that he was vice president for planning at Honeywell Inc.

Snow says he knew how tough the small-computer business was from his previous vantage point, but now admits, "It's even worse than it looked from outside." After enjoying strong growth to the $40 million sales range, last year Vector ran into recessionary troubles and hot competition. Furthermore, these continue; it reports a $1 million loss in the most recent quarter. But Snow hopes that new products and an improving economy should help turn things around.

Johnson goes home to job as president of Vertimag

When Clark E. Johnson Jr. moved from California to Minneapolis in January 1981 to take the reins of the new Vertimag Systems Corp., it was a return to his roots in more ways than one. The 52-year-old Minneapolis native was not only coming home to the city of his birth after a 15-year absence, he was also returning as president and cofounder of a company involved at the leading edge of magnetic-recording technology, his first area of expertise.

As a 1950 graduate with a bachelor's degree in physics from the University of Minnesota, Johnson got his first job experience working on problems of magnetic-recording technology at 3M Co.'s central research laboratories in nearby St. Paul. In addi-

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People

On top. Clark Johnson seeks to keep magnetic-recording leader Vertimag in front.

tion, Vertimag headquarters are located only about a mile from the campus, where Johnson in 1961 also earned a master's in electrical engineering while attending graduate school with Vertimag cofounder Jack Judy, who today heads the university's Magnetics Research Laboratory.

Drawing heavily upon engineers schooled under Judy, Vertimag expects to be in the forefront of so-called perpendicular magnetic recording, with plans to begin production next year of a 5.25-inch floppy-disk–drive product based on the technology (see p. 47). And if Judy is the font of Vertimag's technical expertise, Johnson provides the entrepreneurial experience. Since leaving 3M in 1959, he has been involved with a number of high-technology start-ups over the years. (A third Vertimag founder, vice president Donald A. Sackman, brings large-company experience in international technology transfer and licensing.)

With perpendicular recording eventually promising tenfold or better density improvements over conventional longitudinal techniques, Johnson believes Vertimag is well-positioned to ride the crest of a new wave in magnetic-recording technology. "Historically, magnetic recording densities have increased by a factor of two every two and a half to three years, but longitudinal recording is now reaching the limit of its expansion," says Johnson.

He looks to the perpendicular technique as a means of continuing that historical curve. Indeed, "we think perpendicular is to magnetic recording basically what the transistor was to the vacuum tube." □

IEEE-488

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Unlike some other manufacturers of voltage calibrators, Fluke provides the instrumentation necessary for traceable calibration. The new 732A DC Voltage Reference Standard provides excellent stability of 0.5 ppm/month allowing substitution for standard cells in many applications. And the 752A Reference Divider, with an output uncertainty of 0.2 ppm, sets new standards for ratio accuracy and ease of use. Add to this the built-in calibration and self-test features of the 5440A, and calibration or repair has never been easier.

More than a lab instrument.

The 5440A and its support instruments, the 732A and 752A, liberate the calibration task from dedicated, temperature controlled facilities. Specified accuracy is guaranteed between 15°C and 30°C, so you can perform calibration or high accuracy tests on the production line.

5440A Specifications Summary

Bipolar Output Range	Basic Uncertainty (30 days)	Basic Uncertainty 90 days	Short-term Stability	Full Accuracy Temperature Range	Current Sourcing Capability	Resolution	IEEE-488 Interface/ RS-232 C Output
100 nV to 1100 V	4 ppm	4.5 ppm	1 ppm	15°C to 30°C	25 mA	0.1 ppm	Standard

Find out more!

Once you've compared the 5440A with other calibration systems, you'll agree that Fluke is the unchallenged leader. Call us toll-free at **800-426-0361** or contact your local Fluke Sales Engineer or Representative for more information.

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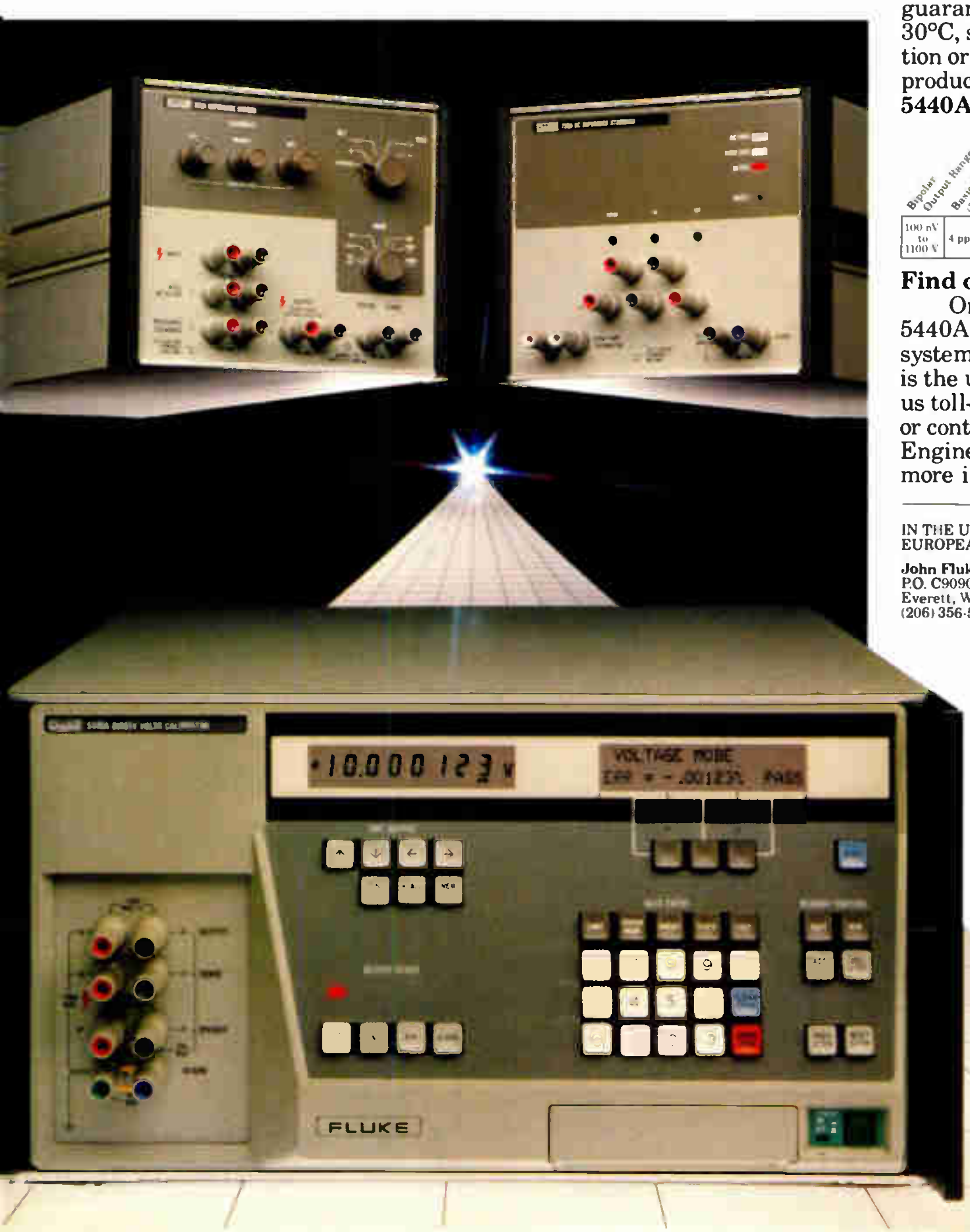
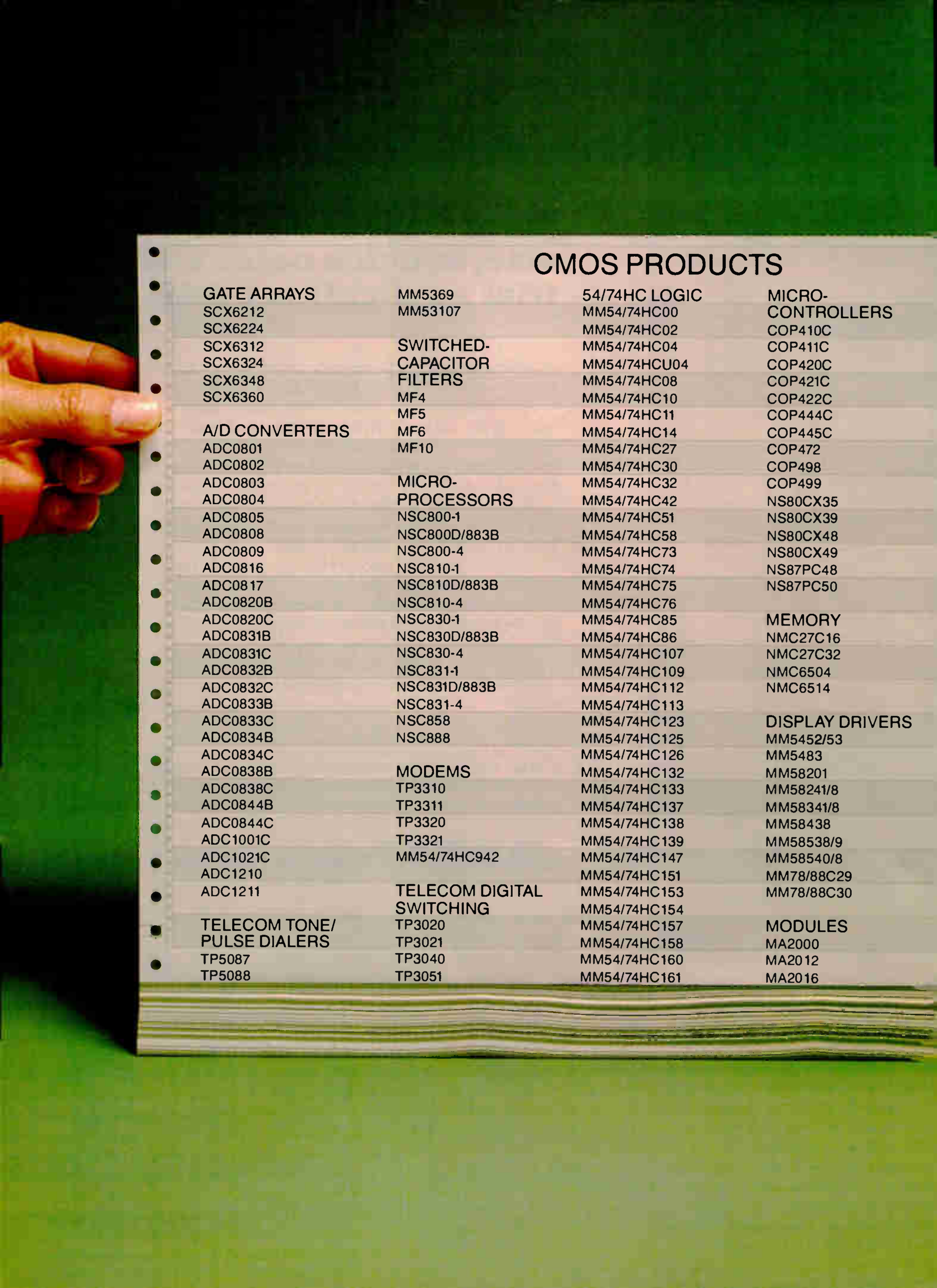


5440A Direct Voltage Calibration System.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ADC0802
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ADC0804
ADC0805
ADC0808
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ADC0816
ADC0817
ADC0820B
ADC0820C
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54/74HC LOGIC
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NS80CX48
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NS87PC48
NS87PC50
MEMORY
NMC27C16
NMC27C32
NMC6504
NMC6514
DISPLAY DRIVERS
MM5452/53
MM5483
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MM58241/8
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MODULES
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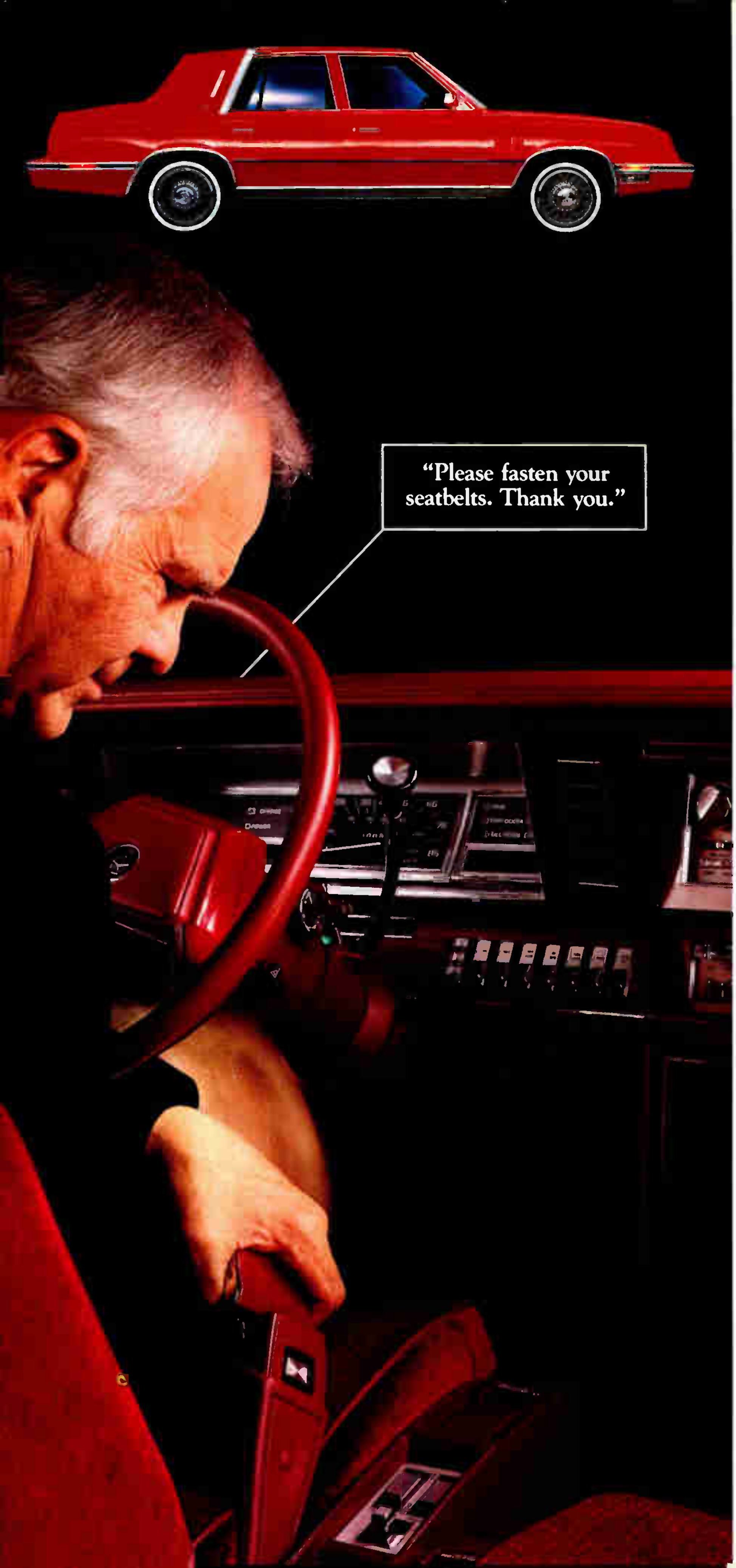
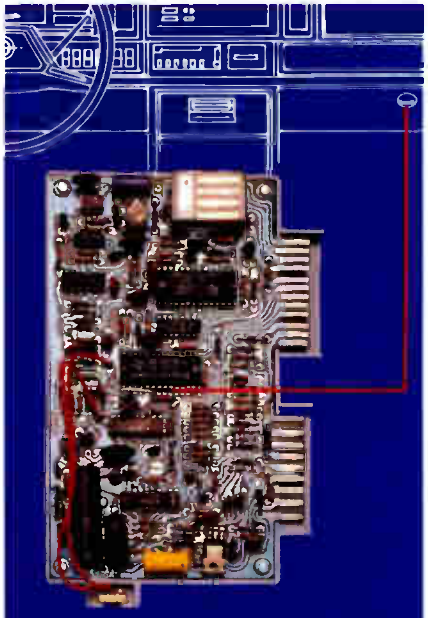


Texas make

Chrysler wanted a more effective way to remind drivers to "buckle up" and warn them of possible car problems. The solution? Solid State Speech™ technology from Texas Instruments. Working closely on a day-to-day basis with TI speech experts, Chrysler developed the Electronic Voice Alert (EVA) in record time. To make cars talk.



Low-cost TI devices are the key to Chrysler's "talking cars." Principal ICs used include TI's TMS5110A voice synthesis processor, a TMS1000 Series single-chip microcomputer, and a TMS6125 read-only memory (ROM).

The remarkable EVA system not only monitors the car's major functions, it actually talks to the driver. In a clear, lifelike voice, it says: "*A door is ajar.*" "*Don't forget your keys.*" "*Your fuel is low.*" "*All monitored systems are functioning.*" And more.

◀ Speaking in a polite, synthesized human voice, the Electronic Voice Alert (EVA) developed by TI and Chrysler reminds motorists to "buckle up" for safety. It also helps owners practice preventive maintenance by warning them of potential car problems. The EVA system vocabulary will be expanded for use in future Chrysler models and is now already programmed for foreign languages.

Instant hesitation can hurt sales

by Tony Schwartz
president, Planned Reactions Inc., New York, N. Y.

When I first became involved with tape recording in the 1940s, I had the feeling I was on the cutting edge of electronics, the same feeling that young people today have about the world of home computers, audio and video recorders, and component television.

In those days, if you were involved in tape or wire recording, people looked on you as a visitor from a strange new world. Many new products were coming out, yet somehow there was more stability to them then. The Webster wire recorder was in existence for a number of years before it was replaced by the Webcor tape recorder.

The Pentron and Brush tape recorders lasted for many years, and companies like Magnacord and Ampex came out with models that were around for a long time. I used the Ampex 601 and later its PR-10 and AG-500 for 10 or 15 years. Only when the company stopped making them a few years ago did I shift to the Revox-Studer line of equipment—fine models that have also been around many years.

Changing models. But the recorder field is different today, and this applies to both audio and video recorders. Take a company like Sony, for instance—and Sony is only one example out of many. Sony has never kept a tape or home video recorder line in existence for any length of time. There's no question that the Sony people make superb equipment, but they are constantly changing their models. This applies to their Walkman-type cassette recorders, their home hi-fi system cassette recorders, amplifiers, and tuners, and their television line.

If I go into an electronics store today and look at a cassette recorder or an a-m–fm tuner and then come back a few weeks later, I may not be able to find the same models on the shelves. Instead, there's a whole new line on sale. The same thing happens in the computer stores. I feel that by the time I get home the product is obsolete. This, of course, makes me—and I'm quite sure a lot of other consumers—leery of buying the current product.

The difference between the old and the new style of electronics is alarmingly akin to the different policies of Volkswagen and the American automobile industry. The Volkswagen bug looked the same for many decades. Any changes that were made could be incorporated into any model, just as one could update many of the Ampex, Revox, or McIntosh products. In contrast, U. S. automobile companies had a standing policy of changing models every year. The implication was that if you didn't get the latest model you just didn't have it. They wanted you to feel that each new model represented the latest technology in transportation, and last year's model represented complete obsolescence.

Costly model changes. I remember going with a dear old friend of mine to visit the Dictaphone headquarters in New York to look at their small electronic tape recorder. This was long before the proliferation of today's mini recorders. The Dictaphone executive asked my friend if he also wanted to see their new dictation equipment. My friend replied that he was not interested because his late-1920s Dictaphone was still working perfectly. The executive then said, "Well, wouldn't you like to see the latest model?" My friend indignantly answered, "My dear man, I drove around in a 1920s Ford for 20 years while all my friends were buying new models every year. I invested the money I saved. I now own the Great Northern Hotel in New York, and I'm financially independent while my friends are still struggling at their jobs!"

What took place with U. S. automobiles is generally referred to as "planned obsolescence." It can create a consumer backlash and a hesitation to buy when people realize its economic waste and stupidity and that this is done done just to make them buy. I wonder if we are observing today the Japanese version of that planned obsolescence, with many new models introduced seemingly every week or two. I can only say that instant hesitation is one of the major effects this approach to marketing in the electronic equipment and computer fields has on me. And there are millions like me, I'm sure.

Electronics *will periodically invite the expression of outside views on this page concerning issues of importance to the electronics industries.*

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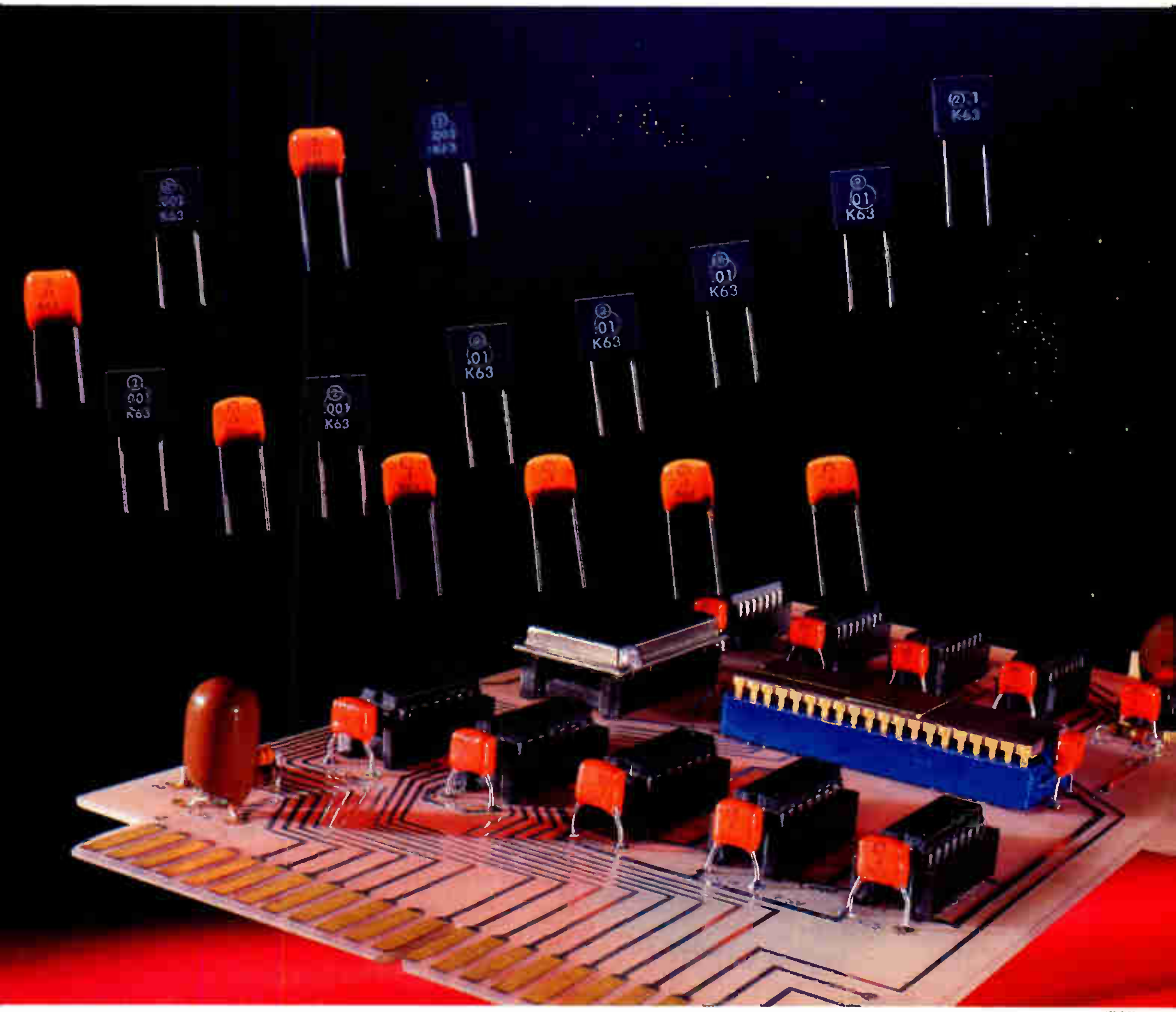

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Meetings

International Symposium, Society for Information Display (Lewis Winner, 301 Almeria Ave., Coral Gables, Fla. 33134), Marriott Hotel, Philadelphia, Pa., May 10–12.

33rd Electronic Components Conference, IEEE and EIA (Thomas G. Grau, Bell Telephone Laboratories, Whippany, N. J. 07981), Contemporary Hotel, Walt Disney World, Orlando, Fla., May 16–18.

National Computer Conference, IEEE and the American Federation of Information Processing Societies (Linda Mooskin, Afips, 1815 North Lynn St., Arlington, Va. 22209), Anaheim Convention Center, Anaheim, Calif., May 16–19.

Photon '83—International Conference on Fiber Optics, Materials, Processes, and Applications, International Society for Optical Engineering (Jacques Boudot, Quartz Productions Corp., P. O. Box 1347, Plainfield, N. J. 07061), Paris, France, May 16–19.

Naecon '83—National Aerospace and Electronics Conference, IEEE (Dan Snyder, Naecon '83, 2046 Northern Drive, Dayton, Ohio 45431), Convention Center, Dayton, May 17–19.

Second Software Engineering Standards Applications Workshop, IEEE (P. O. Box 639, Silver Spring, Md. 20901), Sir Francis Drake Hotel, San Francisco, May 17–19.

Conference on Lasers and Electro-Optics, Optical Society of America (Meetings Department, 1816 Jefferson Place, N. W., Washington, D. C. 20036), Baltimore Convention Center, Baltimore, Md., May 17–20.

Second Automated Manufacturing Conference, British Robot Association (Clapp & Poliak Europe Ltd., 232 Acton Lane, London W4 5DL, England), National Exhibition Center, Birmingham, UK, May 17–20.

Electron Tubes Conference, IEEE *et al.* (Dr. Ing F. Coers, IEEE, Stressmannallee 15, VDE-HAUS, D-6000 Frankfurt 70, West Germany), Garmisch-Partenkirchen, Bavaria, West Germany, May 18–20.

Fourth European Hybrid Microelectronics Conference, International Society for Hybrid Microelectronics (DIS Congress Service, Linde Alle 48, DK-2720 Vanlose/Copenhagen, Denmark), Bella Center, Copenhagen, May 18–20.

Sixth International Symposium on Computer Hardware Description Languages and their Applications, IEEE *et al.* (Mario R. Barbacci, Department of Computer Science, Carnegie Mellon University, Pittsburgh, Pa. 15213), Pittsburgh, Pa., May 23–24.

Custom Integrated Circuits Conference, IEEE (David Lewis, Eastman Kodak Co., Bldg. 81, Rochester, N. Y. 14650), Genesee Plaza/Holiday Inn, Rochester, N. Y., May 23–25.

13th International Symposium on Multiple-Valued Logic, IEEE (Harry Hayman, P. O. Box 639, Silver Spring, Md. 20901), Holiday Inn Kyoto, Kyoto, Japan, May 23–25.

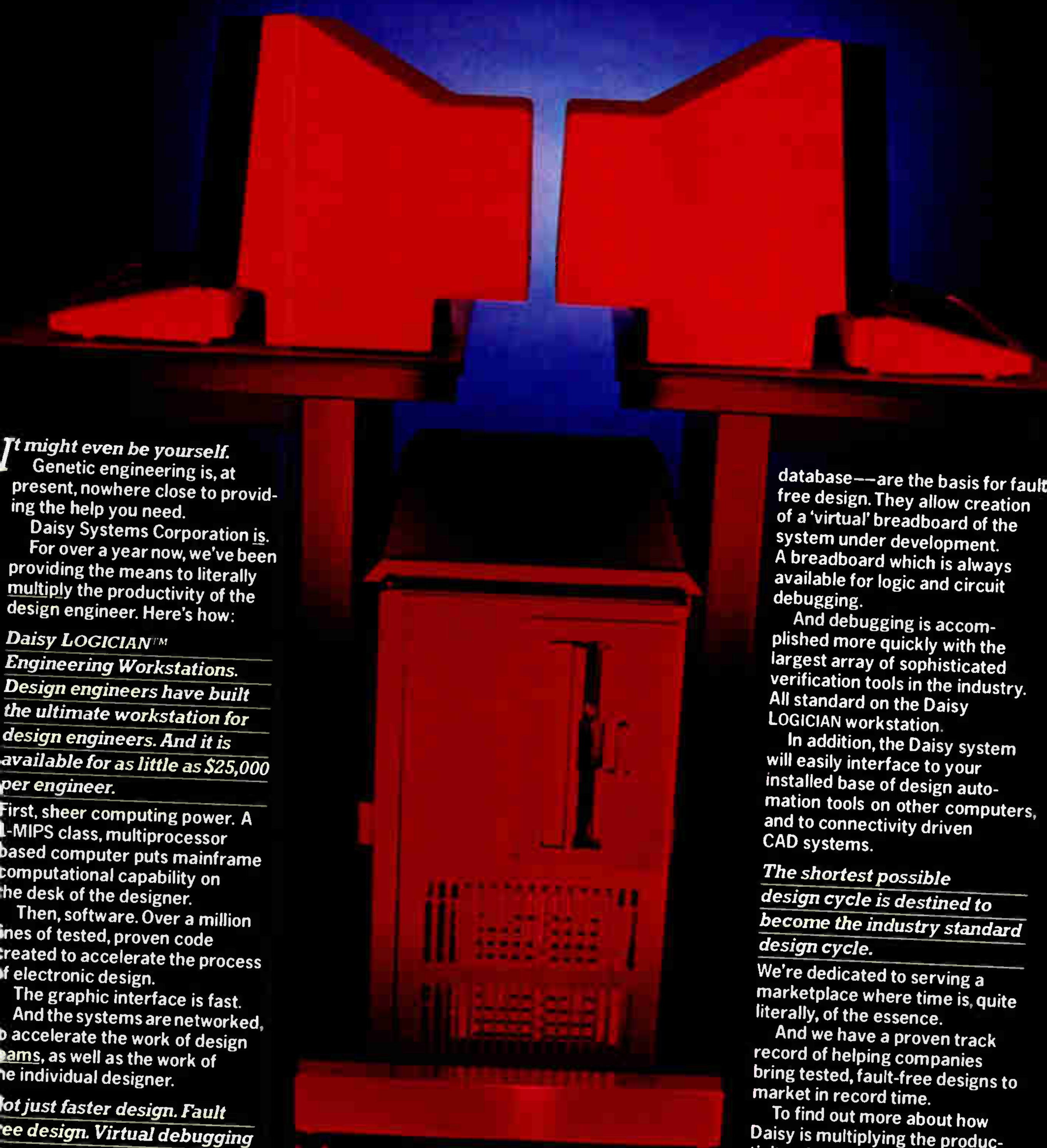
Semicon/West '83, Semiconductor Equipment and Materials Institute (Susan Castillo, 625 Ellis St., Suite 212, Mountain View, Calif. 94043), Fairgrounds, San Mateo, Calif., May 24–26.

Seminars

Microprocessor Applications: Software and Hardware Techniques, Center for Advanced Engineering Study, Massachusetts Institute of Technology (Room 9-335, 105 Massachusetts Ave., Cambridge, Mass. 02139, or call Laura McShane at (617) 253-7406). At MIT, June 6–12 and July 11–17.

Optical Signal Processing, Office of Continuing Studies, Rensselaer Polytechnic Institute (Troy, N. Y. 12181, or call (518) 270-6442). At RPI, June 20–24.

Somewhere in your company there's a design engineer or two you'd like to clone.



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This new generation of scopes is easier to use, more portable and more precise, to give you better measurements faster.

The 2235/2236.

Two 100 MHz additions to the Tek 2200 Series. The 2235 features a low price made possible by radically simplified design. But it makes no compromise with Tek quality. Sensitivity, accuracy and triggering are excellent.

The new 2236 adds a microprocessor-based 100 MHz counter/timer/DMM, integrated into the vertical, horizontal and trigger systems. You get direct digital readout of Delay Time. Δ-Time accuracy to 0.001%. Plus independent floating 5000-count DMM.

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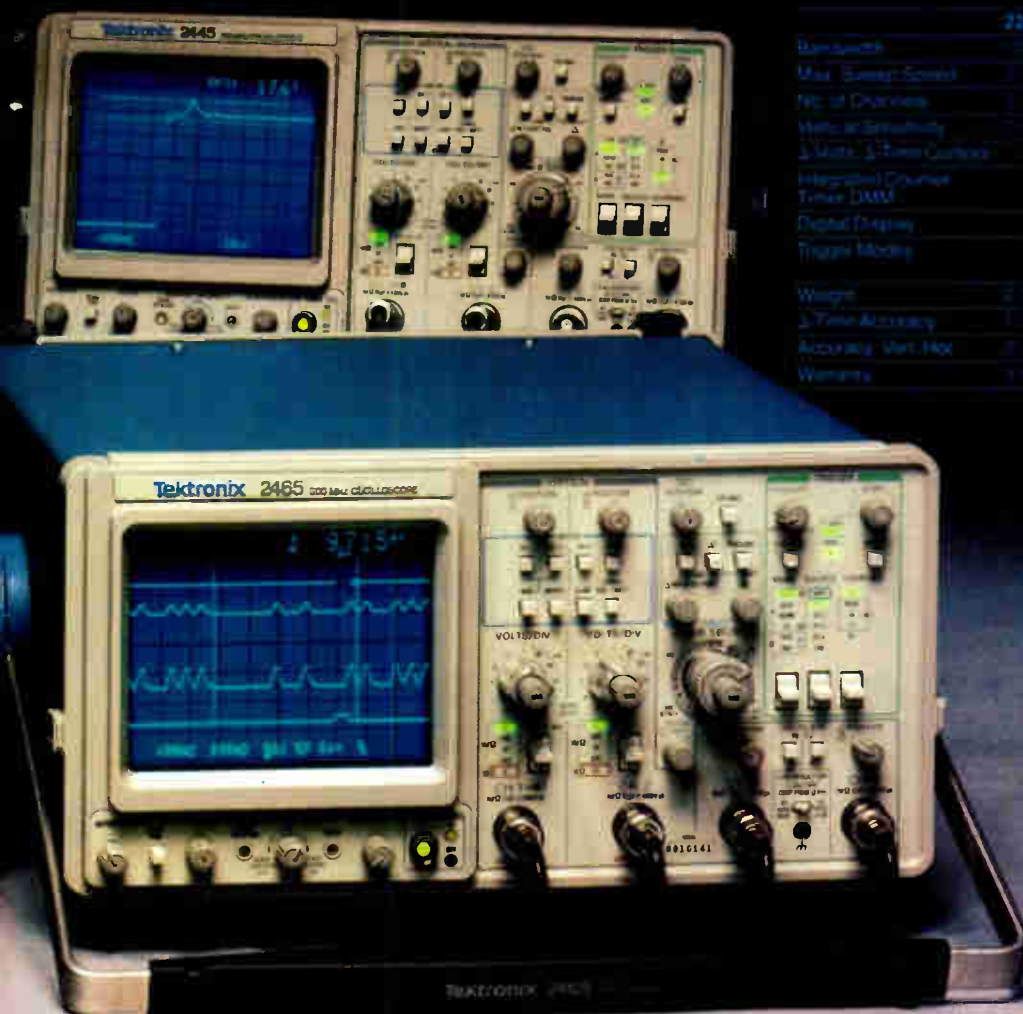
The new 2400 Series portables eclipse the 465B, the previous industry standard. In sweep speed. Triggering. Accuracy. Number of channels. And much more.

The new 150 MHz 2445 and 300 MHz 2465 scopes are more sophisticated in performance, yet simpler in operation than any

Announcing four great scopes all at once!



	2235	2236	2445	2465
Bandwidth	[illegible]	[illegible]	[illegible]	[illegible]
Max. Sweep Speed	[illegible]	[illegible]	[illegible]	[illegible]
No. of Channels	[illegible]	[illegible]	[illegible]	[illegible]
Vertical Sensitivity	[illegible]	[illegible]	[illegible]	[illegible]
Δ Volts, Δ Time Cursors	[illegible]	[illegible]	[illegible]	[illegible]
Integrated Counter Timer DMM	[illegible]	[illegible]	[illegible]	[illegible]
Digital Display	[illegible]	[illegible]	[illegible]	[illegible]
Trigger Modes	[illegible]	[illegible]	[illegible]	[illegible]
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Δ Time Accuracy	[illegible]	[illegible]	[illegible]	[illegible]
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We'll change your expectations of what a scope can and should be. Again.

Tektronix

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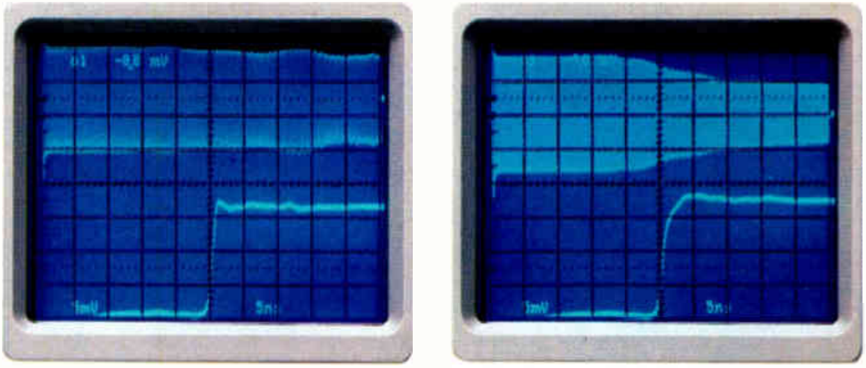
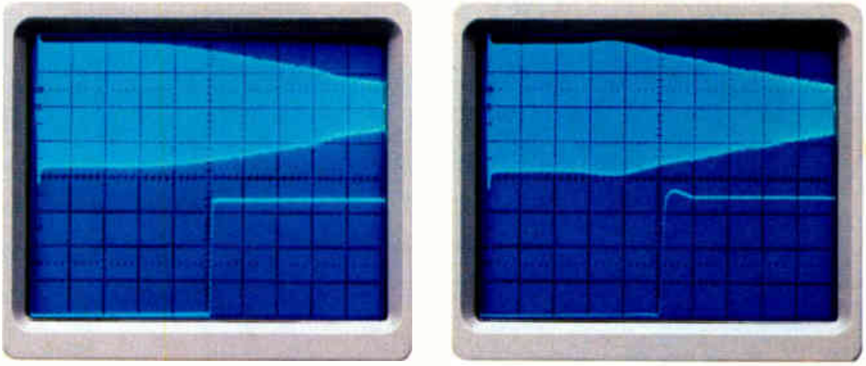
Tek challenges commodity probes to a screen test.

Optimum measurement results with Tek probe. | **Loss attributable to a commodity probe.**

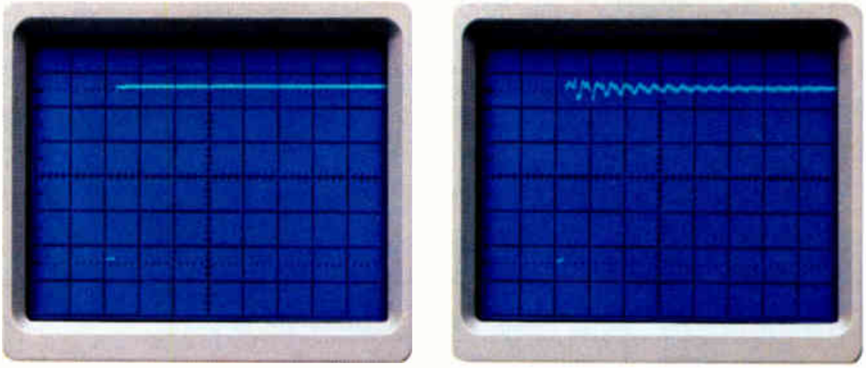
A commodity probe can act like a bandwidth limit switch. (Left) The Tek probe faithfully transfers a signal frequency of 300 MHz. (Right) But the commodity probe limits the bandwidth of the same 300 MHz scope to 200 MHz.



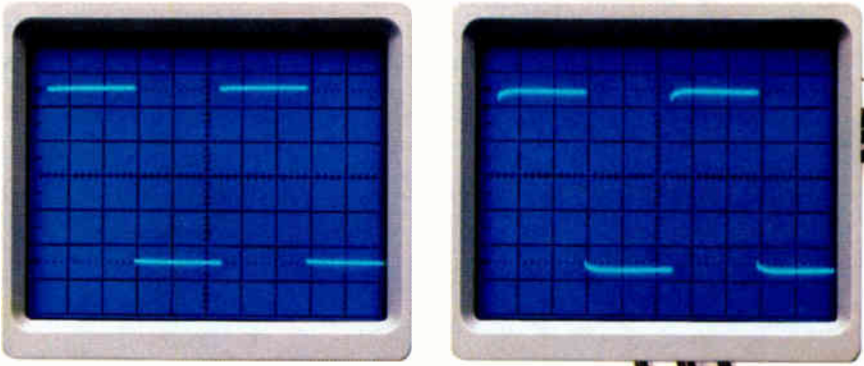
(Left) Tek probes are matched to the system throughout its frequency range for a display that exhibits a clean 100 MHz waveform. (Right) Many commodity probes are peaked to attain higher frequency response, resulting in aberrations.



Commodity probes don't offer a multiplicity of probe tip accessories. (Left) By choosing the appropriate ground lead from Tektronix, ringing simply does not exist. (Right) The long ground lead on a commodity probe causes ringing.



Tek probes deliver superior environmental performance. (Left) After 5 days of exposure to high humidity (MIL-E-16400F), the Tek probe shows no signal degradation. (Right) The commodity probe induces a "hook" aberration.



See for yourself: It takes the right probe to make the best measurement!

No factor is more critical to optimized system performance than proper probe selection. A probe that's not right for your application can mean a significant loss in measurement results, plus costly delays and errors.

By giving due consideration to probe characteristics that your application requires, you can derive full benefits from the instrument capabilities that you have at hand.

For over 35 years, Tektronix has been designing probes that are matched not only to our scopes, but to your own instrument and application needs. They minimize circuit loading, while extending and enhancing system performance. By valuing the special requirements of every application, we build more value into every probe.

Bandwidth/risetime, input voltage, input impedance and limiting aberrations are all among characteristics to evaluate in terms of your own application.

And while electrical considerations are of prime importance, physical parameters such as environmental performance, cable flex life and probe length can be equally crucial. Unnecessary cable length, for example, will decrease bandwidth and increase a probe's loading capacitance:

Make your selection from the world's largest and most respected probe product line. It includes voltage probes, active and passive current probes, high voltage probes, low impedance/high frequency probes and differential probes.

Tektronix doesn't just give you more probes than anyone else. We give you probes that do more.

And to facilitate your measurement application Tek provides a wide range of probe accessories including tips, adapters, connectors and tools. These aids are described in our Accessories Selection Guide.

Call the Tektronix National Marketing Center today for an Accessories Selection Guide! It covers the entire product line, with criteria you need for matching the right probe to your application.

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News update

■ Developing a large, flat-panel display technology can be frustrating, as officials at Lucitron Inc. can attest. The almost five-year-old Northbrook, Ill., firm has yet to deliver its 34-inch-diagonal dc flat-panel display to the Naval Ocean Systems Center, despite delivery-date promises going back to June 1981 [*Electronics*, May 5, 1981, p. 12].

The problem has lain in assembling the large display, says operations vice president Alan Sobel, one of the three former Zenith Radio Corp. researchers who started the company. He notes that at least a dozen 10-in. versions have been built of the display, which relies on a patented multiplexing technique to simplify its drive electronics.

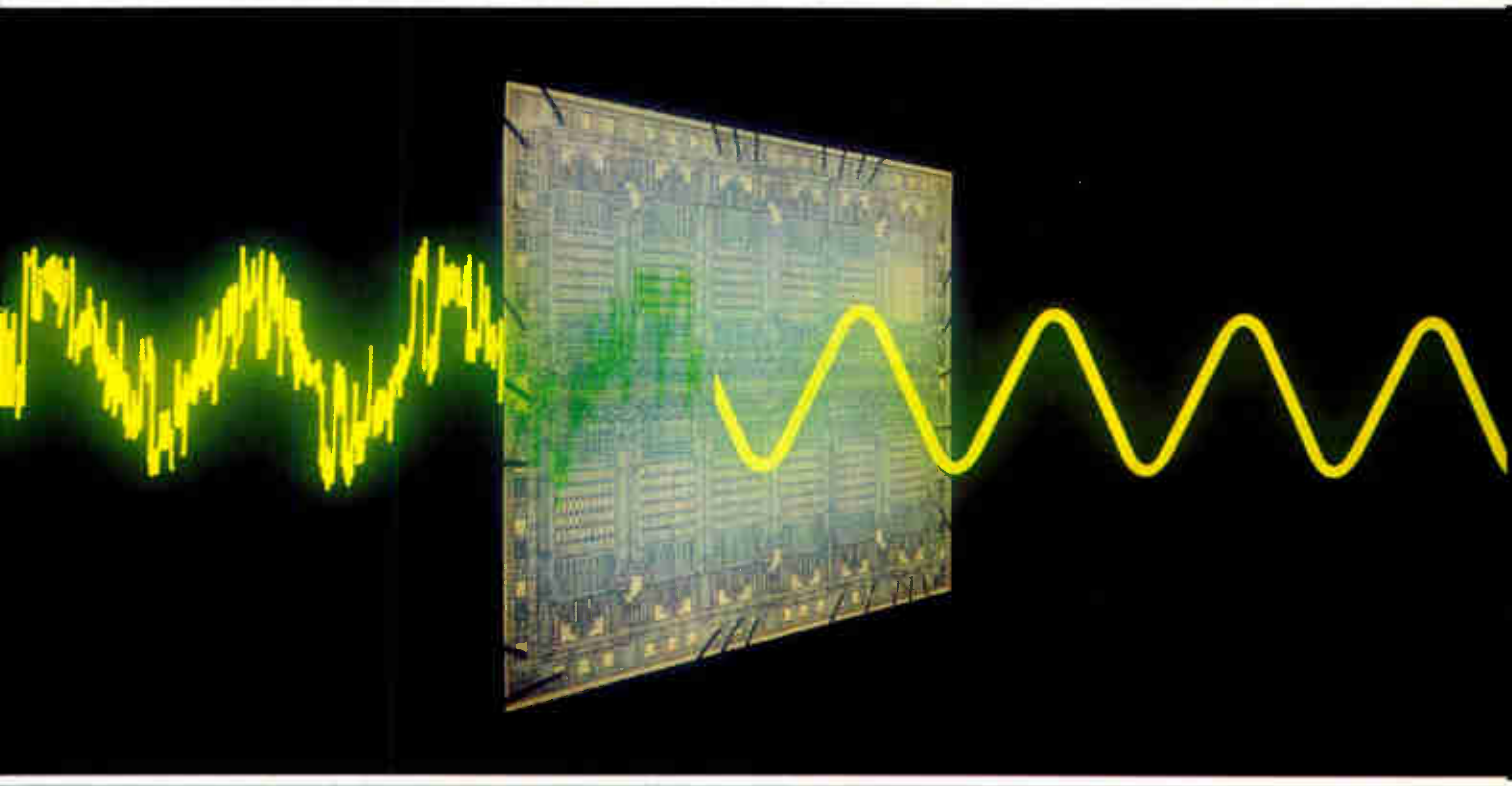
But with the 34-in. unit, "it's been a startlingly hard job to get everything registered and put together properly," he observes.

In Lucitron's Flatscreen Gas-Electron-Phosphor display, a cold-cathode glow discharge in helium gas is used both for scanning and as a source of electrons. The anode glow is scanned by a matrix of row and column electrodes. Electron beams extracted from the glow are modulated and accelerated through several kilovolts to excite standard phosphors. Resolution of the Navy display is 12.5 elements/in. vertically, 18.5 elements/in. horizontally; there will be 25 rows of 85 characters/row based on five-by-seven–dot characters each 0.56 in. high.

Solved. Sobel contends the assembly problems are solved and that two of the 3-in.-thick flat panels will be delivered to the Navy center in San Diego by September. That delivery will be aided by funds pledged to Lucitron last month by another company; the project will continue as a joint effort, he says.

Sobel will not name Lucitron's benefactor because discussions are still under way. Options include continuing on a large (up to 45-in.-diagonal) display for applications like teleconferencing, for example, or on a smaller display for portable computers. Sobel hopes to be producing a display in quantity in two and a half years. –**Wesley R. Iversen**

NOW! A SWITCHED CAPACITOR ARRAY FOR TOUGH FILTERING PROBLEMS.



Precision high-order filtering with the SCA-6 and the SCA-12.
Silicon Systems' new metal-gate CMOS switched capacitor arrays—the SCA-6 and the SCA-12—provide high-order filtering on a single chip. The new semicustom circuits are designed to permit user programming of the metal mask so that up to six (SCA-6) or twelve (SCA-12) biquadratic filter sections may be implemented. Other switched capacitor filter architectures and general analog functions can also be designed. The unlimited variety of configurations assures the customer of a unique proprietary product.

The features and benefits of the switched capacitor array.
Both the SCA-6 and the SCA-12 arrays offer stable precise filtering with no need for external components or trimmers. Buffer amplifiers are built-in for continuous time interfacing and analog driving, and the circuits can be operated from a single or split supply of 9.5 to 15 volts.

They are the first arrays to integrate filters with frequency tolerances better than 1% and passband responses accurate to 0.5dB. With single mask user programming, the customer can have his prototypes within 8 to 12 weeks. Minimum volume pricing is far below that for competing technologies, and board space savings are substantial. The SCA-6 fits in a standard 0.3" wide DIP.

How to put the SCA-6 and the SCA-12 to work for you.
Customers versed in switched capacitor filter design may submit schematics to SSi. Others may provide SSi with continuous time designs, transfer functions, or specs; and if your application is appropriate, SSi will help you program the metal mask to adapt the SCA-6 or the SCA-12 to serve your particular requirements.

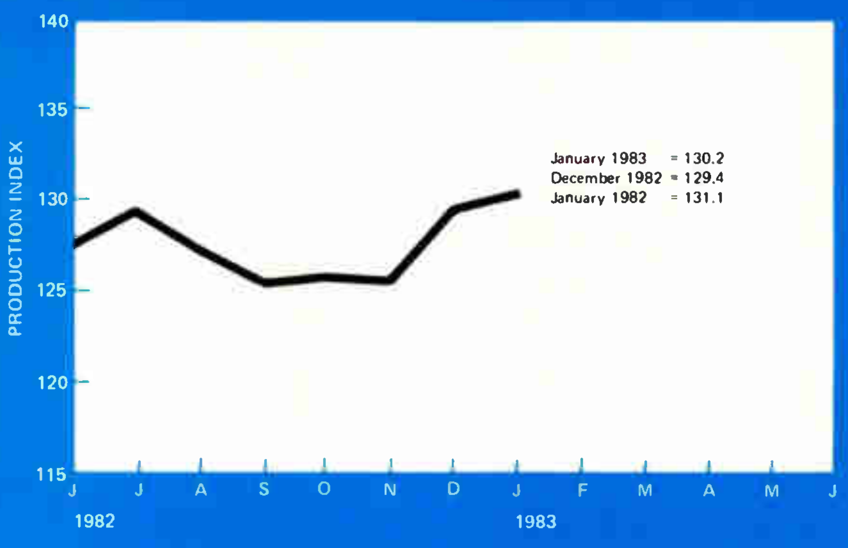
For data sheets, contact:
Silicon Systems Incorporated,
14351 Myford Rd., Tustin, CA 92680
(714) 731-7110, Ext. 130.

SSi Silicon Systems incorporated

Circle 33 on reader service card

Business activity

The *Electronics* production index is a seasonally adjusted measure of the level of production activity among U.S. manufacturers of office and data-processing equipment, communications equipment, and radio-television equipment, instruments, and components. As a reference point, the 1977 yearly average = 100.



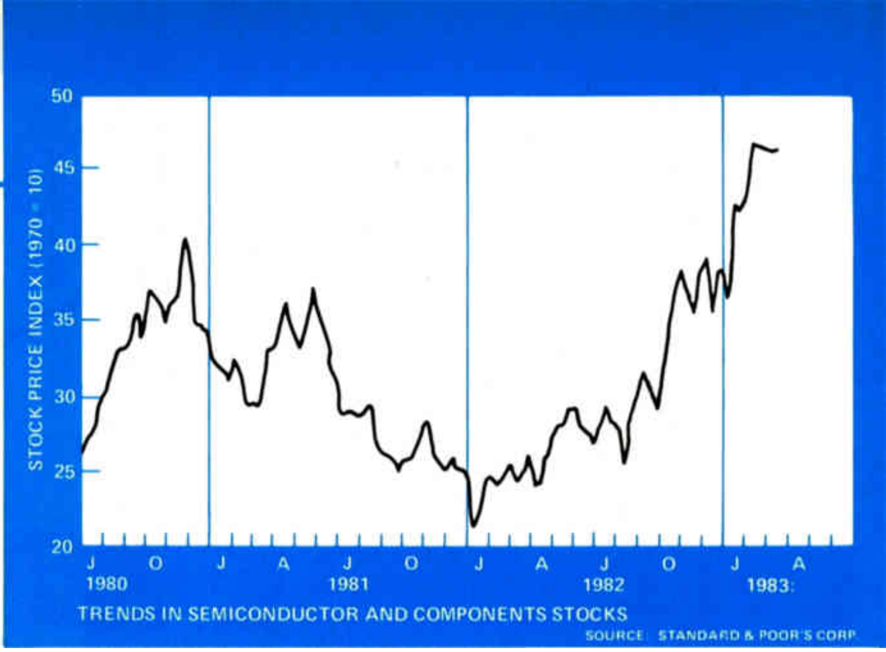
U.S. INDUSTRIAL PRODUCTION INDEX[1]	January 1983	December 1982	January 1982
Office and data-processing equipment	251.3	255.0	258.5
Communications equipment	172.8	169.2	162.7
Radio and TV equipment	79.8	72.2	80.6
Electronic and electrical instruments	156.0 (Feb. '83)	156.0 (Jan. '83)	164.5 (Feb. '82)
Components	316.9	308.3	308.1

U.S. ELECTRONICS ECONOMIC INDICATORS			
Production workers[2] (thousands)	January 1983	December 1982	January 1982
Office and computing machines	192.5	194.3	191.5
Communications equipment	255.6	254.8	266.9
Radio and TV receiving equipment	61.8	60.9	70.2
Components	320.5	320.4	326.2
Shipments[3] ($ billions)	February 1983	January 1983	February 1982
Communications equipment	3.859	3.810	3.742
Radio and TV receiving equipment	0.640	0.679	0.638
Electronic and electrical instruments	3.849	3.902	3.933
Components	2.411	2.408	2.341

U.S. GENERAL ECONOMIC INDICATORS	February 1983	January 1983	February 1982
Index of leading economic indicators[4]	148.3	146.2	135.7
Budgeted outlays of the Federal government[5] ($ billions)	64.152	67.087	57.822
Budgeted outlays of the Department of Defense[5] ($ billions)	16.567	16.297	14.579
Operating rate of all industries[6] (% capacity)	67.3	67.2	72.6
Industrial-production index[1]	137.3	136.9	142.9
Total housing starts[3] (annual rate in thousands)	1,756	1,707	911

Sources:
[1] Federal Reserve Board (1967 = 100) [2] Bureau of Labor Statistics [3] Bureau of the Census [4] Department of Commerce (1967 = 100)
[5] Department of the Treasury [6] McGraw-Hill Publications Co., Department of Economics

Business activity



An analysis of the U. S. trade position in computers and business equipment finds that the surplus of exports over imports slipped in 1982, reports a group with a strong interest in this area—the Computer and Business Equipment Manufacturers Association. According to Cbema's analysis of Bureau of Census data, the U. S. had a trade surplus in this area of $6.6 billion last year, which was down 5.4% over 1981's surplus of $7.0 billion. "A positive balance of trade was maintained with all major world areas except Japan and Taiwan," the Washington-based trade group says.

The negative balance of trade with Japan increased by 39% in 1982, according to Cbema, resulting in a U. S. trade deficit with that country of $1.251 billion in computers and business equipment. In 1981, the U. S. ran a trade deficit of $897 million in these categories, Cbema adds. (The deficit with Taiwan increased 54% to $40 million in 1982 from $26 million in 1981, the group notes.)

Japanese imports in 1982 accounted for 49% of the $4.4 billion worth of computer and business equipment brought into the U. S. last year, Cbema reports. Canada was in the No. 2 position with exports to the U. S. of $559 million in 1982, followed by West Germany with $210 million and Taiwan with $177 million. The trade group, which has 42 member firms, points out that U. S. firms increased their exports to European Community countries, as well as to the Middle East and Africa.

Exports in 1982 of data-processing equipment and parts by U. S. firms, which represented some 83% of total computer and business-machine shipments to overseas markets, amounted to $9.2 billion, up 5.3% over 1981 exports of $8.7 billion, Cbema notes. However, imports of this equipment rose a very strong 39.1% to $2.3 billion, compared with 1981 imports of $1.7 billion. As a result, the export-import ratio for data-processing equipment and parts fell to 4 : 1 in 1982 from 5 : 1 in 1981.

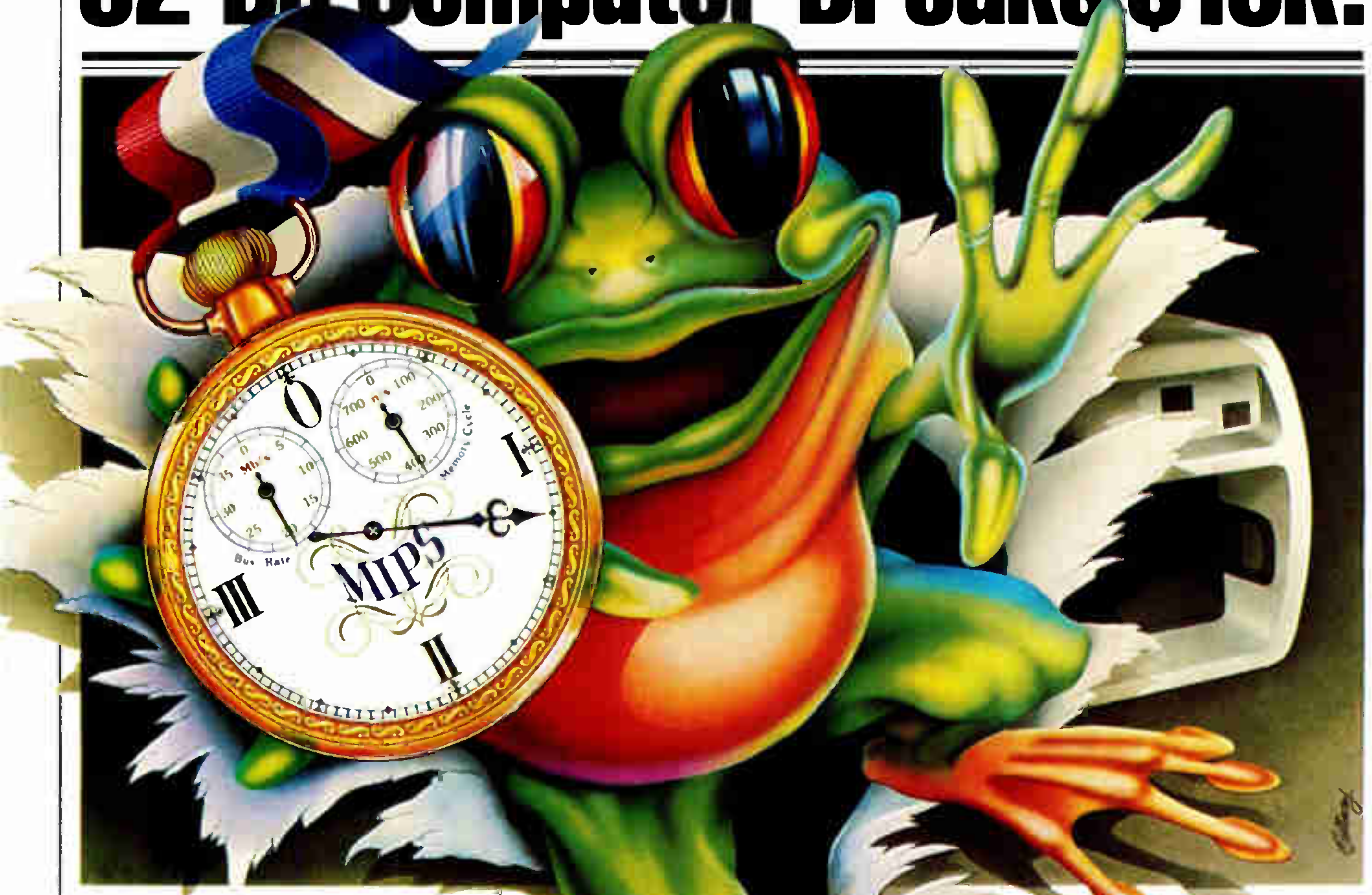
Exports last year of business equipment and parts, which include such items as copiers, calculators, typewriters, and cash registers, slipped 6.1% to $1.5 billion from $1.6 billion in 1981. Imports in this category, however, grew 4.6% to $2.1 billion from $2.0 billion the prior year. Exports of forms and supplies last year totaled $331 million, unchanged from 1981, while imports were up 45% to $4.5 million from $3.1 million.

The slowdown in the world economy that started in 1981, Cbema says, is the main culprit for the slow growth rate of U. S. exports. In addition, it notes that "market competitiveness has increased, particularly from Asian countries. The high value of the dollar has made U. S. exports more costly to purchase, as opposed to products from countries with less favorable currencies."

–Robert J. Kozma

★ ★ ★ E X T R A ★ ★ ★

32-Bit Computer Breaks $10K!

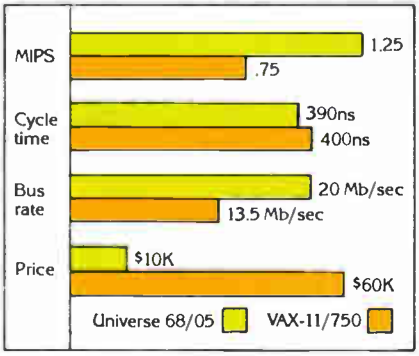


Universe 68/05 First to Smash Price Barrier

The new Universe 68/05 is the first true 32-bit computer priced under $10,000 (OEM quantity one). "True" because, unlike other 68000-based systems, the Universe 68/05 handles 32 bits in parallel on its VERSAbus.

Outperforms VAX*

Its *price* is even more impressive when you look at Universe 68/05 *performance* versus that of 32-bit "superminis" several times more expensive, like the VAX-11/750.



High-Speed 68000, 4Kb Cache, 32-Bit Bus

The key to that performance is a 4Kb cache that eliminates processor wait-states and takes full advantage of a 12.5MHz 68000 processor. Also included are a separate 68000 I/O processor, four serial I/O ports (expandable to 64), 256Kb RAM (expandable to 3Mb), 20Mb/sec, 32-bit VERSAbus, 10Mb Winchester, 1.25Mb floppy disk, and 5-slot card cage. All in a 7-inch enclosure.

UNIX-Compatible Real-Time OS, Too

UNOS*, our UNIX* Rev7-compatible operating system with real-time features, runs Pascal, Fortran, C, BASIC, DBMS, and third party application programs.

For more information, just attach your business card to this ad and mail to Charles River Data Systems, 4 Tech Circle, Natick, MA 01760. Or call us at (617) 655-1800. We'll send you a copy of "The Insider's Guide to the Universe," a detailed discussion of the technical concepts behind this remarkable new computer.

CHARLES RIVER DATA SYSTEMS

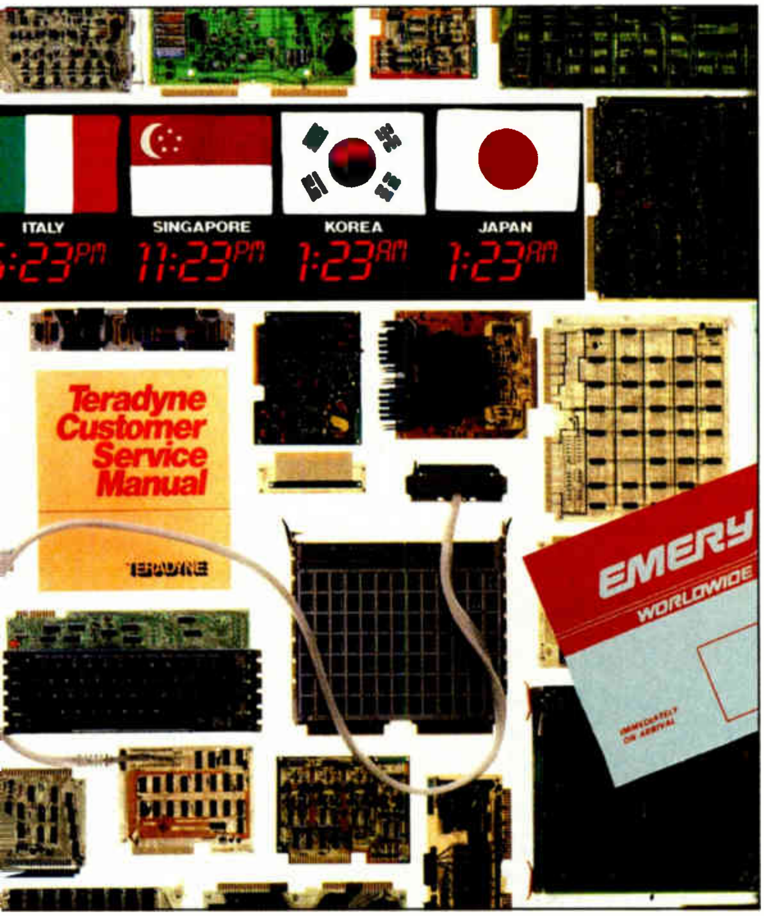
*VAX is a trademark of Digital Equipment Corporation. UNIX is a trademark of Bell Laboratories. UNOS is a trademark of Charles River Data Systems.

Circle 37 on reader service card

Nobody likes mistakes. That's why Teradyne has spent more than 20 years building automatic test equipment that roots out and eliminates errors.

Nobody's perfect, however, and in one of life's great ironies, even Teradyne products sometimes fall down on the job.

But not to worry. We can be absolutely candid about this for two reasons. First, we know that within any reasonable framework, Teradyne equipment performs superbly.



Second, when the inevitable problem does occur, we also know that you can't find better service than ours anywhere. And we're very proud of that.

Only Teradyne offers such a variety of service options. For instance, you can contract for complete on-site service to be delivered within a specified time. If we don't come through, you don't pay.

Or you may choose to be more self-reliant, in which case we'll analyze your needs and help train and equip your people to handle almost anything that comes up. You'll go from downtime to uptime in no time.

The point is, whichever option you choose, we'll give you all the support you need. And in this unpredictable world that kind of assurance can be very comforting.

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We lead it.

TERADYNE

We measure quality

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From the inventors of the first personal computer-controlled, fully programmable digital oscilloscope, come two more instruments destined to make waves.

Personal instrumentation. It's a whole new wave in test and measurement systems.

First, Northwest Instrument Systems introduced the Model 85 aScope™. Now it's joined by the aSource™ Arbitrary Waveform Generator and the aGen™ Programmable Function Generator. Result? The world's first personal computer-based, closed-loop waveform stimulus/acquisition system. A system designed for user-interaction. With easy-to-learn menu-driven set-ups. Single keystroke standard commands. And the ability to address customized applications via co-resident programs.

Yet, for all their features, each of these instruments sells for under $1,000; a tremendous price/performance breakthrough achieved by making these instruments peripherals to a personal computer, not stand-alone products linked to an instrument controller.

aSOURCE

NWIS's aSource converts the Apple II or IIe into a fully programmable arbitrary waveform generator.

Its unique Waveform Editor™ allows you to build complex waveforms by defining them mathemat-

ically or constructing them from previously stored waveform segments. aSource generated waveforms have 12-bit resolution and record lengths up to 4096.

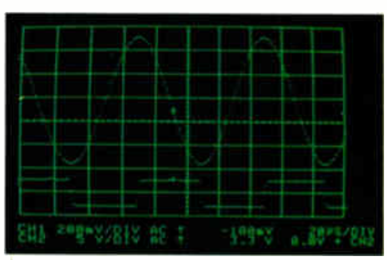
aGEN

The aGen transforms the Apple II or IIe into a fully programmable 0.5Hz to 5MHz function generator that can generate all classic waveforms—sine, square, triangle, ramp and pulse.

Continuous, triggered, gated and n-burst modes, along with variable symmetry, amplitude and frequency modulation, combine to make aGen a full-featured, flexible signal source.

aSCOPE

aScope completes the loop. From its residence in the Apple II or IIe aScope provides you with a dual



channel programmable 50MHz digital memory oscilloscope with standard operating software that includes waveform disk storage and retrieval, hard copy output, waveform digital voltmeter, and waveform averaging.

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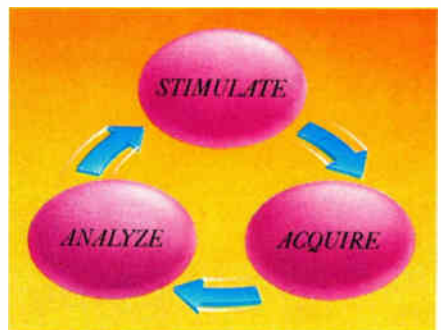
Each of these personal instruments by itself is a versatile, cost-effective programmable instrument.

But used in combination they form an incredibly efficient, high-performance stimulus/acquisition system. A closed-loop system with which you can acquire information via the aScope and analyze it with



your Apple-resident BASIC or assembly language program. The program can then control the stimulus instrument (aSource or aGen) based on the analysis. And characterization, calibration and test results can be displayed according to your needs. Total cost of these capabilities (including the personal computer, monitor and disk drive)? Less than $4,000.

So now you can allocate less time to setting up tests and wading through data. And more to the most important part of your work. Developing solutions.

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Fifth-generation computer program advances in Japan

Japan's national program to develop new computer architectures and software for a generation of machines with artificial-intelligence functions and so-called natural man-machine interfaces has made significant progress in its initial stage, according to Tohru Moto-oka, the Tokyo University professor of electrical engineering who chairs the project's main committee. Last June, a new organization called the Institute for New Generation Computer Technology was formed, and a laboratory in Tokyo was staffed by eight Japanese computer companies, mostly with software designers to be paid by the government for three years. So far, says Moto-oka, **the hardware design of what is called an inference machine has been almost completed** and is expected to be built with conventional components by the end of the year. If successful, it will be replaced with a very large-scale integrated version.

The design of a prototype relational data-base machine is also nearly completed and is expected to be operational in 1984. Current designs are based on Prolog, a language developed in France that is especially useful for mathematical computations. Now in the first of three stages, the 10-year program has some $42 million allocated for its first three years with $10 million earmarked for 1983.

275-Mb/s network to join 50-Mb/s version

Network Systems Corp., which already supplies the ultrafast 50-Mb/s Hyperchannel (local networks like Ethernet typically operate at a rate of 10 Mb/s), is developing an even faster net, to run in the 275-Mb/s range. Code-named Datapipe at the Brooklyn Park, Minn., firm, it is expected to rely on a multidrop fiber-optic link for tying together next-generation supercomputers or to serve as a backbone connecting multiple Hyperchannel networks within large business and industrial complexes. **The fiber link will give it a range of 5 to 20 miles.** Like Hyperchannel, the new system will be designed to connect equipment built by different manufacturers. Datapipe is believed to be targeted for introduction in 6 to 18 months.

Burroughs scratches optical-disk program

Burroughs Corp. has canceled its $35 million development program for high-performance optical-disk drives and media, laying off some 90 research engineers at its Westlake Village, Calif., plant. The move leaves Storage Technology Corp. of Louisville, Colo., as the only U. S. contender in the competition with Japan for the potential market in mainframe optical-disk storage. Burroughs is not offering explanations for its decision, but one industry insider says that **the Detroit computer maker's senior marketing officials offered little support for the program.** The firm originally planned mid-1984 delivery of a 2-to-4-gigabyte optical disk with an access time of 50 to 100 ms. A Burroughs spokeswoman said that 10 to 15 persons will continue basic research.

VAX gets multiprocessor, fault-tolerant features

Its eyes on potential competition from vendors of supercomputers and fail-safe systems, Digital Equipment Corp. is bolstering its VAX superminicomputers with a multiprocessor configuration and a variety of fault-tolerant measures. Enhancements to the family's VMS operating system this spring and summer will enable as many as 16 VAX-11/750,

Electronics newsletter

11/780, and 11/782 systems **to share programs and up to 100 gigabytes of disk-stored data in star-shaped clusters.** The multiprocessor configuration uses a dual-data-path bus that operates at 70 Mb/s. Next year, the VAX clusters will get an advanced version of VMS supporting redundant storage and protection of data should a clustered system fail.

Streaming-tape drive shrinks to size of half-height disk drives

A series of ¼-in. streaming-tape cartridge drives to be introduced by Archive Corp. of Costa Mesa, Calif., points up the trend in the computer industry to shrink components. The drives' big feature is their diminutiveness—only 1.625 in. high by 5.75 in. wide by 8 in. deep. Matching the size of half-height floppy-disk and Winchester drives, the new front-loading Archive model, named Scorpion, will be compatible with the company's 8-in. drives. With capacities of 20 and 45 megabytes, depending on tape length, **these small units offer the system designer many options for storage and backup combinations.** For example, a 5.25-in. floppy-disk drive could be replaced with a half-height drive for software loading and a half-height streamer for hard-disk backup.

$30 billion market in home information to unfold by mid-1990s

Home information systems are likely to be incorporated in up to 30 million households by the mid-1990s, growing to a domestic market with a potential of $30 billion, predicts a report prepared by Booz, Allen & Hamilton Inc. Reservations, shopping, home finances, games, personal calendars, learning, and financial and information services would be provided through such systems, which would be linked to homes through personal computers. According to the New York market research firm's chairman, James Farley, **60% of all household expenditures could be made with the systems,** which could cost as much as $150 billion to construct. Harvey Poppel, senior vice president, says that there are two architectures for home-information systems: cable- and telephone-based. He adds that the lack of standards should not seriously retard growth.

Production-automation awards due for JTIDS

More U. S. Air Force funds for automating its contractors' production with robots may be awarded in May or June for the Class II communications terminal to be used in the Joint Tactical Information Distribution System. Beneficiaries of the program will be **Singer Co.'s Kearfott division in Little Falls, N. J., and Rockwell International Corp.'s Collins Telecommunications Products division in Cedar Falls, Iowa.** The first big award, worth $7 million, was made to Westinghouse Electric Corp., Pittsburgh, Pa., at the end of March.

Addenda

Inmos Corp. of Colorado Springs, Colo., the chip maker that has been backed by $176 million in British government money since it was set up five years ago, figures to break into the black in 1984, company officials maintain. **The turnaround prediction comes after two years of heavy losses**—$31.2 million on revenue of $20.9 million last year and $19.9 million on revenue of $3.2 million in 1981. . . . Continuing its rapid pace of fiber-optic announcements, Bell Laboratories in Murray Hill, N. J., has unveiled a semiconductor laser with electrically tunable wavelengths in the 1.3-to-1.6-μm range. Called the cleaved coupled-cavity laser, **it makes possible gigabit frequency-modulation rates and long-wavelength multiplexing.**

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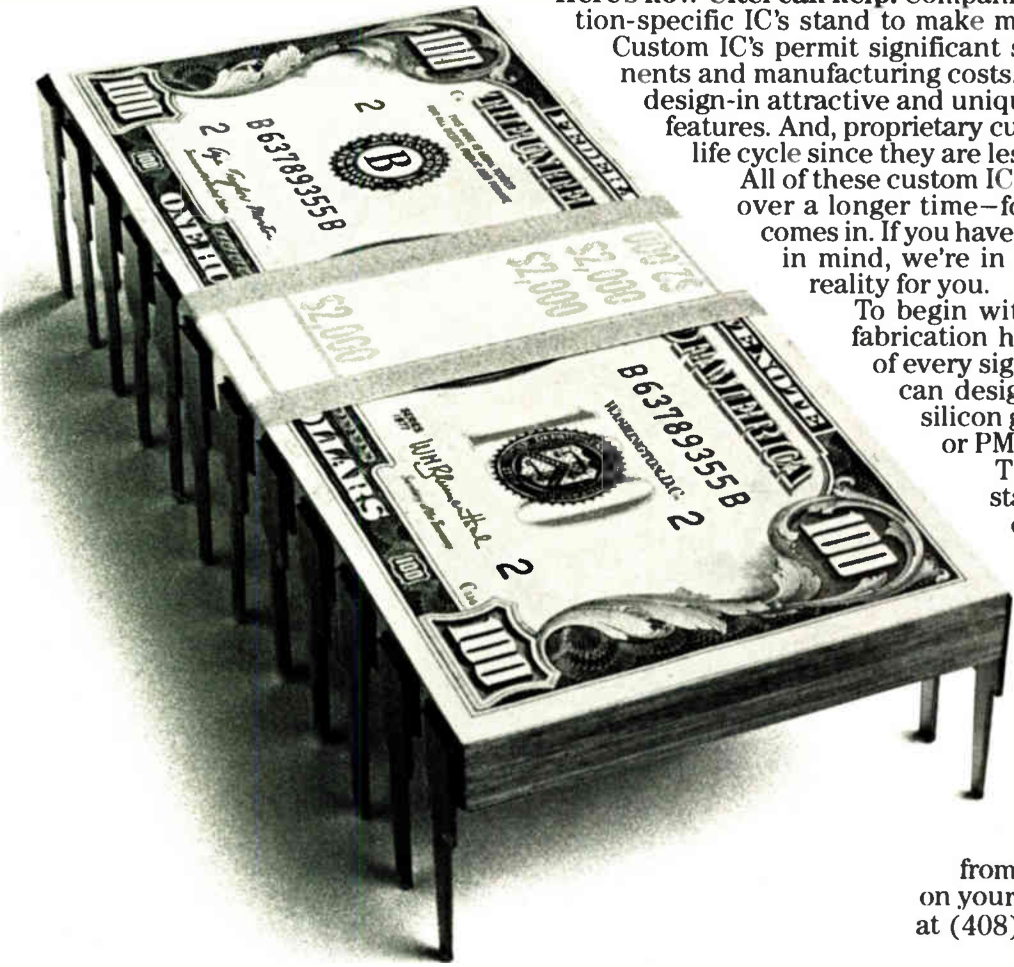

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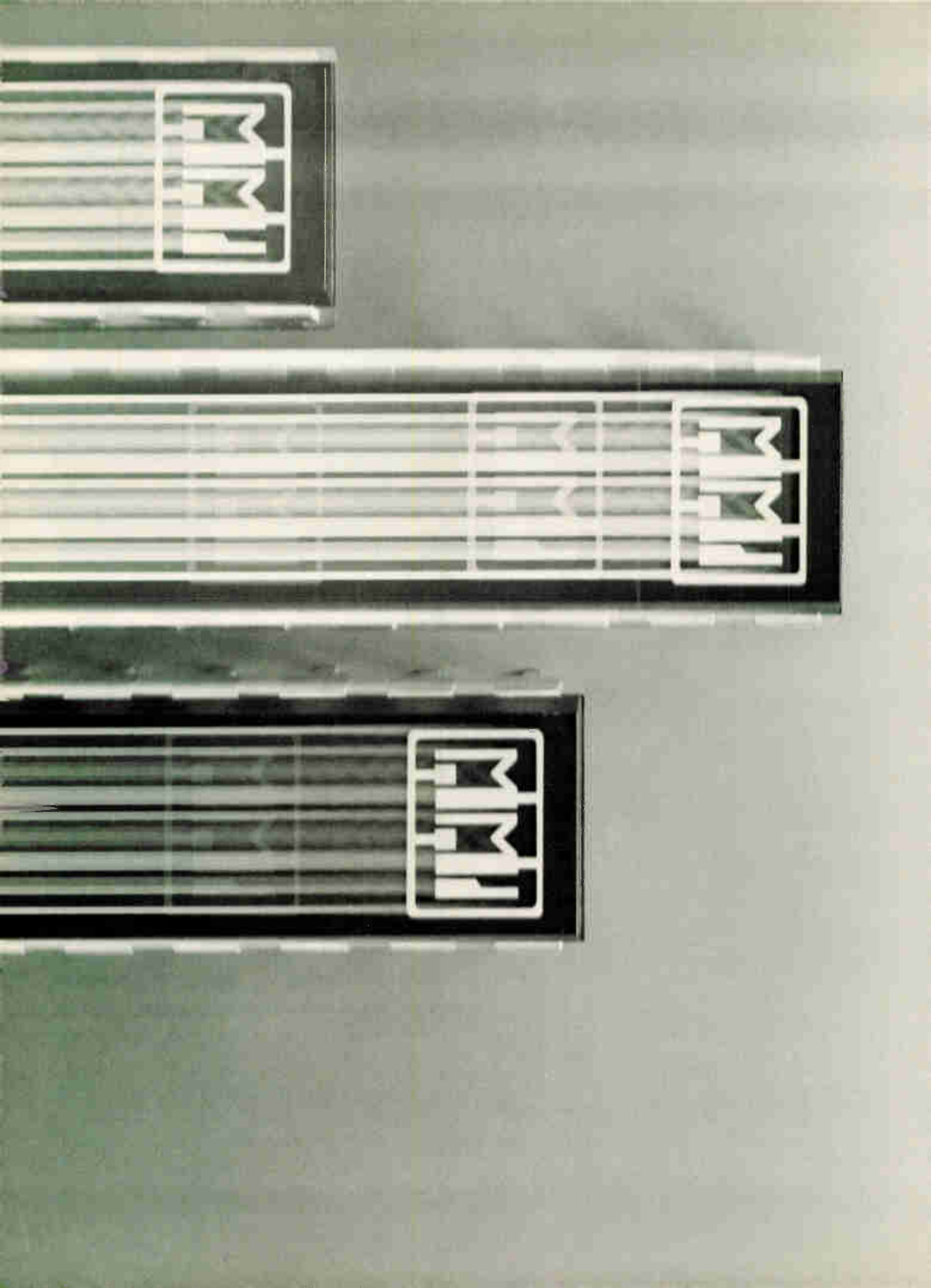

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We're taking on the future.

Perpendicular bits up densities of prototype disk drives

by Wesley R. Iversen, Chicago bureau

Much higher bit densities are possible with new recording technique in chromium-cobalt alloy

Four to eight times denser than conventional magnetic-storage disk techniques, perpendicular-recording technology is emerging from the laboratory in prototype products and could be hitting the market as soon as next year. The earliest arrivals will probably be drives for 3.5- and 5.25-inch-diameter floppy disks with a recording layer of a cobalt-chromium alloy. What's more, work on denser, rigid-disk products is also under way.

The first companies in the field are likely to be a Minneapolis start-up, Vertimag Systems Corp., and Tokyo's Toshiba Corp. Toshiba disclosed details last fall of a prototype 3.5-in. perpendicular-recording floppy-disk drive that could be in production by late next year [*Electronics,* Oct. 6, 1982, p. 68]. The company is now in the process of transferring the technology from the lab to a manufacturing division.

Vertimag president Clark E. Johnson Jr. says production of a 5.25-in.–floppy-disk drive will start by mid-1984. It will use a modified Shugart Associates drive and home-grown head and disk media. Fresh from an infusion of $6.5 million in second-round equity funding in December, the company this summer will build a 25,000-square-foot plant to manufacture the drive units, heads, and media. It plans to show working prototypes of its VSC530 drive with its model 5DSDL 5.25-in. perpendicular-recording floppy disk at the Comdex/Spring '83 computer retailing show in Atlanta next week [*Electronics,* April 7, p. 41].

The Vertimag product will rely, as shown in the diagram (p. 48), on a sputtered, dual-layer medium—a 0.5-micrometer layer of Permalloy sepa-

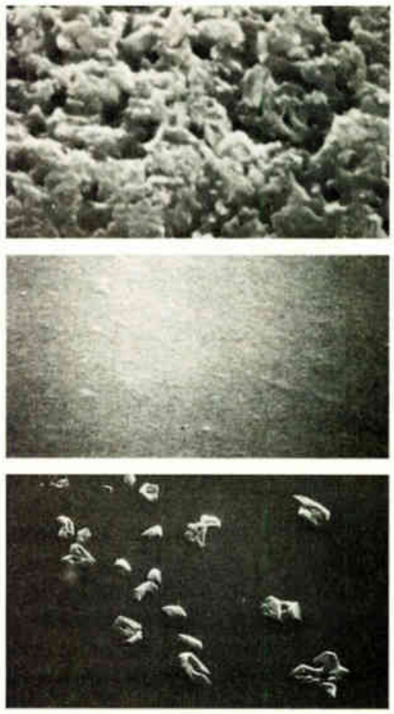
Smooth surfaces key perpendicular recording

Because of the higher bit densities involved, perpendicular magnetic recording requires a much smoother medium than does conventional longitudinal recording. These photos from Vertimag Systems Corp., Minneapolis, show the roughness of a conventional iron oxide recording surface magnified 10,000 times (top, at right) compared with the smoothness of Vertimag's sputtered cobalt-chromium recording medium at the same magnification (center).

The third photo (bottom) illustrates another obstacle to smoothness. It shows the surface, magnified 1,000 times, of a polyester material of the kind used as a substrate. The obtrusions are called oligomers—polymers with low molecular weight that can erupt on the substrate surface because of the extreme heat of the sputtering process. They create corresponding irregularities on the medium's surface that prevent recording.

Vertimag President Clark E. Johnson Jr. notes that yet a third hurdle to recording-medium uniformity is due to most polyester-film vendors' practice of sprinkling the material with a fine silica powder, so that the rolls of film may be separated easily. As these powders cannot be removed completely, the surface becomes too rough for perpendicular recording, he says.

Johnson says Vertimag has found only one polyester-film vendor—Teijin Ltd., Osaka, Japan—that does not use the silica slip agent. In addition, he notes, Teijin also supplies a film material that is extremely "tight," or close to theoretical densities, such that oligomer eruptions are minimized. Vertimag entered a cooperative agreement with Teijin last fall aimed at developing smoother film substrates [*Electronics,* Nov. 30, 1982, p. 41]. **–W.I.**



rates the 0.5-μm cobalt-chromium recording layer from a 50-μm-thick polyester substrate. The Permalloy is a so-called keeper layer, providing a flux-return path that reduces recording current and increases playback voltage. The medium reaches recording densities of about 30 kilobits per inch. At 5 megabytes of formatted capacity (2.5 megabytes per side), the Vertimag disk stores about four times more than 5.25-in. floppies based on conventional longitudinal-recording methods.

Orientation. In perpendicular recording, magnetized regions are oriented with their north-south axis perpendicular to the medium's surface, instead of horizontally as with conventional recording. This increases bit density because the flux regions are not subject to the demagnetization that occurs when the horizontally magnetized regions of longitudinal recording are aligned end to end with like poles facing. This demagnetization leads to an inability to distinguish bits as density goes up. In fact, the demagnetization effects decrease in perpendicular recording as the bit density increases.

The initial products from Japan will likely go the Vertimag product even better. The 3.5-in. single-layer cobalt-chromium disks used with the Toshiba prototype drive boast densities of 50 kb/in. to pack in 3 megabytes of unformatted capacity per side. Going beyond that, Sony Corp. says it has an experimental 3.5-in. floppy-disk drive that uses a proprietary single-pole head and dual-layer cobalt-chromium–Permalloy disk with densities of 65.5 kb/in. At about 4 megabytes per side, the Sony disk is about eight times denser than conventional 3.5-in. floppies.

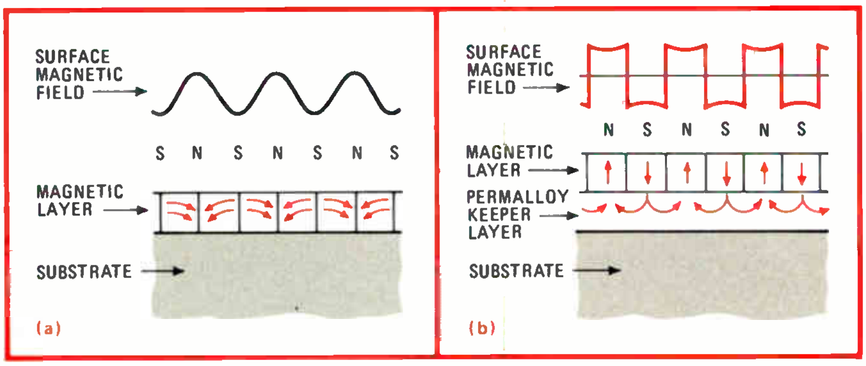
New role. Though Sony has not defined its product plans, the company says the higher densities possible with perpendicular recording may foreshadow an emphasis on new floppy-disk applications such as hard-disk backup. Vertimag's Johnson agrees. "We think backup for Winchester [disks] is going to be one of the biggest markets," he says.

With that in mind, Vertimag will also offer a single-board, four-port, Z80-based controller designed to handle two Winchester drives with Seagate Technology Inc.'s *de facto* standard, the ST506 interface. Two Vertimag floppy drives will back up the Winchesters without going through a host computer. Once they are in production, Johnson expects the controller may fetch about $1,500, the drives around $500 each. The 5.25-in. disks are expected to go for $10 to $15 each.

Rigid-disk drives based on perpendicular recording are also expected next year. One company working on them is eight-month-old Applied Information Memories of Milpitas, Calif. According to marketing director Arnold Cooley, the firm will be in production late this year with perpendicular hard-disk media that will be offered to original-equipment makers.

Proprietary too. It also will have its own proprietary drives ready for shipment by late in the first quarter of next year or early in the second quarter. The smallest box will handle "over 400 megabytes" on a 5.25-in. rigid disk, Cooley says.

Meanwhile, a host of other major Japanese, U. S., and West European computer makers and new U. S. companies are also developing perpendicular-recording-based floppy- and rigid-disk products [*Electronics*, April 21, 1982, p. 89], though most decline to discuss product plans.



Change in orientation. Conventional recording orients magnetized regions horizontally (a), resulting in demagnetization because like poles are facing. Magnetization of perpendicular recording is into the medium (b), avoiding demagnetization so bits can be stored more densely.

Aerospace

Code check speeds launches

Much of the time spent readying each space shuttle for flight goes into customizing the mission program for flight conditions and payload. In fact, verifying that the final code has no defects may take even more time than writing the program itself.

With space-shuttle missions set to increase greatly in the coming years, therefore, the shuttle's prime software vendor—International Business Machines Corp.'s Federal Systems division—is building a unique software tool for verifying the "on-orbit" programs. These are programs that control the orbiter and its tasks, including the launch of satellites, after the big craft leaves the earth's atmosphere.

For the fall. Dubbed System Management Auto-scorer, the verification tool will be used on a new IBM 3081 mainframe to be installed this autumn at the NASA Software Production Facility at the National Aeronautics and Space Administration's Johnson Space Center in Houston. IBM's software operation near the center hopes to be using the tool by mid-1984. Under current verification procedures, test models are constructed for simulating such things as atmospheric conditions and vehicle characteristics and are run against the mission programs.

But the flight load will be so great by late next year that it will be difficult to keep up with it, says Jack Clemons, manager of on-board shuttle avionics software development and verification in Houston. Only with its verification tool does IBM believe it can meet NASA's long-term goal of a launch every two weeks.

Essentially, the Auto-scorer will dissect each mission's programs, themselves produced by computer, from general-purpose shuttle software code and initialization data values for the flight-control and payload requirements. Already in place is the automated tool, called the System Management Preprocessor, that combines the code with mission-specific data values.

Easier. Like automatic program generators, the preprocessor reduces the labor in creating software. It does not generate new code, however. Instead it combines data values with the shuttle's general-purpose code. Since the shuttle's basic code has already undergone a thorough check, only the initialization tables must be verified before each flight.

"The automatic verification tool [Auto-scorer] will take the data in the flight memory that the front end [Preprocessor] automatically generates and run it backwards, generating what it believes is the original input data [the initialization tables]," Clemons explains. "Then, we will compare the input data run backwards against the input data received from the user community [the payload customers, shuttle prime contractor Rockwell International, and NASA]. If there are differences, we will explain them. Hopefully, we won't have any after a while."

The verification codes are large. The preprocessor consists of 29,000 lines of source code and typically generates 30,000 32-bit words of mission-specific programs. Auto-scorer, with about 15,000 lines of source code, is still growing.

NASA and IBM have also created other tools for developing programs quickly for guiding the ships during ascent and landing. Relying on a data base compiled from previous missions, one program, in a mode similar to the on-orbit effort, adds initialization values to a general-purpose code to match flight-control programs with performance factors, such as weather and payload weight.

The software produces equations from polynomials whose coefficients are changed to suit each flight. To verify that the values have been loaded into the proper memory locations, another tool is used to check the code-data match.

More difficult. But with the on-orbit programs, verification is more difficult. "We are no longer just sticking data values in that do nothing but change polynomials. Here we are restructuring the payload input/output interfaces, changing the displays and controls, restructuring the data that monitors the payloads, and so on," says Clemons.

He also says the software facility will cut the critical date for knowing all about a mission to 10 weeks from six months before launch. This could eventually be down to four or five weeks. Some changes could even be made on launch day. It will also be easier to substitute one payload for another, if a problem arises.

Though developing the automated tools is boosting today's software costs by 50%, Clemons says it will pay for itself next year. He estimates he would otherwise need twice the staff to handle launch cycles after mid-1984 and nearly triple the staff in 1985. **–J. Robert Lineback**

Relay satellite would aid future spacecraft

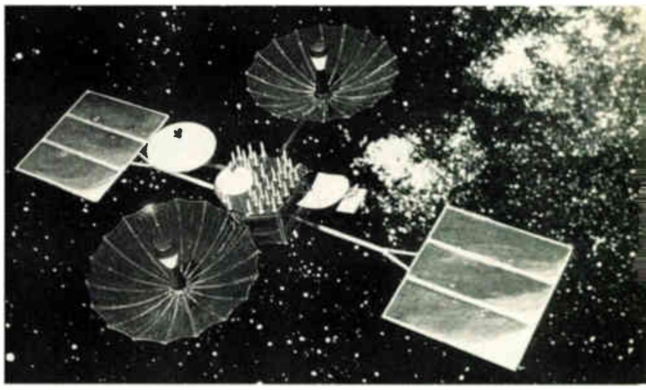
Investigators have already begun to root out the reasons why this month's space-shuttle mission ran into such trouble deploying the world's largest satellite. With initial findings that apparently clear the Challenger space shuttle of blame, U. S. space officials are now looking at the inertial upper-stage (IUS) rocket that was to have boosted the 2½-ton Tracking and Data Relay Satellite into a 22,300-mile-high orbit. It was the second failure by an IUS booster in as many missions.

Instead of placing the $100 million satellite into a geosynchronous orbit, the IUS rocket both malfunctioned in its second-stage burn and stopped telemetering data back to earth. Then the attached TDRS tumbled out of control into a low, distorted orbit.

Initial efforts to correct the orbit were postponed when the nozzle on one of the satellite's 24 1-pound thruster jets would not open, according to the National Aeronautics and Space Administration and the U. S. Air Force. NASA's Robert Aller, director of the TDRS program, says the satellite's orbit may not be corrected until the end of this month. The problem with the IUS may lie with the gyros in its inertial measurement unit—two of five gyros were not functioning correctly before the upper-stage engine fired, officials say.

Consequences. The loss of America's first TDRS system could have dire consequences for NASA's plans to establish a space communications network in orbit for the sophisticated manned and unmanned spacecraft slated for the next decade. Three TDRS systems, built by TRW Inc. of Redondo, Calif., are to be deployed by the space shuttle—one over the Atlantic, one over the Pacific, and a third as an in-orbit spare. Three others will remain grounded as ready-to-fly spares. Each unit will track and communicate with the shuttle, as well as orbiting satellites, and relay the communications and tracking signals to NASA's automated ground station at White Sands, N. M.

Currently, NASA's many stations



Big one. Artist's conception shows the Tracking and Data Relay Satellite in orbit with its twin solar-array panels and S-, C-, and Ku-band antennas extended.

spread around the globe contact the space shuttles on only 15% of the missions. With the in-orbit network, that figure will increase to 85% and allow NASA to close costly overseas tracking stations.

The huge TDRS satellites are the first to simultaneously handle three frequency bands: S, C, and Ku (a high-capacity band offering 14 gigahertz up and 12 GHz down). Whereas many ground stations can communicate with only two satellites at a time, 26 satellites can be assigned to each orbiting TDRS, with 20 different users served at the same time through an array of 30 helix antennas operating at the same frequency. Signals are frequency-division–multiplexed into a single composite and transmitted to ground.

A number of future space systems will rely for communications on the TDRS network, including the European Spacelab to be launched later this year. A second TDRS system is now set to be deployed on the eighth shuttle mission, late this summer.

The booster, made for the Air Force by Boeing Co., Seattle, Wash., had had problems before. In October, the Air Force used it aboard a Titan 34D to position two defense communication satellites in synchronous orbits, though completely losing telemetry transmission to the ground. The IUS will complete its missions without communication from earth.

Unrelated. A probe of the incident found two problems: an overheated rf switch and high impedance on a line leading to an antenna. The Air Force believes these failures are unrelated to the present one.

Ironically, the Challenger's complex on-board software played less of a role than usual in the launching of the TDRS system (see related story, p. 48). This is because the sophisticated and powerful rocket needed for the large TDRS contains its own self-checking programs. However, most of the shuttle-deployed satellites to come will use a simpler so-called payload-assist module (PAM). Such modules successfully launched two payloads last fall from the Columbia space shuttle. **–J. Robert Lineback**

Automotive

Ford will employ fewer chip vendors

Ford Motor Co., the No. 2 car maker in the U. S., is trimming the number of vendors it will call on to manufacture its semicustom and custom semiconductors. What's more, a new purchasing strategy requires suppliers to fill orders for both its automotive and aerospace businesses.

"We cannot have 30 different suppliers for our auto divisions and keep close enough track of all of them," says John R. Wallace, 34, president of Ford Microelectronics Inc., Colorado Springs, Colo., a six-month-old subsidiary of Ford Aerospace & Communications Corp.

Drive and fly. Ford's need for its vendors to fill orders for its aerospace business as well is a reaction to the facts of life in aerospace. Typically, big semiconductor firms have been less interested in relatively low-volume space circuits, which often require tight specifications and process controls, notes Wallace, who a year ago was program manager for Intel Corp.'s standard-cell effort in Phoenix, Ariz. Thus Ford will be offering the high-volume automotive-market carrot while holding the aerospace-business stick to get what it regards as the best deal for all its divisions.

Essentially, if a silicon house wishes to produce Ford-designed components for one portion of the business, it must also be willing to make chips for the other. Combining the two businesses makes sense to Wallace. With few exceptions, integrated circuits in both space and auto systems tend to be custom parts, he notes, and "both space and auto systems require high quality levels."

The microelectronics operation in Colorado Springs is also working on an extensive standard-cell library and a network of computer-aided design and test systems. System engineers in both Ford's automotive and aerospace operations will design circuits using on-site work stations and this central cell library. They will also conduct testability analyses and create their own test programs. The work would then be passed to Ford Microelectronics, which would conduct more extensive analyses and make final touches on layout, make fabrication tapes, select processes and vendors, and be responsible for quality.

According to Wallace, the center will have its CAD system and cell libray running by July and serving all of Ford's chip needs by the end of the year. This relatively fast pace is due in part to Ford's concern that it may be behind in its semiconductor design capabilities. When other car makers first turned to electronics to satisfy Federally mandated emission and fuel economy standards, Ford found it could satisfy them by mechanically fine-tuning its mix of relatively small cars [*Electronics,* Nov. 20, 1980, p. 113]. This could be how the lag began.

In the works. According to Wallace, the microelectronics operation is currently negotiating a number of broad-ranging contracts with several-Ford suppliers. Deciding which chip houses will remain as Ford's qualified suppliers and act as silicon foundries is hard, but "we just have got to narrow our supplier base down," Wallace says. "Some good suppliers will be abandoned, but it's not a case of saying they're not at a quality level—it's just that we have to work with smaller numbers."

The new partnerships he envisions will deal with processing needs and all types of MOS and bipolar technologies. Wallace cannot yet estimate how many of the 30 firms will be retained or when the list will be made final. **–J. R. L.**

Work stations

Executive station needs no keyboard

One of the thorniest problems for makers of executive work stations is coming up with a design that execu-

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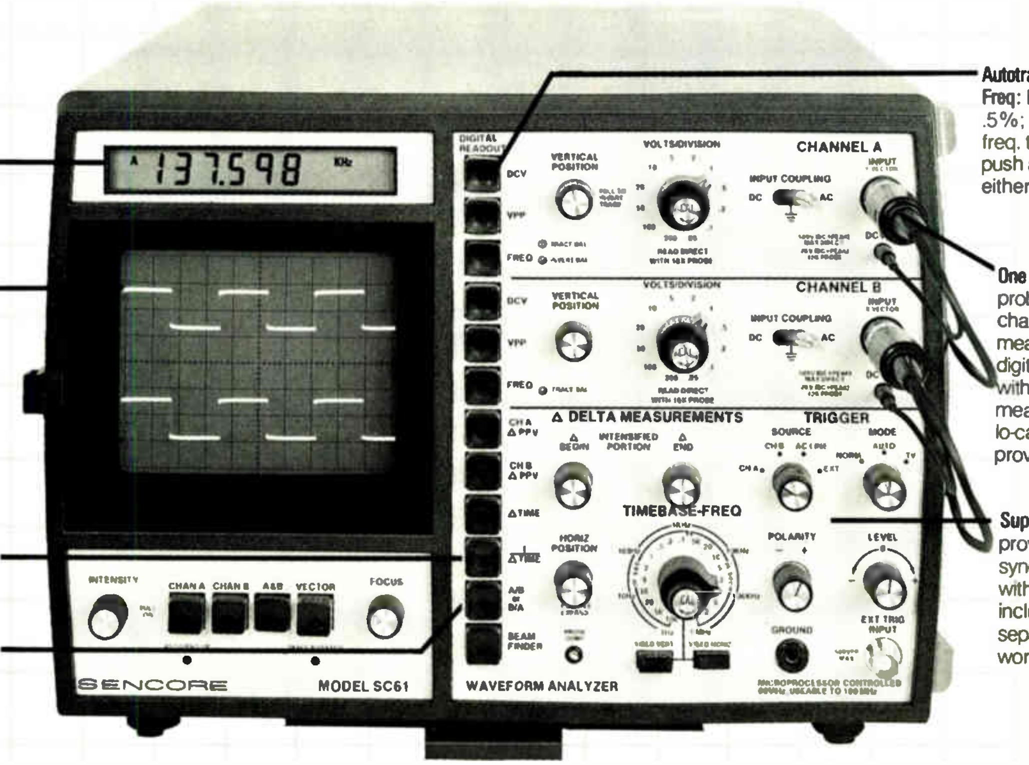

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Circle #51 for demonstration

Petite. Triangular work station by Sydis fits on the corner of a desk, taking up little more space than a 10-button telephone set. The handset at the side of the screen is used to enter voice messages for digital storage and later retrieval; the mouse, right, does the work of a keyboard.

tives will want to use. The bugaboo is the input device, usually a typewriter-like keyboard—members of the managerial class generally do not type and have little desire to learn. One way to tackle this problem is to avoid it, as is done with a new work station introduced this month.

Not needed. On VoiceStation, made by Sydis Inc., San Jose, Calif., the keyboard is there but need not be used. Instead, letters or other documents, for example, can be dictated over a built-in phone handset and stored digitally until a secretary, playing it back, types it into the system. The executive then can edit, file, or send the message using the work stations's cursor-directing mouse and a set of soft keys below the bit-mapped screen, which has 832 by 608 picture elements.

VoiceStation is actually a full-fledged personal computer, based on an 8-bit version of the Motorola 68000 and incorporating word-processing and spreadsheet software that has become standard for computer hardware intended for information processing rather than number crunching. Should the executive want to use the keyboard, though, he has a Unix-based computing system at his fingertips.

Functionally, it resembles the Xerox Star or the Apple Lisa, noted for their advanced document-control design, even to its windowed screen, its mouse pointer, and its attempt to duplicate electronically the top of an executive's desk. It does the last by relying on symbols to indicate in and out baskets, file folders, a revolving file for listing addresses and phone numbers, and even a wastebasket in which discarded items await erasure by a system "janitor." These icons, as the windows are called, mask the familiar Xenix operating system, which organizes special-purpose software designed by Sydis.

The concept of the executive or managerial information station was pioneered by Douglas Engelbart at SRI International in the 1960s in a system using a mouse, though not icons. A more sophisticated version is still marketed under the name of Augment by Tymshare Inc., the time-sharing computer service. Sydis's hardware works in groups of 16, resembling the clustered work stations developed by Convergent Technologies. In such clusters, a shared control processor that is invisible to the user manages disk drives and other peripherals.

A separate Sydis control station with up to 32 of the 68000 microprocessors, linked via a redundant 16-megabyte-per-second contention bus, directs the work stations. They are linked to the controller and to a private-branch exchange over twisted-pair phone lines transmitting data at 320 kilobits/second.

Central. The telephone, in fact, is central to the operation of the Sydis system, as it is with other work stations being developed (see "Storing messages in the phone net," p. 141). Voice and data functions are linked so that documents can be annotated with voice messages. The messages are indicated by small "speaker" icons in the text, and the spoken notes may be played back through the telephone.

What's more, the often exasperating executive's game of telephone tag is eliminated (see related story, p. 139). A caller to the work station—each station has its own phone number—may leave a message on an electronic "while you were out" form, modeled after the familiar telephone-message pink slips.

The station itself bears little resemblance to a conventional computer, as shown in the photo. It is a triangular box that fits in a corner, its footprint not much bigger than that of a 10-button telephone handset. Sydis will show it first at the National Computer Conference next month in Anaheim, Calif., and it will be commercially available in November. The price will be just under $7,000 per station for the minimum 16-module system. But the addition of a second group of 16 stations will reduce the cost to under $6,000 per station.

In its fullest configuration, the system will support more than 300 terminals. A subsequent release will allow them to interface with a network employing IBM's Systems Network Architecture. —Clifford Barney

Computers

Computer builds in printer, floppy disk

Like the Sydis Inc. VoiceStation described in the previous article, a new computer to be introduced by the

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Gavilan Computer Corp., with a bit-mapped screen and integrated software and windowing, is also designed for the executive. There the resemblance ends, however, for where the VoiceStation is intended for executives at their desks, the Gavilan computer is a stand-alone machine, designed for the executive on the move.

The 9-pound portable unit, to be shown by the Campbell, Calif., firm for the first time at the Comdex/Spring '83 computer retailing show next week in Atlanta, comes with a printer, a built-in microfloppy-disk store, and a sizable internal memory of up to 336-K bytes. It operates off batteries and fits into a briefcase.

Mobile. Briefcase-sized computer from Gavilan includes a built-in printer, an eight-line LCD screen, and full-size keyboard. A rectangular panel just below the screen is touch-sensitive, so that a cursor can be moved on the screen with the touch of a finger.

Niche market. Gavilan president Manny A. Fernandez, former chief executive at next-door neighbor Zilog Inc., frankly targets the portable at a niche market of "mobile professionals" who want to take their office with them on the road. This is a market tested by makers of more than a score of small computers, ranging from low-priced hand-held instruments with limited memory, such as Hewlett-Packard's HP-75, to scaled-down transportable versions of full-size machines, such as Non-Linear Systems Kaypro II or the 33-lb Access computer just introduced by Access Matrix.

Sales to executives have been slim. Mainly, these machines are being purchased by home users who simply like their relatively low price. As for the hand-held varieties, they have been either too limited in function or too costly to succeed widely.

Powerless. The problem, as Fernandez sees it, has been that the software for portables has not been powerful enough to support the needs of a professional computer user. The Gavilan machine, built around a 16-bit 8088 microprocessor, comes with a full complement of integrated application software like that written for Grid Systems' Compass, Apple Computer's Lisa, and Sydis's VoiceStation. In size—it is 11.4 inches square by 2.75 in. high, with a full keyboard and an eight-line liquid-crystal display—the Gavilan physically resembles Tandy's new $799 model 100, though the latter has no built-in printer or disk drive. In function, however, the Gavilan is closer to the 10-lb Compass [*Electronics*, Jan. 13, p. 49]. Both machines offer full 16-bit computing in a briefcase.

The Gavilan unit will be sold to original-equipment manufacturers for just under $4,000, whereas the Compass, with a full 25-line, 80-character screen made of a higher-quality electroluminescent display and with more sophisticated communications, costs just over $8,000. (Grid just announced that it will be sold in retail stores as well as through OEMs.)

Icons. Like the IBM Personal Computer, which also uses the 8088, the Gavilan will support the MS/DOS operating system, which means it will have at its disposal all the software developed for the Personal Computer. However, Gavilan also supplies an operating system of its own that provides a flexible interface remarkably similar to those of the VoiceStation, the Lisa, and the Xerox Star: a set of icons with which to call up integrated word processing, graphics, scheduling, communications, and business forms. A touch-sensitive panel just below the screen can be used to move the cursor around the 400-by-64–picture-element screen. A video interface allows connection to a full-sized screen as well.

Look-alikes. The data-structure architecture employed by Gavilan makes all application systems look alike to the user: spreadsheets, text editor, and communication software are all called by the same commands. The help feature is context-oriented, so that a confused user can ask, for example, "Where am I? What just happened? What is being displayed? What can I do?" A zoom section on the control panel allows up to 64 lines of a document to be squeezed onto the screen, with the usable portion windowed.

The Gavilan computer offers one indication, if somewhat confusing, of which way the wind may be blowing in the standards battle over the proper size of an under-5¼-in. floppy disk: Gavilan has chosen the 320-K 3-in. drive championed by Hitachi Ltd. But Fernandez is hedging his choice, for the computer was designed to accept 3¼- or 3½-in. drives as well, just in case these win market acceptance. –**Clifford Barney**

Speech synthesis

150 b/s transmits intelligible voice

A new voice coder, or vocoder, technique is being developed that transmits intelligible speech at rates as low as 150 bits per second. It was reported last week by scientists from Bolt Beranek & Newman Inc., Cambridge, Mass., at the International Conference on Acoustics, Speech, and Signal Processing in Boston. Sponsored by the Department of Defense's Advanced Research Projects

Agency, the BBN research outshines the 300-to-600-b/s rates developed earlier.

Low-bit-rate transmission of speech has important military and commercial implications. For strategic communications in noisy environments, low bit rates mean longer on-off signals, resulting in superior bit reliability. Also, the low rates require less power, making such transmissions harder to detect. Commercially, the transmission of speech at low data rates would vastly reduce storage requirements for such applications as voice mail.

New stage. BBN's so-called segment vocoder represents a new stage in the evolution of devices that use linear predictive coding. Commercial speech synthesizers like those from General Instrument, Texas Instruments, and Advanced Microsystems typically transmit speech at 2,400 b/s (see p. 126). The standard linear predictive coder samples the spectrum—that is, the voice power at various frequencies—of voice input 50 times a second, thereby creating 20-millisecond frames of spectral information. This spectral information is digitized, transmitted, and reconstructed with filters at the receiver.

Recently, vocoder modifications brought intelligible-speech transmission down to below 600 b/s. This was accomplished, BBN scientist Salim Roucos explains, by continuing to sample at 50 b/s but transmitting only when a significant spectral shift occurs. "The spectrum changes fairly slowly," notes Roucos. "You don't usually get significant changes every 20 ms." To further reduce the transmission rate, these vocoders are programmed to transmit only from among the 1,000 most typical spectra. It is the numerical labels identifying the spectra, not the spectra themselves, that are transmitted.

Step further. The new BBN segment vocoder carries the logic of this type of quantization one step further. Instead of quantizing individual spectra, whole series of spectra are quantized. Such quantization is based on a unit of speech called the phoneme. The word "bat," for instance, has one syllable but three phonemes: the

News briefs

National Semiconductor spinoff sets sights on linear ICs

A spate of new linear integrated circuits is due in the next three months from Linear Technology Corp., the National Semiconductor Corp. spinoff that set up shop in Milpitas, Calif., 18 months ago [*Electronics*, Aug. 11, 1981, p. 46]. Its five top managers from National include Robert Dobkin, who developed three-terminal voltage regulators, and Robert Widlar, who invented the first industry-standard operational amplifier while at Fairchild. The upcoming announcements will cover a major distribution agreement and products like an adjustable three-terminal regulator with guaranteed regulation of 1%; high-speed op amps and comparators with 1-millivolt offsets; and a proprietary logic-controlled regulator. By year-end, the firm will offer some 49 ICs to a market it pegs at $1.6 billion in 1982, $2.6 billion in 1985, and $7 billion in 1990.

Microsoft muscles up for Xenix marketing

Earlier this month, Microsoft Corp. announced Xenix 3.0, a new offering of the Bellevue, Wash., firm's multiuser operating system that has the same kind of visual shell, or interface, as Microsoft's single-user operating system MS/DOS 2.0. MS/DOS has received wide use on IBM Corp.'s Personal Computer. With the compatibility, knowledge gained with the single-user operating system could be transferred to a multiuser system built around l6-bit microprocessors.

Available in July, Xenix 3.0—Xenix itself is a licensed version of Bell Laboratories' Unix operating system—will come in three standard subsets for time-sharing, software development, and text processing. To publicize applications developed by third parties for the Xenix environment, Microsoft also announced a support program called Xemax. Selected software vendors will have their products publicized in product literature and receive information in advance on upcoming Xenix enhancements.

Silicon-intensifier target tube helps U. S. Air Force peer into space

The U. S. Air Force can now keep tabs optically on man-made satellites up to 22,000 miles away, thanks to RCA-developed silicon-intensifier target camera tubes. The devices were recently installed in the Ground-based Electro-Optical Deep Space Surveillance System (GEODSS) developed by TRW Inc. and operated under Strategic Air Command supervision at the White Sands Missile Range, New Mexico; Taegu, Korea; and Maui, Hawaii. Made by RCA's Electro-optics division, Lancaster, Pa., the low-light-level tube has an 80-millimeter-diameter faceplate with an imaging light-sensitive photocathode area and signal-storing silicon target roughly four times the size of typical SIT tubes. It serves as the eye of a TV camera that has a 2 : 1 electronic zoom and a scan rate of 0.3 or 0.6 second per frame, slow enough to detect faint, slow objects like the satellites. Software sorts out digitized stars from moving objects, then identifies them using a catalog of stars and orbiting satellites.

PBX with local network meets needs of automated office

A start-up company, Ztel Inc. of Andover, Mass., solves the problem of whether the private-branch exchange or the local network will control the automated office by refusing to make a choice. Going both ways, the company is introducing a PBX that handles digital voice (at 64 kilobits per second) and data (56 kb/s) and, more unusually, also acts as a controller for a coaxial-cable-based, token-passing ring network. Modeled after what IBM Corp. indicates will be its approach to local networks, the ring operates at 10 megabits/s for video and text applications. Two or more rings may be hooked up to the PBX's distributed processors. The price—$800 to $1,000 for each line—is the same as for a standard PBX; the PBX's software, written in C, can handle 50 to 10,000 lines.

Circle 57 on reader service card →

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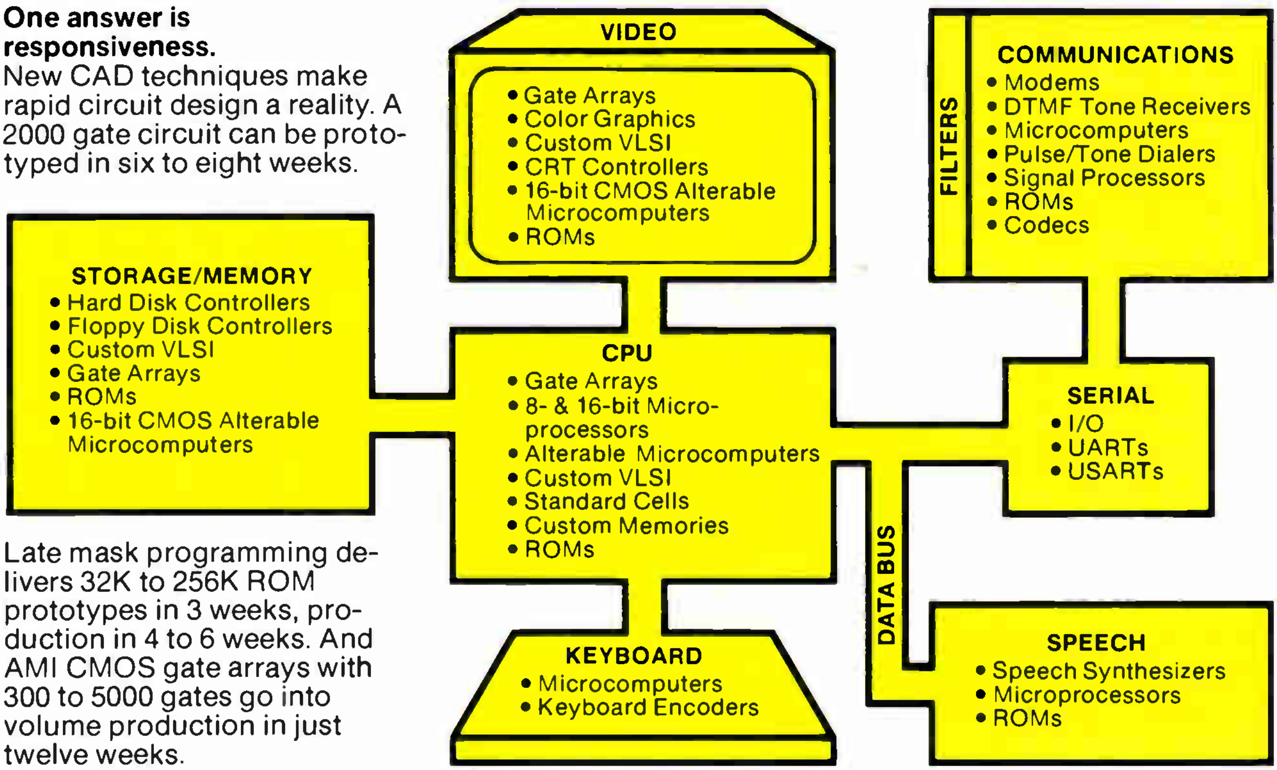


AMI PARTS FOR COMPUTER SYSTEMS

Late mask programming delivers 32K to 256K ROM prototypes in 3 weeks, production in 4 to 6 weeks. And AMI CMOS gate arrays with 300 to 5000 gates go into volume production in just twelve weeks.

"buh," the "ah," and the "tuh."

The BBN technique breaks speech into segments defined by the midpoint of one phoneme and the midpoint of the next. The break is made in the middle because it is hard to identify the precise transition between phonemes. Midpoints, however, are most easily defined as the point where the spectrum is most stable. A mid-phoneme-to-mid-phoneme segment, or diphone, may vary in length from 50 ms to 200 ms, but the average is about 90 ms.

The key point is that each individual's speech—right now, the system is speaker-dependent—may be broken down into roughly 8,000 such diphone templates. Each template represents a characteristic sound and is identified by a characteristic spectral autograph. The segment vocoder achieves its dramatically reduced bit rate by transmitting only one of 8,000 templates in a time frame that might otherwise require identification and transmission of 1 in $1{,}000^4$ or more possibilities.

Thus, each unit of transmission can be defined by only 13 bits since all 8,000 possibilities can be expressed by 13 binary digits, or 2^{13}. Though the speech generated by this technique is not as richly expressive as the human voice, it reflects a surprising degree of pitch variation and is certainly intelligible, as was evident during a brief demonstration using a computer simulation.

Simulation. Roucos and his coworkers Richard M. Schwartz and John Makhoul established the feasibility of 150-b/s speech transmission with their simulation. Hardware implementation, notes Roucos, will require a "computation-intensive" system speed of 3 million to 50 million floating-point operations/s (megaflops) performed either by floating-point processors or by advanced signal-processing chips.

Such rates are high and need a system like the PDP-11 from Digital Equipment Corp. plus an array processor. The group is now studying how many templates are needed for a speaker-independent system, one that could reliably transmit any speaker's voice. **–Norman Alster**

Business

Export-control plans disappoint industry

U. S. electronics manufacturers, already faced with tough competition in the global marketplace, are unhappy with the Reagan Administration's plan to tighten controls on technology exports. So are some key members of Congress, such as Don Bonker (D., Wash.), chairman of the House subcommittee on international economic policy and trade, which must pass on the plan presented earlier this month by Commerce Under Secretary Lionel Olmer.

Bonker finds "little redeeming value" in the Reagan plan to revise and reauthorize the Export Administration Act set to expire Sept. 30. The White House revisions "made in the name of 'national security' offer no U. S. security benefits," contends Bonker, and "appear based on paranoia and an alarming willingness to wage economic warfare against friend and foe alike."

EIA's view. Peter McCloskey, president of the Electronic Industries Association, Washington, D. C., is less harsh. However, he is no less critical of provisions that, he feels, threaten the U. S. image as a reliable source of supply by permitting the President to cut off exports to friendly nations for foreign-policy reasons.

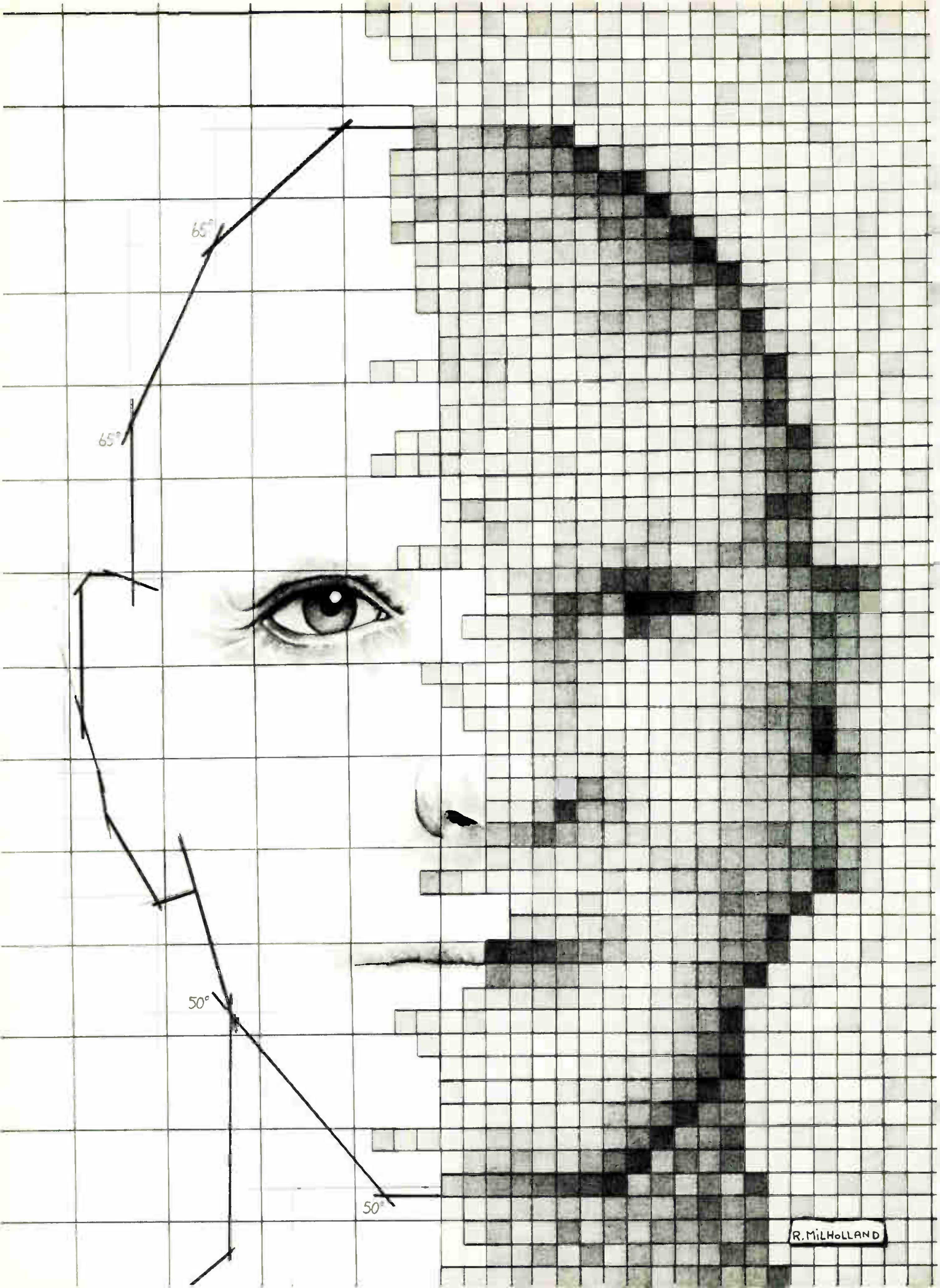
McCloskey also opposes limits on the licensing of technology by U. S. companies to their overseas subsidiaries, but supports better ways of determining whether a foreign equivalent of a U. S. product already exists, so the U. S. product can be exported. By permitting the breaching of export contracts for political ends and the toughening of technology export rules, U. S. electronics manufacturers stand to "lose tremendous commercial opportunities for a very chancy potential saving," he says.

Unrealistic is the label applied by the EIA's Alan Spurney to the Reagan plan's proposed use of bilateral negotiations with other member nations of CoCom—the Coordinating Committee made up of North Atlantic Treaty Organization members and Japan—to restrict technology exports to the Soviet bloc. Citing last year's failure to get U. S. allies to put an embargo on equipment destined for the USSR's gas pipeline to West Europe, the EIA's International Business Council director says U. S. allies "have not exhibited any willingness, much less any zeal, to control product exports or limit the transfer of technology" for political reasons.

Spurney sees a "liberal mix of Richard Perle" in the new proposal that would, for example, permit cutting off U. S. imports from friendly countries that disagree with U. S. export restrictions. Perle, assistant secretary of defense for international security policy, is widely regarded as a hardliner on technology exports. He wants to give the Pentagon authority to veto export licenses, a matter which Rep. Bonker says has been the subject of "secret negotiations within the Administration without consultation with Congress."

Unsaid. Commerce's Olmer came in for criticism from both Democrats and Republicans in the packed subcommittee hearing room for what he did not say as well as for what he did say. He did say the Administration opposes a provision in H. R. 1566, a rewrite of the Export Administration Act with wide industry support, that would lift controls on products for which all license applications had been approved for one year. On the bill's proposal to permit free technology transfers within a company and its overseas subsidiaries, Olmer said the Administration position is still being developed.

A similar answer came in response to the bill's proposal to decontrol exports of instruments and equipment with embedded microprocessors. Although Olmer agreed that existing controls are "unnecessarily broad and need to be streamlined," he said a position is awaiting a decision from the Department of Defense—an observation that prompted Rep. Howard Wolpe (D., Mich.) to observe that DOD has no statutory responsibility in that area. **–Ray Connolly**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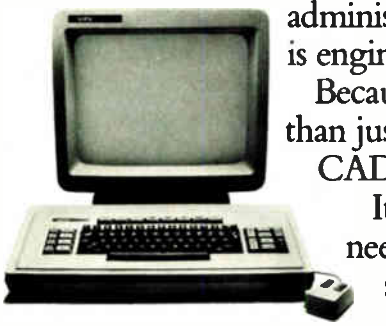

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Washington newsletter

Special panel urges coordinated stance on technology, trade . . .

U. S. electronic industries should hail the recommendations of a tough new report prepared for the National Academy of Sciences by a blue-ribbon panel of academic, industrial, and economic leaders. Attributing the vulnerability of U. S. technological innovation to "domestic weaknesses and damaging [trade] practices of other nations," the 22-person **panel calls for making advanced technology and trade a top national priority that should be reviewed biennially at the Cabinet level** "in both relative and absolute terms." Entitled "International Competition in Advanced Technology: Decisions for America," the report took more than a year to prepare. Howard W. Johnson, chairman of the Massachusetts Institute of Technology, headed the panel.

. . . and advises bilateral negotiations

To protect the U. S. competitive position from unfair trade practices, the Johnson panel recommends bilateral negotiations with countries **whose actions endanger "key technology industries essential to national economic welfare and military security."** If negotiations fail to produce relief, the committee advises that the U. S. "take immediate unilateral actions as a step of last resort."

Motorola to back GE mobile-radio plan

Watch for Motorola Inc. to second General Electric Co.'s proposal to develop the Personal Radio Communications Service [*Electronics,* Dec. 15, 1982, p. 41]. Motorola initially viewed the GE plan as a threat to its developing cellular–mobile-telephone business. **Its move is believed to stem from its decision to compete in the proposed new service,** which awaits a decision by the Federal Communications Commission.

Opposition mounts to IRS software stance

A proposal by the Internal Revenue Service to make software developers ineligible for tax credits unless their products resolve previously insoluble operational problems has the computer industry and some members of Congress up in arms (see p. 12). According to Victor Henriques, president of the Computer and Business Equipment Manufacturers Association, **the IRS ruling would disqualify products produced by standard or well-known programming techniques,** thereby "taking away what Congress has clearly granted" in a 1981 law and resulting in industry losses totaling $50 million a year. At least 35 House members agree. In a signed letter to Secretary of the Treasury Donald T. Regan, they labeled the IRS move "contrary to the intent of Congress." IRS hearings were scheduled to start April 19.

Digital communications sought for airliners

Digital service using satellites to provide two-way air-to-ground communications for commercial airliners will be recommended in May by the International Civil Aviation Organization in Montreal. Already gearing up for the competition are the International Telecommunication Satellite Organization in Washington and the International Maritime Satellite Organization of London. **Both groups stand ready to risk equipping next-generation satellites with transponders** operating in the 1,600-MHz L band, despite the fact that financially strapped airlines have yet to make a commitment to use the service.

Washington commentary

Rewriting the rules at the FCC

A new Federal Communications Commission inquiry has crept up on the broadcast and communications industries, catching them by surprise. Unimpressively titled "A Re-Examination of Technical Regulations," Docket 83-114 will review FCC rules "with the ultimate intent of eliminating those that no longer serve useful purposes, replacing those that are overly burdensome with less constraining regulations or retaining those which are found to be acceptable in their present form, without undermining the Commission's responsibilities."

The goal of FCC's Michael Marcus, chief of the Technical Analysis division who developed the docket, is straightforward. "We hope that by modfying burdensome rules we may be able to stimulate technological innovation in communications," explains the docket's introduction.

The 47-page docket went largely unnoticed when first published in mid-March. Indeed, the Electronic Industries Association's Communications Group ignored it at first, deciding not to duplicate and mail it to members. But now EIA and virtually every other industry group that would be affected by the proposed rule changes—the American Telephone & Telegraph Co. and the National Association of Broadcasters, for example—are hustling to get extensions of two to six months beyond the FCC's May 2 deadline for comment. And Marcus indicates some form of extension is likely to be granted.

No more *status quo*?

Whenever the reexamination of FCC's technical regulations does begin, its potential for introducing change is explosive, at least as great as that expected to develop from the breakup of AT&T. The possible rule changes threaten the *status quo* not only in broadcasting technology, but in the exploding information markets as well. And Marcus, though not deliberately cultivating the role of a revolutionary, sees the elimination of many FCC standards, except for those dealing with interference control and efficent spectrum use, as only beneficial to innovation.

Standards to ensure equipment interoperability and quality of services and equipment, of which the FCC has few, may best be left to the rule of *caveat emptor*, he suggests, excepting only cases where public health and safety are involved, as in the maritime services. As he put it in mid-April, during a teleconference from his Washington office with a Las Vegas meeting of the National Association of Broadcasters, "The New York Times does not have a [Government] standard saying how black its ink should be, yet it produces a readable product."

Nevertheless, Marcus finds that it is members of the engineering community, rather than senior management, who express the greatest fear about the possible consequences of eliminating some FCC regulations. Possibly broadcast and telecommunications engineers, having labored most of their lives under strict FCC regulations, are reluctant to cope with change. Marcus as yet does not know why; he is still asking questions. They are questions for which the EIA, for one, will ask clarification, according to Communications Group vice president John Sodolski.

Questions seeking answers

The docket's questions fall into six categories:

- The substitution of marketplace competition and diverse services and technologies for quality-related technical rules.
- The consumer's ability to distinguish between different quality levels.
- The extent to which interoperability of equipment regulations have outlived their usefulness and how fast they should be phased out.
- What specific bands and services—particularly television and home information services—might benefit from innovation if quality or interoperability rules or both were deleted.
- The extent of interference controls and any redundancy in input/output regulations, such as modulation and frequency tolerance, to achieve necessary control.
- The various regulatory methods available for controlling spectrum efficiency.

Beyond the 47-page docket's fundamental premise that it is time to take a fresh look at rules that have been accumulating since the FCC's formation in 1934, there is additional food for thought in the final category of questions dealing with control of spectrum efficiency. Would it be most beneficial to do it by specifying channel size and communication function, by specifying a particular technology, or by specifying a transmission rate per unit bandwidth? Are there other, more effective approaches?

The Marcus genie may not yet be out of the bottle, but the new FCC docket has at least removed the cap. How engineers and their manufacturers will respond remains, as noted, to be seen. It will be a collection of responses worth reading.

–Ray Connolly

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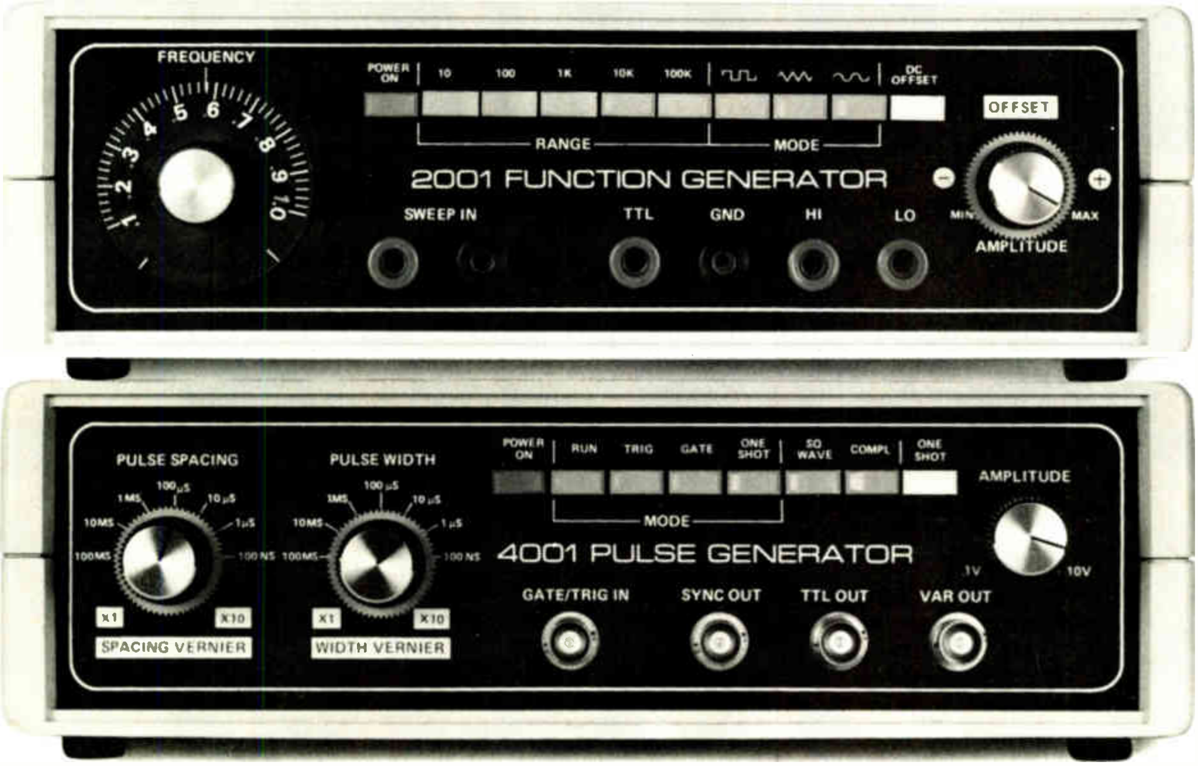

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Program Schedule (Tentative)

9:00-9:10	**Welcome and Introduction**
9:10-9:30	**Session One: Economics of Semicustom VLSI** Richard P. Thomas Group Vice-President Semicustom Products American Microsystems Inc.
9:30-10:00	**Session Two: Large System Design** To be announced
10:00-10:20	**Break**
10:20-11:30	**Session Three: Design Methods** *Gate Arrays* Wilf Corrigan President LSI Logic Corp. *Cell Libraries* Bert Braddock President Zymos Corp. *PALs, HALs, FPLAs* To be announced *Global Compilation* Phil Kaufman President Silicon Computers, Inc. *Structural Design, Precedural Cells* Doug Fairbairn Director, User-Designed VLSI VLSI Technology, Inc.

11:30-12:00 **Session Four: Industry Profile**

Charles Mantell
Gnostic Concepts

12:00-1:40 **Lunch**

Featured Speaker

To be announced

1:40-3:00 **Session Five: Technology Forecast Panel**

Rob Walker
Vice-President
LSI Logic Corp.

Frank Deverse
President
International Microcircuits, Inc.

Dennis Sabo
Gate Array Marketing Director
National Semiconductor Corp.

Paul Scott
Design Manager
Bipolar Gate Arrays
Signetics Corp.

Allan Cox
Marketing Manager
Interdesign Inc.

Speaker to be announced
Texas Instruments Inc.

Session Five: Technology Forecast
(continued)

Subanosecond ECL
Erich Gottlieb
Manager, Strategic Marketing
Advanced Digital LSI Products
Semiconductor Products Sector
Motorola Inc.

Linear-Digital Combinations
Paul Brown
Manager, Custom Products
Exar Integrated Systems Inc.

3:00-3:20 **Break**

3:20-4:30 **Session Six: Design Tools Panel**

Design Automation
Michael Feuer
Vice-President
California Automated Design Inc.

Universal Gate Array Development System
David Stamm
Executive Vice-President
Daisy Systems Corp.

Stand-Alone VLSI Design System
Gene Chao
President
Metheus Corp.

Engineering Project Management
William Johnson
President
Cadtec Corp.

Industry-Standard Simulation & Test Generation Software
Mike Jenkins
Director, IC Marketing
Comsat General Integrated Systems

Popular Place & Route Programs. Other CAE Software
Bill van Cleemput
President
Silvar-Lisco

4:30-5:00 **Session Seven: Systems Integration**

Peter Quinn
Apple II Hardware Design Manager
Apple Computer

Merrill Brooksby
Manager, Hewlett Packard Design Aid
Hewlett Packard Co.

Speaker to be announced
Digital Equipment Corp.

5:00 **Closing**

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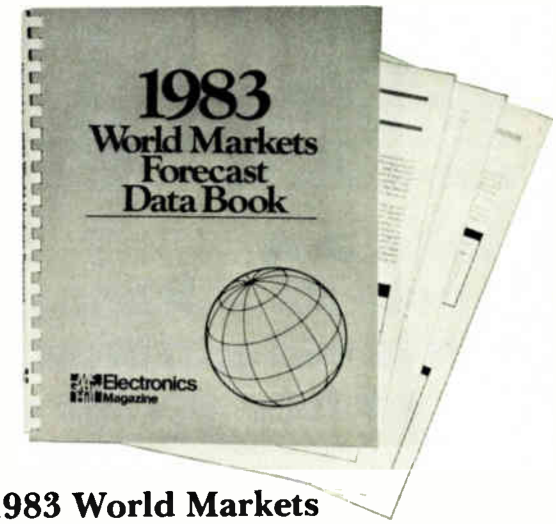

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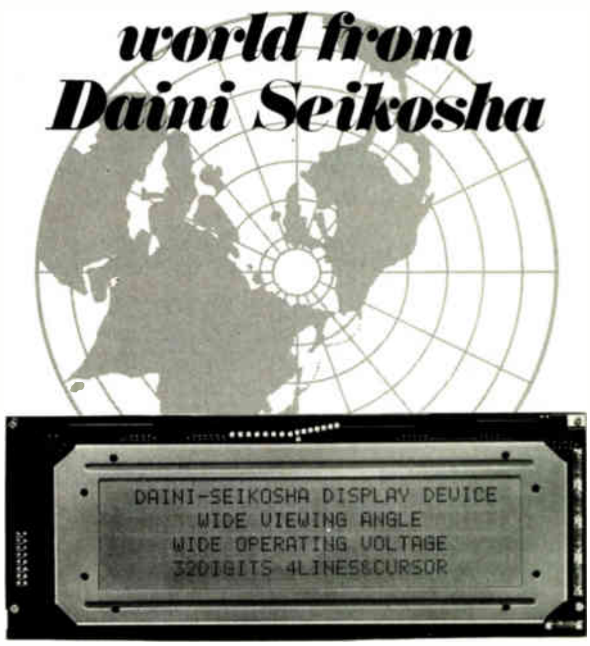

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International newsletter

Josephson-junction memory is fast, consumes only 2 mW

A fully decoded Josephson-junction 1-K memory fabricated at the Musashino Electrical Communication Laboratory of the Nippon Telegraph & Telephone Public Corp. has an access time of 3.3 ns with a low power consumption of only 2 mW. Although the access time is no shorter than for today's fastest silicon devices, **power consumption is more than two orders of magnitude lower.** What's more, the design rule is 5 μm, compared with silicon's 2-μm rule that requires state-of-the-art lithography. The memory has more than 10,000 Josephson junctions, including memory cells, address buffers, X-Y drivers, sense amplifiers, and timing generators. All circuits are configured from AND and OR gates for simplicity. Nondestructive readout senses persistent current.

Home computer market in Europe poised for large expansion, says TI

The West European market for home computers selling for less than $500 will rise eightfold this year over 1981 consumption, concludes a study by Texas Instruments Europe, Nice, France. According to Chuck Digate, European general manager for home computers, the 1981 market came to about 300,000 units, which compares with roughly half a million for the U. S. **Digate expects sales in Europe to reach 2.4 million units this year, as against 5.7 million in the U. S.** What's more, the European market next year is forecast to increase 250% over 1983—to around 6 million units. TI investigations have shown that about 17% of the buyers of below-$500 home computers are less than 16 years old, 19% between 17 and 25 years old, and 38% between 25 and 40 years old. TI will enter the European market this month with its Compact Computer 40 and this summer with its TI-99/2 home computer.

ECC begins registration of Japanese imports

Ever wary of dumping practices, the Brussels-based European Community Commission is monitoring and registering Japanese imports of high-fidelity equipment, quartz watches, and machinery such as fork lifts into EC countries, as of the start of this month. The reason the commission gives for this action is, of course, the concern over the relatively low price of these products, which could hurt West European manufacturers. **The Japanese market share in quartz timepieces is 14.2% and that in hi-fi equipment a whopping 56%.** The commission's regulations call for the EC member countries to report imports from Japan in terms of both units and value.

LCD's viewing area has 480 by 128 dots; weight is 320 g

In June, Sharp Corp. of Osaka, Japan, will start volume production of a low-power liquid-crystal dot-matrix display with about half the capacity of many cathode-ray-tube displays. With 16 rows of 80 characters or 480-by-128-dot graphics, the display is ideal for many portable and automotive applications because of **its small depth of 18 mm, low power consumption of 200 mW, high contrast, and wide viewing angle.** Still, it has a relatively generous viewing area measuring 230 by 61 mm, yet weighs only 320 g. The use of complementary-MOS peripheral circuits with temperature compensation yields high-contrast operation over 0° to 50°C. Products for which this display is suited include personal computers and portable office automation products, test equipment, telephone and radio terminals, and automotive displays. A Sharp spokesman says that a full-page display should follow soon.

International newsletter

New CVD method replaces doping for fiber cladding

A modified method of chemical-vapor deposition for the manufacture of the cladding for graded-index optical fibers eliminates doping and thus could point the way to more uniform and, hence, higher performance. Developed at the Centro Studi e Laboratori Telecommunicazioni in Turin, Italy, **the method controls the inner pressure of the silica support tube in which the deposition takes place to keep it from collapsing at the high temperature necessary to deposit pure silica.** This approach avoids the standard solution: the addition of compounds like oxides of boron and phosphorus that lower the process temperature but can increase transmission loss in the 1.5-to-1.6-μm window. Fibers with silica cladding produced with CVD germanium show losses of 4.6 and 2.2 dB/km at 0.7 and 0.83 μm, respectively.

SGS-Ates expects move into black

If 1983 results meet expectations, the Italian state-controlled semiconductor maker, SGS-Ates SpA of Agrate near Milan, will end a stream of red-ink years and break even. This would fulfill a promise made by chief executive officer Pasquale Pistorio in mid-1980, when the ex-Motorola vice president returned to Italy and pledged a three-year transformation. That year the company lost $22.5 million. Raimondo Paletto, SGS-Ates co-general manager, is predicting sales of $225 million this year (compared with $158 million in 1982), allowing the company to "substantially break even." **The bulk of the sales escalation comes from U. S. and Far East sales penetration,** which has pushed sales in those areas from 14% of total sales in 1980 to an anticipated 40% this year.

The figures were disclosed at a press conference announcing hook-up of the company's computer-aided design system to Italy's major appliance and TV producer, Zanussi SpA of Pordenone. The coupling will allow Zanussi the use of SGS-Ates' CAD system to tailor integrated-circuit designs for its products. The three-year cooperative agreement, SGS-Ates' first with a private Italian company, marks the beginning of its effort to expand its domestic IC market.

Addenda

Look for RTC–La Radiotechnique-Compelec to begin commercial production of gallium arsenide ICs at its plant in the Paris suburb of Limeil Brévannes early next year. **A GaAs dynamic frequency divider-by-two and a GaAs low-power amplifier,** both functioning up to 4.2 GHz and based on research done at the neighboring Laboratoires d'Electronique et de Physique Appliquée, will be the Philips subsidiary's first two parts. . . **Names that won't fly department:** a joint-venture agreement to produce a small business and personal computer has been signed between Basis GmbH of Munster, West Germany, and Delta Communications Services of Hong Kong. The new company, Basis Microcomputer Ltd. of Hong Kong, is calling its Apple II-compatible machine the Medfly.

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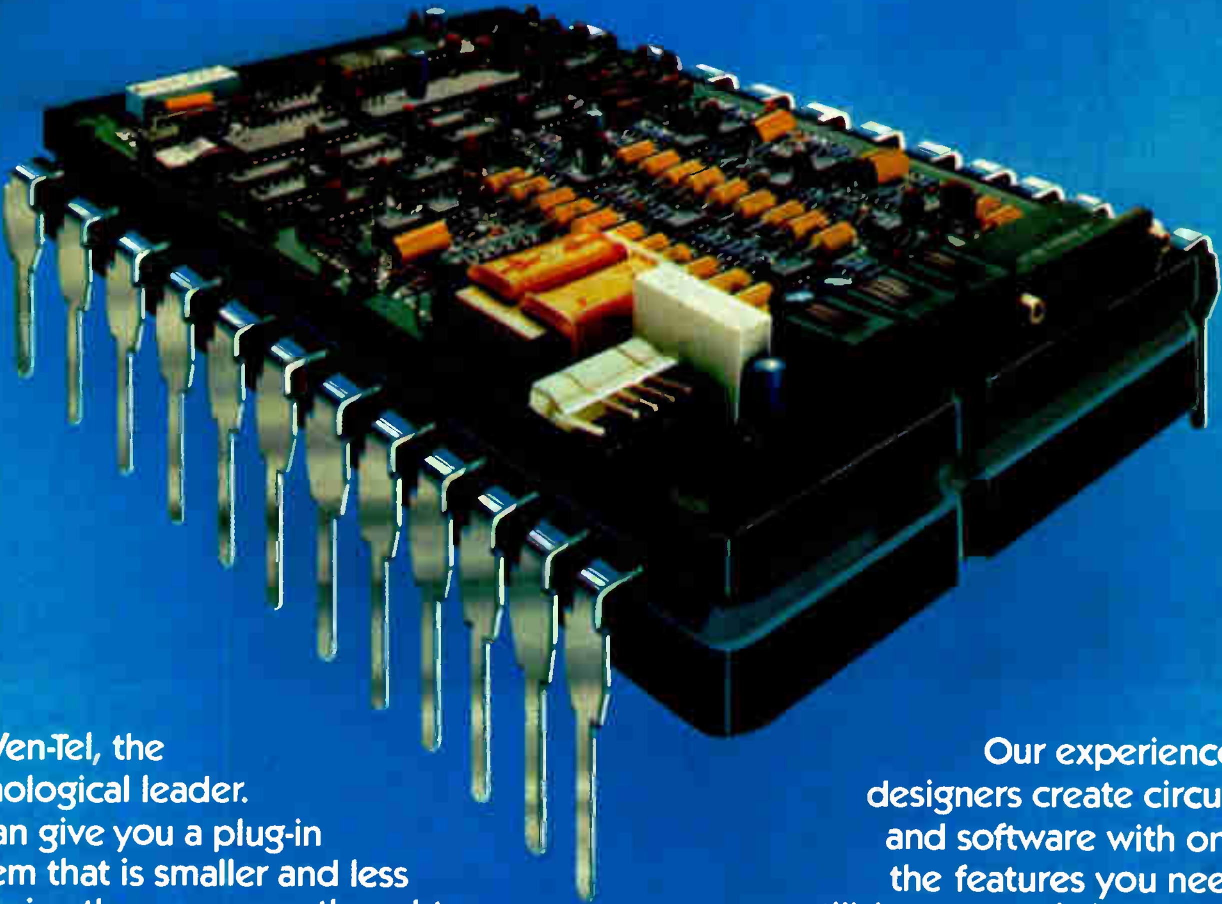

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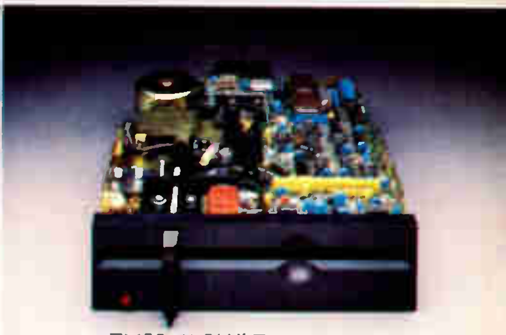
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Sensors exploit optical fiber's physical sensitivity

by Robert T. Gallagher, Paris bureau chief

Physical variables can be measured by monitoring changes in optical phenomena such as wavelength

One of the stickiest problems that had to be overcome before optical fibers could be used in telecommunications—their sensitivity to environmental change—is being exploited in the development of optical instrumentation schemes where the fibers serve as sensors. First indications are that the sensors, often simple and inexpensive structures, may well find their ways into a number of high-volume applications.

According to Alan Harmer, who is coordinating a multiclient study on the subject at the Battelle Memorial Institute's Geneva (Switzerland) Research Center, the sensors can be divided into two types. Point transducers measure external physical changes at a discrete point, and continuous transducers modulate light along the length of the fiber as they interact with a physical variable.

Measurement of the physical variable can be achieved by monitoring changes in any one of five optical phenomena—phase, intensity, wavelength, time modulation, or polarization—and enjoys high sensitivity due to the long interaction of the light with the physical variable, either over time or distance. Other advantages are insensitivity to electromagnetic interferency and high electrical isolation with no fire risk.

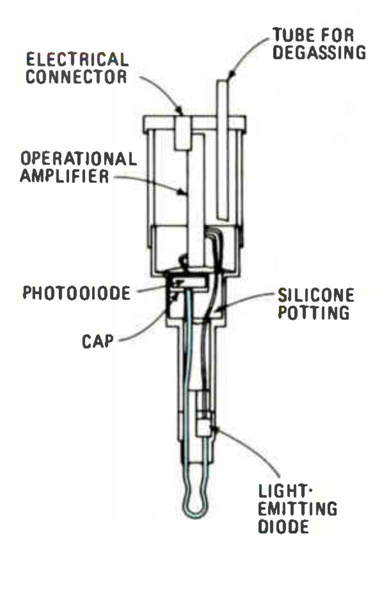
Intensity sensors. Most of Battelle's work thus far has been concentrated on intensity sensors, devices that work on the principle that modulation of transmitted light by absorption, emission, or refractive-index changes will influence the amplitude of the light at the output of the optical fiber.

Already realized are prototypes of optical-fiber refractometers, strain gages, and a microbending switch that could serve as the basis for a completely optical keyboard. (Microbends are small distortions or deformations of a fiber that result in attenuation of the light.) A future project will be devoted to an optical-fiber cable that can sense along its entire length or at any selected points or sections.

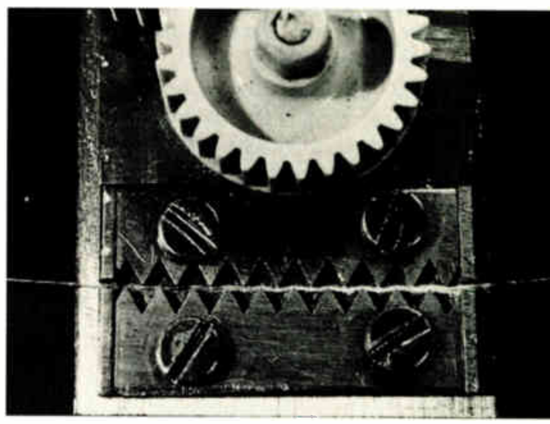
As varied as these prototype units are, their basic structures are identical. Commercially available light-emitting diodes and photodiodes, used as sources and detectors respectively, are connected by way of an appropriate optical fiber—graded- or step-index, monomode or multimode—depending on the application.

Simple electronic circuitry detects the changes in the light amplitude due to microbending loss and drives a display or alarm. Exact changes are measured by comparing the output light of a control fiber with that from the measurement fiber.

Perhaps the most typical application is Battelle's strain gage, where the modulated microbending loss is exploited by clamping an optical fi-



Sentry. The three bends in this refractometer's optical-fiber probe can be varied according to the range of the refractive index of the fluid to be analyzed. Because the instrument can fit into the cap of a standard automobile battery, it can provide constant surveillance of the battery's charge state.



Jaws. Strain gage is formed by a mechanical grating machined into two plates that pinch an optical fiber between them. Microbending caused by the grating results in attenuation of transmitted light in the fiber. Comparing output light with that of a reference fiber makes possible the calculation of related displacement, pressure, strain, or temperature.

ber onto a surface whose displacement, pressure, strain, or temperature is to be measured, using two plates with a periodic mechanical grating (see photograph, p. 85). A change in any of the parameters of interest will cause the fiber to be pinched between the plates, thus causing a corresponding change in the amplitude of light received by the detector.

Despite the device's nearly primitive simplicity, Harmer claims to have measured sensitivities of less than 1 angstrom over a dynamic range of 10 micrometers. To reach this level of sensitivity, the experiment is optimized by using a multimode graded-index fiber and a mechanical grating whose periodicity coincides with the focal length of light propagation in the fiber.

In Battelle's refractometer, the critical angle of light at the interface of an optical-fiber probe and the liquid to be analyzed can be varied and controlled by introducing alternating bends in the fiber. The microbends induce cladding modes, light propagated in the coating around the fiber core, that leak into the surrounding liquid. Different bends in the fiber provoke different cladding modes and therefore permit variation in the range of measurement.

Acid measure. Refractometers designed in this way can achieve extremely high sensitivities leading to resolution levels of 10^{-6} refractive index units. However, Battelle has opted to develop a low-cost instrument to be used for measurement of sulphuric-acid concentration in a lead battery as a means of monitoring the battery's charge level (see figure, p. 85).

The device can be mounted in the cap of a standard automobile battery. The probe tip consists of a polystyrene fiber bent in three different places, with the ends of the fiber epoxied onto a red-emitting LED and a photodiode.

Changes in the sulphuric acid's density correspond to variations in the refractive index of the battery fluid and, thus, in the amplitude of light received by the photodiode. A small operational amplifier integrated in the head amplifies the signal, which is then relayed to a suitable display. A variation on the probe can be used to determine the concentration of antifreeze in water.

By patterning optical fibers in alternating series of curves subjected to manual pressure from a related key, Battelle has developed a microbending switch that can be elaborated into an optical keyboard for hostile environments where an electrically powered unit might be dangerous. Already Harmer has put together a prototype two-by-four matrix of switches, each with a key, and says that a full typewriter keyboard would pose few problems.

Continuous transducer. The next sensor project, for which Battelle is seeking industrial sponsors, is an optical-fiber cable sensitive to external perturbations along its whole length. This sensor basically will be an optical fiber sensitized to external perturbation by an operation that can be as simple as wrapping a wire around it to increase microbending when disturbed.

The cable could serve as an intruder alarm or as a sensor for automatic opening of doors. It even could be used as a readily accessed telecommunications line, because a piezoelectric transducer can be clipped on to the outside at any point to modulate the light in the fiber.

West Germany

Lens measures eye pressure

Seeking to help cut down blindness, researchers at the Fraunhofer Institute for Solid State Technology in Munich have developed an experimental system that continuously measures the pressure of the eye by electronic means and feeds the results to an evaluation and monitoring unit. The measurements can be made while the patient is engaged in normal activities or is asleep.

At the heart of the system is a transparent silicone lens that, like an ordinary contact lens, adheres to the cornea of the eye. It integrates a subminiature sensor whose output is a measure of eye pressure.

Such a lens, together with the associated electronic devices, has been tried out on rabbits. "The success we have had so far leads us to believe that tests on humans can be started towards the end of this year," says Günter Bramm, who is head of the institute's medical electronics department.

Pressure within the eye is one of the most important diagnostic parameters in ophthalmology. Too high an intraocular pressure can lead to glaucoma, an eye disease that afflicts about 2% of people over 40. If the pressure exceeds a certain average value—pressure peaks usually come about during the night—irreversible damage may occur to the optic nerve which, in turn, can result in permanent blindness.

Continual readings. To determine intraocular pressure, eye doctors generally use an instrument known as an electronic tonometer. But since this device is applied only from time to time, it cannot provide continuous data on pressure variations. The Fraunhofer system gets around this shortcoming because it is worn all the time, so that the occurrence of of sudden pressure peaks during the night can be detected.

Similar continuous-measurement systems are being investigated elsewhere—in the U. S., for example, Bramm says. But they are restricted in their application, as it is difficult to use them during the critical nighttime hours when the patient is usually sleeping. It was because of the number of cases of sudden blindness occurring during the night that a Munich eye clinic asked the Fraunhofer researchers to develop a system for around-the-clock measurements.

The elastic silicone lens with its tiny sensor operates according to tonometric principles. The eye fluid sticks the lens to the cornea and thus allows it to follow the movement of the eye. As designed for the rabbit trials, the lens is about 12 millimeters in diameter and has on its inner surface a nipple-shaped protrusion

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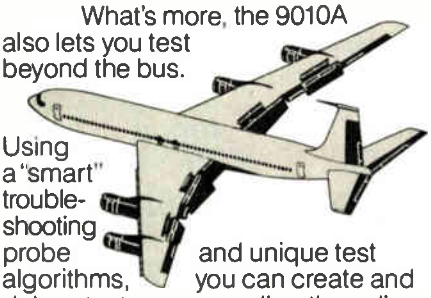

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In addition to the depot application, Collins is also using the 9010A for board level troubleshooting in the factory after the microprocessors have been soldered in place, using a special test adapter. They're even recommending it to their airline customers who will be doing their own service work on Collins new Series-700 Sensors.

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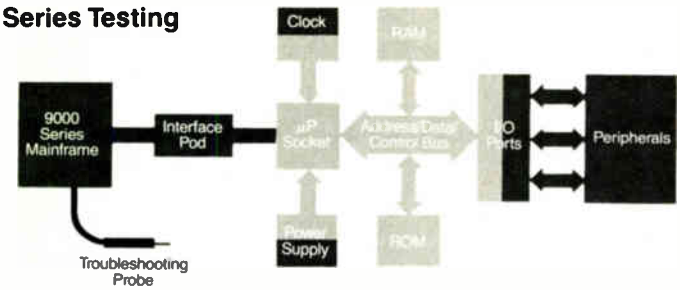

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Eye pressure bears against the small protrusion and results in a slight deformation of the lens. The amount of deformation—the possible maximum is about 80 micrometers—is a measure of eye pressure.

To detect by how much it deforms, the lens has up to 50 conductors spiraling around its surface near the rim and forming a resonant circuit. Its resonant frequency, around 88 megahertz, is a function of the distance between adjacent conductor spirals and hence of the amount of deformation. The conductors, of either silver or copper and from 5 to 10 micrometers wide and thick, are deposited on the lens in a sputtering process.

Induction used. A physical connection, such as a wire between the lens and an evaluation unit, would hamper eye movement and risk being inadvertently pulled from the eye, rendering measurements virtually impossible to make while the patient is asleep. So the resonant circuit in the lens is inductively coupled to an electronic circuit embedded in a frame similar to that for eye glasses.

The circuit is essentially a sweep oscillator, covering the 87-to-89-MHz range. Controlled by a capacity diode, the oscillator detects the lens circuit's resonant frequency and thus the eye pressure. The resonant circuit is passive; hence no energy source is needed in the lens. A small battery is integrated into the frame to power the sweep oscillator.

Evaluation. Data corresponding to the 88-MHz signals is fed either over a wire or by telemetry to the evaluation and monitoring unit in a 19-inch rack. The transmission range from the electronics in the frame to the evaluation unit is limited only by the limits of the transmission medium or by the length of the wire.

In the evaluation unit, the absolute eye pressure, as well as pressure trends in terms of positive- and negative-going values, are indicated. The pressure information can also be recorded.

"The system's hardest part to design was the lens," Bramm declares. Its geometry and design, he says, had to be chosen with a view toward both electrical and mechanical factors (such as conductor width and spacing and resonant frequency and elasticity of the lens material), chemical factors (the silicone lens material must not block oxygen from the eye),' and physiological factors. The tests have shown that the eye irritation even over periods of more than 24 hours was no greater than that caused by conventional measurements using a tonometer, the institute reports. –**John Gosch**

Japan

Design challenges face 8-mm video

There is no serious doubt that 8-millimeter cameras soon will substitute video tape for light-sensitive film. The race has been joined by electronic- and optical-camera companies to be first to market single-unit camera-recorders conforming to the specifications approved by the 8-mm Video Conference in Tokyo [*Electronics,* April 7, p. 76].

Imager choice. One dilemma is the choice of an imager. It is probably impossible to meet today's price goals with solid-state imagers, and small cameras can be built using vidicon imagers. However, after several companies switch to solid-state imagers, those using tubes could find themselves with an obsolete product that will become difficult to sell.

Meanwhile, the first order of business for the manufacturers of 8-mm video-cassette recorders is to get suitable tape into production and then build compatible video heads. Either powdered- or evaporated-metal tape is allowed by the standards, but no suitable head material having all the required characteristics appears

A big marketing problem for a small camera

The introduction of an entirely new video-cassette recorder and camera will pose almost as many problems in marketing as in technology design. For many of the also-rans among the present VCR manufacturers, the issue is clear: they have a chance to start over with a clean slate. For Sony, a leader among VCR makers and developer of the Beta format that is slowly losing the popularity contest to the rival VHS-format group, there is a chance to return to the mainstream. Other firms in the Beta-format group have even more reason to push ahead on the new system because Sony is by far the sales leader. Toshiba Corp., for example, can start again after its ill-fated switch from VHS to Beta (just before the VHS system was released for production).

Worldwide customer confusion will increase because in many areas the new 8-mm systems will be added to the three VCR formats now available: VHS, Beta-format, and Philips' V2000. Compounding the confusion will be the fact that the 8-mm system will be clearly superior only for movies made by the user. A maximum recording time of 90 minutes for the 8-mm NTSC version and 60 minutes for the PAL version—or 80 minutes with an optional thinner tape—will be too short for recording a full football game or a week's TV programs during an absence. An additional unit with tuner and clock and power supply would be needed also—and these functions will not conveniently fit in a portable camera.

Most of the leading manufacturers of VHS and Beta-format VCRs will try to maintain product differentiation in the minds of consumers so that the companies may retain their present sizable VCR business while 8-mm VCRs ramp up. Moreover, the present systems are more suitable as a first purchase for most users, who in the main want to record TV programs for later viewing, and will become even more desirable as their manufacturers add new developments. An example is the addition of stereophonic sound, a feature some Beta-format manufacturers have recently introduced. –**Charles Cohen**

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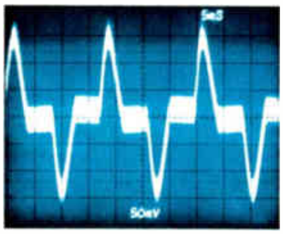

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available for use with powdered-metal tape.

The new 8-mm VCR system, like an American wedding, includes something old, something new, something borrowed, something blue. In fact, much is old—including the use of recording by two rotary heads and a shift in the azimuth of adjacent tracks to decrease crosstalk. Also old is the recording of the luminance signal on an fm carrier and recording of the chroma signal by amplitude modulation at a lower frequency—which the Japanese call "color under."

Sound options. Truly new is the design of the system so that the tape wraps 221° around the drum that guides it. This configuration facilitates the required helical scan by the rotary video heads. Since a 180° wrap is sufficient for the two heads to scan alternate fields, the remainder of the wrap leaves room at the ends of the video tracks for the optional recording of pulse-code-modulated stereo sound. The sound on both the PCM channels and the optional channels for longitudinal recording by fixed heads at both edges of the tape can be erased and recorded independently of the picture.

Moderately new is the mandatory provision for recording and playback of a single sound channel on the video track on an fm carrier at 1.5 megahertz, in between the luminance and chroma signals. Fidelity is better than the conventional analog sound recorded by a fixed head, as is standard on VHS- and Beta-format VCRs. The one disadvantage is that sound cannot be erased and rerecorded separately from the video signal.

Borrowed, at least from the Japanese viewpoint, is the use of four pilot frequencies for video head tracking. This type of system is used by NV Philips Gloeilampenfabrieken of the Netherlands on its V2000 VCR.

New is the relatively small tape cassette, measuring only 95 by 62.5 by 15 mm and therefore much the same size as an audio cassette.

The something blue was the inability to agree on a standard for the Secam system used in France, the Soviet Union, and parts of eastern Europe. –Charles Cohen

Switzerland

Analog-quartz watch eliminates trimmer

The Swiss watch industry is finally mobilizing to recoup some of its losses in the world market, where its share has dropped to some 17% from 40% in slightly over a decade—with most of this loss in the lower-priced range. It has developed a completely Swiss-made, quartz analog watch, called Swatch (for Swiss watch), which eliminates the trimmer capacitor and can be produced on a fully automated production line.

The two-year, $8.5 million development program has resulted in a watch that is waterproof and shockproof and has quartz accuracy, a weight of under 20 grams, and a thickness of 8 millimeters. The only replaceable component is the battery, which has a three-year life.

Fewer parts. Swatch already has been test-marketed successfully in the U. S.—a main target—says Konstantin Theile, marketing leader for Swatch. Devised by ETA SA at Grenchen, until now a parts manufacturer within the main Swiss watch combine Asuag AG, it is designed as a nonrepairable accessory watch for sports, traveling, and leisure use to sell in the $20-to-$35 range.

Swatch represents a "technical breakthrough in slimming down on parts needed and how these are put together" in what will soon be a fully automated production line, says Wilhelm Salathe, ETA vice director and engineering leader. The company has reduced the total number of parts from a conventional 91, with some 55 subgroups, to 51 parts assembled in 29 subgroups by combining, simplifying, and even eliminating functions and parts.

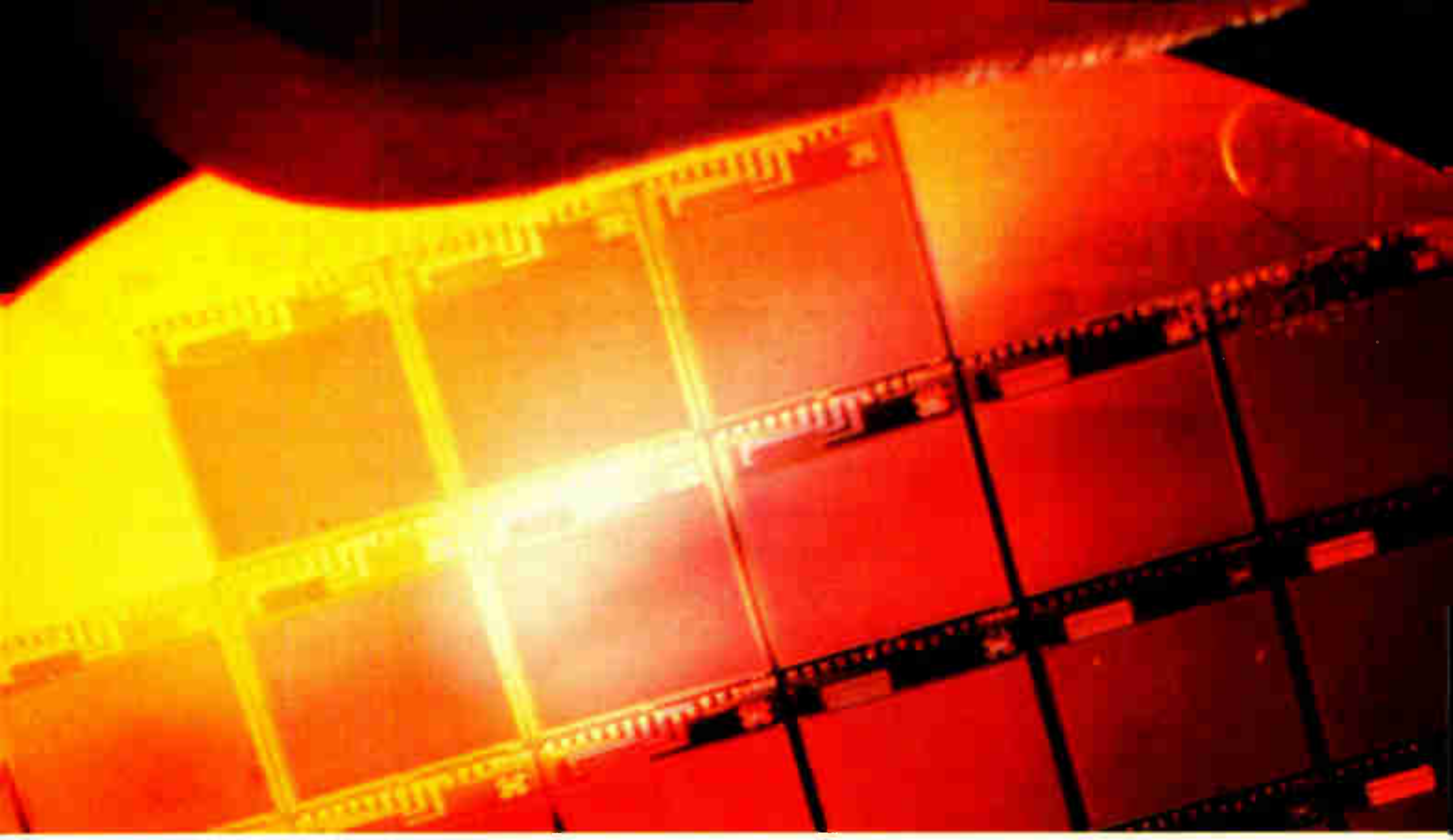
A start in reducing cost was made by using injected-molded plastic for the case with a built-in base plate onto which the watch works are directly mounted. The first mount is the electronics package, which uses special assembly technology in a version of an integrated circuit (SOT-144) produced at Micro-Electronic SA at Marin, near Neuchâtel, a division of Ebauches SA, the big Swiss watch parts and module maker.

The eight-pin circuit employs metal-gate complementary-MOS 6-micrometer technology and has a power oscillation as low as 0.3 microampere. The tape-automated-bonded package measures 3 by 4.4 millimeters, including the bumped leads. The package and a quartz crystal are welded onto a metal frame and then welded to the plastic baseplate.

High-precision crystal. The quartz used must be of higher precision than most such crystal quartz by at least a factor of four, because Swatch eliminates the need for the trimmer capacitor ordinarily connected to the oscillator (this is another step that promotes volume manufacturing and reduces cost). Instead, the stepping-motor rotor, coated with a plastic called poly-oxymethylene (POM) to minimize wear and give more mechanical stability, is connected directly with the seconds-hand indicator of the face and makes half a turn per second, as it drives a two-tooth gear-reduction system.

The Swatch's production has basically eight steps: formation of the plastic case that also serves as the base plate; assembly and welding of the electronic package, with the necessary contacts; assembly of the crown and time-setting mechanism; placing of coils and motor mechanism; assembly of the wheel gearworks and top plate; adding the date faceplate; adding the calendar and day of the week; and laying on the time face plus hands and the bonding of the watch "glass"—also a plastic, PMMA—to the case.

Though ETA will not disclose full details of its manufacturing costs, it has managed in one step alone—by combining case and base plate—to save $8, or 50% of the cost of making a conventional watch. Much of the production is already automated, with the end-assembly step to be converted by fall. Output will reach a million this year and probably 2.5 million next year. **–Laura Pilarski, McGraw-Hill World News**



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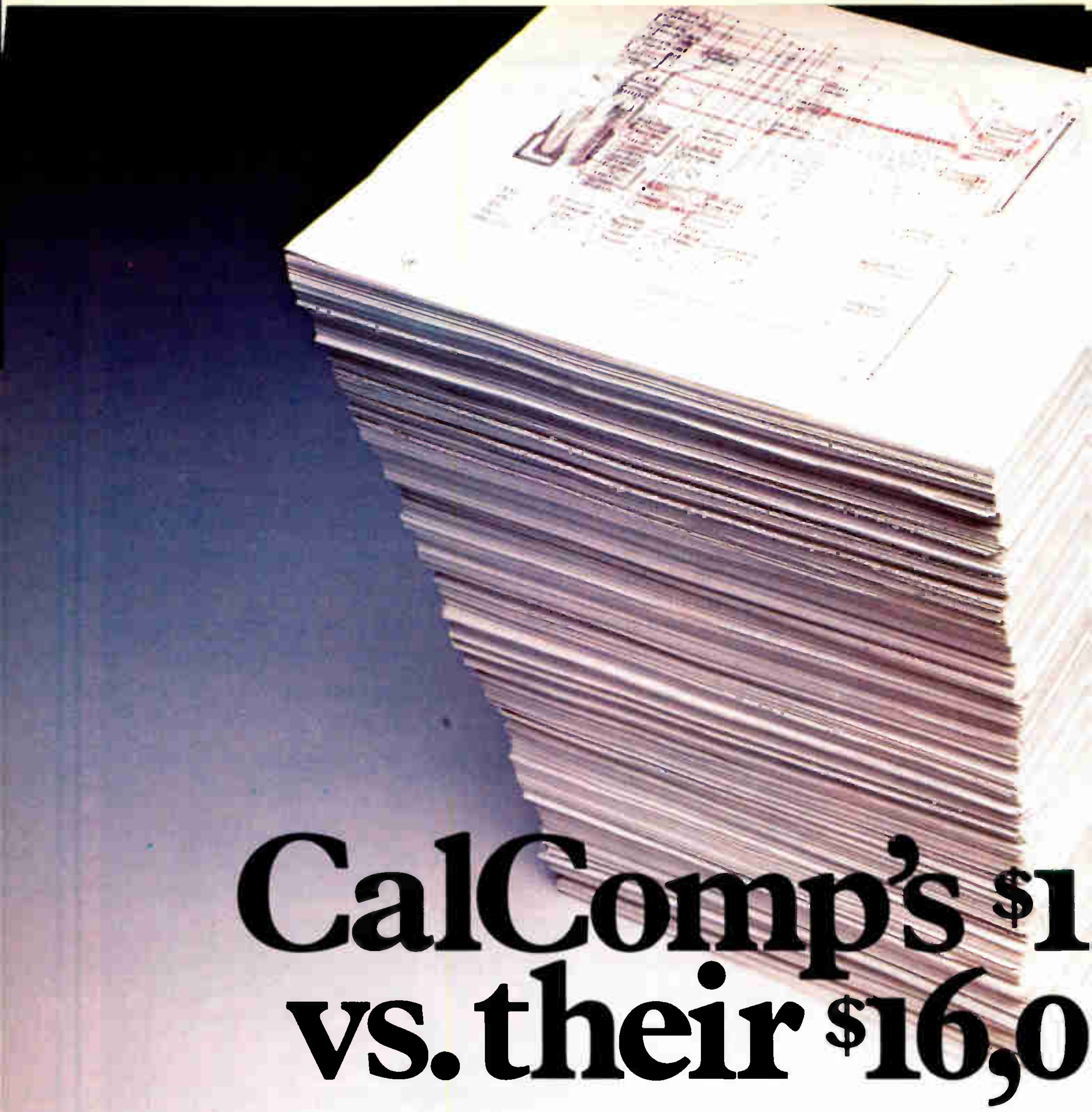

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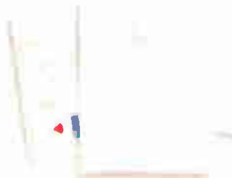

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Circle 97 on reader service card

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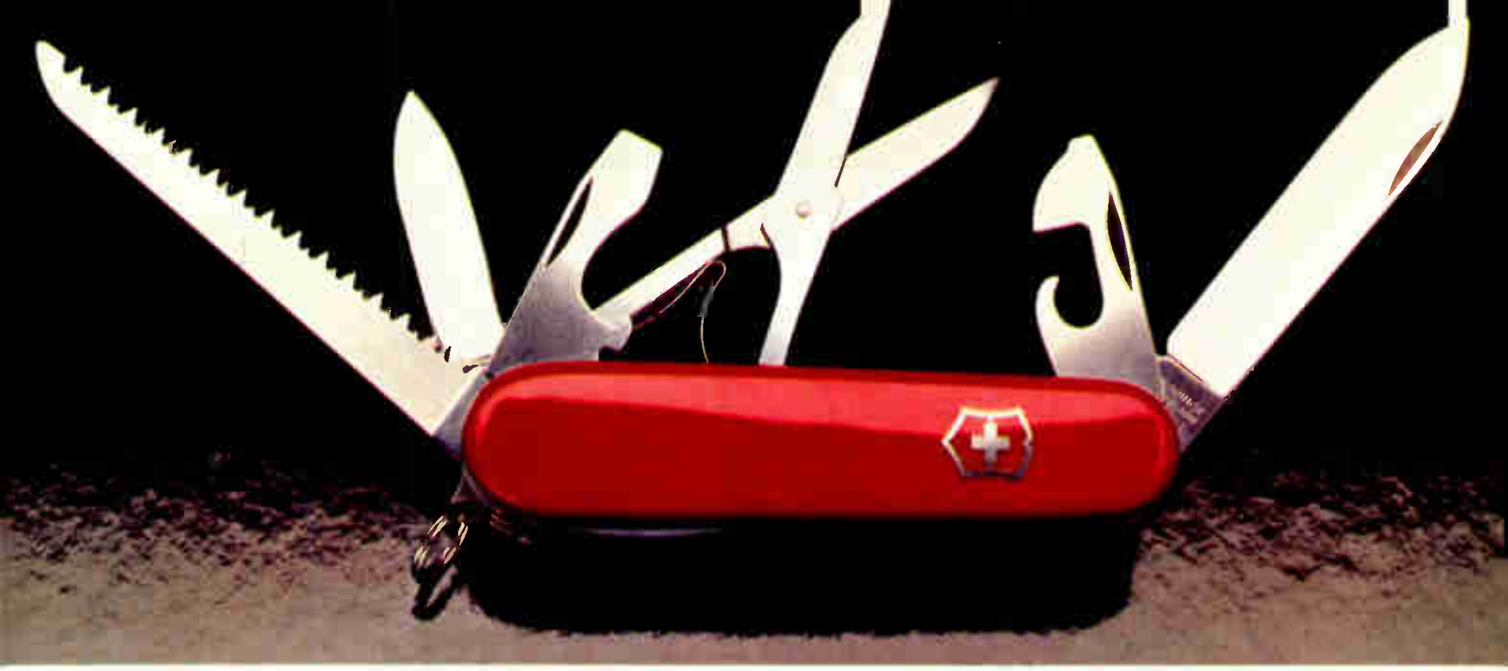

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Circle 99 on reader service card

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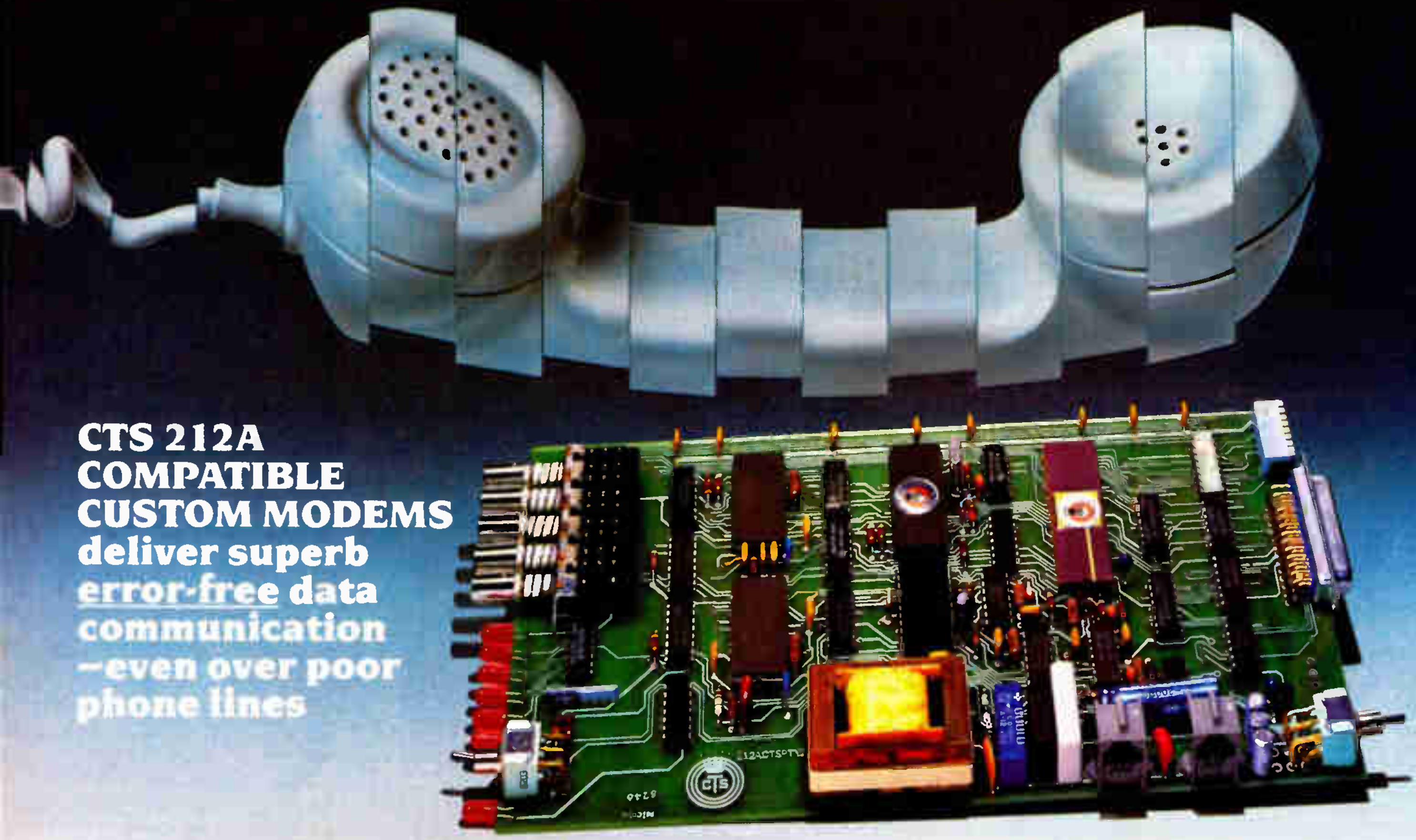

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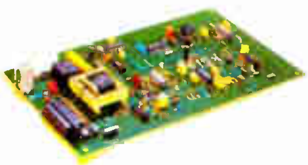


Remote Monitoring Equipment Modem

Data Acquisition Equipment Modem

Patent office prepares to automate

The use of optical-disk memories and digital image processing is the key to $341 million program aiming at 1990 operation

by Karen Berney, Washington bureau

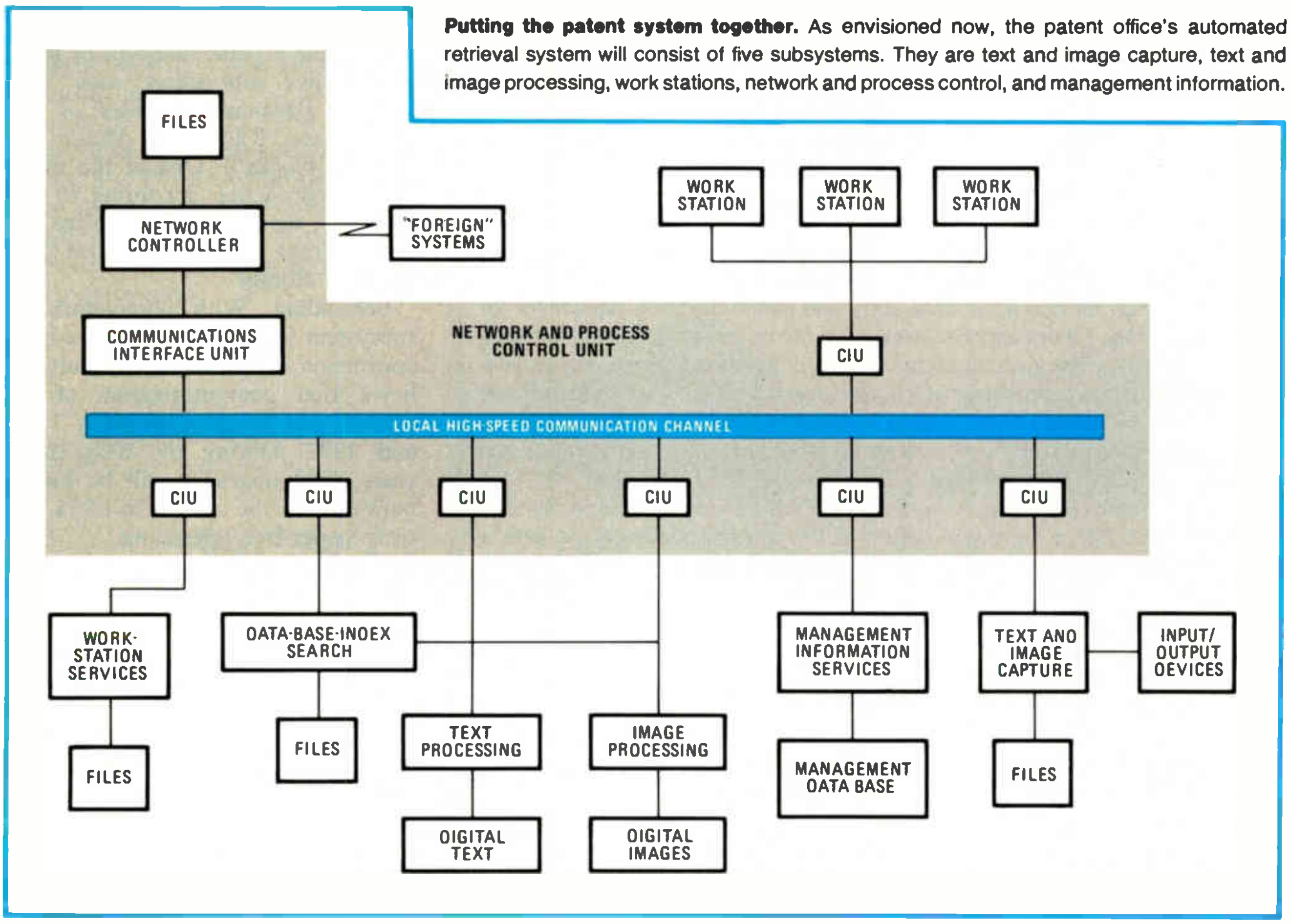
Paperless operation by 1990 has become the goal of the U. S. Patent and Trademark Office, now that the hardware needed for the job is either on the verge of production, in the case of optical-disk storage, or uses technology already in hand, in the case of text and image processing.

Those advances, in the view of John Bryant, the agency's administrator of automation, now make computerized storage of some 24 million pages of patent documentation feasible. The integration and correlation of character data with digital images also can be done, he says. But the necessary custom-tailored software, he adds, could cost up to $75 million, which is 22% of the $341.5 million budget for the eight-year project.

The objective of his agency's automation, he asserts, is to enable patent examiners to guarantee the accuracy of patent decisions and to make them within 18 months. Now, decisions come in 30 months with something less than guaranteed accuracy because at any one time some 7% of the agency's files are missing.

Confronting Bryant's automation strategists when they started moving forward two years ago was the question of how best to convert a total of 4.5 million U. S. patents and 9 million foreign patents into machine-readable form. The answer: digitize the text of 2 million of the most recent U. S. patents and the pictures

Putting the patent system together. As envisioned now, the patent office's automated retrieval system will consist of five subsystems. They are text and image capture, text and image processing, work stations, network and process control, and management information.



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Telecommunications

McGill charts American Bell's strategy

President of new company's Advanced Information Systems division shuffles Net/1000, system 85, videotex, and other pieces

by Marilyn A. Harris, Staff reporter, and Roger J. Godin, Communications & Microwave Editor

Competitors, industry analysts, and the business community await with a mixture of trepidation and eagerness the next moves of American Bell Inc. In a recent interview with *Electronics*, Archie J. McGill, the ebullient president of the Advanced Information Systems division, gave some clues about its direction.

McGill, 52, a former IBM Corp. vice president in charge of computer-systems strategies and plans, founded his own computer and telecommunications consulting firm in 1969 before joining American Telephone & Telegraph Co. as director of market management in 1973. He became vice president for business marketing in 1978 and was appointed to head American Bell when the subsidiary officially came into being Jan. 1. At that time, analysts voiced serious doubts about whether the giant offspring of a regulated monopoly would be nimble enough to survive in the open market.

From AIS headquarters, still under construction in Morristown, N. J., the veteran marketer, ever loath to give away state secrets, measured out his words about the status of Net/1000, AIS's hugely conceived computer network; about new services, such as voice store-and-forward, that may soon augment its existing voice networks; and about his sense of the market for the type of services AIS must peddle for its supper. From between the lines, a hint of where the division is heading emerges.

A condensed version of McGill's answers to *Electronics*' questions follows.

Q. First of all, how is AIS set up?

A. We handle systems, while the Consumer Products division handles instruments. We have 20,000 people; as of Jan. 1, we started selling equipment, and as of Jan. 1, 1984, we'll inherit a $9 billion installed base. We are divided into five lines: small, intermediate, and complex systems—our turnkey PBXs [private branch exchanges], Horizon, Dimension, and system 85, for example; general products, such as terminals and peripherals; and shared services, or enhanced networks, such as Net/1000. Western Electric is our main supplier.

Q. What is the research focus of your engineering, design, and development staff?

A. They do no research. All 4,000 [who were taken from Bell Laboratories] are devoted to development, and we chose those who were directly related to the development of our networks. We do, however, pay for research at the Labs, and we have full rights to the projects we sponsor. There we're focusing on new computer languages and architectures—things that boost productivity. It is an arm's-length deal, though, as the court prescribed.

Q. What is Net/1000's status?

A. As of now, about 5% of it is up, and there are major enhancements coming. We have three service nodes [network-processor sites] in operation now, and though the number keeps changing, we expect to

New home. Archie McGill directs American Bell's Advanced Information Systems division from its Morristown, N. J., headquarters.

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SRM2016C20	2Kx8	200ns	100µA	35mA	5V
SRM2017C20	2Kx8	200ns	100µA	35mA	5V
SRM2018C20	2Kx8	200ns	100µA	35mA	5V
SRM2016C25	2Kx8	250ns	100µA	35mA	5V
SRM2017C25	2Kx8	250ns	100µA	35mA	5V
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have seven up by the end of 1984. Service points [user-access locations] are no problem—you just put in a tie line [a link from service point to node] and a multiplexer, plus a Series/1. The user doesn't need to know if there is a node there.

"The only competition that comes to mind is [GT&E's] Telenet"

Q. Can you list some customers?

A. Three of the Bell Operating Companies are existing customers. The only one I'll name, though, is New York Telephone, and they are already into revenue producing, not just a trial. We're pursuing several major Government accounts and expect to settle those soon. We already have a quasi-Government account hooked up. That's all I'll say.

Q. Who is your competition?

A. The only one that comes to mind is [General Telephone & Electric's] Telenet—they will be the principal competition. I don't sense IBM as a major competitor yet. You see, the edge will come if we've done our homework; we do know the market and we have tremendous lead time.

Q. Can you describe Net/1000's operating system and other software arrangements?

A. Unix already runs on it, along with several other languages, but beyond that I can only say that it has a unique architecture—the same as in system 85. We haven't disclosed it yet because we plan to tie together all our systems. Users will provide their own applications, also. Customer programmability is available on system 85, and it will be on Net/1000 also. We intend to take advantage of inside and outside vendors to get the best price/performance.

Q. Will you be offering videotex through Net/1000?

A. Consumer Products handles videotex. But we would offer a videotex-type service through Net/1000, if the market indicates it, because we are in the business of distributing data-base information. For example, we would hope a videotex service like Air Guide will want to put its offering into Net/1000.

Q. Turning to system 85, do you expect to add voice store-and-forwarding to it soon, and if so, will you develop your own?

A. Yes, you can expect an announcement from us on that. We picked IBM's system for Dimension because it was the best available at the time. But it's certainly a possibility that we'll develop our own. We know as much or more about voice as anyone. Yes, I'm sure we should probably have our own system in that area.

Q. Will you be connecting system 85 into a local network? How about adding wideband capabilities?

A. We already have a local-area network, internally, and with system 85 we can push 64 kilobits around on a twisted pair. That does one heck of a lot of things a local net up till then couldn't do. There aren't that many people who need more than 64-K. It's a question of priority. Wideband will be put on as soon as necessary—when you need big data and when there's a market.

Q. There seems to a movement now to phone work stations. Will you be part of that?

A. You can expect us to announce an integrated voice-data terminal by the end of the year.

Q. It is an open secret that American Bell will be putting out a personal computer, if not several, by year-end. Any comment?

A. I hear and read about that all the time. Don't believe everything you hear. We have talked with a number of companies in the workstation area. If you look at what's implied in system 85, it's obvious that the work station will be intelligent. A personal computer isn't the issue—they're all pretty much the same. We will be going into work stations, though, that are intelligent.

Q. Will they be intelligent videotex terminals, as rumors have it?

A. No. Oh, some components might be similar, like the keyboard, for example, but that's all.

Q. Might you market them in Phone Center stores?

A. We are in fact today testing the stores for the low end of our business line. I wouldn't rule it out.

Q. Will they tie into Net/1000?

A. All our data-using networks will connect into Net/1000.

Q. Are you on schedule?

A. There are always some minor glitches, but we've stayed more or less on schedule for a year and a half. Hardware stays closer to schedule than programming systems, but that seems always the case.

Q. What sense of the market do you have for Net/1000-type services?

A. First, I believe the market is huge. It is and will be segmented. There will be room for a lot of people—thousands of vendors. There will be some who lead, of course, who are broader and who have the skills and capabilities to manufacture at low cost and bring products to market fast. Whoever gets in, though, better be fast, flexible, and good. This is our chance to test ourselves in the marketplace, but it's going to take a while.

Q. You speak of flexibility. It's been hard to track your course so far. Is that elusiveness part of a strategy of flexibility?

A. It's been hard to track us because we haven't made enough announcements; the mosaic isn't filled in yet. But if you read our literature closely—for example, our system 85 announcements—you can see where we're going. We aim to be in information management, voice, data, office sensors, teleconferencing . . . we've known where we're going since 1975.

Q. What will be the biggest trend in 1990?

A. We feel there's absolutely no technological bind. We can see significant price-performance advances all the way down the line. However, software and programming systems are very constraining. We've got to make using these systems as easy as picking up a pencil. When you get past that, marketing considerations will be the only restraint. We have a one-button philosophy: any system function should be available by pushing one button. That's the direction it's got to go. Today, for example, I have difficulty call-forwarding. It can't be that way. □

"We've got to make using systems as easy as picking up a pencil" hardware and the software and convince other firms to start production. CBS/Sony was doing fine without the compact disk and wouldn't have listened to an order. Thus, I had to use my merchandising ability to implant in CBS/Sony the desire to make the disks."

Ohga is optimistic about sales of the players. "Last year Sony sold 20,000 players in Japan," he notes. "This year we expect to sell more than 100,000 plus about 150,000 worldwide, with a domestic price of about $700 and about $2,100 for a complete stereo system built around the player."

Despite its success with compact disks, Sony's results for the year ending Oct. 31, 1982, as well as the first quarter of this fiscal year, were dismal. Business fell off in 1982 faster than Sony's planners forecast. But inventories were cut, and April should see a return to normal, says Ohga. He points out that three quarters of the company's business is done abroad, including the oil-producing nations and Central and South America. He expects the second half of this year to be much better.

Plant in U. S. As for the problem of providing software for the players, Ohga, who was once president of CBS/Sony, says that, initially, customers for classical music should be satisfied with disks from that subsidiary and from Polygram in West Germany. Then, "CBS/Sony will soon announce the location of a plant that it will build in the U. S. to supply disks for the local market." Asked if Sony plans to follow pulse-code–modulated compact disks with PCM compact cassette tapes, Ohga indicates that the company must tread carefully there. "If consumers copy compact disks onto PCM tape, they will have better recordings than the 15-inch-per-second open-reel tapes formerly used as masters," he observes. "The record companies will go out of business."

In at least one consumer area, Beta-format video-cassette recorders, Sony has not been doing well: industry observers say the format, which was introduced by Sony, has only 30% of the market. To bolster that

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share, says Ohga, "late last year we announced that Sony would be making a single-unit camera-VCR that we call Betamovie, and there has been a spurt in sales of Betamax VCRs. They will use a new half-inch pickup camera tube, but soon we will start selling cameras with CCD imagers. Also, in the electronic news-gathering market, which will soon be all single-unit camera-VCRs, Betacam leads [the rival] VHS by 9 : 1."

Ohga would obviously like to see another U. S. market—stereo a-m broadcasting—open soon. But he laments the lack of a standard. "The Federal Communications Commission should be stronger and select one system," he maintains. "It is nonsense for the consumer to buy equipment to receive all stereo systems. It also imposes a heavy burden on manufacturers." □

Sony's new tempo

On that March day in 1953 when Norio Ohga graduated from the prestigious National University of Fine Arts and Music in Tokyo, after having majored in opera singing, not even the most prescient among his classmates and teachers could have dreamed that today he would be president and chief operating officer of electronics manufacturer Sony Corp. His trip to the top has been relatively swift: after becoming a consultant in 1953, he started working for Sony in 1959 as general manager of its tape recorder division while continuing to sing. But in 1964, he stopped singing because of the demands on his time as director of Sony with three concurrent general manager positions—at the tape recorder division, for product planning, and for industrial design.

In 1970, Ohga became the second president of CBS/Sony, which was started in March 1968. He became chairman of that record-manufacturing joint venture and president of Sony last September, succeeding the late Kazuo Iwama. —**Charles L. Cohen**

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Displays

All eyes are on big displays

The Society for Information Display's meeting in May will look at big-picture techniques as they move closer to implementation

by Stephen W. Fields, San Francisco regional bureau manager

"Big" will be the order of the day in Philadelphia May 9–13, when display specialists will gather at the annual Society for Information Display meeting. The focus will be on technologies for building large-area electronic displays, ranging from low-resolution single-color systems for billboards to high-resolution four-color arrangements that could be used for wall-sized units. Scientists and engineers from around the world will report on the latest in displays, covering the spectrum from TV monitors to liquid-crystal displays and beyond.

Many of the more interesting presentations will elaborate on techniques proposed at earlier SID meetings that are now coming closer to reality. For example, International Business Machines Corp. will present a paper describing projection of an image consisting of 4 million picture elements from an array of liquid crystals onto a screen. According to Anthony G. Dewey, a researcher at IBM's General Products division in Los Gatos, Calif., the technology that is used has been extended to 64 million pixels projected on a screen 1 meter on a side.

To build the display, Dewey says, "required the development of a reflective liquid-crystal cell with a 100-square-millimeter active area, the development of a 32-fiber array for writing the image onto the LCD, the design of a high-resolution, off-axis projection system, and the computer hardware and software to control the system." The 100-mm² LCD contains an array of 8,000 by 8,000 pixels, or 80 pixels/mm. The system has a magnification of 10 times, so the projected image is 1 m² with a resolution of eight pixels/mm or about 200 pixels per inch (photographs in this magazine have a resolution of about 125 pixels/in.).

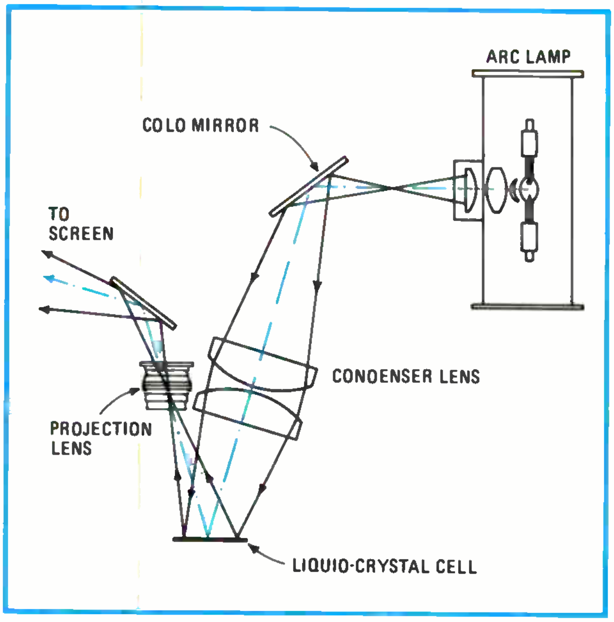
Uses 32 lasers. The IBM system employs 32 commercially available 10-milliwatt gallium-aluminum-arsenide lasers, each connected to an optical fiber. The opposite ends of the fibers are arranged in two staggered rows mounted on an X-Y platform, making up the writing head. The computer, an IBM Series/1, controls the lasers (and hence the image information) and scans the writing head across the LCD. A full screen update requires 250 scans and takes 62.5 seconds.

Light from an arc lamp is focused on the LCD, and the reflected image is projected onto a screen through a system of lenses and mirrors (see diagram). The system could be used, say its developers at IBM, for computer-controlled high-resolution plotters and graphics printers.

Another important update will be given by Oki Electric Industry Co. of Tokyo. In 1980, the company developed a large-capacity high-resolution display based on its work with thermal-recording technology. The display was an array of 1,792 by 2,400 pixels with a resolution of eight pixels/mm. Last year, the Japanese company succeeded in displaying a gray scale; since then it has increased the contrast ratio of the display by a factor of four. The company says it will discuss the details in Philadelphia.

Engineers from Nippon Electric Co. of Kanagawa, Japan, will describe a reflective-mode thermally addressed smectic LCD with 1,500 lines of resolution that is capable of presenting three colors against a black background. The display employs an argon laser to write on a cadmium telluride absorbing layer that thermally activates a 20-mm² light valve.

Gain for the system is said to be 6.4, which provides 100 foot-lamberts on an 8-by-8-foot screen. The frame rate is 3 seconds, making it too slow for television yet practical for the



Projection. This IBM projection system focuses light from an arc lamp on an LCD; the reflected image is projected through lenses and mirrors. It could be used for plotters and graphics printers.

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Probing the news

class of large, wall-sized displays that will be attracting so much interest at the SID meeting.

Yet another approach for a large-area color display comes from the Forschungs Institut fur Anthropotechnik in Wachtberg-Werthoven, West Germany. Researchers there have put together a system that employs four television monitors addressed as a single unit to provide a large, real-time display.

Message center. Intended as a low-power electronic billboard is an LCD-based unit developed by Princeton Research Associates Inc. of Princeton, N. J. It measures 3 by 12 ft and contains a 16-by-64-element LCD array controlled by an 1802 complementary-MOS microprocessor from RCA Corp.

According to Joseph R. Burns, executive vice president of the small consulting firm, the "LCD message center is our answer to the typical outdoor shopping-center billboard, usually consisting of a grid of light bulbs and consuming about 40 kilowatts." The Princeton Research LCD display consumes about half a watt, he reports.

The firm has built a prototype sign consisting of 1,024 LCD light valves, each measuring 2 in. square with about 3/8 in. separating each element. Characters and even graphics on the sign are controlled by an 1802 microprocessor development system that includes one serial input/output line and 4-K of static random-access memory.

For its prototype, the firm employed a tape cassette for programming. "A production unit would more likely use a terminal and floppy disk to enter and store the ASCII characters that are used as the input for the display," Burns says.

For a production sign, he adds that a cheaper microcomputer manufactured in higher volume would be a better choice for the controller. He estimates that a production sign might cost the manufacturer around $5,000—about the same as a conventional light-bulb system, including its driving electronics. ☐

Reporting was also provided by Charles L. Cohen in Tokyo, John Gosch in Frankfurt, and Marilyn A. Harris in New York.

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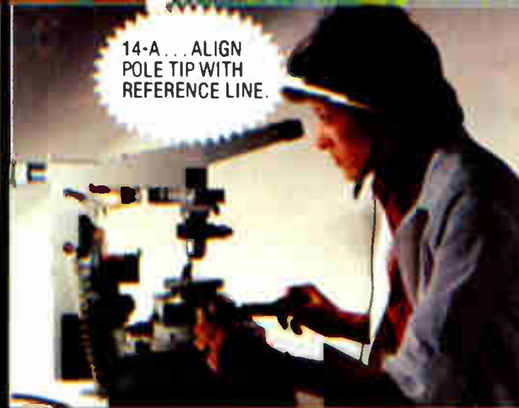

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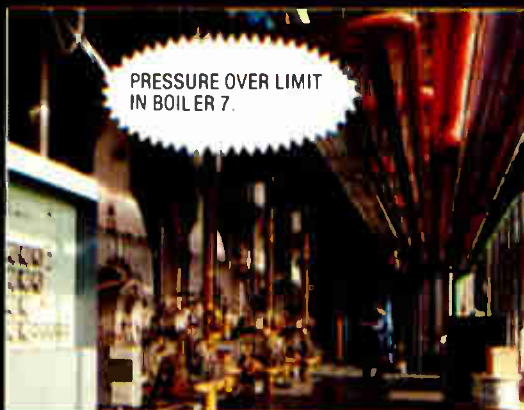

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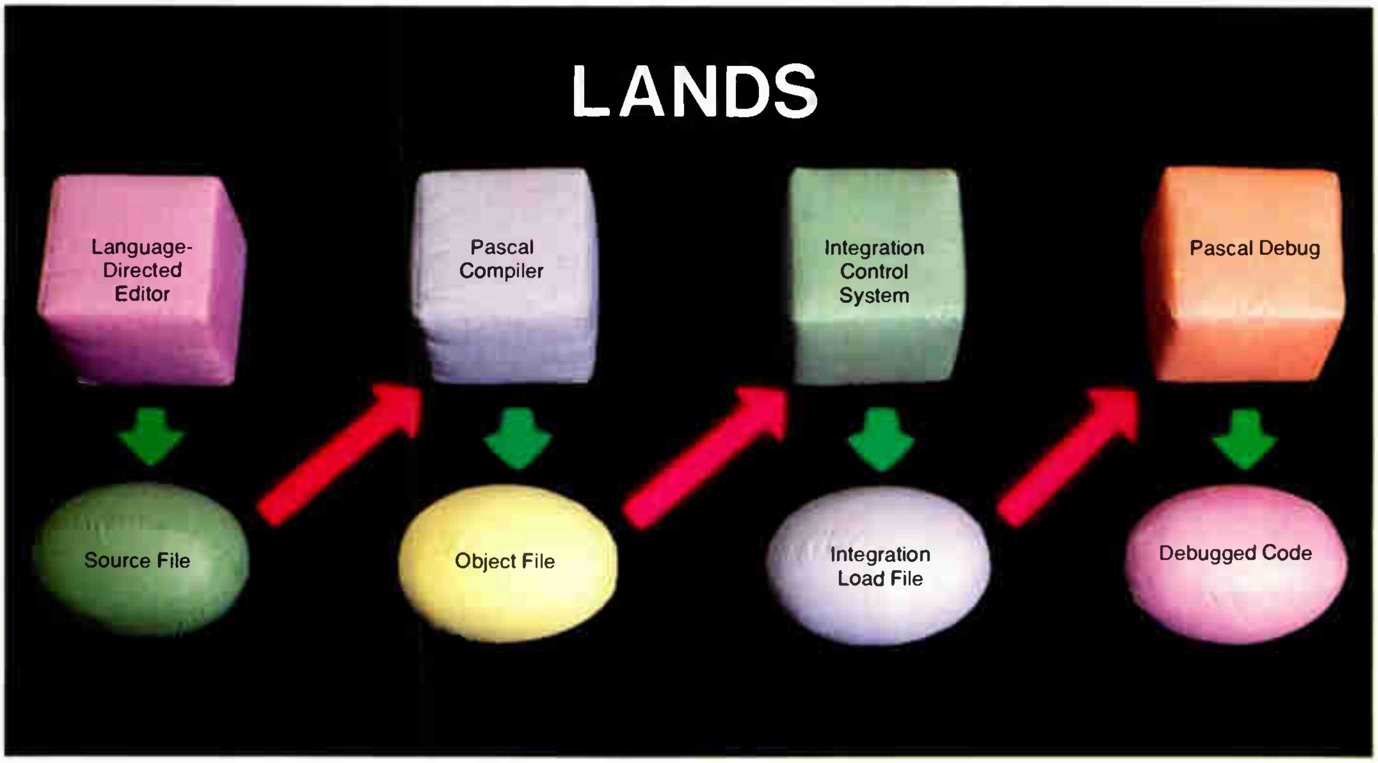

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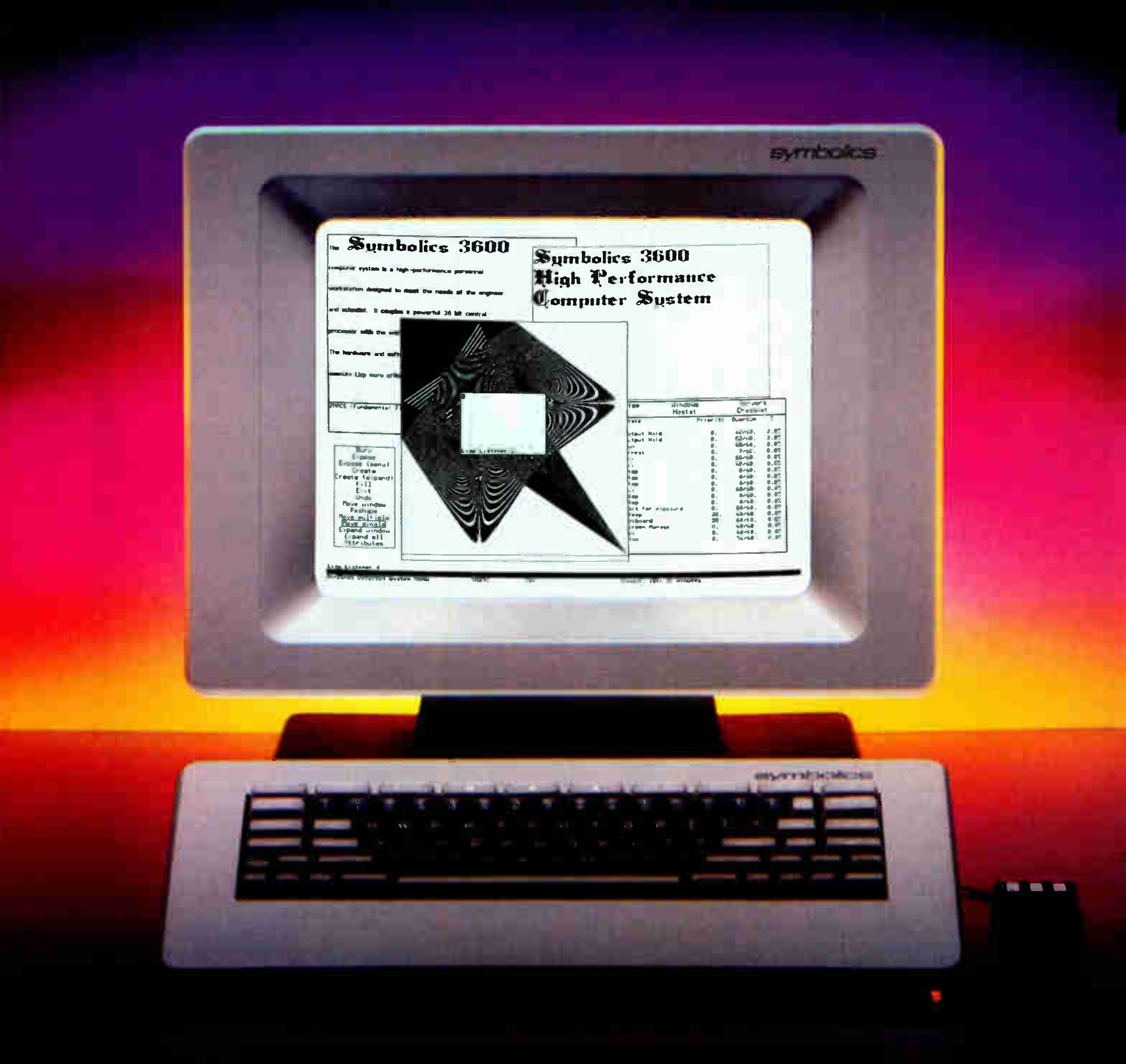
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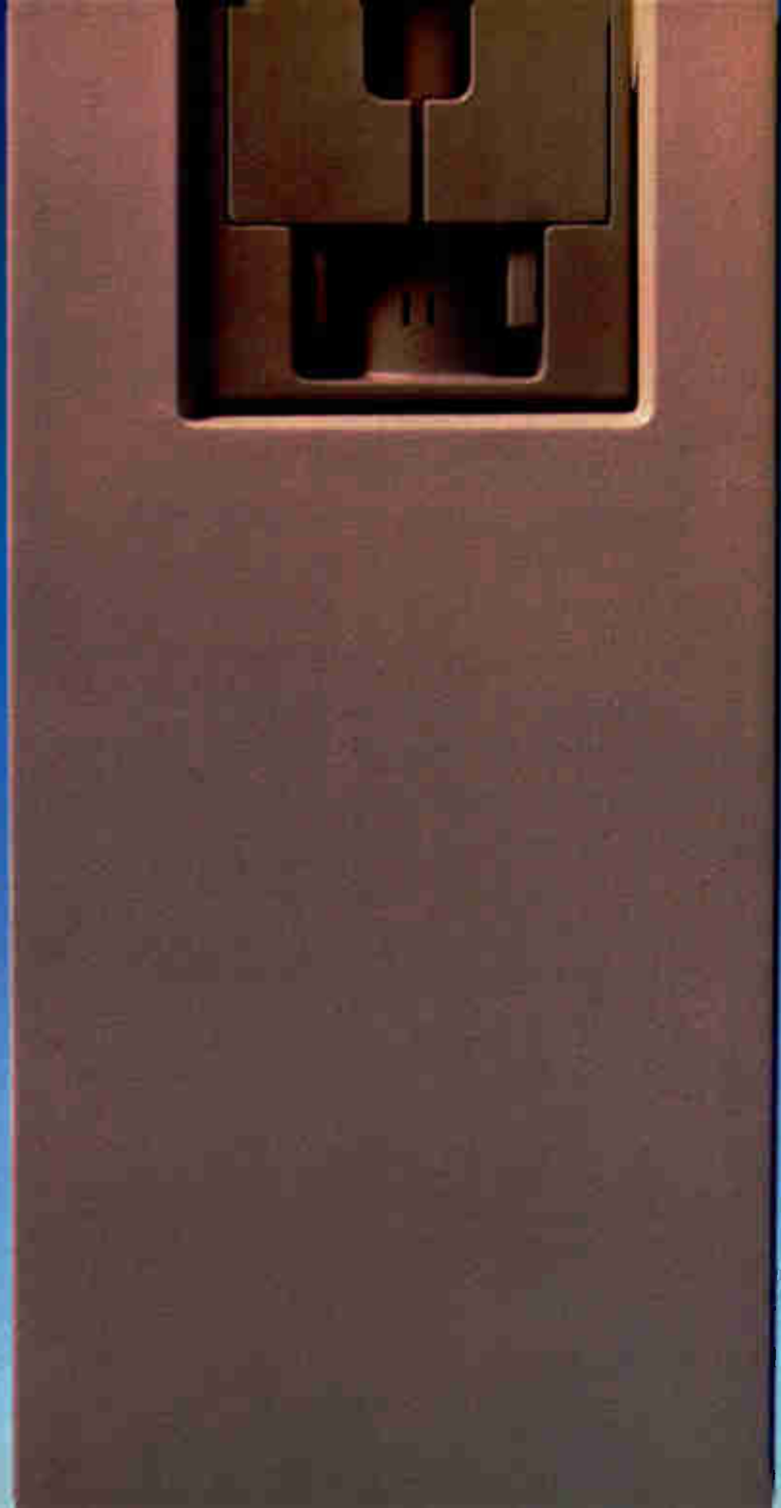

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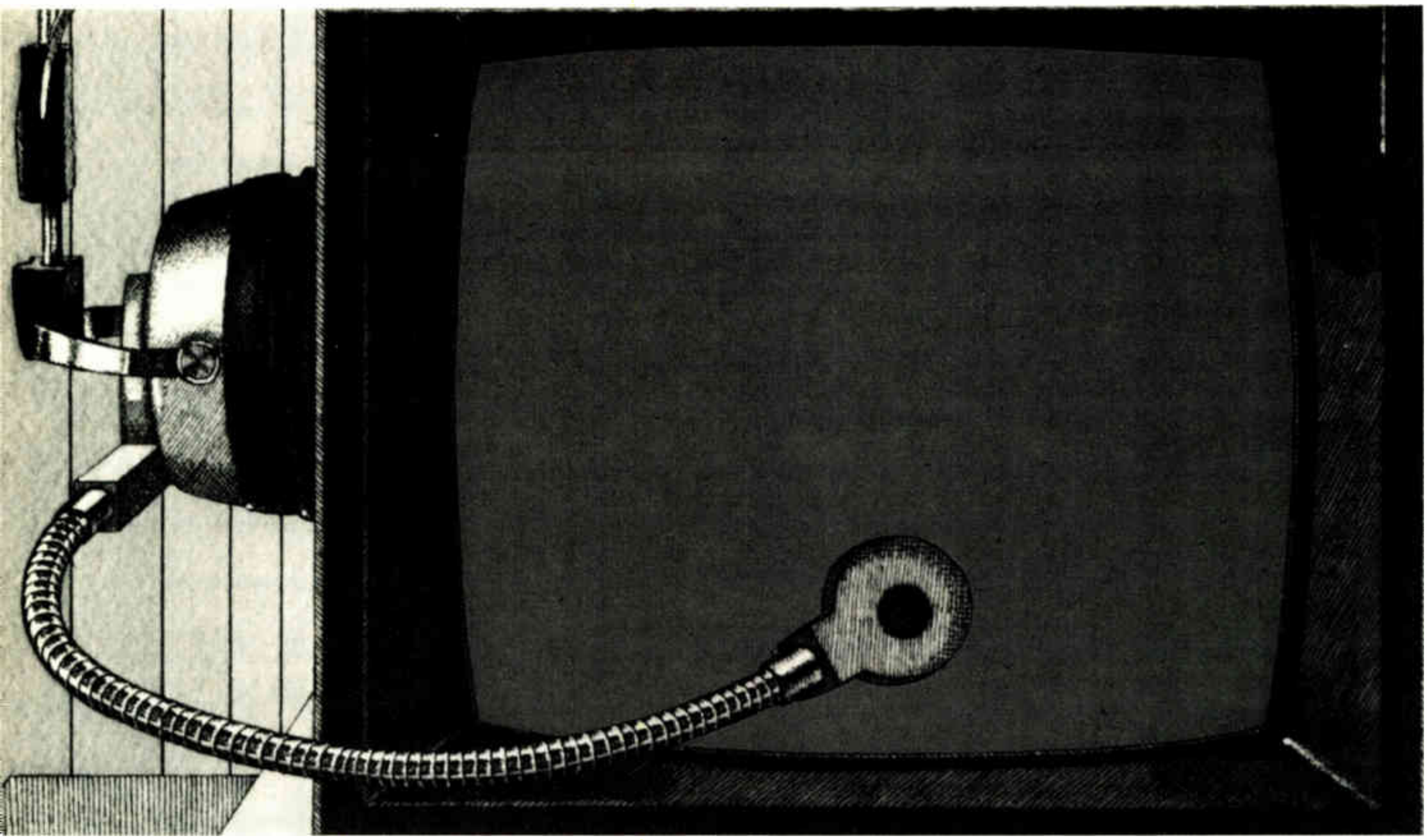


VOICE INPUT

A SPECIAL REPORT

Though the ability to speak or respond to speech has existed in electronic form for decades, a surge in the commercial applications of voice technology is augured by several recent developments—among them the deregulation of the telecommunications market, the emergence of sophisticated speech-processing algorithms along with VLSI circuits for executing them, and the rapid expansion of the population of general-purpose personal computers

by Roger J. Godin, *Communications & Microwave Editor*

☐ Voice technology, the use of speech by electronic equipment, is poised for major expansion. With the cost of the hardware shrinking and the sophistication of the software growing, the burgeoning fields of personal computing and telecommunications systems are ripe for infusions of this technology.

Cost-effective voice input and output systems for personal computers will soon offer users a simpler command mechanism, plus system prompts for training and diagnostics. They will also allow personal-computer makers to supply telephone options like distributed voice store-and-forward systems. The three articles that follow describe (not quite in this order) a first step toward such a distributed capability, plus two systems for small computers, one a general-purpose voice-I/O system and the other a text-to-speech synthesizer.

The basic categorization of the technology is in terms of input and output functions. Voice input can be divided into speech recognition and speaker verification; voice output includes speech-coding, notably voice-response setups, and speech-synthesis applications, plus store-and-forward systems. According to Vishnu Atal, supervisor of the speech-synthesis laboratory at Bell Laboratories in Holmdel, N. J., coding and synthesis differ in that the former uses human speech as the source of parameters stored for later output, whereas the latter produces voice output without human-speech antecedents.

Speech coding has become a well-established market segment ranging from simple toys, games, and appliances to more complex telephone-monitoring and -messaging devices. However, speech synthesis has found only limited application in voice-coding development systems and text-to-speech converters.

Virtually all the commercial chips termed speech synthesizers may more properly be viewed as speech-coding devices because they use set vocabularies developed by human speakers to produce their voices. Linear predictive coding has become an almost *de facto* standard approach for these applications because it provides reasonable speech quality from cost-effective chips. But the other techniques, like wave-form coding and phoneme stringing, will continue to find applications as long as there are manufacturers to provide and refine them.

Indeed, the number of vendors of voice technology is increasing rapidly, and marketing efforts on new products should be substantial. In 1982, the U. S. market totaled about $25 million, and there were some 40 vendors of speech-coding and -synthesis products, about 15 in speech recognition and roughly 10 in voice store-and-forward, which sometimes is called voice mail.

This market splintering can only foreshadow a shakeout. Already, some of the original vendors have dropped out or are having financial problems, especially in the

OUTPUT

speech-recognition segment. Pioneers such as Heuristics have disappeared completely, and Threshold Technology Inc. is struggling to get out of Chapter 11. In addition, Centigram has dropped recognition in favor of speech-synthesis and voice-response systems, while Telesensory Systems Inc. has spun off its voice operations, which, with new funding, have become Speech Plus Inc.

Yet forecasts remain bullish, especially for voice-response, store-and-forward, and voice-recognition equipmemt. International Resource Development Inc., the Norwalk, Conn., market research firm, says that in 1982, the market was made up of about $15 million in speech coding and synthesis, $6 million in voice response and store-and-forward, and $5 million in speech recognition. By 1984 these sectors should grow to $48 million, $32 million, and $25 million, respectively, and by 1987 they could reach $237 million, $274 million, and $270 million.

The following pages supply insight into the reason for such optimism and offer up examples of state-of-the-art work going on industrywide. The article beginning on page 128, from Texas Instruments Inc., describes a voice-recognition and speech-synthesis board aimed at personal computers. The one that starts on page 133, from Digital Equipment Corp., outlines an effort to allow speech output from any text data base. The third, from Rolm Corp., begins on page 137 and explains the integration of speech-coding store-and-forward technology with advanced telephone switching equipment.

These three developments seem destined to merge into user-friendly office information systems providing voice commands and feedback in a distributed-processing setup. This merging will owe much to very large-scale integrated processors, because powerful computational hardware is becoming economical enough to integrate voice technology into personal computers and therefore explore that rapidly expanding market. Furthermore, the new circuits are programmable, rather than being dedicated designs, so they can be adapted to several applications or modified as speech algorithms are refined.

Outside the U. S., of all companies active in voice technology, NEC Corp. is clearly the most advanced. Having benefited from a close working relationship with Nippon Telegraph & Telephone Public Corp., NEC has numerous speech-recognition products ranging from chips to full systems. The Tokyo-based company is unique in that its product family includes both a speaker-dependent word processor that can recognize an unlimited Japanese vocabulary and speaker-independent models with a maximum 128-word vocabulary.

Marketing such products in the U. S., though, has posed some significant problems for NEC, which it hopes to overcome with a direct-sales force now being formed. Also, although NEC is strong in recognition, it lacks any significant voice-output capability. Such products are important for the market in personal-computer options, since speech output in the form of prompts and messages is vital to widespread end-user acceptance.

Other Japanese companies, such as Hitachi, Sharp, Matsushita, and Toshiba, also have voice products on the market both in the U. S. and in Japan—but typically their thrust is to reduce the cost of established designs aimed at talking clocks, calculators, and other consumer products. However, in view of their ties with advanced research at NTT and the fifth-generation computer project being coordinated by the Ministry of International Trade and Industry, it is likely that many Japanese firms will play a significant role in voice technology.

In Europe, developments have paralleled those in the U. S. Speech coding using LPC or formant synthesis is available from several companies, including NV Philips Gloeilampenfabrieken in the Netherlands and Triangle Digital Services and Costronics in the UK. Most European speech-recognition research has taken place in the UK, where the government has funded two programs. The first teamed up Logica Ltd. for algorithm development with Marconi Space & Defence Systems Ltd. for a parallel processor recognizing about 200 connected words on a speaker-dependent basis using pattern matching. The other program is an advanced research project at the National Physical Laboratory where nonpattern-matching techniques are being explored. □

John Gosch, Jesse Leaf, Robert Neff, and Kevin Smith provided assistance with the information on international developments in voice technology.

Voice recognition joins speech on programmable board

Using a general-purpose VLSI signal processor, one board handles speech chores on request

by Lee Dusek, Thomas B. Schalk, and Michael McMahan, *Texas Instruments Inc., Dallas, Texas*

□ Hardware with enough computational power to process speech signals has heretofore been limited to specialized designs such as speech-synthesizer chips, various charge-coupled devices, and other analog-type speech analyzers. However, programmable single-chip digital signal processors are now available that can carry out many voice processing functions, including speech synthesis, word recognition, voice coding, and voice verification.

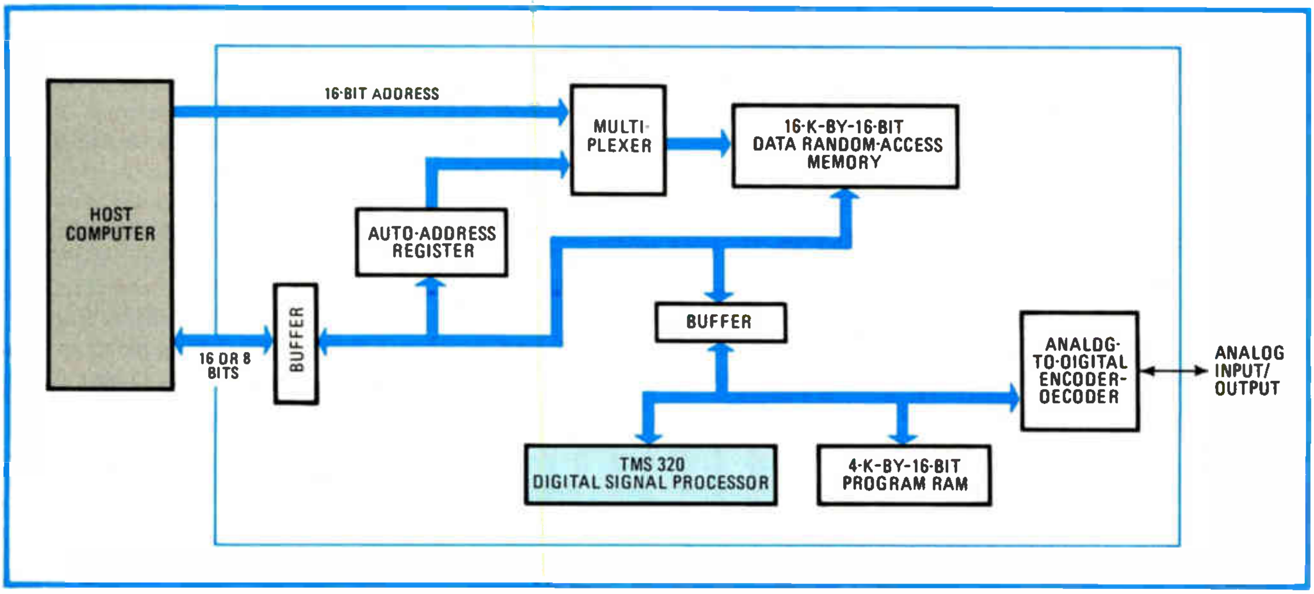
Fulfilling all those requirements is Texas Instruments' high-performance digital signal-processor board, the SBSP3001 (Fig. 1), built around the high-speed TMS320 single-chip microcomputer (see "A processor built for speed," opposite). The 3001 uses the 320 to digitize and compress speech using a technique termed linear predictive coding and stores it in on-board or system memory in a compact form. Later, the compressed speech can be synthesized and played back.

Straight, high-quality digitization of speech requires a bit rate of about 100 kilobits per second. But by using LPC, the 3001 board compresses it to approximately 2.4 kb/s or less. Once compressed and stored, the speech data can be used for generating synthetic speech output for a variety of purposes.

Listening for recognition

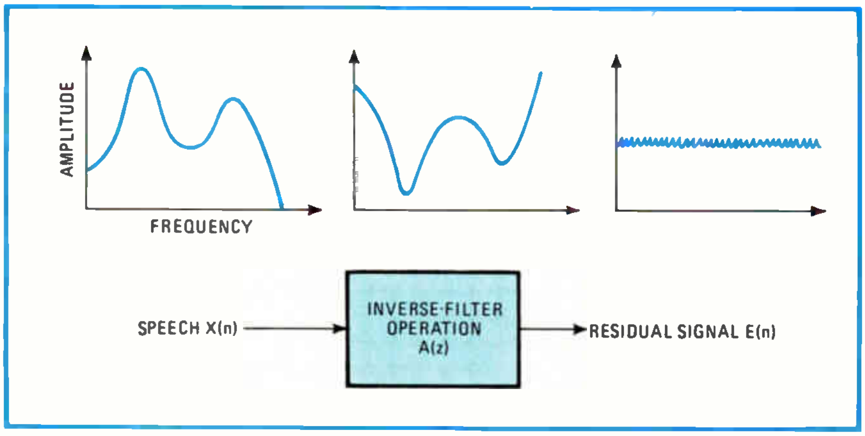
The speaker-dependent word recognizer implemented with the 3001 can handle both isolated words and connected speech. Its maximum capacity of about 32 seconds of vocabulary represents about 50 utterances. Any one vocabulary item can take a maximum of 2.6 s, and a single utterance can contain up to 21 connected words.

Because the application programs are kept in random-access memory, the board can be quickly reprogrammed with host-system–supplied software. Thus, the board can serve either as an input or an output speech peripheral. The desired program is merely downloaded from a host system. In fact, because the 3001 is a highly flexible general-purpose digital-signal processor, it will do a host's bidding for almost any kind of signal processing. All it needs is the application software and it can become



1. One board gives system speech. A general-purpose signal-processing board with voice-frequency analog channels, the SBSP-3001 handles both speech recognition input and synthesized speech output and can use software downloaded over a Multibus interface.

2. Peak-to-valley matching. In speech recognition, users enroll a vocabulary of utterances, which are stored as templates. Input-frequency spectra are compared with reverse template spectra to produce a residual-error signal for each sampling frame. Minimum residuals result in recognition.



a vocoder, a modem, a fast-Fourier-transform processor, a digital filter, or a speech I/O peripheral.

Basically, speech recognition involves four steps: feature extraction, pattern-similarity measurement, time registration, and a decision strategy. An additional task, called enrollment, involves the creation of speaker-dependent reference patterns, which key the recognition to a certain speaker.

Because of wide variations among different speakers, today's speech-recognition devices must be tuned, or enrolled, to accept speech from only one (or a few) users. In many applications, however, recognizing only a specific individual is even a desired attribute.

Step by step

Enrollment creates a set of feature vectors called templates for each vocabulary word in the system's repertoire. The vectors, which are included in the similarity measurement as part of the recognition process, define the spectral shape of the reference pattern for individual vocabulary words.

All individual and multiple-word utterances of the overall vocabulary must be enrolled. Successive repetition of the utterances leads to significant improvement in performance as a recognizer. The substitution error rate decreases substantially with each additional training session. After five training inputs, for example, substitutions generally decrease to about one third the rate that exists after the first training pass.

Feature extraction transforms speech signals into time-varying parameters, called features, that not only can be recognized by the system but can also reduce the amount of data that must be processed. Of all the available feature-extraction methods, LPC is one of the most effective.

Based on a tenth-order LPC model that runs at an 8-kHz sampling rate, the board operates on a 30-millisecond Hamming window with a frame period of 20 ms,

A processor built for speed

With an extensive repertoire of single-word, single-cycle instructions, the TMS320 single-chip microcomputer—which serves as the processor for the SBSP-3001 signal-processor board—executes commands at rates up to 5 million instructions per second, making it one of the fastest devices available for dedicated, real-time digital-signal processing and other applications.

At first glance, the 320 appears to be a general-purpose machine. But a closer look reveals that its circuitry is optimized for high-performance signal processing. Its modified Harvard architecture separates program and data memory spaces, so the processor can pipeline its operations—fetch information from its program and data memories in parallel—to allow the execution cycle of a previous instruction to overlap the fetch cycle of the next instruction.

Input and output data is formed into 16-bit words, but internally the chip operates as a 32-bit computer. A 32-bit arithmetic and logic unit prevents loss of precision when the chip performs operations on analog signals, and the results of all arithmetic operations are carried out to 32 places in both the accumulator and ALU. Performance is further enhanced by an internal 16-by-16-bit parallel multiplier, which produces a 32-bit product and accumulation in just 400 ns. Multiplication takes just 200 ns.

The 320's large program memory—implemented in on-chip read-only memory organized into 1,536 16-bit words and externally expandable to 4,096 words—permits fairly complex programs to be executed. In addition, a high-speed on-board random-access memory organized as 144 words of 16 bits each is included. High-speed control is achieved over almost every machine state by using simple single-word, single-cycle instructions instead of more common microcoded ones, which can require five to ten machine cycles for execution. Special instructions address the specific conditions not only of speech synthesis, analysis, and recognition but in other digital signal-processing applications as well, including high-speed modems, image processing, and spectral analysis.

which is short enough to capture most dynamic-speech events adequately. Although extracting the compressed-speech features from the input signal and encoding them into LPC-10 parameters is not simple, by using autocorrelation analysis and a modified Le Roux-Geuguen algorithm, the 3001 is able to perform feature extraction in real time.

The next step—computing the measured similarity, or distance, between the extracted speech parameters and stored reference patterns—is basically a frame-by-frame comparison of speech data with reference data, or templates. This operation is analagous to passing the input signal for the current frame through an all-zero inverse filter that represents the reference template data. When the reference data matches the input data—that is, the spectral valleys in the inverse template match the spectral peaks in the input signal—a low-energy residual error signal will result (Fig. 2). If the inverse template matches the input data perfectly, the error measure is normalized to 1. To be within recognizable limits, the value must be less than 1.2 in the 3001 speaker-dependent system.

The parameters that are used to compute the difference between input samples and stored-template reference patterns are also computed by the autocorrelation and residual-energy algorithms (Fig. 3). Autocorrelation is a fairly simple software procedure, consisting of a sequence of register loadings and multiplication operations. By taking the inner product of the autocorrelation coefficients of the input speech parameters and the impulse response of the inverse filter template, it becomes easy to compute the residual error.

The approach to minimizing this error over a sequence of frames is called dynamic programming. A technique used to optimize the residual error accumulated over all frames between the input speech and its template, dynamic programming helps the system decide if an utterance can be recognized as matching a enrolled template and depends on the residual error of the entire utterance rather than any of the individual frame residuals.

The time-registration function allows recognition of connected speech and is performed by a type of dynamic-programming called time warping that compensates for variations in the length and timing of the input utterances, but which does not change the meaning of the inputs. A straightforward approach would attempt to derive the reference-data and the speech-signal parameters from frames of the same period (20 ms in the 320's LPC-10) and make a comparison for every frame.

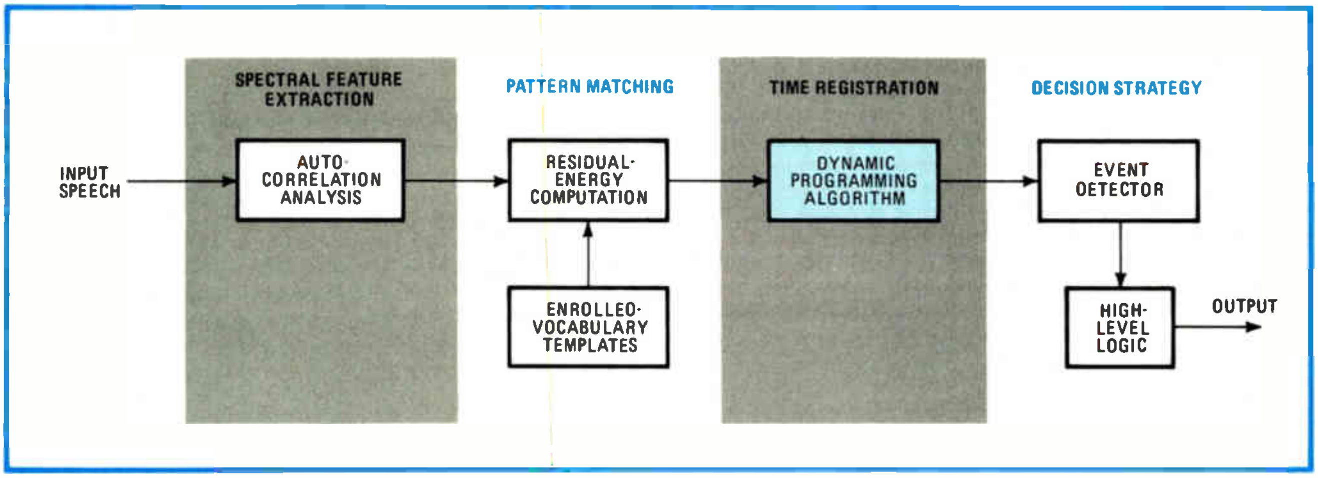
However, for speech recognition, using a reference-frame period that is twice the input period leads to two important advantages. First, the amount of reference data that must be stored and the number of dynamic programming computations that must be performed is halved. Second, the dynamic-programming computation is simplified by eliminating a memory element that would be required when comparing every frame (Fig. 4).

Time warping

The time-warping approach can accept speech inputs with a varying time factor of 2 : 1. However, the system prefers that utterances be spoken at a more or less constant average rate for greatest accuracy. Furthermore, the time-warping routine need not start and finish on specific speech-input frames, eliminating the need for determining the end points of input parameters.

Although the processing time increases substantially, the unconstrained end points offer two major benefits: system reliability improves greatly, and the speaker does not need to pause between words. System reliability is improved because for 98% or better accuracy in recognition with fixed end points, the reliability of the end-point determination must be at least 98% accurate as well. However, because end points can be very difficult to determine, this expectation is unrealistic. With an unconstrained end-point dynamic-programming algorithm, the system can recognize vocabulary words even when they are not discretely separated in time.

The dynamic-programming function then scans for minimum-distance matches of the spoken-word parame-



3. Stepping through recognition. Each utterance to the SBSP-3001 takes four steps. First features are extracted, then pattern matching with enrolled templates produces residual signals. Using dynamic programming, the residuals are time-registered, and a decision is made.

Your word is your computer's command

Speech-recognition technology is in a highly transitional stage. The number of companies with products is growing briskly, even though many customers are skeptical because early systems fell short of expectations. The difference now is that progress in dynamic programming and pattern-matching algorithms, such as those described by Texas Instruments Inc. in the accompanying article, has reached the stage at which speech recognition can be accomplished by cost-effective very large-scale integrated processors.

This progress has resulted from extensive research in both industry and academia. Because of variations of the speech signal in one individual and between different persons, the task of recognition is much harder than that of synthesis. Therefore, it is usually easier to divide the task into subcategories of speaker-dependent or -independent and of isolated or connected words.

The ultimate goal. Most of the research aims at of developing a speaker-independent system that recognizes connected words. But this task is so formidable that it still requires mainframe computers and will need substantial breakthroughs in algorithms, hardware, or both before it can be used feasibly with significant vocabularies.

Work towards this goal led to systems designed for more conservative performance, such as speaker-dependent isolated-word recognition. Systems implementing this type of recognition have been introduced by several companies over the last several years. The main problem is that users must speak with distinct pauses between words, limiting applications to narrow market segments where vocabularies are small, such as digit recognition at computer telephone ports, airport baggage handling, and the like.

As with all voice technology, speech-recognition systems rely on the various time and frequency characteristics of the voice. Recognition systems can use any method, including digitization, formant filtering, and linear predictive coding, to extract the features unique to an utterance. Such features are then compared with stored feature patterns, with matches indicating recognition.

This pattern-matching approach can, however, take significant time if vocabularies are large or if feature patterns are generalized to cover a number of speakers. At International Business Machines Corp., where large, speaker-independent vocabularies of over 5,000 words are sought, research centers on a different approach. Applying information-theory principles, IBM scientists are using a mainframe computer to do probabilistic analysis of the phonetic, acoustic, and syntactical conditions existing in strings of energy extracted from speech input.

Meanwhile, new speech systems will spark the development of flexible software packages that should make the next two years spectacular for the speech-recognition business. So says Janet Baker, a speech consultant with Dragon Systems Inc., Newton, Mass., and a number of companies apparently agree with this appraisal, because new products are appearing regularly for nearly every market segment from toys and games to high-level computers.

For stand-alone recognition products, Votan Inc. of Hayward, Calif., using its technique called spectral coding, cuts bit rates of digitized input speech to only 9.6 kilobits a second, to which it applies pattern matching for recognition. The Votan product can be used both for coding speech and for recognition and is offered as systems or boards.

Another system and board maker, Interstate Electronics Inc., has delivering recognition products based on pattern matching for several years. According to Edward O'Neill, director of marketing, the Anaheim, Calif., company is adding basic software so that users can get speech recognition into their terminals and computers within minutes after they receive Interstate's box.

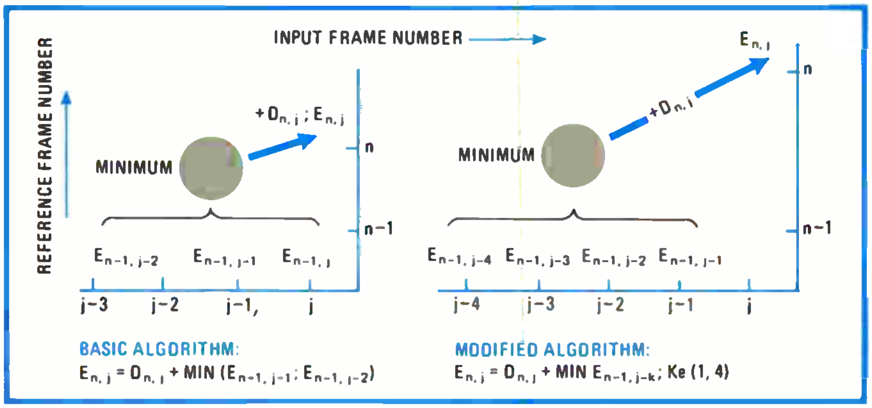
Verbex Corp., a Bedford, Mass., subsidiary of Exxon, is an experienced vendor of speech-recognition systems to the Government that is about to introduce a high-end data-entry terminal. Featuring a 300-word vocabulary for speaker-dependent continuous-speech applications, the system is expected to have good noise immunity and a 300-millisecond response time.

Still, as the number of personal computers continues to increase, speech recognition is getting its biggest thrust from add-on systems for these small machines. Threshold Technology, Delran, N. J., is experiencing substantial business improvements as a result of new products that plug into Hewlett-Packard Co.'s series 80 personal computers and Televideo model T950 terminals and that give users up to 120 words of recognition. In fact, Threshold reported a 25% increase in sales for the fourth quarter of 1982, an encouraging sign for both the company and the market for recognition products in general.

Other ventures. Recently, two semiconductor companies besides TI have announced voice-technology products keyed by recognition capability. At Intel Corp., the first product is a development system aimed at allowing customers to understand speech transactions and how they might fit into their equipment. Rather than invest heavily in speech research, Intel has put established speech algorithms on its standard signal-processor and microcomputer chips.

NEC Corp. has numerous speech-recognition products, developed in part under programs undertaken with Nippon Telegraph & Telephone Public Corp. and already introduced in the U. S. NEC's experience in voice technology and manufacturing strength will make it a formidable competitor once the voice-technology market takes off.

As for TI, the board discussed in this report is a Multibus version of the system it announced in January for its own personal computer. The aim seems to be to make it as easy as possible for original-equipment makers to integrate TI's voice I/O technology into their products. According to Larry Woodson, marketing manager for speech products, a voice chip set including software in read-only memories will be also eventually marketed. –**Roger J. Godin**



4. Time warping saves steps. Making template frame periods twice as long as input frame periods permits the distance D(n,j) between the residual error of a set of input frames and the templates, E(n,j), to be calculated directly. Time-warping also eliminates end-point detection and allows the recognition of connected speech.

ters among all the stored templates to find suitable word-recognition candidates. The candidates are passed to a high-level decision-logic operation that applies a threshold-comparison test and a next-closer-error threshold test to determine which word or words are to be selected.

The high-level decision logic and the error threshold are somewhat empirically derived. However, by using dynamic programming, once the input utterance's error residual is below the threshold, it is possible to determine if the difference between the template yielding the lowest residual signal and the next smallest residual is great enough. If the difference is sufficient, the 3001 will issue a match, or recognition, signal to the host. If there are two templates whose residual errors are too close together, the utterance will be rejected to minimize the jeopardy of a system substitution mistake. The host system must then take any action needed, such as prompt the user to repeat.

Because the error threshold and what is a sufficient difference are rather empirical, it is possible to redefine the values according to the requirements of a specific application. User programmability of these parameters allows performance to be optimized for vocabularies, noise environment, or other criteria.

Talking back

Speech synthesis is much simpler than any of the other speech-processing functions and so makes the least demands upon the 3001's capabilities. For synthesizing speech output, the TMS320 is programmed with an LPC algorithm that includes a random-number generator, a pitch pulse generator, and a 10-pole lattice filter. Pitch and energy data and 10 filter-weighting values are fed separately to an LPC-10 speech-synthesizer system programmed into the 320. Experience has shown that a 20-ms frame provides sufficient resolution to define speech and obtain results of good quality.

The unpacking and decoding functions, which require only about 2% of each 20-ms speech frame, convert the coded data stored in the board's memory into equivalent 16-bit words in accordance with a coding table stored in the 320's program memory. Part of this word, the pitch data, generates the excitation function, which consumes another small 1% of the 20-ms frame. If the pitch parameter is 0000, indicating unvoiced speech, the excitation function is obtained from an algorithm for generating random numbers that is implemented in the 320. Otherwise, for voiced speech, the excitation function consists of a series of pulses spaced one pitch period apart.

This excitation output is then weighted by the 10-pole LPC filter, which performs about 1,600 multiplications and accumulations on 160 samples per 20-ms frame. The operation, which takes the rest of the frame, then feeds the entire frame of synthetic speech samples to an external digital-to-analog converter for speech output each time the converter interrupts the 320.

How it goes together

Besides the TMS320 signal processor, the 3001 board includes a 16-K-by-16-bit data random-access memory used primarily to store speech parameters, such as vocabulary templates for word recognition. This RAM also serves as an I/O buffer between the host and the 320. Such an approach requires an auto-address register, which can also be interfaced with the 320 as an I/O device. The register is designed to automatically increment, decrement, or remain constant following each memory access. Therefore, it is quite efficient when accessing contiguous buffers in the external memory.

The 320 communicates with the rest of the system using its 16-bit bidirectional parallel data bus. Communications is interrupt-driven, and interrupts may be received asynchronously from an external controller or synchronously at the 8-kHz sampling rate of the analog subsystem.

As a speech peripheral, the 3001 board also contains analog interface circuits, which have independent input and output channels made up of analog-to-digital and digital-to-analog converters and low-pass filters.

The 320 does all the system's signal processing. The general-purpose signal-processing capability is provided by a separate 4-K-by-16-bit program RAM, in addition to its data RAM. This separation is easy because the TMS320 is a Harvard-architecture computer having independent program and data buses on the chip. Having a large external program RAM is also for program development and supporting applications that require more memory than is available on chip. □

Three-tiered software and VLSI aid developmental system to read text aloud

A phonemic dictionary and translation rules, plus transition smoothing, enable formant synthesis to yield excellent speech output

by Edward Bruckert, Martin Minow, and Walter Tetschner, *Digital Equipment Corp., Maynard, Mass.*

☐ Text-to-speech systems could be useful wherever information can be conveyed as effectively by voice as by vision. Perhaps their most promising application is to large data bases, which would become much simpler to access if they could themselves "answer" the telephone calls made to them.

Extensive speech, however, needs to be of higher quality than the robot-like voices adequate for simple messages. And improved intelligibility demands additional sets of linguistic principles and levels of detail, which in turn require far greater hardware and software capability than does low-quality speech—all of which must be reconciled with the cost constraints of the marketplace.

A three-tiered software approach developed by Dennis Klatt of the Massachusetts Institute of Technology answers all these needs. Using a two-processor board, it succeeds in extracting high-quality voice output from text written in the American Standard Code for Information Interchange.

The laboratory setup at MIT used a Digital Equipment PDP-11/60 minicomputer, a high-speed array processor, and limited memory. In contrast, the board developed with Klatt's aid at Digital Equipment holds only a commercial microprocessor—Motorola's 68000—and one digital signal-processing chip package—Texas Instruments' TM32010—whose low cost more than offsets the expense of substantially more memory. All software is written in the high-level language C and is transportable.

Three-level processing does the job

Of the three processing levels needed to turn text into speech (Fig. 1), the first generates unambiguous digital representations of speech sounds from 8-bit ASCII text, no matter what character sequences might appear in the input. The second accepts these digital representations as input and from them calculates sets of acoustic parameters. These parameters control the third level, synthesizing the voice output.

The digital representations generated on the first processing level correspond to phonemes, the basic building blocks of speech. Only about 40 phonemic symbols are required to represent all the sounds of English.

Converting text into a phonemic form is done by a pronunciation lexicon supplemented by a library of letter-into-sound rules for words omitted from the lexicon. The lexicon is a dictionary of specific sequences of phonemes developed by translating words into phonemes. The letter-to-sound rules generate "best-guess" phonemic sequences derived from knowledge of how a character string should be pronounced.

In phonemic symbols, the ASCII text, "The old man sat in a rocker," becomes:

DH IY ' OW LD M ' AE N) S ' AE T IH N AX R ' AA K RR .

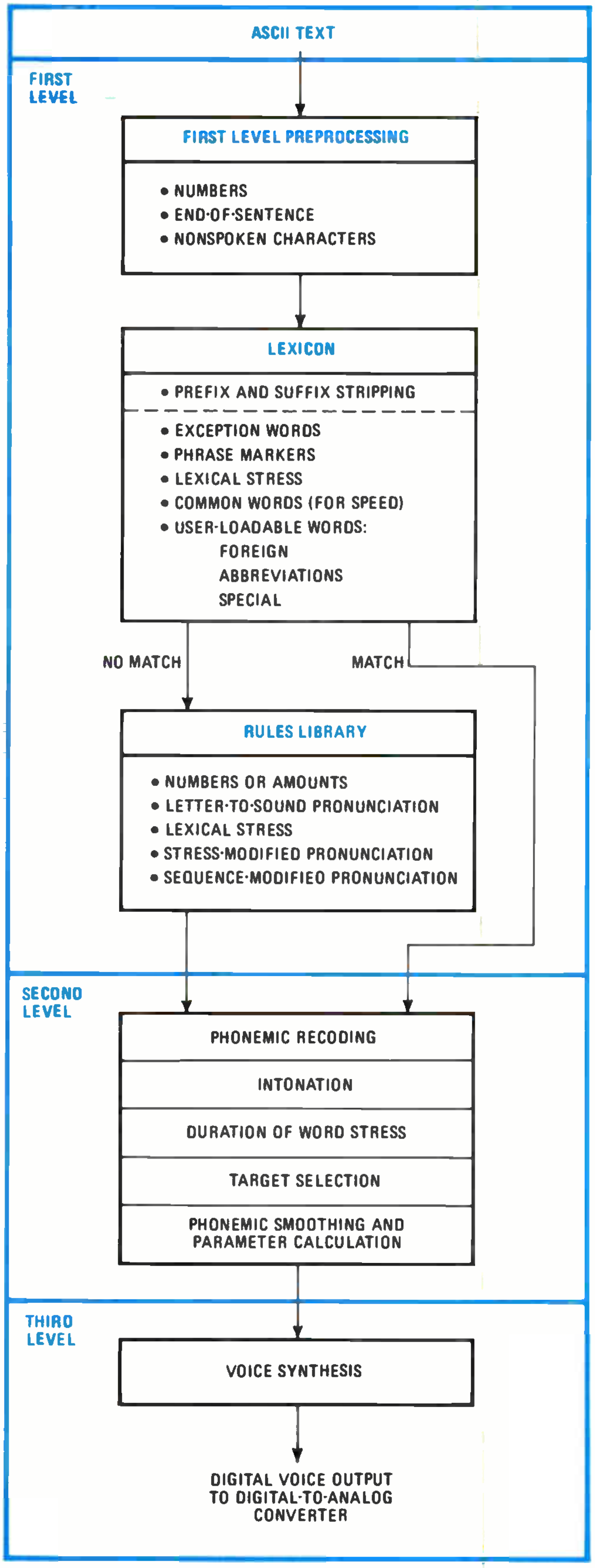
Other symbols included in this sentence are apostrophes, to indicate which vowels within a syllable receive primary lexical stress; a closing parenthesis to indicate a phrase boundary; and a period to indicate a sentence termination. The first is a stress symbol, and the others syntactic symbols. The lexicon uses the phonemic and stress symbols and occasionally the closing parenthesis; the endpoint symbol is dealt with before it, and the closing parenthesis also affects the second level.

The first-level process searches for a text word in the lexicon and, if successful in matching it, transmits its stored phonemic representation directly to the second-level process. If not matched in the lexicon, the word is transferred to the rules library and produces a "best guess" phonemic output.

The words selected for the lexicon include the many exception words not covered by rules in the letter-to-sound library. A good example is "of," the only English word in which *f* is not pronounced *f*. Also included are unstressed function words such as "and" and "or," because they would be pronounced incorrectly if handled by the letter-to-sound rules, and phrase markers like "since" and "although," because they determine syntax-oriented stress.

Words loaded into the system's dictionary by users might also include foreign words commonly used in English (*détente*, *lasagna*) and abbreviations (etc., Ms.). Common prefixes and suffixes are stripped from words before accessing the lexicon so that multiple forms of the same root words need not be stored.

Because numbers, sentence endpoints, and nonspoken characters such as apostrophes and virgules are a particu-



1. Three-level process. When the task of converting English text into analog voice is divided into phonemic analysis, smoothing of phoneme transitions, and speech synthesis of the results, software can produce a voice of high quality from cost-effective hardware.

larly difficult task in text-to-speech conversion, they are identified by preprocessing before the lexicon is searched. Preprocessing identifies numbers in the ASCII code and generates phoneme strings appropriate to the variety of ways in which numbers can be spoken. For example, "1920" could be "one thousand nine hundred and twenty" or "nineteen twenty." End-of-sentence detection is needed to distinguish between those periods that end sentences, others that designate abbreviations, and still others that function as decimal points. "Silent" characters like slants (virgules) and apostrophes must be accounted for as well.

Although the pronunciation of common cardinal and ordinal numbers is covered in first-level preprocessing, the ways in which humans speak combination numbers and amounts requires further analysis within the rules library. Without special attention in number-to-sound rules, for example, "$12.40" might be turn into "dollars twelve point forty."

As for the library's letter-to-sound rules of pronunciation, they may be universal or modified by such exceptions as "*f* is always pronounced *f* if 'of' is in the lexicon" or "*b* as the last letter in a word is always pronounced *b* except that it is silent when preceded by *m*." Stress rules differentiate between lexical variations such as "photograph," "photographic," and "photography" and the different pronunciations of, for instance, the second *o* in "photograph" and "photography."

To achieve high quality, a text-to-speech system must have both a large lexicon and a large library of rules. The larger both are, the better the chance that the pronuncication of a particular word either will be exactly specified by the dictionary or will benefit by the most accurate "best guess" in the library. In the developmental system, there are nearly 500 rules in the letter-to-sound library, and they are constantly being added to and refined.

However, more emphasis is being placed on enlarging the lexicon because its branching tree structure makes for shorter searches than does the library's serial structure. (The library runs every ASCII letter submitted to it past every one of its rules.) The lexicon, which had 1,500 words in the laboratory system, is now being expanded to what will ultimately be about 7,000 words. At 20 bytes per word of memory space, it will then occupy 140 kilobytes of read-only memory. A properly selected lexicon of this size, when used in conjunction with the current letter-to-sound rules, can ensure the correct pronuciation of the roughly 20,000 words to be found in a standard pocket dictionary

Before speech is synthesized, the phonemic representations received from the first level are modified on the basis of syntactic analysis. Whereas the first level by and large deals with only individual words as the basis for its

Sorting out speech

There are two main reasons why the market for true speech synthesis has been much larger than the one for speech coding. The first is that for most listeners, the quality of voice output not derived from human speech is just not good enough. The second reason is that synthesis products have been difficult to use.

Vendors of speech-output integrated circuits offer a variety of speech-synthesis systems to their customers for development use. Beyond development and evaluation products, though, the main use of speech synthesis to date has been in text-to-speech systems.

Stand-alone systems and those for home computers have been introduced by the Votrax division of Federal Screw Works, Texas Instruments [*Electronics*, Feb. 10, 1981, p. 117], Speech Plus (formerly Telesensory Systems Inc.), and others. However, apart from robot-like speech, these systems have typically had little or no user software support and have required considerable host-processor resources to operate. Although users could buy low-cost text-to-speech hardware, they were usually faced with the far from trivial task of writing software drivers and also had essentially to turn their computers into dedicated text-to-speech processors while using the boards.

One solution is a dual-processor architecture with the personal computer as host and a microprocessor operating the voice subsystem. The accompanying article describes how Digital Equipment Corp. has developed a text-to-speech system that uses the dual-processor approach to attain nearly natural speech performance. To prove how natural the system sounds, the DEC team has arranged a dial-in demonstration at (617) 493-7625 so that everyone may hear it for themselves.

What sounds good? The fact that people perceive speech differently, so that its quality is hard to quantify, has slowed the growth of not only speech synthesis, but voice technology in general. The inherent characteristics of the natural speech signal make determining exactly what constitutes high-quality voice technology very subjective. The consequent lack of agreement on how speech quality should be measured and specified has been a major problem for users and vendors alike.

Fortunately, the problem is being addressed. The National Bureau of Standards has established a committee to review the important parameters contributing to speech quality and what test conditions might be used to measure them. Subsequently, the Institute of Electrical and Electronics Engineers formed a similar working committee. It is hoped that by year's end a final version of the guidelines will be set. Still, these guidelines will not be a standard, and users of voice technology would do well to know something about the natural speech signal.

Because people develop a facility for spoken communication so spontaneously, it is sometimes difficult for them to understand why simulating speech with a machine is so complex. Possibly there is a large genetic component in the human ability to speak, as some linguistic experts such as Noam Chomsky have suggested. But machines certainly have a much harder time of it, for research into the natural speech signal has proved essential to the development of voice technology.

The vocal tract can be viewed as an cylinder with one end open and a sound source at the other, much like the pipes of an organ. Acoustically, the output sound is very rich in harmonics because, as in an organ, for each source frequency there are numerous resonant frequencies at wavelengths of 4L, 4L/3, 4L/5, . . . where L is the length of the cylinder. Therefore, natural speech is extremely hard to simulate because the sound source—the larynx and vocal cords—is highly dynamic and subject to biological variation, while the open end—the mouth and lips—can adopt varying sizes and shapes.

Modeling speech. This source-filter model is a reliable first-order approximation to the real speech signal. The energy of typical human speech is distributed over a frequency spectrum of approximately 5,000 hertz. Assuming a 17-centimeter-long vocal tract and a 340-meter-per-second speed of sound, resonant frequencies called formants exist at around 500 Hz, 1,500 Hz, 2,500 Hz, and so on.

But though the absolute spectrum of speech and the number of formants are very large, for most practical purposes many of the higher-frequency terms are negligible. Telephones, for instance, band-limit speech to 3 kilohertz and the corresponding first three or four formants. Most technologies take advantage of this fact that most speech information can be derived from the lower-frequency part of the signal. But this truncation is what prevents simulated speech from ever sounding really natural.

Indeed, the speech signal is quite complex, and study has led to two basic approaches to voice processing. One approach, basically a time-domain technique, is simply to digitize the waveform. However, direct digitization requires prohibitively large bit rates, making sophisticated compression methods necessary. The other approach concentrates on frequency-domain modeling of the biological speech mechanism, using a computer to rapidly vary parameters to simulate spoken sounds.

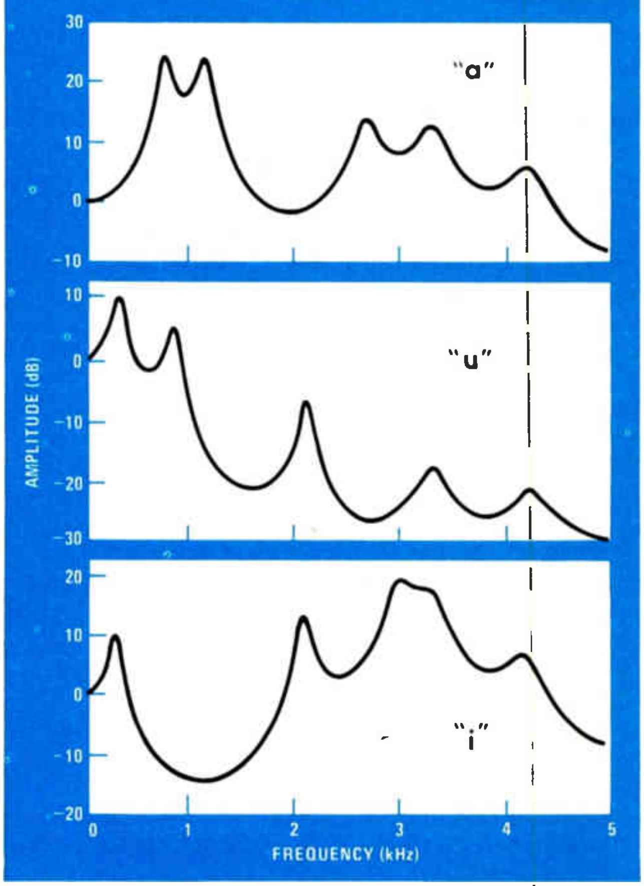
Both approaches trade off complete naturalness for lower cost and less complexity. In speech-output devices, this tactic means reduced fidelity, while for speech recognition, it means restrictions on vocabularies and users.

The most popular method of speech synthesis, linear predictive coding, combines frequency- and time-domain techniques. LPC uses a time-based sampling approach augmented by coding frequency-domain parameters such as formant frequencies, bandwidths, and amplitudes in each sample. Then these samples are used to drive a source-filter model of the human vocal tract, which can be integrated cost-effectively in semiconductors, yielding a reasonable naturalness at storage rates of around 2 kilobits a second.

—**Roger J. Godin**

TEXT-TO-SPEECH VOWEL CONTROL PARAMETERS

Vowel	Formants (Hz)			Formant bandwidths (Hz)		
	F_1	F_2	F_3	B_1	B_2	B_3
a	620	1,220	2,550	80	50	140
u	450	1,100	2,350	80	100	80
i	310	2,020	2,960	45	200	400



2. Frequency is the key parameter. Spectrograms of vowels a, *u*, and *i* illustrate the characteristic five frequency peaks, or formants, of the vocal tract. Basically harmonics of the fundamental pitch frequency of the vocal cords, these formants occur in all speech sounds.

selection of the phonemes that determine their pronunciation, the second level is concerned with the effects of the surrounding phrase and sentence. The pronunciation selected in the first level may have to be recoded phonemically because of what follows or goes before or what both follows and goes before. For instance, the word "the" is usually pronounced one way (as "thee" apple) when followed by a word beginning with a vowel phoneme and another way ("thuh" book) when followed by a consonant phoneme.

Rules for intonation, duration, and word stress—what word in the sentence should be stressed—are then applied to modify the phonemic representation. One intonation rule, for instance, deals with the fact that a word generally has a higher pitch at the beginning of a phrase and drops at the end of the phrase. (The robotlike sound of a low-quality system is partly due to the monotonicity that this rule corrects.) Also, the duration of a sequence of phonemes composing a word may change with their position in the sentence.

Once a phoneme has been selected and modified to represent a given sound within the context of a phrase or sentence, the characteristics of the next phoneme within that context are identified in a procedure called target selection. Targets specified involve the phoneme after the current one and include its sound-source amplitudes and formant frequencies.

In synthesizing the human voice, it is important that there be smooth transitions between phonemes at each formant frequency rather than discontinuities, which produce distinctly audible clicks in output speech when the frequency and amplitude of successive phonemes change with unnatural abruptness.

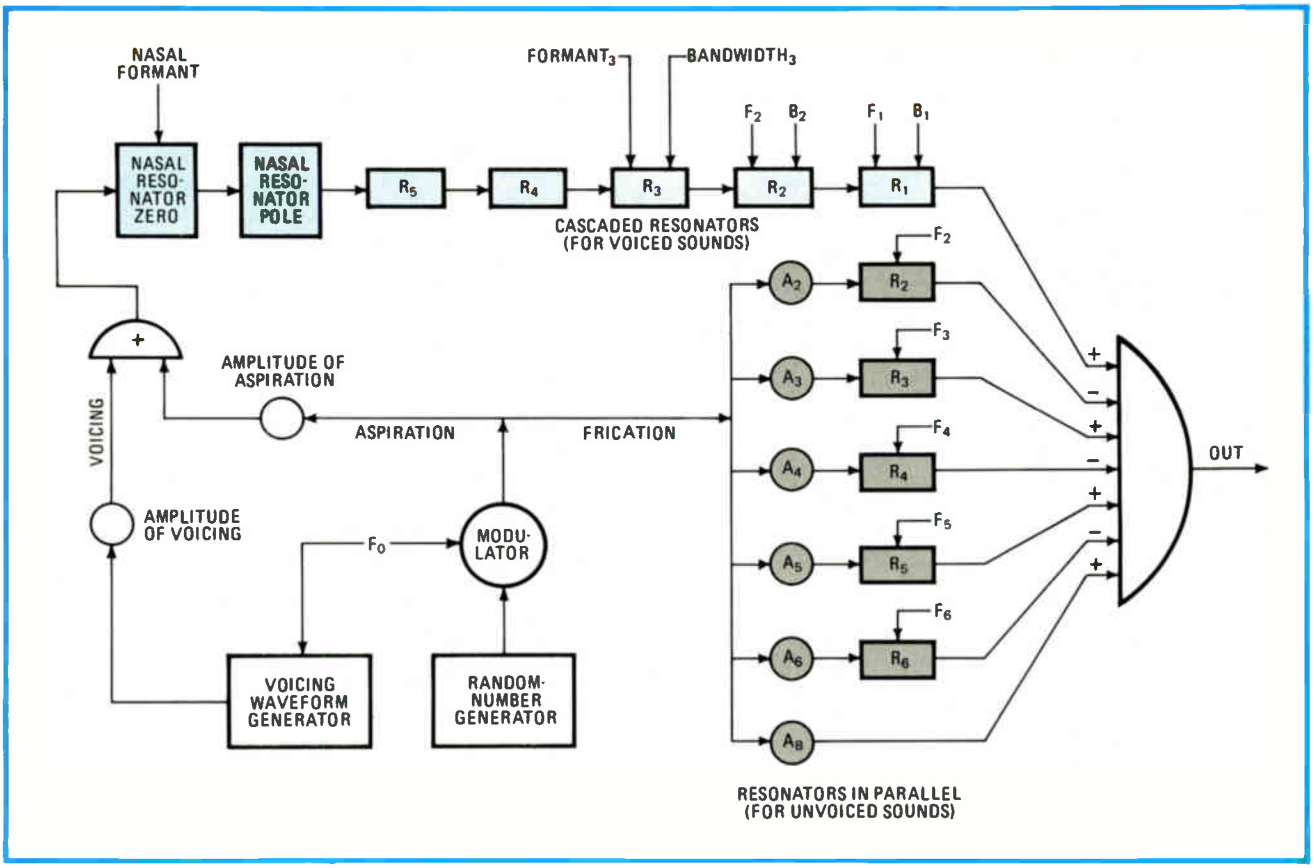
The vocal tract smooths phoneme transitions by aligning the frequency and amplitude at the end of one phoneme with those aspects of the beginning of the next phoneme. The shape of the ends of each phoneme, and often its center, therefore varies with the phonemes that precede and follow it. Such variations on a given phoneme are called allophones.

One way in which text-to-speech systems smooth phonemes is to link their facing ends by linear extrapolation of their contours as defined by their parameters. The DEC system executes a more complicated smoothing algorithm based on the locus theory of consonant-to-vowel transitions and an asymptotic approach to target contours. This approach is more difficult to implement but results in speech that is perceived as much more natural. Once implemented, the algorithm requires relatively little processing time and avoids even the small discontinuities of the simpler allophone and diphone concatenation. (A diphone extends from center to center of two successive phonemes.) The smoothing is done separately for each of the three formant frequencies (F_1, F_2, and F_3) contained in each phoneme.

A total of 18 control parameters are calculated in the second-level process and transferred to the voice synthesizer along with the phoneme sequences. Other parameters that control the individuality of the voice are sent only when changing speakers; these time-varying parameters are augmented by several constants that can be modified at the beginning of a sentence to switch between a man's, woman's, or child's voice.

The control parameters that are usually varied to generate isolated vowels are the formant frequencies (F_1, F_2, and F_3) and bandwidths (B_1, B_2, and B_3) of the lowest three formants (Fig. 2). Also important are the fundamental pitch frequency (F_0) and the amplitude of voicing (AV). Vowels preceded by a consonant may need still other parameters to be varied. Most consonants require even more variable parameters, particularly fricatives (like *f*, *v* and *s*) and plosives (like *p*, *b*, and *t*).

A new set of 18 control parameters is calculated every 6.4 milliseconds, an interval somewhat smaller than actually needed to handle the most abrupt phoneme-to-pho-



3. Series and parallel synthesizer. The voice output of DEC's developmental system is based on a formant synthesizer approach developed by Dennis Klatt. Voiced sounds are modeled by sending pitch pulses to series resonators, while unvoiced sounds are handled in parallel.

neme transitions that are likely to be encountered. Each parameter is 16 bits long, so that the data-transfer rate from the second level to the third level is about 45,000 bits per second.

Speaking the words

Voice synthesis is accomplished by digital signal processing in the third processing level. The simulated natural sound sources—ostensibly, vibrating vocal cords or the turbulent noise of free rushing air—are filtered by the "organ-pipe" formant resonances of the vocal tract (see Fig. 2 again). The fundamental frequency of the vocal cords and fourth and fifth formants help establish the basic quality of the voice—male, female, child, and the characteristics unique to each voice—and do not change significantly during speech. The first three formants, which have to do with voiced vowel sounds, change considerably in both frequency and bandwidth during the course of speech.

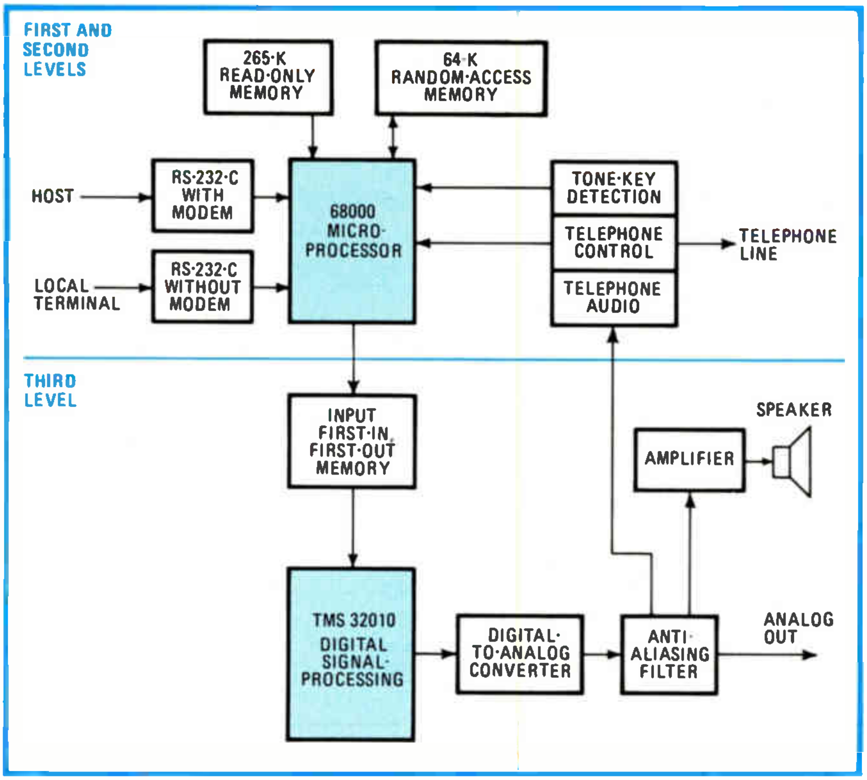
The intelligibility of the human voice is maximum when all its sound energy is transmitted to the listener, but has been found to degrade very little if the frequencies above 5,000 hertz are absent. Therefore, high quality can be achieved by synthesizing only frequencies up to 5,000 Hz. To process this frequency range, the development system's digital signal-processing sampling rate is 10,000 per second, or twice the highest frequency.

The voice synthesizer (Fig. 3) is an electronic model of vocal tract. The cascaded digital resonators (or filters) are used to produce voiced sounds. The parallel resonators produce unvoiced fricative sounds of better quality than a less elaborate setup would.

The sound source's waveform input to the cascaded resonators is the sum of a pulse train at the fundamental frequency (F_0) (its amplitude being set by the AV control parameter) and aspiration noise, which is frication noise that originates in the vocal cords. Turbulent noise used for unvoiced speech and aspiration and frication is simulated by a random-number (white-noise) generator and modulator. The white-noise output may be modified by F_0 during sounds like *z* that also contain voicing.

The output of the formant resonators is a sum of three products, C_1 (current sample input) + C_2 (output value of the first previous sample) + C_3 (output value of the second previous sample). The coefficients C_1, C_2, and C_3 are related to the frequency (F) and bandwidth (B) of the formant. Two resonators, RNP and RNZ, that precede the five formant resonators can modify the spectrum of the voicing waveform to simulate the effects of nasalization.

From a mathematical point of view, the frication sound resonators could have been cascaded, but to simplify implementation, they were put in parallel. The par-



4. Simple hardware. A primary goal of the text-to-speech system development was to produce high-quality speech output from simple, cost-effective hardware. Clever algorithm coding made it possible to realize the system with a commercial microprocessor, a commercial single-chip signal processor, and a minimum of other parts.

allel configuration necessitates equipping all the formants with amplitude controls, which as a side benefit also happen to be useful in generating waveforms, such as single-formant patterns, that violate normal formant-amplitude relationships.

In the cascaded configuration, the amplitude of a formant peak depends on its frequency and bandwidth and on the frequencies of the other formants. Therefore a single amplitude control is sufficient.

A parallel resonator for the first formant (F_1) has been omitted in the synthesizer because F_1 has negligible influence in generating fricative sound. However, a sixth formant is added just inside the 5,000-Hz cutoff point to simulate high-frequency sounds such as *s* and *z*. The fricative sound elements also include a bypass path with amplitude control (AB) to introduce white noise from the random-number generator. This source helps in simulating *f*, *v*, *b*, and *p* sounds, which contain no prominent resonant formant peaks.

All sound-source and resonator contributions to the synthesized voice waveform are added to form 12-bit samples that are transmitted to a digital-to-analog converter. At the rate of 10,000 samples/second, the data transfer rate out of the synthesizer is 120 kb/s.

Mating hardware to the task

The hardware implementation of the developmental system (Fig. 4) was developed by specifying a microprocessor to handle the first- and second-level processes and a digital signal-processing chip to handle voice synthesis in the third-level process. An effort to minimize support hardware for these two principal devices reduced both the cost and the complexity of the system.

The microprocessor had to be reasonably fast to support real-time operation and have an extensive addressing range to permit a large lexicon. The Motorola 68000 was selected because it has a 10-megahertz clock and, with 24-bit addressing, can address 16 megabytes of memory.

The choice of a digital signal processor was dictated by the basic task of computing the three formant products (C_1, C_2, C_3) for each of the 12 resonators. This computation requires 36 multiplications in each 100-microsecond sample. The Texas Instruments' TM32010 DSP chip is specifically designed for fast mathematical computation and executes a 16-by-16-bit multiplication in only 0.200 μs [*Electronics*, Feb. 24, 1982, p. 105]. Therefore it performs the basic computing task in less than 10 μs, leaving most of its time free for other tasks.

Memory linked to the 68000 consists of 256-K bytes of ROM, of which over half is reserved for the lexicon, and 64-K bytes of random-access memory. Other than the d-a converter, the major support hardware consists of an input first-in, first-out buffer, an antialiasing filter with a cutoff of 5,000 Hz, and digital and analog input/output interfaces. The input FIFO in effect decouples the high-speed digital signal-processing chip from the much slower output of the second-level process.

The system can be accessed through RS-232-C ports from either a local terminal or a host computer. The speaking rate is variable from 120 to 300 words per minute. A choice of several voices and a loudspeaker, telephone or analog output are provided. ☐

Digital voice store-and-forward system answers the phones, takes messages

System uses existing digital phone switch to answer nonsubscriber calls and notify users of digitized voice messages in mass storage

by Julie Holding and Stuart Taylor, *Rolm Corp., Santa Clara, Calif.*

☐ Although the telephone has played a key role in improving office productivity, it requires both the caller and the called to be simultaneously available for voice conversation. This sounds a simple enough accomplishment, yet the chance of a caller reaching an intended party the first time is only about 35%. Otherwise, the result is a volley of callbacks commonly called telephone tag, where an average of three calls is needed to complete a connection.

Voice store-and-forward message systems using dedicated computers to digitize, store, and access speech promise to minimize these missed connections. However, as stand-alone systems, these devices are unable to perform an important function: answering busy or unattended phones for the user. But by integrating directly into a telephone system, Rolm Corp.'s PhoneMail voice store-and-forward message system is able to provide notification, telephone answering, and many other features.

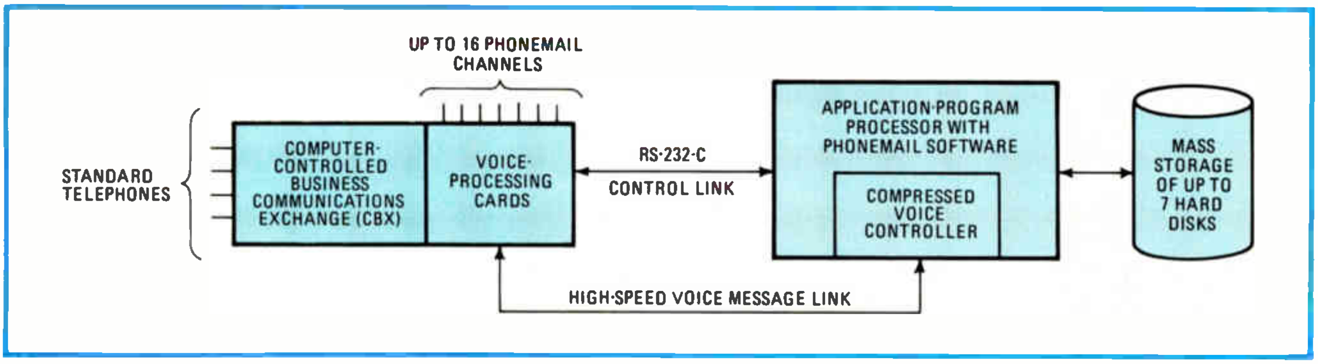
PhoneMail is a distributed-processing system based on a structured set of software modules built around the existing facilities of an advanced digital telephone switch, the Rolm computer-controlled business communications exchange, or CBX (see "Making the most of the phone," p. 143). This integration with an existing telephone system gives PhoneMail many advantages for voice store-and-forward applications while at the same time distributing PhoneMail software functions and allowing the application computer for the system to be used for general processing as well.

The PhoneMail system's hardware has three major components (Fig. 1): the CBX, processing, and mass storage. The CBX interfaces with telephone lines, digitizes speech, and switches voice messages. The application processor controls communications between the PhoneMail system and the CBX, formats speech data, and manages the third component—hard-disk mass storage. However, it is the modular software and the communication links between the application processor and the CBX that make PhoneMail unique.

Linking voice and control

Of the two communications links between processor and digital switch, the first is an RS-232-C command link that the system uses to pass control information. All call setup, tone-key input, and message notification information is conveyed over this link. It also enables the system to add voice store-and-forward to existing CBX features, such as call forwarding and waiting. Because the CBX performs all the telephone interface functions including speech digitization, the PhoneMail application processor can be used for general processing.

The second is the message link, a high-speed data bus for the transfer of compressed digitized voice data. In the CBX, digitization occurs as pulse-code modulation performed at a 12-kilohertz sampling rate. Switching is based on a time-division–multiplexing scheme, with the digitized voice being transferred as streams of 16-bit sam-



1. Add-on economy. Integrating the PhoneMail voice store-and-forward system with a Rolm communications business exchange (CBX) enabled engineers to take advantage of existing connections to user handsets and speech-digitizing hardware.

ples. But because this data rate would require excessive amounts of storage for voice store-and-forward applications, the PhoneMail system performs data compression and expansion on all the voice messages that it has the job of handling.

Both communications links are implemented by a set of circuit cards installed in the CBX backplane and the application processor itself. These compression and expansion cards, called voice-processing cards, have capacity for eight channels each, and two cards can be installed in a CBX to handle either 8 or 16 channels of simultaneous conversation in a PhoneMail system.

A shielded flat cable up to 50 feet long connects the cards to the compressed-voice controller card in the application processor. The controller card manages the compression process and the communication links with the PhoneMail operating system and ensures that the data is properly formatted.

The application processor formats speech data so it can be reliably delivered later to the system user. The storage format for voice messages is organized in frames. The first 2 bytes of each frame define the initial volume level and characterize the voice message in terms of silent periods and control tones. When recording, the system software removes silent periods longer than 200 milliseconds from the message data stream to maximize storage efficiency. This has also been found to increase the intelligibility of the stored speech in some instances. Control tones are also removed from the voice-message data before storage because they are annoying to the listener and are capable of disrupting system operation during playback.

Structured software spreads functions

The overall PhoneMail system is composed of several modular software elements, each designed to manage various system subtasks, such as protocol conversion, channel access control, and administration. The basic elements of PhoneMail software are the user-interface module, the command-and-prompt handler, the system administration module for data-base management and statistics reporting, the CBX communication element, the voice-channel protocol handler, and the diagnostics module. These modules and subtasks are general functions needed for many applications, and they are built on top of the application processor operating system, or APOS, which is an interrupt-driven system with a very simple but effective interprocess communication mechanism.

Two major protocols—the voice-channel protocol, VCP, and the telephone-to-application protocol, TAP—specify how information is passed between the various software modules and the utilities that each provide. TAP, which is a subset of VCP, defines the communication as well as the control message formats between the CBX and the application processor. A generalized communications protocol, TAP is designed to allow the telephone to act as a data terminal when used in a CBX system with different application programs running in the application processor.

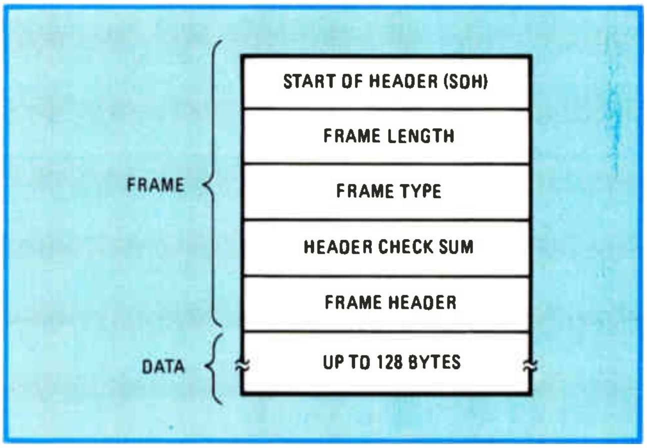
TAP is built in accordance with the International Standards Organization layered hierarchy for open systems interconnection, although its levels do not directly correspond with the seven ISO layers (see table). The physical level of this protocol uses asynchronous framing on a full-duplex RS-232-C link. In TAP, the ISO data-link level is called the asynchronous line protocol (ALP), which is a simple, general-purpose protocol permitting reliable data transmission over the command link and which supports a full-duplex conversation between the CBX and the application processor.

The protocol also performs message framing (Fig. 2), data check-summing, and message acknowledgment and ensures an orderly flow of information over the command link on a character basis. Just above ALP is the transport level, which controls message routing. Finally, the application level is dedicated to such functions as call setup and disconnection.

The second protocol, the VCP, permits the CBX to control the voice channels and the voice filing system. VCP has been designed to handle multiple client programs, and although PhoneMail is the only application currently offered, it will be possible for future applications to make use of VCP for the purpose of gaining

A COMPARISON OF ISO AND PHONEMAIL COMMUNICATIONS PROTOCOLS

Level	International Standards Organization (ISO) layered transport protocol	Telephone-to-application protocol (TAP)
7	application	application
6	presentation	
5	session	
4	transport	transport
3	network	
2	data link	asynchronous line protocol
1	physical	RS-232-C



2. Framing messages. For a clean interface between its different levels of protocol, PhoneMail uses a common frame structure that separates control fields and data. Control information indicates the type, length, and check sums for ensuring header accuracy.

Storing messages in the phone net

The deregulation of the telecommunications industry is probably the strongest reason for expecting voice technology to expand rapidly. In an open market, the technology of speech subsystems like those described in these three articles will be rapidly integrated into larger systems by telecommunications vendors. Furthermore, speech-encoding research is being investigated as a means of meeting increased demand for communications channels.

Based on speech-coding technology, telephone-based systems used for voice response and voice store-and-forward are already becoming common. If consumer products with canned vocabularies are included, voice-response systems make up nearly all of the current voice-technology market.

Besides consumer items, voice-response equipment typically is used to provide voice prompts to users of various dial-up computer data bases. The largest use has been by financial institutions where customers call in for stock quotes, account balances, and other services selected by tone-keyed commands requested by voice prompts. Equipment for such applications can also be used for order entry by sales and marketing organizations.

Voice mail attracts. However, it is the voice store-and-forward (VSF) market that has attracted the most interest among both customers and vendors. Because the cost of memory and processing continues to drop, adding voice messaging to private telephone systems is becoming quite cost-effective. Recognizing the large market potential, big companies including AT&T, IBM, United Technologies Corp., ITT, and others are flocking to the telecommunications market offering not just VSF but complete communications systems [*Electronics*, March 10, 1983, p. 93].

This systems concept implies an integration of office functions. For VSF technology, such a move has big implications. Currently, most equipment is built around dedicated minicomputers as stand-alone add-ons to a customer's existing communications plant.

However, such a setup does not notify users when voice messages are waiting to be picked up. With a VSF system in a private automated branch exchange, notification lamps can be lit on the hand sets. One of the first such systems, from Rolm Corp., is described in the accompanying article. The major drawback of this approach is that users must commit themselves to a vendor not only for his VSF equipment but also to his PABX sourcing.

Currently American Telephone & Telegraph Co.'s deregulated unit, American Bell Inc. of Morristown, N. J., is offering a VSF option to its enhanced PABX. However, the equipment used is the audio distribution system from International Business Machines Corp., which IBM also markets as a stand-alone product. American Bell's recent disclosure of its next-generation business phone sets that attach to its PABX have features for messaging that seem to foreshadow upgraded capabilities such as voice mail.

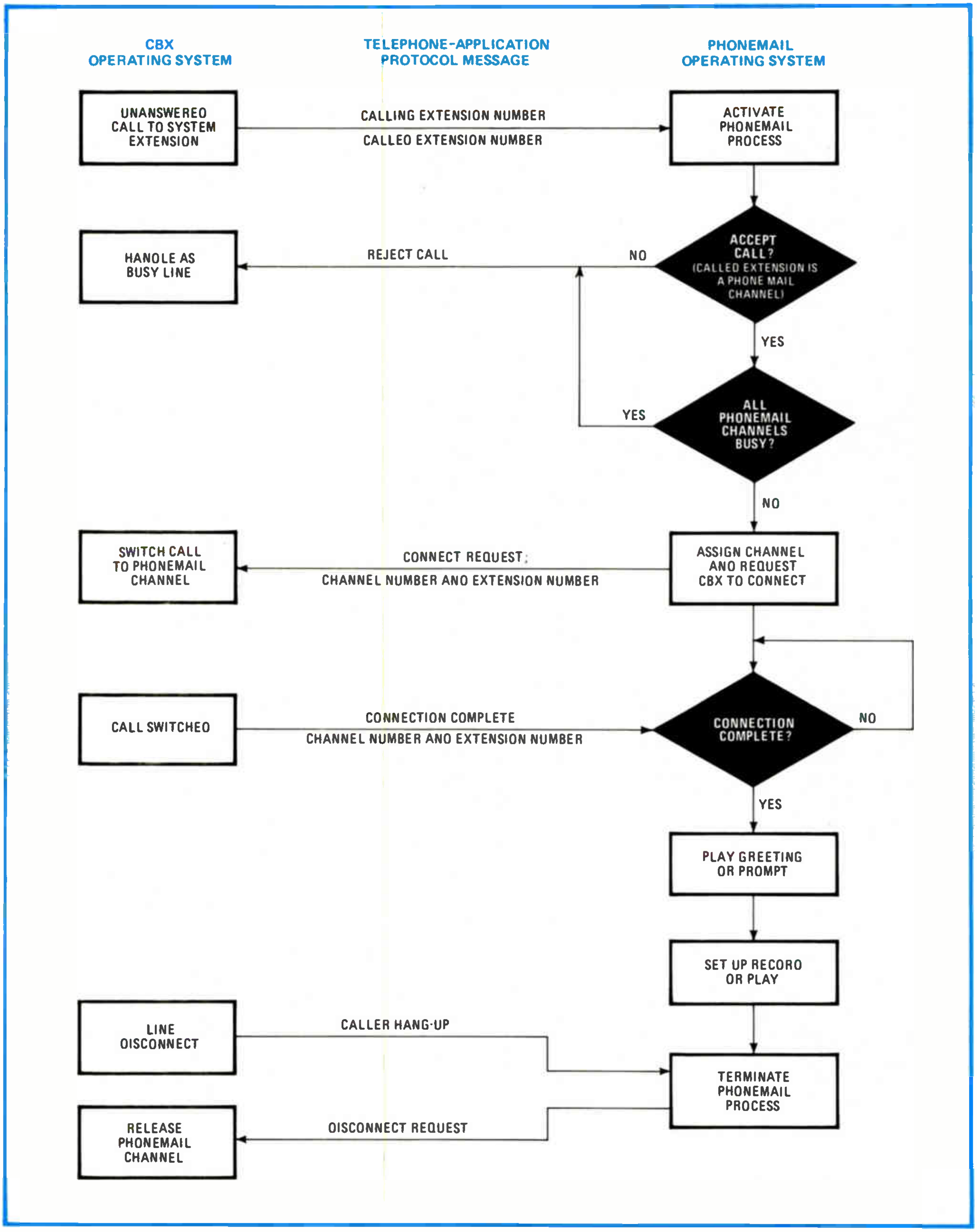
Also recognizing the need for signals at the user hand set, IBM has a cooperative agreement with Mitel Corp. for PABX switching technology that is expected to allow advanced voice-messaging features. Likewise, Digital Equipment Corp. has signed up with Northern Telecom Ltd. for development of a computer-to-PABX interface and also has announced a joint venture with Voicemail Inc. of Santa Clara, Calif., for VSF technology.

Even the simple messaging lamp on the hand set seems to be only an interim solution, because personal computers and work stations are beginning to absorb the phone itself [*Electronics*, June 30, 1982, p. 97]. Already this type of phone station is being offered by Northern Telecom, Basic Telecommunications Inc., and Tymshare Inc.; and at Bell Laboratories, an experimental device called the EPIC (executive planning, information, and communication) terminal is being tested. Moreover, two Californian start-up firms, Sydis Inc. and CXC Corp., are planning phone work stations that will offer many advanced voice features and will link with a number of computer systems.

Indeed, Bell Labs' Vishnu Atal, supervisor of the speech synthesis laboratory in Holmdel, N. J., predicts that the current systems using speech-digitization methods will soon disappear altogether. He expects that very large-scale integrated synthesizers will cut the price of advanced coding techniques like multiple-pulse linear predictive coding, in which the sound source is varied dynamically, thus outflanking standard LPC, which uses a set pitch pulse rate or white noise. Such an advance would mean bad times for closely coupled systems, because linking a VSF system to a particular branch-exchange architecture will make it very difficult to adapt to advances in speech coding technology without redesigning the PABX.

Leading the pack. In the current add-on VSF market, VMX Inc. of Richardson, Texas, is the leader, with IBM, Wang, and BBL Industries gaining fast. VMX was the first VSF vendor and holds a patent on the technology that it is currently defending in a suit against Commterm Inc. The outcome of this court case could have profound effects on the market, since nearly all vendors now use similar coding schemes, typically a form of digitization that cuts bit rates by coding the difference between successive samples as in continuously variable-slope delta modulation.

"I think the market is just now beginning to understand what voice messaging is," says Gordon Mathews, chairman of VMX and originator of the basic patent. "People are now aware of the difference between a telephone-answering machine and the capability of sending voice messages without ever calling the recipient." Mathews also believes that keeping VSF equipment separate from specific PABX architectures will prove popular because it grants a division manager the freedom to select the communications equipment he needs rather than comply with a corporate mandate. Also, free-standing systems can assure customers of transparent conversions to next-generation technology like multipulse LPC. –**Roger J. Godin**



3. Typical call procedure. Interaction with a person calling into the PhoneMail system is handled by the CBX as a regular call. However, instead of the user who would receive the call, the software responds and sends accept, reject, and connection requests to the CBX.

access to the application processor's resources.

In terms of the PhoneMail software, a voice channel can be viewed as a connection set up between the time-division–multiplexed bus of the CBX and a voice data file in mass storage addressed by the application processor. This connection is half-duplex, so on a particular channel at a particular time it is possible to be either recording or playing back but not to be doing both simultaneously.

The number of voice channels available is limited to 8 or 16 by the voice-processing cards in the CBX. Allocation of the channels is accomplished with an open command. If the request is valid and a channel is available, a channel identification including the channel number and a backplane position verification number will be returned in an open response message. This ID is used for all further access to the channel.

To identify a particular channel, the command-and-prompt handler must use the complete channel ID in messages to the voice channel protocol handler. Channel ID values are temporary and exist only for a particular connection between an incoming call and a valid Voice-Mail-user extension. When a channel is closed the ID is discarded and will no longer be recognized. By sharing the voice channels this way, up to 800 users can be on a 16-channel system.

A connect command explicitly associates a file with a channel. An explicit connection permits various complex record and playback functions, such as playback from a message pointer, playback of a portion of a message, playback of entire messages, and override recording. A temporary implicit association exists when the command to "execute/playback" a message is accepted. Only one explicit association can exist at a time, but an implicit association may exist temporarily while an explicit association is idle. A disconnect message is used to dissolve an explicit association. If the user enters any data on the telephone keypad, data messages will also be received.

In a typical PhoneMail application (Fig. 3), the command-and-prompt handler logs on to the voice-channel protocol handler. If a voice channel is available and the channel ID is valid, the VCPH allocates a voice channel by requesting a telephone connection from the CBX over the TAP. The CBX then services the request by making a connection between the calling party to the VCP. The caller then is prompted by the VCPH to record or play a message. When the message is complete, the caller hangs up—thereby generating a completion message to the VCPH—the CBX disconnects the phone line and frees the PhoneMail channel, and the VCPH logs off the application.

Voice file cabinet

The voice-file system structure and access methods of PhoneMail determine how messages are stored and accessed in the system. A voice file can be either a single message or a set of vocabulary words. Vocabulary files are a special case and typically can only be read by the user. Such vocabularies may be used to add the time of a call to an incoming voice message.

Each voice file has associated with it a voice header record containing general information about the nature of the file. The contents of the voice header record are determined when the file is created and may later be examined or modified by the user. The voice header record contains pointers to a doubly linked list of voice index records. Each index record contains pointers to, and information about, the number of voice data blocks in a particular stored message. □

Making the most of the phone

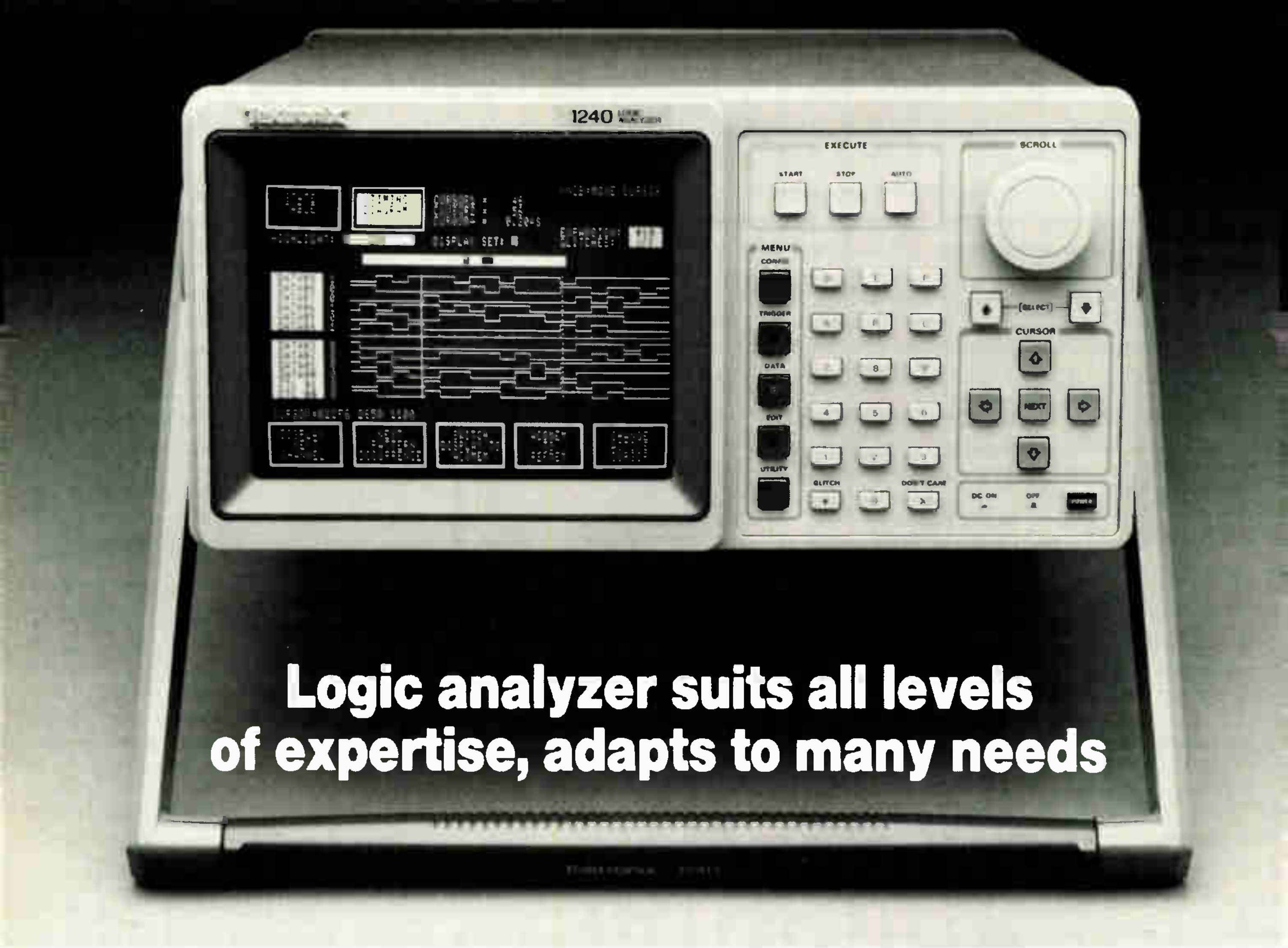
The difference between electronic mail and a voice store-and-forward message system such as PhoneMail is that the telephone is used as a terminal and the human voice, instead of typed words, conveys the message. The basic elements of a voice store-and-forward system are the capabilities of digitizing analog speech, compressing the digitized speech, and storing it on mass-storage device for later retrieval.

In operation, users are assigned what is termed a voice mailbox, an identification number, and an access code. To use the system, a user dials its extension and logs on. He or she can then listen for messages, save and delete them, answer and forward them, or even record messages to be sent to others. All PhoneMail commands are entered from the keypad of any tone-keyed phone with verbal prompts to guide users through all feature—though these can be overriden by someone who is familiar with the system.

The system's ability to answer calls is unique to voice store-and-forward systems in two ways. First, the CBX will allow even nonsubscribers of PhoneMail to access it directly without operator assistance and screening. Second, the system eliminates the frustration of not being able to reach the person who can take a message. In other systems currently available, a caller must first dial the intended extension. When the phone is not answered, a second extension must then be dialed in order to access an answering attendant.

The system's message-notification function is also unique because it is based on the CBX's ability to pass information on to both the calling and called parties' extensions. If the system is used with Rolm phones, the CBX notifies a user that messages have been received by relaying a special dial tone or by automatically lighting the message lamp, or both.

Other voice store-and-forward systems available today are stand-alone systems not integrated into the telephone switch, so message notification must be done through a separately wired message light or through an operator who routes the call to the correct mailbox, which requires users to call in to find if any messages are waiting.



Logic analyzer suits all levels of expertise, adapts to many needs

Touch-sensitive screen and display-scrolling knob ease use of unit that analyzes dual–time-base data and balances channel against memory needs

by Doug Boyce and Dave Moser, *Tektronix Inc., Beaverton, Ore.*

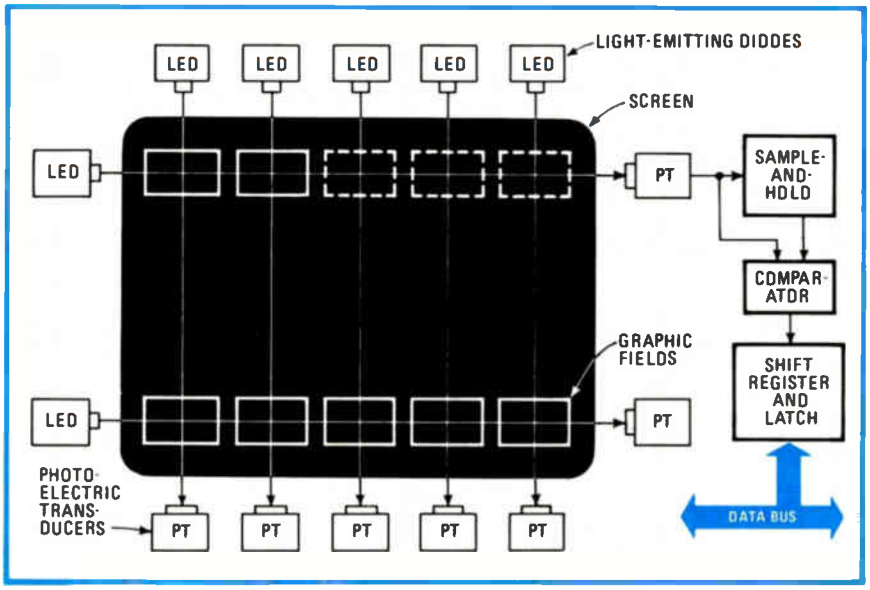
□ The spread of digital systems has forced a rapid but somewhat fragmented evolution of the logic analyzer, the oscilloscope of the digital world. There are the expensive analyzers aimed at knowledgeable users willing to undergo a lot of training, and there are inexpensive ones whose long-winded ease of use irks the experienced user. Worse yet, the latter instruments often prove inadequate to deal with those complex problems that can arise at any phase of a digital system's life cycle. Also, some analyzers focus on just software debugging, while others tackle hardware development alone.

In the design of the 1240 logic analyzer shown above, the objective was an instrument that would be easy for operators with different levels of experience to use, would cover a broad base of applications, and would adapt readily to any working environment. As a result, the 1240 has a touch-sensitive screen that streamlines test selection, as well as a rotating knob that scrolls the display directly. It can acquire and correlate data paced by two different clocks, and plug-in boards enable it to match the channel and memory requirements of very different applications.

To make the 1240 available to users of very varying degrees of skill, its man-machine interface had to present the clearest possible picture of all the instrument's functions and the simplest possible access to them. The first characteristic would enable an inexperienced or infrequent user to understand and use those functions quickly, while the second would allow the experienced user to configure the instrument in a few keystrokes instead of having to run through a lengthy programming process.

A menu-driven operating system coupled with a proprietary touch-sensitive display was considered ideal for both purposes, not least because it reduced the number of keys needed on the keyboard. With the touch-sensitive display, menu selections could be presented as labeled rectangular graphic fields right on the screen. Then, by simply touching a certain field area on the screen, the

1. Light touch. Ordering up a menu for the 1240 can be done with the touch screen, shown in the schematic at right for one LED–photoelectric-transducer pair. The comparator detects a touch by checking the present transducer output against the prior one.



user could access any menu instantly, no matter how familiar he or she was with the instrument.

For the touch-sensitive display, a series of infrared beams is created by pairs of light-emitting diodes and photoelectric transducers that form a matrix across the top and bottom portions of the screen (Fig. 1). The crossing point of these beams is the center of an area where the software can display a box labeled with a menu selection. Each point is scanned every 4 milliseconds, and each scan cycle consists of two phases. During the first phase, the transducer output is sampled with the LED beam turned off; this gives a measurement of ambient light. In the second phase, the output is measured with the beam turned on.

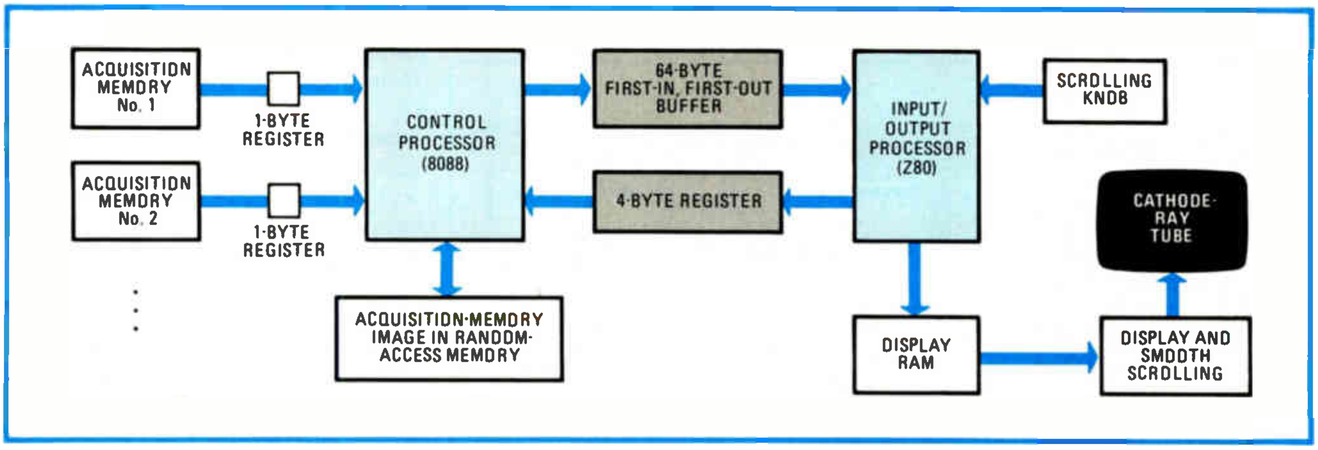
The LED-on measurement is checked against the LED-off reading in a comparator circuit. If the beam path has been broken, the comparator's output will be low for that scan cycle; an unbroken beam will generate a high value. This digital information is loaded into a shift register and latch, which accumulates a data byte whose individual bits represent the status of each menu-selection point. This byte is then read by the software to determine if a menu has been selected, and if so, which one.

Maximizing the use of these on-screen fields minimizes the number of keys needed on the keyboard, simplifying operation. It was therefore necessary that the menu system present logical pathways to various instrument functions. To this end, the system was organized in a hierarchical fashion, with the five major menu choices—config(ure), trigger, data, edit, and utility—implemented as hard keys on the front panel. Choosing one of these calls a set of major submenus. For example, if the user touched the data menu's key, the display would produce the state-table menu plus a selection field for the timing-diagram menu.

Each of the submenus uses the on-screen selection fields to perform certain operations unique to that display. For instance, the state-table menu has fields for choosing which data to highlight in bold, for switching the display to the memory holding acquired data or reference memory, and for changing which of two cursors is active. Not only does this scheme eliminate a confusing array of push buttons, but it also presents choices in those displays to which they are germane, again making the operator more efficient.

In the course of defining the 1240's architecture, it was noted that further improvements in control of the acquired-data display would be highly desirable. Chief among these improvements was the ability to scroll smoothly through both vertical state tables and horizontal timing diagrams.

Conventional logic analyzers are usually scrolled by depressing a key that updates the display on a character-by-character basis. In the process, a discontinous, flickering image is produced that most users find annoying. A



2. Rolling conversation. Two processors are involved in getting measured information onto the screen of the analyzer. The input/output processor also interprets the motion of the scrolling knob to get data from the other for display, which can thus be scrolled up or down very easily.

desirable alternative would be to update the data display one picture element at time for a flicker-free effect.

The smoothest way of scrolling is to rotate a knob that scrolls the display directly. From an architectural standpoint, this means the knob's rotation has to be expressed through a dedicated register that is read by the central processing unit and is employed to drive algorithms that update the display memory.

The processing overhead added by this scheme is considerable, especially in addition to the other menu-ing functions. So a dual-processor architecture was adopted in which the data-acquisition tasks are handled by a control processor and the display and scrolling tasks are handled by an input/output processor (Fig. 2).

The control processor, an 8088, reads data from the high-speed acquisition memories through a 1-byte register and stores its acquisition-image memory. The I/O processor, a Z80, builds the image to be displayed in its random-access memory from which it is read by hard-wired circuitry for video display and scrolling.

During execution, the I/O processor translates the knob position into a 4-byte word that it sends to the control processor; the control processor then sends new data to the I/O processor so that the latter can build an updated display in its random-access memory.

However, this scheme creates an unbalanced communication between the two processors, which can be expensive in terms of processor overhead. That is, the I/O processor occasionally sends just 4 bytes to the control processor, which reciprocates overwhelmingly with all the acquisition data for an entire display image. To balance the communication, the architecture was rounded out by inserting a 64-byte first-in, first-out memory to buffer the data passing between the two processors.

Just as optimizing communications makes the instrument more efficient, providing an optimized clocking scheme for data acquisition makes the user more efficient. Therefore the 1240 provides the unique feature of split acquisition of measurement data.

3. Time and again. To coordinate the data collected during a test session, this menu allows the user to set up two separate time bases. In this case, time base T_1 is set to capture asynchronous data with 100-ns resolution, while T_2 will demultiplex bus data.

Split acquisition refers to the ability to acquire data using two separate time bases both concurrently and in a correlated fashion. It is very handy for the many contemporary systems that have dual-processor configurations—for example, a system with two asynchronous processors that communicate through a dual-ported RAM, which is a common architecture of, for example, terminals.

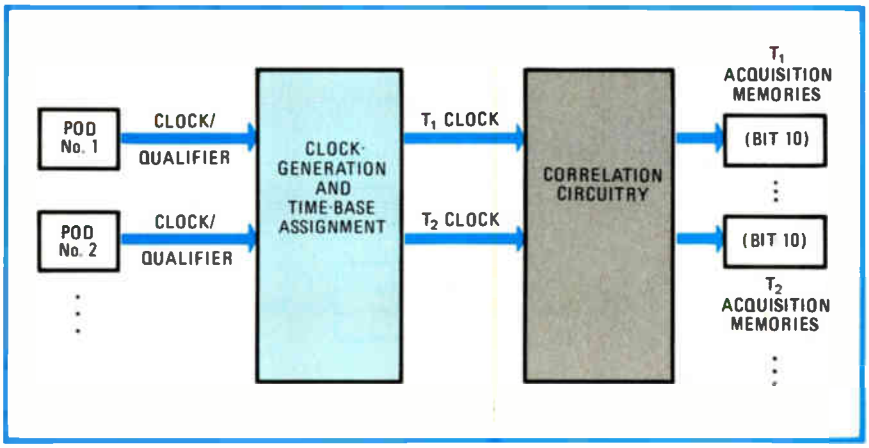
With single-time-base analyzers, the analysis of real-time communications between two processors requires one of two cumbersome operations. Either the user must acquire the two processors' data asynchronously and then wade through a large mass of data to find pertinent information, or he or she must try to synthesize a common clock, which may be difficult or impossible.

As a simpler, and hence more productive, solution, the 1240 allows concurrent acquisition of data using two time bases. Furthermore, triggers may be defined on the 1240 using information from both time bases, and displays of the resulting data may be aligned with respect to time of occurrence.

For this mode of operation, the 1240 provides a menu for setting up the two time bases, T_1 and T_2. As shown in Fig. 3, sampling channels clocked by time base T_1 are set to sample asynchronously every 100 nanoseconds and their triggering is qualified by logically ANDing clock qualifier lines of pods 4 and 5, whose logical values are set to 1 and 0 respectively. Time base T_2 is set to operate in a split, or demultiplexed, mode, where the first clock with its clock channel combinations and qualifiers must be recognized and its data sampled before the last clock is eligible for sampling.

With this arrangement, the channels associated with time base T_2 can easily acquire data from a multiplexed bus, while those of T_1 asynchronously acquire control states from the same system. Many such synchronous and asynchronous and split combinations are possible between the two time bases.

Design of the dual–time-base scheme presented a number of chal-



4. Clock assignment. Using the clock-generation and -correlation circuitry at left, timing information is stored as a tenth bit along with acquired data. This permits data taken using two different time bases to be correlated even if the channel speeds are the same.

Test-driving the 1240 logic analyzer

Combining dual–time-base acquisition and multilevel triggering makes some very powerful data-acquisition techniques possible to the 1240. Consider an application in which a microprocessor writes to a parallel device through a peripheral controller. Suppose that, during the writing of record, data byte $20H_{16}$ is incorrectly written to the device.

Further, suppose that the command sequence for initiating a write to the device is command character 02_{16}, followed by two command bytes, 34_{16} and 20_{16}, and that at the end of the record the byte $0A_{16}$ is written. Also, each time the processor initiates a write through the peripheral controller, a device-select line to the controller goes high.

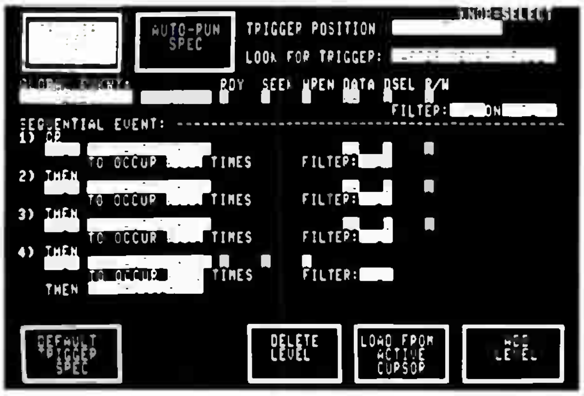
On the asynchronous side of the controller, it is suspected that the problem stems from the timing of three control lines: RDY, SEEK, and WREN. If, during the writing of a record, WREN goes high while SEEK and READY are still high, a write error occurs.

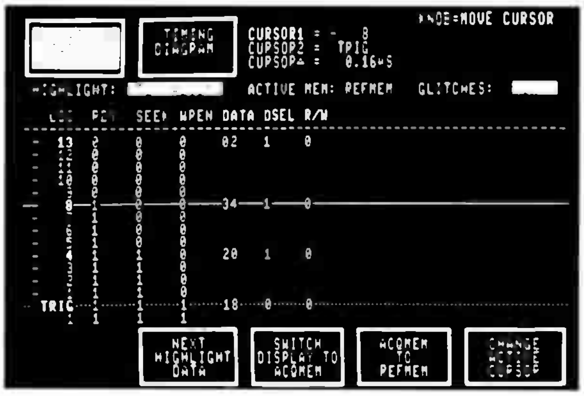
To see if this is the problem, data-acquisition channels connected to the central processing unit's data bus are assigned to time base T_2, which runs synchronously off the system clock. Also, the probe channels hooked to the device select (DSEL) and read-write (R/W) lines on the CPU control bus are assigned to timebase T_2. The probe channels connected to the RDY, SEEK, and WREN lines on the peripheral controller are assigned to time base T_1, which is set to sample asynchronously every 10 nanoseconds.

This is more easily done than said using the 1240's trigger menu (see below left). Here, a global event recognizer has been defined to reset the entire trigger any time the end of the record ($0A_{16}$) is written without the sequential trigger events occurring, so the test can run until the fault occurs.

The sequential trigger in this menu has its first three levels assigned to T_2, with each of these levels active only when the peripheral controller has been selected (DSEL line at 1) and written to by the CPU (R/W line at 0). These levels search for the command character (02_{16}) followed by the command bytes (34_{16} and 20_{16}). If all these conditions are met, the trigger falls through to the fourth level, which is assigned to T_1 and monitors the device control lines. If this level detects RDY, SEEK, and WREN high at the same time, then the trigger is activated.

The data acquired using this triggering scheme is displayed with both the T_1 and T_2 time-base data time aligned (see below right). The gaps in the T_2 synchronous columns (DATA, DSEL, and R/W) represent the difference in sample speeds between the T_1 and T_2 time bases. In these columns, the command character (02_{16}) and bytes (34_{16}, 20_{16}) leading up to the trigger event. A look at the corresponding T_1 asynchronous columns at the TRIG location shows that, indeed, both SEEK and WREN were high at the same time, causing an erroneous write to the peripheral device while it was deselected (DSEL line at 0).





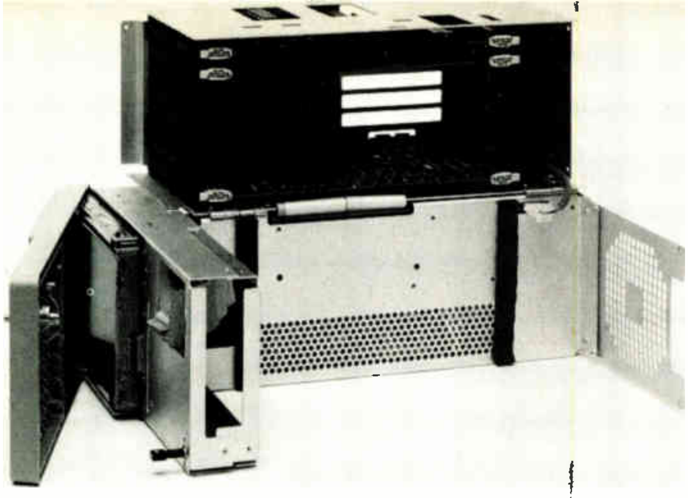
lenges. One of the most interesting was establishing and maintaining a timing relationship between data acquired from each time base so it could subsequently be displayed on the screen in a time-aligned manner.

In the DAS 9100 and other previous logic analyzers, the relationships between concurrent low- and high-speed acquisitions were preserved by storing slow clock transitions as part of the high-speed acquisition data and using the clock-transition information as a reference to construct a time-aligned data display.

This approach essentially gives a one-way correlation between the two data sets; only the high-speed data contains information correlating it with the low-speed data. However, the 1240 is aimed at a broader set of cases, including paired high-speed, synchronized, acquisitions. For the 1240, therefore, a one-way correlation would not guarantee that timing relationships were valid.

This difficulty was overcome with a unique combination of hardware and software. In the 1240's hardware (Fig. 4), each probe pod contains (in addition to the nine data channels) a clock-qualifier line that is passed through special circuitry to define the two clocks and assign them to the appropriate acquisition memories. After passing through special correlation circuitry, the clock data is stored as a tenth bit in its respective acquisition memory along with data from the nine channels.

The value assigned to the correlation bit establishes the two-way timing relationship between the two data sets. The correlation bit of a data word in one time base is given a value of 1 if data was stored in the opposite time



5. Flip-top box. For access to channel cards, the 1240's card cage flips up as above; pods plug into the open slots, seen at the cage's back, when the cage is flipped down. This design allows the high-speed bus to be next to the pod inputs, preventing timing degradation.

base in the interval since data was last stored in its time base. Conversely, the correlation bit is assigned a value of 0 if data has not been stored in the opposite time base in the interim.

A software routine uses this information and the memory address to align the data on the instrument's display. It is worth noting that this scheme can be extended to multiple time bases; a 2-bit correlation word would allow three time bases to be correlated, and so on.

Trigger capability

Along with dual-time-base acquisition, research also indicated that users would like considerable depth and flexibility in triggering, even though simple trigger combinations involving one or two word recognizers cover most situations. More powerful triggering is on occasion absolutely required to solve a problem. Fulfilling this need was consistent with the 1240 design goal of maximum flexibility within the bounds of reasonable cost.

The optimum approach turned out to be a trigger system based on two event recognizers, one global and one sequential. The global-event recognizer is set to true any time the specified event occurs during data sampling. It can then initiate a wide range of actions, such as triggering or resetting the instrument. It can also start a counter-timer or duration filter, each with 10-ns resolution.

The sequential-event recognizer can be set to trace program flow or high-speed timing sequences. This recognizer will support up to 14 events, or levels, in its sequence. Each level has its own duration filter and iteration counter and can initiate one of several actions, including a trigger, reset, delay, or jump to another level.

The triggering capability and dual time bases of the 1240 make it a logic analyzer that can tackle complex debugging tasks simply (see "Test-driving the 1240 logic analyzer," p. 147). But even this flexibility is not enough for the wide range of common applications at which the unit is aimed. Consequently, the designers also took on the three-headed dog of logic analysis—width, depth, and sample rate.

For logic analyzer designers, and therefor for users, the classic tradeoff has always been among the number of acquisition channels provided (usually referred to as the data width), the depth of memory behind each channel, and the analyzer's maximum sample rate. Unfortunately, deciding on a single width, depth, and sample-rate combination necessarily limits the range of applications that a logic analyzer can address.

To broaden the range of the 1240, several of its features make it easy to reconfigure its acquisition hardware. One such feature is modularity. The 1240 mainframe currently accepts two different card types: the 9-data-channel 1240D1, which operates asynchronously up to 100 megahertz and synchronously up to 50 MHz with glitch capture and triggering, and the 18-channel 1240D2, which acquires data synchronously or asynchronously up to 50 MHz with demultiplexing capability. Up to four cards of either type can reside in the analyzer.

To further increase flexibility in the data-acquisition hardware, the 1240 allows the memories on the acquisition cards to be chained together using the instrument's menu-driven display and keyboard. Thus many width, depth, and sample-rate combinations are possible even without adding or removing cards.

If no special arrangements are specified, memory depth for the acquisition cards is 512 bits/channel. But the memory depth of a channel can be expanded to 2,048 bits by chaining the memories of up to four cards; the tradeoff of channels against memory depth is in the hands of the user, not the instrument designer. For example, if the instrument contained four 18-channel cards, its default setting would be 72 channels with a memory depth of 512 bits. Through chaining, the user can easily reconfigure the analyzer to 36 channels with 1,024 bits or 18 channels with 2,048 bits.

To implement the chaining feature, a unique mechanical design satisfies the need for both high-speed data acquisition and access to the acquisition cards for service. Electronically, chaining is accomplished by use of a high-speed data bus between the acquisition circuitry and memory. The bus permits incoming data to be stored in the high-speed memory of any acquisition card.

A conventional acquisition card layout (with backplane bus interface on one edge and probe connections on the opposite edge) was considered, but in such a design the high-speed data paths would have been physically too long, so that there would have been unacceptable propagation delays. Therefore, a special, hinged card cage (Fig. 5) was designed so that the board's probe connector is in close proximity to the bus lines.

At the same time, this design allows all the cards to be accessed easily when the hinged card cage is swung open. It also permits probe connections to be located on the side of the instrument, which most users consider to be the optimum location, rather than at the rear of the analyzer, which is more typical.

To conform to the overall product goal of maximum environmental adaptability, a modular approach to external computer communications was taken. This resulted in the development of what is called a COMM pack. This module, about the size of a video-game cartridge, plugs into the back of the instrument and configures it for a particular communications environment. Initially, both RS-232 and General-Purpose Interface Bus (IEEE-488) COMM packs are available. □

Counter eases frequency and phase measurements

by Naveen Tangri and Jerry Bauer
American Microsystems Inc., Santa Clara, Calif.

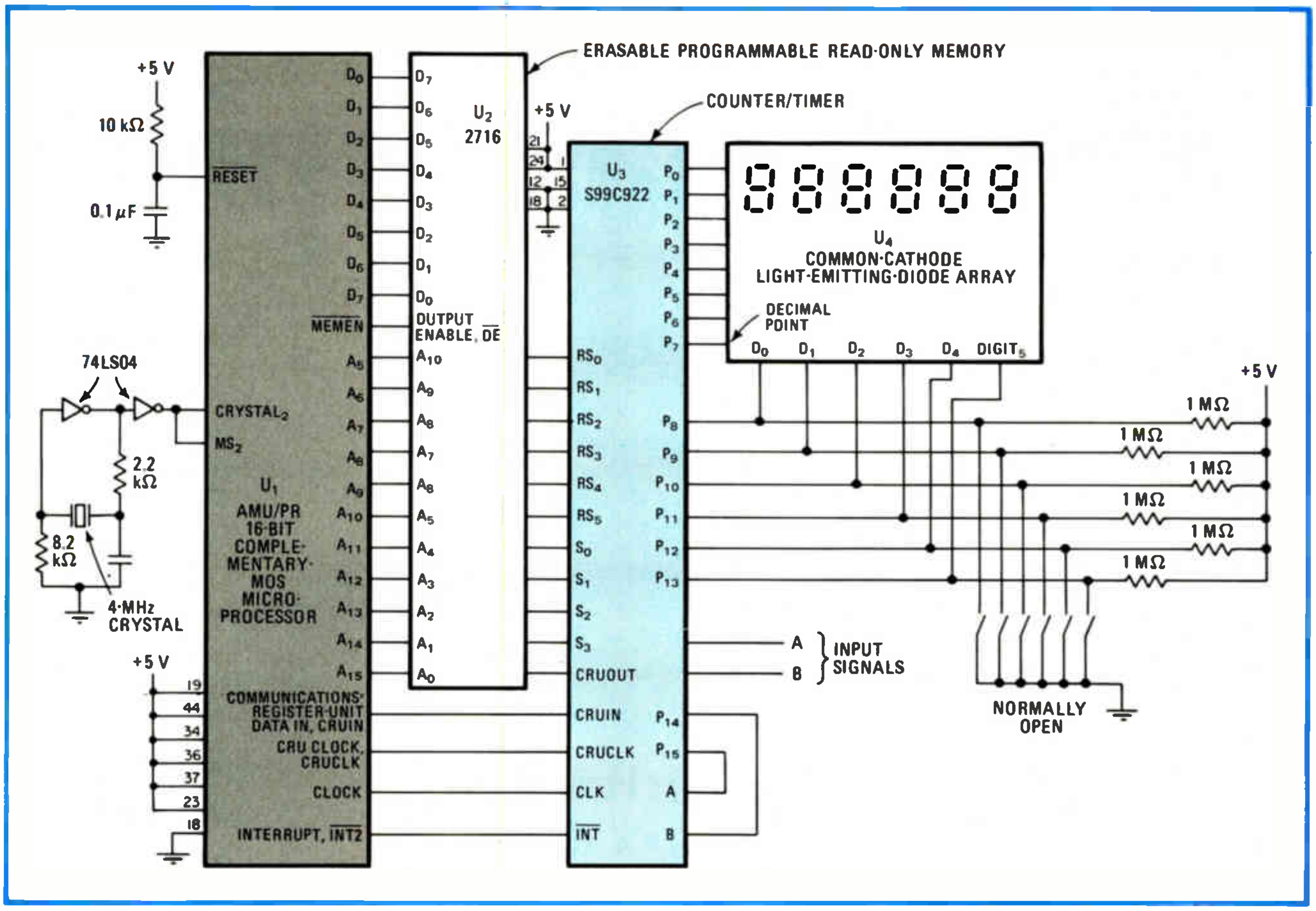
The external edge-detection and gating circuitry that is usually required for frequency and phase measurements is substantially reduced with this design. In addition, it offers the convenience of measuring both the frequency and phase of two signals applied to the two inputs of counter S99C922, which can be programmed in eight different counting modes. Battery-powered instruments may find this counter particularly useful because it is implemented with complementary-MOS devices.

Erasable programmable read-only memory U_2 contains the algorithm that programs counter U_3, which counts the number of prescaled clock cycles while input signal A is high. The counter then measures the time that signal A is low. American Microsystem Inc.'s AMU/PR microprocessor sums these two measurements and calculates the period of waveform A and its duty cycle. Following this sequence, the processor calculates the reciprocal of the period to determine the frequency of A. Similar operations are also performed for signal B.

If the measured frequencies for signals A and B are the same, the microprocessor then calculates the phase difference between the two input signals. To measure the phase difference, counter U_3 is programmed to count the number of prescaled clock cycles between the rising edges of A and B.

Some input/output ports of the counter are used for driving the display and scanning the keyboard. In additon, the measurements of duty cycle, frequency, frequency difference, and phase difference are mutually independent. □

Designer's casebook is a regular feature in Electronics. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $75 for each item published.



Meter. Using AMI's 16-bit complementary-MOS microprocessor AMU/PR, erasable programmable read-only memory 2716, and counter-timer S99C922, this instrument circuit measures both the frequency and phase of the input signal. The upper limit on frequency and duty cycle is set by the time required for microprocessor U_1 to load the counter's control register when the selected input signal is low. The 4-megahertz crystal and associated circuitry provide a system clock of 2 MHz. The all-C-MOS implementation makes it attractive for battery-powered applications.

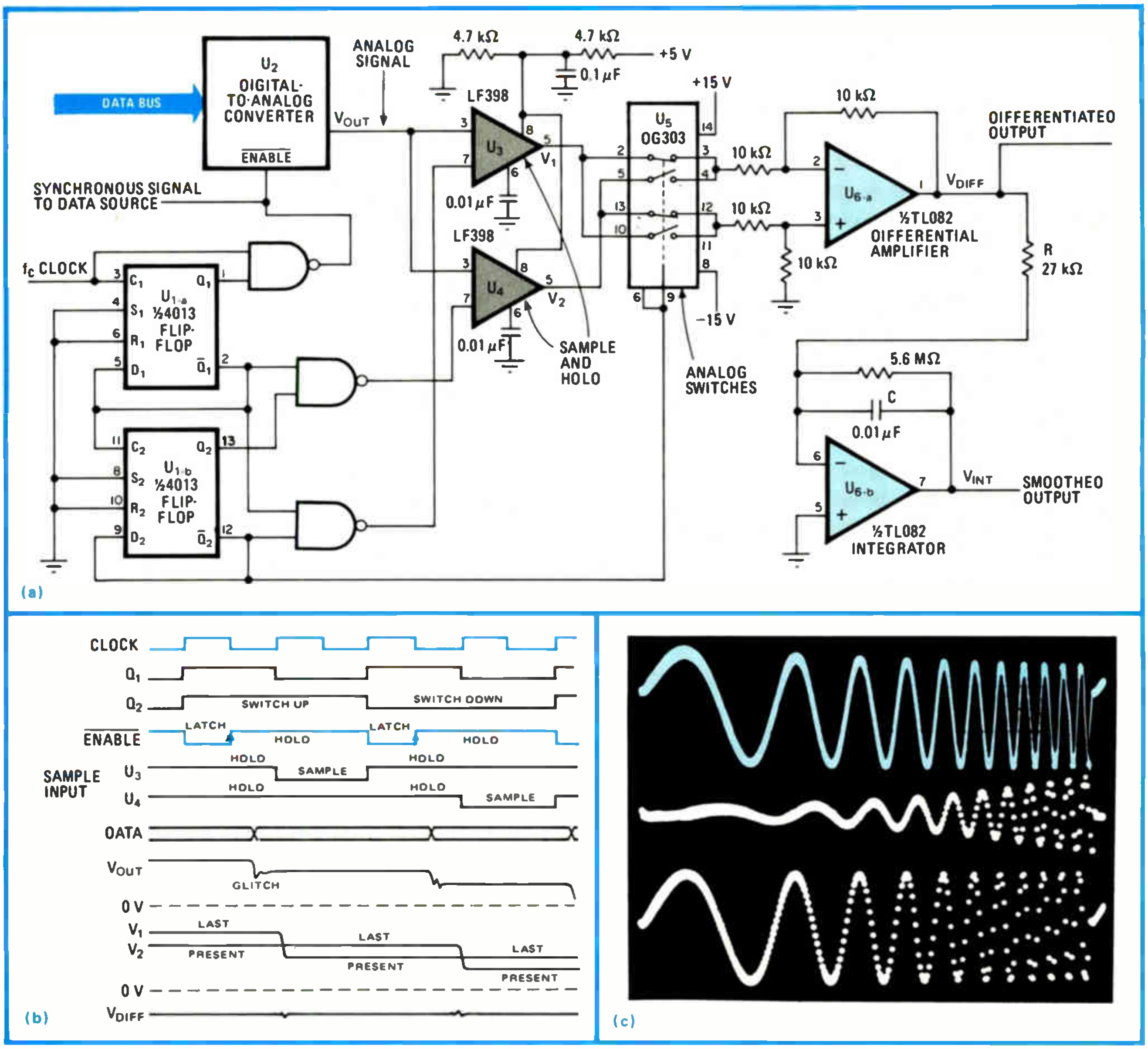
Deglitcher circuit refines d-a–converter output

by Steve Kirby
York Electronics Center, University of York, York, England

The output of a digital-to-analog converter is often distorted and requires filtering. This deglitcher-differentiator design suppresses unwanted pulses and thus smooths a d-a–converter's output. Alternatively, the circuit offers an efficient means of differentiating low-frequency analog signals, an improvement over a previous circuit [*Electronics,* Jan. 27, 1983, p. 112].

Successive d-a–converter outputs or continuous analog signals are alternately sampled by sample-and-hold circuits U_3 and U_4 at half the clock's frequency (a). D-type flip-flop $U_{1\text{-}b}$ stretches the pulses supplied by flip-flop $U_{1\text{-}a}$ by one clock cycle and directs them to the sample inputs of U_3 and U_4 while latching data into converter U_2 on the rising edge of every second clock cycle (b). A synchronizing signal generated by $U_{1\text{-}a}$ informs the data source that new data must be loaded once it goes high.

To allow glitches to settle, U_3 and U_4 sample the d-a–converter output a half clock cycle after new data is latched in. U_3 and U_4 alternately hold the current and preceding outputs while analog switch U_5 sends the inputs to the differential amplifier $U_{6\text{-}a}$ in sync with the sampling frequency. Thus the differential-amplifier output (V_{diff}) becomes ($V_{present}$–V_{last}). This output is integrated



Polished. This linear interpolator-differentiator circuit (a) samples, differentiates, and integrates the analog output of a d-a converter to provide a smooth digital-to-analog–converter output. The sample-and-hold circuits U_3 and U_4 sample the d-a–converter output at a sampling frequency of $f_c/2$ and feed the differential amplifier $U_{6\text{-}a}$ through analog switch U_5. The differential output (b) is further integrated to obtain a smooth output. The oscilloscope photo (c) shows the response of an exponentially swept sine wave, the smooth output being shown at the top.

to obtain a smooth analog output V_{int}, which is a linear interpolation between successive converter outputs. The RC time constant is adjusted to make the output equal in amplitude to the converter's output. The photo (c) shows the circuit's response to an exponentially swept sine wave. The top wave is a smooth output, the next one represents a differential output, and the last response is the output of the d-a converter. □

Thermistor controls heater precisely

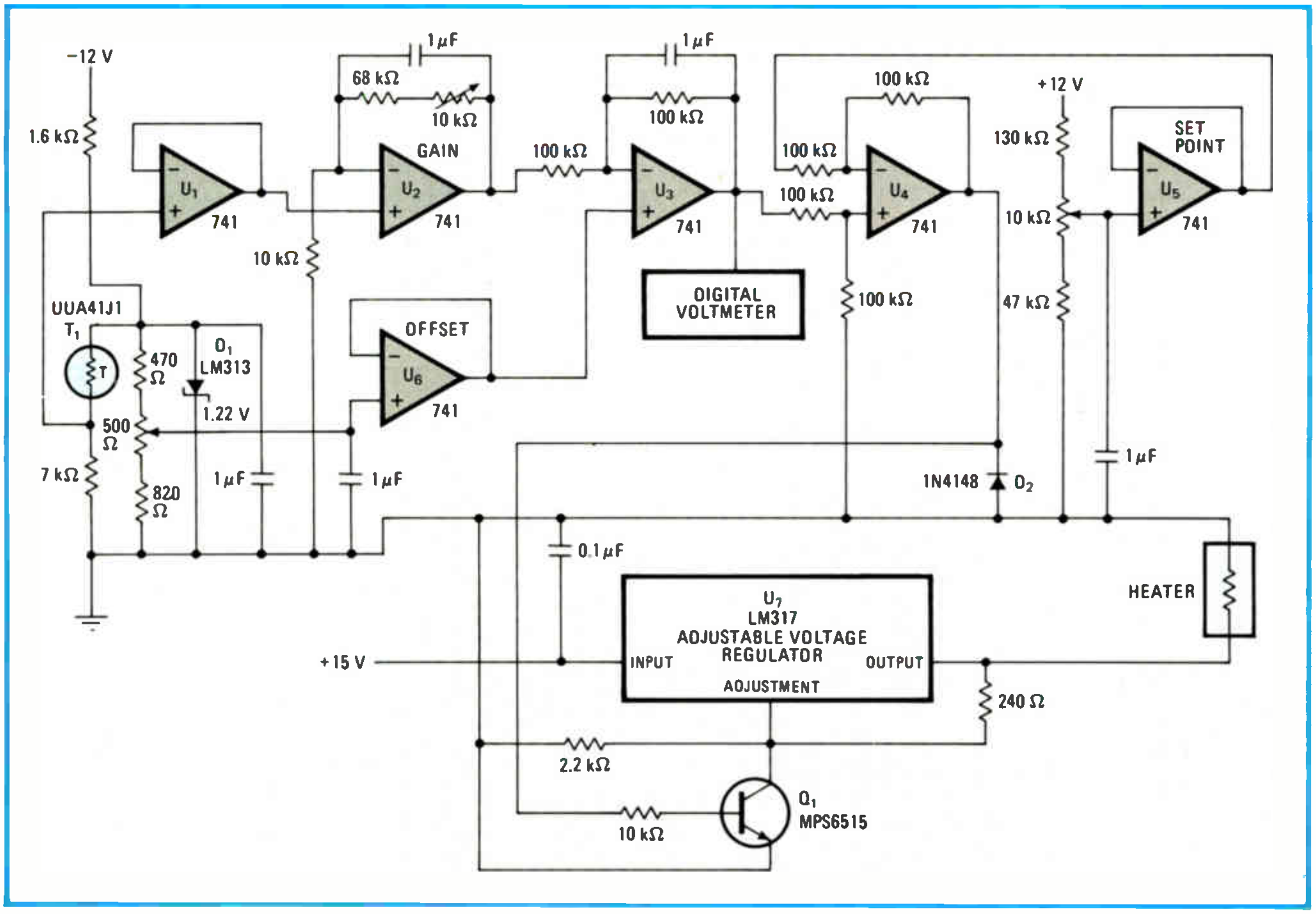
by C. J. Garland and T. G. Barnett
London Hospital Medical College, London, England

Many physiological experiments require heating systems that can operate with an accuracy of ±0.2°C over a small temperature range and deliver an output greater than 15 watts. This simple, inexpensive heater uses an interchangeable thermistor, a voltage-adjustable regulator, six common operational amplifiers, and a few discrete components to provide a maximum power output of 18 W over a temperature range of 37° to 42°C. In addition, the heater is accurate to within 0.1°C.

To ensure high regulation and stability, thermistor T_1 is connected in a half-bridge configuration to a supply of 1.22 volts that is derived from reference diode D_1 (see figure). The voltage across the 7-kilohm resistor, which is part of the temperature-sensing network, rises in proportion to the heat sensed by the thermistor. This voltage is then amplified by operational amplifier U_2 whose gain is adjusted so that the circuit provides an output of 100 millivolts/°C. Op amp U_1 serves as a buffer while U_6 supplies the necessary offset and allows a direct reading from the digital voltmeter in degrees Celsius.

The circuit is calibrated in degrees Celsius by replacing thermistor T_1 with a decade resistance box and simulating temperature values by substituting resistance values that are listed on the thermistor's data sheet. In addition, amplifiers U_4 and U_5, voltage regulator U_7, and transistor Q_1 provide proportional control for the heater.

Because Q_1 is turned on gradually by the switching action of difference amplifier U_4, adjustable voltage regulator U_7 generates a proportional output for the heating element. It is composed of a wire having a value greater than 8 ohms. For stability and accuracy, the 12-V supply must be well-regulated and the adjustable regulator mounted on an adequate heat sink. □



Thermistor heat. A simple, low-cost thermistor-controlled dc heater is constructed using thermistor UUA41J1, voltage regulator LM317, six 741 op amps, and a handful of discrete components. The heater is accurate to within 0.1°C and gives a maximum power output of 18 watts over the temperature range of 37° to 42°C. The output of op amp U_3 is calibrated in degrees Celsius with the aid of a 20-V digital voltmeter.

Batch-made packages hold dense ICs, save space, survive tough environments

Mass production lowers cost; materials and processes used yield a compact, highly reliable, and readily repairable package

by Robert Lomerson, *General Dynamics Corp., Fort Worth, Texas*

☐ Today's avionic, missile, and aerospace electronic systems require a high-density, hermetically sealed integrated-circuit package that can be reliably attached to the surface of a conventional printed-circuit board and that can survive the hostile environment found in these applications. Units like the dual in-line package, the flatpack, and the leadless ceramic chip-carrier are ill-matched with these needs, and so a long-term development program has produced a new type of package that pares size and weight, boosts system reliability and repairability, and reduces pc-board complexity.

So far the program has resulted in two different high-density packages, the earlier Versipak and the more recent Isopak[1], both hermetically sealed, leaded units made by matrix, or batch, processing. The matrix technique is based on the stepping and repeating of a package pattern across a panel of Kovar, a metal alloy with a temperature coefficient matching that of glass. The result is an array of packages that can be processed, assembled, tested, and burned in as a unit. This mass handling lowers costs and increases reliability.

Both of the leaded package versions can be readily and reliably attached to standard pc boards. In addition, Versipaks butt-soldered to pc boards have withstood 1,060 cycles of thermal shock over a −135° to +174°C range.

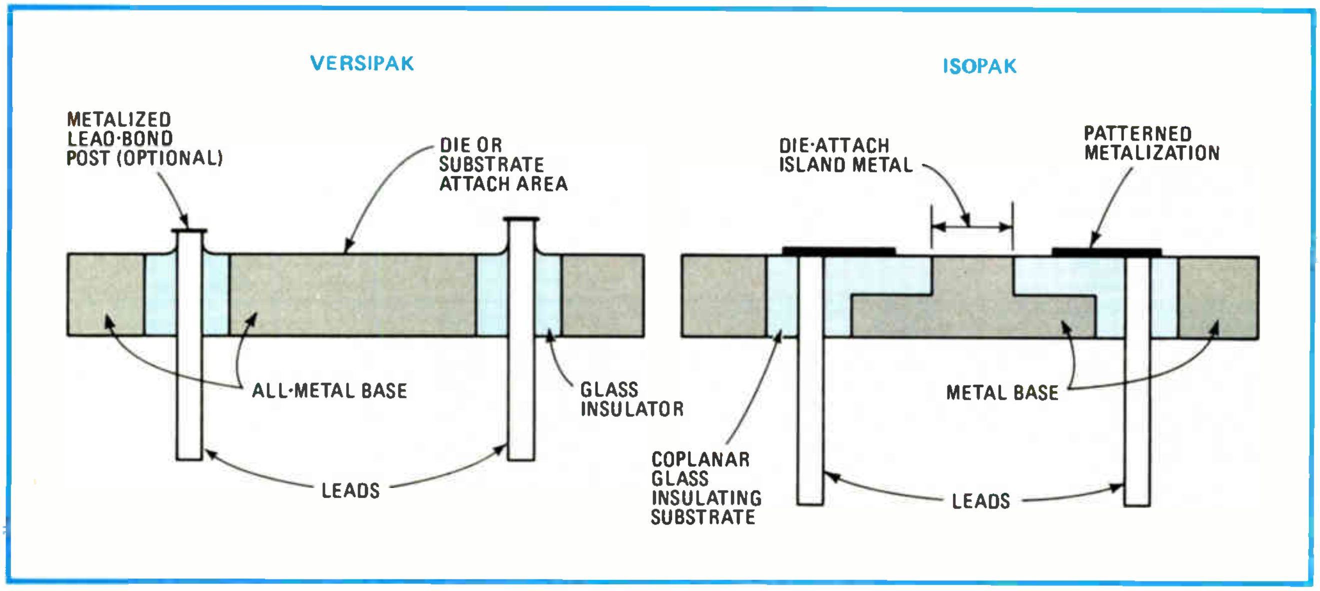
When the program began, the main competition for these applications was the ceramic DIP and the ceramic flatpack, with the leadless ceramic chip-carrier coming into prominence later. Each of these package types has its own set of drawbacks.

The competition

The ceramic DIP is limited as to the maximum number of pins it can support, which excludes its use with the dense ICs that very large-scale integration makes possible. Also, it has questionable reliability, is generally about 600 times the volume of the average IC, and requires accurately positioned through-holes for mounting.

The package size and height (0.75 by 0.30 by 0.15 inch) in itself is wasteful of space, encourages big pc boards, and requires a complex and often ineffective heat-sinking arrangement. What's more, the DIP format requires a pc board with through-holes on repeating centers, so any package with a sizable number of leads

[1]The author received a patent on this packaging technology before his association with General Dynamics began.



1. Packed in. The Versipak, left, and the Isopak, right, are leaded Kovar-glass high-density IC packages. The more recent Isopak has a smooth glass top layer on which thin-film conductors may be deposited. Both units are fabricated in large matrixes.

dictates either very fine-line traces running between the pc-board holes or an excessive number of conductive layers, or both.

The flatpack is widely used in military applications and makes more efficient use of space than does the DIP. However, it is difficult to handle because its long, unsupported leads bend easily. In addition, it is awkward to handle automatically. Finally, it is a relatively expensive package to use.

Chip-carrier drawbacks

The leadless ceramic chip-carrier is potentially a high-density package since it takes up about a third the board area of a DIP. However, as many engineers have found, soldering this package to a large pc board requires special substrates whose temperature coefficient of expansion (TCE) almost matches that of the carrier's alumina body. Failure to do so results in solder-joint failures at the junctions of the carrier and pc pads. Consequently, packaging experts are looking into expensive and often hard-to-process metal-cored substrates or nonstandard pc materials such as polyimide, Kevlar, or quartz.

Also, the chip-carrier has its input/output pads on its periphery, and as the number of pins increases, so must the length of the carrier's sides. An alternative is to put the pads on a tighter pitch, a customization that raises the price of this relatively expensive unit even higher and that also raises the price of the pc board.

The alumina body of the chip-carrier has poor thermal conductivity, so thermal management of this unit is a problem. Another limiting characteristic is the high dielectric constant, which can cause large signal-propagation delays in high-speed applications. Also, the ability to inspect the package is limited because the area underneath it is hidden. Finally, leadless chip-carriers can generally be removed and replaced on the pc board only four to six times before the mounting pads are damaged.

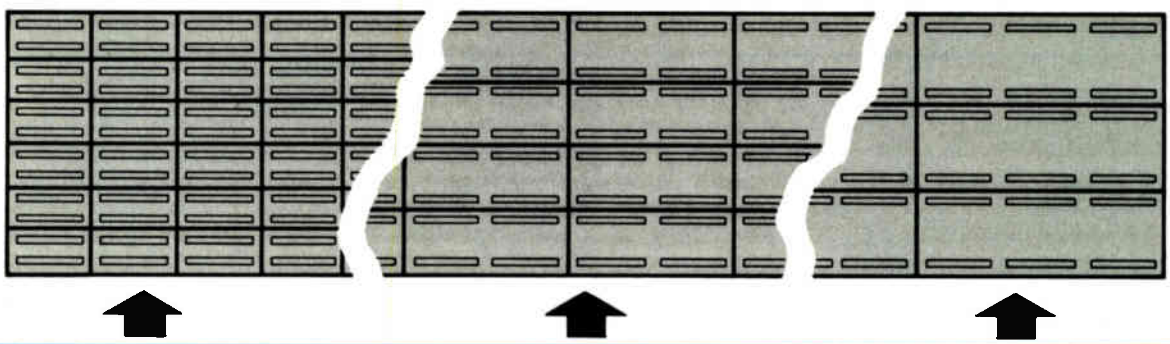
General Dynamics' engineers have bent their energies to designing packages that would overcome the limitations of the DIP, the flatpack, and the chip-carrier. The ideal microelectronic package was defined at the start as "the smallest enclosure capable of adequately protecting the enclosed device consistent with a lead configuration that can be easily handled and reliably attached to a parent substrate."

The basic package would function as a simple or complex unit with 1 to 1,000 leads. It would accommodate discrete devices or hybrids and have single or multiple interconnection layers and a built-in ground plane. Furthermore, its lead configuration would allow it to be used as a DIP, flatpack, or chip-carrier.

The ideal package would be suitable for good thermal management, compatible with high-speed devices, and compatible with wire, tape-automated, and flip-chip bonding. The unit was to be readily available, producible in house, have a fast turn-around time, and be obtainable in small and large quantities. In addition, it would have low tooling and package costs, be amenable to mass handling in fabrication, sealing, and final testing, and fit on pc boards with 10-mil lines and spaces. To provide high reliability, it would be easily protected from electrostatic damage, be suitable to vacuum bake-out, capable of dry-box sealing, accept laser-welding techniques, and have internal aluminized bonding pads.

Matrix packaging

In an effort to achieve the aims of the ideal package, a matrix-manufacturing approach has been developed. The package pattern is stepped and repeated across a Kovar panel in the same way that an IC pattern is stepped and repeated across a silicon wafer. After this, all remaining process steps are done in a mass-handling, or batch,



SMALL PACKAGE	MEDIUM-SIZED PACKAGE	LARGE PACKAGE
SINGLE PACKAGE (BASIC) UNIT	DOUBLE PACKAGE UNIT	TRIPLE PACKAGE UNIT
ALL 12 SLOT ROWS (1–12) RETAINED	SLOT ROWS 2, 5, 8, 11 DELETED	SLOT ROWS 2, 3, 6, 7, 10 AND 11 DELETED
10 LEADS (5/SLOT)	20 LEADS (5/SLOT)	30 LEADS (5/SLOT)
0.180 BY 0.280 in.	0.280 BY 0.580 in.	0.380 BY 0.880 in.
126 PACKAGE SITES	40 PACKAGE SITES	21 PACKAGE SITES

2. Versatile matrix. A Versipak matrix consists of a large number of package sites stepped and repeated on a sheet of Kovar. Three different outlines may be formed—small, medium-sized, and large. With the proper matrix, almost any package configuration can be made.

mode. Both the Versipak and Isopak packages (Fig. 1) are basically Kovar substrates with glass insulation and Kovar leads. The earlier Versipak, developed in 1970, is simply a Kovar substrate with its axial leads isolated by glass, while the more recent Isopak [*Electronics*, May 5, 1982, p. 42] has a full layer of glass that can support thin-film aluminum conductors. Thus the newer package is suited for both single-chip and multichip (hybrid) use.

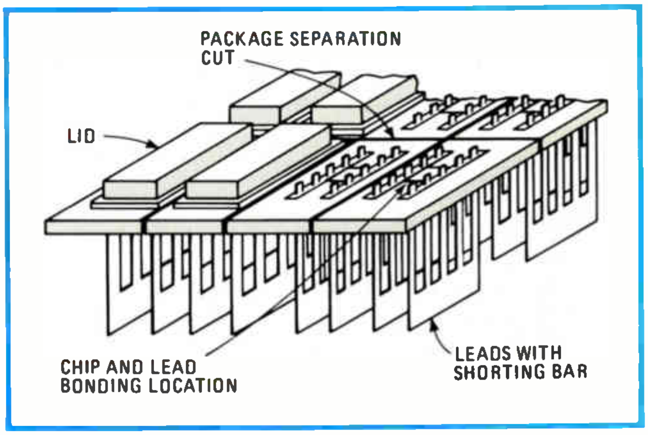
A Versipak matrix base with various lead openings is pictured in Fig. 2. By selecting the number of standard lead slots, the number of leads per slot, and the package size, it is possible to achieve virtually any package configuration without retooling. The basic matrix has 12 rows of lead slots with 5 leads per slot on 50-mil centers. The overall matrix is 1.5 by 6 in.

To construct a matrix, a photomask is passed over a resist-covered Kovar panel and the lead slots are etched out. Next, glass preforms are placed in the slots and a fixture positions Kovar leads over the glass. Then the glass is melted and the leads penetrate it to the required depth. The leads are lapped to their proper height. Finally, the matrix is cleaned, and the leads are plated.

The planar nature of the matrix package, coupled with the axial orientation of the leads, creates a number of advantages that both lower cost and enhance the reliability of the unit:

- All parts are etched, so no machining is needed.
- The glass-sealed alloy (Kovar) forms a single-layer substrate.
- Thermal management is easier because of the lack of metallic interfaces.
- The thermal match between the Kovar and the pc board provides high resistance to thermal shock.
- Axial leads allow through-hole or surface mounting.
- Handling is simpler thanks to the batch processing, and protection of the package's contents against electrostatic discharge is easily implemented.

Batch processing also boasts advantages that are absent from the manufacture of other types of IC packages, including a high degree of manufacturing control, accurate positioning of bonding posts, high-speed final sealing by seam, resistance, or laser welding, and easy pretinning of leads by dipping in molten solder.

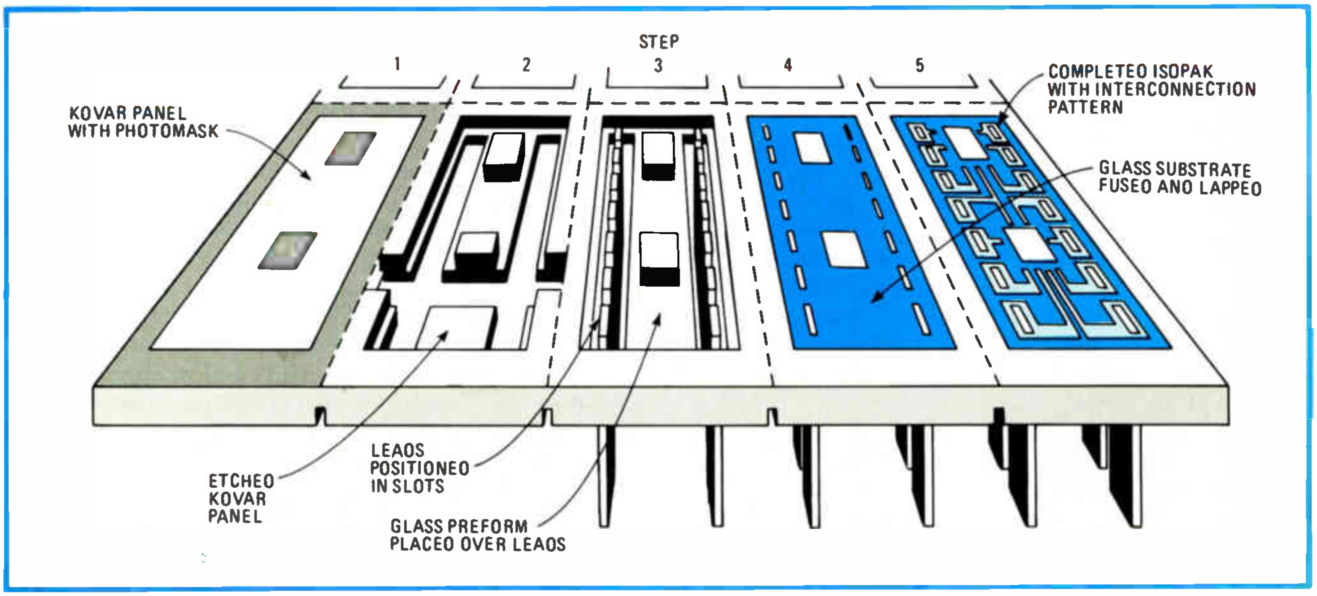


3. Package assembly. In the matrix process, most steps are done in a batch mode. For example, bonding of ICs into packages and laser welding of the lids is done while the matrix is still whole. After assembly and testing, the same laser is used to separate the packages.

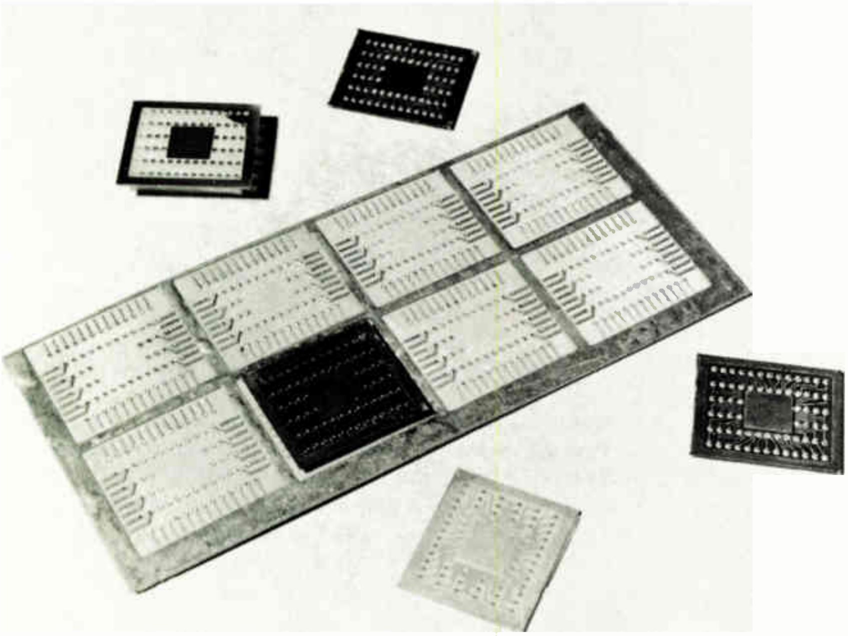
The Versipak matrix (Fig. 3) is ideally suited to complete automation because lead posts and package outlines are all within precisely controlled positions. Posts are easily mass-aluminized for aluminum wire or tape-automated bonding. About 100 packages can be handled, moved, tested, lidded, and leak-checked as a unit.

This matrix can be quickly and reliably attached to a pc-board test fixture for a preliminary burn-in and test if desired, or it can go directly to bake and final seal. When desired, matrixes of packages and lids are placed in a vacuum oven, baked, and transferred to a dry box containing a nitrogen-helium gas mixture. The matrix of lids is accurately positioned over the package matrix by tooling holes and then is automatically welded.

The lidded matrix is next reattached to the pc-board



4. Isopak fabrication. A five-step process produces the Isopak. Kovar islands formed in the second step are for chip sites and to conduct heat down to a heat sink. The completed package has a smooth glass surface with thin-film aluminum conductors.



5. Butt-soldered. A 68-pin Isopak has no thermal incompatibility with the pc board to which it is butt-soldered. Its footprint is smaller than that of either the equivalent leadless ceramic chip-carrier on 50-mil centers or a pin-grid array on 100-mil centers.

test fixture, placed on the laser table and separated into individual packages. The test fixture containing the separated packages is now used as a carrier for mass leak-checking of the packages for hermeticity and subsequently as a test socket for burn-in and final test. For further handling, the group of packages that compose the matrix is magnetically transferred to a magnetic-foil–covered carrier that guards against the effects of electrostatic discharge.

Another advantage of the package is that the magnetic quality of Kovar and the shortness of the leads simplify bonding placement and processing, yet provide the compliancy required for attachment to a variety of substrates. Furthermore, both hermetic sealing of stainless steel or nickel lids to the package and then the separation of the sealed packages from the matrix may be accomplished at high rates with a single laser tool. Such tools integrated into full turnkey programmable processing systems have been in use since the 1970s.

Using Isopak

The second of the two packages, Isopak, embodies all of the features and advantages of the Versipak and, in addition, incorporates a self-contained glass insulating layer that facilitates complex device interconnections or the construction of a complete thin-film hybrid. Since this layer and the rest of the package form a single continuous unit, the various metalized ceramic films and package interfaces usually found in conventional hybrid packages are eliminated, thus promoting significantly better thermal characteristics.

Figure 4 illustrates the basic construction and features of an Isopak. As in the Versipak matrix fabrication, the Kovar matrix is carefully cleaned, oxidized, and placed in a fixture with matching leads and glass preforms and fused at high temperature in a controlled atmosphere. Afterwards the oxide is stripped, and the fused glass is carefully ground and lapped until the leads, glass, and package perimeter are coplanar. Following the electroplating operation, the matrix is ready for deposition of a metallic thin film on the glass substrate and the subsequent circuit-pattern definition.

With this technology, an engineer can design an entire system from microcircuit to package. He or she can now design a hybrid circuit and a package to match, rather than fitting the circuit to an existing package. Two or more packages can be used as a unit by not separating them during the laser scribing. In addition, custom photolithography of both the basic package pattern and the thin-film circuitry is relatively easy to do.

Computerized numerically controlled (CNC) photoplotters are ideally suited to creating matched package bases and thin-film artwork. Apertures, cavities, perimeter lines, and other pertinent data are stored in the parts library of a CNC artwork generator for callup and editing as required, thus permitting a complete new package outline to created quickly and inexpensively.

Of particular interest is the ability to design thermal islands into the matrix as mounting pads for the direct eutectic bonding of thermally active components. Any number of these can be designed into the basic package. This feature also permits the removal and replacement of eutectically bonded devices of a multichip hybrid without removal of the substrate, as is conventionally done.

The polished surface of the Isopak provides a superior substrate for the deposition of thin films because it does not exhibit the waviness of glazed alumina or the crystallinity of unglazed polished alumina. The low dielectric constant of glass, coupled with the close ground plane offered by the Kovar base, makes this package eminently suitable for high-speed devices. Other features such as aluminum metalization, short leads and their close proximity to the IC, and the capability of repetitive soldering directly to a test fixture further enhance the suitability of this package to high-speed applications.

As ICs become smaller, the interconnection problem becomes more complex. The nature of the Isopak matrix not only permits definition of very fine lines, but the ultra-smooth nature of the glass and the similarity to IC wafer processing facilitate the multilayering of thin-film circuit patterns.

When the mass-handling capability of the Isopak matrix is extended to thin-film hybrids, it greatly reduces the total number of steps required. The precise location of leads, islands, and so on, within the matrix also makes it ideally suited to automatic die and lead bonding.

If desired, closely positioned optical windows or lenses may be mass-produced in a matrix of lids. These optical ports can be precisely located for specialized optoelectronic purposes or for fiber-optic coupling.

When it is used as an IC package, the Isopak resembles a pin-grid array. Whereas the pin-grid array has pins on a 100-mil grid, the Isopak has its pins spaced 50 mils apart in a row and its rows spaced 100 mils apart. A 68-pin Isopak (Fig. 5) takes up 0.53 square inch, whereas a 68-pin chip-carrier and pin-grid array are 0.902 and 1.21 in.[2], respectively.

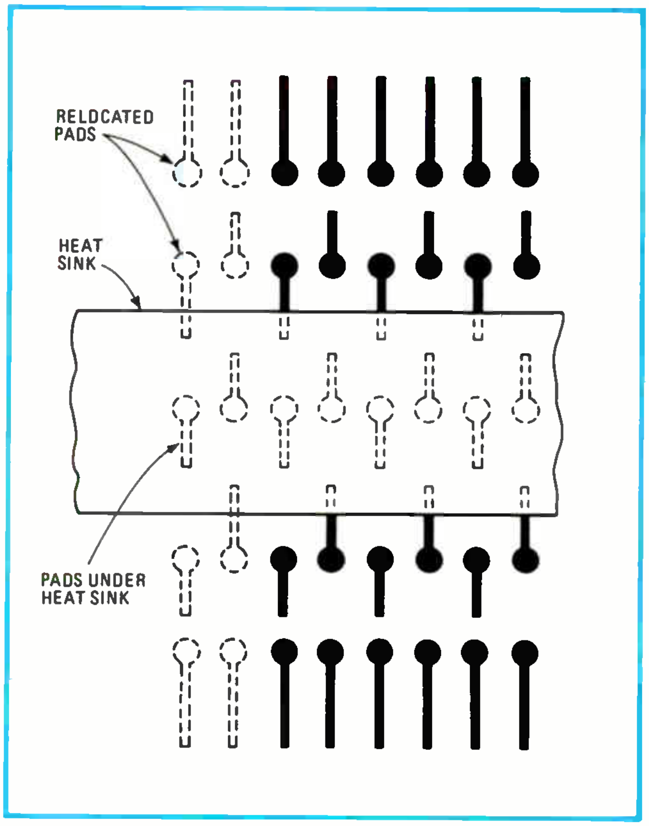
Mounting flexibility

In addition to small size, the flexibility of both Isopak and Versipak in terms of the ability to mount them on a pc board is another major advantage. Both can be used either with a through-hole mount or with a flatpack (planar) mount. However, they are best suited to a butt-soldered surface mount where the unit has short axial leads soldered to surface pads. This setup allows a user to get all the advantages of surface mounting in a smaller area than, say, a flatpack mount. In addition, lead lengths are extremely short—a factor favorable to high-speed operation. Butt soldering can be done by vapor-phase, hot-oil, resistance-reflow, or hand soldering.

Both package types eliminate any thermal-expansion incompatibility with the pc-board because they are attached with compliant leads. In addition, the bilateral lead arrangement of the Versipack leads and the ability to reduce the number of leads around two of the sides of the quadrilateral Isopak (Fig. 6) lets them straddle a heat sink to provide excellent, low-cost thermal management. It is almost impossible to equip other quadrilateral package types with adequate thermal control because their leads act as a fence against the heat sink.

The metal base of the package can be simultaneously soldered to the heat sink when the package leads are attached by vapor-phase soldering, thereby ensuring a low thermal resistance between junction and heat sink. Versipaks soldered to heat sinks have demonstrated less than a 3°C-per-watt temperature differential between the chip junction and the heat sink.

The ability to repair a package is perhaps even more important than the initial ease of assembly, since it may have to be done under adverse conditions and still result in a unit that can withstand severe environments. Both Versapak and Isopak have demonstrated their repairability. In a test of this capability, 14-lead, butt-soldered packages that had their bases simultaneouly soldered to the heat sink were removed and replaced 10 times with no degradation of the solder joints. A 50-lead butt-soldered package was also removed and replaced 10 times with no degradation of the solder joint. This capability could permit very high-speed devices that cannot be socketed for testing to be soldered directly to a test board and subsequently removed.



6. Depopulated. In the pc-board footprint for an Isopak in which the number of pins has been reduced to 68, mounting-pad locations (shown dotted) that would be under the heat sink have been moved to the colored locations, allowing the package to straddle the heat sink.

A poor coefficient of thermal matching is damaging to any interconnection system. But its effects are greatly amplified when simultaneously integrated with other forces, such as mechanical shock, vibration, and gravity. In view of this synergistic effect, severe testing was performed on matrix units to determine their limits and to understand the nature of any failures.

High stress

For example, unmounted packages successfully withstood 10 cycles of thermal shock produced by instant transfer from liquid nitrogen at −197°C to molten solder at 288°C. Versipaks butt-soldered to a pc board successfuly withstood 10 cycles of thermal shock produced by instant transfer from liquid nitrogen to liquid Fluorinert, FC-74, at +174°C.

The same type of units soldered to a pc board also withstood 15,000 g for 0.6 millisecond with no failures. Similar results were encountered during vibration testing over a frequency range of 100 to 2,000 hertz. Finally, butt-soldered units were temperature-cycled for 1,060 cycles between −135° to +174°C with no failures.

Versipak and Isopak have shown resistance to shock and vibration in excess of any usual military requirements for such testing. Also, the temperature-shock limits are considerably higher than the usual −65° to +125°C to which packages are usually tested. □

VAX computer helps user generate Basic programs

by Marty Halvorson
Digital Equipment Corp., Albuquerque, N. M.

Equations having many variables taking numerous values are a common sight to engineers. Though many would like to rid themselves of the hand calculators used for such problems and replace them with a computer, they cannot because of a dearth of software for such specialized applications. However, this program for Digital Equipment Corp.'s VAX line of computers is capable of generating Basic programs for designs that are undergoing many additions. It also gives the hardware-design engineer a tool to solve many equations iteratively. The only requirement for using this program is that the designer have the ability to translate the design equations into the form required by Basic.

The equations to be solved are separated into left- and right-side variable terms, while variables appearing on

VAX PROGRAM FOR GENERATING PROGRAMS

```
20    dim equations$ (50), lst$ (50), rst$ (200)  \
      dim iterm% (50), scale% (200), scaleamt$ (200), rstv% (200)  \
      filename$ = space$ (B0)
30    print "Enter equations in Basic format"  \
      print "   All variables must be defined by either blanks or parenthesis"  \
      print "         The only functions names recognized are COS, SIN, SQR, and TAN"  \
      print "         and they must be capitalized"
40    eptr% = 0%  \
      lptr% = 0%  \
      rptr% = 0%  \
      rlast% = 0%
50    alphabets$ = 'ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz'
60    def fnans$  \
      fnans$ = 'N'  \
      if seg$ (ans$,1,1) = 'y' or seg$ (ans$,1,1) = 'Y' then fnans$ = 'Y'
61    fnend

100   input "equation => "; equations$ (eptr%)  \
      equations$ (eptr%) = edit$ (equations$ (eptr%), 16%)  \
      if equations$ (eptr%) == ' ' then goto 200
110   equals% = POS (equations$ (eptr%), '=',1%)  \
      if equals% <> 0 then gosub 1000
120   eptr% = eptr% + 1%  \
      goto 100

200   print 'Left-side term questions'
210   for n% = 0% to (lptr% - 1%)
220           if iterm% (n%) = 0% then goto 250
230              print '              Do you want generated program to output this'  \
                 print "              intermediate left-side term ' "; lst$ (n%); " ' (no)";  \
                 input ans$
240           if fnans$ = 'Y' then iterm% (n%) = 0
250   next n%

300   print "Right-side term questions"
310   for n% = 0% to (rptr% - 1%)
320           if rstv% (n%) = 0% then goto 360
330              print "              Do you want generated program to scale this"  \
                 print "              input right-side term ' "; rst% (n%); " (no)";  \
                 input ans$
340           if fnans$ = 'N' then goto 360
350              scale% (n%) = 1  \
                 input "enter scale amount in the form '1E +- value' "; scaleamt$ (n%)
360   next n%
```

```
400    input "Output file name =)"; filename$ \
       if filename$ = ' ' then &
            terminal% = 1% &
       else &
            terminal% = 0%
410    if terminal% = 1% then &
            goto 500
420    if pos (filename$, ' . ' , 1%) = 0 then &
            filename$ = filename$ + '.BAS '
430    open filename$ for output as file #1, recordtype list

500    ln% = 1000% \
       if terminal% = 0% then &
            print #1, ln%;" print 'INPUT VARIABLES' "
510    for n% = 0% to (rptr% - 1%)
520         if rstv% (n%) = 0% then goto 580
530         ln% = ln% + 10% \
            if terminal% = 0% then &
            print #1, ln%;" print '  ";rst$ (n%); " ('; "; rst$ (n%); "; ') =) '; "
540         ln% = ln% + 10% \
            if terminal% = 0% then &
                 print #1, ln%; "  input ts$ "
550         ln% = ln% + 10% \
            if terminal% = 0% then &
                 print #1, ln%; "  if ts$ = 'q' or ts$ = 'Q' then goto 9990"
560         ln% = ln% + 10% \
            if terminal% = 0% then &
                 print #1, ln%; "  if ts$ () ' ' then "; rst$ (n%); " = val (ts$)";
570         if terminal% = 0% then &
                 if scale% (n%) () 0 then &
                      print #1, " * "; scaleamt$ (n%) &
                 else &
                      print #1,
580    next n%

600    for n% = 0% to (eptr% - 1%)
610         ln% = ln% + 10% \
            if terminal% = 0% then &
                 print #1, ln%; '  '; equations$ (n%)
620    next n%

700    ln% = ln% + 10% \
       if terminal% = 0% then &
            print #1, ln%; "  print 'RESULTS' "
710    for n% = 0% to (lptr% - 1%)
720         if iterm% (n%) = 1% then goto 740
730         ln% = ln% + 10% \
            if terminal% = 0% then &
                 print #1, ln%; "  print '  "; lst$ (n%); " ='; "; lst$ (n%)
740    next n%

800    ln% = ln% + 10% \
       if terminal% = 0% then &
            print #1, ln%; "  goto 1000"
810    if terminal% = 0% then &
            print #1, " 9990  end"
820    goto 30000

1000   gosub 10000
1010   llast% = lptr%
1020   lptr% = lptr% + 1%
```

both sides of an equals sign are identified as intermediate values. By entering the command RETURN, the user terminates the equation input.

Next, the user specifies for each intermediate variable whether the generated program must print that variable as a result. The program then seeks a scale for each input variable by asking the user if the output program must scale that variable. If the answer is Y or y, the program then requests the user to enter the scale factor for the program.

The Basic program contained in the VAX computer is now ready to generate a program, and it first requests the user to provide an output file name. Upon completing the previous steps of entering the equation, the user may compile, link, and run the new program. In addition, this generated program may be terminated by entering a Q or q in response to an input request. □

Software notebook is a regular feature in *Electronics*. We invite readers to submit short, original, unpublished programs and software solutions to engineering problems. Explain briefly and thoroughly the program's operation. We'll pay $75 for each item published.

```
1030    gosub 10100
1050    for n% = rlast% to (rptr% - 1%)
            rstv% (n%) = 1
1070        for m% = 0% to llast%
1080            if rstS (n%) = lstS (m%) then &
                    rstv% (n%) = 0% \  iterm% (m%) = 1%
1090        next m%
1100    next n%
1110    rlast% = rptr%
1120    return

10000   i% = 1%
10010   end% = equals%
10020   gosub 11010
10030   lstS (lptr%) = termS
10040   return

10100   i% = equals%
10110   end% = LEN (equationsS (eptr%))
10120   gosub 11010
10130   if termS = ' ' then goto 10230
10140   if termS = "COS" then goto 10230
10150   if termS = "SIN" then goto 10230
10160   if termS = "SQR" then goto 10230
10170   if termS = "TAN" then goto 10230
10180   for n% = 0% to (rptr% - 1%)
10190       if termS = rstS (n%) then goto 10230
10200   next n%
10210   rstS (rptr%) = termS
10220   rptr% = rptr% + 1%
10230   if i% >= end% then return
10240   goto 10120

11010   s% = POS (alphabetS, SEGS (equationsS (eptr%), i%, i%), 1)
11020   if s% <> 0 the &
            begin% = i%  \  goto 11100 &
        else &
            i% = i% + 1%
11030   if i% <= end% then &
            goto 11010 &
        else &
            term$ = ' ' \  return
11100   t$ = SEGS (equationsS (eptr%), i%, i%)
11120   s1% = POS (tS, ' ', 1) + POS (tS, ' ( ', 1) + POS (tS, ') ', 1)
11130   if sl% = 0% then &
            if i% < end% then &
                i% = i% + 1% \  goto 11100 &
            else &
                last% = end% \  goto 11150
11140   last% = i% - 1%
11150   termS = SEG$ (equationsS (eptr%), begin%, last%)
11160   return

30000   end
```

Engineer's newsletter

NASA readies 30-GHz satellite experiments

The National Aeronautics and Space Administration is initiating the flight experimentation phase of its Advanced Communications Technology Satellite Program at 30 and 20 GHz [*Electronics*, May 5, 1982, p. 38], and its notice of intent is now available to all those interested in placing high-technology experiments aboard the space shuttle for a 1988 geostationary-satellite launch. All work should be designed **to come up with means for preserving orbit space and electromagnetic spectrum resources.** The NOI is available from the Communications division at NASA headquarters in Washington, D. C. Replies are due by June 17, and Ronald J. Schertler of the Lewis Research Center in Cleveland, (216) 433-4000, can provide information about what documentation is available to experimenters.

Dial up for the latest on local networks

Computer-network system integrators who want to find out the latest information about local networks should call Associated Computer Consultants' Local Area Network Center in Soquel, Calif. Just hook a modem to a terminal and dial (408) 475-7940 during West Coast business hours. Two keyboard carriage returns initiate access to such material as conference listings, publications, reports, and data about the company's products. Also included is **national and international news of local network technology.** More details may be obtained from the firm at 2901 Park Ave., Soquel, Calif. 95073; the phone number is (408) 425-0937.

Slide rule calculates optical system data

A manufacturer of fiber-optic transmitters and receivers, Codenoll Technology Corp. will supply anyone interested with a nomograph-based slide rule that the optical systems integrator can use to perform simple flux budget and bandwidth calculations. For the details, write to the firm at 1086 North Broadway, Yonkers, N. Y. 10701, or call it at (914) 965-6300. One side of the rule relates optical transmitter power, receiver sensitivity, transmission loss, and flux budget to the system figure of merit. **The flip side relates transmitter and receiver rise and fall times and fiber and system bandwidth.** Although the slides are marked with the specifications of devices manufactured by Codenoll, they can be used for any set of transmitter or receiver data.

Apple readies data for software designers

The first version of Lisa, the much-heralded, user-friendly computer from Apple Computer Corp. at Cupertino, Calif., is a $10,000 box that runs six programs. But Apple is readying a set of software tools that will enable the rapidly growing cottage industry of independent, third-party software designers to come up with what the firm hopes will be a multitude of application programs to make Lisa more versatile. The package is based on the languages Smalltalk and Flavors [*Electronics*, July 28, 1981, p. 104], which are much favored by those trying to model human thought processes. Written in Apple's Clascal, the software in the company's package is based on **the concept of a "class"—a highly flexible, abstract data type that allows objects (another data type) and their attributes to be manipulated handily.** Through the class concept, the independent software developer obtains direct access to Lisa's icons, multiple screens, graphical capabilities, and mouse controller without the need to write special software for the same purpose. Product delivery should be this year.

–Harvey J. Hindin

Modulation measurement reaches new peaks in performance

For sheer performance there is nothing to compare with the new Marconi 2 GHz Modulation Meter.

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SPL53-4101	8A	1.2A	0.6A						
SPL53-4102	8A	1.2A	0.6A			2.5A/5A PK			
SPL65-5000	8A	1.2A	1.2A	0.5A	1.2A/1.5A PK		85W cont. 95W PK	2.10 x 5.00 x 9.00	$150
SPL130-4100	15A	4A/6A PK	1.5A		2A/4A PK	1.5A	130W cont. 150W PK	2.45 x 5.00 x 10.50	$198
SPL130-4101	15A	1.5A	1.5A						
SPL130-4102	15A	4A/6A PK	1.5A	1.5A					
SPL200-4100	35A	4A/8A PK	1.5A	1.5A		1.5A	200W cont. 250W PK	2.45 x 5.00 x 13.00	$270
SPL200-5100	35A	4A/8A PK	1.5A	1.5A					
SPL200-5200	35A	4A/8A PK	1.5A	1.5A	4A/6A PK				

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Program simulates computer systems

Software's user can configure a system arbitrarily, simulate its execution, and analyze its performance

by Stephen Evanczuk, Microsystems & Software Editor

In specifying hardware and software for a large data-processing system, analysts have had either to draw on published results of performance studies or to develop their own model of the proposed system in some simulation language. But with CACI's Network II.5, a software package that does not require special knowledge of a simulation language, system designers can back their proposals with hard figures on a system's expected performance.

System analysts have been drawing from the growing pool of knowledge about system and subsystem performance generated by simulation specialists using general-purpose languages like Fortran or special-purpose simulation languages like GPSS. But CACI is "trying to stay out of the new–programming-language business," says William J. Garrison, senior associate at the company; it does not want to introduce yet another language to assail already beleaguered analysts.

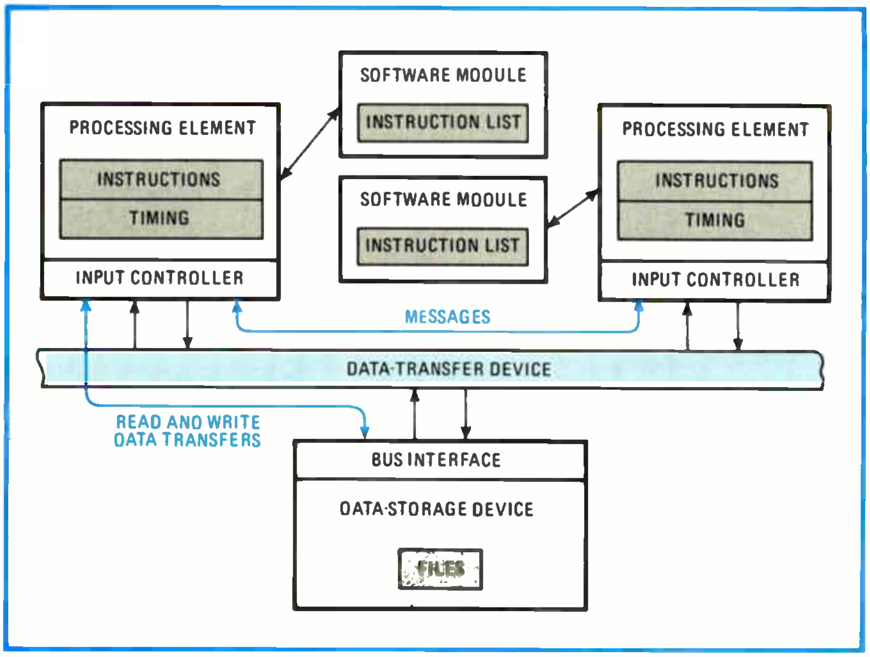
Inside the design loop. Instead, the software offers a complete solution for specifying configurations, simulating execution, and analyzing the performance of arbitrary computer systems. Intended for use early in the specification and design cycle, the package allows a designer to specify the hardware and software characteristics of a proposed system and to receive reports on expected system utilization and overhead due to delays and conflicts in the system.

Network II.5 recognizes three primitive elements of a system: the processing elements, data-transfer devices, and data-storage devices (Fig. 1). Processing elements, characterized by an instruction set and a basic cycle time, represent a system's central processing units. Data-transfer devices, representing buses or networks in the simulated system, are characterized by transfer rate, protocol, and a list of connections.

Data-storage devices have a specified capacity, access time, and an access method. Further, information may be held either in a data-storage device's general storage or in a named file. The named files may be dynamically created, modified, moved, deleted, and even specified for reading only.

In simulating the interaction of hardware and software in a complex system, the cost of executing an actual arithmetic or logic instruction is more important than the computed result. Consequently, instructions in processing elements are characterized by their effects. As such, a single instruction as defined by the software can range from an entire program on down to a subroutine or even an individual machine instruction. The system analyst determines the needed level by the degree of resolution required to analyze various aspects of a system.

In creating a software module for simulation, the designer specifies which processing elements may execute the module, when it may execute, what it does when it is executing, and what other modules will run when the executing module finishes. Network II.5 directly supports modeling distributed systems with such



1. System simulation. With Network II.5, hardware elements of a system are specified as either processing, data-transfer, or data-storage elements. A set of characteristics specified with the interactive Netin preprocessor permits control of details of the simulation.

features as modules having a specified list of processing elements able to execute them and modules that either may or may not be executed concurrently on separate processors.

Furthermore, the system designer may specify a start time for a module or even a rate at which the module is automatically activated by the simulator (Fig. 2). Coming soon, says Edward C. Russell, CACI modeling and simulation department manager, are "enhancements that allow for all input parameters to be randomized."

Before a module may execute, the software checks that the specified conditions have been met, including start time, allowed hardware, and the state of a pair of inter-processor or -task communication facilities called messages and semaphores. Thus, a module may be delayed from executing until a specified message has been received or a semaphore has been set. Similarly, semaphores can be used to cancel the execution of a module.

Network II.5 puts out six different reports on the activity generated during a simulation. Besides separate reports on the usage statistics of software modules and each of the three elements, the simulator prints at the terminal an ongoing narrative trace of the events in a simulation run as they occur, plus a snapshot of the status of each hardware and software element in the simulated system.

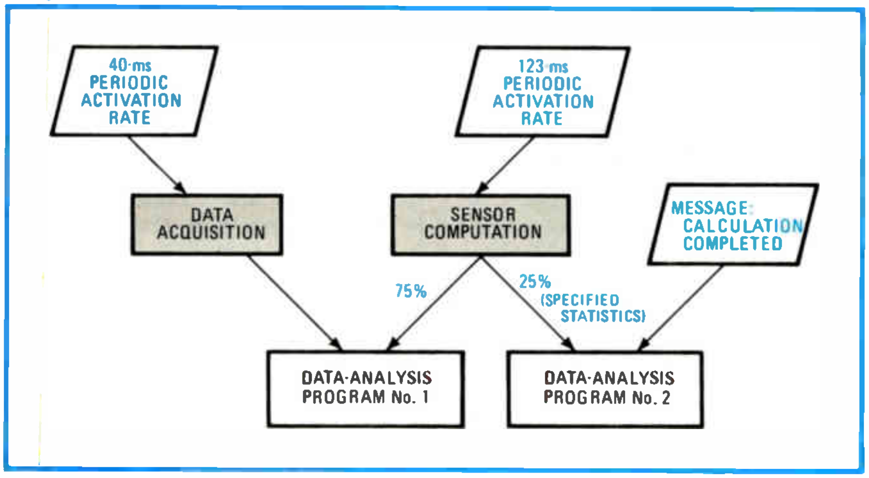
Besides these run-time reports, Netplot—a Network II.5 post-processor—generates a line plot showing the busy times of each device. From the default full-run plot, the designer may examine time slots in more detail, expanding sections as needed.

One important feature of the software package is an interactive preprocessor called Netin, which allows a designer to build and maintain the needed data structures that specify a system to be simulated. Netin serves as a guide, prompting as needed for required information through a series of questions. For example, when a data-storage device is brought into existence, Netin will prompt the user for the device's attributes.

Network II.5 is available now for $17,500 and runs on a wide range of hardware including most IBM mainframes, VAX minicomputers from DEC, Control Data Corp. 6000, 7000, and Cyber computers, as well as Univac, Prime, and NCR equipment. Although the simulator is written in Simscript II.5, knowledge of that language is not necessary to use it.

Training course. CACI offers a four-day hands-on training course for $4,500 plus travel expenses. Following the training course, Network II.5 is available for a free 30-day trial installation. The basic purchase price covers a year's maintenance, including updates.

CACI, 12011 San Vicente Blvd., Los Angeles, Calif. Phone (213) 476-6511 [338]



2. Module simulation. Network II.5 allows specification of a rate at which software modules may be activated. Once a module terminates, the next one to be executed may be specified deterministically or by statistics. Execution can also depend on inputs such as a message.

FDIC

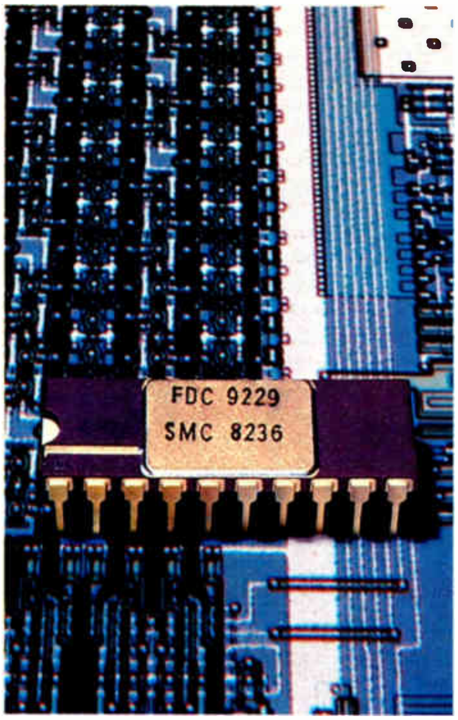
DEFINITION: FLOPPY DISK INTERFACE CIRCUIT. SMC'S FDC 9229. IT ELIMINATES THE "GLUE" AROUND ALL POPULAR FLOPPY DISK CONTROLLERS.

Building a floppy disk controller/interface module can get sticky. The "glue" or discrete componentry required can cause space problems and increase costs significantly.

That's why Standard Microsystems introduced its FDC 9229 Floppy Disk Interface Circuit (FDIC™). It complements all popular floppy disk controller/formatter LSI circuits by combining a digital data separator, write precompensation logic, head-load timer and crystal oscillator, all in a 20-pin dual-in-line package only 0.3 inch wide.

Just one pin configures this MOS integrated circuit to work with 179X, 279X or 765-type floppy disk controllers. So you reduce the number of external components to a bare minimum.

What's more, the FDIC™ provides a cost-effective solution to the problem of converting jittery serial bit streams from floppy disk drives into separate controller clock and data signals. Its revolutionary all-digital data separator is extremely accurate and requires no analog adjustments or additional hardware.



The FDIC™, fabricated with SMC's COPLAMOS® technology, is available in two versions: the 8 MHz FDC 9229 for 5¼-inch disks and the 16 MHz FDC 9229B for 3-inch, 5¼-inch and 8-inch disks. Both operate from a +5v supply and come in plastic or ceramic dual-in-line packages.

The FDIC™. It provides all floppy disk drive interface and support on one chip. And it's another innovation on a long list that has made Standard Microsystems the one to watch.

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STANDARD MICROSYSTEMS. THE ONE TO WATCH.

CRT, MAGNETIC AND DATA COMMUNICATIONS CONTROLLER CIRCUITS.

Computers & peripherals

32-bit processor powers terminal

High-resolution graphics station with Bellmac 32 and 256-K bytes of RAM supports six windows

A series of four cathode-ray-tube terminals being introduced by Teletype Corp., which is owned by American Telephone & Telegraph Co., has at its high end a work station that brings the power of a minicomputer to the user's desktop. The 5620 is a high-resolution monochrome graphics terminal that houses a Bellmac 32 microprocessor and 256-K bytes of random-access memory. The Bellmac 32 is a 32-bit processor developed by Bell Laboratories.

The 5620's bit-mapped green-phosphor CRT has a visible screen area of 8 by 10¼ in. and displays 800 picture elements in the horizontal dimension and 1,024 vertically at a resolution of 100 pixels/in. Software downloaded from the host computer makes the screen divisible into up to six windows, and as each of these can be made to appear to the host as a separate physical terminal, the user can work on several programs at once. Likewise, listings of two or more versions of one program might be displayed simultaneously for development work, or a programmer might work on one program while compiling or executing another.

Priced at $6,115 (discount schedules are not yet available) and set for deliveries beginning in the fourth quarter, the 5620 sports a low-profile (3-cm) detachable keyboard. Its RS-232-C port runs at keyboard-selectable rates from 300 to 19,200 baud.

A support package of software has been developed for the 5620 and will be available through AT&T's Western Electric subsidiary. Intended for use with hosts running under release V of the Unix operating system, the support package requires about 150-K bytes of space in the terminal's RAM. Downloaded from the host, this software includes a Unix-like operating system written specifically for the 5620, a screen formatter, and multiplexing software that allows the unit to appear to the system to be more than one terminal.

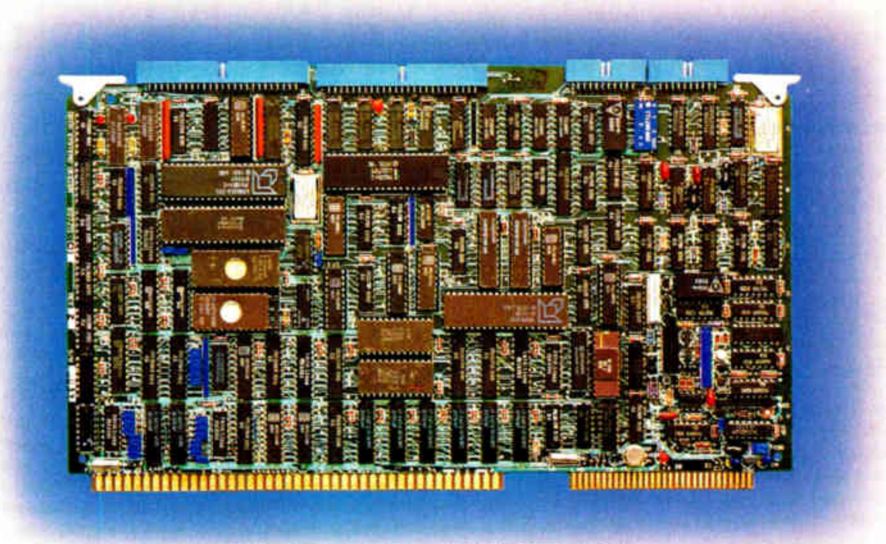
The remaining 100-K bytes or so of memory are available for executing downloaded application programs or program modules or for storing messages and data. RAM is organized in 32-bit words and is accompanied by a 24-K-by-16-bit bank of erasable programmable read-only memory. Firmware stored in the latter lets the terminal power up into an interactive mode for logging onto the system and requesting programs to be downloaded.

Possibilities. The 5620 has an 8-bit parallel port that could be used to expand its local memory, but Teletype is not committed to doing so. It would also be possible to use this interface to attach local disk storage.

However, the manufacturer currently has no plans to offer a stand-alone microsystem. Instead, it is targeting its terminals for use in large-system environments, pointing to the many problems that can arise when independent microsystems are introduced into such an environment: a disorganized jumble of inaccessible individual data bases, scattered and uncoordinated program development that often results in duplication of effort, and inaccurate financial projections made by people unfamiliar with a company's policies and practices, among other complaints.

The other terminals being intro-

ONE SLOT SHOPPING.



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DSD's new 7215 single-board Multibus® controller/interface handles two SA1000-type 40Mb Winchesters, a ¼" streamer, and two 8" floppies.

Plus on-board data separation, 32-bit ECC, and self-diagnostics. All on the same board.

There's also a version for 5¼" drives, the 5215, with similar capabilities.

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DATA SYSTEMS DESIGN

Circle 171 on reader service card

duced are the 5540, the 5420, and the 5410. All have low-profile detachable keyboards and can display 80 or 132 characters per line. The low-end 5410 is an asynchronous conversational unit based on the ANSI 3.64 standard. It has eight soft keys that can be programmed from the keyboard or by the host. Key setups and on-screen labels for them are retained in nonvolatile memory when the station is turned off. The 5210's list price is $995 and shipments will begin in the third quarter.

The 5420 adds to the horizontal split-screen capability of the 5410 a scroll mode, windowing, and a page mode that makes use of 72 lines of local memory. A buffered bidirectional printer port is standard on the 5420, which lists for $1,495.

Last is the 5540, a unit compatible with IBM 3270 terminals that supports bisynchronous line protocols as well as Synchronous Data-Link Control and Systems Network Architecture communications. It includes a 5¼-in. floppy-disk drive for controller programming, device identification, and options. Two controllers are available: a desktop unit that can cluster up to 12 terminals and a dual-processor unit for up to 32.

The 5540-series terminals start at $1,633 with 24 programmable function keys as standard. An optional light pen costs $417. A cluster including controller, four displays, and a printer will sell for slightly over $13,000.

Teletype Corp., 5555 Touhy Ave., Skokie, Ill. 60077. Phone (800) 323-1229 [361]

Head cleaner is dry, nonabrasive

Cleaning disk for 5¼- and 8-in. floppy-disk drives is a web of nonwoven polyester fibers

A cleaning disk for the read-write heads of 5¼- and 8-in. floppy-disk drives has been developed that uses neither wet cleaning solutions nor abrasive surfaces, both of which have significant drawbacks. The Verfin head-cleaner disk, which resides inside a jacket much like a standard disk, is made of a random nonwoven web of polyester fibers containing cleaning components added during the manufacturing process.

Failing to keep heads clean can not only result in errors and lost data but also shorten the useful lifetime of the heads. As data-storage densities increase, head maintenance becomes more and more critical to a system's performance.

Wet head-cleaning systems have a number of problems. As the cleaning disk soaked with liquid, usually isopropyl alcohol with fluorocarbon additives, turns at 360 r/m, the liquid migrates towards the outside of the disk under the influence of centrifugal force and spins off the edge.

If the user reduces the amount of liquid applied to the disk to avoid spinoff, the disk may become in effect a dry-process cleaner, with insufficient fluid to either lubricate or clean properly. The alcohol, in addition, is a potentially flammable chemical that is introduced into a closed electrical environment.

All previous dry cleaning processes, according to the maker of the Verfin disks, have relied on mild abrasives to remove contaminants from the heads and carry them inside the disk jacket where they are absorbed by the jacket lining. The removal of the heads' protective coatings and actual head wear are potential problems with prolonged use of these disks.

Gentle. The extremely low abrasion factor and the excellent particle-absorbing quality of nonwoven polyester webs such as the one used in the Verfin cleaning disk is pointed up by the fact that very similar materials are often employed to line floppy-disk jackets, where those characteristics are valuable. The cleaning components used have been found to be effective when the disk is used for 20 s once every 8 or 10 h of drive use. The manufacturer recommends using each cleaning disk 15 times or

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Available in standard E.I.A. RS-296-D Class I tape reel packaging for automatic insertion. Also available as Type RN in 2% and 5% tolerances at 200 PPM/°C.

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Circle 173 on reader service card

EC-244R

Circle 175 on reader service card

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RUR-820	Single	8	200	TO220	$1.21
RUR-D810	Dual	8	100	TO220	$1.55
RUR-D815	Dual	8	150	TO220	$1.72
RUR-D820	Dual	8	200	TO220	$1.97
RUR-D1610	Dual	16	100	TO3	$3.30
RUR-D1615	Dual	16	150	TO3	$3.54
RUR-D1620	Dual	16	200	TO3	$4.20
BYW51-100	Dual	8	100	TO220	$1.77
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BYW51-200	Dual	8	200	TO220	$2.23

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Software

Microsystem is adapted to APL

Character-generation ROM lets IBM Personal Computer display symbols for language package

A general-purpose programming language useful for business and mathematical calculations, APL—for A Programming Language—is normally found only on mainframe computers. Its large memory requirements and the unique symbols it uses to represent its operations have made it unsuitable for microcomputers. But now STSC Inc. has come up with an enhanced version of APL for the IBM Personal Computer.

A character-generation read-only-memory chip supplied with the language replaces the one in the PC and gives the machine the ability to display the special APL symbols. With it, the PC can either use the language as a standalone system or be integrated as an APL terminal into a mainframe environment—a factor of interest to people working with management information systems [*Electronics*, March 24, p. 151]. A communications mode allows the PC to act as either a dumb or an intelligent terminal, talking with other computers using either the APL or ASCII character set.

The APL*PLUS/PC system contains all the APL language's primitive functions and operators, special features for the environment of the IBM Personal Computer (such as support for the Intel 8087 math coprocessor), and most of the STSC proprietary enhancements found in the firm's mainframe version of APL. These enhancements include a file system similar to the firm's Sharefile system for mainframes, which gives read and write access to data bases stored on floppy or hard disks and supplies exception-handling and report-formatting facilities.

In the communications mode, programs and system primitives are provided to upload and download files and other data objects to and from other APL or non-APL systems. Unlike many communications programs, the STSC software allows peripherals to be driven and gives full control of the communications to APL statements. Other features include screen management for display and editing, system functions that allow the equivalent of peeking and poking into memory, and a workspace equal to the maximum 644-K bytes that can held by the PC, less the 90-K bytes taken up by the MS-DOS operating system and APL.

Not trivial. Neither this product nor an earlier version for Tandy Corp.'s Radio Shack model 3 microcomputer was simple to develop. As STSC's APL language-processor programmer Phelps Gates will explain to a meeting of the Association for Computing Machinery in Washington, D. C., this month, there were "system integration problems."

One such problem was developing the custom ROM that the customer gets with the language and plugs in. According to Gates, all the ASCII symbols are supported, with only a few other infrequently used characters lost. However, if the user wants the full PC character set or cannot bear the obscurity of the APL symbols, he or she can turn to the English-like substitute notation for APL known as keyword form. This readable and printable notation, which will be made available in STSC's next APL release, is also ideal for printers that do not support APL symbols.

In developing a version of the language for the IBM microsystem, STSC at least did not have a problem that occurred with the model 3—that of too limited a memory space. Even after some little-used parts of APL like arithmetic progression vectors, data synonyms, concurrent access to the file system, and other less-known

APL: not for the uninitiated

APL is either a blessing or a curse, depending on how its unreadable notation and tightness of exposition are viewed. Its origins go back to 1962 when mathematician and computer scientist Kenneth Iverson came up with a special notation for expressing mathematical algorithms intended for data processing. This symbol set was meant to be a conceptual tool with which the algorithms could then be translated into a conventional programming language. A modified version of APL was developed in the late 1960s by International Business Machines Corp. as a language for its 360 mainframes, and since then, many variations of the language have appeared.

Interactive. APL is unique in that the language is interactive and a programmer can build, test, and modify programs dynamically with immediate execution of the expressions entered. Moreover, APL allows direct manipulation of data in arrays and files.

To improve the interactive programming process, APL's symbols invoke macros that handle any looping required at the object-code level. Further, APL primitive operations are designed from the start to be array-oriented: they can perform direct processing of entire data structures such as matrixes rather than only single elements, as is the case with Fortran or Algol. APL needs no program loops to do this; data is retrieved from arrays by using either Boolean operations or direct indexing.

APL can handle, in a few lines of code, what other languages may take pages to do. However, the price paid is great difficulty in reading the code for all except the initiated. It may take days to decode a few APL lines. The advantages the language offers to those who can handle it are conciseness, power, and elegance. As such, the language is suitable for quick programming, computation, and results. It is much less suitable for large programs for production environments, where software debugging and maintenance are primary concerns.

—**Harvey J. Hindin**

features were removed (as they are for both microsystem versions), there was too much code for the Radio Shack unit. There, the remaining code had to be divided into a portion to be permanently resident in memory and another that is stored in overlays on the system disk and loaded temporarily when needed.

Permanent code includes the interpreter core, the syntax analyzer, and the commonly used routines for language-primitive functions. The strategy guiding the division of this code, Gates says, was to separate input/put from computation wherever possible.

For the IBM computer, overlays are not used. All code is resident in memory at all times when the system is configured with a minimum of 128-K bytes of RAM.

Benefits. As it turns out, the APL environment can be enhanced on a microsystem in ways that are much more difficult in the case of a mainframe. For example, system functions allow the user to interact directly with the memory to examine or change its contents or to invoke machine-language routines directly. The close coupling of the keyboard and the system permits such niceties as slowing the display or automatic switching between the workspace in a PC and one in a remote computer.

Workspace switching is achieved by converting the PC from an intelligent into a dumb terminal or back again with either a keyboard or program command—a beneficial microsystem-to-mainframe integration feature. Other keyboard features include diagnostics, a help function, and graphics functions.

APL*PLUS/PC is available immediately for $595.

STSC Inc., 2115 East Jefferson St., Rockville, Md. 20852. Phone (301) 984-5000 [411]

Relational data base serves CTOS-based microcomputers

MicroRIM Inc. has developed a new version of the MicroRIM (Relational Information Management) relational data-base program that can now serve the large and growing market of microcomputers using Convergent Technology's CTOS operating system.

In addition to the CTOS version, MicroRIM is also available for the IBM Personal Computer and for other 8- and 16-bit hardware with the CP/M and MS-DOS operating systems. The microcomputer version of MicroRIM retains all the capabilities of the original version, which was used on mainframe computers in conjunction with the National Aeronautics and Space Administration's space shuttle project, and so it can be used to share data with the many companies and Government agencies already employing RIM.

MicroRIM provides column records and data formats and makes it possible to combine different tables of information. Its software includes standalone query, data-base definition, and report-writer capabilities. A full-screen entry and edit function loads data and changes the data base. Available now, it goes for $795.

MicroRIM Inc., 1750 112th Ave. N. E., Bellevue, Wash. 98004. Phone (206) 453-6017 [414]

Cross-compilers serve embedded microprocessors

Suitable for software development for embedded microprocessor systems, the InterPas/68000 and /8086 and InterC/68000 and /8086 series of cross-compilers initially will run on VAX minicomputers and soon will run on PDP-11 systems.

InterPas and InterC compilers are provided with a full set of development tools, including a librarian, a linker, a locator, and formatters that support popular data protocols for downloading software to emulation equipment or resident monitors. InterPas/68000 and /8086 compilers are based on the ISO standard and feature two precisions of integers and real numbers, an "otherwise" clause in case statements, global static data, and data initialization. In addition, they support an include facility and optionally produce source, object, and cross-reference listings.

InterC/68000 and /8086 C cross-compilers support the full Unix Version 7 C language. They feature separate compilation, enumeration types, the void datatype, plus a complete C preprocessor. In addition, InterC/8086 gives access to the entire address space of the 8086 through the use of 32-bit pointers.

InterPas/68000 and /8086 and InterC/68000 and /8086 all run on the VAX under Berkeley 4.1 Unix or VMS. They will be available on the PDP-11 under RSX-11M and Unix this summer. Both InterPas and InterC sell for $3,995.

Intermetrics Inc., 733 Concord Ave., Cambridge, Mass. 02138. Phone (617) 661-1840 [413]

CP/M-86 program puts system in touch with IBM machines

With MicroTech Exports' latest version of the Reformatter file-conversion package, complete files can be shuttled back and forth between microcomputers running under the CP/M-86 operating system and IBM computers.

Reformatter handles all conversion functions such as reorganization and ASCII-to-EBCDIC character translation and enables CP/M-86 users to read and write IBM diskettes in 3740 single- and double-density formats. Moreover, it can examine or alter any IBM file attribute and the volume identification of the IBM diskette, delete any active IBM file, examine any sector on an IBM diskette by specifying track and sector address, and display records in an IBM file.

Reformatter requires one 8-in. floppy-disk drive in a multiple-drive system. It runs on any single-density CP/M-86 and double-density CP/M-86 systems that support both single- and double-density diskettes. The file-conversion software also supports IBM Diskette 1 and comes on a standard 8-in. CP/M-86–compatible disk. The program sells for $350 and is available from stock.

MicroTech Exports Inc., 467 Hamilton Ave., Palo Alto, Calif. 94301. Phone (415) 324-9114 [415]

LocalNet™ keeps university students from learning too much.

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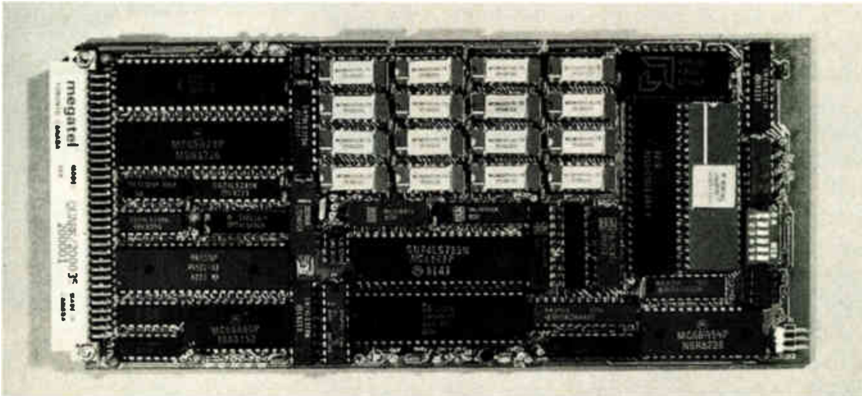
See us at NCC

Microcomputers & systems

Dense system card links to net

Small Z80B-based board holds 128-K bytes of RAM, graphics and Omninet interfaces



A complete microsystem including an interface linking it to a local network has been packed onto one small 3.9-by-8.8-in Eurocard. The Quark/200, a CP/M-compatible board, holds: a display interface with a programmable character set and a graphics mode; an interface for up to four double-sided, single- or double-density 8- or 5¼-in. floppy-disk drives; a full-duplex serial interface port as well as an output-only serial port (both RS-232-C-compatible); a parallel printer interface; and 22 general-purpose input/output lines for keyboard inputs and other I/O functions.

Also resident on the card is hardware for implementing the protocols of Corvus Systems' Omninet local net. A similar card, the Quark/100, does not have the networking facility [*Electronics*, Aug. 25, 1982, p. 150].

Programmable-array-logic technology and some gate arrays allow fewer than 50 integrated circuits to perform all of the control functions required for a complete stand-alone system. The card's 6-MHz Z80B microprocessor is supported by 128-K bytes of random-access memory, 2-K bytes of character-generator RAM, a bootstrap loader in a 512-byte programmable read-only memory, memory management for user and video RAM, and a 60-Hz real-time clock interrupt. Access to the Z80B's data bus and to a subset of its address and control lines is provided to allow the system designer to add special-purpose peripherals.

The on-card video display interface permits the direct connection of any standard direct-drive or composite-video monitors. This makes unnecessary the terminal required by many single-board computers. In the interface's alphanumeric mode, anywhere from 23 to 31 lines of 80 characters each can be displayed, depending on the monitor's capabilities. In its graphics mode, the Quark/200 supports a resolution of 640 by 224 to 248 bit-mapped picture elements.

The Omninet interface includes its own network processor, which relieves the host processor of many of the tasks required for communications. The interface implements the lower four layers of the International Standards Organization seven-layer network model; it retransmits and acknowledges the reception of messages without disturbing the CPU.

Memory-linked. Communications between the network interface and the CPU is by direct memory access. The network interface executes command blocks in memory set up by the CPU. Two I/O ports are provided in the Omninet interface for interrupt control, status, and commands.

Omninet supports up to 64 computers and carries data at transmission speeds of 1 Mb/s. The medium is an RS-422 differential twisted-pair cable up to 4,000 ft long.

The software that comes with the Quark/200 includes CP/M 2.2, the source file for the CP/M BIOS, a menu-driven installation routine to customize the BIOS for the target system, and a set of utilties. An optional demonstration package that includes MP/M II and CP/NET enables a user to link together several of the systems so that one acts as a file server and the rest as network slaves.

Power supply requirements for the Quark/200 are +5 V at 2.3 A and +12 V at 100 mA, the same voltages as required by 5¼-in. floppy-disk drives. A version for use with 50-Hz power systems is available.

The complete Quark/200, which sells for $1,260, includes software, an assembled and tested board, a transition board for making connections to the system board, connectors, hardware, and CP/M manuals. Quantity prices for the assembled and tested Quark/200 range from $645 to $860. Delivery is from stock.

Megatel Computer Corp., 150 Turbine Dr., Toronto, Ont., Canada M9L 2S2. Phone (416) 745-7214 [371]

Portable computer has modem, printer as standard features

Integrated into a single compact unit, Access, a transportable computer system, has as standard a high-speed dot-matrix printer, a direct-connect modular telephone jack and acoustical coupler, a 7-in. amber monitor, two high-performance double-density 5¼-in. floppy-disk drives, a low-profile detachable keyboard, 64-K of user memory, a Z80A microprocessor, a comprehensive software package, various input/output ports, a storage compartment for 10 diskettes, and a leather carrying case.

In addition to the full 64-K bytes of random-access memory, Access makes use of five microprocessors. The unit's printer delivers printouts at a rate of 80 characters/s.

Data can be printed as it is transmitted at an adjustable rate from 0 to 300 b/s. Displaying 80 characters/line on 24 lines, the amber monitor also has an extra 25th line for showing status and time.

Access sports one bidirectional parallel port that is Centronics-compatible, one fully implemented IEEE-488 port, and two RS-232-C serial ports with software-selectable rates up to 9,600 b/s. The two disk drives provide 184-K bytes of data storage per disk. Available optionally are double-sided, double-density disk drives for a storage capacity of 736-K bytes. Access is available with the CP/M 2.2 operating system. The software package includes Perfect Writer, Perfect Speller, Perfect Filer, and Perfect Calc. Available now, Access goes for $2,495.

Access Matrix Corp., 2159 Bering Dr., San Jose, Calif. 95131. Phone (408) 263-3660 [373]

Microcomputer is designed for use as a network station

Billed as a third-generation microcomputer, the Stearns computer is designed with communications in mind, to be used in two proprietary interactive communications networks: MicroNet, and later, the Intelligent Communications System (ICS). Additionally, it provides users with both data and word processing, neither of which is considered secondary and therefore subject to a loss of performance.

The stand-alone Stearns computer is compatible with the IBM Personal Computer (for data processing), running most of the programs developed for it at 2½ times the rate of the Personal Computer. Also supported are the 3270 bisynchronous, asynchronous, Systems Network Architecture, and Synchronous Data Link Control protocols.

The Stearns computer couples an Intel 8086 16-bit processor with an optional 8087 coprocessor used for mathematical functions. Also, peripheral support chips speed up internal processing. The computer can be configured with up to four 5¼-in. floppy-disk drives and up to two 5¼-in. Winchester disk drives. Both

draft- and letter-quality printers are available optionally.

As many as five individual work stations may be linked with MicroNet. All will share common data storage and other resources. An ICS network will handle up to 32 separate work stations, all interconnected in an exchange network. The basic ICS configuration is a star with a central minicomputer-driven node. Expansion is accomplished by linking multiple ICS clusters in a ring arrangement, with redundant path connections to ensure reliability.

Two operating systems are available: MS-DOS and CP/M-86. Languages supported include Basic, Pascal, Fortran, and Cobol.

Available in May, the single-disk version will sell for $3,300.

Stearns Computer Systems, 3501 Raleigh Avenue So., Minneapolis, Minn. 55416. Phone (612) 929-4400 [379]

Q-bus–based board is compatible with Munix

Based on the Motorola MC 68000 microprocessor, the QU 68000 is compatible with the DEC's Q-bus and Unix-based Munix operating system. It can replace a PDP-11/12 board that has run out of steam, according to the company, increasing system performance.

Users may transport their Unix-based software to the faster QU 68000 without expensive reimplementation, obtaining power the manufacturer compares with a VAX for less than the price of a PDP-11/12. The system offers a comprehensive memory-management scheme that supports Unix with virtual addressing space of up to 16 megabytes, an efficient C compiler that supports a variety of Unix-based software tools and languages, and a dual-bus, dual-port–memory configuration that allows uninterrupted, high-speed input/output data transfer and direct-memory access.

The QU 68000 board and Munix software are priced at approximately $3,000 each in single quantities.

Cambridge Digital Systems, P. O. Box 568, 65 Bent St., Cambridge, Mass. 02139. Phone (617) 491-2700 [374]

VME bus gets CPU with 16032 plus memory, graphics cards

Original-equipment manufacturers wishing to couple the 32-bit power of the Versa Module Europe (VME) bus with National Semiconductor's 16032 microprocessor can now do so with a 16-slot VME card cage, four boards, and an operating system and high-level languages to support the cards. Available are a 16032-based central-processing-unit card, a 256-K-byte memory card (expandable to 1 megabyte), a graphics card that supports a resolution of 1,024 by 1,024 picture elements, and a peripheral-interface card.

The CPU card uses the 16032 and the 16082 memory-management unit to provide demand-paged virtual memory. It also has an option to add the 16081 floating-point unit.

The memory card uses 64-K random-access memory chips to achieve its total 256-K bytes. The graphics card supports 1,024-by-1,024-pixel resolution and can be upgraded to red-green-blue or eight-level gray scale with another card. The peripheral-interface card provides a direct-memory-access SASI disk interface, three RS-232-C serial interfaces, and a parallel printer interface.

The cards are available 90 days after receipt of order and are priced at $2,756 for the CPU card, $1,856 for the memory card, $1,609 for the graphics card, and $1,218 for the interface card. The card cage is $1,095.

Elite Corp., 906 N. Main, Wichita, Kan. 67203. Phone (316) 265-0959 [376]

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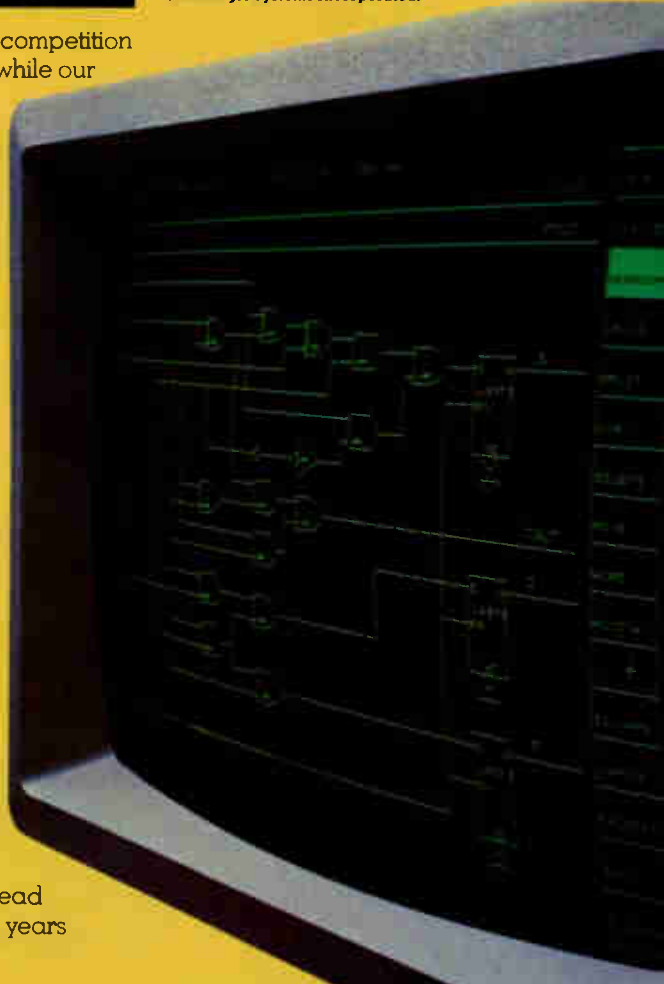

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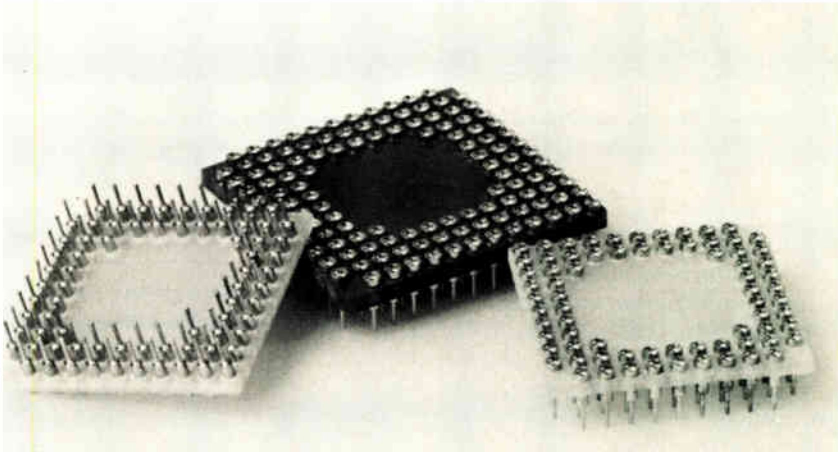
Circle 183 on reader service card

Packaging & production

Pin-grid socket eases insertion

Machined contacts of sockets for pin-grid–array packages cut insertion and withdrawal forces



Users of leadless ceramic chip-carriers are often bedeviled by the lack of thermal compatibility between the package and printed-circuit board. The pin-grid array, with its matrix of pins on 100-mil centers, experiences no thermal-mismatch trouble and so seems certain—at least for a while—to be a popular package for the gate arrays and very large-scale integrated circuits now appearing with 64 or more input/output leads.

Because these chips are expensive, in many applications they will be socketed rather than soldered directly to a board. The PPS series of pin-grid–array sockets from Augat aims to serve the needs of these integrated circuits. Sockets are available in versions for chips with 64, 68, 72, 73, 120, 121, 148, and 149 pins.

Package pins mate with cup-like contacts mounted on the socket. Rather than using the standard stamped inner contact adopted by the rest of the industry, Augat opts for a machined inner contact, which enables it to hold to much tighter contact tolerances to ensure a uniform performance with the higher–pin-count packages. The less precise tolerances of stamped inner contacts result in excessive insertion and withdrawal forces—a real problem when high pin counts are involved.

The PPS sockets' machined contacts reduce insertion force by more than 50% compared with stamped and formed inner contacts, according to Augat. With an 0.018-in. pin diameter, the average insertion force for the Augat socket is 3.4 oz and average withdrawal force is 3.0 oz. The operating temperature range is -55° to +125°C.

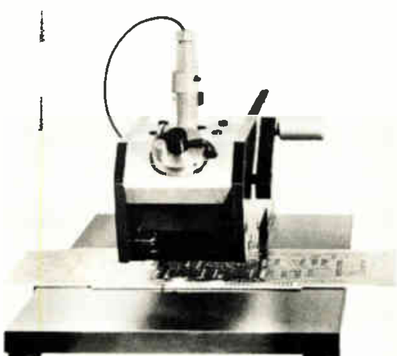
The base of the socket is 0.062-in. glass epoxy material. The socket's pins may be soldered or wire-wrapped. Pricing is on a per-contact basis, ranging from 4¢ to 6¢ per line, depending on quantity. Deliveries are from stock to three weeks.

Augat Inc., Interconnection Components Division, 33 Perry Ave., P. O. Box 779, Attleboro, Mass. 02703. Phone (617) 222-2202 [391]

Beta-backscatter system has optical device-positioning probe

Designated the CB-4, a beta-backscatter probe system for measuring gold, copper, tin-lead, and photoresist on printed wiring boards features an optical positioning system that makes it possible to align and measure very small areas of boards. Once a board is placed in the CB-4, the exact area to be measured by the HH-3 miniature probe is illuminated.

Interchangeable reticles, included with the system, correspond exactly in size and shape to the specimen masks used on the unit's HH-3 probe. A cross-hair reticle is also available. Probes may be instantly interchanged by simply pulling one out and inserting another.



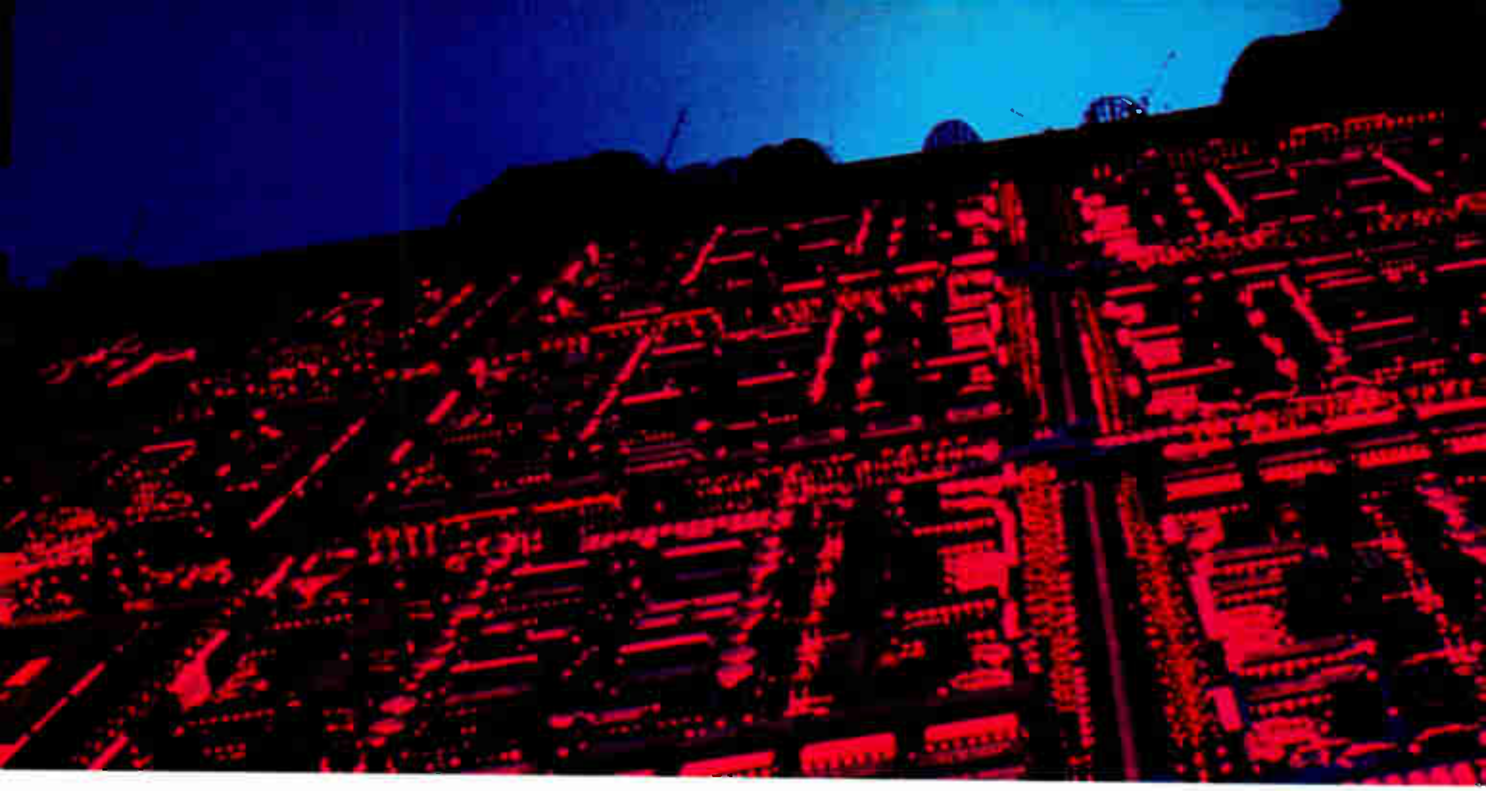
The standard CB-4 probe system permits measurements to be made up to 6 in. in from any edge of a board. An extended version allows measurements up to 14 in. from any edge. Available in two weeks, the CB-4 is priced at $1,695; probes go for $850 each.

UPA Technology Inc., 60 Oak Dr., Syosset, N. Y. 11791. Phone (516) 364-1080 [393]

Magnetron-enhanced ion unit etches silicon dioxide rapidly

Billed as the first magnetron-enhanced ion etcher, the MIE 710 system combines the best features of fast, high-pressure plasma etching with slower and lower-pressure reactive-ion etching. Previously, the company claims, it was necessary to select either fast etching with its accompanying high pressures (typically over 500 millitorrs) or slower reactive-ion etching with its pressures around 10 millitorrs.

Another sacrifice required for fast etch rates was limited anisotropy and resist integrity. Reactive-ion etching, on the other hand, gave slower rates but excellent vertical-wall etching. The magnetron-field MIE 710 produces vertical-wall etching for both



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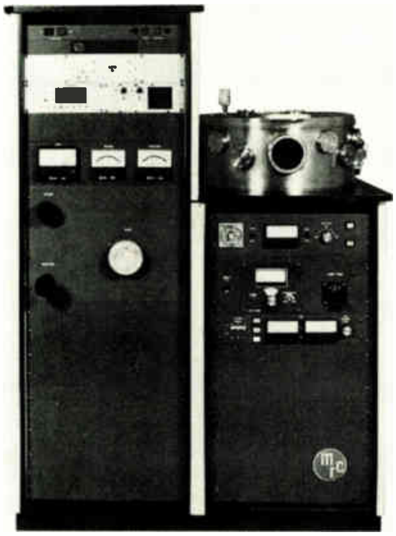


silicon and silicon dioxide. It has produced etch rates of over 3,000 Å/min on SiO_2 and can be employed for materials like gallium arsenide, for which the technique previously was impractical.

The MIE 710 reduces the potential for radiation damage by employing only low-voltage plasma sheaths at the substrate. Available after May's Semicon West show, the MIE 710 will sell for under $300,000.

Materials Research Corp., Orangeburg, N. Y. 10962. Phone (914) 359-4200 [394]

System grows 75-mm GaAs crystals with 4-kg charges

Attempting to help meet a demand for gallium arsenide chips that it expects to pass the $1 billion mark by 1990, Cambridge Instruments is introducing two high-yield crystal-growth systems. The technology employed in both the CI-351 and CI-354 systems is matched to industry requirements for large, circular undoped GaAs wafers.

The CI-351 uses 1-kg charges and produces 50-mm crystals; the CI-354 has a charge capacity of 4 kg and is capable of producing crystals 75 mm wide. Guaranteed to produce at least 50% yields, both machines incorporate facilities for continuous monitoring of crystal shape, plus automatic diameter control. Most crystals can be grown in less than 36 h.

Both crystal-growth systems have chambers that are more compact than those in earlier models. A newly designed cantilevered crystal-pulling mechanism has lowered the overall height of the system. Operator convenience has also been improved by the addition of a desktop console for monitoring and controlling the systems.

Available in about four to six months, the CI-351 is priced at $191,000 and the CI-354 sells for $299,000.

Cambridge Instruments Inc., 40 Robert Pitt Dr., Monsey, N. Y. 10952. Phone (914) 356-3331 [395]

Plasma system etches 6-in. wafers at a 40/hour rate

A series of tabletop systems using fluorine- or chlorine-based processes for automatic plasma etching can process up to 40 wafers/h. Systems are available in three versions for etching polysilicon and nitride (model 600F), oxides (model 600FX), and aluminum and aluminum alloys (model 60C), and there are two models in each version for handling 3- and 4-in.-diameter wafers and 5- and 6-in.-diameter wafers.

The Plasmafab 600 series incorporates many of the design features in the firm's larger, high-production models. For example, it includes a similar high-reliability Omega Track wafer-handling system without bulk, vibration, friction, or complex in-vacuum mechanics.

A system using optical spectroscopy to detect end points ensures that every wafer is etched exactly to completion, regardless of starting thickness or process variations. The tabletop systems accommodate standard 25-wafer metal or plastic cassettes. The plasma-etching system's 500-W power supply is credited with making it simple, reliable, and capable of high etching rates.

Priced from $$85,000 to $126,000, systems can be delivered in three to five months.

ET Electrotech Inc., 40 Oser Ave., Hauppauge, N. Y. 11788. Phone (516)231-3700 [396]

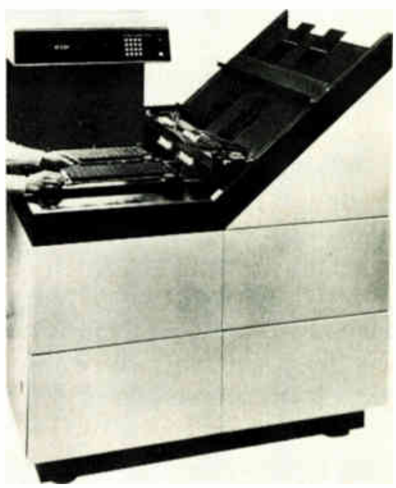
Automatic IC inserter boasts rates of 54,000 an hour

At 54,000 devices/h, the Innovation III automatic loader, which inserts integrated circuits into burn-in board sockets, does so at five times the rate claimed for any other loader now offered, its maker asserts. Taking into account operator efficiency, time required to load ICs, and nonloading time when boards are moving into position and being replaced after loading, actual throughput is said to be 15,000 devices/h.

The company claims that the cost of loading devices is reduced from $12.50 per 1,000 devices inserted manually to $2/1,000 with the Innovation III. The microprocessor-based system has stepping-motor control of positioning for precise registration of sockets to devices, a device ejector for the removal of devices before they reach the burn-in board, and sensors that alert operators to low supplies of ICs waiting for loading.

Detection of jams, low IC supply, low air pressure, and operation modes are signaled to the operator by visual displays, with alarm signals also available. The Innovation III goes for about $40,000 and is available in 14 to 16 weeks.

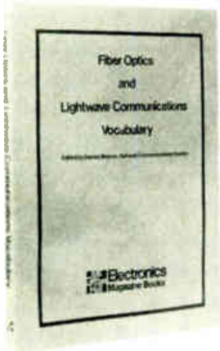
Reliability Inc., P. O. Box 218370, Houston, Texas 77218. Phone (713) 492-0550 [397]



Data Communications Books.

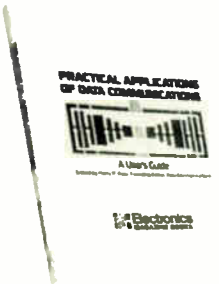
Basics of Data Communications
This compilation of essential articles from *Data Communications* magazine includes chapters on terminals, acoustic couplers and modems, communications processors, networking, channel performance, data link controls, network diagnostics, interfaces, and regulations and policy. Pub. 1976, 303 pages, softcover.
Order No. R-608, $15.95.

Data Communications Procurement Manual
The information you need to turn data communications procurement into a smoothly running, cost-effective operation. Includes sample solicitation clauses and forms, specification checklists on 38 devices, and 8 useful appendixes. By Gilbert Held. Pub. 1979, 150 pages, clothbound.
Order No. R-925, $24.50.



Fiber Optics and Lightwave Communications Vocabulary
The basic reference document on fiber optic and lightwave communications for those who design, develop, operate, use, manage, or manufacture data communications or data processing equipment and components. 1400 entries, with inversions and cross-references, and index of terms. Edited by Dennis Bodson. Pub. 1981, 149 pages, softcover.
Order No. R-030, $12.95.

McGraw-Hill's Compilation of Data Communications Standards
Presents verbatim reprints of all 123 interface protocol data communications standards promulgated by International Telegraph and Telephone Consultative Committee (CCITT), International Organization for Standardization (ISO), European Computer Manufacturers Association (ECMA), Electronic Industries Association (EIA), American National Standards Institute (ANSI), and U.S. Government (NCS and NBS). Special feature for easy access to applicable standards: cross-reference tables of standards produced by each of these groups corresponding to similar standards published by the others. Edited by Harold C. Folts. Pub. 1981, 1923 pages, clothbound.
Order No. R-100, $250.00.



Practical Applications of Data Communications
Selected articles from *Data Communications* magazine cover architecture and protocols, data-link performance, distributed data processing, software, data security, testing and diagnostics, communications processors, and digitized-voice and data-plus-voice. Pub. 1980, 424 pages, softcover.
Order No. R-005, $17.95.

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Circle 188 on reader service card

Products newsletter

Relays include IC for microprocessor link

Billed as the third wave in relays, the nine-member IC relay family shown this week at Electro/83 by Aromat Corp. of Mountainside, N. J. (a subsidiary of Matsushita Electric Works), have built-in integrated circuits and can be applied directly to intelligent control systems. Five types are known as the C unit relays and are characterized by extremely low power consumption (0.002% that of a polarized nonlatching relay), and four are known as the C3 relays, which have numerous functions that enable them to be directly connected with a microcomputer. **The five C relays, combined with a bipolar IC, operate exactly like common single stable relays but use less power.** With an IC designed exclusively for signal processing, the C3 relays can perform set, reset, monostable, toggle, and automatic set and reset functions. Priced at $7 to $10 each in lots of 500, the relays can be delivered in four to six weeks.

Portable logic analyzers weigh in at just 11 lb

The 300 family of portable logic analyzers, results of the joint venture between Sony Corp. of Japan and Tektronix Inc. of Beaverton, Ore., gets two more members as of next month. The compact 11-lb units offer state and timing analysis, as well as three levels of triggering. The 318, priced at $5,300, provides 16 parallel channels of data acquisition at up to 50 MHz. The 338, for $5,800, delivers thirty-two 20-MHz channels. **The use of large-scale integrated gate arrays is credited with the low weight.** One chip has 828 gates used for counting, multiplexing, and latching; a second with 797 gates does clocking and decoding.

ROM's access time drops to 250 ns

NCR Corp.'s Microelectronics division in Miamisburg, Ohio, is now offering maximum access times specified at 250 ns on 64-K read-only memories. Priced at $5 each in 10,000-unit quantities, the NCR 2364-25 is organized as 8-K by 8 bits and is **housed in a 24-pin package that is pin-compatible with 2564-type erasable programmable ROMs.** As with the company's slower 64-K ROMs—the 300-ns 2364-30 and the 450-ns 2364-45—turnaround times on the 250-ns device are promised at six weeks. A faster, four-week cycle is available for an extra 50¢ a chip.

Single-mode optical fiber breaks $1/meter barrier

Single-mode 630- and 820-nm optical fibers with maximum attenuations of 15 and 6 dB/km, respectively, are now offered at 95¢ a meter by Lightwave Technologies Inc. of Van Nuys, Calif. **Premium grades with maximum attenuations of 10 and 4 dB/km are available** at $1.50 a meter. Delivery is from stock.

Enhancements ease use of business computer

Making the Unidata 3000, a small business computer with an integral application-program generator, even easier to use are several enhancements, among them a full-screen editor, password sign-in, multiple levels of user coaching, integrated help messages, and a 15-megabyte Winchester disk drive. The full-screen editor lets users of the Portsmouth, N. H., firm's computer [*Electronics,* Jan. 13, p. 224] put the entire form being designed on screen; **at sign-in various interactive coaching lessons are available, selectable to suit the user's experience level.** The enhancements are free, but the disk drive sells for $3,000.

Uncle Sam wants you

"The level of responsibility in this job is one of the neatest things for engineers." So says Andy A. Watts, a civilian engineering manager employed by the U. S. Army. "The primary thing the Government has, and it's intangible and hard to explain, is that you receive a great deal of authority and responsibility very early in your career, more so than in private industry," he explains.

Watts's title is militarily precise and typically complex: chief of the Communications Engineering division for U. S. Army Communications Electronic Engineering Installations Agency–Continental United States. The unit engineers and installs all communications at all domestic Army installations—telephone, radio, and microwave. He works at Fort Ritchie, Md., which is in the western part of the state, not far from Camp David and about 60 miles from both Baltimore and Washington, D. C.

Tough contest. Watts's spur is the Federal establishment's shortage of engineers. "It's tough to compete with industry," he says. He points to a recent survey of engineers in the Washington area by the Institute of Electrical and Electronics Engineers that indicates that until a Government engineer reaches the mostly supervisory GS-13 level, or $34,930, salaries in private employment are 10% to 15% better. It can take 10 or 15 years to reach that level, with each advance (one per year is permitted) corresponding to a promotion in private industry.

A freshly minted bachelor of science, a GS-5, gets $17,383, but those with honors or high academic standing can get around $21,000. But, adds Watts, the chance to be in on a project and in charge of its destiny from the start makes up for that.

"We have the opportunity to control a project from beginning to end with almost total control of technical decisions; we don't just handle bits and pieces of several ongoing projects." It is not unusual for a young EE just a year out of college to take on such technical responsibility. He or she would specify components, talk to vendors, travel around the country to meet with users, Watts says. "You're telling people what the 7th Signal Command and the U. S. Army Communications Command can do for them after they've told you your needs." Right now, he adds, his operation is "inundated by projects."

Still, working for the Federal government is in general going to lose some of its pay-and-benefits luster. What has long been a major attraction in Government work, liberal pension benefits, are going to be reduced significantly, says Watts, as the result of an ongoing overhaul of the Federal retirement system. Retirement after 30 years of service at age 55 with 50% pay will become a thing of the past. And starting in January 1984, new employees will be covered by Social Security.

Vacations are more or less comparable with those offered in the private sector, ranging from two weeks to start to up to 4½ weeks after 15 years. Health programs also match up, except that the employee must pay 40% of the premium.

Watts, a 41-year-old Texas A&M graduate who was at Texas Instruments Inc. for a few years, has been at Fort Ritchie for seven years after working also in other domestic installations and in Europe. He emphasizes that the need for engineers is strong. "I see ads in the weekly Federal Career Research Service publication for positions paying $17,000 to $30,000 that run week after week. There are virtually no applicants."

Cannot fill slots. At his own post, Watts says, the need is critical. "We can't hire the authorizations we have," he says. In his engineering division, 88 technical persons of all types are authorized and 71 are now working there. There are five GS-5 positions open plus two others that pay $30,000.

One of the things that the Government has done to attract more engineers is to make it easy for them to join the Federal work force. The means is so-called direct hire: that is, each installation can do its own recruiting and hiring of new employees. **–Howard Wolff**

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