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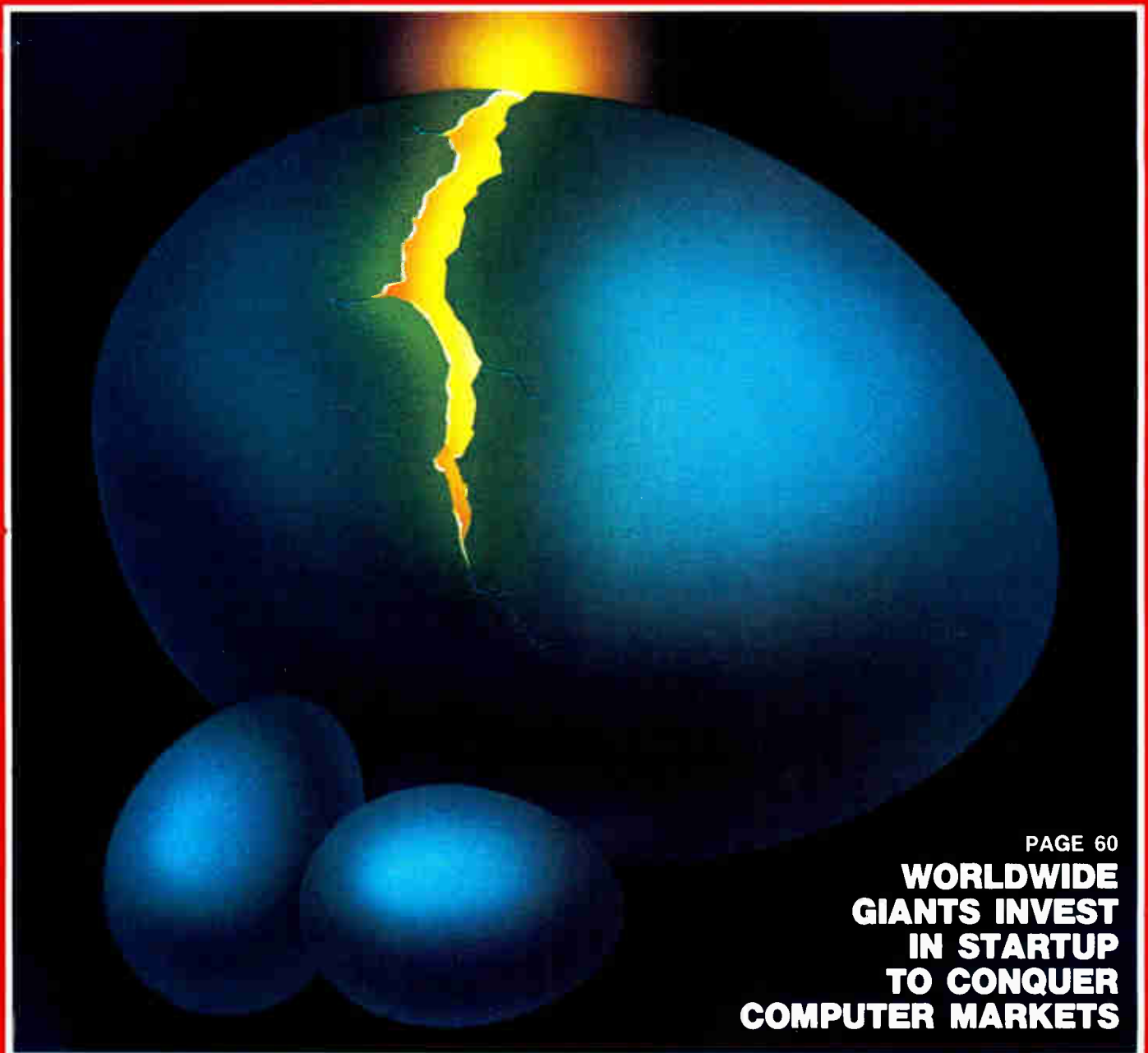
Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY

JANUARY 27, 1986

HOW A NEW VENTURE STARTED UP BIG



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WORLDWIDE GIANTS INVEST IN STARTUP TO CONQUER COMPUTER MARKETS

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World Radio History

ADEMARK OF NATIONAL SEMICONDUCTOR CORPORATION.
OF AT&T BELL LABORATORIES

World Radio History

"We did it!"

"I knew we'd close that sale. Did you see their faces?"

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"Looks like we made all the right decisions at the right times."

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World Radio History

JANUARY 27, 1986 VOLUME 59, NO. 4

Electronics

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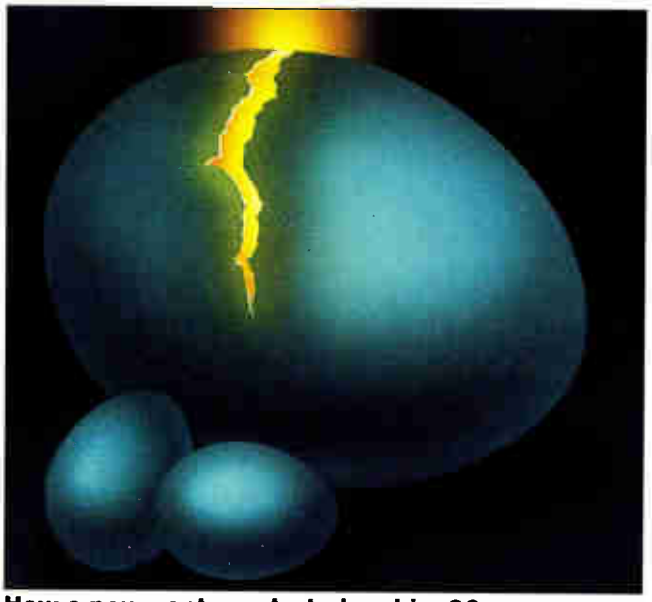

How a new venture started up big, 60
A computer startup with the backing of three giant global partners—AT&T, Kyocera, and British & Commonwealth Shipping—may turn out to be the ultimate in strategic alliances. In fact, Counterpoint Computers' backers are calling it the model of the next vehicle for economic power in the worldwide electronics industry

Cover illustration by Jeffrey Lynch

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There isn't much happening in the electronics industry that *Electronics* doesn't cover, but we confess that we have been neglecting one area—books. With this issue, however, we are beginning a regular column of reviews; it appears on p. 8.

Hitting the books will be Ann Jacobs, who when we last visited her [*Electronics*, Nov. 18, 1985, p. 5] was recreating Victorian needlework when she wasn't writing and editing stories as assistant editor of the New Products section. Ann, a Detroit native who has worked for the University of Chicago Press and the McGraw-Hill Book Co., has also been a book reviewer. She put in three years sorting the good from the bad from among the thousands of books turned out by the publishing industry when she worked the culture beat for the Northwest Arkansas Times, a daily newspaper published in Fayetteville, Ark.

"We want to present our readership with the most recent, pertinent information we can get on what is available between hard covers," says Ann. To do that, she will poll 50 mainline publishers, including trade (general interest) and technical houses. "Also, we are not going to neglect the specialized-publications departments of large manufacturers in the electronics industry, such as Texas Instruments Inc. and Digital Equipment Corp."

She is zealous about her work. "Even in these days of the so-called cool media, where the trendy are tuned in to flashing images and full-volume speakers, it is no less true that important information and knowledge are to be found on the printed page," she says.

Our selection policy will be to consider for review books for engineers, designers, and managers that advance the state of the technology or show the reader how to apply it successfully—in short, books of general interest to the electronics engineering community. We will not review software or any of the seemingly unending stream of books that are being published to help users of personal computers become better friends with their machines.

BOOKISH. Ann Jacobs will hit the books.

And here's a special note for all followers of our long-running New Literature feature: the column will appear every other week, alternating with the Books column. This feature will continue to keep readers abreast of what's new in the world of catalogs, booklets, application notes, and other technical publications of that sort.

Laurence Altman

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WEEK 14

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It's full CMOS, and powers down to 50μA. Its 45ns access time and 4K x 4 configuration is ideally suited to signal processing. And its high-performance CMOS process is remarkably radiation resistant.

Am99C68/Am99C88

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On the other hand, our 8K x 8 Am99C88 is the stuff power-frugal navigation and communication systems are made of.

The Am99C88 also uses our rugged, high-performance CMOS process. Plus, it's available with low power-down current and access times down to 70ns, to match the requirements of virtually any design.

Both of these new memories are available in popular military packaging. And both can be ordered to commercial specifications, so commercial designers can capitalize on these power-saving benefits as well.

The Am99C68 and the Am99C88. Now your design efforts won't go to waste.

WEEK 15

When we numbered our new Bipolar Gate Array Family the Am3500, we goofed.

Am3500 Family

Wrong number.

True, 3500 is the actual number of gates. Only, our counting method is very conservative. If we counted like everybody else, the figures would rightly be 5000 for our Am3500, 3700 for our Am3525, and 5200 for our Am3550.

We thought about changing the part numbers. But, by then, the marking machines were marking and the shipping department was shipping.

Now, all we can do is remind you the only time you need a number around 3500 is when you're ordering. Otherwise, just remember 5000, our equivalent gate density. (A density, by the way, 50% greater than comparable arrays.)

Of course, it's just as important that you remember each part is fabricated using our IMOX™ three-layer metal process, for fewer constraints when placing our high-level macros.

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Better yet, when deciding on a gate array, simply remember that the wrong number is the right call.

WEEK 16

If you're designing a graphics system, our new Am8158 Video Timing Controller will give you the time to do it right.

Literally.

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Am8158

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WEEK 17

Simply replace your current chips with our new Am2130 1K x 8, Dual-Port Static RAMs, and you've got a memory made for sharing.

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Am2130

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KALMAN FILTERING: THEORY AND APPLICATION

Harold W. Sorenson, editor
IEEE Press
$58.95 ($35.35 members)
plus $2 shipping/457pp

It's appropriate that the IEEE should publish this book in the year of Halley's Comet, because the set of recursive equations known as the Kalman filter grew out of Karl Friedrich Gauss's least-squares method, which consists of equations for computing the orbits of comets. This volume includes 20 applications papers and 23 papers on theoretical considerations.

Kalman's 1960 publication of the equations that constitute the filter coincided with the needs of the information community for an across-the-board method that engineers could apply without completely understanding the underlying mathematics. The Kalman filter, whose basic function is to provide estimates of the current state of a system, has been extended to solve problems of dynamic modeling in disciplines as disparate as satellite tracking and beef cattle demographics, as this volume demonstrates. The editor is a professor of engineering sciences at the University of California, San Diego, currently on leave to serve as chief scientist of the U. S. Air Force.

HANDBOOK OF TRANSFORMER APPLICATIONS

William M. Flanagan
McGraw-Hill Book Co.
$49.50/432pp

The material in this handbook on all types of transformers is intended for the designer, the builder, and the end user. It opens with a chapter on the fundamentals of magnetic circuits, then moves on to consider circuit analysis and the types of transformers: power, audio and wideband, pulse and multiple-phase, and rectifier and inverter. One chapter covers iron-cored devices that resemble transformers and are usually designed and manufactured by transformer facilities. Flanagan also details materials, mechanical and thermal considerations, and insulation systems. Under the economics of magnetic devices, he delves into size-weight-cost relationships and procurement practices. Flanagan has 37 years of experience in the transformer field.

LOGIC TESTING AND DESIGN FOR TESTABILITY

Hideo Fujiwara
The MIT Press
$35/284pp

Computer designers, logic designers, and test designers should all find this book useful. Part I focuses on test generation, fault simulation, and complexity of testing. Part II takes up design techniques that minimize the cost of test generation and test application; scan design for sequential logic circuits; compact testing, such as signature analysis; built-in testing; and various design techniques for testable systems. The organization of the material also recommends the book as a text for a graduate-level course in computer science. The author is an associate professor in the Department of Electronics and Communication, Meiji University, Japan.

THE SALES MANAGER'S GUIDE TO MILITARY PRINTED-CIRCUIT OPPORTUNITIES

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This guide is organized into four modules, each profiling a different company's needs for military printed-circuit boards. It is intended for pc-board makers who appear on the qualified products list of MIL-P-55110. The publisher interviewed 67 pc-board purchasers at Ford Aerospace and Communications, Hughes Aircraft, Lockheed, and Loral. A summary table describes buying practices of each of the companies. It also identifies those buyers who are interested in expanding their vendor base. The final section of the guide is a geographical cross-index of the companies by location. Orders should be sent to Stephen E. Grossman Inc., 146 Main St., Los Altos, Calif. 94022; phone (415) 941-6222.

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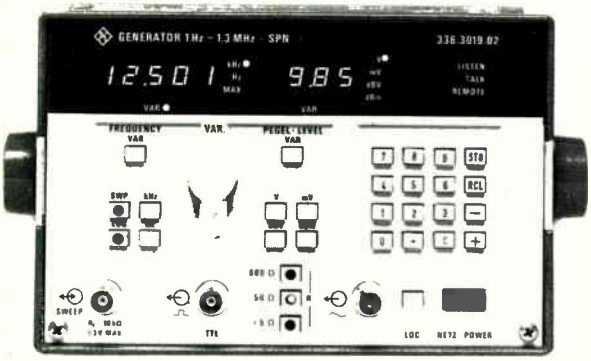
SILICON-ON-INSULATOR: ITS THEORY AND APPLICATIONS

S. Furakawa, editor
$59/295pp
KTK Scientific Publishers/D. Reidel Publishing Co.

These two volumes contain the papers presented during the U. S.-Japan seminar, "Solid Phase Epitaxy and Interface Kinetics" held in Oiso, Japan, June 20-24, 1983. Topics included solid-phase epitaxy, growth mechanisms and interface kinetics, silicon-on-insulator structures, silicide-on-Si structures, and novel nanometer and layered devices—more than 50 papers were harvested from the meeting. Each paper is preceded by an abstract, and the full text is given in English. The editor is a member of the Department of Applied Electronics at the Tokyo Institute of Technology.

World Radio History

Small but mighty for lab and service



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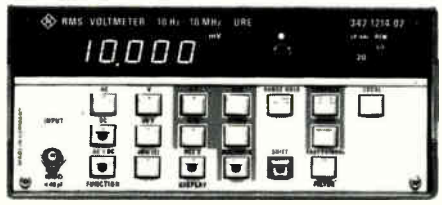

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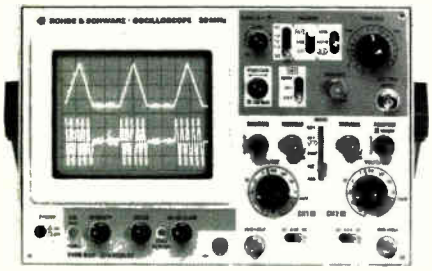
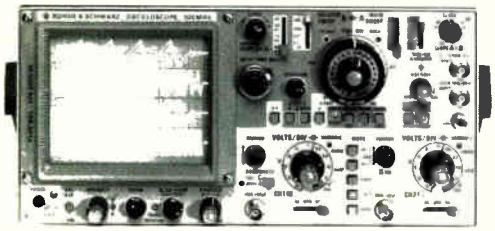


Oscilloscope BOP · DC to 30 MHz (above)
Value-for-money 2-channel scope for production and service. Sensitivity 1 mV/div to 2 V/div, timebase 20 ns/div to 0.5 s/div; deflection error ±3 % (from 5 mV/div). Autotrigger and TV field or line sync triggering. Built-in 1-kHz calibration source. Modes: CH1, CH2, CHOP, ALT, XY, AC, DC, × 10 timebase.



Oscilloscope BOL · DC to 100 MHz (below)
High-grade 4-channel scope for lab and R & D. Sensitivity 2 mV/div to 5 V/div; 2 independent timebases for 2 ns/div to 0.5 s/div; deflection error ±2 %. Autotrigger, variable holdoff, TV field or line sync triggering. Built-in 1-kHz calibration source. Modes as for BOP plus 8-trace display (4 signals and 4 magnified extracts).

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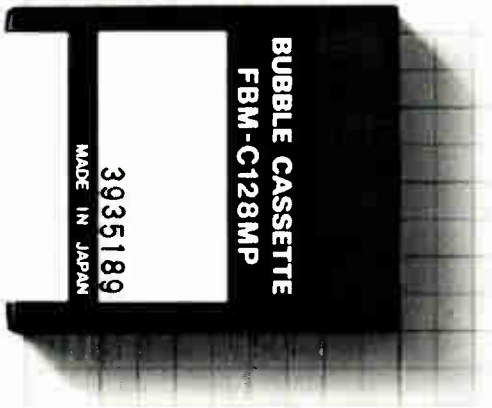
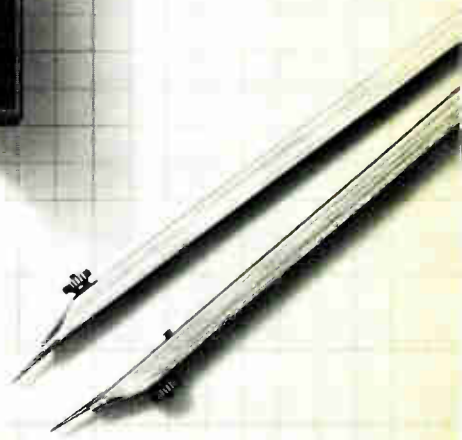
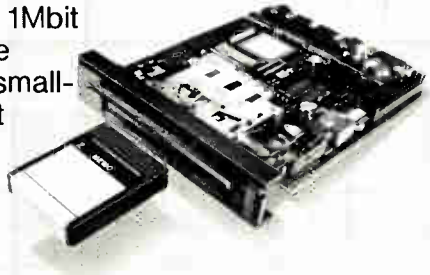




Smallest in size, bigger in memory.

Fujitsu introduces world's smallest 1M bit compact bubble cassette.



Fujitsu's unique 1Mbit compact bubble cassette is the smallest and thinnest memory of its kind in the world. It's also lightweight, easy to carry, dust-proof, shock-resistant and maintenance-free with no mechanical parts, so it's ideal for use in hand-held terminals of every kind. And it features a fast access time of 12.8ms and 8-bit parallel interface. For full details on this amazingly compact, high-performance memory system, contact the address below.

Major Specifications

Compact cassette	FBM-C128MP
Holder unit	FBM-U550GA
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Sub-pages	192 bytes
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Interface	8-bit parallel (DMA capability)
Transfer rate	100K bits per second (max)
Transfer method	64 bytes block transfer
Dimensions	
FBM-C128MP	52(D) x 43(W) x 11(H) mm
FBM-U550GA	156(D) x 125(W) x 25(H) mm

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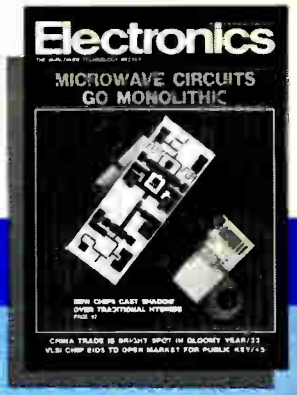

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TECHNOLOGY NEWSLETTER

TI CHIP HEADS FOR FAST LANE OF DIGITAL SIGNAL PROCESSING

Look for a development disclosure by Texas Instruments Inc. in the coming weeks on a new fast digital signal processor it is revving up—the TMS320C25. The 1.8-μm CMOS processor runs twice as fast as TI's current speed champ, the n-channel 32020. In addition to brute speed, the 320C25 contains an enhanced reduced-instruction-set-computer architecture that can boost throughput as much as three times over the 32020. Special instructions have been added for a number of applications, such as adaptive filtering. The 320C25 will operate at 100 ns and contains 4-K by 16 bits of masked read-only memory. It has the unusual capability to concurrently perform direct-memory access of off-chip memory while executing algorithms from its own internal storage. Samples are expected in limited quantities in the first half, with a formal introduction by year's end. □

PORCELAINIZED STEEL SUBSTRATES GET A BOOST

Porcelainized steel substrates may finally see their day, thanks to a joint technology agreement between CTS Corp., Elkhart, Ind. and Fujikura Ltd., Japan. Although a promising low-cost, rugged, versatile substrate for thick-film hybrids, these substrates haven't taken off because sodium impurities in the porcelain tend to contaminate semiconductors. The agreement makes it possible to combine CTS's metal and conductive paste technology with a near-zero-sodium-content porcelainized steel from Fujikura. CTS is already supplying prototype thick-film circuits on the new substrates. Near-term applications include automotive electronics and military equipment. □

A BETTER WAY TO MEASURE TRANSISTOR SPEED

An electro-optical sampling technique that was developed at the University of Rochester's Laboratory for Laser Energetics could become a new standard for measuring transistor and circuit speed. Femtosecond laser pulses (1 fs = 10^{-15} s) are used in conjunction with a voltage-sensitive crystal to accurately measure events as brief as 300 fs in duration. Refined since its development in 1982 by the lab's senior scientist Gerard A. Mourou and Janis Valdmanis [*ElectronicsWeek*, Sept. 17, 1984, p. 38], now of AT&T Bell Laboratories, the technique recently proved its mettle by measuring a 5-ps room-temperature switching time on a new gallium arsenide permeable-base transistor developed at the Massachusetts Institute of Technology's Lincoln Laboratory. Standard nonoptical ring-oscillator measurement techniques are useless below 8.5 ps, according to the lab. Proof of the electro-optical method's utility had to await the development of devices as fast as MIT's GaAs transistor, says Mourou. □

MASSIVE NETWORK PLANNED BY UNIVERSITY OF MICHIGAN

The University of Michigan is launching plans for a massive effort to involve 5 to 10 industrial partners and a new university-funded organization known as the Center for Information Technology to develop what the school calls "the most advanced information technology environment in public higher education." The object is a network that will tie together the school's main campus in Ann Arbor with satellite campuses in Flint and Dearborn, linking some 20,000 work stations by the end of the decade, says Douglas E. Van Houweling, the school's provost of information technology. Though equipment and software from many different vendors will be employed, "the goal is to present a single system image to the user," says Van Houweling, with computer-based resources widely distributed and available to all students and faculty through any work station on the net. □

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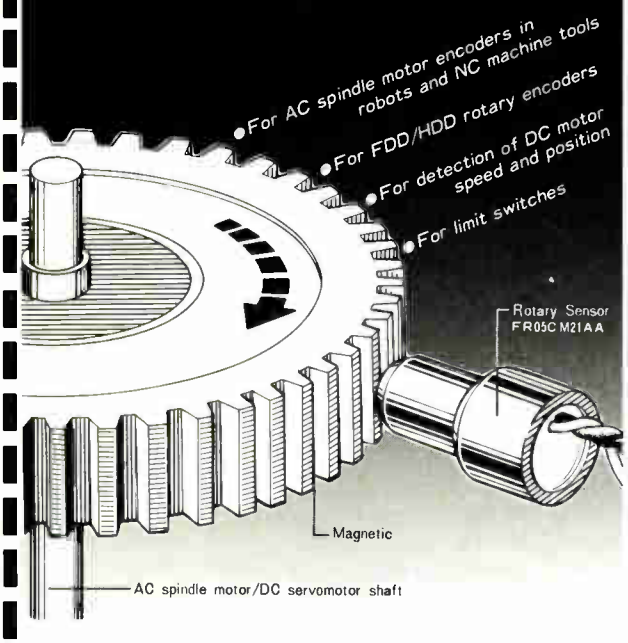
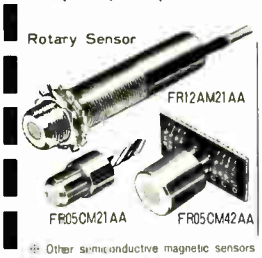
ROTATION AND POSITION DETECTION
For Office and Factory Equipment

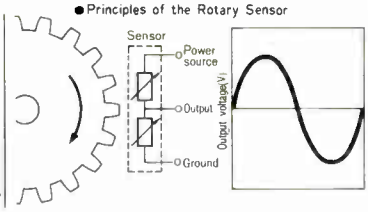


●Consists of a semiconductive magnetoresistor and a permanent magnet. ●Senses position deviation at any speed: when the object is at rest or moving rapidly. ●Rotating magnetic gear generates output voltage. ●Higher sensitivity and resolution. Plus, excellent temperature characteristics and frequency response. ●Low cost.

Rotary Sensor



●Principles of the Rotary Sensor



※ Other semiconductive magnetic sensors

●Non contact proximity angle sensor ●Pattern recognition sensor ●Vaccum switch ●Hall element

ROTARY SENSOR

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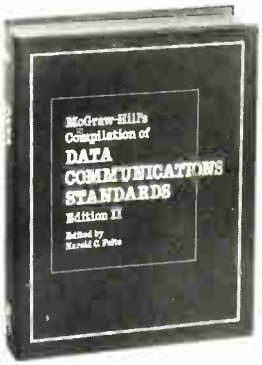

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ELECTRONICS NEWSLETTER

FRANCE MAKES BID TO SUPPLY SOVIET COMPUTER-EDUCATION DRIVE

The USSR intends to launch a nationwide computer-education program using Western technology—and a French consortium hopes to fill a significant portion of the resulting order. Two French nationalized electronics companies, Thomson SA and Bull SA, have joined in the consortium with several French software publishers and Leanord SA, a personal computer manufacturer based in Lille. Together, they have set their sights on supplying 10% to 20% of the 500,000 to 1 million student work stations the Soviet program will require. □

BIDDER PROTESTS ARE STALLING ARMY AUTOMATION AWARD TO EDS

A Government Printing Office effort to automate publication of Army technical and training manuals could be held up because of protests by the losing bidders. The five-year contract, worth some $62 million a year, was awarded to Electronic Data Systems Corp., the Dallas subsidiary of General Motors Corp., in early January. AT&T Technologies, Volt Information Sciences, and Xerox, however, have all filed protests alleging benchmark-testing irregularities, among other things. The complaints will hold up final award of the contract for at least 45 days. □

TI MARKETEERS REGROUP TO IDENTIFY NEW CHIP NEEDS

Texas Instruments Inc. has restructured its semiconductor marketing organization around 14 narrowly defined market segments in an effort to identify future integrated-circuit needs. The new alignment is an attempt to overcome what top TI managers admit has been a strategic weakness of the Dallas chip maker. Headed by Jerry Rogers, formerly manager of the firm's microprocessor division, marketing teams will try to identify opportunities for very large-scale integration in such areas as high-speed modulators-demodulators and local-area networks. TI for the moment won't disclose the full list of target areas. □

SEMI SEES FLAT YEAR FOR EQUIPMENT SUPPLIERS

No matter what happens to semiconductor sales this year, suppliers of production equipment and materials will have to wait until 1987 for a significant recovery, says Sam A. Harrell, president of the Semiconductor Equipment and Materials Institute Inc. "My own guess is down 6%, but others here have it going up 3% to 9%," observes Harrell, who is also president of Micronix Corp., Los Gatos, Calif. He explains that a strong rebound won't show up in 1986 because equipment and materials orders and shipments lag semiconductor sales by up to a year. At SEMI's annual information seminar last week in Newport Beach, Calif., members heard that overall sales tumbled 15% last year, with a stunning 45% decline in the materials segment. □

DENMARK SLOWS EUROPEAN PUSH FOR STANDARDS

European government officials are urging Denmark's Folketing, or parliament, to reconsider its decision not to reform the European Communities' decision-making structure. They believe the proposed changes would ease passage of sweeping European standards and norms, particularly in data processing, data communications, and telecommunications. All 12 EC member countries had tentatively approved the package, a key element of which is a majority voting scheme to replace the existing system—in which each country has veto power. But the Folketing rejected it last week, on grounds the reform would give too much power to the EC. □

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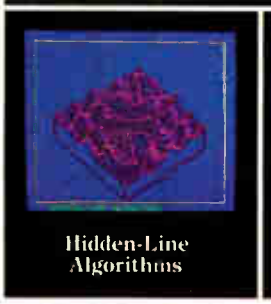
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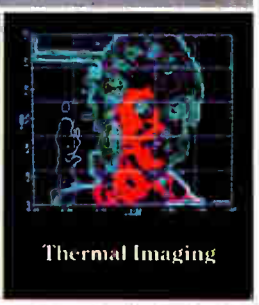
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PRODUCTS NEWSLETTER

TRANSCEIVER ROUNDS OUT AMD'S ETHERNET-CHEAPERNET CHIP SET

The Am7996 transceiver takes care of the transmission, receiving, and collision-detection tasks for local networks, rounding out Advanced Micro Devices Inc.'s Ethernet and Cheapernet chip set. The transceiver supports cable lengths about twice as long as spelled out in the IEEE 802.3 specifications when it is configured into a transmit-mode collision-detect application; then it can support a 1,000-meter Ethernet cable or a 300-m Cheapernet cable. The $23.90 chip also features an optional signal-quality error test. □

GRAPHICS SOFTWARE GIVES HEAD START TO IBM RT RESELLERS

Value-added resellers can shorten the time that it takes to develop graphics applications for IBM Corp.'s new RT work station (see p. 14) with a number of peripheral-independent software packages from Graphic Software Systems Inc. IBM will market the Beaverton, Ore., company's Virtual Device Interface-based software under the name IBM RT PC Professional Graphics Series. The series includes a development toolkit containing device drivers that support IBM's graphics cards, plotters, and color printer; a Tektronix terminal emulator; the Metafile and GSS*Grafstation utilities, which allow graphics applications to be moved from computer to computer; and a plotter. The toolkit sells for $700, the others are $600 each. In the second quarter, Graphic Software Systems will market its own higher-level version for the RT that conforms to the ANSI Graphics Kernel System standard. □

SEQUENT TO ANNOUNCE 30-PROCESSOR PARALLEL SYSTEM

Sequent Computer Systems Inc., maker of the Balance parallel computer, will introduce a larger system at this week's UniForum trade show in Anaheim, Calif. The Beaverton, Ore., company's Balance 21000 contains up to 30 32-bit processors, compared with the Balance 8000's 12-processor maximum. The new computer is software-compatible with the 8000 and serves up to 256 users. It delivers from 2.8 million to 21 million instructions/s—up to three times that of a VAX-8650, which is in the same price range. Prices for the Balance 21000, to be available in July, range from $139,000 for a four-processor 32-user system to $500,000 for a 30-processor system. □

$8,500 SYSTEM MONITORS LOCAL-AREA NETWORKS

A complete system that continuously monitors local-area networks is available for just $8,500. The LanScan, from Communication Machinery Corp., handles 75 lines and costs about one fifth as much as other Ethernet monitors, the Santa Barbara, Calif., company claims. Its 16-bit internal architecture has the necessary bandwidth to analyze incoming network data, and the LanScan comes with display, keyboard, and printer interface. Built-in decoders handle all popular network protocols. □

ENMASSE CUTS THE COST OF TRANSACTION PROCESSING

Enmasse Computer Corp., which hopes to carve a niche for low-cost on-line-transaction processing systems, now has its hardware ready to go [*ElectronicsWeek*, Aug. 13, 1984, p. 38]. The Acton, Mass., company last week introduced a line of expandable computers that can support up to 768 users. Prices start at $60,000, well below the cost of mainframe computers traditionally used for transaction processing. The Enmasse Computer System tightly couples three different processors to work simultaneously on a single transaction and guarantees data integrity should the system fail. Software for the systems integrates Unix, Cobol, and a data-base-management system. □

World Radio History

Electronics

IS IBM TAKING A RISC WITH ITS RISC WORK STATION?

ITS ENTRY GAMBLES ON HIGH-SPEED PROCESSING AND UNIX PORTABILITY

NEW YORK

IBM Corp. surprised legions of Big Blue watchers last week by not introducing the long-awaited laptop version of its Personal Computer. Instead the computer giant unveiled a technical work station that is far more significant. Some industry observers believe that IBM is taking some unusual risks with its entry into this fast-growing market.

They call it a gamble for two reasons: The RT Personal Computer is pioneering reduced-instruction-set-computer (RISC) technology in work stations, and it uses an operating system, called Advanced Interactive Executive, or AIX, that IBM describes as an enhanced version of AT&T Bell Laboratories' Unix System V. IBM is betting that Unix-application portability and high-speed processing are the best route into the competitive work-station market.

GLOVES OFF. Price/performance ratio of IBM's low-end RT is aggressive.

The 32-bit IBM RT (for RISC technology) PC weighs in as heavy competition for such well-entrenched players as Apollo Computer, Digital Equipment, and Sun Microsystems. For their part, however, DEC and Apollo say they are not worried much by the new entry. One reason for their lack of concern may be that IBM hasn't spelled out all its plans in key areas—graphics, networking, software support, and floating-point capability.

The market for technical work stations is one of the fastest-growing in the industry. Dataquest Inc. estimates that 21,000 units were sold in 1985, for a total of about $735 million and expects those figures to mushroom to 191,000 units and $2.7 billion annually by 1989.

To invade a niche dominated by smaller firms such as Apollo and Sun, IBM's Information Systems Group is aggressively pricing its low-end system—a desktop version of the RT PC with 1 megabyte of internal memory, a 40-megabyte hard disk, and a monochrome display—at $8,636 in quantities of 50 or more ($13,085 in smaller orders). Delivery for all RT PC models is scheduled for sometime in March, says the Rye Brook, N. Y. group.

The low-price strategy at the low end presages "the beginning of pretty severe price erosion in the work-station market," says David Boucher, president of Interleaf Inc. His Cambridge, Mass., company has adapted its electronic publishing system for the RT PC.

On the other hand, high-end models of the RT PC are overpriced, maintains George F. Colony, president of Forrester Research Inc., also of Cambridge. IBM is asking nearly $40,000 for the top-of-the-line floor-standing RT PC with a 19-in. high-resolution color display, 2 megabytes of internal memory, and a 70-megabyte fixed disk. Forrester argues that, with prices that high, IBM will be find it more difficult to compete with the likes of DEC's MicroVAX II.

IBM announced enhancements to its 5080 graphics system, which it is offering with high-end RT PC models. Furthermore, the company says the new system is PC AT-compatible, has six 16-bit slots for AT add-on boards, and can even be configured with a PC AT co-processor board that lets the RT act as an AT. In addition, systems configured with the 5080 can easily transfer files to and from an IBM 370-architecture host.

"Ultimately, though, the RT's success is going to hinge on how many third parties support it," says Colony.

By endowing the RT PC with an open architecture, IBM is emulating the strategy it found so successful with the PC. The hope is that third parties will adopt the RT PC as a platform for their products. But the verdict isn't in yet on how easily software houses will be able to adapt their Unix programs to AIX. Together with the new memory-management chip, AIX supports a 40-bit virtual-memory-address space.

At least a few software vendors already have embraced IBM's new baby. Silvar-Lisco is licensing its schematic-capture design system to IBM for remarketing. Cadre Technologies Inc. offers a software-development tool set and environment. Along with those companies and Interleaf, Applix Inc. and expert-systems maker Inference Corp. are already claiming to support the RT.

In all, there are nine application programs ready now. Teradyne Inc. plans to have its Lasar Version 6 available for the RT PC by March, says product manager Andrew Parkinson. Lasar is a simulation program for printed-circuit boards and integrated circuits for use in design verification and the generation of test programs. Parkinson says IBM "has legitimized" the computer-aided-design sector of the industry and "will clearly have a major impact."

IBM plans to sell the RT PC through selected dealers as well as its own distribution centers. Analysts predict strong sales for the new product. Future Computing Inc., the Dallas market researcher, is already forecasting that IBM will sell between 20,000 and 25,000 RT PCs in 1986.

Not everyone is so optimistic. Forrester Research's Colony predicts unit sales in the 12,000 to 15,000 range,

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about 60% of which will be for multiuser environments supporting the maximum eight terminals. Colony adds, however, that IBM should still outsell Digital's MicroVAX II in 1986; he projects DEC will sell 9,000 to 12,000 units this year. Since DEC introduced the MicroVAX II in May 1985, it has sold 12,000 units—said to be roughly the total number of work stations Apollo has sold in its three years of operation.

The n-MOS RT processor executes 84 of its 118 instructions in a single 170-ns cycle. IBM claims benchmark processing speeds of 1.6 million to 2.1 million instructions/s—considerably faster than the MicroVAX II. But benchmark comparisons have more than their share of critics. Among them is Frank Lynch, director of marketing for Silvar-Lisco, which also supports Apollo and DEC with its schematic design software.

"IBM is saying the RT can run around 2 mips. The MicroVAX II runs at 0.9 mips. But when you are running an interactive program, what really counts is the operator's speed, and the quality of the display and keyboard," Lynch says.

Still, others rave about the new system's speed. Says Boucher, whose company—Interleaf—has adapted its software to work stations from DEC, Apollo, and Sun as well as IBM: "It's a very fast machine, certainly in the 68020 class. It's about as fast as anything we've seen." *–Tobias Naegele*

GRAPHICS

TI GRABS EARLY LEAD IN ADVANCED GRAPHICS ICs

HOUSTON

The bell is about to ring for the next round of competition in color-graphics chips, as silicon houses aim to cut the cost of work-station display-processing hardware by as much as 90% and to tap emerging graphics-software standards.

Leading the way is a fast 32-bit graphics-oriented microprocessor from Texas Instruments Inc. that is slated for sampling in six weeks. Delayed a bit, and now expected to arrive in May, is Intel Corp.'s 16-bit graphics coprocessor, the 82786. Out of the picture is a 16-bit raster graphics display processor from Motorola Inc.; the company has dropped the planned product in favor of a new graphics strategy centered around its general-purpose 32-bit 68020 processor.

The developments are all part of what computer-graphics vendors hope will be a revolution in high-resolution color personal computers for the office and more-affordable work stations for the engineer. In addition, major IC manufacturers in both the U. S. and Japan are striking alliances with independent software houses to offer interfaces to industry standards, such as the Computer Graphics Interface (CGI) and the emerging Graphics Kernel System (GKS).

The target end-equipment market should grow from 5.23 million units in 1985 to 9.12 million units in 1988, according to forecasts compiled by TI's Programmable Products Division in Houston.

The Dallas company is pulling the wraps off its 1.8-μm CMOS graphics signal processor, the TMS34010. The 68-pin chip marries the architecture of a general-purpose 32-bit microprocessor to a graphics-oriented reduced-instruction-set computer. The 34010 executes 6 million instructions/s, addresses a gigabit of storage, performs quickly with standard low-speed dynamic random-access memories, and completes raster-manipulating operations in a single cycle.

TI says the 34010 is as programmable as a general-purpose microprocessor but unmatched when it comes to raster operations. The RISC block performs raster operations 2 to 12 times faster than Motorola's 68020, says Kevin McDonough, TI graphics products manager. "About 30% of the GSP is dedicated to manipulations of pixel-size fields," he says. One of the chip's two buses connects to the system host microprocessor; the other—a 16-bit bus—is for memory. (TI plans eventually to offer a second-generation chip with full 32-bit memory bus.)

The 34010's 256-byte cache memory lets the core of the chip run full speed at 50 MHz with 6-mips performance while using slower DRAMs and dual-ported video RAMs. Alongside the chip's 6-mips general-purpose core, a number of graphics-management functions are implemented, such as a barrel shifter.

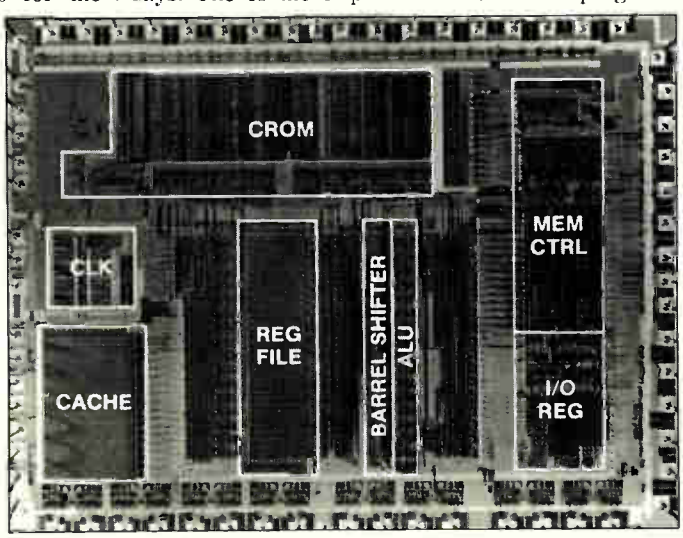
When samples are available March 1, TI will sell the 34010, housed in plastic leaded chip carriers, for $500 in single quantities. Volume deliveries are expected in the fourth quarter. Software-development-system support will also be available in March and a library of graphics functions is due in April. TI has also aligned third-party software support using the CGI standard from Graphics Software Systems Inc. of Beaverton, Ore., and Nova Graphics International Corp. of Austin, Texas.

SIX-MONTH LEAD. "There are other companies working on graphics processors, but we think it will be a minimum of six months before they have silicon," TI's McDonough says. "As a matter of fact, we have been approached by some [for second sourcing] now that the word is getting out."

Competing chips are progressing through design and early conceptual phases. The players include the likes of Hitachi, NEC, NCR, and Inmos, which plans to unveil its transputer-based graphics processor, the G412, later this year. Advanced Micro Devices Inc. plans to introduce its Am95C60 quad-pixel data-flow-manager IC during the third quarter.

"The architectures are significantly different and I cannot say a lot about them, but any of them could solve the problem," notes Harold Blair, president of Nova Graphics. "Some are easier to program than others. Some have much higher bandwidth. Timing studies show you can get anywhere from 10- to 100-times performance improvement over board implementations. These new graphics processors will replace two to three boards, now costing $2,000 to $3,000, and will cost in the $300 range." Nova Graphics has contracts with TI, Intel, and Motorola. Blair leaves this week for Japan to discuss CGI interfaces with several Japanese chip companies.

Intel is providing samples of its 16-bit graphics coprocessor to selected customers under nondisclosure



PICTURE POWER. TI's 34010 graphics processor executes 6 million instructions/s and works with low-speed memory chips.

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pacts. But officially, the graphics-components operation in Santa Cruz, Calif., has pushed back introduction of the CMOS 82786 from March to May to ensure that development support is ready.

In Austin this month, Motorola's Microprocessor Products Group dropped the 16-bit raster graphics display processor, known as RGDP. Last summer, Motorola announced it would introduce in 1986 a high-performance graphics device to operate in the CGI environment. Officials of the microprocessor group have now opted to place the general-purpose 68020 squarely in the center of the high-resolution graphics movement. The support will come from additional graphics software "hooks" and hardware peripherals intended to "tie the 68020 or a future 32-bit processor into a graphics system," explains James Lovegrove, a product manager in the high-end microprocessor operation.

"Most of the customers we see in the work-station and business markets have spent 1985—in addition to surviving—trying to investigate graphics," Lovegrove says. He believes the graphics arena is still in a very early stage of its evolution. *–J. Robert Lineback*

IC PROCESSING

TI TO UNVEIL 1-MICRON CMOS FOR LOGIC

DALLAS

Texas Instruments Inc. will soon launch a 1-μm advanced high-speed CMOS logic family aimed at matching the performance of the fastest bipolar-Schottky components. TI made its entry into advanced high-speed-CMOS standard logic last year [*Electronics Week*, May 27, 1985, p. 19] when it began focusing its new 1-μm CMOS process on small- and medium-scale integration logic after spawning the technology for 1-Mb dynamic random-access memories.

When formally introduced by TI—along with a second-source announcement—the 1-μm silicon-gate logic technology will be called Enhanced Performance Implanted CMOS, or EPIC.

Epic also describes the struggle that TI process engineers faced in 1981 in developing a 1-μm DRAM technology equally applicable to the fabrication flow of high-performance logic.

"The criteria put some very severe restrictions on how we designed the cell of the megabit dynamic RAM," recalls Greg Armstrong, manager of CMOS technology in the TI Semiconductor Group's Advanced Development Division. The task was to create a universal 1-μm fabrication flow, lumping together all the steps for building DRAM-cell capacitors so they could be easily skipped when processing logic.

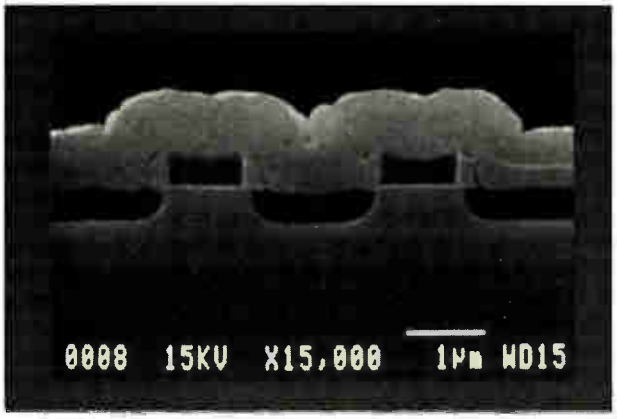
The concept of universal process flow could lead the way to mixed-lot processing of logic and commodity-memory wafers. Each wafer type would sit out certain processing steps.

Armstrong credits the idea to Mohan Rao, semiconductor vice president and manager of advanced development. "He said we are doing our processes in the wrong order," says Armstrong. "In his assessment, a time would come when commodity parts running in large volume would not be as important as the ability to flexibly attack specific markets with a unifying technology. So he said to put one together." The first reaction of many TI process engineers was that the project might have been aimed at too many IC product types.

"It turned out to be quite a challenge, because typically the sequences that go into fabricating the DRAM capacitors are high-temperature steps and thermal cycles that affect diffusions and other structures out in the periphery," says Armstrong.

Four years after its launch, the 1-μm CMOS technology emerged as a promising unifier for TI's broad product portfolio. It was aimed initially at large-scale and very large-scale integration of logic. But a year ago, TI process lab engineers tried the 1-μm process on some existing high-speed CMOS 74-series logic designs. "It then became clear that this process was applicable not only to VLSI, such as microprocessors and digital signal processors, but it could be retrofitted on MSI-type parts," says Armstrong. TI is now attempting to extend the process-development concept to analog circuits and erasable programmable read-only memories. It is also extending the universal-CMOS strategy with its latest efforts on a 4-Mb DRAM trench-transistor-cell process.

"It is important that in the final analysis all products be optimized for the highest performance. But what has been a pleasant surprise is what evolved from the DRAM is what we would have come up with for MSI or VLSI logic," says Armstrong. "That's partly because when you get down to the 1-μm level, you are pushing against the same fundamental limitations of basic physical laws, such as quantum-mechanical tunneling through thin oxides, high-intensity fields due to hot-electron effects, and the need for high-density CMOS without latchup." Those needs are expected to increase below 1 μm.



VERSATILE. Logic wafers can sit out process steps needed only for DRAM fabrication on TI's 1-μm EPIC CMOS production line.

TI is now readying a new family of advanced high-speed CMOS (AHC) logic consisting of SSI, MSI, and some LSI parts. EPIC will be applied to a variety of VLSI products as well, including bit-slice processors, multipliers, and the Lisp processor that TI is developing for the Department of Defense.

The EPIC-based logic family will have 2-ns gate delays, equaling the speeds of TI's own Advanced Schottky bipolar line and a competing FAST family from Fairchild Semiconductor Corp. of Mountain View, Calif. The process has been designed to achieve 0.8- to 1-μm effective gate lengths and potentially can reach subnanosecond gate delays. The process for logic builds silicon gates and source-drain structures and adds a second layer of metal to the memory process for higher logic densities and maximum speeds. EPIC also features a two-layer p and p$^+$ epitaxial substrate and a twin-well structure for latchup suppression.

To enhance early yields, the transistor contacts have been relaxed to 1.5 μm in the AHC parts, as silicon real estate is not as critical for SSI and MSI products as for high-density DRAMs. The gate lengths, however, remain at 1 μm for high speeds.

TI will be aiming the AHC family directly at Fairchild's advanced CMOS technology (FACT). FACT is a sub-2-μm, double-level-metal, single-level-polysilicon process. Fairchild says it has introduced more than 15 parts. And RCA Corp. now says it is delivering samples of some parts from its 2-μm Fast CMOS line. *–J. Robert Lineback*

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IC DEAL WITH CHINESE GIVES FRENCH PROBLEMS

GRENOBLE, FRANCE

To win a $275 million job from the People's Republic of China for telephone switches, France had to agree to furnish advanced integrated-circuit technology to go with the order [*ElectronicsWeek*, April 29, 1985, p. 14]. Now it looks as if the French will have to walk a tightrope to transfer this technology.

The government's balancing act is between the Chinese and Cocom, the Coordinating Committee in Paris that holds veto power over all technology sales from members—which include Japan and most North Atlantic Treaty Organization countries—to Eastern Bloc nations. French officials must lure the Chinese with sophisticated technology and support while keeping the technology transfer modest enough to gain Cocom approval.

Under terms of a preliminary contract signed in Beijing several weeks ago, China agreed to buy a pilot IC production facility complete with related design and production software, personnel training, and technical assistance in starting fabrication. The French will also supply masks for an IC with which the Chinese will validate the technology. Valued at some $70 million, the contract is the first step in the program to sell the digital switches.

The French view the IC technology contract as a key element in a deal of more strategic importance. The larger accord calls for the Alcatel subsidiary of the nationalized Compagnie Générale d'Electricité to supply a 100,000-line digital switching exchange for China's Canton province.

It is unclear whether a Cocom veto on the technology deal would jeopardize the sale of the switches, but it would almost certainly hurt French credibility in future efforts to supply exchanges to the Chinese. Though the switch deal is valued at just slightly more than the technology transfer, Alcatel considers it a foothold in the Chinese market and is counting on further orders to expand its market share in digital switching.

OPTIMIST. CNET director Michel Camus is sanguine about the prospects for transferring his center's technology to China.

The technology intended for transfer to China is high-density MOS 2, a 2-μm n-MOS process with two metal interconnection layers developed at the microelectronics research center of the Centre National d'Etudes des Télécommunications (CNET) in Grenoble. Such technologies are used to produce a significant portion of the world's ICs, including those with military applications. But French officials stress that under the Chinese contract, the CNET process would not be operational for another three years. By then, it would be several generations behind the technologies used for the bulk of commercial ICs.

"To my understanding, Cocom draws the limit at technologies that require a wafer stepper," says Michel Camus, director of the Grenoble center and a principal negotiator in the affair. CNET's 2-μm process thus would qualify for transfer, but Camus acknowledges that the Chinese are pushing for a higher-performance process.

CNET has developed both CMOS and n-MOS technologies with more impressive specifications. Camus will not reveal which circuit the French will supply to verify the transferred technology, but some sources say the parties have agreed on a version of CNET's signal-processing microprocessor, Proteus.

The technology itself is not the only potential problem. Camus admits that two software programs could also arouse Cocom's interest. Under the agreement, CNET would supply the Chinese with Cassiopee, an integrated computer-aided-design system for very-

BELIEVE IT OR NOT, THESE U. S. FIRMS PRODUCED MORE CHIPS LAST YEAR

Now that the scorecards for 1985 are in, it is evident that semiconductor production increased—for the captive manufacturers. While North America's merchant integrated-circuit makers floundered with a 24% drop in the dollar value of their products over 1984, captive IC production increased a healthy 9% in value, according to market-research company Integrated Circuit Engineering Corp. of Scottsdale, Ariz. The result is that captive producers now account for 33% of total U. S. IC production, based on an "if sold" valuing of the semiconductors produced in 1985. The captive share was 27% in 1984.

Captive production—that of companies who typically sell less than one quarter of their production on the open market, by ICE's definition—is dominated by IBM Corp., whose $3 billion worth of production accounted for nearly two thirds of U. S. captive production. That figure is a 7% increase over ICE's 1984 estimate for IBM. Similarly, production at AT&T Technologies saw a 10% rise last year and at General Motors Corp.'s Delco subsidiary it was up 11%.

On the other hand, Hewlett-Packard Co.'s estimated IC production for internal use was down by 9% to a value of $195 million, ICE says. That was not considered a big drop by HP representatives, who commented that HP's business "reflected industry trends" with declines in system sales, even though HP's net revenue was up by 8% for the fiscal year ended Oct. 31.

A major casualty on the list of top captive manufacturers was Commodore International Ltd., whose sinking home computer sales led to a 40% decrease in its IC production—down to $75 million last year. ICE predicts that the computer maker will reenter the merchant market with microprocessor and memory products.

Given the proprietary nature of much of the U. S. captive IC production, forecasts look good for sustained dollar growth for this sector of the industry. ICE sees 8% or 9% annual increases through 1988. *–Eve Bennett*

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large-scale ICs, and Basil, a data base for acquisition and storage of information on the IC manufacturing processes.

Still, Camus is optimistic. The preliminary contract, signed by Sofrecam, a company created by the French Direction Générale des Télécommunications to execute commercial operations, and the Chinese Electronics Industries Ministry, awaits confirmation at the intergovernmental level. Then Chinese engineers and technicians will arrive in Grenoble for several months of training, and as many as 20 CNET engineers will travel to the city of Wuxi to get the facility running. *–Robert T. Gallagher*

PHOTONICS

POLYMERS MAY PROVIDE THE WAY TO OPTICAL ICs

PRINCETON, N. J.

Recent advances in gallium arsenide and lithium niobate technologies have made photonics the latest buzzword in the electronics industry. But researchers at AT&T Co.'s Engineering Research Center in Princeton are already looking at the next generation of optical semiconductors.

Avoiding the conventional crystalline approach to electro-optical materials, a multidisciplinary group of AT&T scientists is developing a method of coating semiconductors with glassy polymers that could bring the dreamworld of integrated optical devices within reach by the 1990s. The researchers are developing a method to produce polymers for use as either switching elements or modulators in a single integrated electro-optic device with both source and detector on-board. The material has the potential, they predict, of providing "a tremendous cost impact on the systems level."

The organic material offers myriad advantages, according to Kenneth Singer, a physicist and one of the project's three principal researchers. It can be put down on a variety of substrates, produced faster than crystals can be grown, and deposited using existing microlithography technology. Moreover, the polymer can be deposited across an almost unlimited area; crystals are severely constrained by their limited growth potential.

TWEAKABLE. Yet another advantage of the polymer could be its ability to be tweaked or fine-tuned for specific uses, says Salvatore Lalama, one of two senior researchers on the project. "Improvements in our material come from changing the material," he says, explaining that improvements in GaAs can only come from changing the way crystals are grown or the way they are processed. "GaAs is GaAs no matter what time of day it is."

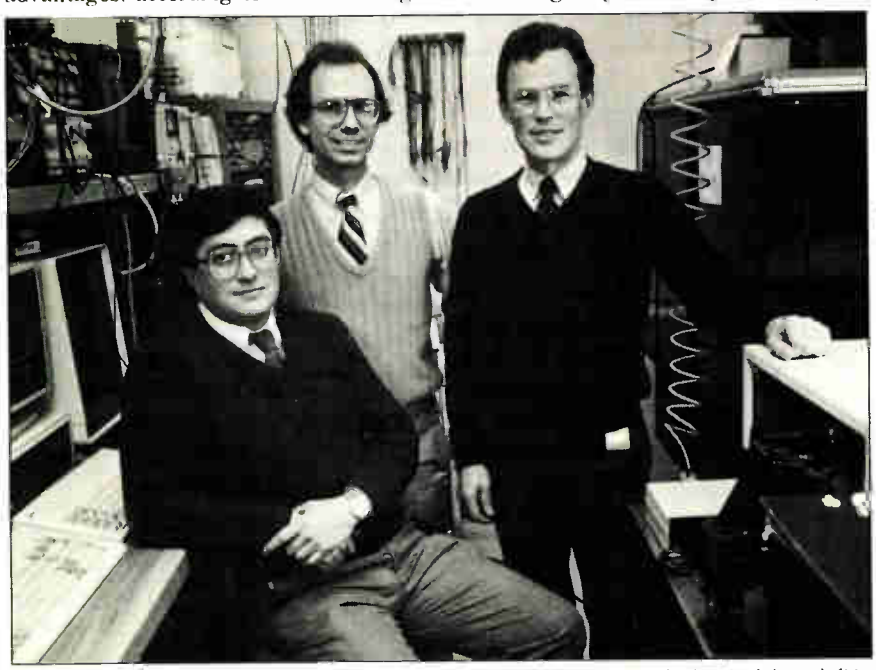
The researchers claim already to have achieved results that "compare favorably with GaAs," but they temper their enthusiasm by stressing that they are still a long way from any hint of product development. "Our material can improve by at least an order of magnitude," Lalama says, adding that "we've already improved in the lab on what we published" at the Optoelectronics and Laser Applications in Science and Engineering conference last week.

"The whole emphasis of our program, was to start with a material with which it has already been shown that you can build guided-wave optical structures—where there's already a technology—and give it the ability to be an active device," Singer says.

The project began as a scientific idea that seemed to fit into the current drive into photonics, says John Sohn, the group's chemical engineer and a senior researcher at the Princeton research center. Organic polymers already had been proven to have nonlinear optical properties and had been used, for example, in the passive guided-wave devices found in local-area networks. The challenge was to alter the passive materials to give them electro-optic properties—and enable them to be used in active devices.

The process was begun with the introduction of a nonlinear optical dopant, in this case an azo dye called Disperse Red 1, as a dopant in a standard polymer, polymethylmethacrylate. Once doped, the polymer is deposited as a thin film onto a substrate using existing spin-coating techniques. It is then heated until it softens—to enhance molecular movement—and subjected to an electrical field until it has cooled to ambient temperature. This orients the dopant molecules and breaks up the centrosymmetric structure that, while inherent to glassy polymers, otherwise prevents them from being used in active devices.

"Integrated optics is a technology that's in its infancy," says Sohn. "People are really trying to go to the next step—ICs. The materials we're working on are the first step into that whole area." *–Tobias Naegele*



MIXED TRIO. AT&T's chief researchers of a polymer-coated electro-optical material are, left to right, physicists Kenneth Singer and Salvatore Lalama, and John Sohn, chemical engineer.

FRENCH GET A JUMP ON OPTICAL PARTS

BAGNEUX, FRANCE

France appears to be the first European country off the mark in the race to supply high-performance components for tomorrow's high-capacity long-distance optical networks.

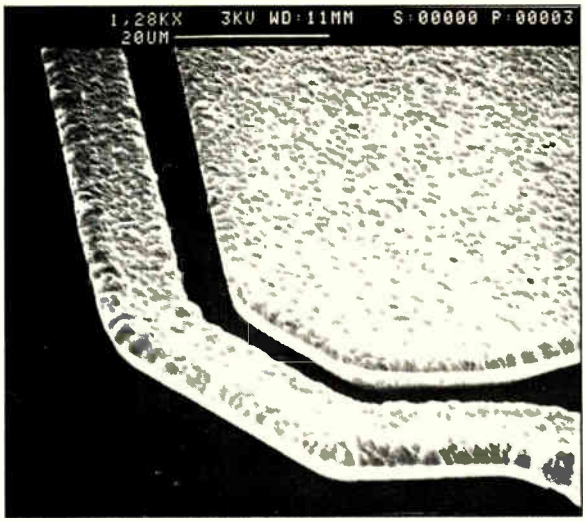
Engineers at the research laboratories of the Centre National d'Etudes des Télécommunications (CNET) in this Paris suburb have developed and patented a technology that yields state-of-the-art performance for high-frequency lithium niobate resonators. What's more, the

World Radio History

process's graduation to the production stage is all but certain.

CNET has signed a contract to transfer the technology to compatriot telecommunications-equipment manufacturer Alcatel, a subsidiary of the nationalized Compagnie Générale d'Electricité, a process in which CNET and Alcatel are already engaged. The resonators, which take the form of optical waveguides fabricated in $LiNbO_3$ crystals, are of particular importance for optical communications near 1.55 μm, where they can be used to overcome chromatic dispersion.

Alcatel's primary objective is to produce resonators with modulation bandwidths up to 3 GHz, like those already being marketed in the U.S. by Crystal Technology Inc. of Palo Alto [*Electronics*, Jan. 13, p. 20]. Reaching that goal should present little difficulty because CNET's devices operate at 7 GHz, more than double the initial objective.



GOLDEN. To modulate light, CNET applies a signal to gold electrodes on Ti waveguides diffused into a $LiNbO_3$ crystal.

TWO IN, TWO OUT. A key difference between CNET's resonators and Crystal Technology's is that the French devices feature two input and two output points, says project coordinator Alain Carenco. This opens up the possibility of using them in switching applications. The U.S. resonators are single-input, single-output parts.

The technology for building the parts is simple enough. In a $LiNbO_3$ crystal substrate, two parallel ribbons of titanium are diffused to serve as waveguides; gold electrodes are then deposited on the surface. Pigtails are added by butt coupling.

The geometry, spacing, and deposition conditions (diffusion time and temperature) of the waveguides can be varied according to CNET's models to accommodate the technical characteristics desired. For a 1.56-μm device, for example, CNET achieves the best results with 7-μm-wide, 950-Å-deep guides separated by 3 μm. Diffusion takes 9 hours at 1,000°C.

The ability to switch light between the two guides is achieved by evanescent wave bias, or what is known as the optical tunnel effect. When a dual coupler is realized in $LiNbO_3$, the application of an electrical field of opposite sign on the two guides disturbs the synchronism between the guides and modifies the distribution of light in the volume of the material. Using CNET's technology, a swing of 8 V applied by the gold electrodes is sufficient to switch light from one guide to the other.

CNET resonators are undergoing field testing at a high-speed test link in Brittany. So far, parts with drive voltages as low as 8 V have been realized, as have others with minimum extinction ratios of up to 40 dB. Carenco believes the figure that bodes best for the future of the technology is the insertion loss, which generally falls between only 0.1 and 0.2 dB/cm. *–Robert T. Gallagher*

QUALITY CONTROL

HARRIS WANTS DATA FROM SUPPLIERS

MELBOURNE, FLA.

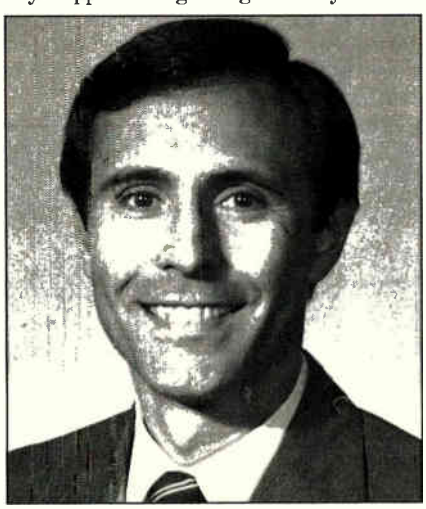
Harris Corp.'s Semiconductor Sector has initiated a program to open two-way communications with its material suppliers that it claims will serve as a prototype for the entire industry. The chip maker wants vendors to use the same statistical techniques for process control that it uses in its own operations and urges those vendors that already use them to supply the information to Harris.

The statistical process-control techniques involve taking samples from a given number of batches and applying the results to a statistical model. This model produces a statistically derived limit of deviation for a given manufacturing process, allowing precise adjustment of manufacturing parameters. The hoped-for result is higher yields.

Harris officials claim that their program is the first by a U.S. semiconductor manufacturer to aim for closer ties with suppliers. Such programs already exist in the Japanese electronics industry.

The company's key objectives include upgrading the quality of purchased materials, reducing the cost of materials through fewer rejects and inspections, and attaining consistency and standardization in manufacturing processes used by suppliers.

Harris has committed about 30 of its more than 5,000 Semiconductor Sector employees to the program. It will conduct a seminar and workshops with six key suppliers beginning in early February and expects eventually to meet with a minimum of 12 vendors.



SERIOUS. Leone says Harris probably will drop vendors who do not participate.

"We're trying to get married more closely to our vendors," explains William C. Parr, manager of statistical development in the chip maker's quality and productivity department. "We see the rest of the industry heading in this general direction."

The Harris program appears to complement an industry panel recently established by Semiconductor Research Corp., says SRC director of manufacturing sciences D. Howard Phillips. The Manufacturing Competitiveness Panel is designed to promote better communications between integrated-circuit-equipment vendors and chip makers, explains Phillips. The Harris program, which includes vendors of materials equipment, is "directly in line with it [the SRC panel]," he adds.

The Harris program is also designed to identify top vendors, so it would also cut the number of suppliers Harris uses. Companies choosing not to participate in the program probably will be dropped, adds Ronald A. Leone, vice president for quality and productivity.

The program's overall aim is to "spark

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an awareness among vendors that statistical process controls are the wave of the future," says Leone. Indeed, the survival of the U.S. chip industry may hinge on widespread implementation of statistical controls, he says. In Japan, chip makers spend relatively more time working with suppliers and put pressure on them to ensure the consistent quality of materials, Leone says. "In the U.S., everybody works in a vacuum."

The seminar and workshops will be divided into three parts: technical presentations to vendors concerning the benefits of statistical process controls, presentations explaining how Harris is already using such controls, and individual workshops with each supplier to hammer out details. "We see the importance of [process controls] primarily because we've seen improvements in our own operations," says Leone. Harris's Semiconductor Sector is a major supplier of components to defense and aerospace contractors and to manufacturers of communications, computer, and industrial equipment.

A major portion of the program involves the exchange of manufacturing data. Leone says Harris plans to look at each vendor's on-line processing data to determine the quality of materials. Once process controls are in place, he says, Harris will make follow-up visits to suppliers every six months to monitor controls. Like the SRC panel, the program will seek to establish a common language among different suppliers and Harris, says Parr, a former associate professor of statistics at the University of Florida and industrial consultant who joined Harris last August.

After deciding what materials it needs, Harris would attempt to correlate specifications and measurements with a supplier. For example, explains Parr, it would determine whether the viscosity of photoresist was being measured in the same way by Harris and its supplier. Next, conventional lot-acceptance sampling would be replaced by systematic monitoring, with the goal of establishing a cooperative link between vendor and customer that would eliminate the need for further measurements.

Aim is to ensure consistent quality of materials

Both Leone and Parr decline to identify the six vendors by name, but Leone says they include suppliers of raw silicon, photoresist, metalization equipment, packages, chemicals, and gases. Unlike similar programs in Japan, notes Parr, the Harris effort will include vendors spread over a much larger geographic area. *–George Leopold*

LOGIC DEVICES

CIRCUIT SAVES POWER IN JOSEPHSON JUNCTION ICs

WAKO CITY, JAPAN

A new logic-circuit configuration for Josephson junction devices could cut power requirements about 1,000 times over conventional Josephson junction devices, while switching at a slightly faster speed than the 1-ps minimum of those devices. Called the quantum flux parametron, it consists of two Josephson junctions and several small inductors operating at the cryogenic temperature of 4.2 K.

The QFP owes its name to the fact that magnetic flux in supercooled inductors can exist only in integral multiples, or quanta, of 2.07^{-15} webers each. It was proposed by a group headed by Eiichi Goto, principal scientist at the Information Science Laboratory of the Institute of Physical and Chemical Research (Riken), a research institute funded by the Science and Technology Agency. It is a variation of the parametron, a logic device invented by Goto while he was a graduate student at the University of Tokyo, which was popular in Japan in the early 1960s. The original parametron fell out of favor because it was too slow and not amenable to integration, whereas the QFP promises to be the fastest device going and can be produced only with very large-scale-integration fabrication techniques.

Like the original parametron, the QFP (see figure) is a two-terminal device excited by a sine-wave clock signal. A three-phase clock provides unidirectional operation—logic-signal flow is to a gate whose clock phase lags by 120°. This technique has been used over the years in a number of two-terminal logic devices such as the Esaki diode pair and Goto-pair logic.

Also like the parametron, an odd number of input signals is applied and the majority value determines the gate's output. The clock excitation is applied to each gate through the exciting coils, which induce current in a loop that includes two Josephson junctions.

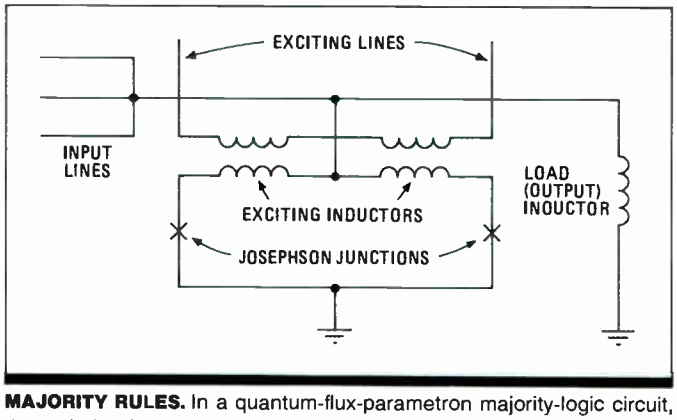
The majority signal from the input terminal divides evenly through the two Josephson junctions and adds to the exciting current in one of the two branches of the loop. The magnitude of this additional current is large enough to take the Josephson junction momentarily out of its superconductive state. This results in the transfer of a flux quantum to the loop that includes the Josephson junction and the load coil, such that a pulse is impressed across the load coil. The output current is inductively coupled to the next logic stage.

The QFP's operating power is extremely low because the transfer of one quantum of flux energy at the time of switching is all the energy required. For the same reason, switching is very fast. With conventional Josephson junction devices, voltage must drop from several millivolts to 0 V, and oscillation makes it impossible to reduce switching time below about 1 ps.

The Josephson junctions in the QFPs are fabricated using conventional lead-niobium nitride sandwich-junction technology and minimum line widths of 5 μm. High-speed operation has been confirmed in a frequency-halving circuit with an input frequency of 1.8 GHz, which corresponds to a pulse-switching time of 50 ps. The measurements were limited by test equipment and not the devices themselves. Simulation shows that 1-ps pulse times would be possible with 1-μm devices fabricated from bridge-type Josephson junctions, which have much lower capacitance than sandwich types.

The QFP differs from other devices in that input and output are inductively, rather than conductively, coupled. Inductive coupling between layers should facilitate fabrication of three-dimensional circuits that will make it possible to squeeze a complete computer into a cube about 10 cm on a side.

The polarity of the QFP's



MAJORITY RULES. In a quantum-flux-parametron majority-logic circuit, the majority signal from three inputs pulses a Josephson junction.

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output is determined by the majority of the input polarity. Energy from the clock signal lets the gate provide a flux gain of 20 dB—sufficient for practical fanout levels. In the experimental divide-by-two ring counter, reversal of the coupling from the output coil of one stage provides the NOT function needed for skipping every other beat to halve the 1.8-GHz clock frequency.

The same basic circuit can be connected as a flip-flop for use in registers, but a simplified memory circuit analogous to a dynamic-random-access-memory cell is being developed. An inductor and a Josephson junction are used in the QFP memory circuit for energy storage in place of the capacitor used in semiconductor DRAMs.

Experimental fabrication of the devices and verification of their operation was a joint project of Riken and Hitachi Ltd.'s Central Research Laboratory in Tokyo. Hitachi made use of the Josephson junction fabrication techniques that it is developing as part of the nine-year, $115 million project for a high-speed scientific and technical computer. The thrust of this project, which is sponsored by the Agency of Industrial Science and Technology (part of the Ministry of International Trade and Industry), is a supercomputer made with nonsilicon devices. *–Charles L. Cohen*

OFFICE AUTOMATION

WILL TOUCH SCREENS OPEN CHINESE MARKET?

MINNEAPOLIS

Intech Systems Inc. figures that using touch-screen technology will be about the only way to tap what it sees as a potentially huge market for word-processing equipment: the People's Republic of China.

Executives at the Minneapolis company believe there's only a remote possibility of cracking that market with keyboard word processors because the complexity of Chinese characters makes them difficult to learn and slow to use. So the company, a wholly owned subsidiary of Detector Electronics Corp., also of Minneapolis, has equipped its product with a touch screen that provides direct access to 13,000 characters.

RECENT DEBUT. The CP2054 character processor, which made its Asian debut at the Asian Office Automation Show in Taipei, Taiwan, last week, uses an analog resistive panel on a cathode-ray tube. The panel's grid creates more than 65,000 touch-sensitive spots in a 256-by-256-pixel format.

"What makes us different from the other vendors who supply word processors for the Chinese language is that a native speaker can learn to use it in a matter of minutes," says T. E. Larsen, Intech's president. "Keyboards are unfamiliar and unwieldy in the Orient, and take much longer to learn to use."

Access to 13,000 characters is improved considerably over processors based on keyboards, says Intech, because keyboard models require the user to break down a given Chinese character into component strokes. In Intech's system, different phonetic representations of the Chinese language are incorporated into each of four versions of the character processor—corresponding with methods for representing Chinese sounds in the U. S., Britain, Taiwan, and the People's Republic. In addition, a user can switch between traditional and simplified character sets in three of the versions.

From its experience with its own factory workers, Intech saw that a touch screen gained more acceptance than a keyboard among inexperienced operators—an important factor when considering the typical Chinese user, who may be totally unfamiliar with a keyboard. To make the product even more friendly to the Chinese, Intech included a video abacus, and users can perform calculations using it or a standard keypad-type calculator.

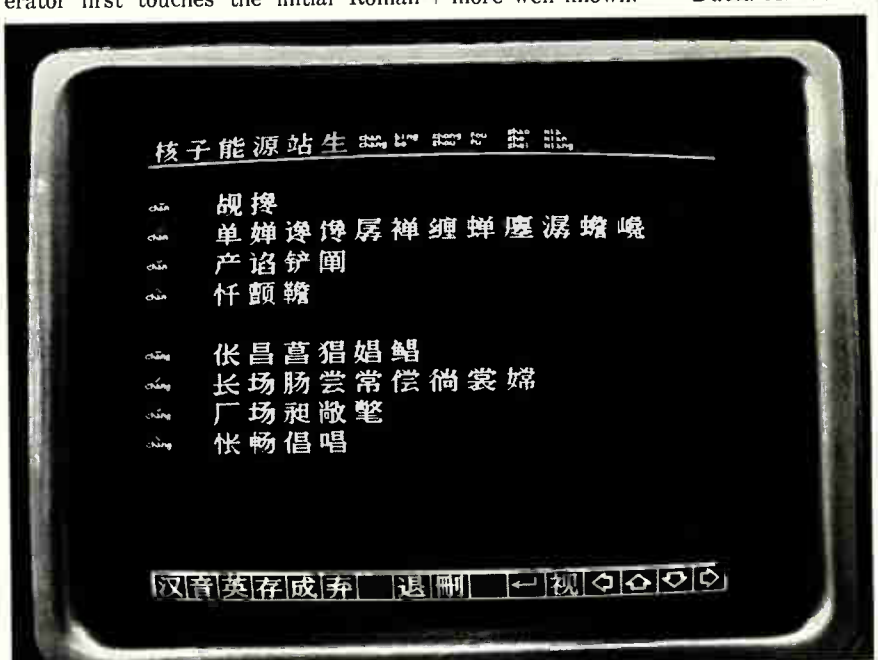
To use the character processor, an operator first touches the initial Roman letter of the sound associated with the character to be printed. Larsen says this is not a training obstacle because most Chinese workers under 40 learned the Roman alphabet in school.

TOTAL TOUCH CONTROL. To generate the character that means peaceful, for example, a user touches the letter A for the sound representation of An, which produces a display of all Chinese characters that have a sound beginning with A. The operator then touches the character that corresponds to the desired meaning, and that character moves to a queue at the top of the screen. When the characters form a document, users can move, modify, or delete text through touch-screen commands.

Besides the monitor, the word-processing system includes a 24-pin dot-matrix printer in a 15-in. triangular cabinet with external connectors to standard peripherals for data storage and communications.

Intech plans to sell about 1,000 character processors this year for about $5,000 each—including a printer—and is opening distribution outlets in a number of Chinese cities and in Taiwan. Because of China's modernization efforts, manufacturers, government agencies, publishers, service industries, and universities are seen by the company as prospective customers.

So far, however, only Syntone, a computer distributor in Beijing, has signed a contract. "We have no illusions that this product will take off like a rocket," says Larsen. "But for most Chinese document preparation it's three times faster than writing, and people will see its advantages as it becomes more well known." *–David M. Weber*



SOUND DISPLAY. After the user taps the letter for a sound, Intech Systems' character processor displays all Chinese characters whose sound begins with the selected letter.

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HALLEY'S COMET SPACE ENCOUNTER SET FOR MARCH.

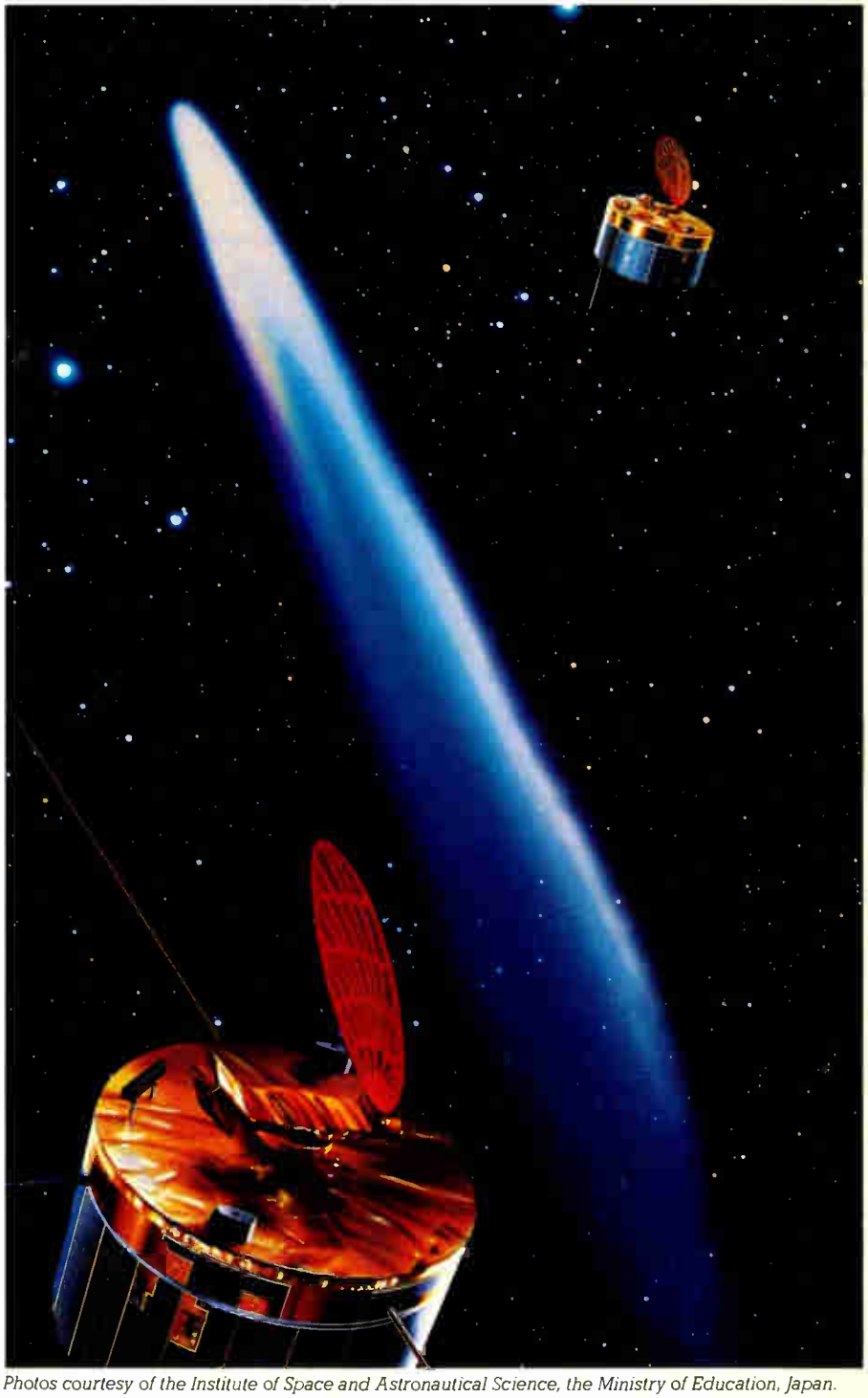
The ultimate space encounter is about to begin. Halley's comet, making a brilliant comeback after 76 years, will soon provide scientists with a once-in-a-lifetime opportunity to shed new light on the origins of the solar system.

As part of a global research effort, Japan's Institute of Space and Astronautical Science, the Ministry of Education, has sent out a welcoming mission of twin interplanetary probes—SAKIGAKE (Pioneer) and SUISEI (Comet)—which are due to intercept Halley's comet in March '86 soon after its closest approach to the sun.

The two deep space explorers will obtain invaluable new data on solar wind—waves of plasma emitted by the sun—and its effect on the comet. Simultaneously, SUISEI will reveal the 3-dimensional structure of the hydrogen cloud surrounding the coma with an ultraviolet TV camera and beam the image data to the earth up to 170 million km away.

For its part, NEC's involvement in these space probes included system design, system integration and the manufacture of major subsystems for telemetry and command, the antenna, power, data processing, attitude and orbit control.

With 20 years of experience in space development NEC has contributed, as a prime contractor or system integrator, to 20 of the 32 satellites placed in space by Japan since 1970.



Photos courtesy of the Institute of Space and Astronautical Science, the Ministry of Education, Japan.

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NUMBER 134

KUWAIT CHOOSES NEC CELLULAR MOBILE TELEPHONE.

NEC will install an integrated cellular mobile telephone system in Kuwait by the 3rd quarter of 1986, paving the way for truly high-grade services nationwide.

NEC's total access communications system featuring 25kHz frequency spacing in the 900MHz band will initially serve up to 25,000 subscribers, and can be expanded to accommodate up to 100,000 subscribers.

Awarded by the Mobile Telephone Systems Company (MTSC) of Kuwait, the full turn-key contract calls for NEC to manufacture and install all key equipment, including an advanced digital switching system plus radio equipment for 21 base stations and 15,000 mobile telephones. MTSC is a shareholding company, 49% Government and 51% public, established to run all mobile communications in the State of Kuwait.

Moreover, NEC will also provide the latest microwave radio and fiber optic links to interconnect the central switching system and base radio equipment, and a medium-scale computer for message accounting and communications traffic control.

This massive project is well under way, drawing upon the integrated computer and communications technology of NEC and expertise of all concerned companies.

Upon completion, the new system will provide sophisticated services such as "Call Transfer", "Call in Absence" and "Privacy".

NEW TTC & M EARTH STATIONS FOR ARABSAT.

An advanced NEC satellite control network is now providing complete tracking, telemetry, control and monitoring (TTC & M) services for the Arab Satellite Communications Organization (ARABSAT) which is comprised of 22 Arab League countries.

The ARABSAT Satellite Control Network analyzes and processes satellite telemetry and tracking data, and commands and monitors operating conditions of the Arab world's first series of communications satellites—the ARABSAT-1A and ARABSAT-1B.

This integrated control system consists of a primary earth station at Riyadh, Saudi Arabia, and a secondary station at Tunis, Tunisia. All necessary equipment including computer hardware and software systems, were developed and installed by NEC on a turn-key basis to assure optimum system performance and long-term reliability.

NEC's contribution to the growing ARABSAT network also includes the completion of three earth stations—one each in Jordan, Bahrain and Tunisia—and it is now manufacturing 7 more for use in other Arab countries.

The ARABSAT system can accommodate 8,000 simultaneous telephone circuits, seven television channels and a community television channel for isolated rural areas. It can also provide telex and data transmission services, and other specialized services.

4-BIT MICROS RIVAL 8-BIT POWER.

The new NEC 75000 Series of 4-bit CMOS single-chip microcomputers is the first to bring VLSI expertise and advanced architecture to the 4-bit realm for results that rival 8-bit performance.

The 75000 Series combines added on-chip memory up to 16k-byte ROM/4k-nibble RAM and higher speed—less than 1μs cycle time at 4MHz. Other high-end features include powerful on-chip hardware, outstanding expandability and an enhanced instruction set.

The 75000 Series comes with a full kit of hardware/software development tools and it also inherits the software of our industry standard 7500 Series through easy conversion.

The first four members of the 75000 family are currently available —the μPD75104 and μPD75106 high-performance general purpose micros, the μPD75P108, an EPROM version, and the μPD75206, which incorporates a VF controller/driver.

NEC

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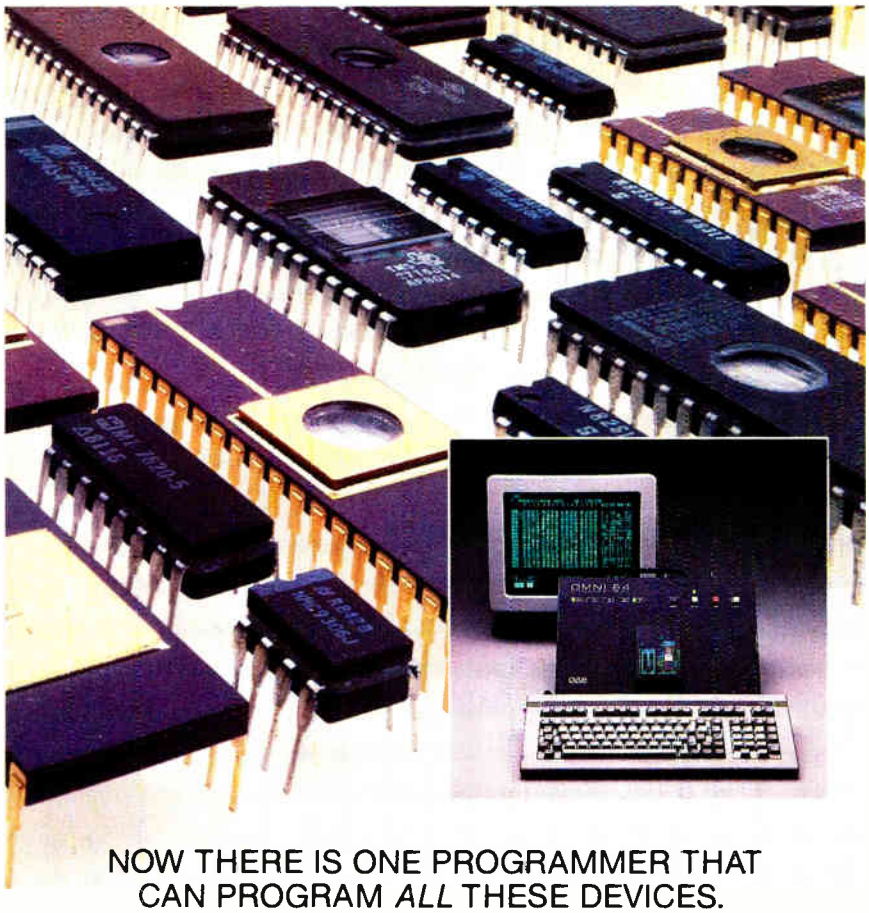

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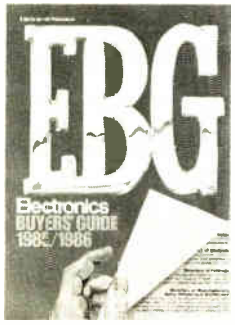

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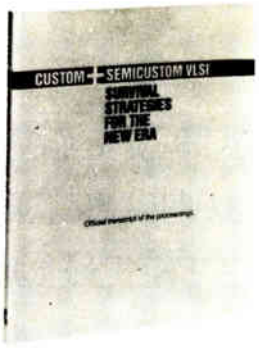

The semiconductor industry is changing. Are you equipped to meet the challenges of this ever-changing industry? Crucial decisions are at hand. *Electronics* Magazine and Gnostic Concepts Inc. sponsored this prestigious seminar and the transcript is now being made available to those who understand the challenge of these changes.

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INSIDE TECHNOLOGY

FIELD-PROGRAMMABLE LOGIC: A NEW MARKET FORCE

FASTER AND DENSER DEVICES PUSH INTO SEMICUSTOM MARKET

by Bernard Conrad Cole

Field-programmable logic devices are showing strong signs of becoming a major force in application-specific integrated circuits. Up until just recently, they were not regarded as a threat by the vendors of gate arrays and standard cells, even though they were smaller and simpler to use than gate arrays, had a faster production turnaround time, and could be programmed by the user. The problem was that FPLDs were neither as dense nor as fast as the competition. They ran no larger than 100 to 300 gates, compared to 1,000 to 6,000 for gate arrays, and at 50 to 75 ns weren't all that fast compared with the tens-of-nanoseconds speeds of gate arrays.

Now gains in density and speed are putting FPLDs on a par with gate arrays in performance. And thanks to computer-aided design tools, they have remained easy to use, with a turnaround time of 1 to 6 weeks where gate arrays require 6 to 18 months.

By 1984, sales of field-programmable logic had grown from a minuscule share of the $5.5 billion ASIC market to $230 million. By 1990, they will more than quadruple, to $1.02 billion of a $13.7 billion market, according to Dataquest Inc., San Jose, Calif. Other companies in the market are even more optimistic. Robert Hartmann, vice president of engineering at Altera Corp, Santa Clara, Calif., predicts that field-programmable logic will account for $2.12 billion in sales in 1990. He also expects that $300 million of that will come out of the gate-array market, leaving gate arrays with a $2.4 billion share (Fig. 1).

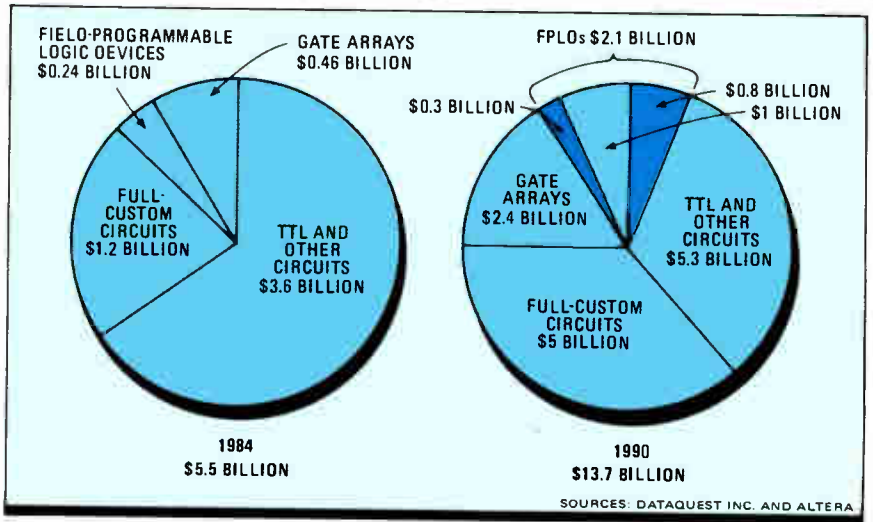
Another sure sign that field-programmable logic is maturing as a semicustom alternative is the rapid increase in the number of companies coming out with products. From a market with essentially two players—Monolithic Memories Inc. and Signetics Corp., which were the first to develop programmable-logic chips—it has grown to include such major semiconductor manufacturers as Advanced Micro Devices, Fairchild Semiconductor, GE/Intersil, Harris Semiconductor, Intel, and National Semiconductor, as well as such startups as Altera, Lattice Semiconductor, VLSI Technology, and Xilinx. Other indicators that the technology is coming into its own are new process alternatives, the proliferation of new logic architectures and programming techniques, and the development of CAD tools as field-programmable logic becomes denser and more complex.

One of the more obvious changes in the programmable-logic market has been a shift from bipolar to CMOS and from fusible-link to floating-gate-based ultraviolet- and electrically erasable logic arrays (EPLDs and EEPLDs). Although about 90% of the field-programmable logic devices sold are of the bipolar fusible-link variety, CMOS EPLDs and EEPLDs are growing more popular. Even traditional bipolar suppliers such as Monolithic Memories and AMD are planning to introduce CMOS versions sometime this year.

CMOS EPLDs are favored now because of their higher density, lower power, and lower manufacturing cost per function, says Altera's Hartmann. With bipolar technology, which is used to manufacture fusible-link PLDs, only a limited number of functions can be designed onto a chip because the high speed requires high power, resulting in high operating temperatures. Because CMOS provides lower power dissipation, designers can pack more functions onto a smaller chip.

Like bipolar FPLDs, CMOS EPLDs are user-programmable. But the CMOS technology allows higher levels of integration—up to 2,000 gates in the standard 20-pin package. Moreover, UV-erasable technology enables PLDs to be reprogrammed in the event of a design mistake or a change in the design approach. "Erasability puts a much greater degree of control in the designer's hands," Hartmann says.

The first company to use electrically erasable CMOS technology in a family of field-programmable logic devices is Lattice Semiconductor Corp., Beaverton, Ore., which is providing pin-for-pin replacements for bipolar circuits with field-programmable array logic—devices with programmable AND arrays and fixed OR arrays. The advantage of EEPLDs is that they can be reprogrammed repeatedly in the same circuit during system prototyping and can be reprogrammed for use in different circuits, says Dean Suhr, Lattice's marketing manager for programmable logic products. "This feature



1. MOVING UP. Consumption of FPLDs could total $2.1 billion by 1990. About half of those sales would be won away from gate arrays and from TTL and other standard devices.

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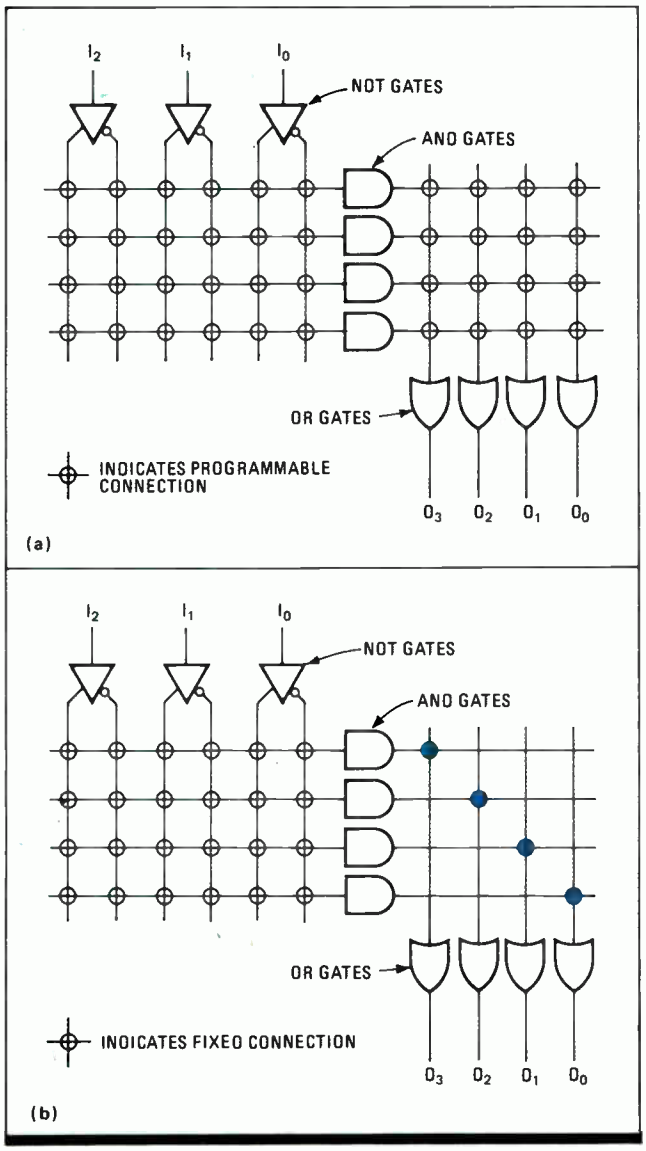

2. TWO METHODS. Unlike a programmable logic array (a), in which both the AND and the OR arrays are programmed, in a programmable-array-logic device (b) the OR devices are fixed.

makes it possible for users to cut the number of standard FPLDs kept in inventory." In addition, because they're reprogrammed easily, EEPLDs can be tested thoroughly for programmability and ac performance before shipment, which is not possible with bipolar or UV-erasable PLDs.

Improvements also continue in bipolar fusible-link arrays. For example, Signetics has a two-level-metal bipolar process with 2½-μm emitter structures, which it is using to boost the speed of its programmable logic devices by some 20%. And the Sunnyvale, Calif., company is developing an improved process that will feature emitters smaller than 2 μm. In building the fuse structures, Signetics uses oxide encroachment to form a very small fuse element, minimizing the programming current and cell area. For example, less than 50 mA is needed to produce the 0.2- to 0.4-μm-diameter shorting spike.

In its programmable logic family, Advanced Micro Devices Inc., Sunnyvale, uses IMOX-S, a high-speed oxide-isolated bipolar process with 2-μm geometries [*Electronics*, June 28, 1984, p. 131]. And Texas Instruments Inc., Dallas, is applying the newest version of its high-speed bipolar process, Impact X, to its family of programmable logic devices [*Electronics*, Dec. 23, 1985, p. 45].

Straddling the fence between the two approaches is National Semiconductor Corp. In addition to its high-speed emitter-coupled-logic FPLDs, the Santa Clara company is developing a family of FPLDs using a combination of bipolar and CMOS technologies. The devices use standard bipolar junction-isolated fusible-link technology in the internal array and CMOS on the periphery, giving the devices the speed of bipolar and the low power and noise immunity of CMOS.

THE ORIGINAL ARCHITECTURES

Until recently, the market for field-programmable logic devices has been dominated by two architectural types: field-programmable logic arrays and fusible-link programmable array logic. First to be introduced, in the early 1970s by Signetics, was the FPLA. Monolithic Memories followed in 1975 with its PAL series. It quickly dominated the market, mainly because its architecture is less sophisticated and easier to use but also because the Santa Clara company gave extensive support to the family and to programming tools it developed. It now claims about 80% of the FPLD market.

Similar to programmable read-only memories, Signetics' FPLAs are multiple input/output structures with field-programmable AND and OR arrays (Fig. 2a). Unlike PROMs, though, FPLAs do not internally decode the binary input signals down to the minimum-term level.

A PAL is basically an FPLA where the interconnections in the OR assembly are fixed and only the AND array is programmable (Fig. 2b), making the chip simpler to program. As the market has evolved, more-complex PAL offerings have emerged, incorporating feedback buffers along with the basic array. That addition allows creation of more than one level of logic by linking on-chip latches, counters, shift registers, and even oscillators. Special fuse functions, such as polarity control, output enables, register/nonregister selection, and buried registers, have also been added.

Architecturally, however, it has been the FPLA portion of the market that has evolved the most, with such variations as field-programmable gate arrays (FPGAs) and field-programmable logic sequencers (FPLSs). Programmable gate arrays are similar to PALs in that they have only field-programmable AND arrays and lack the OR capability needed to generate sum-of-product output functions. Field-programmable sequencers, on the other hand, are basically FPLAs that, in addition to their product-summation combinatorial capability, contain internal storage elements, usually type D or JK circuits, whose clock steering inputs are configurable by the on-chip programmable AND and OR arrays.

PALs are fabricated by Monolithic Memories and second-sourced by AMD, Altera, Harris, Intel, Lattice, National Semiconductor, TI, and VLSI Technology. Only Signetics and TI support FPLAs and their more complex extensions.

Traditionally, users weigh simplicity and programming, flexibility, speed, and logic density when choosing between PALs and FPLAs. PALs overtook the older FPLAs because their fixed OR arrays make them seem easier to use, says Kathryn Douglas, strategic marketing engineer for application-specific products at Signetics.

Fusible-link bipolar PALs are also faster. The original bipolar FPLAs and their extensions had speeds of 60 to 70 ns. By comparison, the simpler PALs were twice as fast at 30 to 40 ns and improvements have pushed propagation delays down to 20 ns. Also, though the FPLA and its variations are extremely flexible switching networks that can mix and match a variety of logic terms to any output, more silicon is needed to make both AND and OR gates programmable. "And more silicon means an inherently larger die size, which translates into higher cost," says Stephen M. Donovan, PAL division marketing manager at Monolithic Memories.

On the other hand, says Signetics' Douglas, the advantage of an FPLA structure, in which both the AND and OR arrays

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are programmable, is that it allows the custom implementation of sum-of-product logic equations. Because all logic interconnections between the input and output pads are programmable, the need for active logic-level definition—a requirement associated with first-generation PALs—is eliminated, making it possible to have direct, mixed logic functions in one programmable logic device. Moreover, FPLAs are closing the gap with speeds in the 20- to 25-ns range (roughly comparable to the simpler PALs) and with the introduction of CMOS versions, which have potentially higher densities.

Monolithic Memories' Donovan argues that such flexibility may be overkill in most traditional FPLD applications—the replacement of small- and medium-scale-integration standard logic in the 100- to 500-gate range. But Douglas responds by pointing to two trends: the density of SSI and MSI devices is increasing toward and beyond 1,500 gates, and users are becoming more sophisticated. As a result, PLDs are being used to replace standard circuits and as an alternative to other custom and semicustom implementations of large-scale integration.

The newest FPLDs are incorporating mixed logic functions

"The argument could be made that PALs are a programmable alternative whose time has passed," Douglas says. "Users were not ready for the higher sophistication that FPLAs and their extensions allow—and Monolithic Memories was there with a simpler architecture, the PAL. But engineers and systems designers who learned the ins and outs of programmable logic with PALs are now ready for something more complex." In addition, the more-complex devices are now much easier to use, thanks to a wide range of new design tools.

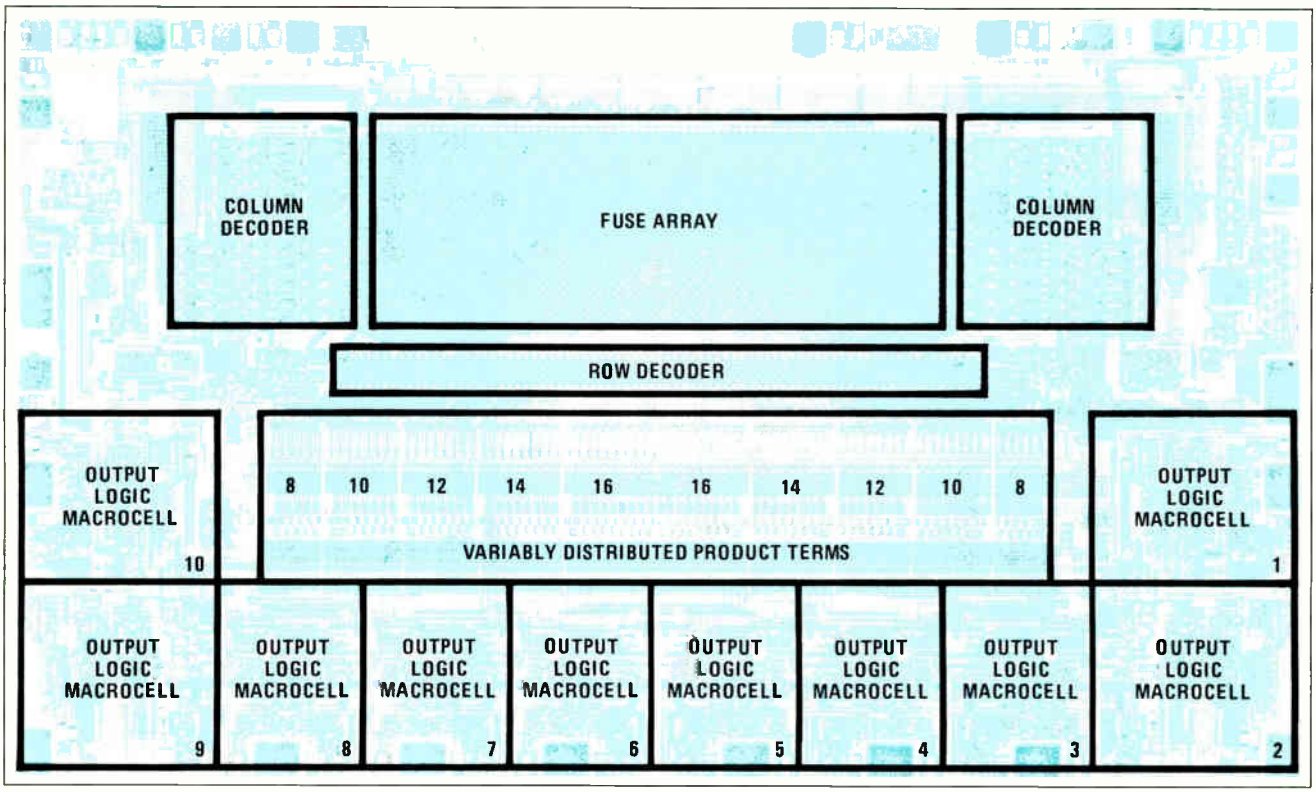
The first efforts at developing more-complex FPLDs have been relatively conservative. The initial architectural variations in PALs can be categorized broadly as incorporating more of the same kind of functions on the same chip to provide all-in-one PLAs. Examples are Monolithic Memories' MegaPALs and similar variations from AMD, Altera, and Lattice Semiconductor.

The bipolar 40- to 84-pin MegaPALs offer the equivalent of 1,500 to 5,000 gates and 16-MHz operation—about four to eight times the complexity of earlier fusible-link FPLDs—but dissipate only 1 W. These chips incorporate such advanced features as product sharing to eliminate redundant terms, buried registers for parallel data capture, and programmable clocks for internal asynchronous operations, says Donovan.

Also from Monolithic Memories comes the field-programmable logic element (FPLE), which uses a PROM-like architecture to create an FPLD that is, in a sense, the mirror image of a PAL. It consists of a fixed AND array whose outputs feed into a programmable OR array. In contrast to a PAL, which typically has many input signals and few product terms, a field-programmable logic element has few inputs and many product terms. In addition, it has a large number of product terms per output signal with full product-term sharing, whereas PALs have a restricted number of product terms per output and no product-term sharing. Thus, says Donovan, the two complement each other both structurally and functionally.

AMD's contribution is its 24-pin AmPAL 22V10 (Fig. 3), the first in a family of second-generation all-in-one PALs. Fabricated using AMD's IMOX-S bipolar process, the chip features propagation delays of 15 ns and a density of about 800 gates. Containing up to 22 input pads and 10 output pads, it can define and program each output individually. Each output is user-programmable for either registered or combinatorial operation. That allows the designer to minimize the number of logic devices he uses for registers, making them available for other functions, says Mitch Richman, marketing manager for programmable logic products.

Another innovation is the use of variable product-term distribution, which allocates from 8 to 16 logic terms to each output pad. "This allows far more complex functions to be implemented than in previous approaches," he says. The device also can preload the output registers to any desired state



3. SINGLE CIRCUIT. The 22V10 from Advanced Micro Devices replaces any of 10 to 20 standard field-programmable array-logic circuits. Containing up to 22 input and 10 output pads, it can define and program each output individually.

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during testing, so its logic can be verified fully.

From Altera comes a range of UV-erasable EPLDs, including the 20-pin 125-mW EP300, the 24-pin 15-MHz EP600, and the 40-pin 20-MHz EP900 and EP1210. These chips have densities ranging from 300 to 1,200 gates, standby power dissipation of only 15 mW, and active power dissipation of 125 to 400 mW. The EP1210, for example, has 28 on-board registers and 236 product terms and takes advantage of term sharing to reduce the need for multiple sum-of-product definitions. Other enhancements include on-board latches to allow input synchronization through the use of a programmable multiclock structure.

The internal 1,200-gate array in this device is divided into two sections, which communicate with each other over a number of internal buses that distribute both the primary input signals and the output signals of each cell. Control circuitry programs any clocking signals and distributes them to all internal latches and flip-flops through two internal signal paths. One path carries a clocking signal to on-chip dedicated input/output latches and to input latches associated with the I/O lines. The other drives the clock inputs to D-type flip-flops within macrocell output blocks, allowing the input latches and flip-flops to be programmed to receive their clock signals from one external source or from independent but related sources.

VLSI Technology Inc., San Jose, offers a 20-pin UV-erasable CMOS programmable logic family that bridges the gap between EPLAs and erasable PALs by taking advantage of what the company calls programmable array combination circuits. Each circuit cell contains a number of product terms, including ORs and exclusive ORs, that can be programmed to allow a shifter, a counter, or any other combinatorial function to be implemented on the same chip. When the XOR function is bypassed, a VLSI Technology EPLD can emulate a variety of industry-standard PALs. But when it is programmed, the chip can be used to design a number of counter and sequencer functions. When the OR feature is implemented, the device can perform shift and combinatorial functions.

A GENERIC LOGIC FAMILY

Using electrically erasable techniques, Lattice has developed what it calls a generic array logic family of programmable devices. The first member of the family is the 20-pin GAL 16V8, which can directly replace any of 21 architectures in the 20-pin, bipolar, fusible-link PAL series from Monolithic Memories and other vendors. Moreover, says Lattice's Suhr, the high-performance CMOS chip runs at bipolar speeds, with propagation delays of 25 ns or less.

Signetics takes the programmable-logic concept one step further with programmable macrologic, which offers the promise of programmable logic devices with densities between 5,000 and 10,000 gates. It takes advantage of the fact that two-level AND-OR gates used in present FPLDs and single-

COSTING OUT LOGIC DEVICES CAN BRING SURPRISES

Cost tradeoffs must take their place next to engineering and design considerations when a user is choosing among logic devices—field-programmable logic devices and logic cell arrays based on read-only memory, gate arrays, standard cells, and standard logic. The cost analyses that measure those tradeoffs often yield surprising results, says Mike Roth, vice president of technical sales and marketing at Hamilton Avnet Electronics Inc., Culver City, Calif.

For example, though the unit cost in volume (1,000 per month or more) is lowest for standard cells and gate arrays, many costs are hidden. The most important are those due to nonrecurring engineering and to changes in design.

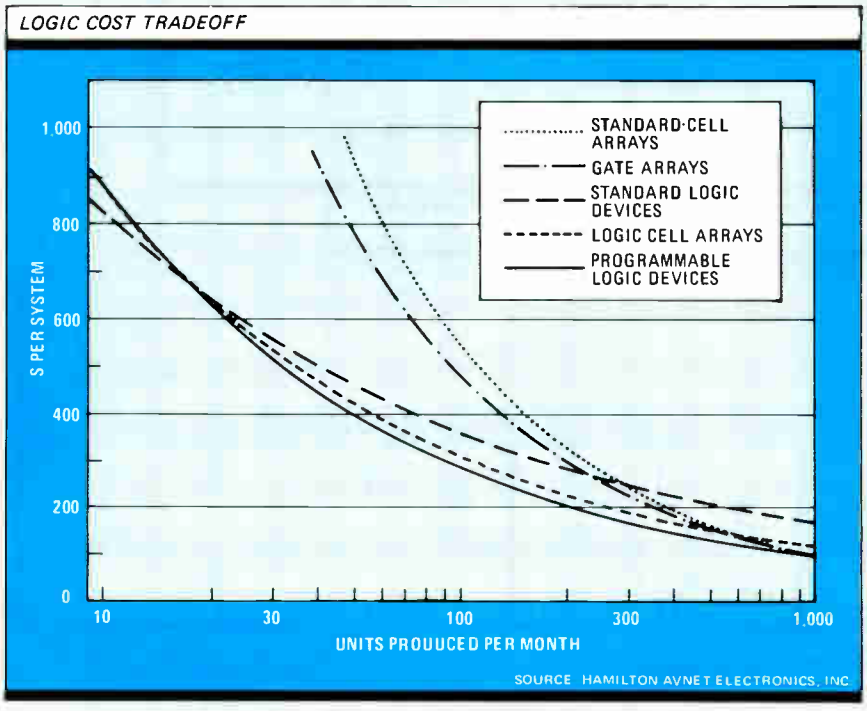
Semicustom gate arrays and standard cells present a problem, says Roth, in terms of nonrecurring engineering and the time required to translate the design, create tooling, make the prototype run, and produce the product. Changes in these circuits often require new nonrecurring expenses.

Although they provide, on average, half the functional density of gate arrays and standard-cell solutions, FPLDs are a comfortable middle ground because they're easily reprogrammed, Roth argues. Often a complete change can be handled with a new FPLD net list or Boolean equation description, which is usually no more than a one-day job. Indeed, many companies use FPLDs to further customize board designs based on gate arrays or standard cells without redesign or costly nonrecurring expenses in memory expansion, input/output modification, and other areas.

Roth says the logic-cell array based on static random-access memory is the most flexible solution, because it can be reconfigured at any time by reloading its RAM. "This process requires about 1.5-K of data and 10 ms. Thus, one circuit can perform various logic functions without any component part changes."

The cost-tradeoff analyses in the chart illustrate these and other hidden costs. They assume that all nonrecurring engineering is amortized over three months and all capital equipment over six months, and they include costs of printed-circuit boards, power supplies, components, and manufacture and test.

Even with these conservative assumptions, the analyses show that for product quantities of fewer than 15 per month, standard logic might be the best solution. Quantities of 15 to 1,000 units per month are handled most economically by FPLDs, with semicustom approaches paying off at 1,000 per month and up. Logic-cell arrays have a higher parts cost than FPLDs, placing their system cost just slightly higher than that of FPLDs. □



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level NAND-NAND gates are fundamentally equivalent. Therefore, the NAND-NAND gates can be used to express combinatorial logic functions in sum-of-products form (Fig. 4).

And because programmable NAND-NAND logic chains can be formed by coupling identical NAND gates with programmable inputs, NAND array strings can be implemented easily to form a single global array with feedback. More-complex functions can be implemented by programming multilevel logic loops through the array and by introducing into the feedback path higher-level macros such as flip-flops, XOR gates, buffers, counters, shift registers, multiplexers, decoders, arithmetic logic units, and memory blocks (Fig. 5).

Another tack is FPLDs using logic blocks based on static RAM

The main design advantage of programmable macrologic is that, unlike multilevel AND-OR implementations, it relies on a single array level to interconnect all macros. This reduces the design task to the building of a PROM-like structure, which is more forgiving than the double array in FPLA-type devices and more flexible than PALs, says Napoleone Cavlan, product-architecture manager at Signetics. In addition, he says, the ability to forge the NAND core into multilevel logic paths at will increases the usage efficiency of the on-chip logic resources. Signetics plans to introduce, within the next few months, the first two devices in a programmable-macrologic family, the PLHS501 and the PLHS502, both packaged in 52-pin plastic leadless chip carriers.

The PLHS501 is a combinatorial logic device with only primitive macros. But this simple structure is deceptive, says Cavlan, for it can implement virtually all logic functions provided by existing combinatorial FPLAs and PALs. It also provides true exclusive-OR output functions, in addition to output polarity inversion, as well as multilevel gate constructs and cross-coupled latches on the chip. Built using Signetics' proprietary ZA-2 oxide-isolation process, using vertical avalanched-induced-migration diodes, it has a NAND matrix about the size of a 16-K PROM and features output delays of 17 ns for single passes through the array and 25 ns for double passes.

More complex is the PLHS502, a sequential device including higher-level macros in the form of clock shift registers and D-type flip-flops, split into banks of eight to facilitate control and data-path manipulation. Built with an advanced high-speed oxide-isolation process, the PLHS502 has a NAND matrix about the size of a 21-K PROM and features output delays of 12 to 16 ns. For sequential operation, maximum setup time is 10 to 14 ns and clock-to-output time is 18 ns.

EDGING TOWARD 10,000 GATES

Using a conservative interconnection factor of only 20%, the PLHS501 has a density roughly equivalent to 3,000 two-input NAND gates, according to Cavlan. For the PLHS502, the figure is 3,600. Densities between 5,000 and 10,000 gates are possible if the chip is fabricated using high-performance high-density CMOS, says Signetics' Douglas.

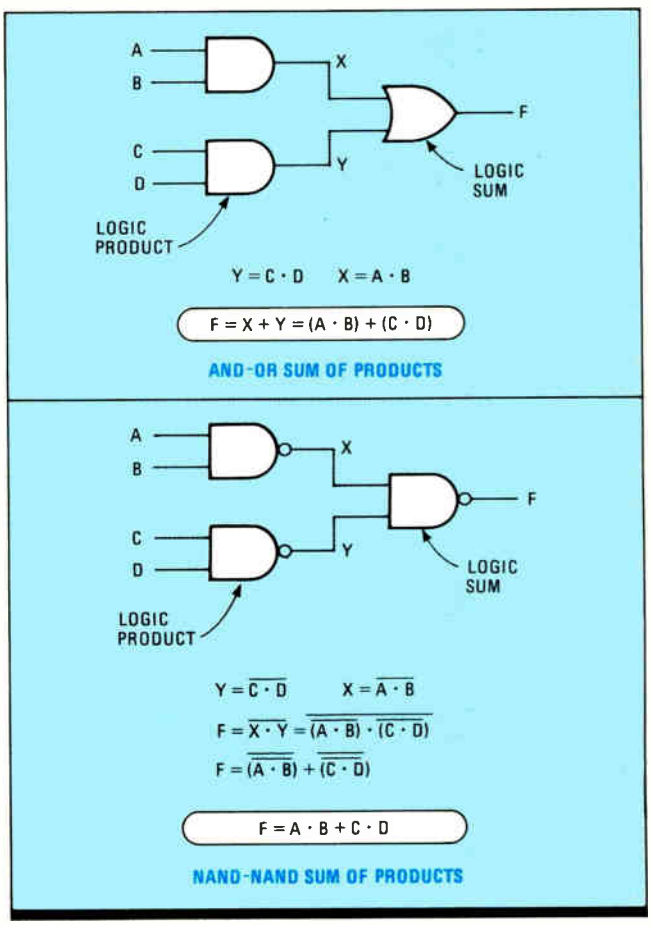
One of the most radical departures in FPLD design is the dynamically reconfigurable CMOS logic cell array from Xilinx Inc., a San Jose startup. The array consists of a large number of configurable static-RAM-based logic blocks that can implement any function of four variables, each integrated with a flip-flop. These logic blocks are interconnected with configurable I/O blocks.

The first family member is the XC2064 (Fig. 6), which is the equivalent of an array with 1,500 gates. It draws its flexibility from a matrix of 64 dynamically reconfigurable logic cells and 58 I/O blocks. At the core of the device is an SRAM matrix that has been divided into an 8-by-8-cell array. Surrounding the matrix are the 58 bidirectional I/O blocks, each of which contains an input register, adjustable input-voltage threshold, and three-state output circuitry. Each block has four logic input paths, a clock input, and two output paths. The four inputs drive the blocks' RAM-based combinatorial logic, from a simple gate to a three-out-of-four majority-voter circuit, directly implementing a four-variable Karnaugh map. If fewer than four variables are needed, a block can be configured to generate two three-variable output functions. Because each block can both accept and generate positive-true as well as negative-true logic, the need for internal inverters or complements for each input signal is eliminated. Each block also includes a storage element that can serve as a D flip-flop or as a gated transparent latch. Also, the two outputs of each block can be programmed independently.

Contributing to the logic-cell array's reconfigurability are a variety of user-programmable interconnection elements. These include metal lines that run horizontally and vertically between the logic and I/O blocks, cross-point-switch interchanges that join segments of metal lines, and programmable interconnection points that link the lines with logic and I/O blocks.

Improvements in processing and fabrication of fusible links and erasable cells have slashed programming failure rates from between 10% and 15% to as little as 3% to 5%. Nevertheless, experienced PROM and EPROM users are often puzzled by the fact that not all FPLDs function correctly after successful completion of a programming operation and fuse verification check. That's because the logic devices do not display the one-to-one relationship between address states and programming elements found in PROMs and EPROMs.

The other elements in a programmable logic device, including latches, counters, buffers, shift registers, and oscillators, often go untested. Thus postprogramming failure rates, rang-



4. EQUIVALENCE. Signetics' programmable macrologic takes advantage of the equivalence between standard two-level AND-OR structures and single-level NAND-NAND arrays.

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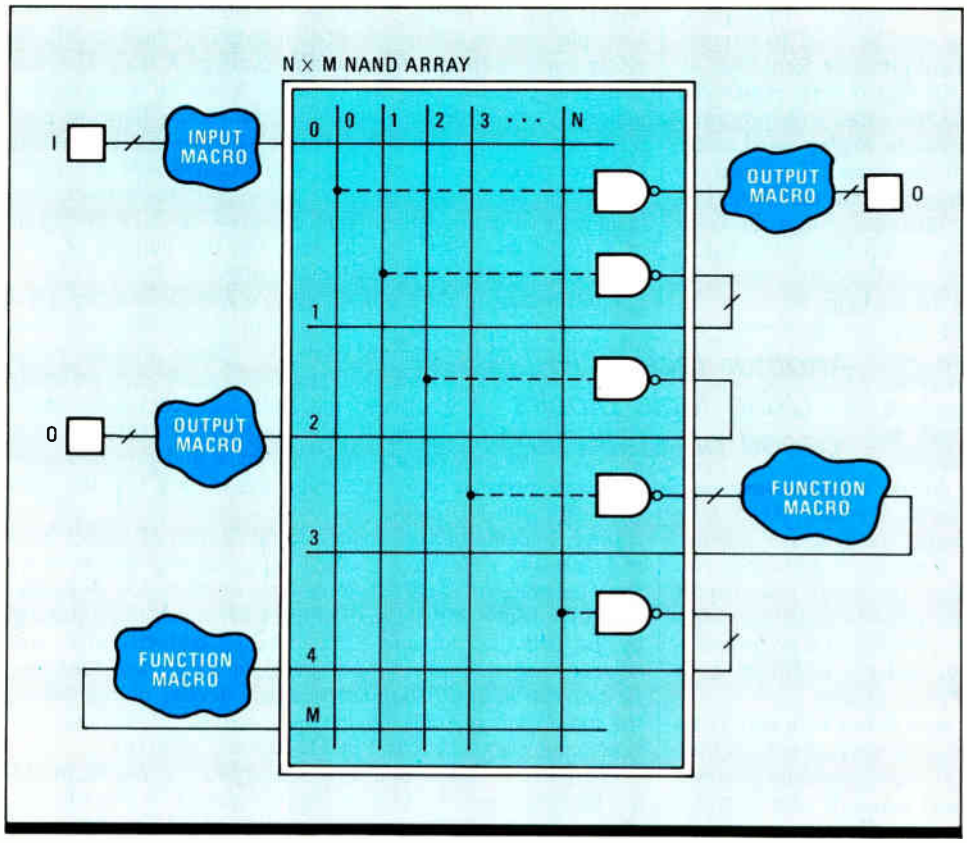

5. SINGLE LEVEL. One plus of NAND-NAND-based programmable macro logic is that complex functions can be implemented by programming multilevel logic loops and adding higher-level macros.

ing from 1% to 4%, are a bugaboo most users believe they have to live with. That may be acceptable for the designer of a small system with relatively low volumes, says AMD's Richman—but large companies using thousands or tens of thousands of such circuits on boards with 100 or more programmable logic devices cannot accept such disastrous yields. "Post-programming yield is the most important aspect to large-volume users, because a failure after programming is more than just a failure of a single component—it is the failure of a complete board, a complete system."

The standard approach to this problem, other than improving the processing, is to use sophisticated test programs. "The problem with such approaches is that, first, they are ineffective and, second, they are something that the vendor tries to shift to the user," Richman says. A better alternative "is to take care of such testing in the factory."

ON-CHIP TESTING

AMD has developed on-chip test circuitry that ensures a better than 99.5% programming yield—compared with the usual 95% to 97%—and a 99.9998% (200 ppm) postprogramming yield, compared with the usual 96% to 99%. "In total, no more than about 5% additional die area is required for this test circuitry," Richman says. "And while this results in a slightly increased die cost, the extra expense is more than offset by the savings due to reduced failure rate."

Acting as a catalyst in the development of ever-more-complex field-programmable logic chips is a wealth of design software and CAD tools, most of which have been introduced within the past 12 months. "There is no way the programmable logic market could have evolved toward higher densities and greater complexities without the development of sophisticated CAD tools," says Douglas of Signetics. When PLDs were in the 100- to 500-gate range, an engineer could generate the appropriate equations by hand, much the way he did when developing a breadboard.

But now, says Douglas, "average FPLD densities are in the 300 to 900 range and some more-advanced designs [are] in the 1,500- to 5,000-gate range, making manual methods completely out of the question. Then there is the problem of working the variety of different architectures." Either the increased density or the variety of architectures alone "requires the support of good CAD tools. But with designers facing both problems, sophisticated CAD tools are an absolute necessity."

The most mature and well-known software programming aid for FPLD users is Monolithic Memories' Palasm (PAL Assembler). Palasm translates Boolean logic equations into a PAL fuse pattern that then can be downloaded to a PAL or PROM programmer to produce the required circuit. It also simulates the logical behavior of the part to verify the design and checks for adequate test coverage. The most recent version, Palasm 2.0, can be used to design most 20-, 24-, 40-, and 84-pin PALs.

A much more sophisticated FPLD design aid is Amaze (Automated Map and Zap Equation Entry) from Signetics, for support of the company's family of integrated fuse logic devices, including FPLAs, FPLSs, and FPGAs. It consists of five modules—the Boolean logic and state-transfer program, the integrated-fuse-logic function simulator, the device-programmer interface, the program-table editor, and the converter for changing PAL to integrated-fuse logic. The modules allow a designer to create the fuse patterns necessary to program the PLDs a number of different ways: as Boolean equations, state-machine equations, truth tables, PAL fuse patterns, integrated-fuse-logic fuse patterns, and schematic entry.

Two high-level languages have been developed as generic design tools to support all FPLD types: PROMs, PALs, FPLAs, FPLSs, FPLEs, EPLDs, and EEPLDs. These are ABEL (Advanced Boolean Expression Language) from Data I/O Corp., Redmond, Wash., and CUPL (Compiler Universal Programming Language) from Assisted Technology Inc., San Jose.

With ABEL, the designer supplies a description of the circuit in the form of Boolean equations or state-machine diagrams. The program takes these descriptions and synthesizes a fuse map for the appropriate FPLD type and then verifies the design by simulating the operation of the actual chip. It incorporates a set-notation feature that groups signals together and operates them as a unit. Various macros and commands are supplied to instruct the compiler to create blocks of text. Also contained in the program is a heuristic-reduction algorithm that minimizes complex logic designs to no more than a few lines of program text.

With CUPL, the designer is relieved of much of the need to supply Boolean equations or state-machine diagrams through the use of a macro, or expression-substitution feature. This capability allows the designer to create a variable name that does not appear on the input or output pins and to write an expression defining it. The variable is then used in any successive equations. When the text for the logic source is compiled

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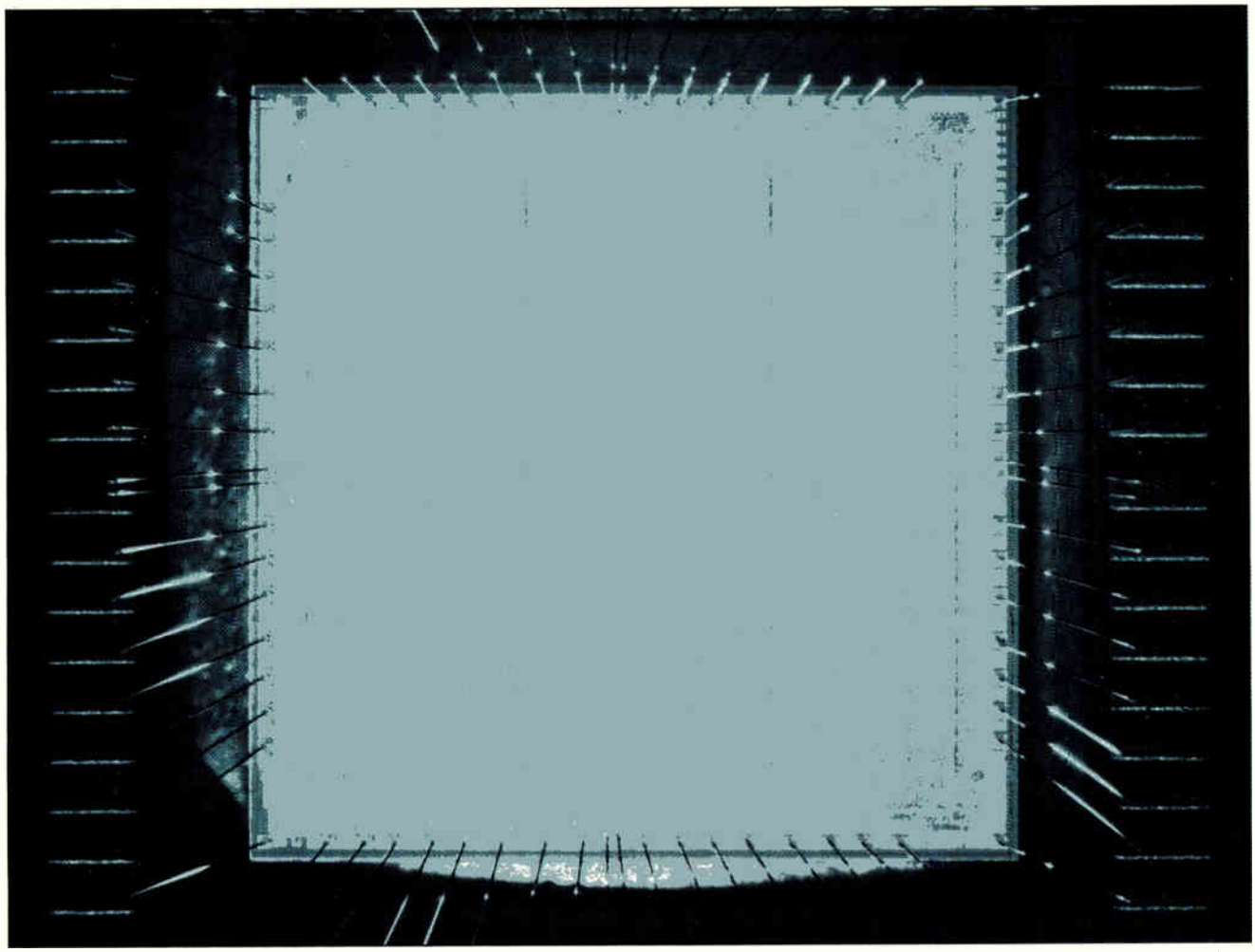

6. DYNAMICALLY REPROGRAMMABLE. A new field-programmable logic device from Xilinx, the XC2064, combines logic blocks based on static RAM with programmable interconnections. The result is dynamic reprogrammability.

for a fuse map of a particular FPLD, the compiler substitutes the defined expression for the variable name wherever it appears. Another CUPL feature allows entire groups of bits to be given a single symbolic name, further simplifying the design process.

Developed to support only Altera's family of EPLDs, the company's A+Plus (for Altera Programmable Logic User System) software system is perhaps the most sophisticated in terms of the number of ways an engineer can enter circuit information, including Boolean equations, state-machine diagrams, schematic diagrams, and net lists, similar to the techniques used in semicustom CAD tools. Key to the input flexibility of the A+Plus system is Altera's design library, which contains a set of schematic primitives divided into categories of input, logic, and I/O primitives.

NEW PARTICIPANTS

The move by more companies to participate in the growing market for programmable logic chips is continuing. Within recent months, two major semiconductor companies—the solid-state division of Sprague Electric Co., of Willow Grove, Pa., and Intel Corp. of Santa Clara—have made the decision to enter the market. And a third, Fairchild Semiconductor Corp.'s High Speed Memory and Logic division, Puyallup, Wash., will formally enter the market in February. Even RCA Corp. is considering a move into the market, mainly in support of its military customers.

Intel's initial entry into the FPLD market is with the 5C060 and 5C121 EPLDs, with 600 and 1,200 gates respectively, fabricated using the Santa Clara company's CHMOS EPROM technology. The 1,200-gate device, for example, is based on 28 macrocells, each of which contains a PAL structure and an I/O architecture control block that can be programmed to create a variety of output logic configurations. Propagation-delay time through the device is 50 ns at 15 MHz. Active power dissipation is 250 mW and standby power is 75 mW.

Another newcomer is Sprague Solid State, whose entries are pin-for-pin CMOS EPLD replacements of industry-standard 20- and 24-pin PALs. In the company's initial circuits, clock-to-output propagation delays are 25 ns for registered parts and 45 ns for nonregistered parts, says Clem Nahmias, director of commercial products. They dissipate 275 mW active and 75 mW standby.

Finally, Fairchild Semiconductor will formally enter the market next month with its FAST PLA family. Fabricated using its Isoplanar-Z vertical-fuse technology, the initial devices will be pin-compatible with the 20-pin series of PALs and will feature propagation delays through the array as low as 15 ns.

Fairchild has several reasons for entering the programmable-logic market, says logic marketing manager Joe Nichols. "First, programmable logic allows us to expand the market for Fairchild Advanced Schottky TTL devices to those whose volumes or logic implementations could not be supported by either standard logic or gate arrays. But just as important is the desire to remain an active participant in the ASIC market. Without field-programmable logic, we would have been locked out of one of the fastest-growing portions of that market."□

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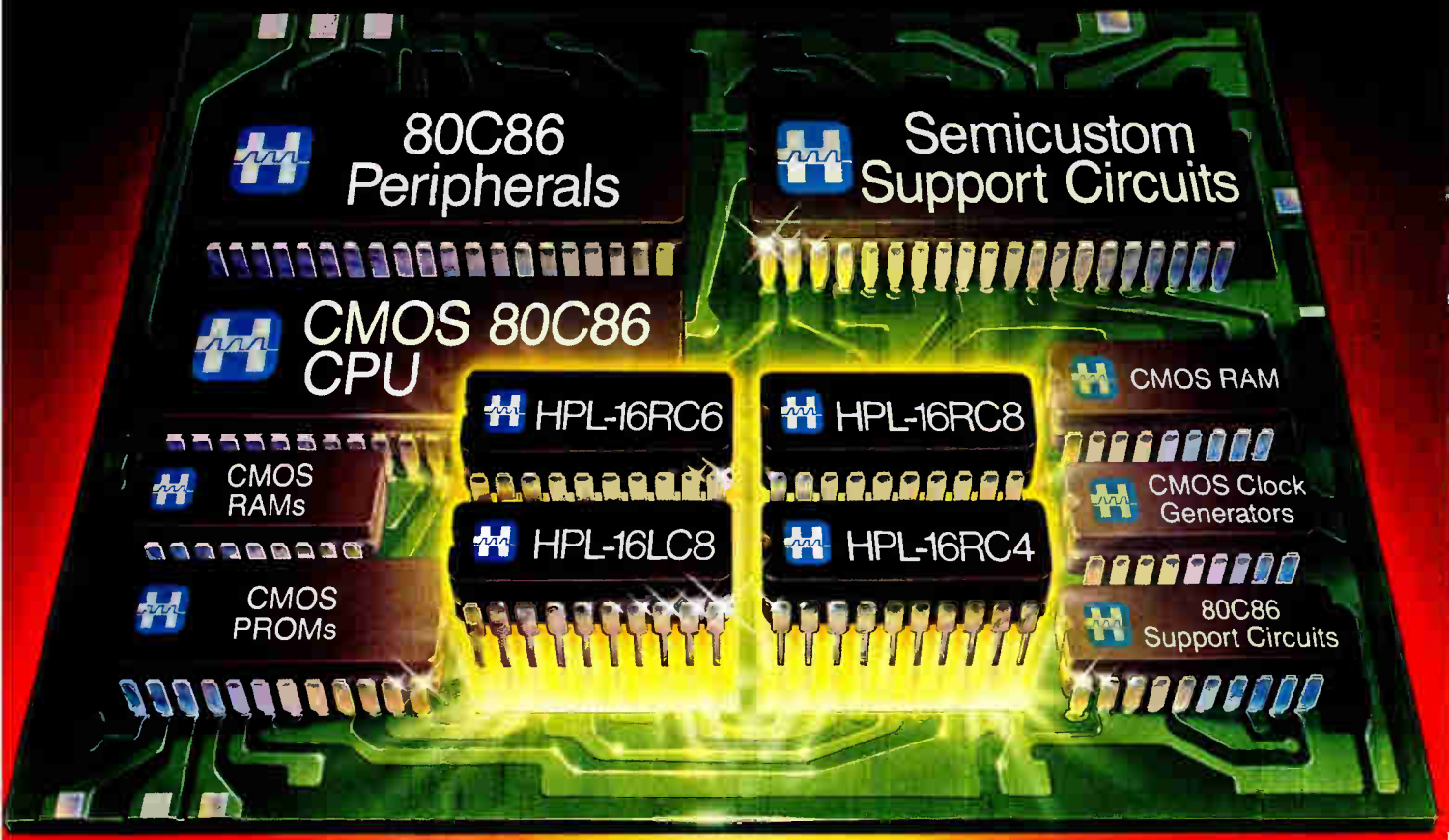

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HPL-16RC4	Replaces 16R4, 16RP4	5 mA/MHz	
HPL-16RC6	Replaces 16R6, 16RP6	5 mA/MHz	
HPL-16RC8	Replaces 16R8, 16RP8	5 mA/MHz	
HPL-82C339*	Programmable Chip Select Decoder	1 mA/MHz	• t_{PD} = 25 ns typ

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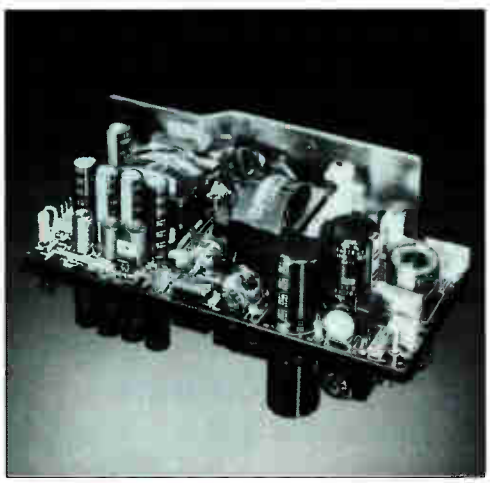
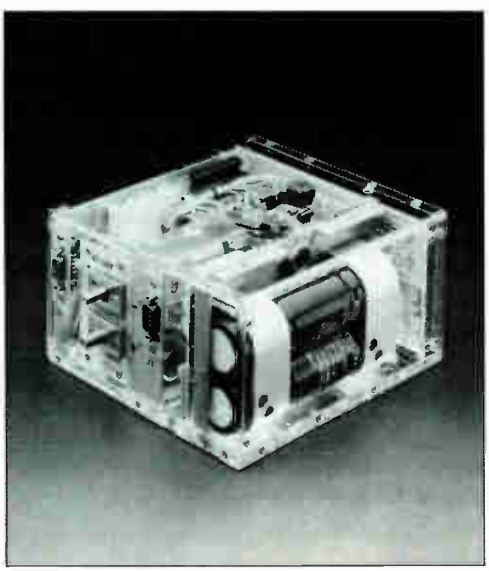
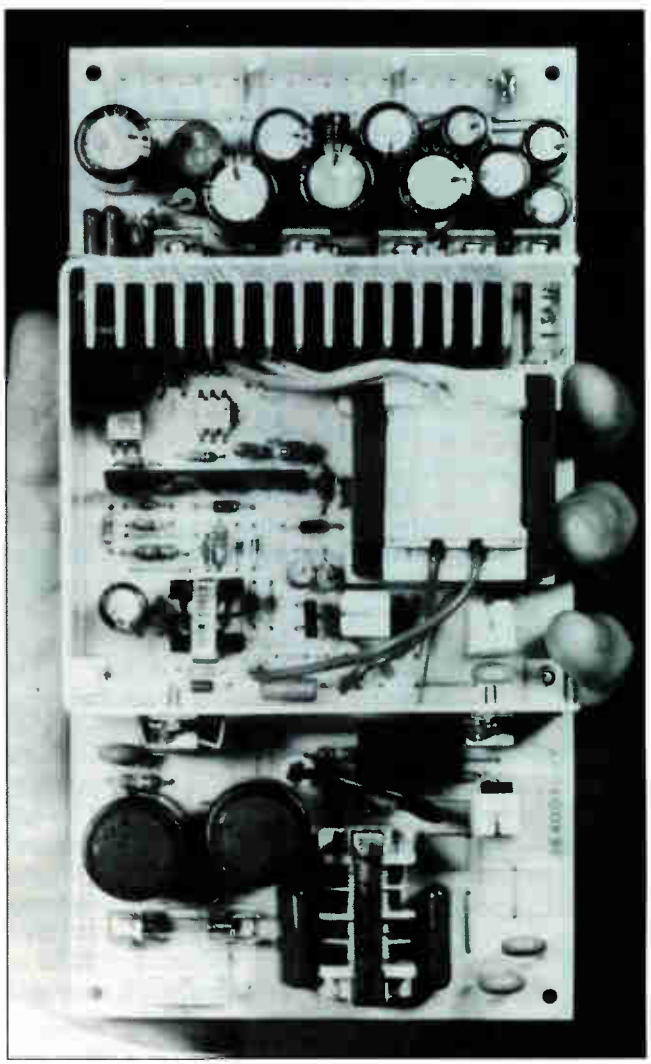
World Radio History

Switching Power Supplies







Electronics *Special Advertising Section*

World Radio History

Switching Power Supplies

RELIABILITY IS UP, SIZE DOWN AS SMDs, ICs POPULATE SWITCHERS, BUT COMPETITION IS FIERCE

"Make it smaller, cheaper, and more efficient" is the battle cry in electronics. When it comes to power supplies, that's just the start: parts also have to meet standards for safety and electromagnetic radiation, and their manufacturers must guarantee high levels of reliability.

Designers of power supplies are constantly on the lookout for new ways to refine their products. Hybrid chips developed and fabricated in-house and surface-mounted devices reduce parts count and add to reliability. For switching power supplies, the jump to 200-kHz switching rates from conservative 20-kHz rates is improving efficiency and increasing power density.

As frequencies shift upward, power-supply designers are prodding capacitor manufacturers to produce filter capacitors with lower equivalent series resistance and inductance. In response, these companies are using new foil materials and improved etching techniques to produce aluminum and tantalum capacitors with impedances as low as 10 Ω at 100 kHz.

Application-specific integrated circuits tailored for power-supply designers include soft-start chips, overvoltage and overtemperature products that combine MOS and bipolar technologies, pulse-width modulators, input-isolation circuits, ac-to-dc converters, and numerous voltage and current regulators covering a wide range of levels. Suppliers of magnetic components have also upgraded their products and are supplying more-efficient ferrite cores along with more-compact switching transformers to meet demands for higher density.

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COVER CREDITS

Cover photo, bottom left: Rantec's new line of standard military-specification dc-to-dc converters uses power MOS FETs operating at 100 kHz. The converters offer a power density of 3.26 W per cubic inch and an MTBF of 72,000 hours. Upper left: A hybrid control circuit replaces 165 discrete components in Power-One's SPL150 series of switching power supplies. Both fully and quasi-regulated models are available. Right photo: Kepco's MRM 260KV 80-W FET-based flyback converter includes control, overvoltage protection, current limiting, and startup functions on hybrid microcircuits developed and fabricated in-house.

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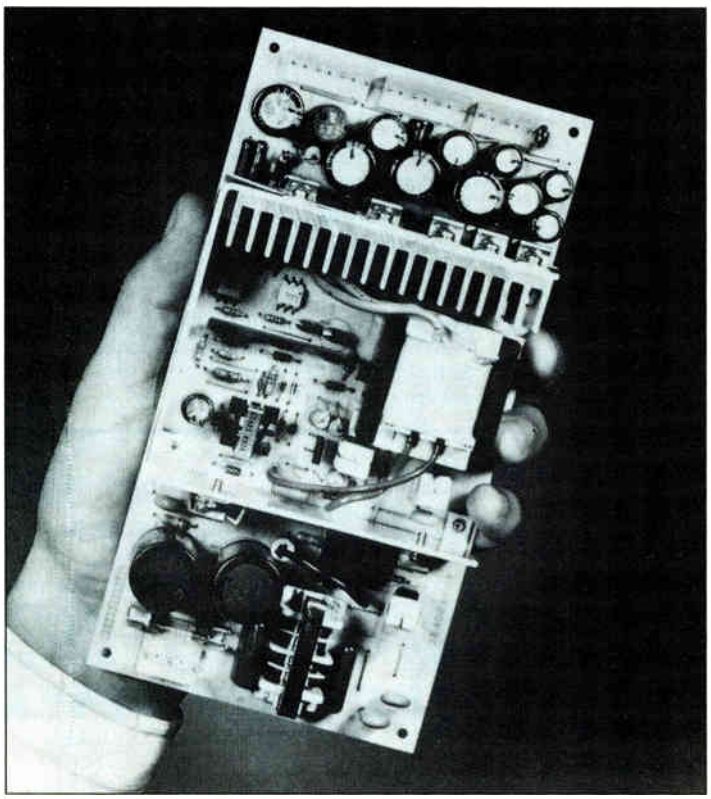
Changing trends

Over the past several years, a steady shift has been taking place in the market for switching power supplies: original-equipment manufacturers are buying switchers rather than producing them in-house. One reason for this trend is the shortage of competent design engineers who are well versed not only in magnetics, power semiconductors, and feedback-loop arrangements but also in the latest changes in the safety regulations set by such standards agencies as the Canadian Standards Association, the International Electrotechnical Commission, Underwriters Laboratories in the U. S., and West Germany's Verband Deutscher Elektrotechniker.



The majority of switching power supplies under 150 W, such as those offered by Kepco, are open-frame models. Where safety and rfi emission standards are critical, mesh-enclosed models are available.

Without the right designers, an OEM engineering group could invest considerable time and expense and still not be able to come up with products that can measure up against designs produced by switching-power-supply specialists.

In addition, because of the active competition among power-supply producers, OEMs find themselves blessed with a buyer's market and all its benefits, including low cost, applications assistance, and on-time delivery.

Switching power supplies fall into several broad categories: low power (150 W and under), medium power (up to 500 W), and high power (up to several kilowatts). Almost all the supplies operate off a 110 or 220 V ac line. Many are also fed by 250 to 290 V dc—dc output can be anywhere from 2 to 48 V, with single or multiple output taps available.

For the most part, dc-operated supplies, or dc-to-dc converters, power those sections on a printed-circuit board that require a dc voltage not available from the main power supply. Other dc-to-dc converters are ideal for remote installation where no ac line is available and equipment must be powered by batteries and solar-cell arrays; dc-to-dc converters allow any voltage level to be set from a battery or solar-cell input. Another area of use is high-voltage supplies to apply the 25 kV or more required for cathode-ray tubes on data terminals and other displays.

Most low-power switchers are offered in open-frame construction, which is basically a pc board devoid of a metal mounting bracket or chassis. Others are supplied with an L-frame for attachment to the equipment chassis. For those applications where safety and radiation standards are demanding, fully enclosed cases house the switcher.

A small percentage of low-power

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*U.S. Navy/Industry Power Supply Ad Hoc Committee Estimates for Time and Cost.

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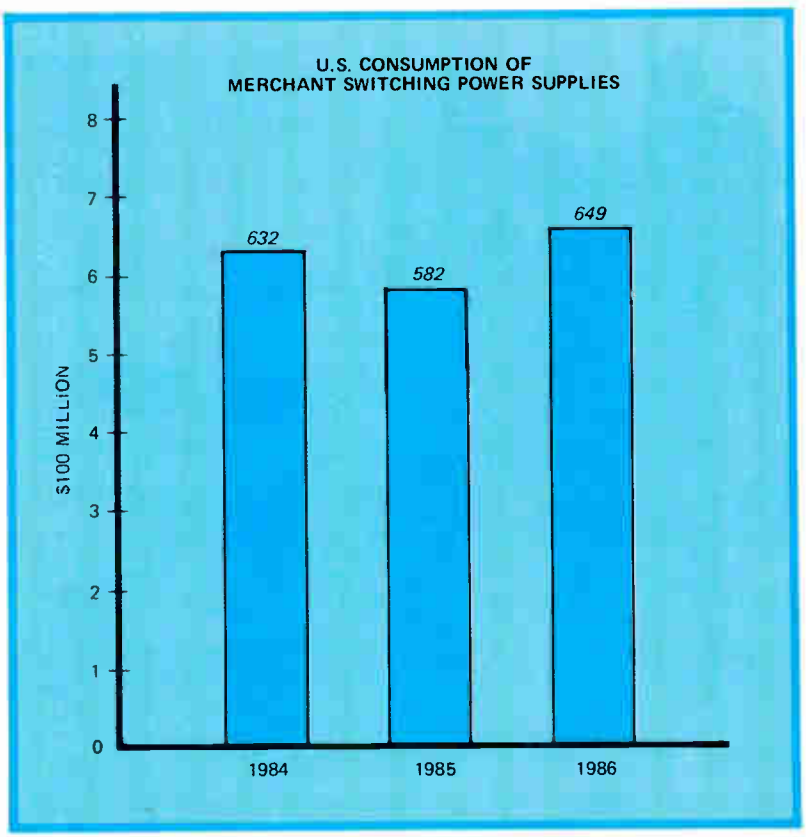
switchers (generally under 30 W) are encapsulated in epoxy or some other material to provide resistance to shock and vibration. However, these supplies tend to be more expensive than open-frame models and are difficult to repair; for many applications, these switchers are modules that are replaced rather than repaired when a defect occurs. The power density of encapsulated units is limited by the surface area available to dissipate heat as well as by the conductivity of the encapsulating material.

Small minicomputers, computer-aided design and manufacturing systems, office automation equipment, and specialized automatic test equipment are target markets for medium-power switchers. Most switching power supplies up to 500 W are open-frame models with multiple outputs taps; in general, switchers above 500 W are enclosed and provide a single output tap, although models with multiple output taps are available.

The market for high-power supplies peaked in the era of magnetic-core memories, almost a decade ago. Now the market is making a comeback, as mainframe designers use current-hungry emitter-coupled logic devices and jam more and more memory chips into their systems. Because this segment of the market caters to low-volume orders at high prices, it has not yet attracted much attention from offshore competitors.



U. S. noncaptive consumption of power supplies dropped 8% last year, according to the Electronics 1986 Market Report, driven down by the slump in sales of personal computers and peripherals. Survey respondents predict a 11.5% increase this year.

Safety standards

End-product manufacturers pursuing worldwide markets know how important it is that the functional blocks within their products meet the safety and radio-frequency-interference standards of the countries into which they wish to sell. Though in many instances the standards organization, such as the Underwriters Laboratories, is not connected with the government, failure to comply with its recommendations could cut off entry into a market or result in products being removed from store shelves and displays.

With more than 25 regulatory agencies in operation around the world, end-product and power-supply designers must be acquainted with numerous standards for current leakage, voltage breakdown, minimum spacing between line-connected parts and grounded metal areas,

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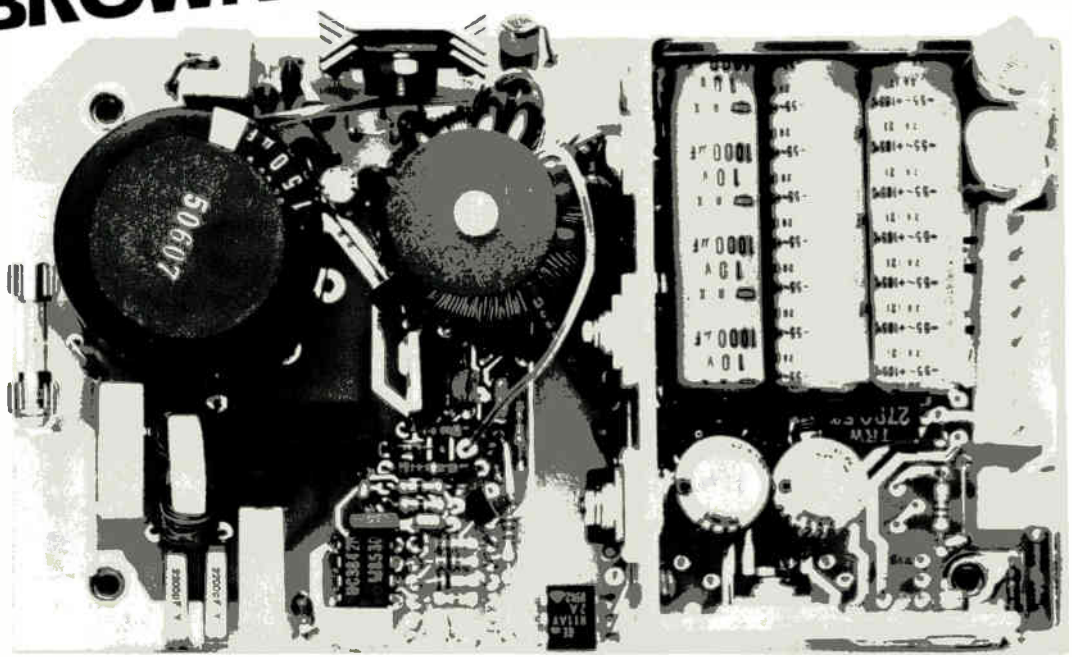

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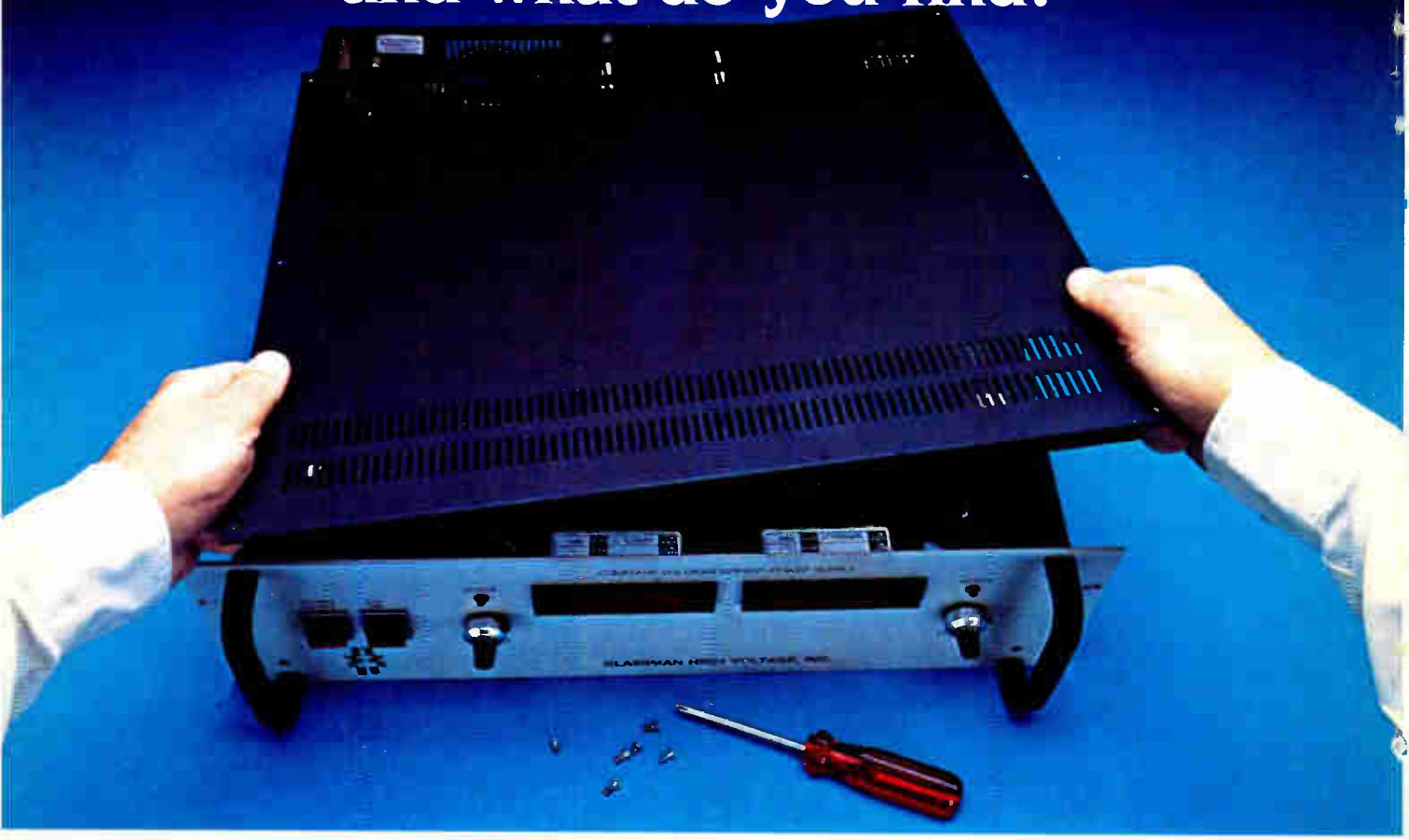

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transformer isolation, and operating temperature limits. All relate to maintaining product safety by minimizing fire and shock hazards. VDE 0806 is a key standard in Europe: Common Market nations honor the safety standards of other member countries if their products meet this world-recognized specification.

Radiated interference is more of a problem in Europe, where countries are closely spaced and densely populated. There, crowded frequency spectrums are a sore political problem as well as a technical challenge. The most demanding specifications for rfi control is West Germany's VDE 0871/6.78. In the U. S., the Federal Communications Commission is in charge of keeping a lid on electromagnetic energy pollution generated by digital equipment ranging from high-speed data-transmission devices to video games.

The impact of these safety and rfi standards on power-supply designers is significant. As customers demand that prices come down and power density be increased, designers are forced to open up the spacing between terminals for safety while adding rfi filters to their bills of materials—all in the interest of delivering products that can meet CSA, IEC, VDE, and UL standards.

Fierce competition

Last year was a disaster for many power-supply manufacturers—a number of which were put out of business by the slump in sales of personal computers and their associated peripherals. Though orders from producers of communications and military equipment picked up, offering some compensation, U. S. noncaptive consumption of switching power supplies dropped by almost 8%, according to the recently completed Electronics 1986 U. S. Market Report [*Electronics*, Jan. 6, 1986, p. 57]. Respondents to the study forecast an 11.5% rebound in 1986. A longer-term market study, produced last year by Salzer Technology Inc., Santa Monica, Calif., projects that the market for noncaptive switching power supplies will grow from $840 million in 1985 to nearly $2.84 billion by 1989. About half the sales, or $450 million in 1985 and $1.59 billion in 1989, will be standard off-the-shelf products, with custom-designed units accounting for the other half. The total market for switching power supplies (captive and merchant) reached $2.61 billion in 1985 and will hit $6.69 billion in 1989, according to the Salzer study.

The field is swarming with

Rf power supplies, such as Glassman's high-voltage products, are inherently safer than 60-Hz supplies because less energy is stored in the capacitors used for filtering. Applications include flying-spot scanners, X-ray sources, and flocking systems.

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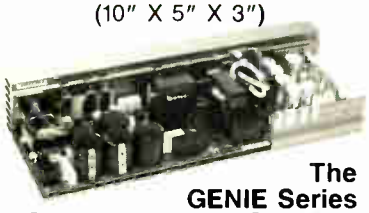

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Switching Power Supplies

Special Advertising Section

competitors, with many new entries from offshore manufacturers. To compete with lower-priced imports, power-supply manufacturers in the U. S. have been making rapid strides in developing less-complex circuitry, producing hybrid chips in-house to reduce parts count, and automating assembly lines to reduce production costs. But in keeping with the dictum that "if you can't beat 'em, join 'em," an increasing number of U. S. manufacturers is establishing joint licensing agreements with overseas companies.

Products abound

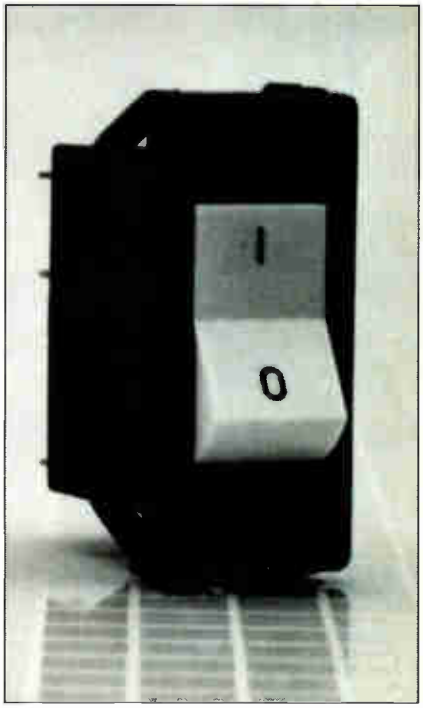
Regulated, rf solid-state, high-voltage power supplies, delivering up to 100 kV dc, are designed and manufactured by Glassman High Voltage Inc., Whitehouse Station, N. J. Safety for personnel and external equipment at these high-voltage extremes is inherently better than for line-frequency high-voltage supplies operating at 60 Hz, because the output capacitance for a 30-kHz design is low enough for the total energy stored to be less than 1 joule in most models. The rf-oscillator power supplies operate at greater than 75% efficiency with tight line and load regulation.

Glassman's WH series 500-W switch-mode power supply, which has a variable output up to 75 kV at 5 mA and down to 5 kV at 100 mA, is suitable for a variety of applications, such as manufacturing (spraying and flocking, ion implantation, precipitation, and deposition systems) and display systems (image intensifiers, radar displays, and projection-TV equipment). All models include remote programming and both voltage and current regulation, with automatic crossover to voltage or current mode dictated by the load magnitude.

A proprietary thick-film hybrid control circuit, which replaces 165 discrete components, enables Power-One Inc., Camarillo, Calif., to offer its SPL150 series of switching power supplies in a compact package that measures 8 by 4 by 2.1 in. The SPL150 series is suitable for system-integration packages involving logic devices, CRT monitors, and electromechanical subsystems such as disk drives and printers. Typical applications include disk drives for computers, CAD work stations, robotics, and process controllers, says Steve Cole, company vice president.

The SPL150 series operates from virtually any main voltage, from 90 to 264 V ac, 47 to 63 Hz, and meets the toughest safety standards of any country. Each unit is UL recognized, CSA certified, and certified for compliance with VDE 0804, 0805, and 0806 as well as IEC 380 and 435. The six SPL150 models, which sell for $217 each in single quantities, provide up to 150 W of power from four separate output taps and come in either fully regulated or quasi-regulated configurations, depending on the user's requirements. Each model can be optimized to satisfy the user's power-supply needs.

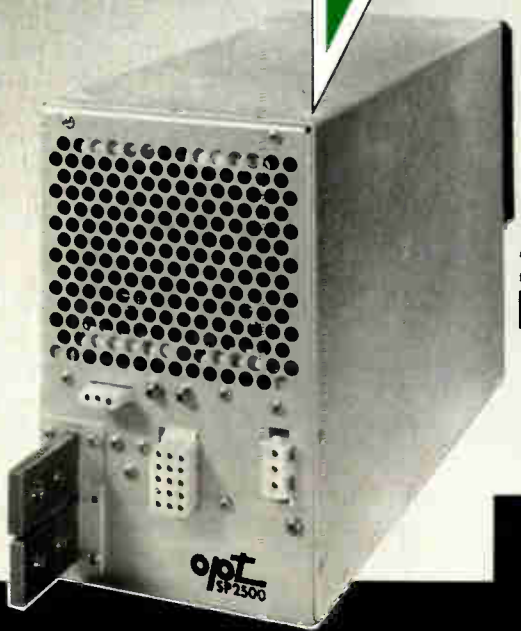
A new two-pole rocker switch and circuit breaker has been introduced by E-T-A Circuit Breakers, Chicago, Ill. The new device fits the same form as the company's popular single-pole 41-10/41-11 series of snap-in mountable



A single E-T-A two-pole rocker switch and circuit breaker replaces two on/off switches and two fuses, reducing assembly time and parts inventory. Optional illumination provisions are also included.

World Radio History

The New Super Power



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This new cost efficient power supply is affordable at less than 0.13 cents per reliable operating hour, and its MTBF is in excess of 140,000 hrs.
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units. Because the two-pole part can be mounted in the same panel cutout required for single-pole units, it saves space and cost.

In addition, these new devices are interchangeable with the Airpax 203-11 and the Heinemann TX2 two-pole units. The two-pole rocker switch and circuit breaker is well suited for protecting switching power supplies, electronic data-processing equipment, office machines, and medical and dental equipment. The single device can replace several components and has optional illumination provisions. This can translate to customer savings in costs for installation, wiring, and inventory. Life expectancy of the devices is 25,000 cycles minimum under load. In addition, they are insensitive to shock and vibration and can handle high in-rush currents without annoying trips to reset. The new model, approved by the CSA, UL 1077, and VDE, comes in ratings from 0.1 to 16 A at 250 V ac.

Military-specification dc-to-dc converters, using power MOS FETs at 100 kHz, are the focus of Rantec Power Systems, a division of Emerson Electric Co. The Chatsworth, Calif., company has a new line of standard supplies designed to meet the needs of military applications. Included are the 4000 series single-output converter, available in 74-, 150-, and 300-W ratings; the 5000 series 180-W dual-output converter; and the 6000 series 175-W triple-output part. This new line of standard products offers an alternative to Rantec's custom military design capability.

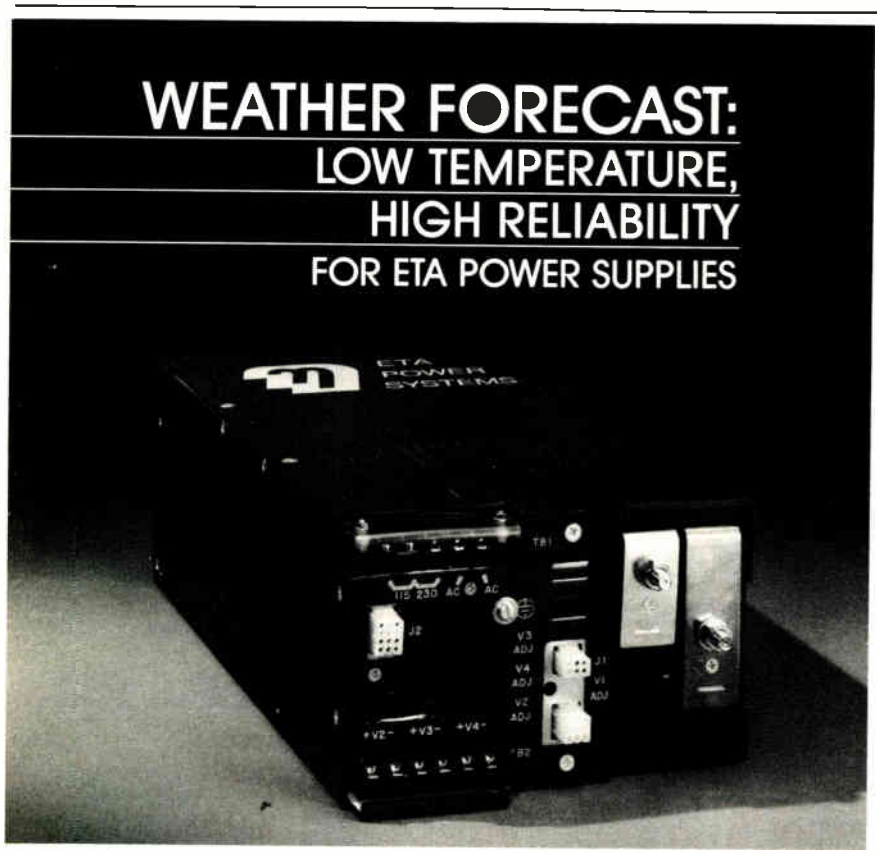
The converter's design is based on single-ended forward converter topology to reduce the number of circuit components required, which improves reliability. The mean time between failures for the 4000 series is 71,400 hours; for the 5000 and 6000 series, it is 72,000 hours, per MIL-HDBK-217C.

All models in the line include soft-start circuitry, low-line lockout, output foldback current limiting, and shutdown overvoltage protection. The Rantec 4000, 5000, and 6000 series converters are qualified in accordance with MIL-E-5400 Class 2, MIL-E-16400 Class 1, MIL-E-4158, MIL-STD-461A Notice 3, MIL-STD-704D, MIL-STD-1275A Notice 2, and MIL-T-27.

Magnecraft Electric Co., Northbrook, Ill., a leading manufacturer of a wide variety of relays, has recently introduced an ac sensing relay. The device, model W-235ACX-2, uses a silicon controlled rectifier and a bridge circuit to provide a highly repeatable ±2% sensor without loading the circuit being monitored. The field-adjustable sensor's output is a single-pole double-throw relay current rated at 10 A. A 1.5- to 15-A current range with a 120-V coil is available from stock; other current and voltage ranges are available on request.

CAD tools

Computer-aided design and development tools are used at Summit Electronics Inc. to reduce turnaround time for the Richardson, Texas,



That's what you'll be forecasting for your system when you use ETA high current, switch-mode, DC power supplies. They maintain the lowest component-to-ambient temperature gradient in the industry. At least 15% less than the others. ETA does it in 500, 650, 800, 1000, 1200, 1500, and 1800 watt models. From one to five outputs.

Reliability is the priority with ETA. A unique hybrid thermal design (patent pending) maintains low component temperatures. You can even reverse the air flow and maintain specs. A MOSFET based design reduces component count. High voltage transistor V-I reshaping enhances safe area operation. Fault tolerant designs provide protection for power supply and system alike. It all adds up to high reliability.

That's why ETA has become the vendor of choice for many Fortune 100 computer/electronic companies.

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World Radio History

company's printed-circuit-board and mechanical designs. The product line includes standard switching power supplies ranging from 50 to 400 W, custom supplies up to 2,000 W, and military power supplies and dc-to-dc converters.

Boasting a power density of 3.6 W per cubic inch, Summit's GX500 500-W supply comes in a package smaller than most 200-W supplies and provides five output taps, with 5 V at 75 A the primary output. The standard configuration offers high-power auxiliary outputs of either ±12 V or ±15 V at 15 A each and lower-power auxiliary outputs of +24 V and −5 V. These outputs can be tailored to user-selectable values between 2 and 48 V. Standard features include adjustable auxiliary outputs, input electromagnetic-interference filter, ac fan output, ac power-failure indicator, and a remote sensor for primary output. The GX500 is designed to comply with CSA, UL, and VDE safety requirements, and investigations are scheduled for completion before midyear.

Kepco Inc., Flushing, N. Y., which is marking its 10th year in partnership with TDK-Japan, has a broad line of frameless, multiple-output switching power supplies. Designed around an economical flyback circuit configuration, the MRM 250KV is a four-output 60-W switcher that delivers +5 V at 2 to 6 A, −12 V at 0.5 to 3 A, −12 V at 0 to 1 A, and −5 V at 0 to 0.5 A.

A design feature is a custom hybrid chip that houses surface-mounted components on a ceramic substrate. The hybrid contains all the signal processing components as well as reference and modulator sections, providing a clean, uncluttered layout that contributes to high reliability. Available off the shelf, the MRM 250KV includes built-in EMI filtering and meets CSA, IEC, UL, and VDE safety requirements.

For industrial OEM applications, Kaiser Systems Inc. provides a line of high-voltage power supplies that are short-circuit proof and designed to limit surges of stored energy into the loads being driven. With output power ranging from a few hundred watts to over 100 kW and voltage levels from 1 to 200 kV, equipment from the Beverly, Mass., company is suited for use in

A silicon controlled rectifier and bridge arrangement are used in Magnecraft's ac sensing relay to avoid loading the circuit being monitored. Its output is a single-pole double-throw relay rated at 10 A.

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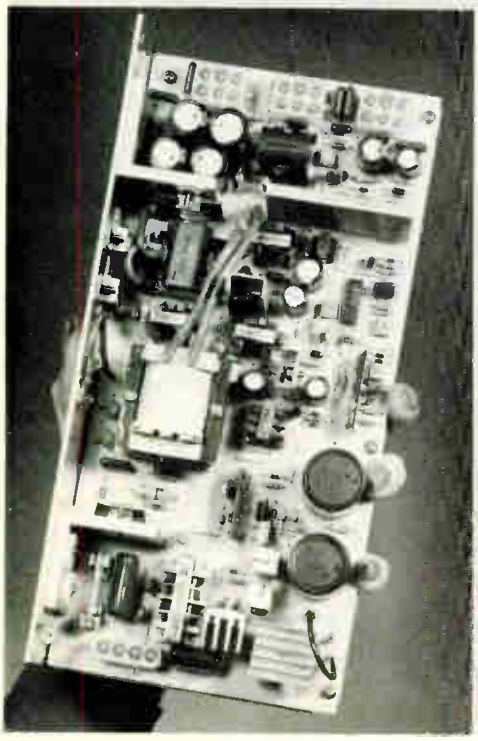

Nine new frameless switchers which produce multiple output voltages for portable computers, terminals, etc.

Kepco/TDK's series MRM power supplies are high-efficiency, low-priced designs ranging from 40~120 Watts. They're UL recognized, CSA certified for safety (international models TÜV-certified to VDE) and have on-board FCC/VDE line filters.

For complete specs, or a demo, write Dept. GHS-14.

◀ 120 Watt, 4-output MRM 270KV

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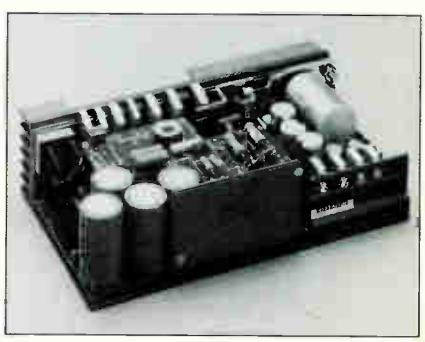
computerized control systems. Many models employ microprocessors as communications and control elements. Kaiser Systems' high-frequency switch-mode and vacuum-tube linear power supplies are suitable for applications ranging from ion implantation to medical and industrial lasers to X-ray, deposition, and electron-gun systems.

The new 1600 switchers from Brown Manufacturing Ltd., Scarborough, Ont., Canada, are designed around a 200-kHz current-mode forward converter topology, featuring magnetic amplifier secondary regulation with high peak currents for magnetic peripherals. The standard size is 4.8 by 12 by 2.5 in., but custom packages are available. Power ranges from 270 to 560 W, with three to five output taps—all fully regulated and protected. Standard versions have CSA, UL, and VDE 0806 approval and comply with FCC/VDE class A rfi requirements. The 300-W three-output model sells for $200 each in orders of 1,000.

Brown Manufacturing's latest entry, the model 36, boasts a density of 4.4 W per cubic inch and can operate from a continuous 90 to 260 V ac input. The 100-W switcher provides two to four output taps and sells for 50¢ per watt in 10,000-piece quantities.

MOS FET designs

For applications that demand high reliability, such as supermicrocomputers and minimainframe computers, data-communications systems, and computer-aided design, manufacturing,



Using a single-piece extruded chassis and new semiconductor packages, Summit Electronics has achieved a power density of 3.6 W per cubic inch with its new GX500 500-W and GX750 750-W series.

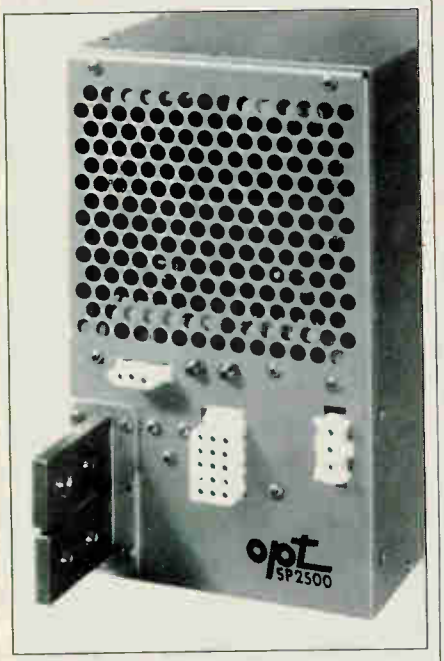
World Radio History

and engineering systems, Eta Power Systems Inc. offers a variety of high-current dc supplies. Models range from 500 to 1,800 W, with one to five output taps, and deliver up to 360 A.

To ensure reliability, the Signal Hill, Calif., company uses a MOS-FET-based switching design that reduces the number of required circuit components. In addition, a unique hybrid thermal design results in a low component-to-ambient-temperature gradient. To weed out potential defects, each unit goes through Eta's "beat-up" testing, which consists of shorting its outputs after the unit is on and loaded. These tests will verify the effectiveness of the circuitry and the quality of the components under abnormal conditions. All Eta models comply with the safety requirements set by the CSA, IEC, UL, and VDE.

Low-cost custom products

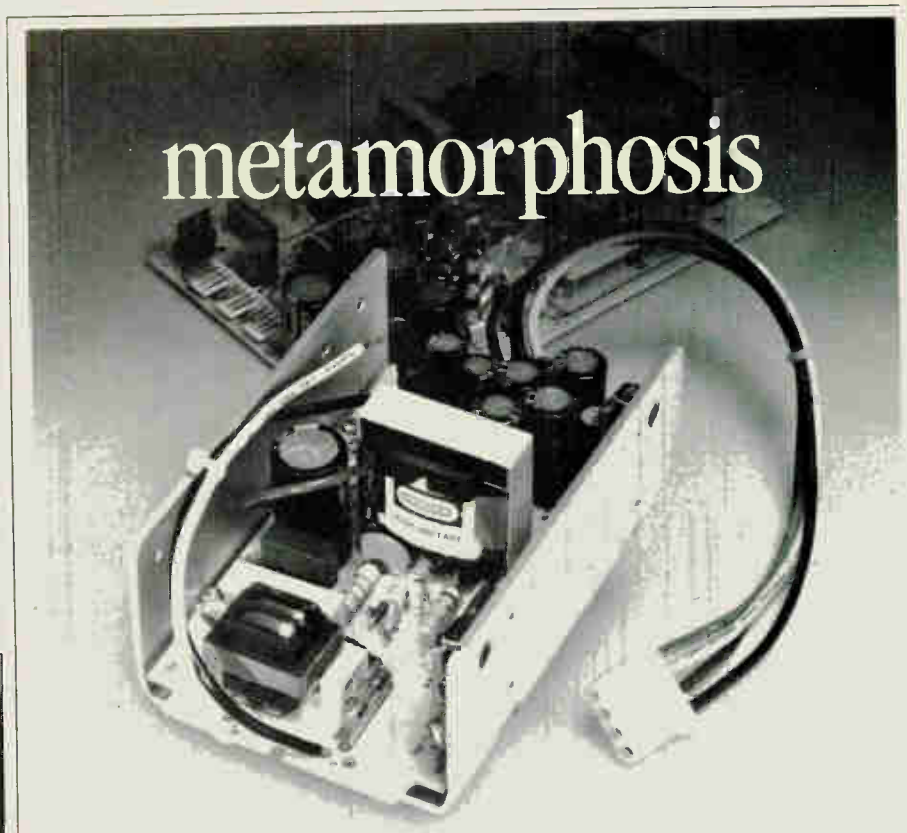
Custom-designed power supplies at prices close to those of standard power supplies are a major draw at Cord Electronics Inc. Furthermore, the Westbury, N. Y., company promises rapid turnaround time from receipt of customer specifications to evaluation sample: four weeks is typical; specials can take seven weeks or so, says George Hardy, Cord Electronics' president.



Opt Industries' line of 1,500- and 2,500-W switchers are designed using 100-kHz current-mode topology with HEXFET bridge circuitry. Units can be master-slaved in parallel to handle up to 3,000 A at 5 V.

The company offers a conservative custom product in the 30-kHz range with bipolar switching transistors. Although less exotic than 100- to 200-kHz MOS FET state-of-the-art designs, the more conventional products are highly reliable, have low EMI and rfi levels, and permit rapid custom-design turnaround, Hardy claims. Besides providing custom power-supply designs at economical prices for production requirements as low as several hundred units per year, Cord Electronics offers standard, off-the-shelf OEM switching power supplies.

A line of 1,500- and 2,500-W power supplies operating at 100 kHZ for mainframe computers and peripherals is available from Opt Industries Inc.'s Power Conversion Systems Group, Phillipsburg, N. J. The SP-1500 and -2500 switchers operate from an input of 115 or 208 V three phase or 208/230 V single phase, 47 to 440 Hz or



Starting with a standard 40W footprint our customer ended up with a custom 80W unit. In spite of three revisions, two prototype runs and an order of 500 pieces, Cord delivered the final product for under $60 per unit!

This is just one example of Cord's ability to provide a custom designed switching power supply in a small quantity at a very reasonable price.

This ability means you no longer have to compromise your product design because of a vendor's excessive R & D costs and large minimum order requirements.

If you need a custom power supply in quantities of 250 and up and cost is an important factor, the most important move you can make is to contact Cord Electronics.

CORD ELECTRONICS
INC. (Power Supply Division)

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260/290 V dc with available output voltages from 2 V dc up to 56 V dc, adjustable to ±10%. Line regulation is less than 0.1% over the input range, and load regulation is 0.2% over the input range. Output ripple and noise are less than 1% peak to peak.

Opt Industries' power supplies are designed around current-mode pwm control topology using 100-kHz power HEXFET bridge circuitry. All ICs used in the supplies are housed in ceramic rather than plastic packages to upgrade reliability; an MTBF in excess of 140,000 hours has been demonstrated. Line and load response time is typically less than 50 μs, and holdup time is 10 ns. Each unit includes overvoltage protection (110% to 120%), remote sensing (both output and return of 0.5 V maximum), input transient protection, and soft-start provisions. Up to six units can be used in parallel to increase current capacity.

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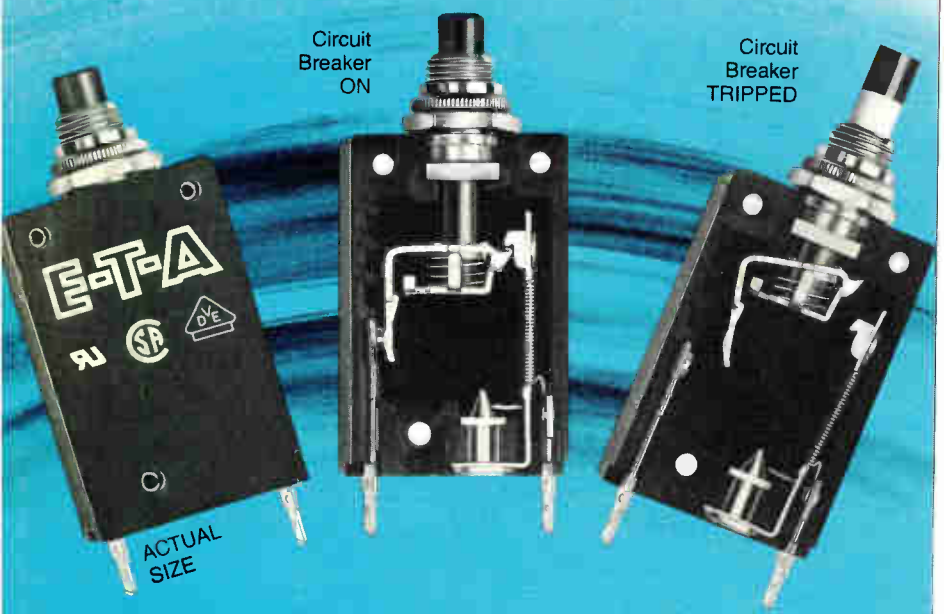

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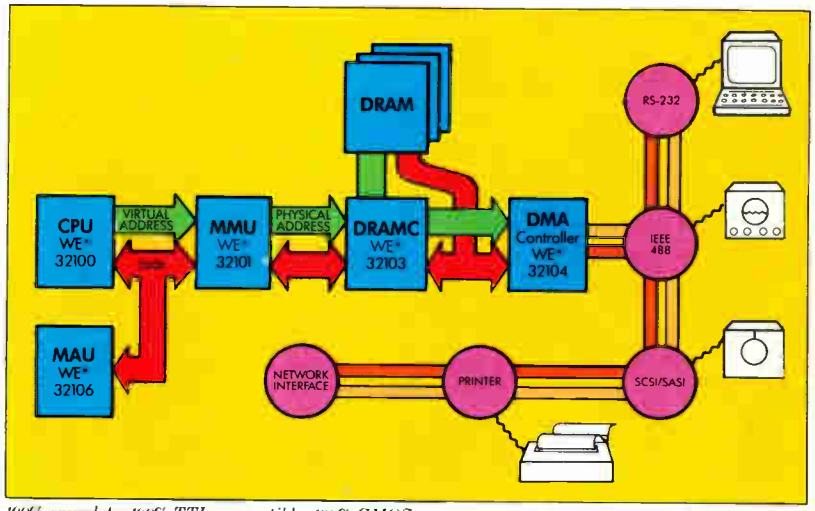

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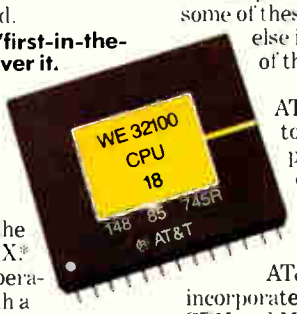

AT&T's 32-bit CPU is a high-performance microprocessor that gives you 2 to 3 MIPS at 14 MHz. And at an unprecedented 18 MHz, you get up to four times the power of an equivalent VAX.*

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Add to all of that an AT&T Evaluation Board that's today's fastest way to benchmark against all other microprocessors. It features zero wait state memory, resident assembly-level debugger, and CPU and Memory Management Unit with Math Acceleration Unit option.

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Electronics is back–with the industry's top reporting on international electronic technology. In the first half of 1985 alone, Electronics–with its worldwide bureau of correspondents–published more than 140 articles on international technology. Important articles with news and analysis that leaders in the field can't afford to be without, such as:

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Philips Uses MBE for Lasers
Siemens Readies Commercial ISDN
Japanese Chemical Firm Moves from Soap to Floppies
Italian Firm Seeks Allies to Crack U.S.
Japan Pursues Role in Space
Bellman Switches on Italtel for Expansion
Robots get Smart in Japan
ITT Invests in European Units Crack U.S.

February

Europe's Esprit Finally Sets Sail
LSI Logic Counts on Sandfort to make its Mark in Europe
Upstart Vendor Makes Waves in Japan's Robot Market
NEC Fashions New Fab Process
Olivetti's Viti Directs ET Designs that Marry Bus & Art
German Startup's Success Surprises Europeans
Britons Seek Tolerant Chips
OBI Rains on IBM's Parade
Mega's Friedrich Aims to Cut Asian Lead in Memories

March

British GaAs Chips Go to Market
NEC's CPU Leapfrogs IBM
Hitachi CPU Challenges IBM
France's Lansat Rival Set for Fall Launch
Olivetti Stakes Claim in Video Typewriters
Italian VLSI Chip has the Right Accent
Koreans Try for VCR Replay
Germans Push X-ray Exposure
There's Life in Resistors, German Company Finds
UK Beats a Path for Europe's Race

April

German System Meets New ICAO Standard
West Germans Squabble Over Choice of IFF
Britain Promotes Open Architecture
US Makes Progress in Japan Telecom Talks
Japan's Lead in Optical Disks: It's Part of the System
Daisenberger Guides US Firms through Red Tape
Asia: It's No Longer Just Japan That Threatens US Markets
Malaysia: Top Shipper of Discretes
Indonesia: Domestic Sales are the Lure

May

Thomson's VCR System Clears Up Doubts
ICL Banks on Networks and Japanese Chips
Min Blazes Bright Path for Korea's Gold Star
Asia: The Four Dragons Rush to Play Catch-up Game
Singapore Casts Lot with Software
Philips' Eurom Chip Finally Debuts
Sagging Prices Sting Japanese Producers
British Telecom Spreads Its Wings with Mitel
South Korean IC Maker Seeks World Markets

June

Plessey Switches Off Flash ADC, Saves Power
Sony Campaigns Hard for BMM Camcorders
Japanese Quit on IBM Software, Turn to UNIX
Apple Tries Again to Blast Off in Japan
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DESIGNING A 32-BIT PROCESSOR THAT'S 'FAIL-SAFE'

NEW TOOLS YIELD A CHIP THAT WON'T RUN FAULTY DATA OR SOFTWARE

An arsenal of advanced design tools is driving a team of engineers at the UK's Royal Signal and Radar Establishment toward a chip that offers a solution to the problem of microprocessor malfunctions. These tools produced a rigorous definition and verification of the 32-bit processor design, which the RSRE team calls "formal specification and verification." They offer a theoretical grounding for the group's promise of a chip that will perform as planned.

The resulting safety-first microprocessor is known as Viper, for Verifiable Integrated Processor for Enhanced Reliability. Such a microprocessor will help control malfunctions that cannot be tolerated in critical military, aircraft, nuclear power, medical, and robotics applications. Viper is being developed by the RSRE's High-Integrity Computing Group in Malvern. The work, funded by Britain's Ministry of Defense, has reached the prototype stage (Fig. 1), and first samples of the chip should be ready toward the middle of the year.

The 32-bit design is "the world's first formally specified and verified microprocessor," says John Cullyer, leader of the Viper team. In addition to the chip hardware, the group is developing a software language—called NewSpeak, after the obfuscatory lingo in George Orwell's *1984*—that contains built-in checks to guard against program errors.

"We believe that in the highest-integrity systems—that is, those which, if they malfunction, might cause death—there are risks in using commercial microprocessors without any parallel means of protection," says Cullyer. He believes that commercial microprocessors are satisfactory in 99% of computer applications. "However, there's a small residue of 1% or less where the operation of that computer is so critical that you've got to be very careful. We believe that Viper fits into that highly critical area."

Seemingly innocent errors can cause big problems, Cullyer says. When many microprocessors go into overflow, an instantaneous change of sign, from some very large positive number to some very large negative number, occurs. "If you get an integer overflow in a commercial microprocessor, this can result in a vehicle turning to the left instead of the right or climbing instead of diving. If such a thing happens in Viper, the chip will stop." The system would be designed to take appropriate recovery action such as restarting the program on another chip.

The design tools (Fig. 2) allowed Cullyer's team to verify the chip's design before Viper was constructed. The starting point was advanced mathematical techniques developed by Mike Gordon at Cambridge University and subsequently refined at RSRE. Gordon used LCF, for Logic of Computable Functions, to prove the formal correctness of small chunks of hardware logic at Edinburgh University. When he joined Cambridge's Computing Laboratory, he modified the language to describe a computer in logical terms. LCF-LSM, for Logic of Computable Functions-Sequential Logic Machines, was used to write a high-level description of a processor and verify the design.

DESCRIBE AND SPECIFY

In chip design, LCF-LSM is first used to write a behavioral description of an extremely basic processor, then to specify a processor implementation. This is done first at the block level of the arithmetic logic unit and main register banks, then at the gate level. Verification comes in the form of a mathematical analysis called first-order predicate logic. Using this, Gor-

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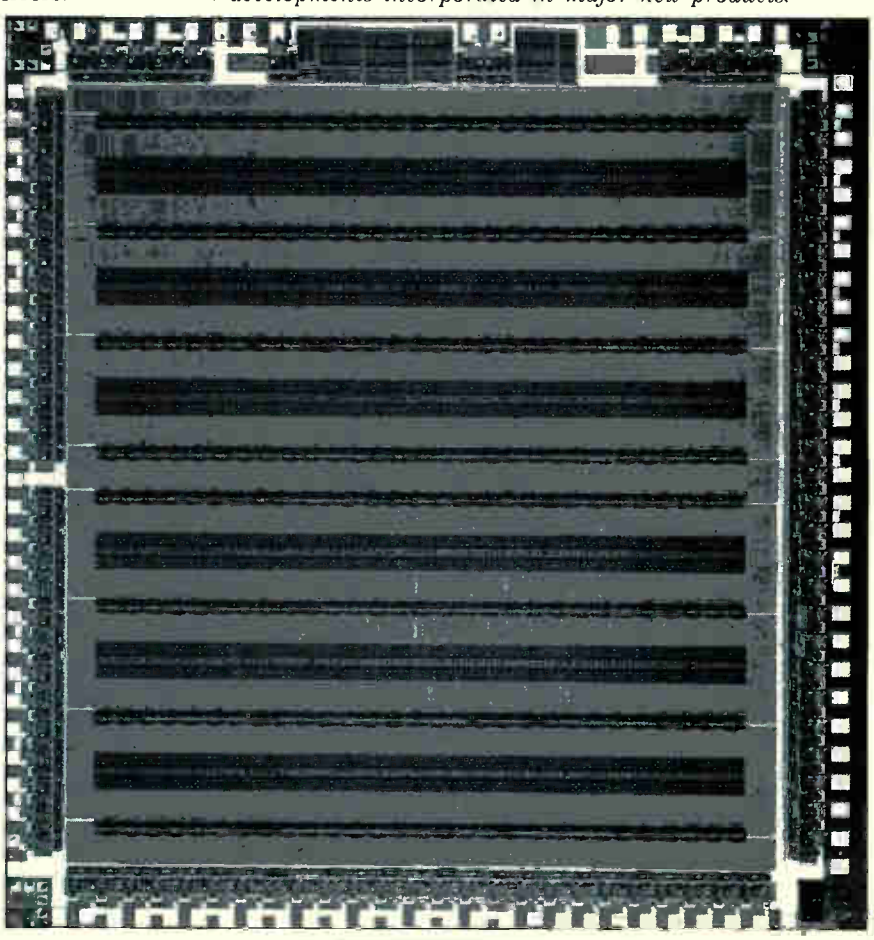

1. STARTING POINT. The prototype British Telecom gate array will be used to design the 32-bit Viper safety-first microprocessor. If an error occurs, the chip stops so that the system does not malfunction in a critical application.

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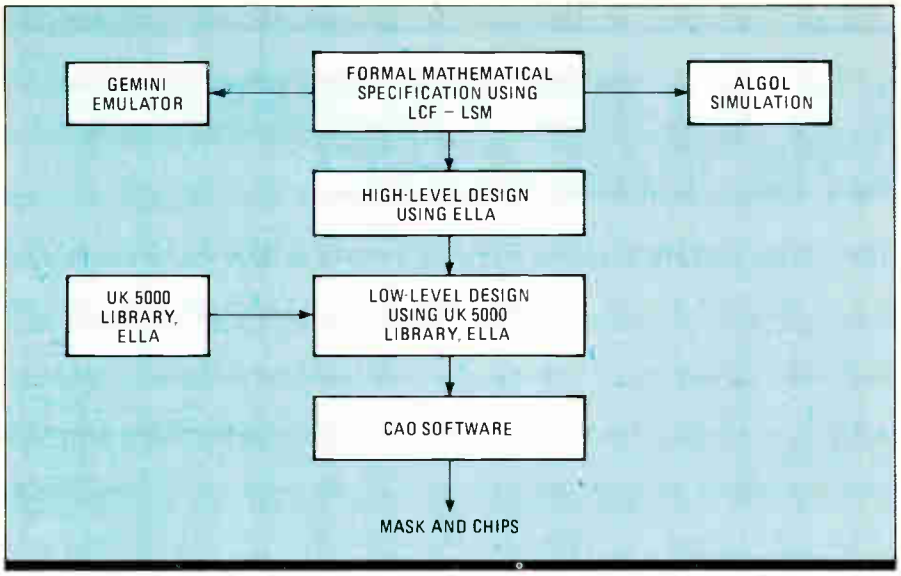


2. HELPERS. Viper's design tools were the key to the success of the safety-first project. The LCF-LSM and Ella languages and the Gemini emulation machine verified the design down to the gate level.

don demonstrated that the lower-level gate and register descriptions corresponded exactly to the higher-level implementation.

LCF-LSM is an extremely powerful analytical tool, Cullyer says. Using it, the RSRE team has been able to expose many popular misconceptions about the workings of a microprocessor. "Over the past few years, the team has spent more time helping to correct misunderstandings about add and subtract functions in processor chips than on any advanced feature of microprocessors," he says. "It has been an illuminating experience to compare the popularly held view of a microprocessor's comparison and arithmetic logic with the reality revealed by formal mathematics."

Though LCF-LSM describes simple hardware at the register, block, and gate levels, it was never intended as a practical hardware-description language. For this purpose, RSRE used its in-house hardware-description language, called Ella [*Electronics*, Jan. 13, 1983, p. 92]. RSRE's contribution was to see how Gordon's LCF-LSM could be turned into a powerful engineering design tool by mapping the language into Ella.

In the resulting setup, a processor is functionally specified at a high level using LCF-LSM. Once locked in, the specification is mapped into Ella at the register-transfer level. The specification is tested by simulation and emulation to ensure that the part performs as required. RSRE used a microcoded bit-slice emulation machine called Gemini and simulation software written in Algol 68.

From this point on, the system designer can work out detailed implementations in increasing levels of complexity down to the gate level. All of these levels are described in Ella. Simulations first performed in LCF-LSM can be repeated in Ella at the block-description level.

At the third design level, the gate level, the technology becomes process-specific. Abstract logic functions, such as a four-input NAND gate, are replaced by their equivalents from a manufacturer's cell library. From this point on, the design work enters the realm of conventional computer-aided design for large integrated systems.

The result is that a designer can work in the same way he always has but within the constraints of a formal language, explains Clive Pygott, a member of the Viper team. "What we are doing is providing the reverse checks to prove that each new level of description exactly corresponds with the level of description above it." The resulting design system leaves room for creativity—unlike silicon-compiled circuits—yet provides the same correct operation.

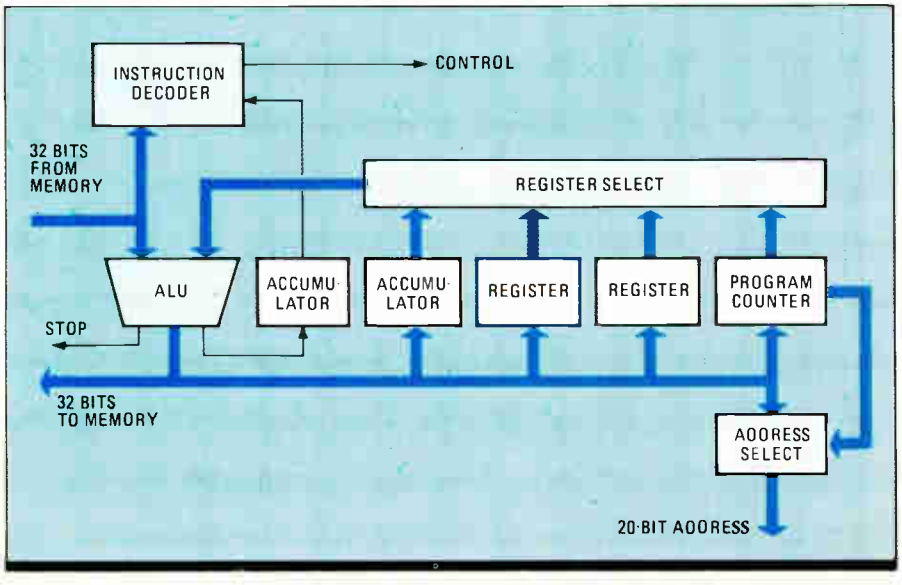
GATE-ARRAY CHIP

The complete Viper processor will be implemented on a single gate-array chip. RSRE will use the UK 5000 gate array it developed in collaboration with a consortium of companies that includes British Telecom, General Electric, International Computers, STC, and the Philips subsidiary TMC. The bulk CMOS (two-level-metal, 2.5-μm) array is completely autoroutable, with scan-path and clock logic signals built into the chip between rows of uncommitted cells. Its synchronous design enforces a strict partitioning between sequential and combinatorial logic blocks. Viper also exploits reduced-instruction-set-computer architecture, which in its simplicity guards against chip-design and program errors, RSRE believes.

The chip's 5,000 gates accommodate Viper's logic design of 2,100 cells and 200 scan-path latches. "Gate-array occupancy is around 80%," says Cullyer. A bipolar version of Viper will be produced by Ferranti Electronics Ltd.; Marconi Electronic Devices Ltd. will produce a CMOS version as well as a later radiation-hardened silicon-on-sapphire version.

Viper's architecture consists of an arithmetic logic unit, an accumulator, two index registers, and a program counter (Fig. 3). A 1-bit register holds the results of comparisons as well as certain bits resulting from shift instructions.

Also incorporated are 16 basic instructions with three spares. The



3. INTEGRITY. Viper's 32-bit architecture includes an arithmetic logic unit, accumulator, two index registers, and a program counter. Sixteen basic instructions perform 750,000 operations per second.

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spares are the top three instructions in the instruction set, and as yet have no operations implemented. These spares are available for future instructions such as multiply and divide, which cannot be fit onto the UK 5000 gate array. The prototype units will run about 750,000 operations per second; later production versions will be considerably faster.

Viper's simplicity makes its operation completely predictable, claims Cullyer, so it has no facilities for creating interrupts. Because interrupts introduce unpredictability and complexity, Viper uses multitasking instead of interrupts. It moves from job to job in strict rotation and within a strict time period.

STOP SIGNAL

Most notable in Viper's safety-first arsenal is the presence of a Stop signal generated by the ALU when an illegal output, an invalid address, impermissible procedure calls, illegal program counter values, or illegal instructions occur. In high-safety operations, processors will ordinarily operate in duplicate or triplicate, says Cullyer. The processors could also be embedded in equipment—which would include a reset and restart capability, within 10 to 20 ms—by hardwired logic.

"The chip is not the total answer. It has to be combined with an ultrasafe means of programming," says Cullyer. To that end, RSRE is developing the powerful new real-time language called NewSpeak, for programming Viper chips.

"NewSpeak will be safer than existing higher-order languages," claims Cullyer, because like the hardware, it has a formal mathematical basis. But NewSpeak will not be ready until the project's full commercial launch in the late 1980s. In the meantime, RSRE has completed development of a stop-gap two-part compiler composed of Vista (for Viper Standard Assembly Language) and a software checking program called Malpas.

The facilities of Vista and Malpas will be incorporated in NewSpeak, along with many original features. For example, the RSRE researchers have turned the program-annotation column—the space reserved for comments in Basic—into a powerful program checking tool. Instead of Annotate, the researchers introduce the terms Assert, Signed, and Hismark.

Assert requires that any mathematical equation used in the program be declared. Signed and Hismark require that the programmer's name and personal identification code be assigned to the statement. The setup works much like an accountant's audit trail. And, says Cullyer, "if anything goes wrong at program run time, they will know who to drop on."

Like Pascal, NewSpeak is strongly data typed. A new variant of the language called Flavor represents the dimensions of a physical quantity and can be assigned to declared integers. "We are extending the concept of a type not only to include its numerical range but to include something of the order of dimensional analysis—foot/meters per second, latitude in degrees, minutes, seconds, and so on. That is very much stronger than any present-day higher-order language achieves," says Cullyer.

During compilation, the NewSpeak compiler will perform a dimensional analysis of any equations used in the program, checking that the determined quantity shows the expected dimensions of mass, length, and time. The technique, which has long been used by physicists to check the validity of their experiments, also ensures that dimensional standards, be they metric or imperial, are consistently used. And another program check ensures that program loops, such as If-Then statements, are bounded. "NewSpeak programs are always bounded in run-time and memory-space," says Cullyer.

He notes that fully documented, safety-first chips such as Viper will be expensive and will be used perhaps in only 1 in every 100 microprocessor applications. Even so, RSRE could find a commercial market for the microprocessor.

First prototype chips and Vista software will be distributed this year as part of a single-board computer to government research establishments and key industrial laboratories. Following a six-month peer-review period, test sites will report to the Ministry of Defense, the Civil Aviation Authority, and to other agencies with a national responsibility for safety-critical computing.

If their reports are favorable, the Ministry of Defense will push ahead with hermetically sealed and fully ruggedized versions, and chips could become available to industry by 1989. At the least, the Viper project will almost certainly serve as a model for all those interested in the little-discussed subject of safety-critical computing. □

HOW THE UK'S VIPER WAS HATCHED

With concerns rising about computer safety in hazardous situations, safety-first systems such as Viper meet a real need, says John Cullyer of the Royal Signal and Radar Establishment, Malvern, England. "Commercial microprocessors cannot be considered as high-integrity items, and they should not be used in safety-critical applications without a backup in some other technology."

His organization considers safety-critical hardware so important that three years ago it set up a high-integrity-computing group to bring together laboratory work in this field. Royal Signal was already researching methods of writing bug-free software, but often this research uncovered hardware design faults, says Cullyer. So he brought together a team to begin work on a 32-bit microprocessor that would bypass the reliability hazards of commercial processors.

Cullyer, leader of the Viper team, studied at the University of Bristol, where he earned his BSc in 1962 and his PhD three years later. He has spent the ensuing 20 years working in communications and computers, with particular emphasis on safety-critical avionics.

John Kershaw, Viper's architect, earned a BSc at Cambridge University and completed his doctorate there in 1966. His career includes a stint at Computer Technology Ltd. In 1977, while at Plessey Co. plc, he invented the Gemini microcode emulator. For the Viper project, Kershaw devised the Vista structured assembler, which will be the initial means of programming the Viper chips.

Clive Pygott was responsible for detailed designing of the Viper and circuit-level validation methods. He graduated from Birmingham University in 1974 and received his PhD there in 1979. Pygott has specialized in the application of formal methods to hardware design, including the development of a novel database machine known as Cameo.

ROYAL TRIO. Cullyer, Pygott, and Kershaw designed the Viper safety-first system at the Royal Signal and Radar Establishment.

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EMBEDDED COAXIAL WIRES SPEED PRINTED-CIRCUIT BOARD

TINY CABLE, PUT ON BY WIRING MACHINE, CUTS DELAYS FOR GaAs CHIPS

Today's high-speed digital integrated circuits are beginning to outrun the interconnections on the printed-circuit boards that bear them. As digital designers try to squeeze more and more performance out of their board designs, they quickly find that their biggest problem is not how fast the chips run, but how to get signals from chip to chip without excessive delay. The problem will worsen with the advent of gallium arsenide ICs, which should soon be finding their way into systems. For example, a signal between two GaAs chips operating at 1 to 4 GHz will experience 85% of its delay in the pc board and only 15% in the active components. In other words, the board has become a limiting factor for digital designs requiring the interconnection of GaAs chips.

A straightforward solution to this problem would be to turn to microwave system design techniques, such as stripline, microstrip, or coaxial interconnection. Stripline and microstrip have been tried, but are limited in their frequency response and ability to adapt to automated production techniques. A coaxial cable with a low-dielectric-constant insulator would increase propagation speed, have a controlled impedance, prevent crosstalk, and minimize signal degradation due to reflections. Unfortunately, standard coaxial cable is bulky and difficult to handle, requires special connectors, and is not suitable for the high-density board interconnections required for ICs.

Now, after a two-year development effort led by product-development manager Leonard Schieber, Multiwire's Advanced Manufacturing Group, Melville, N. Y., has produced a coaxial interconnection board for high-speed high-density circuitry. The Kollmorgen Corp. division's CoAxe circuit board provides a true coaxial connection between chips by means of a 50-Ω microminiature coaxial cable that is embedded in the ground plane by a modified standard Multiwire automated wiring machine (Fig. 1).

Crucial to the board's success was developing a suitable coaxial wire. The wire's outer diameter had to be small enough to fit a standard Multiwire machine, because one of the aims of the program was to retain as many as possible of the automation features developed for existing equipment, manufacturing techniques, and software from Multiwire processing. A 50-Ω characteristic impedance dictated the ratio of wire diameter to shield diameter. Core material with the lowest dielectric constant available had to be used to maximize propagation speed. Minimum crosstalk level and skin effect determined the shielding thickness. Finally, current-carrying capacity put a lower limitation on wire diameter.

Because no wire was available to meet all these requirements, Multiwire developed its own—a coaxial wire with an outer diameter of 9.5 mils and an inner conductor of 3.1 mils. The insulation is PTFE Teflon (polytetrafluoroethylene), or expanded Teflon (also known as GoreTex). The outer shield of the subminiature coaxial cable is a continuous copper plating over its insulation layer. The result was a coaxial wire with impressive electrical characteristics.

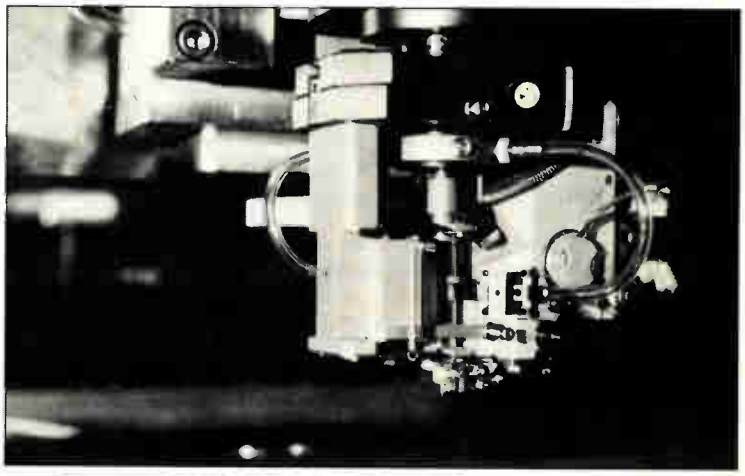
This wire is applied by a numerically controlled wiring machine similar to those used to fabricate standard Multiwire boards, which use either 4- or 6-mil insulated wire written into a proprietary adhesive. The machine is driven by the same computer-aided-design data base already developed for standard and high-resolution automated wiring in the standard Multiwire process.

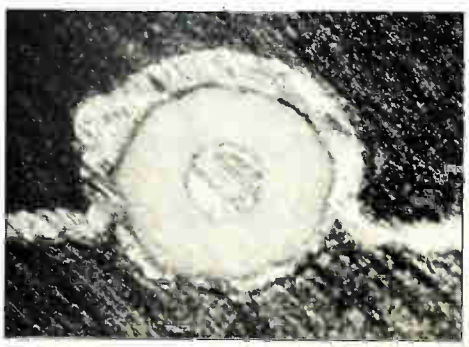
As in the standard Multiwire process, the machine applies the wire to an epoxy-glass substrate covered with adhesive. After all circuits have been wired and the adhesive is cured, the board is panel plated. This operation not only connects all the coaxial shields, but actually makes them a part of the ground plane (Fig. 2). This minimizes return-current effects and eliminates ground drops in drain wires (pigtails of braid used to ground normal coaxial cables.)

INTERNAL CONNECTIONS

After this step, wire-termination areas are cleared and the ends of the wires are stripped. The board gets an epoxy coating and holes are drilled to the wire terminations (Fig. 3). The holes are then plated, providing a through-hole connection to the coaxial wire's inner conductor. The system provides plated conductive patterns for surface features including pads for attaching active and passive components such as leaded and leadless chip carriers and capacitor and resistor chips.

These steps produce a one-layer structure. For even denser structures, wiring can go on both sides of the substrate, which may contain additional voltage planes. Successive layers can be placed on top of the first layer.





1. REWIRED. For its CoAxe system, Multiwire added a wiring head to accommodate microminiature coaxial wires to its standard automatic wiring machine.

2. GROUNDED. In a CoAxe board, wires are embedded in the ground plane, minimizing return-current effects and eliminating the ground drops in drain wires.

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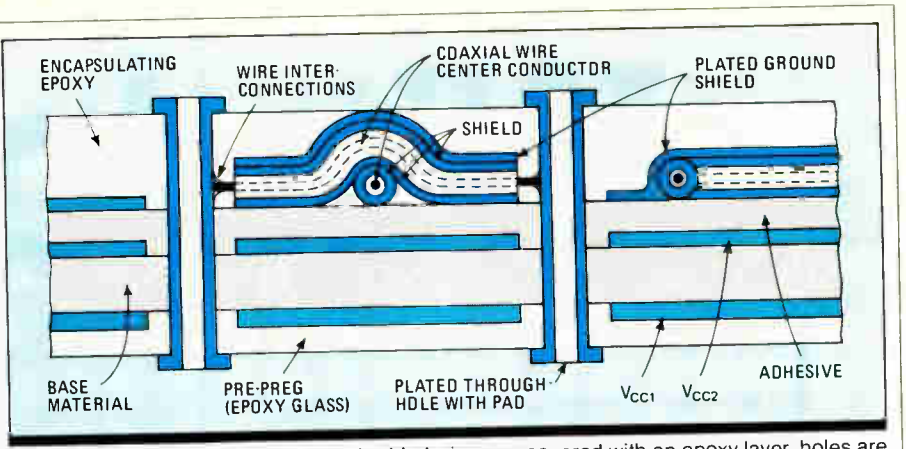
For high-speed circuitry, the CoAxe board has a number of advantages over existing high-frequency techniques such as stripline and microstrip. From the performance standpoint, the technique achieves propagation speeds of 26.3 cm/ns, or 87.7% the speed of light. This is a factor of two to three better than competitive board approaches based on substrates with low dielectric constants such as polyimide, with a dielectric constant of 4, and Teflon, with a dielectric constant of 2.2.

In addition, the use of automatically routed coaxial wires preserves signal integrity in two ways. First, it virtually eliminates crosstalk and noise pickup. Second, the round, smooth inner conductor eliminates the reflections produced by the wall roughness and right-angle bends of conventional pc-board traces. In Multiwire's discrete wired technique, corners and crossovers are made with relatively gentle bends, which provides smooth conduits even at extreme frequencies. Shielding is provided on both conductors at crossovers, accounting for the extremely low coupling effects. The ability to use crossovers enables a considerably higher packaging density than can be obtained with multilayer pc boards, which are extremely difficult to manufacture.



3. COAXE STRUCTURE. After the embedded wires are covered with an epoxy layer, holes are drilled and plated to make connections to the cable's inner conductors.

GIGAHERTZ PERFORMANCE

A finished CoAxe board resembles other Multiwire or multilayer pc boards, but there is a great difference in CoAxe's performance in the gigahertz range associated with GaAs digital ICs. Characteristic impedance is exactly matched to requirements for preserving signal integrity. Time delay can be reduced to 1.2 ns/ft, and the dissipation factor of 0.0002 means attenuation can be as low as 4.9 dB/ft at 1 GHz. All of these figures are based on an effective dielectric contant of 1.3 for GoreTex insulation. PTFE Teflon, which has an effective dielectric constant of about 2, produces a small degradation of these results. The inner copper conductor's dc resistance is 1.08 Ω/ft.

Wiring densities slightly better than standard Multiwire boards (equivalent to a four-layer pc board) can be achieved. Coaxial and unshielded leads can be wired on the same board, as can multiple wiring layers.

In addition, Multiwire is developing techniques to interconnect very high-speed microwave chips embedded directly in the board's ground plane. At present, the handful of companies developing digital GaAs ICs are concentrating on packaged units in special high-frequency ceramic chip carriers.

The CoAxe program is currently at a stage where Multiwire is supplying sample boards for customers to evaluate. Usually, only the customer has the devices and special measurement equipment available to fully characterize a loaded board with GaAs ICs. The company reports the successful construction of board wiring patterns using the equivalent of three 50-Ω coaxial conductors between 18-mil laser-drilled holes on 60-mil centers.

A test board is under development for Gigabit Logic Inc., a Newbury Park, Calif., company that specializes in digital GaAs chips. The board will accommodate 40-mil-pitch ceramic leadless chip carriers, enabling a user to evaluate different members of the company's digital GaAs IC family. All leads on this board are of equal length and within 5 mils of each other.

Through the use of microcoaxial wires and Multiwire wiring techniques, circuit boards are being fabricated with the desirable properties of coaxial cables and the packaging simplicity of pc boards.

This interconnection allows a designer to fully utilize the speed advantages of GaAs circuitry in the 1- to 4-GHz region. Since the greatest growth for GaAs chips will be in the digital area, the CoAxe technique does have promising capabilities. Although testing is still incomplete, calculations indicate that the CoAxe board should outperform the circuitry. Extension of the technique to microwave and millimeter wavelengths appears likely in the near term. □

COAX DESIGN TAKES SYSTEMS MAN'S TOUCH

Combining the Multiwire technique and a tiny coaxial cable into the CoAxe board to create a favorable interconnection environment for GaAs chips was not a run-of-the-mill, straightforward project. The new circuit-board process not only blended computer-aided design, automatic wiring machines, special substrates and materials, and microminiaturization. It also had to handle the problem of achieving signal integrity at gigahertz rates—an effort akin to a system-integration problem. The upshot was that 2½ years ago, the Multiwire division of Kollmorgen decided it needed a system designer, rather than someone versed in interconnections or packaging, to head the effort.

The task fell to Leonard Schieber, a veteran systems engineer with almost 40 years of experience in high-technology products and systems. Much of Schieber's work was with servos and systems related to aerospace projects at companies such as IBM, Martin Marietta, and Kearfott.

The product-development manager approached the design of the CoAxe board from the standpoint of one who has used circuit boards for many years. "You end up with a much better product if you start with a need, rather than having a technology you are trying to find a need for," he says.

The need was a circuit board for GaAs digital circuits in the 1- to 4-GHz range. Rather than letting the designer specify an interconnection, Schieber says, Multiwire's aim was to give him a board that solved his problems. And this was done by creating the tiny coaxial wire, modifying an existing Multiwire machine, and building up a multilayer structure on a standard epoxy-glass substrate—all the while applying standard Multiwire technology.

SYSTEMS MAN. Schieber led Multiwire's CoAxe effort.

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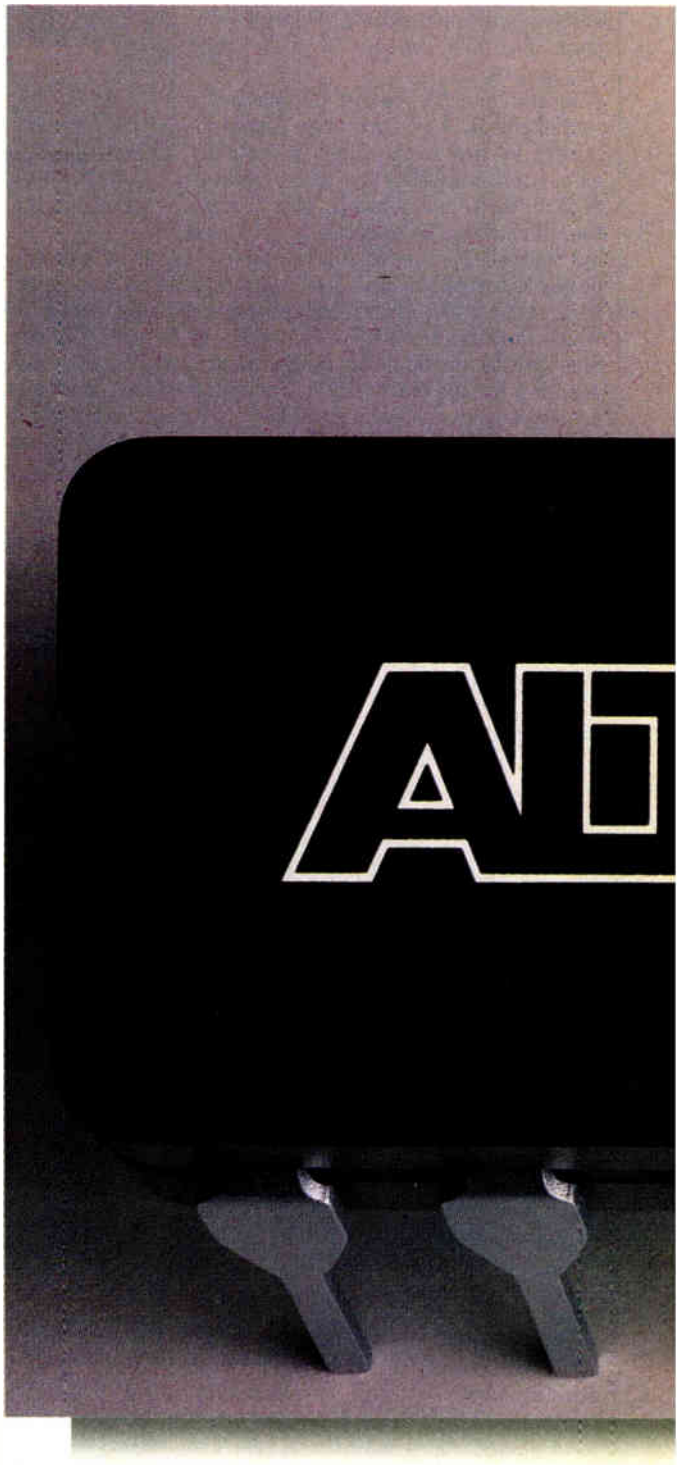

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PROBING THE NEWS

HOW A NEW VENTURE STARTED UP BIG

COUNTERPOINT COMPUTERS MAY BE THE ULTIMATE STRATEGIC ALLIANCE

by Clifford Barney

SAN JOSE, CALIF.

What may be the ultimate strategic alliance is about to swing into action in a big way. Take a San Jose computer startup, add the backing of three giant global partners with assets totaling $150 billion, and the end product is what its backers are calling the model of the next vehicle for economic power in the worldwide electronics industry.

Founded just 20 months ago, Counterpoint Computers has good bloodlines. It already has managed to forge close links with three companies that want to make it big in the computer business: AT&T, Japan's Kyocera, and British & Commonwealth Shipping. And at least two other equally powerful companies may soon join the team. Counterpoint itself has managed to raise $19 million, part of it from its three current partners—no small amount, but birdseed compared with the combined resources, both financial and strategic, of its corporate team.

With the backing of three blue-chip Silicon Valley venture capitalists—the Mayfield Fund, Arthur Rock, and Hambrecht & Quist—a management group headed by former Convergent Technologies executive Pauline Lo Alker started Counterpoint to function as the keystone in a global alliance of corporate giants. Alliance members—which do not compete with one another—were chosen so that their strong points can come together and be shared by Counterpoint.

Although strategic alliances have become so big and so important a trend in the worldwide computer industry that the term has almost become a buzzword, Counterpoint is different in scope as well as in size. "Both Silicon Valley startups and large companies are starting to experiment with alliances that even five years ago no one would have thought about," declares James D. Edwards, president of AT&T Co.'s Computer Systems Division in Morristown, N. J.

There's good reason for forming these alliances. According to Alker, "Our industry is under siege." Deregulation and the growing internationalization of industry are bringing about a fundamental shift in economic power. The growth of Japan and Korea in the Far East, and of IBM Corp. and AT&T in the U. S., has brought about an era where bigness is required for growth, she believes.

SCOPE, NOT SIZE. But big is a matter of scope, not size, Alker maintains. Expansion and diversification, not market dominance, is her prescription for growth. By providing the link between its giant worldwide partners, she says, Counterpoint will be able to share in their resources and—possibly—help them to share each other's, as well.

In the electronics arena, the technology leadership that U. S. manufacturers have traditionally enjoyed is not nearly so important these days. "Technology has become a checklist item," Alker says flatly, challenging the popular wisdom that U. S. high-tech companies can compete in world markets because they have superior technology. "Technology is [just] the ante," she points out. "You have to have it, but you can buy it. It's not enough to succeed. For that you need quality sales and service, and above all a complete product line. That's why IBM is so successful."

For Alker and her Counterpoint team, the alliance was about the only approach they could use to get into the worldwide market in a big way and in a reasonably short time. They also avoided the price usually paid for entrepreneurism in the electronics industry: difficulties in raising money, hiring good people, building a product, and simply operating the new venture often combine to kill off a startup even as its founders struggle to nurture it.

Counterpoint will market the Advanced Systems Platform (ASP), a generic high-performance computer that can be configured for many applications at many prices. The startup will get help from Kyocera Corp., the world's largest supplier of ceramic packages for integrated circuits, in packaging its systems. AT&T will be an original-equipment-manufacturer customer as well as a technical partner, especially in the area of Unix, the operating system under which Counterpoint's engines will run. British & Commonwealth Shipping Co., a London-based conglomerate with high-technology operations, will provide an entry into the European market. Counterpoint is looking for two more partners, at least one of which will be in Europe. They must not compete directly with those already on board, and they must share the same business values.

That's a key point. Counterpoint could be unique in the industry in making candor and trust an important part of its business plan. Though the profit motive is an article of faith, Alker puts trust among partners and mutual adherence to corporate values first in forming alliances. The key elements of the alliance's

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cooperation, she says, are "trust, vision, and a fast response to the market."

Her initial interview with Kyocera president Kazuo Inamori included no discussion of business plans, she notes, only a probing on both sides of personal beliefs and background. It lasted five hours and was conducted entirely through interpreters. "In those five hours we became partners," Alker says. "Then he said to me, 'Let me take a look at your product.'"

"Of course, we're looking for a profitable return on our investment," says Inamori. "But what attracted me was Pauline Alker's management philosophy, which is to create many business relationships internationally, with emphasis on personal, human ties. I liked her sincere, straightforward approach. I think this type of company is a model for a new concept of business in the 21st century."

Not even the biggest electronics companies can be all things to all people nowadays. IBM found itself wanting in the telecommunications sector so it acquired Rolm Corp., and it signed marketing arrangements with other equipment vendors, such as Stratus Computer Inc. for its fault-tolerant computer line. AT&T was similarly drawn to Counterpoint, as it has been to other software and hardware suppliers, to fill a product—and development—need.

"Counterpoint serves a market we're interested in—the high-performance engineering work-station market," Edwards says. He calls the AT&T-Counterpoint relationship "a good fit," similar in some ways to AT&T's alliance with Omnicad Inc., a Rochester, N. Y., developer of Unix-based computer-aided-design software that runs on AT&T's personal computer. AT&T acquired part of Omnicad in April 1985. Similarly, AT&T invested in Ing. C. Olivetti & C. of Italy, which makes the U.S. giant's PC 6300 personal computer. Convergent Technologies, Alker's former employer, makes the 7300 personal computer for AT&T.

AT&T needs help from other vendors in providing its customers with all the products that they need, Edwards points out. "As we have entered the computer business, we have found a customer expectation level that is very demanding. They would like a full and broad product line [from AT&T] encompassing IBM's and DEC's product line and anticipating all the new products they need."

Although AT&T has produced an enormous stream of new products, Edwards says, "the market wants more and additional products that go beyond our resources. The stage was set to ally ourselves with someone to round out our product line."

Counterpoint, he notes, "doesn't bring [to the partnership] the strength of an Olivetti, but it brings a strength that a large company like AT&T doesn't have—entrepreneurial spirit." Counterpoint will provide AT&T with "very innovative marketing" techniques and a way to rapidly translate market requirements into products, he says. "They're an extension of our development capabilities located in a hotbed of ideas."

AT&T, he continues, "can extend our development capability to a lab with innovative ideas, an extension that doesn't bring with it the overhead and constraints that a large company has."

TREND SETTERS. Kazuo Inamori, Pauline Alker, and James Edwards say they are setting up a model of international corporate cooperation that others will emulate.

The theme of Counterpoint, whose name was chosen to reflect the musical structure in which different melodic lines maintain harmony with each other, is that companies can wield even greater power by cooperating with other giants in a global marketplace. Not only can they share technologies, manufacturing facilities, and markets, but they can leverage their already great advantages of size by cooperating in software development and parts commonality.

Shared values and trust are paramount to the alliance

Counterpoint provides no specific mechanism for this sharing, Alker says, but all partners recognize that adding resources will be useful to all. Counterpoint, Edwards says, "can become big faster and have more influence in how they move into new markets through the alliance.... They can concentrate more on the business and less on where they get their next round of equity financing. Often, entrepreneurs get so caught up in raising capital that they lose sight of the market."

Counterpoint's big partners have invested a relatively small amount of money in the new company—"very, very much less than 50%," Alker says. But their commitment is such that the president of each partner sits on Counterpoint's board of directors.

"Each individual member has to motivate and inspire the team," Alker says. "Unless top management is committed, it won't work." Edwards, for example, notes that AT&T took only a minority position because "we want to see who the other shareholders are" in any company in which it invests. "That's how we judge the viability of a company." He says Counterpoint has "the who's who of venture capitalists participating on the board, and a strong equity pool." The relationship exists at the middle-management level as well as at the top, however. Both Kyocera and AT&T have sent teams of engineers to work at Counterpoint's San Jose headquarters.

Kyocera's Inamori says Counterpoint will take the initiative in the area of joint research and development. "We're ready to help where we can and when we're asked," he says. There are no agreements yet about basic technology research, Inamori said, because the relationship is still only 16 months old.

As far as joint-manufacturing arrangements, Kyocera will make available to Counterpoint its expertise in compact chip packaging, surface-mounting technology, and circuit design gained through the work it has done for IBM's Personal Computer products. Kyocera will manufacture components, not finished products, for Counterpoint's ASP, a 68020-based machine. Although the Japanese company is best known for its dominant position in ceramic IC packages, it has also built computers for NEC Corp. and Tandy Corp.

Kyocera will help market the ASP in Japan by introducing Counterpoint salesmen to customers when they come to Japan. There are no Counterpoint people resident in Japan yet, but Inamori says he assumes that will come in time. Kyocera is interested in sales and marketing work for Counterpoint elsewhere in Asia, but no specific agreement exists.

The agreement with AT&T, Alker says, is "a major business contract." The two will work on joint development of Unix, AT&T Bell Laboratories' proprietary operating system. In addition,

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there are other potential relationships in both services and manufacturing. AT&T makes a 32-bit microprocessor, which conceivably could be used in the Counterpoint product.

AT&T has received some of the 200 ASP machines Counterpoint has shipped since last August and is busy evaluating them. AT&T plans to offer the ASP to the computer-aided-design and -manufacturing market under its own label, Edwards notes. (Alker, however, will not comment on who got any of the machines and was even reluctant to release the actual number shipped.)

Because British & Commonwealth Shipping is not a computer manufacturer, the newest partner's relationship to the alliance has not yet been fully worked out. H. Wynne Denman, a director of British & Commonwealth Shipping, says his company is still discussing with Counterpoint ways in which it could help the fledgling company.

"We have not defined our working relationship with Counterpoint yet, as the other two partners have, but we are interested in looking at the possibilities," says Denman. Although the British organization will not manufacture anything for Counterpoint, it could assemble some products, but more certainly will be involved in marketing and distribution in Europe, he adds.

Some of British & Commonwealth's subsidiaries already assemble electronic products, both of their own design and on a subcontracting basis for other companies. British & Commonwealth also has an office-equipment subsidiary, but this will not be linked with Counterpoint's product, Denman says. "We are a significant investor in Counterpoint and we are a business, not just an investment company," he notes.

The company provided a small amount of backing for Counterpoint in its very early stages, says Denman, but was made through an investment-management organization. Its decision to increase its holding to $2.5 million, and to discuss a working relationship with the startup, is not as surprising as the company's name might suggest.

Although originally its business was almost entirely ship ownership and management, it has since diversified so that shipping now forms only a small part of its annual revenue. British & Commonwealth Shipping has invested in high-technology companies before. In 1980, it was one of the founders of Celltech, a genetic-engineering company in the UK, of which it now owns 23%. It is also a shareholder in Telerate, a supplier of financial information worldwide.

The goal is a computer that can be tweaked for a wide range of jobs

Denman says British & Commonwealth's decision to increase the investment in Counterpoint was based on several factors. "We think Counterpoint has a product range for which there is a demand, and we have been impressed by Mrs. Alker's success in meeting her targets to date. We back people, not just products or technologies, and that is exactly what we are doing with Mrs. Alker and her team."

To make the grand vision work, Alker concedes, Counterpoint will have to deliver on ASP. The market is already flooded with Unix-based machines that run on Motorola Inc.'s 68000 family.

But Alker remains confident that the ASP will make it. "Product definition is our major strength," she says. The ASP is designed to be a flexible platform with a long product lifetime, so that new technologies can be easily adapted.

The actual product made from the ASP, she says, will vary according to the market needs. As AT&T's Edwards says, "A lot of companies can create a platform that is difficult to move to another generation [of technology] or another market. They can 'tweak' [the ASP] to go after other markets." Besides the CAD/CAM market, Counterpoint thinks its product will be suitable for factory automation, business data processing, and technical publishing.

Key features of Counterpoint's ASP include a dual-bus architecture; a migration path from a single processor up to eight processors, with power ranging from 0.9 million to 6 million instructions per second; dual-point distributed memory for high multiprocessor performance; a range of bit-mapped displays and ASCII terminals; interface to any industry bus; open system buses; and Unix System V version 2.2 and Berkeley 4.2bsd networking extensions.

Counterpoint now has about 110 employees in San Jose, 40 in engineering (hardware and software and product design), 40 in manufacturing, 18 in marketing, and 6 in sales, plus a few in administration. Alker says it has enough money in the bank to ride out 1986, and expects to pick up more capital when it signs up two new members of the alliance this year. By that time, the company should have even stronger wings. □

Additional reporting was provided by Michael Berger in Tokyo, David G. Boothroyd in London, and Robert J. Kozma in New York

ASIAN ROOTS UNDERPIN ALKER'S PHILOSOPHY

Though her speech crackles with American slang, Pauline Lo Alker, 43, traces her business approach—based on openness and complete trust—to the Chinese culture in which she was reared. She was born near Canton, the daughter of a banker, and both the war against Japan and the Communist revolution were part of her childhood. The family settled in Hong Kong in 1949.

Alker wanted to attend college in the U.S. at Northwestern University, but bowed to family wishes and instead went to Arizona State College with an older brother who could not meet Northwestern's admission requirements. When she graduated in 1964 with a degree in music and mathematics, she found herself, as a woman and an alien, almost unemployable. Alker sought a job as a programmer, having studied math to learn computer science. Unable to land a job, she worked for a year as a bookkeeper. "It taught me humility," Alker says.

She kept knocking on door after door until she finally got past the personnel department at General Electric Co. by taking a job typing technical manuscripts. Within six weeks, she had a job as a programmer and remained in software engineering at several companies for 13 years.

At one, Amdahl Corp., Sunnyvale, Calif., she got her first taste of an international alliance when that company traded its technology and its U.S. foothold for money, manufacturing, and marketing help from Fujitsu Ltd. "I learned then that the sheer force of personality can bring two companies together despite cultural differences. I also learned that these relationships are an intricate balance, and that a good relationship can turn sour without openness and complete trust."

In 1976, she switched to marketing—"the best move I ever made." Alker began at Intel Corp. A marketing trip to China when she worked for the Santa Clara chipmaker opened her eyes to the emerging power of the Pacific Rim countries.

At Intel, Alker worked for Paul Rosenfeld, now marketing vice president at Counterpoint, and met Alan Michels, with whom she went on to form Convergent Technologies. Fred Kiremidjian, engineering chief at Convergent, is a Counterpoint cofounder and vice president.

To Alker, Convergent was the final preparation for Counterpoint. Now she is building an enterprise that, she believes, is not just another company, but a new model for growth. *–C. B.*

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COMPACT DISC CHALLENGES CASSETTE FOR AUTO MARKET

A DOZEN SUPPLIERS LAUNCH CD PLAYERS

by Wesley R. Iversen

LAS VEGAS

The Compact Disc is the current star of the consumer audio industry, but the optical digital format has not made much of a dent in the $2.8 billion market segment for auto sound equipment. By most estimates, car CD players accounted for only 5% to 10% of the 850,000 CD units sold last year. Judging by the action at this month's Winter Consumer Electronics Show, however, CD vendors expect to play a much bigger role in the auto market.

Some dozen suppliers showed up with new products—from CD player-only units and adaptations of portable CD players to a range of combinations with AM/FM receivers or cassette-tape players, and even one that incorporates an auto antitheft system. They may not have an easy time of it, however. Despite the flood of new products, some industry observers think that car CDs will have slow going because of the cassette's strong position. The conventional car audio-cassette system is very popular, and the expected emergence of digital audio tape [*Electronics*, Jan. 20, 1986, p. 19] will make it even more popular, they believe.

Sony Corp. once again demonstrated its determination to lead the CD pack with the introduction of the industry's first Compact Disc changer for cars. Known as the CDX-A10 DiscJockey, the system includes a magazine and changer mechanism designed for trunk or rear-compartment mounting that connects to the passenger compartment by cable. It can handle up to 10 disks under programmable control from a built-in AM/FM tuner pack or control pod in the passenger compartment, and provides up to 10 hours of continuous play.

By moving the CD player out of the cramped quarters dictated by the automobile's dashboard area, Sony says it had room to engineer a system that may be the most immune yet to shock and road vibration—a major drawback of car CD players, according to their critics. The changer mechanism and associated electronics are housed in a free-floating suspension system that ensures precise disk tracking under the most adverse road conditions, Sony officials say.

The CDX-A10 automatically begins sequential playback starting with the first of the 10 disks. But the DiscJockey also provides for a variety of disk-play options, including fast forward and reverse at 10 times the normal speed, and it lets the user select and program into memory up to 10 selections in any order from any of the 10 disks. Another feature allows the user to skip from track to track in either direction.

Sony says the DiscJockey will be available in March at a suggested price of $1,000. The optional XT-10 tuner pack that works with the system carries a suggested $129.95 tag.

While many suppliers at the Las Vegas show focused on CD products for permanent aftermarket auto installation, other vendors at the show, including Concord, Jensen, and Sparkomatic, displayed adapter systems that allow any of the spate of new portable CD players also shown in Las Vegas to be played in the car through an existing stereo system.

The move toward car adapters for CD portables sparked criticism from some at the show, including Larry Carpenter, national sales manager for automotive entertainment systems at Sony Corp. of America, Park Ridge, N.J. "The shock absorption in portable units is totally unacceptable for mobile applications," says Carpenter, whose company started shipping car CD players last year.

But Jon A. Passini, sales and marketing senior vice president at International Jensen Inc., Schiller Park, Ill., counters that tests conducted by his company for more than a year show that portable CD players "sound as good as a dash-mounted unit" and are relatively unaffected by road bumps and vibration. "These units are made to be portable, and the car environment is less hostile from a G-force perspective than walking or jogging," he says.

Until prices for installable car CD players drop from their current $600 level, some suppliers figure a market will exist for auto adapters for connecting the CD portables, which cost around $300. "It's a relatively inexpensive way

JUKEBOX IN TRUNK. Sony's CDX-A10 DiscJockey has magazine and changer mechanism.

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to have CD in your car," says Passini.

But to use Jensen's $24.95 car CD adapter, users will also have to purchase one of two new Jensen AM/FM tuner and cassette-deck units designed to accommodate the adapter. Jensen's electronically tuned JXL-45 and JXL-55 units, which sell for $259 and $299, respectively, both come with an under-the-dash connector for the single CD-adapter cord, providing both 9-V dc for the CD and digital audio input from the CD to the car system.

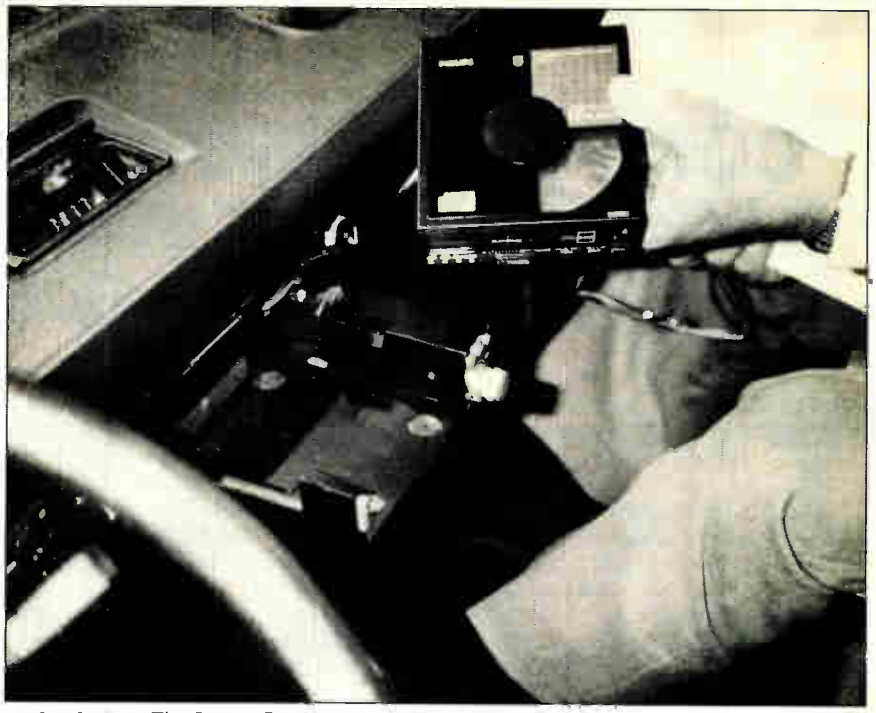
Like Jensen, Concord Systems Inc. requires that its $14.95 CDA-1 Compact Disc adapter be used with the Tarzana, Calif., company's own line of car receiver and cassette units. But Sparkomatic Corp., Milford, Pa., brought out a $19.95 adapter that allows the hookup of a portable CD player to any car radio or sound system, the company says. The Sparkomatic adapter gives up some of the performance advantages of the CD's digital recording format, however. The system incorporates a small transmitter that attaches to the car's radio-antenna input for FM transmission of the CD's output signal over a cable to the car's sound system.

NO PATCH CORDS. While other manufacturers were featuring new car CD players or portable-CD adapters, the Philips Auto Audio division of Amperex Electronic Corp., a North American Philips Corp. subsidiary in Hicksville, N. Y., offered a hybrid unit that bridges the gap between the two approaches. The Philips CD 10 player includes a carrier tray with a built-in preamplifier that fits in the dash. The CD player slips into the carrier and is plugged into the car's power and audio-input connections without the use of patch cords.

For use outside the car, the player can accommodate an optional clip-on battery pack for portable application and a clip-on ac adapter for home play. The CD 10 with auto tray is planned for March availability at a $399 suggested list price; prices of the battery and ac adapters have not yet been set.

Though it produces good sound under most driving conditions, the CD 10 will suffer more from skipping caused by road bumps and vibrations than will more solidly mounted in-dash CD units, concedes Willem Aling, technical manager for Philips Auto Audio. The company's new DC-085, which is designed for permanent auto installation, contains a much more sophisticated shock-absorption system, Aling says, as well as a more powerful error-correction system—it has 15 frames of buffer memory, with 588 bits per frame. The DC-085, also to be on store shelves in March, will carry a $549 price tag.

Sanyo Electric Co.'s Consumer Electronics division, Compton, Calif., also



TWO WORLDS. The Philips CD 10 is a hybrid that can be used outside, as well as in, the car.

came up with a new twist with its FTEC2 CD player. Not only does the dash-mountable unit incorporate an AM/FM receiver and an input for a portable cassette player, but it also contains a security system to protect both the player and the car. Once installed, the unit requires that a three-digit access code be entered into the player's front panel before the car can be started. What's more, if anyone attempts to steal the in-dash unit by cutting wires, the car's horn will sound at one-second intervals for five minutes. The FTEC2 sells for $699.95.

Although Sony is the first to introduce a car CD changer in the U. S., Alpine Electronics of America Inc. showed a prototype 15-disk CD changer for cars at a trade show three months ago in Japan. But the Torrance, Calif., company has decided to hold off introducing the system, says Tom Cumberland, a technical-services specialist at Alpine. It instead chose to bring out in Las Vegas what's believed to be the industry's first changer for audio cassettes. It fits in the car trunk and holds six cassettes.

Some suppliers are pushing portable units adapted to cars

"We think people are looking for programmability of what they've already got," Cumberland explains, citing the large existing penetration of conventional audio cassettes in cars. When the CD changer finally is introduced, it will use a bidirectional fiber-optic link, which eliminates problems with ignition noise that Alpine encountered when using conventional copper cable during design of the changer, he says.

Despite all the hoopla about car CD players, some vendors sound a note of caution. Roy L. Harkey, senior vice president of marketing and sales for Clarion Corp. of America, Lawndale, Calif., says the optically read disks are not as indestructible as the industry once thought—particularly in an automotive environment, where fingerprints, dirt, and scratches on the disk can cause mistracking and instability, he notes. For that reason, Clarion's first car-CD entry, a $599 player set for March availability, requires the disk to be enclosed in a cartridge for loading and handling.

TAPE CHALLENGER. Harkey notes that some engineers believe a new format based on miniaturized digital audio tape (DAT) cartridges ultimately may be better suited for the auto than CDs. A prototype DAT home player from Onkyo U.S.A. Corp., Ramsey, N. J., made its initial appearance at the Las Vegas show. Other manufacturers are expected to jump on the bandwagon this year. Introduction of commercial home DAT players is expected in 1987, with car DAT players likely to follow.

For Clarion's part, Harkey says it already has a prototype DAT car player waiting in the wings. "We're excited about CD and we've introduced our first player," Harkey says. "But at the same time, we're realistic. We don't know in the long term if CD or DAT will be the most highly used format for the car. So we're positioned to go either way." □

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CAN SCHOOLS KEEP UP WITH SUPERCOMPUTER NEEDS?

FEARS GROW U.S. WON'T HAVE ENOUGH ENGINEERS TO COPE WITH BOOM

by Tom Manuel

NEW YORK

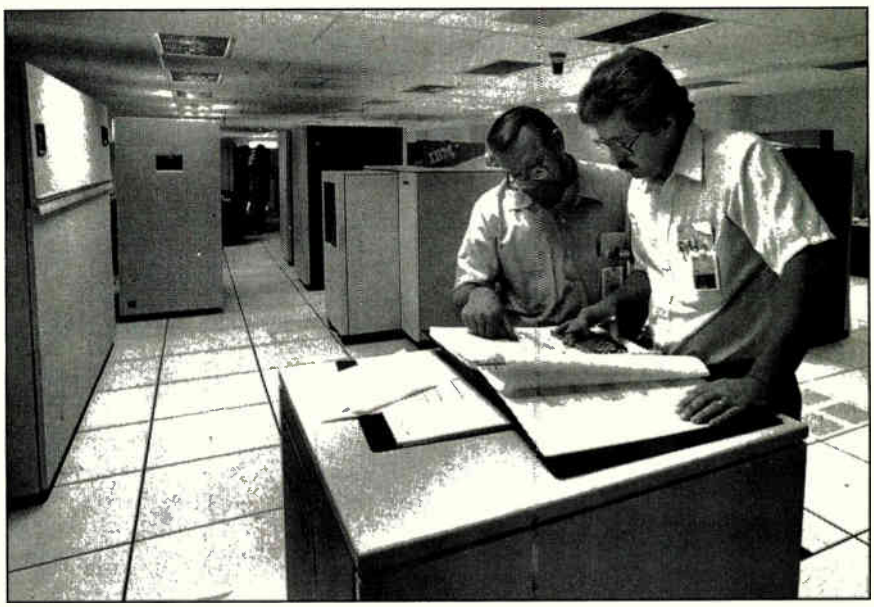
Just as supercomputers are becoming vitally important to a rapidly growing number of users and to the competitive position of U.S. industry, fears are beginning to develop that there will not be nearly enough engineers trained to apply and run them. Nervously eyeing a 60% annual growth in such installations, engineering educators are beginning to wonder if they can meet the rising demand for engineers who can use the superfast machines.

At the same time that supercomputer uses are exploding, another development is further complicating the problem. Most developed nations, including the U.S., have been supporting development programs that are helping universities buy the giant systems and train their students how to use them. But that support seems to be leveling off in the U.S., and federal budget cutting seems certain to affect supercomputer education. To cope with these impending cuts, educators expect to turn to three-way cooperation among governments, universities, and industry to improve the educational effort.

But that may not be enough to cope with the growing demand for engineers able to handle the giant systems. Many observers think the supercomputer is only starting to make an impact in commercial computing circles. "We believe the supercomputer market will show spectacular growth over the 1985-1990 period—60% a year in system installations," says Rick J. Martin of the New York investment house Sanford C. Bernstein & Co.

Worldwide supercomputer installations should increase from 129 at the end of 1985 to more than 1,350 by the end of 1990, says Martin, who recently completed a major study of the market leader, Cray Research Inc. of Minneapolis. "Site penetration will probably still approximate only 38%, well below the rate for commercial mainframes," he says. "That suggests sustained rapid growth for the years beyond 1990."

With such growth in the wings, educators believe they must put even more emphasis on training budding engineers in how to use supercomputers. Although research on both hardware and software must continue, for the majority of students, learning how to apply supercomputers is a much greater need.



INTEGRATED APPROACH. At Cornell, the theory and simulation center uses IBM mainframes connected to Floating Point Systems array processors.

"Universities have a key role in computing: keeping people up with the changes in computing," said John Lott Brown, president of the University of South Florida in Tampa, at one of several education sessions at the First International Conference on Supercomputing Systems in Tarpon Springs, Fla., last month.

Harold Hanson, executive director of the House Committee on Science and Technology, agrees with Brown that the federal government should support development of supercomputers and education in their uses. "Although there are people in Washington that recognize the promise of computers, we are in a time of financial retrenchment. We haven't got the money."

Behind this lack of funding is the recently signed Gramm-Rudman-Hollings budget-reform law, mandating systematic cuts in the national deficit and a balanced federal budget by fiscal 1991. Several speakers at the conference alluded to the likelihood that Gramm-Rudman would mean significantly reduced federal spending on science and technology.

Hanson still is hopeful, however, even though he is wary of what he calls a "meat-ax" approach to balancing the budget. "In the long run, educational progress in computers and supercomputers will continue," he believes. "Supercomputers will become part of our educational arsenal."

GLIMPSE OF THE FUTURE. Typical of the new education efforts getting under way is the interdisciplinary organization at Cornell University's Center for Theory and Simulation in Science and Engineering, Ithaca, N.Y. It is beginning to teach supercomputer techniques using a large and growing computer installation comprising IBM Corp. mainframes that are connected to Floating Point Systems Inc. array processors.

Similar programs are running successfully at Carnegie-Mellon University in Pittsburgh, the University of Illinois at Urbana, and elsewhere. "Though

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graduate students in science already have their hands full, they still have to be taught programming, algorithms, and networking, and also must learn how to use [supercomputers] as opportunities for new ways of doing science," says Kenneth Wilson of Cornell.

Few educators will dispute that, but supercomputers are too expensive for most universities. Sidney Fernbach, a San Francisco supercomputer consultant, estimates that out of 180-odd machines installed worldwide, 30 are at universities (table).

European countries have nine of these: four at West German universities, two in the UK, and one each in France, Italy, and the Netherlands. That reflects quickened interest in closing the gap between supercomputer work in Europe and that in the U.S. and Japan.

In Japan, five of the major universities—Tokyo, Kyoto, Kyushu, Osaka, and Tokohu—have snapped up supercomputers over the past two years at a hefty 85% discount from Hitachi, Fujitsu, and NEC. In fact, it is there that the ultimate in government-university cooperation may have been attained: the computers are owned by the Ministry of Education and are available to any qualified student.

SUPERCOMPUTERS ON CAMPUS

Location	Supercomputer model(s)
U.S.	
Colorado State University	Cyber 205
Florida State University	Cyber 205 (to be replaced by an ETA10)
University of Georgia	Cyber 205
Houston Area Research Center, Texas	NEC SX-2
University of Illinois	Cray X-MP
University of Minnesota, Minneapolis	Cray-1, Cyber 205, Cray-2
University of Pittsburgh and Carnegie-Mellon University	Cray-1
Princeton University	Cyber 205 (to be replaced by an ETA10)
Purdue University	Cyber 205
San Diego Consortium	Cray X-MP
University of Texas, Austin	Cray X-MP (on order)
Canada	
University of Calgary	Cyber 205
Dalhousie University, Halifax	Plans to buy one
Europe	
University of Berlin	Cray-1
Bologna University	Cyber 205
Ecole Polytechnique, Paris	Cray-1
University of Karlsruhe	Cyber 205
University of London	Cray-1
Manchester University	Cyber 205
Amsterdam University	Cyber 205
University of Stuttgart	Cray-1, Cray-2 (on order)
Japan	
University of Kyoto	Fujitsu VP200
University of Kyushu	Fujitsu VP100
University of Nagoya	Fujitsu VP100
University of Osaka	NEC SX-1, SX-2 at the Laser Institute
Tohoku University	NEC SX-1
University of Tokyo	Hitachi S810/20

SOURCE: SIDNEY FERNBACH

As in Japan, U.S. universities have only recently started acquiring supercomputers. Until the National Science Foundation sponsored four national computer centers—at Cornell, Princeton University, and the universities of Illinois at Urbana and California at San Diego [*ElectronicsWeek*, March 4, 1985, p. 13]—there were supercomputers only at Colorado State University, Purdue University, the University of Georgia, and the University of Minnesota. The NSF program gives many more universities access to supercomputing, and that access will expand as more networking is installed.

In addition, computer company sponsorship has put more supercomputers on U.S. campuses, and some wealthier universities have made outright purchases. The University of Minnesota in Minneapolis has added the Cray-2 to its supercomputer stable and the University of Texas at Austin has ordered a Cray X-MP/24 system for installation this quarter.

Down in Houston, a university research and development cooperative called the Houston Area Research Center has ordered a NEC Corp. SX-2 supercomputer [*Electronics*, Jan. 20, 1986, p. 68]. As part of the deal, NEC Information Systems Inc.—the U.S. arm of NEC—will collaborate with the center on developing applications and cooperate in R&D. The system, to be installed in nine months, is capable of 1.3 billion floating-point operations/s and is valued at $20 million.

ENGINEERING CENTERS. More industry help comes from Control Data Corp., whose engineering-center program aims to make its Cyberplus large-scale parallel computers available to students. The Minneapolis company donates machines for the establishment of engineering centers and encourages all the centers to share experience, software, and course materials. A network connecting the centers will be established, and the centers may even share computer resources.

These resources now include about 20 Cyber 180/810 or larger mainframe systems at 20 centers. The 1986 program will add 10 Cyber 180/830 systems and 10 Cyberplus systems, and match some research grants. The Cyberplus is a very fast parallel computer—each processor executes up to 700 million instructions/s—which suits both scientific computing and artificial intelligence. This year, the program expands to universities in as-yet-undisclosed locations outside the U.S.

With 30 or more supercomputers available to students worldwide, there's a big need to get more than computer science, mathematics, and physics students involved, educators say. Students and researchers in many disciplines need hands-on experience. For example, supercomputers would allow designers in all fields to try a multitude of designs by testing their performance in simulation instead of building expensive, time-consuming models.

The biggest challenge in supercomputing education—beyond making the machines available to a variety of students—is to build tools that make use easy for students in all disciplines. In the U.S., good tools are not yet common.

According to many observers, too much reinventing of the wheel is going on in supercomputing at universities. A recurring theme at the Tarpon Springs conference was that emphasis should be put on learning what application tools are available and how to use them, rather than teaching students to program in Fortran and assembly language and then encouraging them to develop their own tools.

"Supercomputers are intended to solve problems more effectively, but this is not yet happening," says consultant Fernbach. He believes, however, that software tools for using supercomputers will come along more rapidly now, with the growing availability on the market of inexpensive vector machines, minisupercomputers, and supercomputers.

Also, the conference was told that if industry is going to get a growing supply of new employees trained and experienced in the use of supercomputers, companies are going to have to start working with the universities and share some of their expertise and tools as well as cooperate in making machines available. Says Rex Krueger, Control Data's president of higher-education marketing, "The shortage of experimental and hands-on tools is felt." □

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INTELSAT DRIVES TO REASSERT DOMINANCE

SATELLITE COOPERATIVE FIGHTS BACK, SOME SAY UNFAIRLY, AGAINST NEW COMPETITORS AND OPTICAL-FIBER TECHNOLOGY

ACTIVE. More has changed at Intelsat than just its headquarters in Washington.

WASHINGTON

At the sleek new Washington headquarters of the International Telecommunications Satellite Organization, more has changed over the past year than just the surroundings. Intelsat, the 110-nation nonprofit consortium that carries roughly two thirds of the world's telephone traffic and nearly all international TV transmissions, has lost its virtual monopoly on some of its businesses. It now faces competition from emerging optical-fiber technology and from a handful of fledgling private U. S. satellite companies.

But in recent months, the 21-year-old cooperative has moved aggressively—some say unfairly—to reassert its dominance. Besides new domestic services that it plans to offer member nations and the mid-1987 launch of a next-generation satellite—Intelsat VI—Intelsat is pushing satellite technology to meet the challenge posed by planned transatlantic optical-fiber networks and private satellite networks, officials say. These innovations, they say, will include higher-power satellites with such additional features as on-board data processing, and smaller, less expensive earth stations that are important to developing nations just now creating domestic telecommunications networks.

Intelsat is not moving as fast as it would like, however. Excess satellite capacity and a September launch failure forced Intelsat to push back the schedule, delaying deployment of Intelsat V satellites and postponing Intelsat VI launches for a year. Downplaying the delays, Richard R. Colino, Intelsat's director general and chief executive officer, says they will let Intelsat make modifications that will boost the power and coverage of K-band transponders.

Intelsat's competitive problems began in November 1984, when the Reagan administration decided to allow private U. S. telecommunications companies to compete with Intelsat for the first time in all areas except international telephone service. Last July, the Federal Communications Commission authorized three U. S. companies to offer limited competition. Since then, the FCC has conditionally approved a fourth competitor, Financial Satellite Corp., which will offer financial-data network services [*Electronics*. Jan. 20, 1986, p. 68].

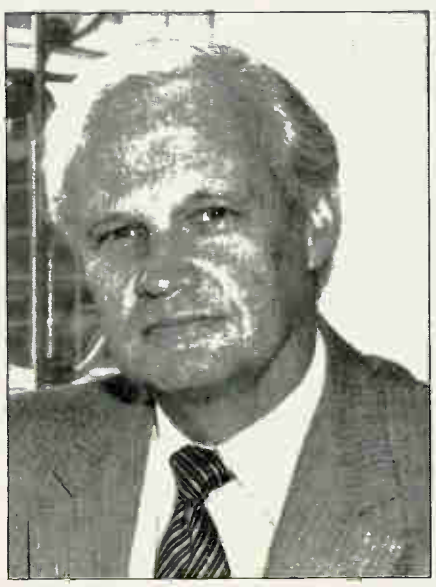
In response, Intelsat announced in September that it would begin leasing its excess satellite capacity to member nations for domestic use. In December, it offered nonpreemptable long-term leases on 36- and 72-MHz transponders on its current Intelsat V satellites. Intelsat's new U. S. competitors condemn the action, predicting the rise of predatory pricing by Intelsat, which would drive them out of the domestic business before they ever launch a satellite.

Intelsat is using its "monopoly revenues" to subsidize its new domestic satellite services, claims Fred Landman, president of Pan American Satellite Corp., New York, which will launch its first satellite for domestic service in Latin America in this year's third quarter. "That's unfair," he says.

HARDBALL. In a letter sent last November to FCC chairman Mark S. Fowler, David J. Markey, then the administrator of the Commerce Department's National Telecommunications and Information Administration, criticized Intelsat's domestic service for its members. Markey argued that it "raises serious questions regarding the possibility of cross-subsidies and below-cost pricing for Intelsat's nonmonopoly services." Though Markey urged the FCC to consider regulatory measures against Intelsat, Rodney Joyce, the acting assistant secretary of commerce for communications and information policy, puts it more bluntly: "It's time to start playing hardball with Intelsat."

Undeterred, Intelsat officials say 27 countries are now using some 40 Intelsat transponders for domestic services. "You're seeing Intelsat responding to its members," says Walter R. Hinchman, Intelsat's director of business planning and service development. "Its members have been using Intelsat for domestic services for a long time, but not very extensively and not with complete satisfaction." As a result, domestic

RESPONSIVE. Intelsat is meeting its members' needs, say Hampton (left) and Hinchman.



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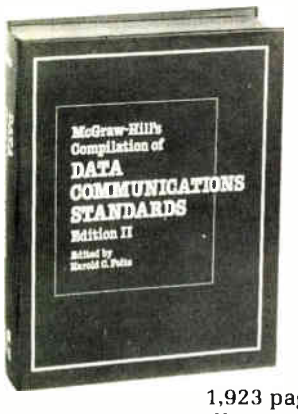

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service could be preempted at any time. Now Intelsat has the capacity to offer these same services on a nonpreemptive basis, Hinchman says. "That's bringing a tremendous amount of interest on the part of [Intelsat] signatories."

Hinchman and John D. Hampton, Intelsat's deputy director general for operations and development, bristle at the suggestion that high-capacity fiber-optic cables pose a serious threat to its business. "All in all, optical-fiber cables are patently not going to force the demise of satellite communications," says Hampton. He maintains that optical-fiber service would be limited to more costly point-to-point communications and that, unlike satellite users, fiber customers will have to obtain terrestrial connections from a third party. "I think that service implication is terribly important," he notes.

Intelsat doesn't believe that fiber optics threatens its business

One way that Intelsat hopes to exploit its ability to link geographically dispersed users is a new service that makes use of time-division multiple-access (TDMA) technology. Intelsat's TDMA digital services across the North Atlantic became operational in October. Intelsat VI, designed to operate for at least 10 years, will introduce satellite-switched TDMA services that can access six separate antenna beams.

Intelsat is also working to develop optical intersatellite links. "Satellite links may have a role to play in terms of being able to better position satellites to cover the land masses," Hinchman says.

Nevertheless, "the greatest common thread is reducing the cost of earth stations because we believe the system will be designed around a lot more of them," says Hampton. To do this, higher-power satellites will jump from C-band to K-band frequencies, and on-board data processing eventually will be added.

PACIFIC BOOM. As fierce competition looms over the Atlantic and in Latin America, Intelsat now looks to the Pacific as its next big market. Intelsat deputy director general David Tudge estimates that the annual growth rate of traffic on Intelsat satellites in the Pacific region was about 20% last year, higher than in any other ocean region.

But as it aims to push satellite technology and serve the growing telecommunications needs of the developing world, Intelsat will have its hands full back home, where it will undoubtedly continue to lock horns with an FCC bent on creating competition in international markets. *–George Leopold*

BOTTOM LINES

SOFTWARE COMPANY MERGERS RISE 42%

Mergers and acquisitions of computer software and services companies increased 42% last year over 1984, according to the Computer Software and Services Industry Association. A total of 203 transactions took place in 1985, compared with 143 transactions in 1984, Adapso says. Acquired companies were in processing services, professional services, software products, and computer consulting. Adapso said the majority of acquisitions were by computer-hardware companies. It added that hardware vendors are showing signs of "even more intensive acquisition programs within the next 12 months," especially in the telecommunications sector.

ZITEL'S $6 MILLION CREDIT LINE RENEWED

Zitel Corp., a San Jose, Calif., maker of semiconductor memory systems for original-equipment-manufacturer computers as well as minicomputers and mainframes, had its $6 million line of credit renewed by the Union Bank of San Jose. The company says the line includes a $5 million unsecured working-capital credit line at the prime rate and a $1 million capital-equipment line of credit.

FIBRONICS TO BUY SPARTACUS COMPUTERS

Fibronics International Inc. has agreed to acquire Spartacus Computers Inc., Bedford, Mass. Under terms of the deal, Fibronics will issue about 380,000 shares of its stock in exchange for all Spartacus shares. Fibronics, of Hyannis, Mass., designs, makes, and sells fiber-optic and other high-speed network products that connect mainframe computers and peripherals. Spartacus, which had revenue in fiscal 1985 of about $4 million, manufactures KNET Network Software and the K200 Ethernet Control Unit, which allow communications between IBM Corp. and non-IBM computers.

PATHWAY DESIGN RAISES $1.7 MILLION

Pathway Design Inc., Natick, Mass., has obtained $1.74 million in a third round of financing. The 2½-year-old company, which makes products that allow personal computer-to-mainframe communications, said it will use the funds for working capital, research and development, and to expand its sales force.

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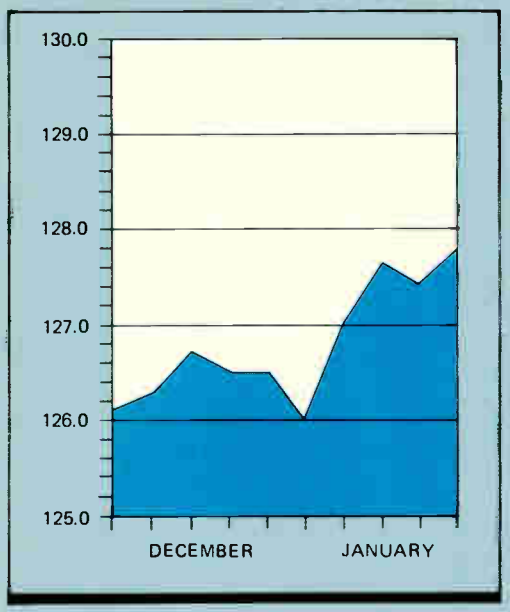
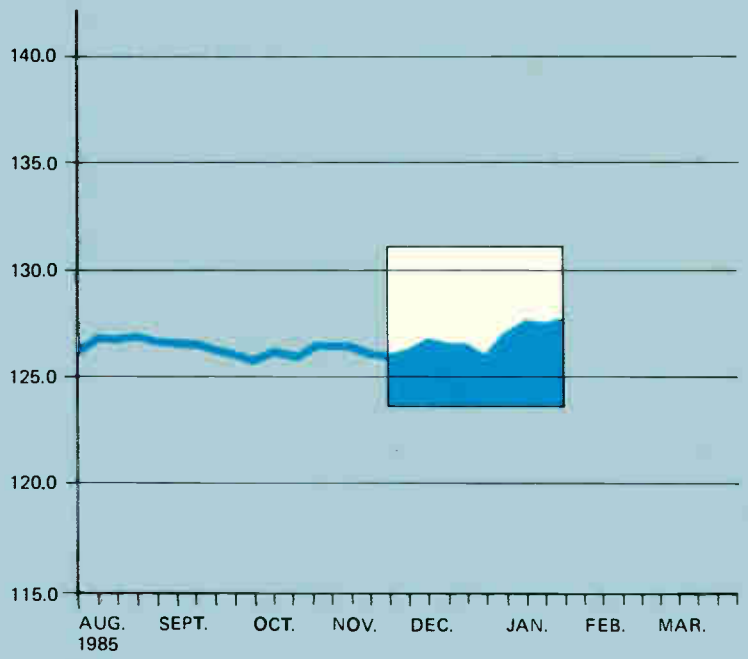
ELECTRONICS INDEX





THIS WEEK	= 127.8
LAST WEEK	= 127.4
YEAR AGO	= 129.5
1982	= 100.0

The *Electronics* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

U.S. ELECTRONICS COMPONENT-PRODUCER PRICE INDEX

	December 1985	November 1985	December 1984
Digital bipolar integrated circuits	60.7	60.7	62.1
Digital MOS ICs	30.9	31.7	42.4
Linear ICs	59.0	60.0	64.2
Capacitors	185.6	185.6	191.9
Resistors	189.4	189.5	187.5
Relays	313.2	313.2	319.3
Connectors	236.6	236.1	233.4

The *Electronics* Index rose 0.3% in the latest week, despite another drop in the prices of electronic components. According to the latest government statistics, component prices as a whole were down 2.3% in December 1985 from their level in December 1984 but fell only 0.1% from November 1985.

It could be argued that the decline in prices is the result of lower unit costs brought on by manufacturing efficiencies. However, observers familiar with the electronics industry's performance during the past 18 months could counter that the price declines were the result of the continuing industry depression.

A good sign, however, is the one-month drop in component prices in December from November, which was benign compared with some of the more rapid price plunges witnessed by the electronics industry in previous months. This could indicate that components markets are starting to firm up and could be headed for a recovery.

Manufacturers of digital MOS integrated circuits saw prices of their products perform dismally in 1985. From December 1984 to December 1985, prices of MOS ICs dropped 27%, as the industry slump took hold. This decline was not helped by November's performance: prices of MOS ICs fell 2.5% more. As for digital bipolar ICs, December's prices were down 2.2% from levels of 12 months ago but were the same as those registered in November. Prices for linear ICs slipped 2% in December from the prior month's level but were off 8% for the year as a whole. Though prices of relays in December were the same as in November, they are off 2% from December 1984's levels.

Not all components have fallen in price. Both resistors and connectors rose over the past 12 months. Prices of resistors stayed the same as in November but are up 1% from December 1984; connectors went up 1.4% during the same period. Relay prices stayed flat from November to December and are off 2% from December 1984.

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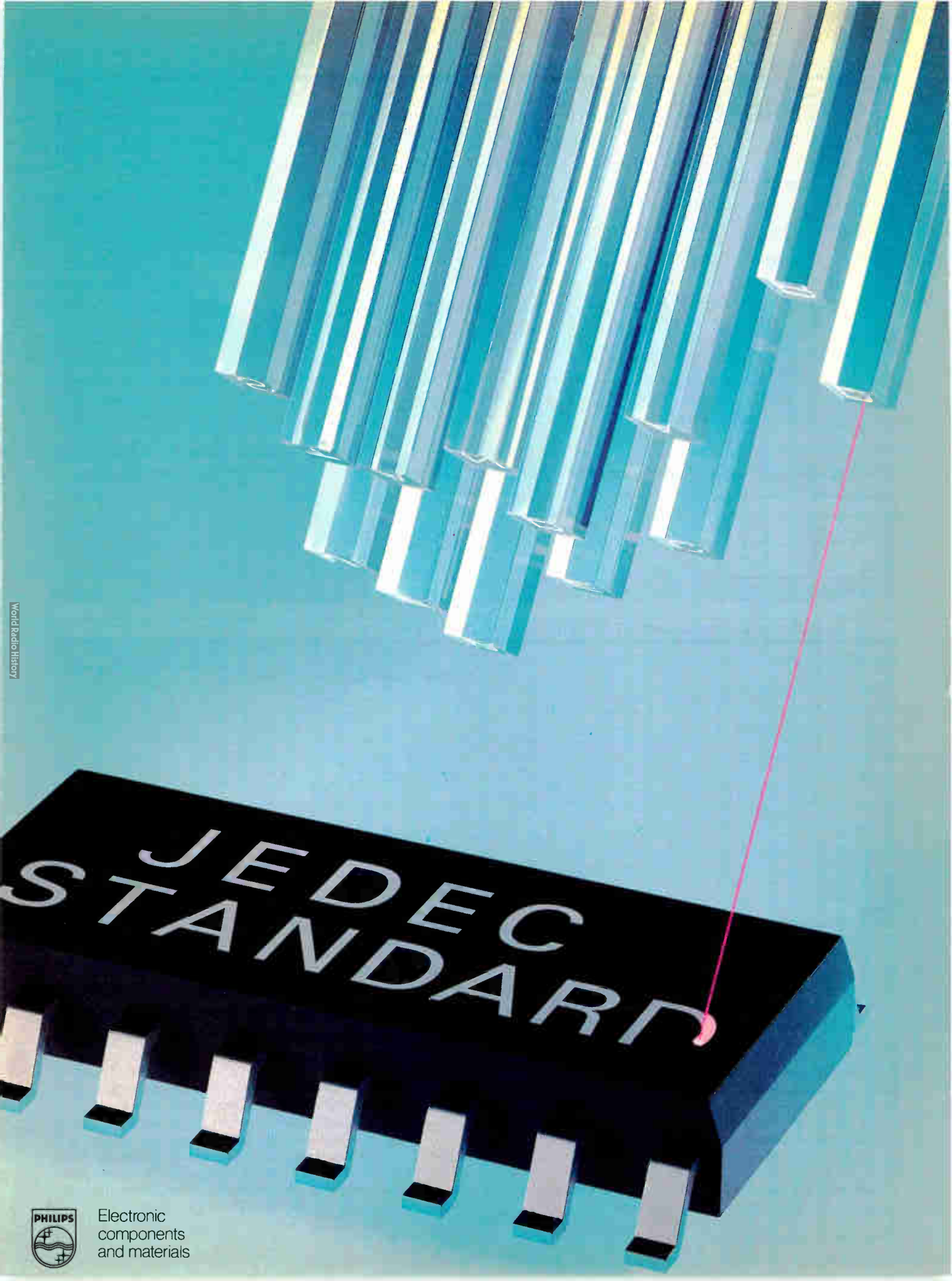

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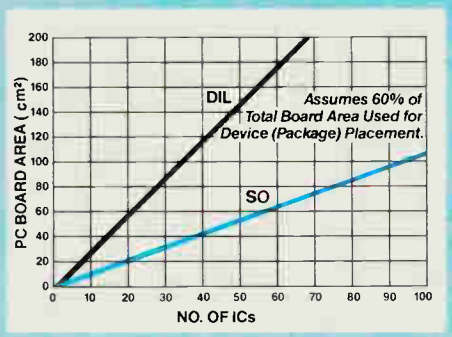

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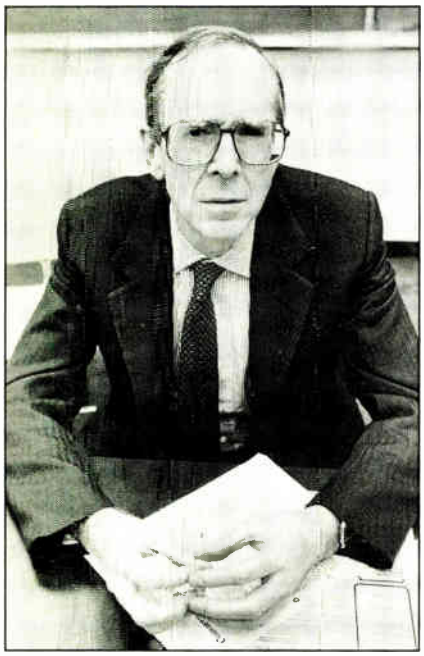

ADRIAN HORNE: Small companies should consider licensing more often.

NEW YORK

Struggling startups often would be better off licensing their technology, rather than trying to convince venture capitalists to back a manufacturing operation, says Adrian Horne, a British-born marketeer who's made a career out of structuring licensing programs. "Today's venture-capital investors are more interested in management than ideas," says Horne, who set up the licensing program that put Dolby noise-reduction circuits in virtually every cassette deck sold worldwide in the past few years. "When you get down to it, ideas rank about fourth behind management, management, and management."

The step from laboratory to marketplace is a difficult one for small companies with big ideas. Stories of talented engineers with can't-miss inventions that never came close are legion. And though Wall Street may be bullish on America, these days it's downright bearish on high technology.

The little guy has only a couple of options, Horne says. If his invention is aimed at a small, growing market just beginning to emerge, he can probably go it alone, ramping up production as demand increases. But if the idea has immediate market potential, there is only one sure recourse—licensing, says Horne, whose consulting company, Trans-Atlantic Technologies Inc. in Stamford, Conn., helps small companies bring new ideas to market.

"It's likely that you can make more money licensing in some cases than if you try to manufacture," says the 51-year-old marketing specialist. "An inventor's job is to sell the technological idea. He doesn't have to sell himself as a capable manager. Licensing can be a good way to leverage technology."

Licensing, of course, is not the only way or even the best way to market every product. But it may be the only alternative for a small manufacturer strapped for cash, Horne says. If demand is likely to be immediate, a small company with limited manufacturing facilities must recognize that it can't do the job alone, making licensing attractive. And if the company's product is a component of, or enhancement to, an already existing product, again licensing is probably a better way to go, because it doesn't pit the newcomer against strong, established competition.

One company that has sought Horne's

PEOPLE ON THE MOVE

PETER APPLETON-JONES

☐ Elxsi, which makes high-performance computers, has named Peter Appleton-Jones, 47, president and chief operating officer. Before his appointment at the San Jose, Calif., subsidiary of Trilogy Ltd., Cupertino, Calif., Appleton-Jones was president and chief operating officer of Applitek Corp., a Boston startup for high-end networking products. Prior to that, he served as an executive vice president for Cray Research Inc., where he was responsible for worldwide sales, marketing, support, and software development.

M. PETER THOMAS

☐ LM Ericsson has fulfilled a promise by naming M. Peter Thomas the new president and chief executive officer of its U. S. subsidiary, Ericsson Inc. The Swedish parent company said in December it would name a U. S. executive to lead the wholly owned Richardson, Texas, subsidiary as part of a new strategy to capture more U. S. sales. Thomas, formerly president and chief operating officer of Telenova Inc. of Los Gatos, Calif., succeeds Haka Ledin, who remains on the board of directors. At Telenova, Thomas helped create a joint venture program with Wang Laboratories Inc. He also served as president of ITT Corp.'s Network Systems Division.

WILLIAM L. BRADFORD

☐ Panatech Semiconductor, a division of Panatech Research & Development Corp., Santa Clara, Calif., has promoted William L. Bradford to president from vice president of marketing and general manager. Before joining Panatech Semiconductor, Bradford served in several management positions with NEC Micro Computers, most recently as the U. S. single-chip marketing manager. He also worked at Trans World Airlines Inc. and Hughes Aircraft Co., where he designed communication, navigation, and radar systems. Panatech is the North American technology and marketing partner for thermal printheads, CMOS programmable logic devices, and gate arrays of the Electronic Device division of Ricoh Co. of Osaka, Japan.

JOHN C. BUCKINGHAM

☐ AA Gage Inc., a manufacturer of measuring devices and gauging systems, has named John C. Buckingham as its president. The Ferndale, Mich., company is a subsidiary of Cambridge Research & Development Inc. of Westport, Conn. Buckingham had been president and chief executive officer of West Agro-Chemical Inc., Westwood, Kan.

HECTOR DE J. RUIZ

☐ Thomson Components-Mostek Corp. has hired another former executive of Motorola Inc. Hector De J. Ruiz, formerly Motorola's assistant group general manager for the MOS Memory Group in Austin, Texas, has joined Mostek as senior vice president of integrated-circuit products. Ruiz will report to Mostek president James Fiebiger, who before joining the Carrollton, Texas, chip maker last year was assistant general manager of Motorola's Semiconductor Products Sector in Phoenix, Ariz. Ruiz will direct Mostek's engineering activities for existing and new products. He also will be responsible for marketing Mostek's ICs, including those imported from Thomson's manufacturing centers in France.

JOHN KEATING

☐ AT&T Ricoh Co., a joint venture formed by AT&T International and Ricoh to develop and market telecommunications products in Japan, has appointed John Keating director and vice president. Before joining AT&T International, Keating was manager of strategic planning and new ventures for Bell Telephone of Pennsylvania. He also was manager of systems engineering for Acrodyne Industries.

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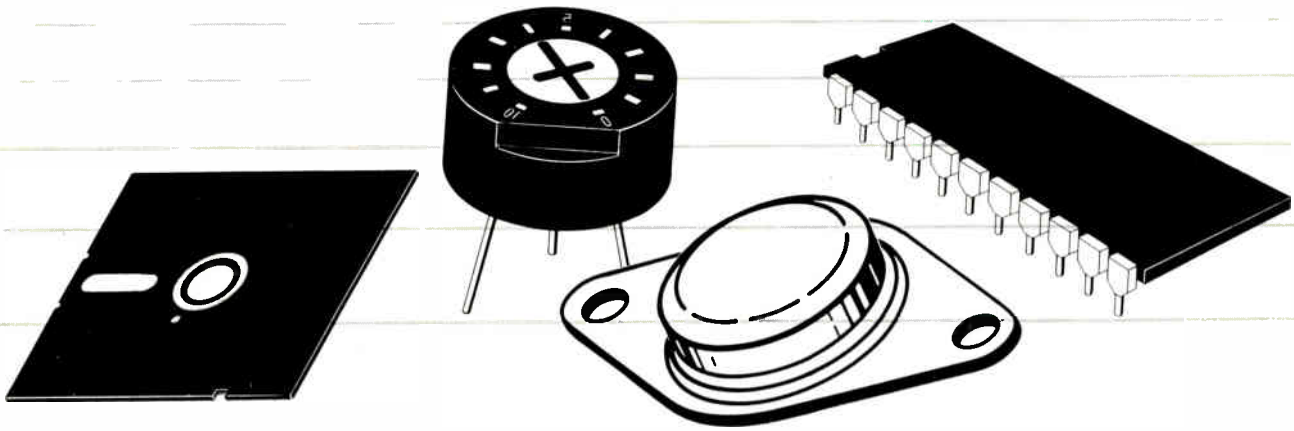

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Joachim Wank, Application Technology Section, Plastics Group

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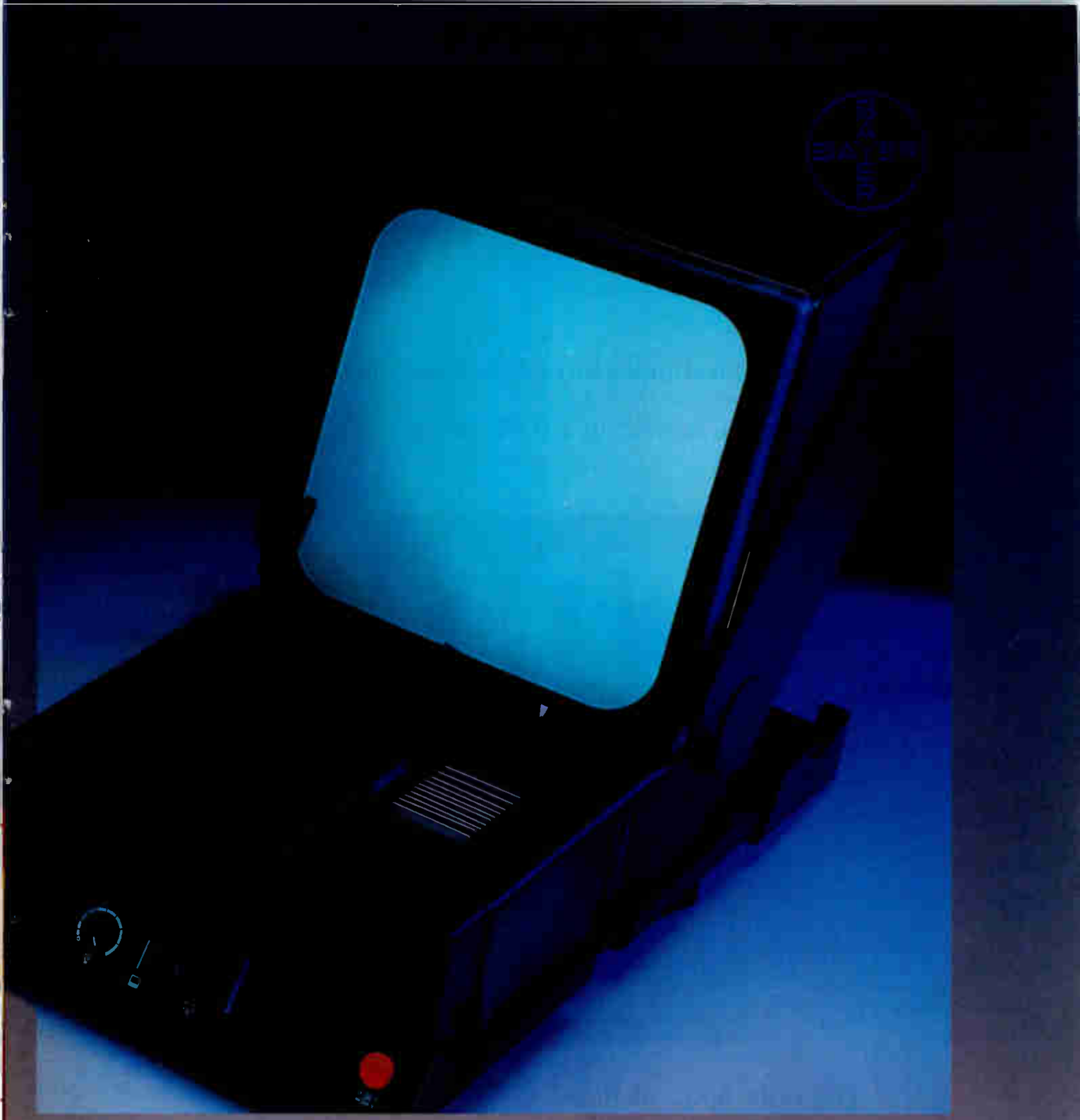

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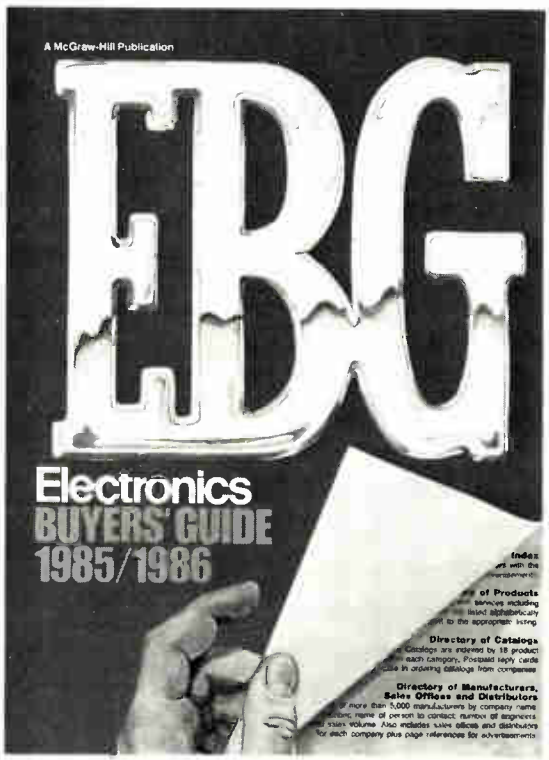

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licensing assistance is Rapitech Systems Inc. The New York company is seeking licensees for a standard connector that houses the serial-to-parallel conversion and interface circuitry for an RS-232-C port [*Electronics*, Jan. 13, 1986, p. 25]. It is taking the licensing route because it isn't prepared to manufacture the connector in the volume it expects the market to demand.

But the classic case for licensing is that of Dolby noise reduction, Horne says. Ray Dolby, founder of Dolby Laboratories Inc. and inventor of the noise-reduction circuitry that bears his name, recognized that to launch his product on a large scale, he had to give up the idea

Licensing can produce profits for small firms without much capital

of manufacturing it. So in 1970 he hired Horne, an acquaintance and graduate of Harvard Business School, to develop a licensing program.

Though Dolby could have been marketed as a stand-alone noise-reduction box, Horne saw that it had greater potential as a part of the stereo cassette deck. In fact, Horne says, there was no market whatsoever for high-fidelity cassette players until Dolby licensed its patented system.

STRUCTURED PRICING. The success of the product hinged on worldwide acceptance, Horne decided, and only a carefully worked-out strategy would yield the required result. To achieve that, Horne says, he had to come up with a pricing structure that was high enough to bring a profit from small manufacturers, such as Switzerland's Willi Studer, yet low enough to keep volume producers such as Sony Corp. from producing their own noise-reduction circuits.

By 1983, Horne says Dolby's Type B circuit had 160 licensees—about 100 of them active—in 35 countries. The 40 million circuits produced each year bring Dolby annual royalties of $9 million.

Horne left Dolby in 1975 to freelance. In 1978 he signed on with Westland plc, the British helicopter maker, as a corporate planning executive. There he handled technology exchanges and international industrial relations.

He says he decided to leave the company in 1984 to join IMRS, a Stamford software company. After a year, Horne decided that match wasn't right, and he returned to freelancing.

Because his expertise lies in the structuring of a product's marketing program, Horne explains, his relationships with clients have a naturally short life cycle—hence his checkerboard job history. *–Tobias Naegele*

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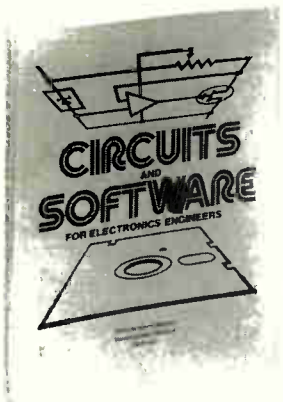

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NEW PRODUCTS

SUPERMINICOMPUTER INVADES WORK-STATION TERRITORY

SYSTEM TOPS 6 MIPS, YET SELLS FOR AS LITTLE AS $95,000

Work-station users have a new alternative: Celerity Computing's $59,000 C1230 superminicomputer can handle multiple users, as well as doing the computation-intensive tasks such as circuit simulation that work stations have had to hand off to superminis. What's more, the dual-processor C1260 version that starts at $95,000 can hit 6.5 million instructions per second, up in VAX-8650 territory.

The machines use a souped-up proprietary processor, based on NCR Corp.'s 32000, in a reduced-instruction-set-computer architecture. Celerity has improved the Accel 32-bit processor it used in its initial computer, the C1200 [*Electronics Week*, Sept. 10, 1984, p. 82]. Cycle time has been cut from 125 ns, in the version based on the C1200, to 100 ns. As a result, the C1230 does single-precision operations at 3.25 mips when performing the Whetstone benchmark, which contains floating-point and integer calculations. The dual-processor C1260 provides 6.15-mips throughput in single-precision operations.

"Our C1260 and C1230 meet engineers' needs for increased computing power where they work—in the office or lab," says Celerity's president, Stephen Vallender. "The products deliver supermini performance in a compact system at a price far below computers at similar performance levels."

Vallender compares the $100,000 C1260 with Digital Equipment Corp.'s recently announced VAX-8650. The VAX-8650 can perform about 6.4 million or 6.5 million instructions per second, he says. "You very quickly realize that the C1260 at 6.15 mips is almost as capable as a VAX-8650, at one fifth the cost."

A standard feature of Celerity systems is the 64-bit Accel floating-point extended-arithmetic unit, a coprocessor that handles mathematically complex portions of programs. The coprocessor supports all floating-point operations, including prescaling, exponentiation, trigonometric functions, and conversion between formats.

The 32-bit Accel main processor features high-capacity virtual memory and the support for up to 24 megabytes of memory, both important for running large applications programs. Memory caches are used for address-translation instructions, floating-point processor registers, and stack registers.

WORK-STATION RIVAL. Celerity's multiuser system does design tasks plus number crunching.

The main processor and the floating-point coprocessor use a RISC architecture that substantially speeds program execution by reducing overhead associated with high-level languages, the company explains. The instruction set has been limited to basic commands that execute in a single machine cycle.

Although its architecture has more than 150 commands—compared with the 30 to 35 typically found in RISC systems—Celerity says its RISC strategy maintains higher execution speeds without limiting the process to too few commands and thus sacrificing functionality. A three-stage pipeline architecture with delayed jumps provides a basic cycle time of as little as 100 ns. The floating-point operations Celerity chose to support are a function not available with standard RISC systems, the company says.

The Celerity systems are designed to support applications with intensive input/output needs, such as those requiring frequent access to a large data base. For example, the C1230 provides 23 I/O slots on two I/O buses and can support 64 simultaneous on-line users, with up to 4,096 processes. The C1260 supports up to 128 users.

Celerity's family of superminicomputer systems has a complete implementation of the Unix 4.2bsd operating system for stand-alone and multiuser environments. The company chose 4.2bsd, developed at the University of California at Berkeley, because that version is widely accepted for engineering and scientific applications, which typically require demand-paged virtual memory and analog processes.

The computers support an expanding library of design and analysis software—more than 70 programs, including Patran II, Ansys, and Nastran used for modeling, finite-element analysis, and three-dimensional display of applications.

The C1230 ranges from $59,000 to $87,000, with an average price of about $75,000. The dual-processor C1260 costs $95,000 to $123,000, with an average of about $110,000. Users of the C1200 may upgrade to the new systems. *–Ellie Aguilar*

Celerity Computing, 9692 Via Excelencia, San Diego, Calif. 92126 Phone (619) 271-9940 [Circle reader service number 338]

HP DIGITAL SCOPES HIT ANALOG PRICES

At $7,900, Hewlett-Packard's HP 54201 overcomes the price/performance disadvantage that has forced makers of digital storage oscilloscopes to woo users with talk of fancy automatic features instead of price. And with its 300-MHz repetitive-signal bandwidth, the HP 54201 adds measurement capability that should strengthen the lure drawing users from analog scopes.

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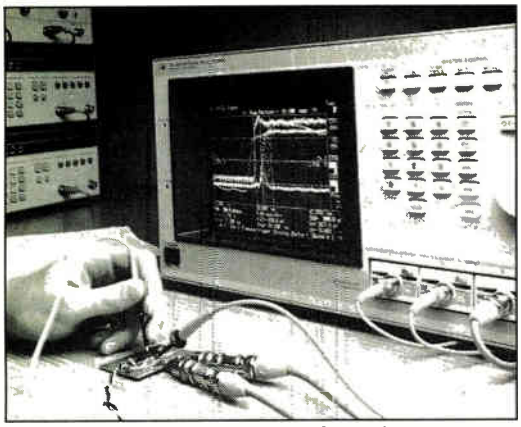


ANALOG PRICE. HP's new 54201 digital storage oscilloscope provides 300-MHz repetitive bandwidth at prices typical of analog scopes.

"The HP 54201 is getting down into the price realm of analog scopes," says Murray Haynes, the Palo Alto company's oscilloscope product manager. "The education process is to overcome the cost objection. While the user will pay a little more, he will make his measurements faster and more accurately. He won't have to count graticule lines to figure rise time. He can just push a button and the instrument's computer will do it."

Haynes compares the 54201 with the 2465, a 300-MHz analog scope from Tektronix Inc., Beaverton, Ore. Although the 2465 sells for $5,500, Haynes argues, the addition of standard features in a digital storage scope, such as a counter, digital meter, and IEEE-488 instrument bus interface, brings the cost to somewhere between $8,000 and $9,000.

Hewlett-Packard is so confident the new scope will do the job that it recently dropped all but two of its analog scopes. The 54201, which is an enhanced version of the HP 54200 introduced a year ago, is designed to replace the company's 1740 and 1720 families, which include both general-purpose and storage analog scopes.

The 54201 has a 300-MHz bandwidth and a ±200-ps timing accuracy, compared with the 54200's 50-MHz bandwith and ±2-ns accuracy. Other improvements include a higher microprocessor clock speed that reduces automatic measurement times by up to 30%; waveform math capabilities whereby the signal of channel 1 can be added to or subtracted from the signal on channel 2; and statistical delay measurements that retain maximum, minimum, and average signal-delay values on screen.

The 54201's ±200-ps timing accuracy suits it for a range of tasks, from aiding in product concept through manufacturing evaluation. Such features as automatic parametric measurements, separate cursors for time and voltage, and automatic waveform scaling simplify troubleshooting and characterizing a product design.

The 54201's 50-MHz single-shot bandwidth should prove useful to designers of digital and analog systems who deal with transient fault conditions. Transients as narrow as 10 ns in duration can be captured easily, stored in waveform memory—which is specified at 1-K words on each channel—and analyzed using the automatic waveform measurement functions.

The 54201 comes in two versions: the basic unit, 54201A, and a model with enhanced triggering capabilities, model 54201D. The latter offers a triggering feature that includes a 27-bit-wide state triggering on specific routines with four user-definable sequence terms; and triggering when there is a missing or extra bit in a serial data stream.

Available two weeks after ordering, the HP 54201A costs $7,900 and the 54201D goes for $9,800. *–Steve Zollo*

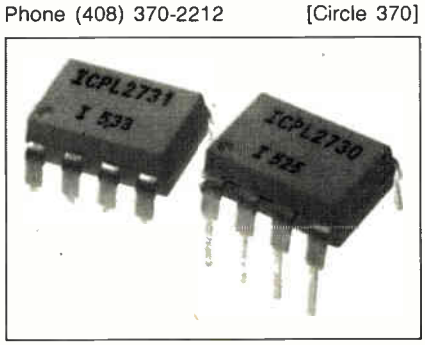
Hewlett-Packard Co., Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, Calif. 94303 [Circle 339]

COUPLERS SUPPORT 200-kb/s TRANSFERS

Two high-gain dual-channel opto-couplers support a typical data-transfer rate of 200 kb/s. The ICPL2730 and 2731 will replace Hewlett-Packard's dual couplers of the same type number at 10% lower cost, the manufacturer says.

Other features include a typical current-transfer ratio of 1,000%, low output-saturation voltage—typically 0.2 V—and high common-mode rejection. The dual couplers can be used for line receiving, polarity sensing, and low current-ground isolation. Delivery is from stock.

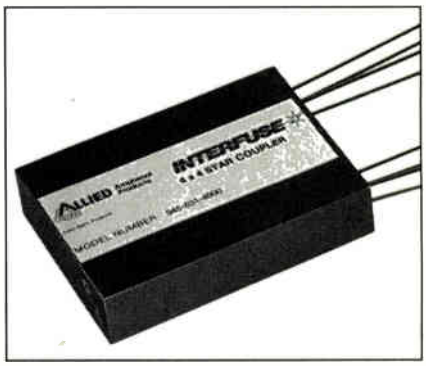
In quantities of 100, the ICPL2730 sells for $3.04; the ICPL2731 for $3.80.
Isocom Inc., 274 E. Hamilton Ave., Suite F, Campbell, Calif. 95008.
Phone (408) 370-2212 [Circle 370]



STAR COUPLERS HAVE FOUR TWO-WAY PORTS

The 945 series of Interfuse star couplers offer three or four bidirectional ports for use in single-mode telecommunications systems and local-area networks. They also function in test-and-measurement applications in which signal monitoring is necessary, and in sensors that require beam-splitting or multiplexing.

The maximum excess loss—the total optical power lost as light passes through the coupler—is less than 0.5 dB. The couplers come in standard wavelengths of 820-, 1,300-, and 1,520 nm.



In quantities of one to four, the 4-by-4 coupler costs $1,575; the 3-by-3 is $975. The couplers operate over a temperature range of −55° to +125°C.
Allied-Signal Inc., Amphenol Products, 4300 Commerce Ct., Lisle, Ill. 60532.
Phone (312) 983-3581 [Circle 371]

BOARD CONTROLS VMEbus STORAGE

The VUSC, a universal storage controller for VMEbus-based systems, operates up to 12 peripherals and, when linked with a serial-port board, doubles as a single-board computer that can serve as a VMEbus master. The double-height board controls hard and floppy disks, optical memories, backup devices, and printers through two ST-506 and two SA-450 interfaces, and up to eight peripherals using the Small Computer System Interface.

Control is orchestrated by a 68000 microprocessor working with an SCN68454 intelligent multiple-disk-controller chip. The disk-controller chip offloads tasks from the host processor, freeing the host to service other instructions. The chip also works with a disk phase-locked-loop chip to transfer data. System memory—with no wait states—consists of 512-K bytes of dual-ported local memory and 64-K bytes of EPROM.

Users can program operations such as single-command backup of Winchester disk drives and creation of caches in main memory for frequently used data

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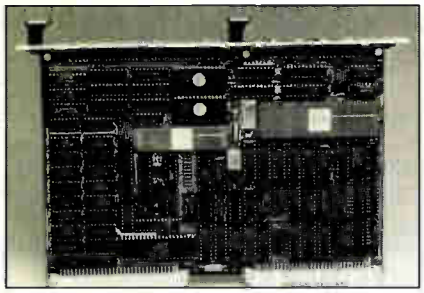


blocks for higher throughput.

In sample quantities of 1 to 10, the VUSC costs $2,190. Production quantities will start in the second quarter.

Dual Systems Corp., 2530 San Pablo Ave., Berkeley, Calif. 94702.
Phone (415) 549-3854 [Circle 358]

BOARD LINKS STD AND IEEE-488 BUSES

The CDI-488 board creates an interface between STD and IEEE-488 buses. It can be programmed as a talker, listener, or controller, and can be either polled or interrupt-driven.

Other features include software-readable address switches and eight status indicators, both for the IEEE-488 standard. The maximum data-transfer rate is 1 megabyte/s, although 250- to 500-K bytes/s is typical.

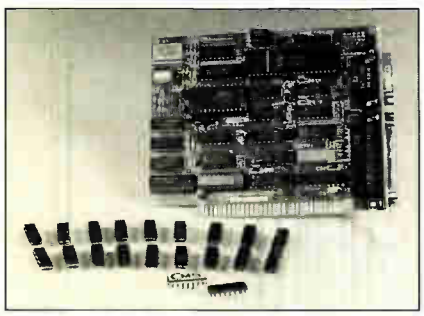
The CDI-488 costs $300 each, and delivery takes 30 days.

Computer Dynamics Inc., 105 S. Main St., Greer, S. C. 29651.
Phone (803) 877-7471 [Circle 359]

CARD ADDS RAM, MORE FUNCTIONS TO IBM PC

Plus-Pack for the IBM Corp. Personal Computer and PC/XT combines two of the company's existing products—Rambooster, a memory-upgrade kit that provides 640-K bytes, and 4X4, a four-function board offering serial and parallel ports and a clock-calendar.

The resulting product occupies only one half-size board slot. It can be bundled with the manufacturer's 20-megabyte hard disk or with the Drive Plus full-slot add-in card. Both a standard and a ruggedized drive with head lifters are available in Drive Plus for $995 and $1,159, respectively.



Plus-Pack costs $290. The suggested retail price for the 20-megabyte hard disk is $1,100. All are available from stock.

CMS Inc., 401-B W. Dyer Rd., Santa Ana, Calif. 92707. Phone (714) 549-9111; original-equipment manufacturers call (714) 549-4810 [Circle 361]

DISK CONTROLLER TRANSFERS AT 16 Mb/s

The GMSV09 double-width VME module is a disk or tape controller that works without interleaving, providing transfer rates up to 16 Mb/s. The module controls two Storage Module Drives and up to four QIC-02 (quarter-inch cartridge) interfaces to the VMEbus.

The controller reads soft- and hard-sectored track formats, and the user can program the sector length. Error-correction codes, up to 11 bits long, are handled through a burst-error processor.

The four available Storage Module Drive and QIC-02 interfaces start at $2,495. Delivery takes four weeks.

General Micro Systems Inc., 4740 Brooks St., Montclair, Calif. 91763.
Phone (714) 625-5475 [Circle 360]

12-BIT ADC WORKS IN JUST 5 MICROSECONDS

The 12-bit AD7572 analog-to-digital converter offers a maximum conversion time of 5 μs while consuming only 215 mW maximum. It also includes an on-chip buried zener-voltage reference, successive-approximation register, control logic, comparator, and clock.

Fabricated in the company's proprietary linear-compatible CMOS process, the AD7572 fits into a 24-pin DIP that is 0.3 in. wide. The part comes in nine grades and three temperature ranges. Prices in quantities of 100 start at $47 for the 5-μs version and at $35 for a 12.5-μs version. The company recommends the latter for designs that require the same low power and high accuracy but not the speed. Commercial and industrial grades are available now, and the rest will appear in March.

Analog Devices Inc. Literature Center, 70 Shawmut Rd., Canton, Mass. 02021 [Circle 362]

VIDEO CONVERTERS DO COLOR GRAPHICS

The NE5150 and NE5151, two red-green-blue triple video digital-to-analog converters, target high-resolution bit-mapped color graphics displays. Each part offers a typical power dissipation of less than 1 W and a low glitch or switching-transient energy of 30 pV/s.

The NE5150 contains three ECL memory look-up tables with read-write controls, letting the user select 16 out of a possible 4,096 colors. It also contains four composite video controls—blanking, synchronization, reference white, and 10% bright. All logic inputs are both TTL- and ECL-compatible.

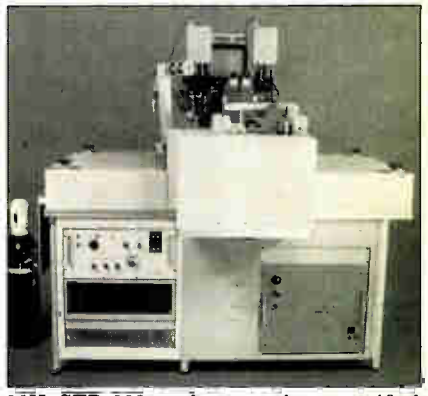
The NE5151 is similar but selects colors from external memory look-up tables, then accesses the three DACs. It is capable of update rates of 150 MHz. Both parts are available now in 24-pin Cerdip packages for the commercial temperature range. In lots of 100 to 999, both parts sell for $43 each.

Signetics Corp., 811 E. Arques Ave., P. O. Box 3409, Sunnyvale, Calif. 94088.
Phone (408) 991-2000 [Circle 363]

CHIP-PROBE SYSTEM DOES THREE TESTS

The DCP/T-1, a direct chip-probe and test system, performs three electrical tests at three different temperatures but requires only one physical connection to the part's pads. The system, which screens ICs before they are assembled into hybrids, removes dice automatically from waffle packs or wafers and delivers them individually to a test station.

As the electrical test begins, the temperature forcing system cycles dice through −55°C to +125°C and then back to ambient temperature. There, they are aligned and probed under MIL-STD-883 and two other specified temperature ranges.



After temperature cycling, the dice are sorted according to the electrical-test results and placed in the appropriate waffle pack or reject vial. The system significantly increases the first-pass yield of hybrid circuits.

A system for ambient temperature only is $185,000; with thermal forcing capability, the cost is $235,000.

Teledyne TAC, 10 Forbes Rd., Woburn, Mass. 01801.
Phone (617) 935-5400 Circle 350]

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UNIT TESTS BOARDS BY EMULATING BUS TIMING

The model 3200 performance tester handles 8-, 16-, and 32-bit single- or multiple-processor bus-structured boards by emulating their bus-timing protocols. The system consists of four dedicated test units for performance, functional, analog, and measurement testing, depending on the requirements of the test.

The tester measures dynamic faults up to 100 MHz, and uses signature analysis to compress large amounts of data for very large-scale-integration fault detection. It includes a color graphics terminal, one hard and two floppy disks, and a line printer. A bar-code reader for automatic loading of test programs is optional. The 3200 links to process-control systems through its RS-232-C ports.

Shipments are starting this month. The base-system price, including 96 lines of 2-K-byte RAM-backed driver-receivers, is $240,000.

Zehntel Inc., 1600 S. Main St., Suite 320, Walnut Creek, Calif. 94596.
Phone (415) 946-0400 [Circle 351]

DUAL POWER SUPPLY SHARES THE LOAD

The PowerSystem is a redundant dual power supply designed for operations that will not tolerate downtime. Each of its two multiple-output supplies drives half the load in normal operation and the full load if a failure occurs. In the case of failure, independent ac on/off switches for each supply allow the faulty unit to be replaced while the functional supply continues to support operation.

The PS4001, which fits a standard 19-in. rack, sells for $3,210. Delivery takes four to eight weeks, and samples are available in six weeks.

Powertec Inc., 20550 Nordhoff St., Chatsworth, Calif. 91311.
Phone (818) 882-0004 [Circle 365]

200-W POWER SUPPLY SITS ON A DESK

A 200-W uninterruptible power supply, which is packaged to resemble a personal computer, comes in 117- or 220-V models. Panel controls on the PC-200 include a master power-reset switch and alarm reset. A 3-A line fuse and a transient suppressor protect the inputs.

The PC-200, which weighs 29 lb, is available for immediate delivery. In quantities of one to five, its price is $365.

Ram Technologies, 690 W. 28th St., Hialeah, Fla. 33010.
Phone (305) 888-1676 [Circle 367]

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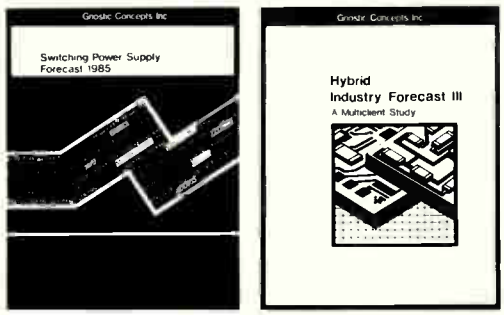

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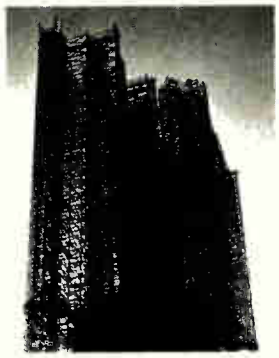

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MEETINGS

NEPCON WEST ADDS MANAGEMENT SESSIONS

This year, for the first time, management will be a major topic at Nepcon West, the biggest of five Nepcon conferences and the largest packaging and production conference in the U. S., according to William Ashman, conference director for Cahners Exposition Group, the show's sponsor. "People who attend this conference tend to be technically oriented, but some go on to be managers," Ashman says.

The 30 sessions, which will feature 180 papers, are grouped under six separate tracks to "let people take sessions according to areas of interest," Ashman says. Besides five nuts-and-bolts categories—cleaning, surface-mount technology, packaging, printed-circuit-board manufacturing, and soldering—Nepcon West 86 has a track for manufacturing management.

One of the key sessions in the management track covers just-in-time manufacturing (JIT), a method by which equipment makers have suppliers deliver parts as needed instead of maintaining huge inventories. Strong interest in JIT at last fall's Nepcon Northwest inspired this session.

In the management of factory automation, "the biggest concern is when we talk about robots," says Ashman. In the U. S., robots are seen as guided vehicles that are fully programmed by a computer, whereas the Japanese see a robot as an arm that performs a manufacturing function, he says. Though the U. S. auto industry may take an approach similar to the Japanese, the electronics industry is "just beginning to get involved in robotics. The area needs definition."

Another session will deal with industry regulations. Although this topic concerns manufacturers across the country, it is "always an area of concern in California because they have such stringent antipollution laws," says Ashman. Mary L. Belefski, a U. S. Environmental Protection Agency project officer, is featured speaker.

ISSCC: 1986 IEEE International Solid-State Circuits Conference, IEEE *et al.* (Lewis Winner, 301 Almeria Ave., Coral Gables, Fla. 33134), Anaheim Hilton Hotel, Anaheim, Calif., Feb. 19-21.

AutoCADcon 86, CAD Design Systems Inc. (1305 Remington Rd., Suite D, Schaumburg, Ill. 60195), Westin Hotel O'Hare, Chicago, Feb. 20-21.

SMTA Meeting, Surface Mount Technology Association (P. O. Box 1811, Los Gatos, Calif. 95031), Hyatt Anaheim, Anaheim, Calif., Feb. 24.

OFC '86: Conference on Optical Fiber Communication, IEEE and Optical Society of America (Optical Society of America Meetings Department, 1816 Jefferson Pl. N. W., Washington, D. C. 20036), Marriott Marquis Hotel, Atlanta, Feb. 24-26.

AdaJug/SigAda Conference, Alsys Inc. (Benjamin Brosgol, Alsys Inc., 1432 Main St., Waltham, Mass., 02154), Airport Hilton Hotel, Los Angeles, Feb. 24-28.

1986 SAE International Congress & Exposition, Society of Automotive Engineers (400 Commonwealth Dr., Warrendale, Pa. 15096), Cobo Hall, Detroit, Feb. 24-28.

Micad '86: Third International Conference and Exhibition on CAD/CAM, World Computer Graphics Association Inc. *et al.* (Caby C. Smith, WCGA, Suite 399, 2033 M St. N. W., Washington, D. C. 20036), Palais des Congrès, Paris, Feb. 24-28.

Supercomputers Get Down to Business, ZeroOne Systems Inc. (2431 Mission College Blvd., Santa Clara, Calif. 95054), Silverado Country Club, Silverado, Calif., Feb. 25-26.

Nepcon West 86, Cahners Exposition Group (Show manager, Nepcon West 86, Cahners Exposition Group, 1350 E. Touhy Ave., Des Plaines, Ill. 60017-5060), Convention Center, Anaheim, Calif., Feb. 25-27.

IGWO '86: Topical Meeting on Integrated and Guided-Wave Optics, IEEE and Optical Society of America (Optical Society of America Meetings Department, 1816 Jefferson Pl. N. W., Washington, D. C. 20036), Marriott Marquis Hotel, Atlanta, Feb. 26-28.

Sensors: Devices, Materials & Processing, The Metallurgical Society (420 Commonwealth Dr., Warrendale, Pa. 15086), Marriott Hotel and Sheraton Hotel, New Orleans, March 2-6.

Agri-Mation 2, Society of Manufacturing Engineers (1 SME Dr., Dearborn, Mich. 48121), Hilton Hotel, Chicago, March 3-5.

Comdex in Japan '86, Interface Group Inc. (Corporate Headquarters, 300 First Ave., Needham, Mass. 02194), Harumi Exhibition Center, Tokyo, March 3-6.

ADEE West: Automated Design & Engineering for Electronics West, Cahners Exposition Group (Show manager, ADEE West, 1350 E. Touhy Ave., Des Plaines, Ill. 60017-5060), Moscone Convention Center, San Francisco, March 11-13.

World Radio History

LETTERS

Hughes VHSIC contracts

To the editor: "How DOD's VHSIC is spreading" [*Electronics*, Dec. 16, 1985, p. 33] is timely and informative. However, you omitted some key information concerning the Very High Speed Integrated Circuits program's packaging contracts with the U. S. Army's Laboratory Command.

The 264-I/O leaded and leadless ceramic chip carriers on 20-mil centers that can satisfy the speed requirements of VHSIC phases 1 and 2 actually were developed under a contract between Labcom and Hughes Aircraft Co.'s Microelectronic Circuits Division, Newport Beach, Calif., awarded on Sept. 30, 1983. At the same time, a similar contract was awarded to Honeywell Inc. for the family of 50-mil-center pin/pad-grid-array packages mentioned.

The Martin Marietta work to which you refer was accomplished under a Labcom contract similar to the Hughes contract but awarded approximately six months later. Martin Marietta accepted the Hughes-designed peripheral-lead package family and decided to tool up the same 264-I/O package style selected by Hughes. The Hughes 264-I/O package has been tooled by both Bournes Inc. of Riverside, Calif. (thick-film version), and Tektronix Inc. of Beaverton, Ore. (cofired version). Our contract was completed in October 1985.

In keeping with contract requirements, all three Labcom contractors (Hughes, Honeywell, and Martin Marietta) are working together on an EIA Jedec subcommittee of the JC-11 Mechanical Standardization Committee. This subcommittee (called JC-11.9.1), of which I am chairman, has been established to coordinate VHSIC packaging activities for Jedec, including referrals of all newly designed VHSIC-related packages for which registration and/or standardization is desired by the manufacturers.

Stanley M. Stuhlbarg
Manager, Advanced Programs
Hughes Aircraft Co.
Microelectronic Circuits Division
Newport Beach, Calif.

Time after time

To the editor: "Logic Designers Toss Out the Clock" [*Electronics*, Dec. 9, 1985, p. 42] reminds me of the Philco 2000 computer that flourished about 1960; I understand that the whole machine was asynchronous. I also recall a "completion-recognition" adder that had an "extra" output line to indicate that addition is complete.

Nicholas Bodley
New York

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ELECTRONICS WEEK

NKK TAKES OVER U. S. SILICON PLANT

Tokyo's Nippon Kokan KK has taken over operation of the Great Western Silicon plant at Chandler, Ariz., after concluding an agreement in December to purchase the plant from General Electric Co. The plant, near Phoenix, produces 200 tons of polycrystalline silicon annually for the semiconductor and photovoltaic industries in the U. S. An NKK representative says the company will be known as Great Western Silicon Corp. and few operational changes are planned.

AMD REPORTS RISE IN ORDERS

After four straight quarters of declining sales, Advanced Micro Devices Inc. has "turned the corner," according to president W. J. Sanders III, who made the statement while announcing results for the third quarter, which ended Dec. 31. AMD reported a net loss of $10 million on sales of $144 million, down from a profit of $29.3 million on sales of nearly $239 million for the same quarter a year ago. But Sanders says the company is seeing the beginning of a recovery in orders. In addition, AMD restored full pay to managerial and professional employees whose salaries had been cut last summer.

KODAK CAN'T SELL IMAGER

The Color Video Imager, one of several new video products announced last fall by Eastman Kodak Co.'s Consumer Products Division, is dead, though Kodak says it is looking at alternatives. The imager, which makes hard-copy prints of video images from either video tape or a TV signal, uses Kodak's instant film. Kodak was barred in early January from using instant film or any products that use instant film after it was found guilty of infringing on patents held by competitor Polaroid Corp.

PERKIN-ELMER JOINS WITH CITIZEN

Perkin-Elmer Corp. plans to form a joint-venture company with Japan's Citizen Watch Co., Tokyo, to manufacture Perkin-Elmer semiconductor-processing equipment. The new company, Perkin-Elmer Japan SA, initially will make step-and-repeat alignment systems and dry-process etching systems that are already manufactured in the U. S. Perkin-Elmer will maintain a majority stake in the company. John Suzuki, president of Perkin-Elmer Japan, the Norwalk, Conn., company's marketing subsidiary, will also head Perkin-Elmer Japan SA.

UTC UNIT TO TEST VHSIC SOFTWARE

United Technologies Microelectronics Center, the last remnant of United Technologies Corp.'s unsuccessful venture into the chip business, won a $1.8 million contract to evaluate and test development software for use in the Defense Department's Very High Speed Integrated Circuits program. The 18-month contract was awarded to the maker of semicustom and military chips by the Aeronautical Systems Division of Wright-Patterson Air Force Base.

GTE JOINS SIEMENS IN TELECOM...

GTE Corp. has announced a pair of joint ventures, one in the U. S. and one transatlantic. The Stamford, Conn., company says it has signed a memorandum of understanding with Siemens AG of Munich to form a joint venture to produce and market central-office telecommunications and transmission equipment primarily in the U. S., but also in some overseas operations. The new company, not yet named, will be formed by integrating businesses already held by each parent.

...AND SPINS OFF SPRINT IN NEW UNIT

GTE also says it is merging its Sprint and Telenet subsidiaries into a joint-venture company with United Telecommunications Inc.'s US Telecom and US Telecom Data Communications Co., both in Kansas City, Mo. US Sprint, as the new long-distance telecommunications company will be known, will have 4% of the market at its inception, the companies say, and should be profitable by 1987. GTE will take a write-down on its 1984 earnings of $1.3 billion to account for a reduction in Sprint's assets.

U. S. STUDIES JAPANESE DUMPING

Once again, the U. S. International Trade Commission has ruled that Japanese semiconductor imports may be harming domestic producers of 256-K dynamic random-access memories. The ITC's 5-0 ruling last week means the Commerce Department will continue investigating complaints that Japanese companies have been dumping memory chips here. The unfair trade petition was initiated by the Reagan administration in recognition of shorter semiconductor research cycles and to head off protectionist trade legislation. The investigation could lead to antidumping duties on 256-K and later generations of Japanese memories.

POWERTEC BUYS CONVERTER MAKER

Powertec Inc., a Chatsworth, Calif., manufacturer of switch-mode ac/dc power supplies, has acquired Semiconductor Circuits Inc., one of the original manufacturers of encapsulated dc-to-dc converters and low-power ac/dc power supplies. Powertec will maintain SCI, of Windham, N. H., as a wholly owned subsidiary with its own manufacturing and marketing organization. The acquisition was funded with net assets using cash reserves of about $4.5 million and stock payments over the next three years, depending upon SCI's earnings. Powertec, which emphasizes manufacturing in the U. S., has already moved to pull back most of SCI's offshore manufacturing.

IBM JOINS N. C. IC RESEARCH CO-OP

IBM Corp. has affiliated with the Microelectronics Center of North Carolina in an intensive program to develop the underlying science and technology required for next-generation submicron integrated circuits. MCNC is a consortium of seven North Carolina universities and research groups located in Research Triangle Park. IBM's participation is expected to accelerate MCNC's programs to develop new commercial IC technologies.

PENRIL'S MILLER RESIGNS AS CEO

Kenneth M. Miller, president and chief executive officer of Penril Corp. since 1973, unexpectedly resigned last week and was replaced by Alva T. Bond, who is a founder of the company. Under Miller, the Rockville, Md., company went from a $2 million vendor of modems to a diversified manufacturer of data-communications and test equipment and power supplies, with 1985 revenue of $74 million. However, Penril reported a first-quarter loss of $108,000 for the period ending Oct. 31, compared with a profit of $770,000 for the same period a year ago. Miller will remain on Penril's board of directors and also will serve as a consultant to the company.

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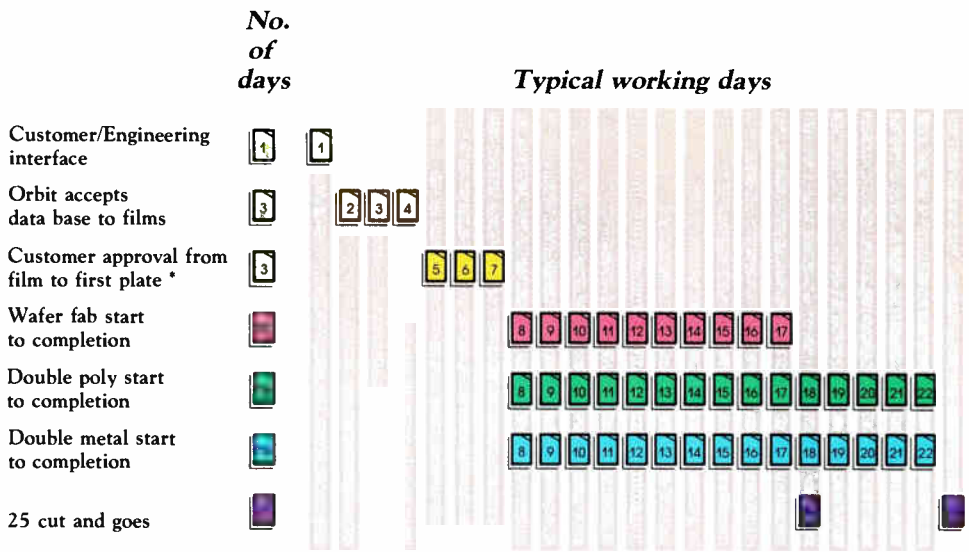

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