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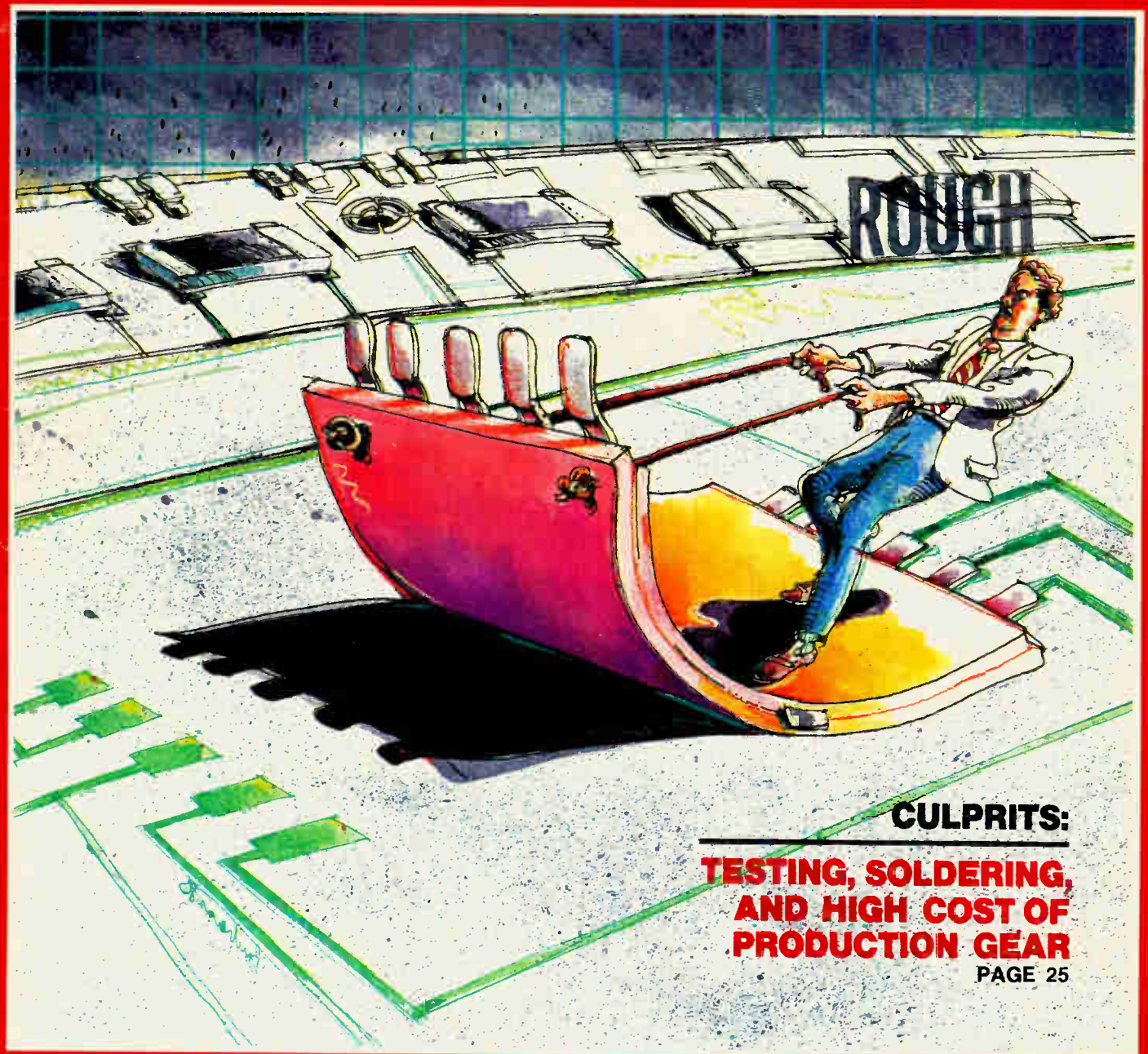
Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY

FEBRUARY 10, 1986

WHAT'S HOLDING BACK SURFACE MOUNTING



CULPRITS:

TESTING, SOLDERING, AND HIGH COST OF PRODUCTION GEAR

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SLOT ISOLATION YIELDS DENSEST BIPOLAR PROM YET/35

REAGAN'S BUDGET: HOW THE INDUSTRY WOULD FARE/42

"We did it!"

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

"It's our competitors' faces I want to see. We've really cracked this market now."

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

"Like National's 32-bit microprocessor family?"

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Circle 1 on reader service card

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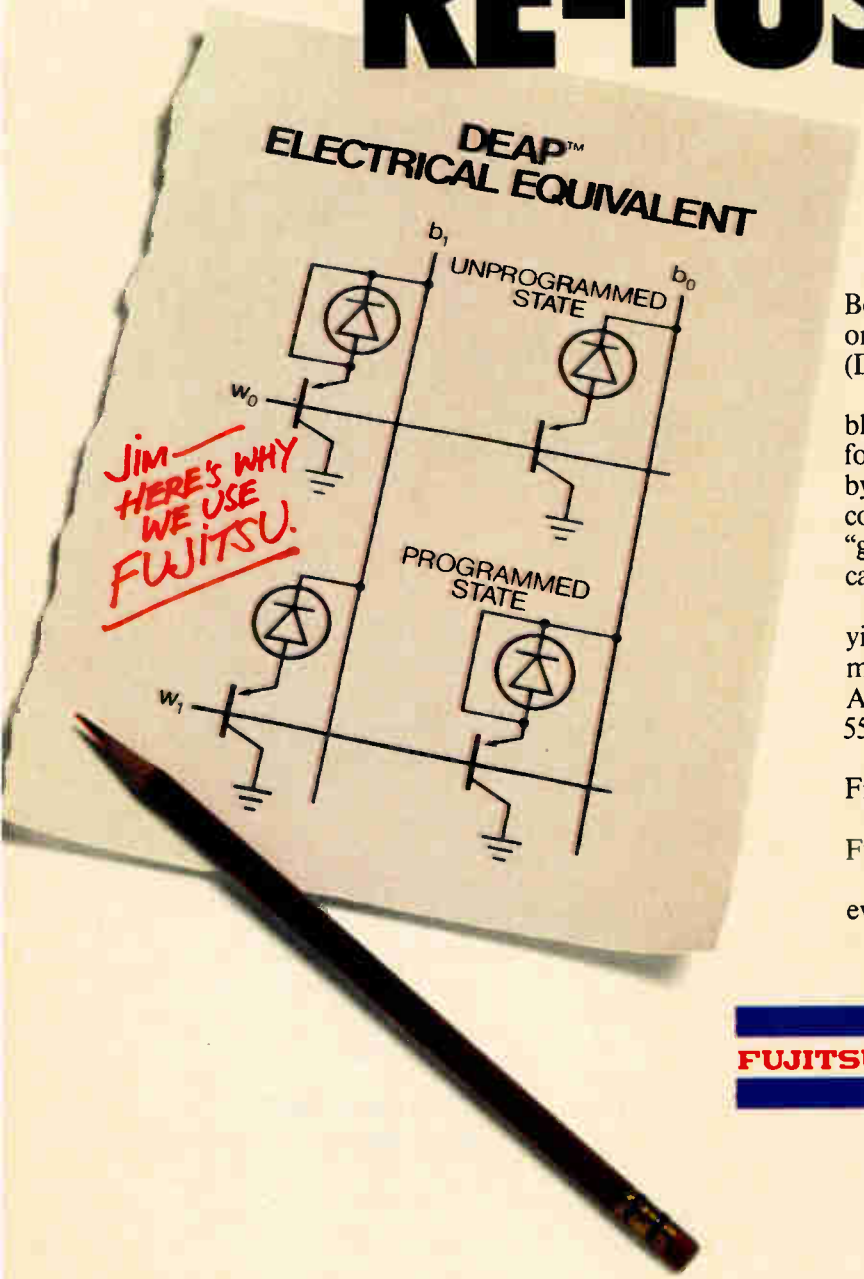

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FEBRUARY 10, 1986 VOLUME 59, NO. 6

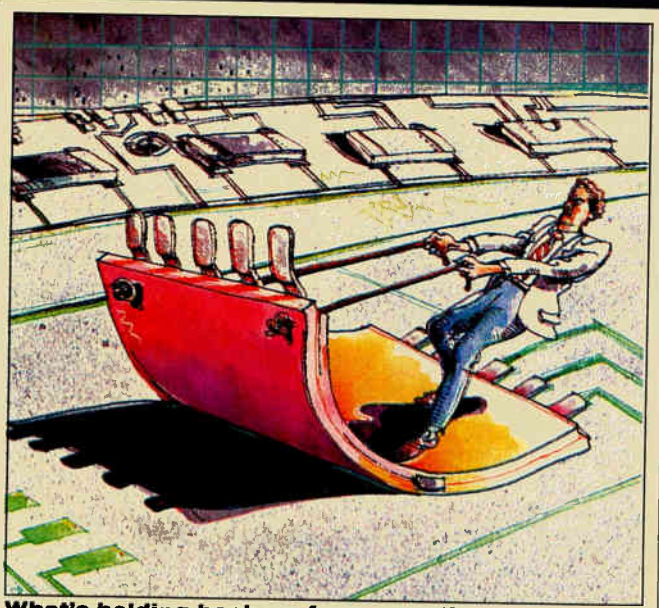
Electronics

NEWS

INSIDE TECHNOLOGY

PROBING THE NEWS

COVER



Cover by Yvonne Buchanan

NEW PRODUCTS

DEPARTMENTS

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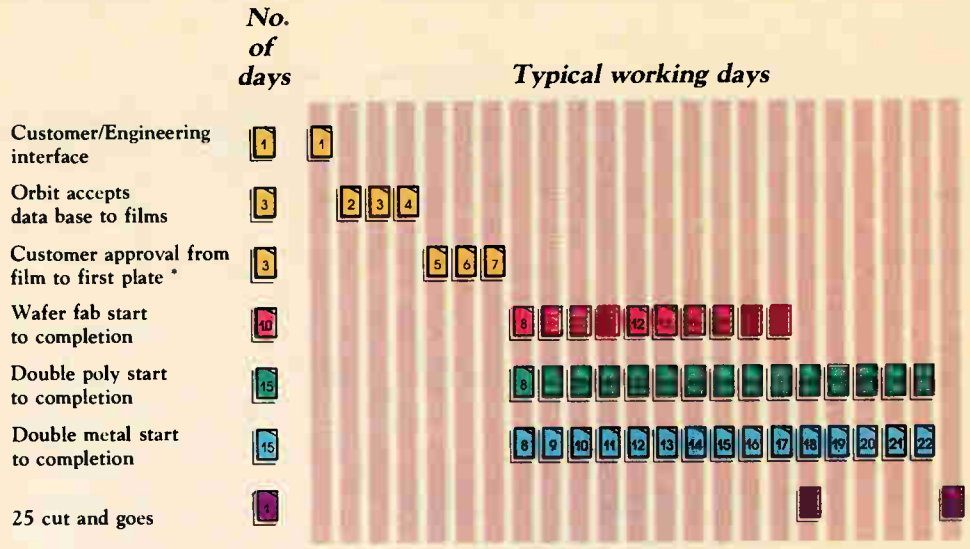

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Circle 4 on reader service card

A fundamental change taking place in electronic technology is the integration of the computer with the engineering process. This, in turn, is radically changing the way in which engineering itself is practiced. The computer now plays a major role in product development, from conception, simulation, chip and board design, and performance test and measurement through manufacturing and documentation. The process is not yet a seamless, smooth, and efficient whole, but it is getting there.

To cover a change as profound as this calls for special effort on the part of *Electronics*, whose editorial charter for technology leadership is to keep its readers abreast of developments that could affect their profession and their companies. Accordingly, as a first step we are putting more editorial horsepower into this important area with the addition of Jonah McLeod, a veteran technical editor, to our team in Palo Alto. We think he is ideal for the job and ideally situated. Although the movement to computer-aided design, test, and manufacturing is universal, much of the technology is being spawned at innovative companies in the Pacific Northwest. **Jonah will be half** of a new one-two punch that *Electronics* will launch to keep our readers fully informed on the latest technology developments in CAE, CAD, CIM, and instrumentation. Another senior technical editor, who will be based on the East coast, will team up with him shortly. Together they represent a strong commitment to the readers of *Electronics* in covering this significant area.

JONAH McLEOD: A topflight technical man.

Jonah has a BS in economics from the University of Texas at Arlington and credits toward an MS in applied economics from the University of Santa Clara in California. He got his early electronics training as a Navy technician. For the past eight years, he has been an engineering editor at Hayden Publishing Co. His latest assignment was as executive editor of the defunct *Systems & Software* magazine; before that, he was on *Electronic Design* magazine.

Jonah has also written three books on memory technology. Add to that industry jobs at Bendix, Rockwell/Collins Radio, and Xerox, and the sum is an editor regarded in the industry as a topflight technical man with key contacts.

When he's not on the job, Jonah will continue to run eight miles a day, write for pleasure, and spend time with his wife and two daughters.

Laurence Altman

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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.

Because one Am8158 supplies the dot clock, the character clock, plus clocking for all sync and blanking pulses. All of which amounts to a rapid decrease in design time and a sharp drop in component count.

But that's only part of the picture.

In addition, the Am8158 is software programmable. So you can alter the display timing on short notice. A few, simple instructions upgrade you from a mid-resolution 640x480 picture to a high-res 1280x1024 display.

Am8158

All the time you need.

Don't look surprised.

It's all in keeping with our image of delivering more video functions on a single chip. An image that's become the hallmark of our bit-mapped graphics family.

So before you tackle your next graphics system, pick up an Am8158.

Because it can't hurt to have lots of time on your hands.

Circle 151 on reader service card

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.

For openers, our 70ns access time (100ns for the military version) helps multiple processors manage, massage and display data up to 20% faster.

What's more, the Am2130 is as practical as it is quick.

Am2130

Share a great memory.

Each independent port accesses the entire memory. There's an on-chip interrupt flag, so devices on opposite ports can communicate. And full arbitration circuitry is built in, so you don't have to add it on.

There's even automatic power-down capability for maximum efficiency.

All these features mean the Am2130 is the most powerful dual-port static RAM on the market. It's available right now, off the shelf, in quantity. Guaranteed.

The Am2130. Use it to create a memory of your own.

Circle 152 on reader service card

WEEK 18

If you've been looking for the best route into local area networks, our new Am7996 Transceiver may prove doubly useful.

On the one hand, it's a full-function, fully-supported Cheapernet transceiver. One chip for transferring data in both directions and for handling collision detection and spurious transmissions.

Am7996

It works both ways.

Combine it with the rest of our networking family—the Am7990 LANCE controller and the Am7992B Serial Interface Adapter—and, together, you've got the cheapest Cheapernet hook-up imaginable.

Then look at it this way.

The Am7996 Transceiver fully supports IEEE 802.3 systems. In fact, the entire chip set is 100% Ethernet compatible.

As a result, your Ethernet interface logic can carry everything except a high price tag. While your Cheapernet connections will meet the performance and quality levels of the world's most widely-recognized local area network standard.

The Am7996. It makes sense no matter which way you're going.

Circle 153 on reader service card

Design and application seminars are available for this product. Write or call for information.

WEEK 19

No matter what size DRAMs you're using, from 16K to 1M, you'll find our new Am2976 Dynamic Memory Driver pretty impressive.

With its wide, 11-bit data path, the Am2976 is a natural for reducing the parts count in large, MOS memories. Just two chips, for example, handle not only the 9 address lines, but also the $\overline{RAS}$, $\overline{CAS}$ and $\overline{WE}$ signals for a 1 Megaword system.

Still not impressed? Then consider this.

Am2976

Memory driver cuts a wide path.

With $\overline{RAS}$ and $\overline{CAS}$ driven from the same chip, there's minimum skew time between signals. A balanced output impedance makes rise and fall times symmetrical. Built-in collector resistors restrict undershoot to −0.5V, maximum. And power-up and power-down are glitch-free.

Why, even the pinout's impressive. In both the slim DIP and surface mount LCC/PLCC packages, corresponding inputs and outputs are directly opposite each other. A simple arrangement which makes board layout easier and manufacturing cheaper.

The Am2976. Give it some room in your next design.

Circle 154 on reader service card

On October 1, 1985, Advanced Micro Devices committed to deliver fifty-two new products in one year. One a week. Every week. On the shelf. In volume.

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BOOKS

ELECTRONICS APPLICATIONS SOURCEBOOK: 1986 EDITION

Harry L. Helms, editor
McGraw-Hill Book Co.
$250 the set/3,200pp

Twenty leading electronics manufacturers submitted applications materials for publication in this two-volume set. These include Analog Devices, Burr-Brown, Exar, Linear Technology, RCA Solid State, and Tektronix, among the most prolific sources. A sampling of the areas covered in these volumes includes converters, amplifiers, microprocessors, operational amplifiers, and CMOS and QMOS devices; oscilloscopes and testing procedures; and filters, ICs, oscillators, and sample-and-hold circuits.

All notes are reproduced exactly as received from the company without alteration or deletion. Types of information submitted include application notes and technical briefs on the devices, data sheets that contain commentary on the application, extracts from corporate applications handbooks, and reprints of magazine articles.

Participating companies were asked to select the applications material they believed was most important. Further criteria for inclusion were the extent to which the device or technology is used and availability of other information. Preliminary information was not included, the publisher says, because of the many changes that can take place before a device goes into production.

Cross-indexes are by component number and subject, and there is also a list of company prefixes. As a source for current information and leads to important areas of the electronics industry, this set is a useful addition to the manager's reference library. The editor is a computer consultant and author of a number of articles and books on computer science and electronics.

NOISE AND THE SOLID STATE

D. A. Bell
John Wiley & Sons/Halsted Press
$32.95/175pp

The replacement of thermionic devices by solid-state devices has not eliminated thermal and shot noise from circuit designs. On the contrary, it has introduced some new phenomena. Among these are generation-recombination noise, $1/f$ noise (formerly known as contact noise), and noise in avalanche devices and transferred-electron devices, such as the Gunn diode.

The author notes that the trend toward reducing chip area and power dissipation leads to an increase of noise, and that one approach to the analysis of switched-capacitor networks is to seek an equivalent analog circuit that can be analyzed by a computer program such as Spice.

This survey of some important research areas in semiconductor design should prove a useful review for the working engineer. D. A. Bell's earlier books include *Information Theory and Its Engineering Applications* and *Electrical Noise.*

INTEGRATED CIRCUITS: CHEMICAL AND PHYSICAL PROCESSING

Pieter Stroeve, editor
American Chemical Society
$69.95/348pp

This compilation of technical papers is a cross-section of current research and development in IC fabrication and reflect the dialogue taking place today between workers in such diverse fields as chemical engineering and solid-state physics. Topics covered include photoresists, molecular-beam and vapor-phase epitaxy, ion implantation, and wafer design and characterization. A paper by H. B. Pogge, of IBM Corp.'s East Fishkill, N. Y., facility, entitled "Advanced Device Isolation for Very Large Scale Integration," explores recent advances in trench isolation for fabricating very dense devices and circuit structures.

The book was developed from a symposium sponsored by the Division of Industrial and Engineering Chemistry of the ACS held in 1984. Each paper is followed by a bibliography and the publisher has indexed the entire volume—a welcome aid not often found in published symposium papers.

THE ARTIFICIAL INTELLIGENCE EXPERIENCE: AN INTRODUCTION

Susan J. Scown
Digital Press/Digital Equipment Corp.
$15/184pp

For those familiar with computers but who have little or no background in artificial intelligence, this is an easy-to-understand introduction to the subject. Following two overview chapters, the author discusses AI techniques and languages. Lisp and Prolog are covered, and there is a brief mention of object-oriented languages extended by a list of companies that have developed knowledge-engineering tools. A chronology of AI research, a bibliography, and a glossary round out the book.

In a fast-moving field such as AI, a book quickly goes out of date. But this one, geared to keep both managers and general readers informed, lists magazines to follow for current information and companies that create products for implementing expert systems.

TECHNOLOGY NEWSLETTER

CMOS AND GaAs CHIPS FOR NEW SUPERCOMPUTERS MAKE SOLID PROGRESS

The two top U. S. supercomputer manufacturers are reporting solid progress on their next-generation machines—one based on CMOS arrays and the other on gallium arsenide. Top officials at ETA Systems Inc., St. Paul, Minn., say they are on schedule to deliver the first ETA 10 supercomputer to Florida State University by Oct. 1 of this year. Between 50 and 60 of some 92 different array options for the liquid-nitrogen-cooled system are already working, according to ETA. Honeywell Inc. is delivering the 20,000-gate CMOS gate array that will form the basis for ETA's eight-processor machine, which performs 10 billion floating point operations per second. Meanwhile, officials at supercomputer leader Cray Research Inc. report that about a dozen different GaAs device types out of about 100 that will be used in the Cray-3 have so far been designed and built. The GaAs chips, which are based on depletion-mode metal-semiconductor FETs, vary in density from 300 to 500 gates and are being fabricated on a Cray pilot GaAs line at the company's facilities in Chippewa Falls, Wis. First deliveries of the Cray-3—a 16-processor design—are expected in late 1987. It is billed as 10 times faster than the current Cray-2, which executes up to 1.2 billion flops. □

HMOS GIVES INTEL THE EPROM SPEED RECORD

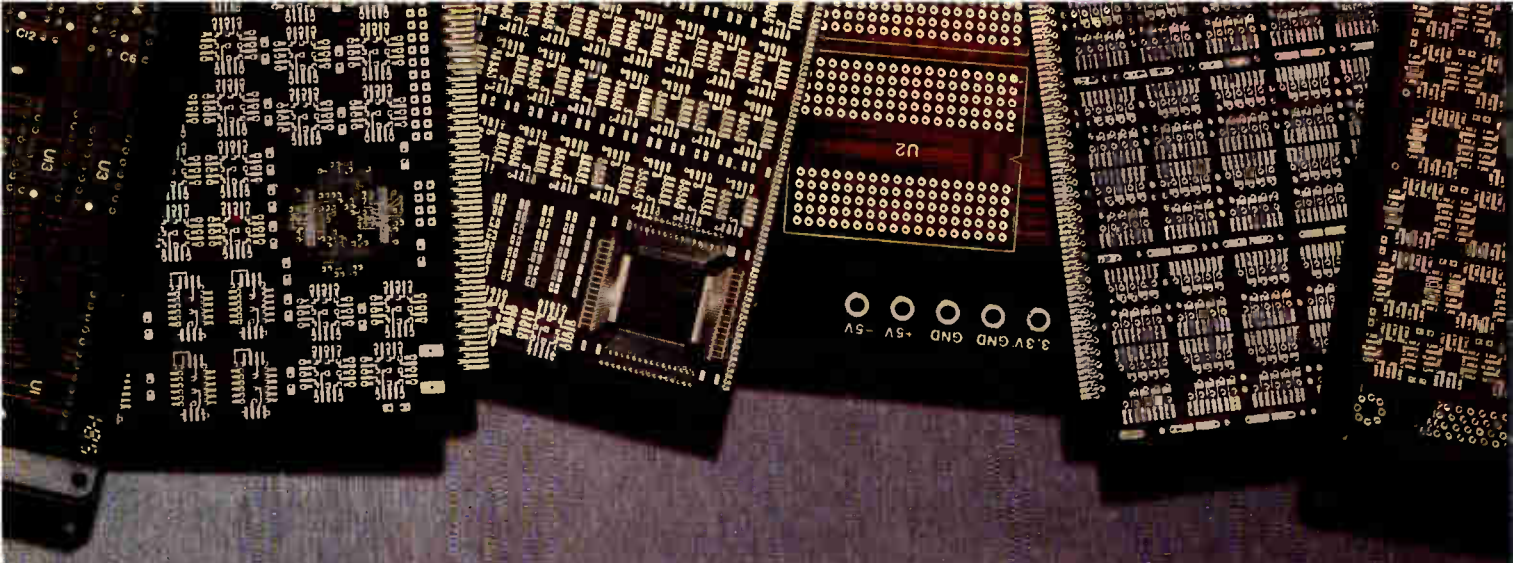
Intel Corp. is using a scaled-down high-performance MOS (HMOS) process, similar to the one it uses for its 1-Mb products, to produce the fastest-yet 128-K erasable programmable read-only memory. To produce the 110-ns part, Intel performed a 15% linear reduction on its patented HMOS II-E technology, resulting in a 1.2-μm compacted HMOS II-E process. The 27128B EPROM keeps pace with Intel's 80386 and 80286 microprocessors without any wait states. □

1,000-GATE ARRAYS, BIPOLAR RAMs MAKE NEC'S MAINFRAME THE FASTEST YET

Fast gate arrays and bipolar random-access memories make NEC Corp.'s ACOS 2040 mainframe the fastest yet—about 1.3 times faster than the company's previous top-of-the-line ACOS 1540 and Fujitsu Ltd.'s M-780/40 [*Electronics*, Nov. 25, 1985, p. 20]. The ACOS 2040 runs at 170 million instructions per second. It uses 1,000-gate large-scale integrated circuits with propagation times of 100 ps, 4,000-gate circuits with propagation delays of 170 ps, and 16-K bipolar RAMs with access times of 3 ns. The chips are mounted on 100-by-100-mm ceramic modules and are water-cooled much as the Tokyo company's supercomputers are. The main memory has a capacity of 512 megabytes, available in 256-K RAM chips configured 320 to a board. The ACOS 2040 is aimed at large-scale networks and data-base applications, including computer-aided design and artificial intelligence. □

TI DESIGNS 256-K VIDEO RAM WITH NEXT-GENERATION FEATURES

Texas Instruments Inc. has added second-generation features to a planned 256-K video random-access memory. These features boost data bandwidth and ease the memory's use with graphics controllers. The Dallas company's 1.3-μm CMOS chip, organized as 64-K by 4 bits, contains a selected writing mode as well as a new serial input and register, which enable a graphics subsystem to erase the data in the array 100 times faster than in available video RAMs. The selected writing mode also enables controllers to individually address any or all of the RAM's 4-bit-wide input/output ports. This new feature allows single bits to be changed in the 64-K-by-4-bit array in half the time it takes available video memories to perform a read-modify-write cycle. □



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Because Multiwire circuit boards use round, insulated wire for signal interconnections, instead of etched foil, their physical and electrical properties make them the best response to the technical challenges of your next application.

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High-speed circuits demand critical timing and flexibility to control wire lengths. The Multiwire circuit board construction, wire characteristics, and routing system lend themselves to implementing controlled impedance designs in even the most complex, high-speed designs.

THERMAL MANAGEMENT.

A variety of approaches have been used with Multiwire circuit boards to achieve successful thermal management—from the addition of heat sinks or copper planes to the use of special substrates.

GREATER PACKAGING DENSITIES AT REDUCED COSTS.

Our sophisticated CAD tools routinely design boards accommodating component densities of 2.0 IC's per square inch or greater.

FASTER DESIGN. LESS EXPENSIVE REVISIONS.

Multiwire Division's design services can shorten your design cycle by weeks and save you thousands of dollars. We can design your board from as little input as a schematic and net list. Design revisions will be fast and inexpensive. And your prototype boards will be 100% electrically tested.

We'd like to send you our brochure, which explains the technology in more detail and why Multiwire Division is your best source. To receive your copy, simply fill out and return the coupon.

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ELECTRONICS NEWSLETTER

MICROSOFT TO DUMP ASCII IN JAPAN FOR ITS OWN SUBSIDIARY

Microsoft Corp.'s plan to go public is having a profound impact on ASCII Corp., the company that once marketed Microsoft products throughout the entire Far East and then was cut back to Japan alone last September. Now Microsoft, Bellevue, Wash., plans to shortly replace ASCII in Japan with a wholly owned subsidiary. ASCII president Akio Gunji says the breakup was bound to happen sometime. His company continues to develop new products for the Japanese market and represents several companies besides Microsoft, he adds. About $10.3 million of ASCII's $68.5 million in sales for the year ending March 31 will be for Microsoft products, it is estimated. Gunji adds that many companies in Japan fear that IBM Corp. will take over Microsoft and put the squeeze on microcomputer operating systems, just as it has done with mainframe operating systems. Another sore point: Microsoft says that Kazuhiko Nishi, ASCII vice president and formerly a Microsoft officer, owes it over $500,000 for two loans. ASCII says the loans are not carried on its books and Nishi won't comment. □

SGS WILL SUPPLY CHIPS TO AT&T

Look for SGS Microelettronica SpA and AT&T Co. to announce later this week an accord whereby the Italian company will supply bipolar integrated circuits to the U. S. telecommunications giant. Neither company would comment on the terms of the agreement, though it is generally seen as part of AT&T's continuing strategy of recruiting European partners to give it a credible local presence on that side of the Atlantic. AT&T already owns a 25% interest in Ing. C. Olivetti & C., Ivrea, Italy; it has also established joint ventures with Dutch multinational Philips in public switching and with Spain's national telecommunications operating company, Telefónica SA, in components. SGS will be looking for a boost in its U. S. market penetration from the deal. □

THE FINAL CHAPTER MAY HAVE BEEN WRITTEN ON OSBORNE

The book seems ready to close on Osborne Computer Corp., the Fremont, Calif., company that both enjoyed and suffered from the tempestuous fortunes of the personal computer industry. Last week, a creditors' committee ordered the liquidation of the company's equipment and inventory because Osborne has not been able to meet payments on a $6 million loan since August. The company enjoyed phenomenal success after its founding in 1979 with the Osborne I, a portable business computer bundled with software. But the company quickly fell on hard times; rising competition and an inability to get new products out the door finally forced it to seek protection under Chapter 11 in the fall of 1983. It has operated since under president Ron Brown, who brought it out from its reorganization in January 1985. Brown reportedly is continuing efforts to raise financing so that he can maintain Osborne as a trading company. □

JAPANESE SATELLITE VENTURE MAY TURN TO ARIANE IF SHUTTLE IS NOT READY

Japan Communications Satellite Co. intends to launch its first satellite in late 1987 no matter what happens to the U. S. shuttle program. The Tokyo company, a joint venture of Hughes Communications, C. Itoh, and Mitsui, may shift to a European Space Agency Ariane rocket if a shuttle launch cannot be scheduled in time. Because of design changes that would be needed for Ariane to handle its bird, JSAT has only about four months to settle on a launcher. Meanwhile, prime contractor Hughes Communications Inc., Los Angeles, which is responsible for supplying and launching the satellite, is moving ahead with ground-station preparations. □

Only one man could create a full line of VME boards this fast.

Yes, me.

VME is still in the cradle and already we're offering you a complete line of twelve analog and digital I/O VME boards.

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		Channels	Resolution (bits)	Speed (kHz)	Channels	Resolution (bits)	Speed (kHz)	DIO (lines)	Clock
DT1401	General Purpose	32 SE/16 DI	12-16	2.5-50	2	12	50	16	Yes
DT1402-F	High Speed	32 SE/16 DI	12	125	–	–	–	16	Yes
OT1405	Low Level	32 SE/16 OI	12-16	0.16-6.7	2	12	50	16	Yes
DT1408	Simultaneous S/H	4SE	12	100	2	12	50	16	Yes
DT1406-8V	Voltage Output	–	–	–	8	12	125	–	–
DT1406-8M	Current Output	–	–	–	8	12	28.5	–	–
DT1406-8CL	Current Loop	–	–	–	8	12	28.5	–	–
OT1403	High Resolution	–	–	–	2 or 4	16	100	–	–
DT1414	General Purpose	16SE	12	25	–	–	–	16	Yes
DT1417	Digital I/O	–	–	–	–	–	–	32	–

Fred Molinari, President

DATA TRANSLATION

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PRODUCTS NEWSLETTER

IXYS' POWER MOS FET LINE FEATURES A 1,000-VOLT PART

A 1,000-V, 2- to 8-A part is the star performer in Ixys Corp.'s new power MOS FET line. The line of 36 MOS FETs, which have switching capabilities above 100 kHz, is manufactured using the San Jose, Calif., company's proprietary high-performance double-diffused MOS technology. The high breakdown voltage does not come at the expense of low on-resistance: the 1,000-V model IXTM8N90/100 boasts a low 1.5 Ω, as much as 30% lower than Motorola Inc.'s and Siemens AG's best 800-V FETs. Ixys thinks the combination of high voltage, low on-resistance, and high-frequency switching opens up new application areas for power MOS FETs in single-transistor flyback and forward converters. Delivery of the parts, which have not been priced, will take from one to four weeks. □

CADNETIX ADDS IBM PCs TO ITS CAE NETWORK

Cadnetix Corp. is adding IBM Corp.'s Personal Computer/XT and PC AT into its Ethernet-based computer-aided-engineering network. The CDX-3100 software package, which sells for $7,900, enables a PC to do schematic capture and net-list extractions. For more computation-intensive parts of the design, such as compilation and simulation, the PC passes the tasks to the Boulder, Colo., company's 68020-based network servers and simulation engines. The company is also unveiling an enhanced multilayer pc-board router, the model CDX-75000, with a routing time just half that of its predecessor, the CDX-7500. The $77,000 router will be available in April, and the CDX-3100 is available now. □

LATTICE'S LOGIC CHIP TARGETS MMI FAMILY OF PROGRAMMABLE DEVICES

Lattice Semiconductor Corp. is attacking a Monolithic Memories Inc. family of bipolar programmable-logic devices with its CMOS EEPROM-based Generic Array Logic, the 20V8. The Portland, Ore., company says customers need to stock only a single part; it can replace 20 of the devices in MMI's 24-pin PAL family of bipolar PLDs. Production volumes will be available in March. In lots of 100 pieces, the 25-ns version of the 20V8 will sell for $17.63 each. The 25-ns CMOS GAL matches the bipolar A-series PLDs in speed, but consumes half the power—90 mA. □

MENTOR GRAPHICS KIT DEVELOPS CHIPS FROM MOSIS LIBRARY

Mentor Graphics Corp. is helping put low-cost prototypes into designers' hands with the first design kit for CMOS 3, the 3-μm CMOS standard-cell library distributed by the MOS Implementation System (Mosis) project. The Beaverton, Ore., company's $400 kit integrates the Mosis library and design rules with the front-end processing and automatic layout capabilities of a Mentor work station. Typically, the Mosis project—at the University of Southern California's Information Sciences Institute—can manufacture a prototype run of 12 to 24 chips for $3,500 to $10,400 in 8 to 10 weeks. □

TOSHIBA'S 3½-in. DISK DRIVE IS JUST 1 IN. TALL

Toshiba America Inc. is introducing a 3½-in. disk drive that is only 1 in. high—one third as tall as full-height 3½-in. drives. Aimed at the portable computer market, the 1-lb drive comes in ½-megabyte single-sided and 1-megabyte double-sided versions. The Toshiba ND-351S and ND-352S operate from a power supply of just +5 V; they consume 1.5 W during operation and 25 mW at standby. The drives, not yet priced, will be in production by April, the Tustin, Calif., company says. □

Electronics

NEW TESTS WILL TRY TO GET STALLED DIGITAL NET MOVING

PHONE COMPANIES PUSH TO GET ISDN PRODUCTS WORKING TOGETHER

DALLAS

Telephony's long-awaited integrated services digital network is still bogged down in industry standards committees. This slow process has left potential customers, particularly the Bell operating companies, chomping at the bit, impatient with incompatible ISDN offerings from switch vendors, each of which is pushing a different notion of what the eventual standards will be.

In an attempt to spark more rapid progress, two BOCs—Southern Bell and Pacific Bell—have initiated a new round of field trials. These trials differ from earlier ones because they will attempt to connect equipment from different vendors and make it all work together. Earlier trials involved equipment from more than one vendor, but each vendor's equipment was tested in isolation.

The BOCs hope that trials connecting gear from different vendors will provide an anvil on which the switch makers can hammer out their differences. Without a customer in charge, the vendors themselves could not set up such a trial without treading precariously on federal antitrust laws, note officials at digital-switch houses.

"We've got customers now saying, 'sit down at the table and figure out how we are going to interwork these (ISDN) features,'" says J. L. (Jerry) Johnson, manager of product planning for digital switch equipment at AT&T Network Systems. "We were going to end up doing that anyway [through industry panels], but they are putting pressure on us to expedite it." Johnson joined AT&T's rivals and prime customers for central-office switches in Dallas last week at the annual Western Telecommunications Showcase, cohosted by the U. S. Telephone Association and U. S. Telecommunications Suppliers Association.

When they weren't dashing to line up early ISDN field trials, switch makers were unfolding their latest product roadmaps aimed at guiding the regional BOCs to new sources of revenue—enhanced digital data and voice networking services. Many of the regionals are asking switch makers to demonstrate the openness of ISDN, which is still being defined by the American National Standards Institute's T1D1 committee and by the CCITT abroad.

Telephone companies are concerned about whether "the equipment can handle the load of the service features without blowing a fuse," says analyst Francis McInerney, executive vice president of market researcher Northern Business Information Inc., New York.

MARKET DIP. At stake for the switch makers is a huge piece of the central-office equipment business, which is expected to slide into a four-year 2% slump after peaking at $5.7 billion in 1986. Causing some of the dip in the late 1980s will be lagging technical and market issues centered on ISDN, according to many at the Dallas show.

At the start of the three-day meeting, Southern Bell announced it was directing AT&T and Northern Telecom Inc. to work out potential networking incompatibilities of their respective 5ESS and DMS-100 switches for a multivendor ISDN field test slated for the first half of 1987 in Atlanta. In a similar move before the show, Pacific Bell announced plans to test a public ISDN system in Northern California, interconnecting dissimilar digital-switching equipment from AT&T, Japan's NEC, and Northern Telecom. PacBell expects trials involving users in three cities to begin by spring 1987 [*Electronics*, Feb. 3, 1986, p. 64].

In the Atlanta trial, one central office will use AT&T's 5ESS, while another will use a Northern Telecom DMS-100 switch. Both will be connected by way of Signaling System #7 protocols using ITT Corp.'s 1200 Signal-Transfer Point system, says Robert Wolfe, manager of strategic planning for BellSouth Services.

"Not only is this a significant rollout in technology,

THIS PHONE HANDSET HAS A BUILT-IN COMPUTER

Personal computers have been given telephone handsets. So it seems appropriate that a new handset from AT&T Network Systems integrates an 8-bit computer with a liquid-crystal display onto the back of the phone's earpiece.

The battery-powered unit is the ruggedized, hand-held terminal of AT&T Network Systems' new Craft Access System for automating field-maintenance service centers. The total system consists of the portable telephone-computer units, expert-system data bases, an administrative minicomputer, and networked application processors.

To be introduced in the second quarter, the 28-oz Craft Access Terminal was unveiled last week at the Western Telecommunications Showcase in Dallas.

With a price tag of about $1,200, the system contains a 1,200-baud modem and 8-K bytes of battery-backed memory.

Network Systems' Gary Lafaver, department chief of management operation systems, says the system has shown the potential to pay for itself within a year. The unit saves time by eliminating the need for repair personnel to talk to dispatchers and supervisors, he says. Instead, it automatically assigns electronic mail messages. Work orders are downloaded from a central processor to the portable unit over phone lines.

but it is a commitment in vendor arrangements. We have already had our second meeting with the vendors, in which we explored what we have to do to make these systems work together," Wolfe adds. Johnson, who with other AT&T Network Systems officials hosted the field-trial announcement, says the early 1987 timing for the multivendor environment will be tough.

Northern Telecom officials say the Atlanta trial will be a critical test for the ISDN movement itself. But they also believe a number of details in interfacing AT&T's digital switching and its DMS environment will be worked out. Still, some major incompatibilities are likely to remain, such as the different signaling techniques used in interfacing computers to private branch exchanges.

"Both companies have their own views, and they may both be correct or incorrect when it comes to ISDN implementation," speculates analyst McInerney. "The [BOCs] will tell you that both firms have a lot to prove here." The market researcher believes Northern Telecom held on to its early market lead in digital switch deliveries last year despite a strong surge by AT&T.

Estimates place Northern Telecom shipments of digital lines in the U. S. at 5.9 million, or just over 45% of the total digital lines installed in 1985. AT&T had 5.5 million, and GTE was third with 1.2 million delivered. McInerney predicts ITT Corp. and Ericsson Inc. are nearly out of the race as the market window slams shut (see "ITT's System 12 may be more than just a U. S. problem").

Siemens Communications Systems is soon expected to make a strong bid in the U. S. market based on parent Siemens AG's ISDN experiences in West Germany. "We have an advantage and a disadvantage," confesses Ron Weindruch, vice president of sales for the wholly owned Boca Raton, Fla., subsidiary. "We were one of the last digital switch suppliers to hit the market."

Siemens's EWSD system was introduced abroad in 1982 and will not officially be on the market in the U. S. until 1987. "We lost all those market windows everyone talks about, but it also means we have the latest version of technology," says Weindruch. Siemens has an agreement with BellSouth to install for field trials a narrowband ISDN switching system by mid-1987. A broadband application is slated for 1989.

HURRY UP. AT&T's Johnson says customers want telecom companies to make their ISDN features work together.

Meanwhile, AT&T and Northern Telecom continued a brisk pace in ISDN product disclosures at Dallas. Among the announcements, AT&T Network Systems unveiled a Centrex local-area network offering, intended to be ISDN-compatible and based on an enhanced 5ESS switch.

The Central Office LAN will provide businesses combined voice-data networking over existing twisted-pair phone lines in office buildings. The Central Office LAN initially will have data rates up to 64 kb/s and will become available later this year. In the future, AT&T plans to upgrade the Central Office LAN package to support 2 Mb/s.

STAGED. During an elaborately staged multimedia show, Northern Telecom—the U. S. subsidiary of Canada's Northern Telecom Ltd.—detailed a major project to revamp its early front-running DMS-100. The Nashville, Tenn., supplier promises it will introduce a series of modules restructuring the distributed processing architecture of DMS-100. The

ITT'S SYSTEM 12 MAY BE MORE THAN JUST A U. S. PROBLEM

ITT Corp.'s growing problems with its System 12 digital exchange may extend beyond its foray into the U. S. market. While the industry buzzes over delays that ITT is experiencing in completing its first U. S. installation, European observers claim that the company's foreign subsidiaries have also had major problems with the switch.

Installation of System 12 lines overseas has been plagued by software problems, according to some of its customers and competitors. "If they don't get the software stabilized—and quickly—they'll never install anything like the 12 million lines they say they have sold," maintains a top executive at one of ITT's European competitors. In many countries, observers say, the slack caused by the company's inability to furnish working exchanges has been taken up by competitors in those markets. One ITT customer, however, says otherwise. West Germany's Bundespost is experiencing no problems with its nine System 12 switches.

ITT denies any difficulties with System 12 and calls it "the most successful such product ever launched." The switch is very important to ITT: it says that it has already invested $1 billion in the project worldwide and that the 12 million lines have been installed in 21 countries.

System 12's U. S. problems are "simply a matter of ITT having underestimated the task of adapting the system to U. S. standards," says Roland Mecklinger, a member of the board of managers at ITT's affiliate Standard Elektrik Dorenz AG in Stuttgart, West Germany. "The adaptation process is an enormous task," he says, adding that it takes from 300 to 400 man years to adapt such a switch to U. S. standards. It has already cost ITT between $100 million and $150 million to convert System 12.

Despite its U. S. problems, ITT does not seem ready to throw in the towel. "We will step back, analyze the problems, and review the measures that must be taken," Mecklinger says. "ITT is not likely to retreat from a telecommunications market as big as that of the U. S."

ITT's biggest customers are Turkey and the People's Republic of China, where, say observers, it is also behind schedule. And difficulties in supplying Taiwan have led to cancellation of a supplementary order, they say.

Most of ITT's competitors are quicker to criticize the company's method of developing the exchange rather than the design itself. They think that because the work was farmed out to units in the U. S., Belgium, West Germany, Spain, and France, the job of making the end product gel was too difficult. Says one competitor: "Telephone exchanges just don't divide up so neatly that you can develop different parts all over the world and put them together at the end like jigsaw puzzles." *–Robert T. Gallagher and John Gosch*

switch has encountered call-capacity shortfalls recently and last year lost market share to AT&T's 5ESS switch. Northern Telecom predicts a 25% increase in processing capacity by speeding up the DMS's internal clock, optimizing software code, and repacking internal service circuits.

In the coming months, Northern Telecom will drop the use of the proprietary NT40 16-bit microprocessor in the switch and begin using a 32-bit Motorola 68020, doubling the call-handling capability. The DMS software is being converted, and some code is running on test beds, says Steve Hester, vice president of network systems in Research Triangle, N. C. A new message-switching bus module will be added to the system in 1987, speeding up transfers among processors.

The final phase of the upgrade is the addition of a new network module designed to increase connectivity throughout the switch, allowing Northern Telecom to offer nonblocking features, packet integrations, and the ability to switch multiple and sub-multiple lines with 64-kb/s connections. Once ready, the new network structure will handle 16 Gb/s at once, switching multiple 64-kb/s connections, says Roy Merrills, group vice president of Integrated Network Systems.

The multivendor trials will begin in the spring

"Northern Telecom has a different ISDN strategy than AT&T, which is working under the assumption that its 5ESS equipment will be able to handle" the full load of ISDN features, notes McInerney. "Northern claims privately that its trials in Canada have revealed unusual traffic patterns, especially on the D channel—the signaling channel of ISDN," he notes. "And it thinks its competition has not correctly anticipated those patterns." —*J. Robert Lineback*

IC MATERIALS

RESEARCHERS TILT SILICON TO GROW PURE GaAs ON IT

URBANA, ILL.

Researchers at the University of Illinois are cutting silicon ingots a new way—tilted at 4° and stepped in two directions atomic layer by atomic layer—so they can deposit extremely pure gallium arsenide thin films on a silicon wafer. They are also introducing layers of indium gallium arsenide atop the GaAs film to further lower defects at the surface. The results could lead to GaAs-on-silicon starting materials with fewer defects than available crystalline GaAs wafers.

The techniques, based on molecular-beam epitaxy, produce GaAs films on silicon that contain only 10^3 defects/cm^2. That compares with about 10^4 defects/cm^2 in standard liquid-encapsulated Czochralski-pulled crystalline GaAs wafers sold on the open market today, says Hadis Morkoc, professor of electrical engineering in the University of Illinois' Coordinated Science Laboratory and leader of the group that developed the new process.

The ability to grow GaAs effectively on a silicon wafer could have profound impact, sparking what one researcher describes as "an explosion of interest" in the field during the past couple of years. The list of companies pursuing the idea includes Fujitsu, Oki Electric, NEC, and NTT in Japan, as well as Texas Instruments in the U. S.

As a substrate replacement, GaAs on silicon could overcome handling problems associated with today's GaAs wafers, which are extremely brittle. Because the thermal conductivity of silicon is about three times that of GaAs, thin films of the material grown on a silicon substrate could also make possible the fabrication of more densely integrated and higher power GaAs devices.

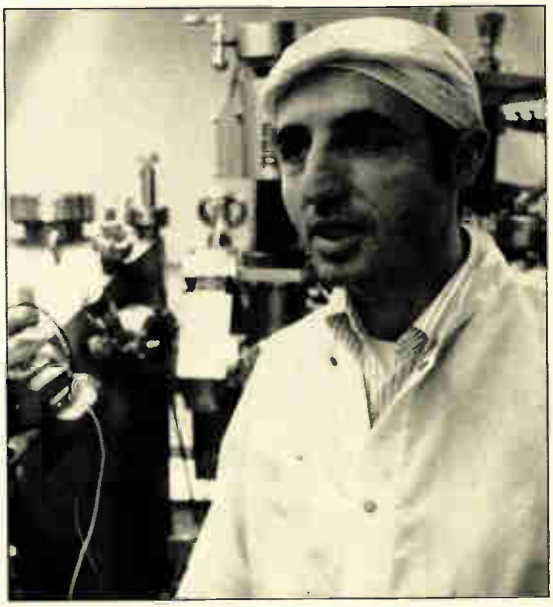
Significantly lower cost could also be expected, because the GaAs thin films could be grown on much larger-diameter substrates than current 3-in. commercial GaAs wafers, says George W. Turner, a technical staff member at the Massachusetts Institute of Technology's Lincoln Laboratory in Lexington, Mass.

Turner, for one, says that GaAs-on-silicon wafers could be commercially available "within a couple of years." They will be used first as a straight replacement for crystalline GaAs wafers in building GaAs circuits, he believes. But the longer-term prospect is development of new kinds of devices that couple the optoelectronic and fast electronic switching properties of GaAs with the low cost and higher density of silicon by fabricating devices that work with each other in both the GaAs layer and the underlying silicon substrate.

MISMATCH. The key to the Illinois technique is a new approach to the tilting of the silicon substrate to overcome the problem of dislocations caused by the 4% mismatch in the lattice constants of silicon and GaAs. If GaAs is MBE-deposited on a flat silicon substrate, many dislocations thread their way from the the silicon-GaAs interface to the surface of the epitaxial GaAs layer.

This occurs because 24 GaAs atoms occupy the same space as 25 silicon atoms, introducing a missing plane and thus the potential for a threading dislocation every 25 atomic spaces, Morkoc explains. With a flat silicon substrate, the density of these dislocations can be as high as 10^{12}/cm^2 at the epitaxial GaAs surface, he says. Such a high density level creates defects that can interfere with device operation, causing microscopic cracks in the GaAs layer and trapping impurities.

Morkoc and his coworkers have significantly cut the threading-dislocation density by tilting the silicon substrate 4°. The wafers have a descending series of steps on the surface, cut out by the wafer manufacturer with a diamond saw. The steps are about 2.8 Å or two monolayers deep, and about 38 Å or 10 atomic spaces long, resulting in the 4° tilt. These steps reduce threading dislocations by offsetting the lattice-constant mismatch between the silicon and the GaAs, Morkoc says.



CLEAN FILMS. The University of Illinois' Morkoc sees economic and technical advantages for GaAs on silicon.

Others, including Lincoln Laboratory, have reported work with wafer tilting, but the Illinois stepped approach goes further, says Morkoc. With conventional experimental tilting techniques, the steps descend in one direction, creating a parallel staircase effect. The Illinois wafers use steps that descend in two directions simultaneously, eliminating the flat planes that occur in one direction with the

parallel staircase approach; these planes can be a starting point for dislocations.

In all, two-directional tilting stops the formation of about 97% of the threading dislocations that would occur if a flat silicon wafer were used, Morkoc says, bringing the defect density to about $10^4/cm^2$ at the GaAs layer's surface.

To further reduce the dislocation count, University of Illinois researchers then add alternating layers of indium gallium arsenide and GaAs atop the pure epitaxial GaAs layer, creating an InGaAs/GaAs superlattice. "What we're doing is purposely introducing a little bit of lattice mismatch, because the InGaAs has a slightly larger lattice constant than the GaAs," says Morkoc. The result of this step is a strain field at the superlattice-GaAs interface that acts to bend out some of the remaining dislocations that have reached the pure GaAs surface. The superlattice "doesn't let the dislocations go through," Morkoc explains. "By the time we get through, the dislocation density [at the superlattice surface] is about $10^3/cm^2$."

Illinois researchers have successfully fabricated metal-semiconductor FETs and heterojunction bipolar transistors on their wafers. The devices work as well or better than comparable devices built on pure GaAs wafers, at frequencies from dc to about 20 GHz, says Morkoc. Lincoln Lab has reported similar results for some types of majority-carrier devices. At Texas Instruments Inc., GaAs-on-silicon bipolar and MES FET devices have achieved only 70% of the performance of devices built in bulk GaAs, says George H. Heilmeier, TI vice president and chief technical officer.

Low-defect GaAs layer on silicon could cut costs

Most researchers agree, however, that the proof of the pudding will be the ability to fabricate a GaAs-based continuous-wave laser in a GaAs-on-silicon material that can work at room temperature. Minority-carrier devices such as lasers that rely on recombination to produce the optoelectronic effect are more severely affected by defects and dislocations in GaAs than are majority-carrier devices, says Lincoln Laboratory's Turner. The problem is that defects in the GaAs drive up the threshold current required for lasing, so far preventing fabrication of a cw laser in GaAs-on-silicon that won't burn up.

The Lincoln Laboratory group, as well as the Nagoya Institute of Technology in Nagoya, Japan, have reported the successful fabrication of pulsed GaAs lasers that work at room temperature in GaAs on silicon, Turner notes.

Lincoln Laboratory, among many others, is working toward the cw-laser goal, Turner adds. For the University of Illinois' part, "we're working on that now," says Morkoc, "and we hope we can get it done within the next few months." *–Wesley R. Iversen*

INTEGRATED CIRCUITS

NEC MOVES INTO GaAs ICs

TOKYO

Every manufacturer in the gallium-arsenide integrated-circuit business will have to turn a sharp eye on NEC Corp. now. The Tokyo company is poised to go to market with GaAs chips for designers who need the blazing speed of GaAs for critical paths in high-speed ECL-based hardware—test equipment, optical-communications gear, and computers.

NEC will start offering samples of three ECL-compatible GaAs chips in late February and follow up with a half dozen more in the spring. The packages are optimized to tap the highest-speed GaAs performance, but signal and power-supply levels are identical with those of silicon emitter-coupled logic. Initial price for the chips will be $253, says an NEC official, about twice that of 100K ECL circuits.

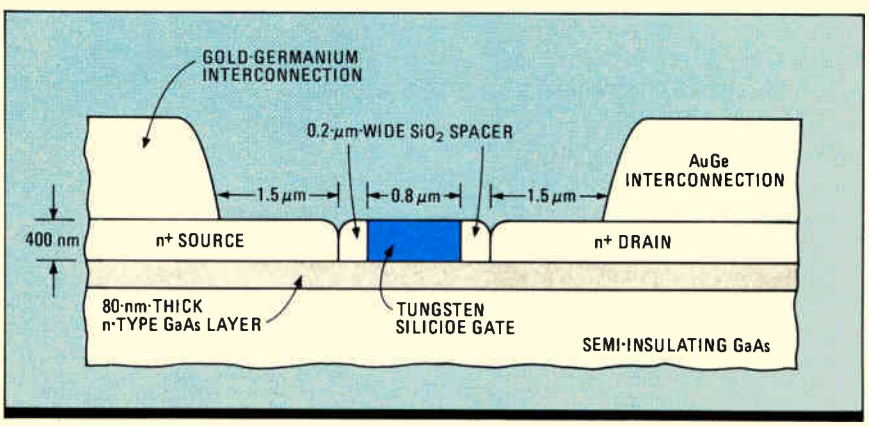
At the outset, then, NEC will be at the high end of the market. The two leading U. S. producers of standard GaAs logic chips have comparable parts that list for less than $200. But NEC figures it can halve its prices when it gets into production and could then move into the market now dominated by Harris Corp. subsidiary Harris-Microwave Semiconductor, Milpitas, Calif., and GigaBit Logic Inc., Newbury Park, Calif. But "right now I don't see them [NEC] as a competitor," says GigaBit's Anthony Livingston, vice president for sales and marketing. "We're all competing against ECL."

NEC's first three chips will be a three-input OR/NOR gate, a D-type master-slave flip-flop, and a T-type master-slave flip-flop. The flip-flops operate at clock rates of up to 2 GHz, compared with a maximum of less than half that for silicon devices. Gates have a propagation delay of 250 ps, the flip-flops 400 ps. All devices feature a pulse rise time of only 130 ps and a fall time of 120 ps.

Hideaki Kohzu, engineering manager for the Microwave and Optical Devices Department of NEC's 2nd LSI Division, says the devices actually operate at higher frequencies but are rated at 2 GHz because that is the test equipment's top limit. But to achieve that kind of speed, current drains from the –5.2-V power supply are fairly high. The gate draws 50 mA, the T-type flip-flop 60 mA, and the D-type flip-flop 70 mA.

The large frequency margin contributes to high yield. Even more important is a self-aligned fabrication technique that provides high transconductance—250 mS/mm—and excellent drain characteristics without suffering from short-channel effects.

After selective silicon-ion implantation has converted the top 80 nm of a semi-insulating GaAs substrate to n-type, metal-semiconductor FETs (MES FETs) are fabricated on the n layer. Gates are a 0.8-μm-wide stripe of tungsten silicide. NEC designers chose that material rather than the aluminum more commonly used in microwave transistors because tungsten silicide can withstand subsequent processes at temperatures exceeding 700°C. Aluminum's limit is 500°C.



CLOSE UP. MES FET lies atop an n-type GaAs layer. Silicon dioxide spacers only 0.2 μm wide sandwich tungsten silicide gate between self-aligned source and drain.

A metal-organic chemical-vapor deposition follows for selective epitaxial growth of the source and drain. Silicon dioxide spacers 0.2 μm wide on either side of the gate make the deposition self-aligning. The tiny gaps between the gate and the source and drain minimize parasitic series resistance. A less obvious effect of the geometry is minimization of short-channel effects that occur with the more usual configuration, in which the source and drain implants extend more deeply into the substrate than the channel does.

Gold layers handle the interconnections. The second layer has air bridges to reduce capacitance between wiring and FET gates for improved high-speed performance. This air-bridge design tends to create unwanted mechanical resonances, but NEC has managed to eliminate them.

For compatibility with ECL, the GaAs ICs use source-coupled FET logic, which generates a given logic signal and its complement on separate terminals. This permits a single-gate chip to act as either an OR or a NOR circuit. Also for compatibility's sake, the chip uses the same −5.2-V power-supply voltage as ECL, although 3 V would be adequate for GaAs logic.

Signals and power supplies match ECL's

Kohzu says that when gate arrays and memory products are announced—in perhaps 1 to 1½ years—the true inherent performance of GaAs devices will become fully apparent. The lion's share of the power consumed in the small-scale-integration gates is dissipated in the input-level shifter before the logic gate, the level shifter after the logic gate, and the 50-Ω driver. Internal gates in a gate array would require only between 2 and 5 mW each and still have a propagation time of just 100 to 150 ps.

The six devices that will be added this spring are an exclusive-OR gate, a 4 : 1 multiplexer, a 1 : 4 demultiplexer, a four-stage ripple counter, a decision circuit, and a line driver. *–Charles L. Cohen*

COMPUTER-AIDED ENGINEERING

HP PUSHES ITS CAE IN UNEXPECTED SETTING

LOS ANGELES

Hardware that could figure significantly in the drive by Hewlett-Packard Co.'s Design Systems Group to become a major player in computer-aided-engineering surfaced last week in a surprising milieu—the International Modal Analysis Conference for mechanical-engineering test engineers.

The hardware in question, the 3565S signal-processing system, monitors and measures up to 62 signals simultaneously. This sort of integrated multichannel instrumentation is most often associated with electrical-engineering applications.

But HP marketing officials offered some solid reasons for giving the system its debut at IMAC. A companion application package for mechanical engineers was also unveiled by the company at the show. The ME Series 90 Test System performs a central mechanical-engineering design task: analyzing the dynamic properties of structures. The conference "always has been an important event to us—we're close to the [mechanical-engineering test] community," explained Lee Thompson, general manager of HP's Lake Stevens Instrument Division, Everett, Wash., which makes both systems.

But the HP 3565S has even broader significance, since it "is absolutely vital to our strategy." That strategy, enunciated late last year and officially named the DesignCenter concept, depends on the Design Systems Group, Fort Collins, Colo., serving as the single vendor that ties together many formerly separate CAE pieces produced by different HP divisions [*Electronics*, Oct. 14, 1985, p. 40].

But this strategy has been slower than expected to produce new hardware and software offerings, as HP officials concede. In addition, HP's first products, an earlier ME Test Series introduced at Autofact '85, drew mixed reviews. And developments in Manufacturing Automation Protocol (MAP) equipment dominated that show and diverted attention from HP's efforts. Therefore the company was eager to unveil its model 3565S, which represents the strength of traditional HP instrumentation expertise, even though the right CAE forum was not yet at hand, analysts speculate.

With this first CAE offering for the electrical-engineering field, "HP is still running late in CAE but can catch up, no question about it," says Peter D. Schleider, a research analyst with L. F. Rothschild Unterberg Towbin of New York.

The new system's 62-channel signal-handling capability represents a giant improvement in capacity over the model 3562, which is limited to only two channels. Capabilities for multiuser tasks thus are greatly expanded for such applications as signal characterization, waveform analysis, and device testing, the company says. The system includes a number of advanced features, such as multiple-input multiple-output frequency-response measurements that allow all paths to be measured simultaneously.

A complete system also includes new signal-processing software—HP Vista (virtual instrument software for testing and analysis). It links configurable measurement hardware and the HP 9000 Series 300 work-station com-

LASERS AND ULTRASONIC BEAMS GUIDE ROBOT JANITOR

The Auto Sweepy robot developed by Toshiba Corp. in cooperation with the owners of the Kasumigaseki Building in Tokyo goes about its chores unattended but doesn't win awards for intelligence. It neither stores a map nor knows its location. Instead, a gas-rate gyro and short-range laser beams pulsed in a radar-like fashion guide the janitorial robot back and forth in overlapping rectangular swaths through long narrow halls and broad gymnasiums. Medium-range ultrasonic sensors are tuned to detect people in the robot's path, and as a backup, tactile sensors halt it if a collision should occur.

FOLLOWING THE PATH. HP's 3565S uses multiple-input/output frequency response so it can track what's going on in 62 instrumentation channels simultaneously.

puter. Pricing is between $21,000 and $300,000, depending on configuration and channel count.

HP has set ambitious goals for itself in the CAE/CAD/CIM market: to move up from a ranking it estimates as fifth in sales for 1985, with about $200 million. Total market size in 1985 was about $6 billion, with the EE portion having about 52% and mechanical engineering some 37%.

If HP expects to succeed with its DesignCenter idea, it must tell its story better, industry sources advise. "I'm not that familiar with it," says Jerry D. Hutcheson, president of VLSI Research Inc., San Jose, and a consultant on semiconductor manufacturing. He adds that in the past, HP often thought customers would seek the company out, rather than vice versa. As for the new HP system, "I can see how it would be useful as a generic product for collecting and analyzing data."

HP plans major product introductions throughout the year, particularly at the Design Automation show in June. The company is close-mouthed about how the forthcoming HP Spectrum computer family will fit into the upgrading of the work-station platform for CAE/CAD/CIM, but it is expected to play a major role. *–Larry Waller*

FIBER OPTICS

FULLY OPTICAL SWITCH LOOMS FOR VIDEO

CORBEVILLE, FRANCE

Designers of tomorrow's broadband video communications systems may soon have all the tools they need to create optical networks. A team of engineers at Thomson-CSF's Central Research Laboratory is putting the finishing touches on the technology for what could be the last key component: a fully optical switch whose simple design makes it inexpensive to produce.

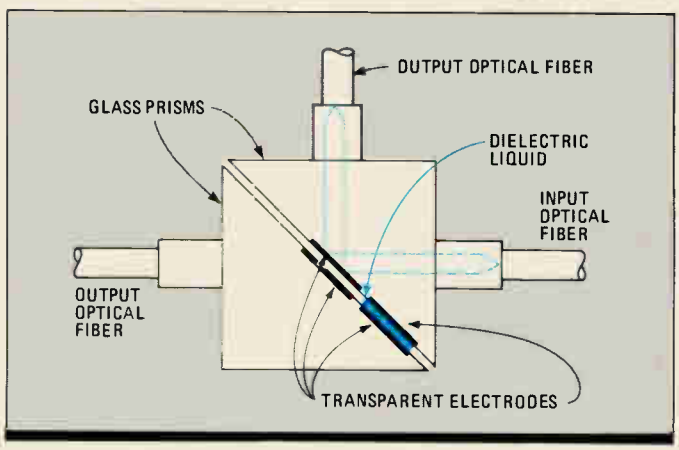
Thomson's Lidos, for liquid dielectric optical switch, will allow designers to take full advantage of an optical signal's original bandwidth. With electrical switches, optical signals must be converted to electrical form for switching, and then back to optical form for further transmission, thereby setting limits of usable bandwidth for the original signal.

The company expects to find a host of industrial applications for Lidos, such as video telephone, video-program distribution or consultation of video data banks. But the technology can't handle standard telecommunications activities because switching speed and potential matrix size are limited. For public telecommunications switching, Thomson is working on a method that uses holography [*Electronics*, Oct. 14, 1985, p. 19].

PARALLELISM. Lidos is based on the reflection of light within a prism and electrically induced motion of a dielectric liquid. A switch consists of two prisms with their hypotenuses parallel at a distance of from 10 to 30 μm (see drawing). Each hypotenuse surface has a pair of transparent indium tin-oxide electrodes, one deposited in the center of the prism surface, the other contiguous with the first. Optical fibers are coupled to three of the four sides of the prisms by way of lenses, each aimed at the center electrode of its respective prism. One fiber is input, the others output.

Movement of a droplet of liquid dielectric from one set of facing electrodes to the other controls the direction of the output signal. This dielectric, a mixture of nitrobenzene and hexane, has a refraction index identical to that of the prisms and is held in place by its own surface tension. It is moved from one position to the other by manipulating voltage differences between the electrodes.

When the space between the two center electrodes is empty, internal reflection at the hypotenuse of the prism switches light entering one side of a prism at a 90° angle toward the other surface of the same prism for injection into its respective output fi-



PLAYING ANGLES. The Thomson Lidos method switches optical signals using prisms and electrically controlled liquid dielectric.

ber. When the space between the two center electrodes is occupied by the liquid dielectric, however, the refractive property of the prism's hypotenuse is cancelled and the light passes through the facing prism into the opposite output fiber.

Using this method, Thomson has realized two-by-two matrices in the laboratory and currently is working on a prototype for industrial production. According to Jean-Pierre Le Pesant, who is coordinating research on the project, industrial models will evolve from 8 by 8 to a maximum of 64 by 64. One of the principal advantages of the technology is that it has no mechanically moving parts, thus offering significantly increased reliability over alternative solutions using moving mirrors.

It also produces a physically small component with impressive technical specifications. The two-by-two laboratory matrix is a cube only 10 mm on the diagonal with electrodes of 30 mm^2, capable of handling light beams from 500 μm to 2 mm in diameter. Switching speed of the matrix with a supply voltage of 30 V is 40 ms; the insertion loss is a mere 0.8 dB. *–Robert T. Gallagher*

SEMICONDUCTORS

AMORPHOUS TRANSISTORS GET A BOOST IN MOBILITY

TOKYO

Stanford R. Ovshinsky, president of Energy Conversion Devices Inc., visited Japanese companies last week to peddle an amorphous-silicon transistor he calls a DIFET. Immediate applications for the dual-injection FET appear to be restricted to niche areas such as thin-film active-matrix displays, where low-performance amorphous devices hold some advantage over single-crystal silicon devices.

Ovshinsky has lofty visions about the device's future capabilities, predicting 10-Mb memory chips and entire supercomputers built with 25 layers of devices. Ovshinsky is, however, well known in the industry for making controversial claims in his new-technology announcements over the past 20 years.

Recombining holes and electrons in DIFETs can emit light, and it is this capability that the Troy, Mich., company is touting as useful in building optical data paths between layers of a multilayer device. For displays, the light-emitting property could be exploited, but the DIFET may first be used simply as a better amorphous-silicon driver transistor in thin-film active-matrix displays such as liquid-crystal displays, where growing single-crystal silicon is not practical because of the high temperatures required.

The DIFET is similar in structure to earlier single-crystal devices, in which an isolated gate similar to that of a MOS FET controls a bipolar transistor or thyristor. Both electrons and holes are injected into the channel—electrons at one electrode and holes at the other. The channel region, between the n-type and p-type electrodes, can be n-type, p-type, or intrinsic silicon.

Yasuhisa Omura, a research engineer at Nippon Telegraph & Telephone Corp., Tokyo, described a similar structure made of single-crystal silicon at the 1982 International Conference on Solid State Devices held in Tokyo. He named it the Lubistor, for lateral unidirectional bipolar-type insulated-gate transistor.

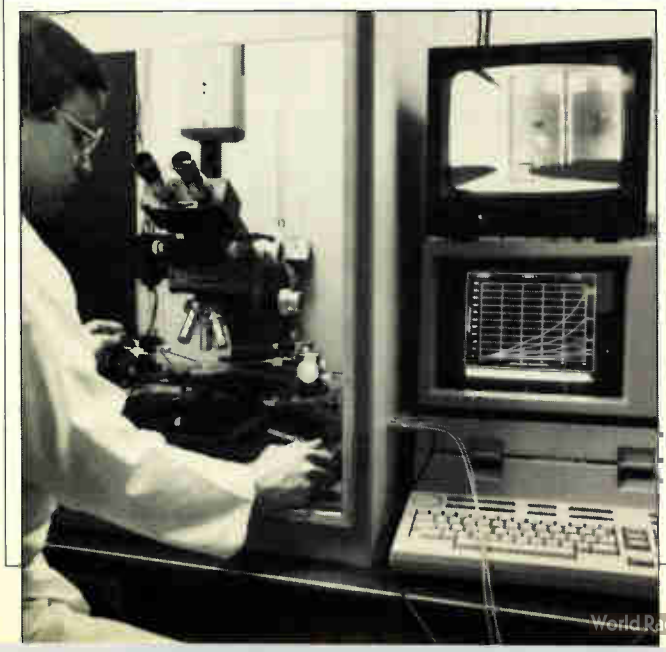
Yutaka Hayashi, Head of the Semiconductor Device Division of the Japanese Ministry of International Trade and Industry's Electrotechnical Laboratory, says that if he were a patent examiner, he would not give ECD a patent because Omura described his device first. "We are aware of the patent to Mr. Omura. ECD's DIFET employs different principles of operation and new device physics. We do not believe the Omura patent will affect the strength of ECD's DIFET patent," says Robert S. Nolan, a patent attorney with ECD. No DIFET patents have yet been awarded.

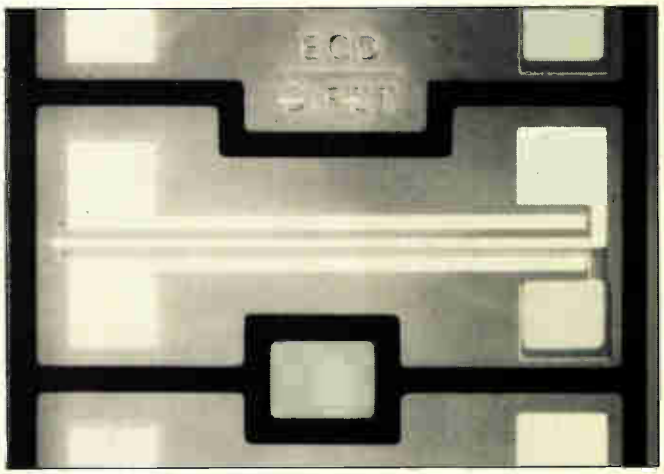
STILL BEHIND. For an amorphous-silicon transistor of a given size, dual injection increases carrier mobility by a factor of about 20, with beneficial effects on both operating speed and the current-carrying capability for a given size of transistor. The improvements do not place amorphous devices in competition with single-crystal devices, however, which are still about two orders of magnitude ahead in performance comparisons.

Amorphous silicon may never show the high-speed performance of a crystalline material, admit the DIFET's developers, Wolodymyr Czubatyj and Michael G. Hack of ECD and Michael Shur of the University of Minnesota. But they say the DIFET could bring amorphous silicon into new application areas.

The DIFET achieves its performance improvement because it overcomes what is known as space-charge limited conduction, a problem with unipolar amorphous devices. The many defects within the jumbled amorphous material form deep traps for both positive and negative charges, severely limiting carrier mobility. This effect has restricted the use of amorphous devices to applications where they can be made large. Injecting both electrons and holes as in the DIFET fills these carrier traps and allows far more current to flow.

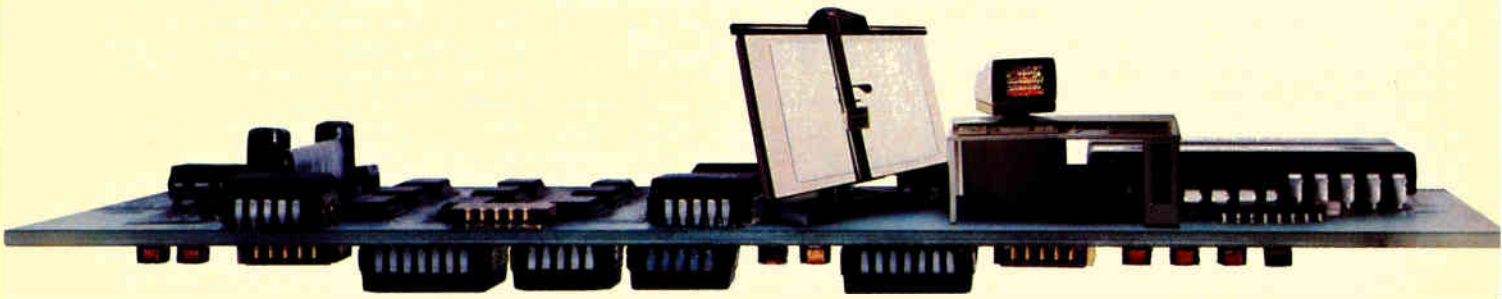
ECD has had working DIFETs for





BUILT AND TESTED. Holes and electrons both are injected into the gate-controlled channels of amorphous-silicon dual-injection FETs (above) developed and tested by Energy Conversion Devices Inc. (left).

GSI's System: PC-800 Model 4.



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several months and has done extensive testing, say Czubatyj and Hack. Working with NTT, ECD is seeking to put the drivers on an amorphous substrate with memory circuits. Ovshinsky claims that 10-Mb memories are only a year away.

He says it will soon be possible to wed the light-emitting property with the multilayer-fabrication capabilities of amorphous silicon. Once they fashion a 10-Mb memory, Ovshinsky says, it will only be a matter of time before they develop a 25-level device. ECD is now working on a thin-film-transistor computer with a Japanese computer maker.

ECD has technical and business arrangements with several Japanese firms, including Canon, Hitachi, and Sony. *–Charles L. Cohen, Wesley R. Iversen, and Jon Joseph*

CONTROL SYSTEMS

HAND-HELD IR CONTROLLER REPLACES LIGHT SWITCH

EINDHOVEN, THE NETHERLANDS

Computer-controlled lighting in large buildings has come under more direct individual control with a novel energy-saving system from Philips NV.

The Philips integrated-function system (IFS) is built around a central microcomputer and local microprocessor controllers. It cuts down on the amount of power cabling needed and provides more economy and flexibility than conventional computer-controlled lighting systems give.

Occupants can control their lighting through microcomputer programming or, as an override mechanism, with infrared remote-control units similar to those used for TVs. The remote controls do away with the need for power cables within walls and partitions to support manual wall switches, and the need for program-override systems controlled by telephone dialing.

Though initial costs of the system are high, Philips experts say IFS, if combined with high-efficiency lamps, can mean up to a 50% saving in energy costs, compared with conventional control systems.

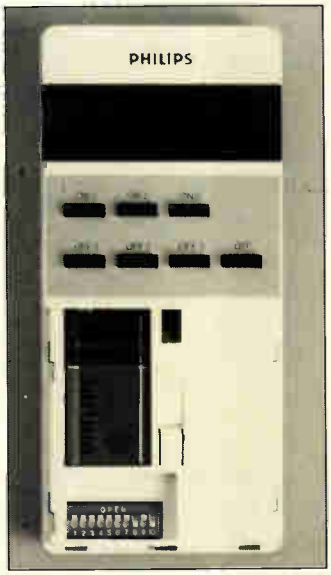
HORIZONTAL ONLY. Wiring for the system runs above the ceiling. A two-wire cable powers the local microprocessor controllers. Each local controller—with one microprocessor, three relays, a data-bus interface, and input, address, switching, and supply sections—can switch three lighting circuits in response to signals from the central microcomputer. Running parallel to the power cable is a standard unshielded twisted-wire control cable that links the local controllers with the microcomputer.

To save energy, conventional control systems provide centralized switching dependent on the time of day, the day of the week, holidays, and natural-lighting levels as determined by photocells or other sensors. Generally, occupants have little or no control over the lighting or lighting levels of their rooms or floors.

At $15 or so per square meter, IFS initially will cost about twice as much to install as a conventional computer-controlled lighting system, admits Harry Crijns, IFS product manager at the company's lighting division in Eindhoven. Though the system saves on cable costs, the local microprocessor controllers and the remote-control units jack up the price.

But Crijns claims that the high initial costs are more than offset by the system's high flexibility and economy. "The IFS system pays for itself within three years."

The IFS system provides economy and flexibility in several ways. Because no vertical wiring or wall-mounted switches are used, it's easy to change a floor's layout—to add more rooms by partitioning existing ones, for example. Further, no rewiring of the ceiling lights is needed to suit certain rooms.



BY REMOTE. In the IFS system, an infrared remote-control unit replaces wall-mounted switches.

The central microcomputer can be programmed using a Philips P2500 system to control lighting of rooms according to individual demands. A specific data address—corresponding to one of the three circuits controlled by the local microprocessor—is assigned to a room by the programmer.

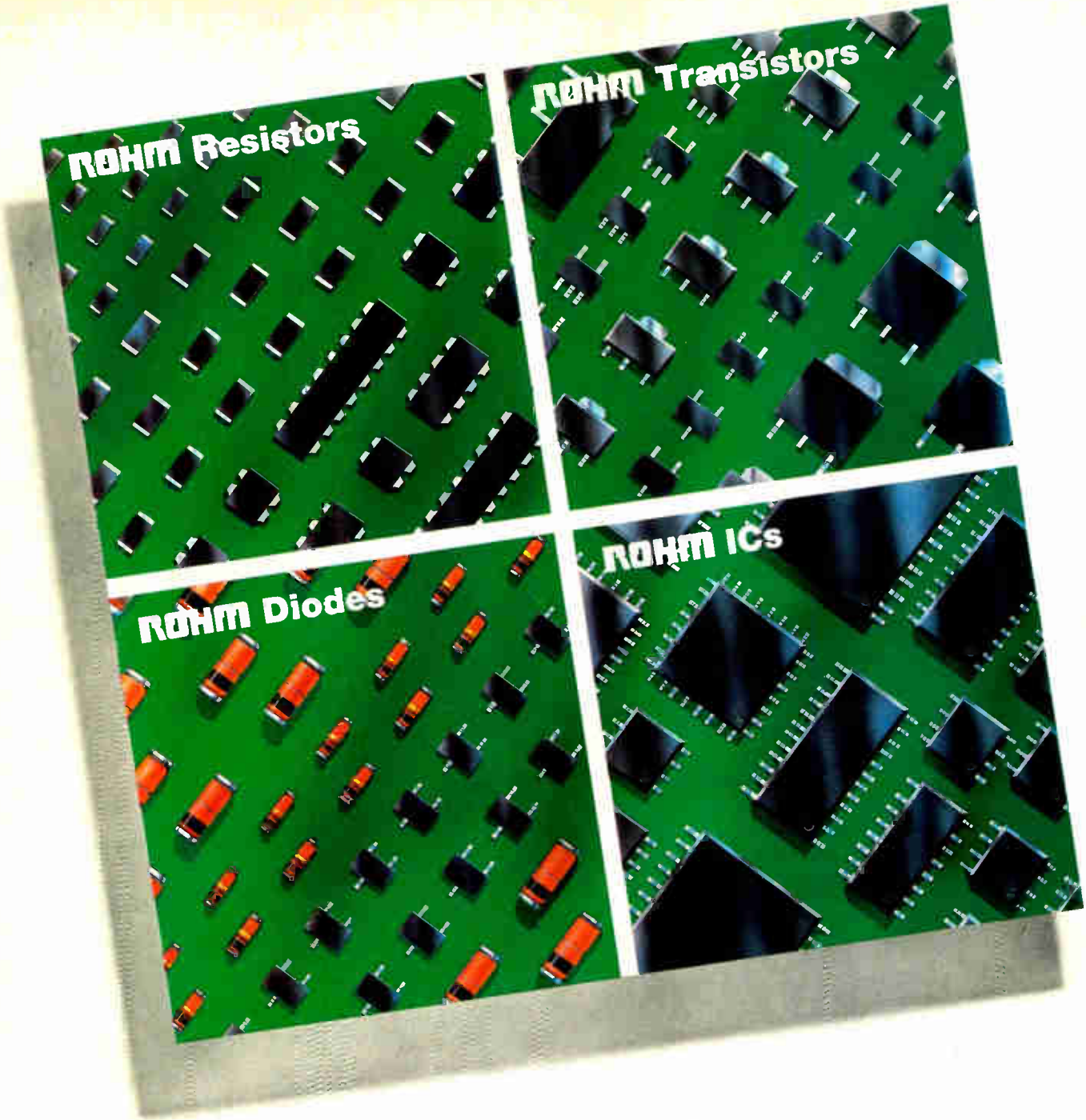
Occupants of rooms can override automatic switching with their remote controls to adjust lighting levels or turn lights on or off. Ceiling-mounted IR receivers pick up the signals and feed them to the local controllers.

Such individual control means that several rooms don't have to share a single lighting circuit, requiring all lights to be switched on when only one is needed. Nor does a user have to go to a different room on another floor to switch on his or her lights.

ENERGY SAVING. The IFS approach, Crijns insists, provides greater energy savings because lighting always operates at the right place, at the right time, and at the desired levels. In addition to lighting control, the IFS system can be used to control other electrical equipment, such as air-conditioning units. That spells an additional savings in energy.

Philips has equipped several large buildings in the Netherlands with IFS, including one at its Eindhoven headquarters for test and demonstration purposes. The company soon will go after the European market and, once it gets Underwriters Laboratories approval, will hit the U.S. market. *–John Gosch*

CENTRAL CONTROL. A Philips P2500 system programs the IFS central microcomputer.



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INSIDE TECHNOLOGY

WHAT'S HOLDING BACK SURFACE MOUNTING

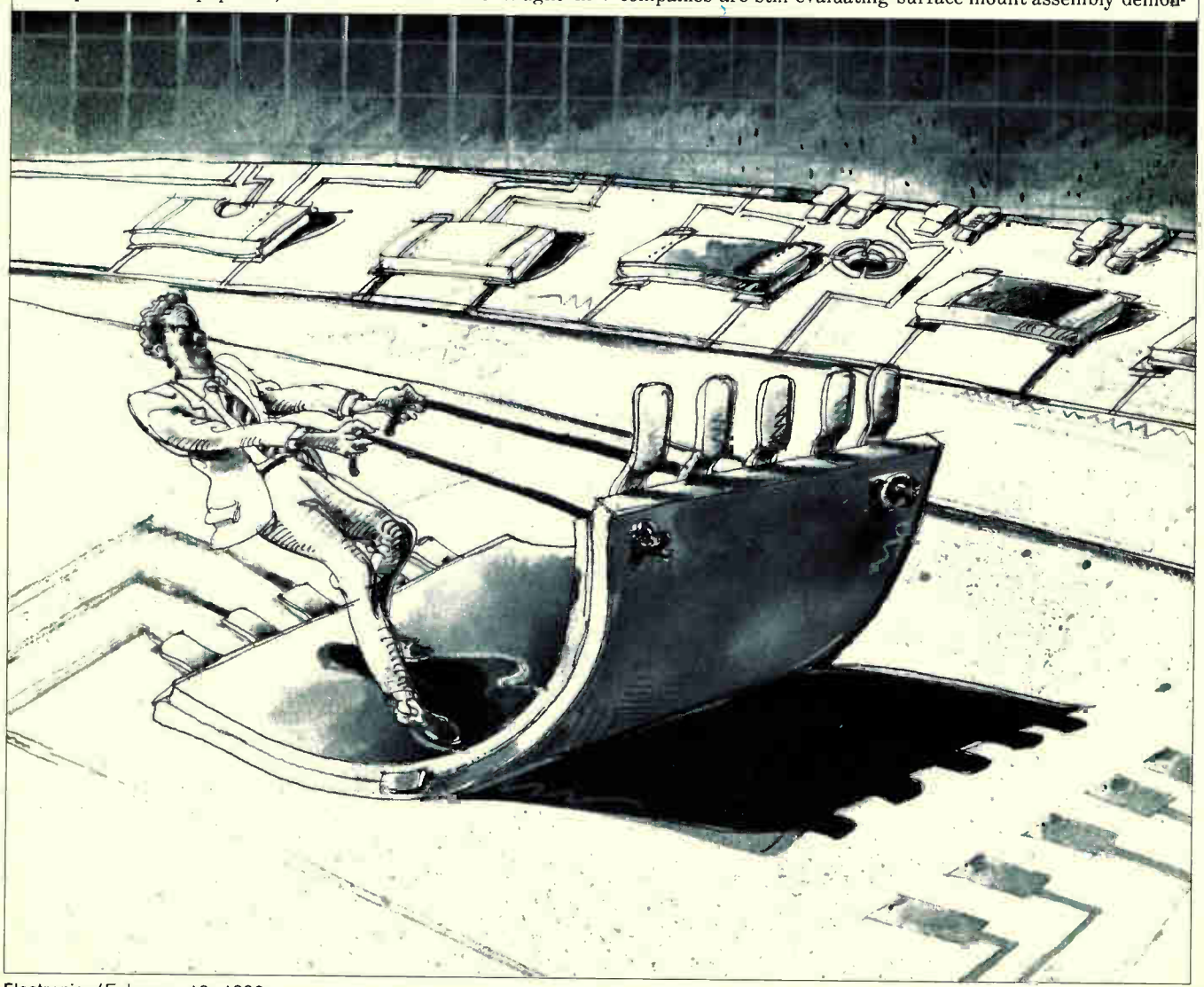
CULPRITS ARE TESTING, SOLDERING, AND HIGH COST OF PRODUCTION GEAR

by Jerry Lyman

Despite the rosy predictions, the switch to surface mounting of components isn't taking off on schedule. Instead of becoming common practice in the 1980s, surface mounting now may not make its mark in the U. S. until the 1990s—if then. There are three principal catches. First are the problems of reflow-soldering tiny leaded and leadless surface-mounted devices and then testing boards with components on both sides, techniques in which domestic manufacturing engineers are just starting down the learning curve.

Just as big a stumbling block is the expense of installing new production equipment, which manufacturers caught in the current industry slump are reluctant to undertake. A complete assembly line consisting of machines for surface-mounted placement, soldering, testing, and repair can easily cost several hundred thousand dollars. Nonetheless, the technology's pluses—increased interconnection density, smaller board area, better performance, and reduced manufacturing costs—could still make it the method of choice for fastening components to printed-circuit boards.

In the U. S., the computer, telecommunications, and automotive industries, which are leading the move to surface mounting, remain the only large assemblers using this method. Most companies are still evaluating surface-mount-assembly demon-

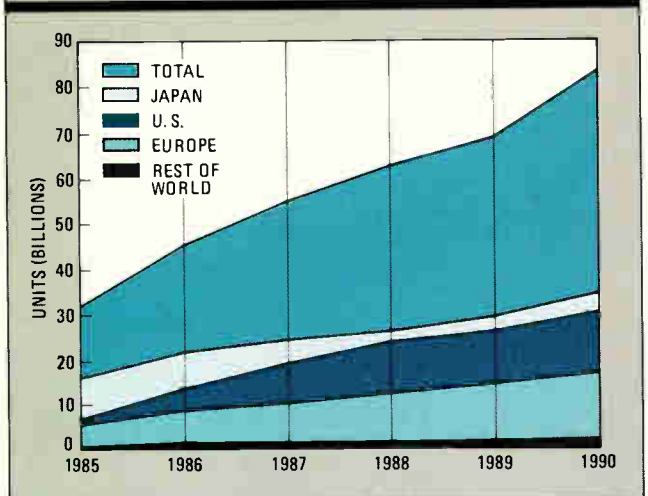


stration units, says Charles-Henri Mangin, president of market researcher Ceeris International Inc. In 1984, the U.S. automotive industry used 1.4 billion SMDs—mostly chips and small-outline transistors, Mangin says. The rest of the U.S. electronics industry used nearly half a billion SMDs, mostly for computers and telecommunications products. This amounted to only 3% to 4% of the total assemblies of components by domestic operations. In Japan, by contrast, 70% to 75% of all board applications use surface mounting.

The 1990s could present either a rosy or a gray scenario for the U.S. market, according to the Old Lyme, Conn., company (Table 1). In Ceeris's more pessimistic view, by 1990 only 30% of all pc boards will have SMDs. And these boards will have a mix of 50% SMDs and through-the-board components. The more optimistic view forecasts that 50% of all boards will contain SMDs by the end of the decade. Of these components, 60% will be surface mounted, and the remainder will be mounted conventionally. Either prediction means that surface mounting will garner only 15% to 30% of the total U.S. component market in five years.

Unlike the early days of surface mounting, when both the devices to be attached to boards and the machines to place them were scarce, both surface-mountable components and what are called pick-and-place machines (Fig. 1) are readily available now. The machines come in a variety of units, ranging from mass-placement units to small machines for prototyping. What's more, digital and linear integrated circuits and discrete components are available in small-outline-transistor packages, SOIC packages, plastic leaded chip carriers, and, to a lesser extent, in plastic four-sided flatpacks [*Electronics Week*, April 8, 1985, p. 49] from many sources in the U.S., Europe, and Japan.

U.S. LAGS JAPAN IN SURFACE MOUNTING



SOURCE: ELECTRONIC TREND PUBLICATIONS

TABLE 1: HOW SURFACE MOUNTING WILL FARE IN U.S. BY 1990

	Low estimate	High estimate
Makers of pc boards with surface-mounted devices	100	290
SMDs per board	140	160
Total SMD packages (billions)	14	46
Share of surface mounting in total components	15%	30%

SOURCE: CEERIS INTERNATIONAL INC.

HERE TO STAY

In fact, two surface-mount packages—plastic leaded chip-carriers and SOICs (Table 2)—have enjoyed spectacular growth, according to Electronic Trend Publications' latest market research report on surface mounting. Consumption of the plastic leaded chip carrier jumped from 1 million units in 1983 to an estimated 97 million in 1985; use of the small-outline packages during the same period grew from 6 million units to 485 million units, says the Cupertino, Calif., market researcher. The plastic leaded carrier will be the highest-volume chip carrier in the U.S. by 1989 with sales of 2.1 billion units, according to the forecast. That year, production of small-outline packages will rise to 4.2 billion units and garner 23% of the IC-package market.

These packaging success stories have helped persuade manufacturers of discrete passive and active components that surface mounting is here to stay. The world market for total discrete devices will grow from 31.7 billion units (19.9% of the total discrete market in 1985) to 83.1 billion units (39.1% of the market by 1990) during the same period, according to Electronic Trend Publications. In the U.S., the number of SMDs will grow from about 6 billion units in 1985 to about 30 billion units in 1990 (chart, left).

At the same time, component manufacturers in the U.S. and Japan are gradually filling in the gaps in surface-mounted passive components. Last year, Kyocera International Inc., San Diego, and Bourns Inc., Riverside, Calif., introduced surface-mounted trimming potentiometers. Kyocera introduced a 4-mm surface-mounted variable ceramic capacitor. Rohm Corp., Irvine, Calif., introduced a family of surface-mounted light-emitting diodes in SOT-23 packages. Several companies introduced hermetically sealed elements in chip-carrier packages—among them, Technitrol Inc. with its TTL chip-carrier delay module and Fox Electronics with its high-speed CMOS oscillator.

More than high cost is holding back the march of pick-and-place machines onto U.S. board-assembly lines (chart, p. 28). Manufacturers are finding that, with most surface-mounted boards containing a mix of SMDs and through-hole components, they can still use existing equipment for some board assembly. Because mixed boards will still be used heavily later in this decade, makers have no reason to regear entirely with pick-and-place equipment.

In addition, board design, placement and attachment of components, and soldering are different in surface mounting

TABLE 2: PLASTIC LEADED CHIP CARRIERS LEAD U.S. MARKET (millions of units)

	1983	1984	1985	1986	198	1988	1989	CAGR*
Total	6,315	8,239	9,703	11,384	13,374	15,703	18,436	20
PlasticDIP	5,299	6,934	7,679	7,717	7,999	8,557	9,209	10
Cerdip	752	927	1,032	1,145	1,272	1,412	1,567	13
Ceramic DIP	126	157	176	197	221	247	277	14
Flatpack	76	78	73	68	64	59	55	−5
Leaded chip carrier	13	26	49	89	164	301	553	88
Leadless chip carrier	9	19	35	62	113	204	369	84
Plastic leaded chip carrier	1	4	97	626	1,164	1,676	2,292	292
Quad flatpack	1	2	4	10	23	55	133	144
Small outline	6	41	485	1,366	2,209	2,984	3,687	189
Pin grid array	1	2	3	5	7	12	18	62
Other	32	49	70	99	139	196	277	44

*Compound annual growth rate (%)

SOURCE: ELECTRONIC TRENO PUBLICATIONS

than in standard board assembly. Companies weighing a large investment in surface-mounting equipment need to consider the extensive education required in these techniques.

The need to learn new soldering technique has turned out to be one of the biggest roadblocks to the spread of surface mounting. Manufacturing engineers trained in wave-soldering larger through-the-board leaded components now face the hurdle of combining reflow- and wave-soldering techniques and applying them to much smaller leaded and leadless components placed on the surface of boards that have three times greater packing density. The engineer also must now cope with boards that have components on both sides.

ASSEMBLY TRIO

Three types of surface-mounted assembly exist. In Type 1 assembly, surface-mounted components are reflow-soldered to one or both sides of a pc board. Single-sided boards make up most of this type of assembly. A typical example is a memory board with single in-line packages with random-access-memory chips in plastic leaded chip carriers and chip capacitors reflow-soldered to one or both sides of the board.

The most popular assembly is Type II, which has both surface- and through-hole-mounted components. In this category are boards with surface- and through-hole-mounted components on the top only; boards with both surface- and through-hole-mounted components on the top and surface-mounted components on the bottom; and boards with surface- and through-hole-mounted components on both the top and bottom of the substrate.

A Type III assembly consists of through-hole-mounted components on the top side and surface-mounted components (typically passive chips and SOT-23 discrete semiconductors) on the bottom. Many companies, when applying surface mounting for the first time, choose this assembly, which is usually wave- rather than reflow-soldered.

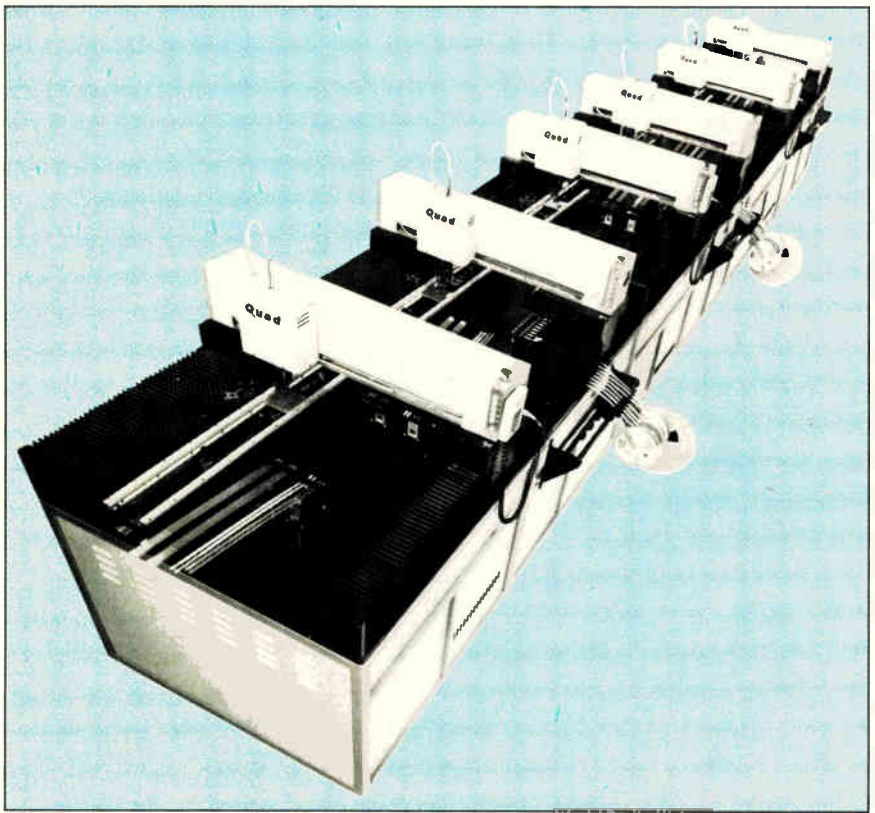
Board assemblers have been efficiently wave-soldering pc boards with arrays of dual in-line packages and leaded passives since the late 1960s. Suddenly, assemblers must deal with newer, denser boards with small passive chips and leaded and unleaded chip carriers that must be reflow- rather than wave-soldered. On top of this, the solder joint's mechanical strength now becomes critical because the clinched leads aren't there to help hold components on the board. In addition, a mismatch of the thermal coefficients of expansion of the board, passive chip components, and IC package can result in thermal stresses that can fracture solder joints, a situation that doesn't exist in through-the-board asssembly. The design of mounting pads also becomes critical.

Finally, a manufacturing engineer comfortable with standard wave-soldering equipment and operations must learn reflow-soldering based on screened-on solder pastes. He also needs to learn vapor-phase or infrared solder-reflow equipment. Often when a neophyte assembler must apply wave-soldering in a Type II or III SMD assembly, he quickly finds that his standard equipment won't do the job. He then must go to a dual wave-soldering machine [*Electronics*, Feb. 9, 1984, p. 119].

Manufacturing a Type II board takes many more steps than does a through-the-board assembly (Fig. 2). Equally important is the solder fillet for chip components, which must allow for adequate transfer of thermal and mechanical stresses from board to ceramic passive components. The solder mass should be controlled to result in a maximum fillet of two thirds the overall thickness of the chip, according to Murata Erie North America Inc., Rockmart, Ga. Larger fillets can result in peeling of the end termination, fillet weld cracks at the top corners, and cracks in the ceramic chip.

Another pesky problem in reflow soldering, especially in belt-driven or in-line systems, is tombstoning, in which chip capacitors, resistors, and SOT-23 packages stand on end after soldering. This results from improper pad design, unequal solder mass, and misplacement of chips. Poor chip-end terminations, vibration of presoldered assemblies, poor quality of the solder paste, and the wrong soldering temperature also cause tombstoning.

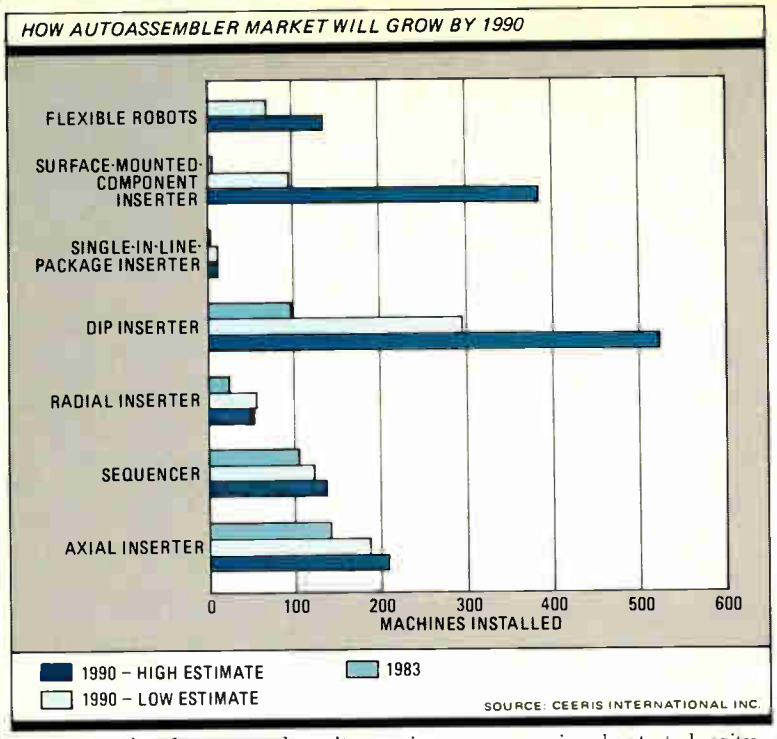
1. TEAMING UP. Quad System's QS-34 pick-and-place assembler can operate alone or with other machines to form a complete surface-mount assembly line.



Vapor-phase reflow-soldering has taken the lead in the U.S., and IR reflow is starting to come to the fore. In vapor-phase soldering, the assembled board is immersed in saturated vapor generated by a pool of boiling Fluorinert liquid. The vapor, at the temperature of the boiling liquid, completely envelops the board and begins to condense, giving up the latent heat of vaporization. The heat rapidly and uniformly raises the temperature of the assembly to the liquid's boiling point, causing the solder to flow.

Vapor-phase soldering offers uniform and rapid heating, maximum temperature control, geometry independence, and a clean environment. But the drawbacks of the technique are the cost and complexity of the machine as well as the $500-per-gallon cost of the Fluorinert required. What's more, because liquid condenses on the surface of the work piece during the process, with this technique surface-mounted components are much more prone to misalignment.

Unlike the vapor-phase system, which heats by conduction, an IR solder-reflow system transfers heat by radiation. A typical IR process requires less power than an equivalent vapor-phase-soldering



system and, of course, doesn't require an expensive heat-transfer fluid. In addition, because of its preheating cycle, an IR system can substantially reduce component tombstoning.

The major process limitation of IR solder reflow is uneven heating resulting from hot spots on the assemblies. This can be minimized by reducing the conveyor belt's speed and allowing conduction to equalize the hot spots.

CUTTING DEFECT LEVELS

Open solder joints on J-leaded plastic chip carriers turned out to be a big problem at Texas Instruments Inc.'s Surface Mount Center in Houston. Production and test boards had solder defect levels of 100 to 300 parts per million. About 90% of all defects were due to open solder joints on J-leaded chip carriers.

Because a 100-ppm level on a board with 10,000 solder joints would give about one defect per board or a yield of zero, TI's engineers decided to aim for a 90% functional yield. For a 10,000-joint assembly, this would require a defect level of less than 10 ppm. After extensive tests, engineers substituted IR reflow for the original vapor-phase process and cut the failure rate 98%. TI's soldering experts believe that the cause of the joint failures is the fact that the vapor-phase system heats the smaller mass of the IC packages first rather than heating the board and package at the same rate. In this case, the solder paste melts and starts to reflow on the IC lead first. With good solderability, the solder wicks up the lead, reducing the amount available to form a fillet between the lead and pc-board pad. If the gap between the lead and pad is too large for surface tension of the molten solder, it separates, forming two independent surfaces that do not form a solder fillet.

With an IR system, rather than plunging the assembly into the vapor-phase system's constant temperature, the assembly goes first to a preheating stage, in which the board and components are temperature-stabilized and -equalized. Once components reach equilibrium, the transport mechanism will carry the substrate to the final stage, in which a high-energy spike adheres the component to the solder joint. The gradual heating of the assembly avoids the different heating rates of the vapor-phase system and all but eliminates wicking.

To come to terms with soldering carriers that have compliant leads, the Institute of Electrical and Electronics Engineers formed a task force, which reported some preliminary findings last year. It will furnish additional data at an International Electronics Packaging Society meeting Feb. 24, just before Nepcon West in Anaheim, Calif.

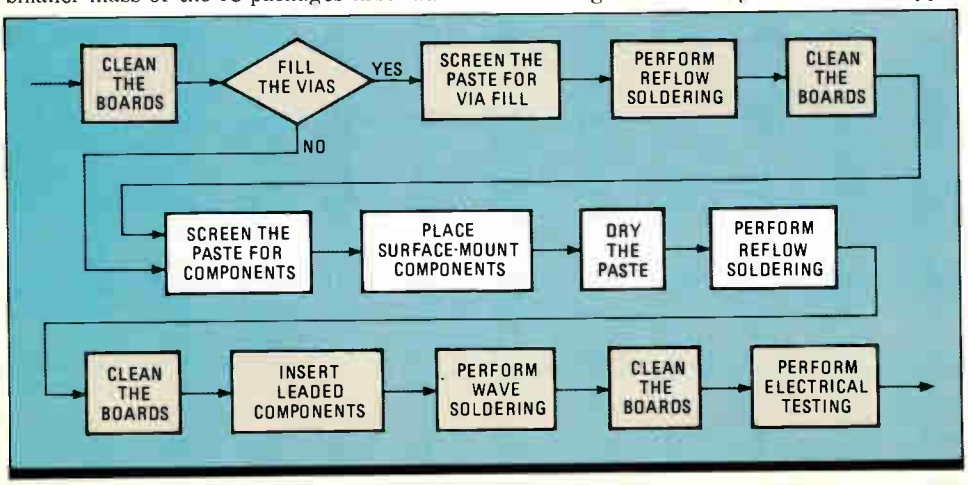
Surface mounting brings both higher packaging density, with many of its components on 50-mil centers, and even higher density, with components on both sides of a board. It also brings the problem of testing these jammed assemblies.

Because most defects in surface-mounted boards are assembly-related, these assemblies are usually tested in-circuit rather than functionally. In-circuit testing efficiently locates this type of defect. But fixturing is the main problem of in-circuit testing for surface-mounted pc boards.

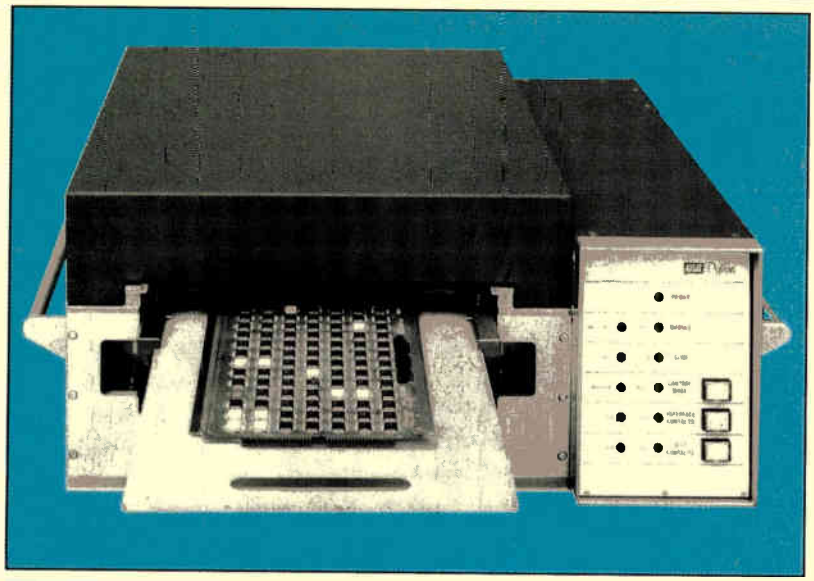
Standard bed-of-nails fixtures with spring probes on 100-mil centers will not do for most SMD boards," says Peter Hansen, applications engineering manager at Teradyne Inc., Boston, Mass. "With the denser boards, we need probes on 50-mil centers and now face the problems of optimizing probe shape, travel, pressure, and many other variables for this new design. The industry simply must gain experience on how to cope with this problem," he says. "Surface mounting will be a major force in board assembly. But people have seriously underestimated the test problem with its potential for trouble."

As a result, the automated-test-equipment industry has come up with a two-sided clamshell fixtures with special probes on 50-mil centers. They interface a board's many leads with the tester. Augat/Pylon, GenRad, Teradyne, and Zehntel already offer units. A typical fixture (Fig. 3) is a pneumatically actuated bed-of-nails unit for loaded pc boards of up to 8 by 10 in. with surface-mounted devices on 50-mil centers on both sides of the board.

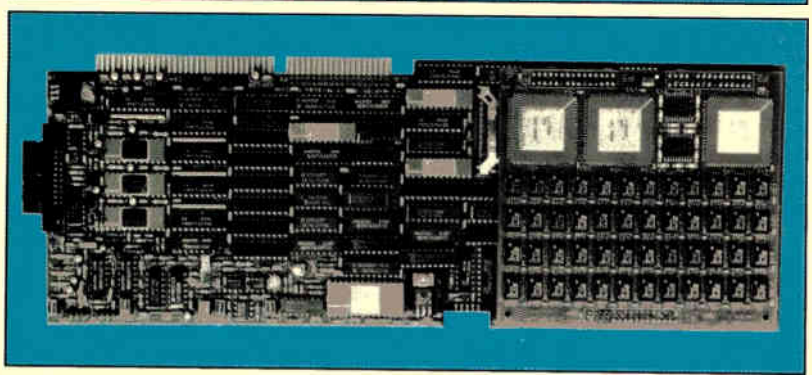
This Augat/Pylon Inc. unit features a horizontal mount, which reduces overall wiring lengths. It is fan-cooled for maximum heat dissipation in the unit under test. (Older vacuum-actuated units have no provision for



2. MIXING METHODS. Boards with surface- and conventionally mounted components take many steps to assemble. SMDs can be on one side or mixed with through-hole devices.



3. GO-BETWEEN. Two-sided surface-mounted boards need a special interface fixture, such as the pneumatically actuated unit from Augat/Pylon.



4. COMBO. An image-processing board has surface-mounted random-access memories with gate arrays and standard logic chips in dual in-line packages.

cooling.) The use of transfer contacts eliminates the chance of wire failure.

Interestingly, Teradyne Inc. has kept its fixture wiring short to preserve the signal quality of the unit under test. Because surface mounting offers higher performance, a good fixture shouldn't degrade this advantage.

Another approach to SMD testing is to design appropriate test nodes onto the board. Several companies have already designed boards that can be accessed from the top with standard vacuum-actuated fixtures. Another technique features clusters of test points around critical areas.

SELECTED SUCCESS

Despite an industry recession and the fact that some manufacturers are still mired in debugging production lines, surface mounting is making inroads in some sectors. Imaging Technology Inc., for example, is using surface mounting to produce image-processing hardware—a mixed-component board designed for the IBM Corp. Personal Computer (Fig. 4). The board combines standard DIPs, gate arrays in leadless chip carriers, and surface-mounted plastic leaded chip carriers.

Manufacturing engineers at the Woburn, Mass., company attended sessions at TI's Surface Mount Center to gain first-hand experience, says Tony Camarato, vice president of manufacturing. In fact, the company's engineers turned out 15 to 20 sample boards at the center.

Armed with that knowledge, Imaging Technology's engineers bought equipment—a pick-and-place machine and a batch vapor-phase reflow-soldering machine—and went into successful production. The biggest problems were finding a good solder paste and redesigning some solder pads for surface-mounted components, such as plastic leaded chip carriers and passive chips, according to Camarato.

At John Fluke Manufacturing Co., surface mounting also has moved from research and development [*Electronics*, Feb. 9, 1984, p. 120] to manufacturing. The Everett, Wash., company has gone to surface mounting mostly to cut board size. Out of 30 designs, it has six in production.

The assembly line for the company's popular miniature digital multimeter combines a pick-and-place machine for conventional chip components and a special robotic soldering station for 60-lead four-sided plastic flatpacks that cannot be handled easily by a pick-and-place machine. Fluke's SMD boards are mostly Type IIs and use both vapor-phase belt and dual-wave soldering for their mix of components. The company is building a flexible assembly line that can produce either standard boards or boards with mixed components, based on just-in-time component delivery. With the new line, Fluke aims to be able to switch board types with only a 5-minute delay.

"Testing is a problem," acknowledges Robert Burns, engineering section manager of Fluke's advanced process and component group. "Our solution is to put in many testing points." The company uses 9 million SMDs a year and has the capacity to use 15 million SMDs a year.

With the exception of Fluke and a few other large companies, most component makers are loath to start up in-house surface-mounting efforts. That gap is being filled by a spate of surface-mount-assembly business, represented by AWI, Orchard Electronics, Microindustries, and a host of startups. One such company is Xetel Corp., founded in April 1984 by a group of former TI employees. The Elgin, Texas, company designs, prototypes, produces, and tests boards. What's more, Xetel engineers have designed special test clips for testing the more popular sizes of plastic leaded chip carriers and SOICs.

Xetel does mostly Type II and Type I assemblies with two pick-and-place machines, a belt-type vapor-phase-reflow system, and a wave-soldering machine. The SMD-board designs are done on a Cadnetics Corp. computer-aided design system. The new SMD assembler has standardized on pc boards with 8-mil lines and spaces. "Despite the fact that we are in a recession, the last four months has seen our design business growing. At the same time, our assembly business is picking up. I am optimistic about surface mounting in general," says Xetel president Emory Garth.

At Microindustries Corp., "business has picked up radically in the last six months," says Chuck Richardson, vice president of manufacturing and business development. The Westerville, Ohio, company has taken orders for completely surface-mounted boards. Surface mounting's slow development in the U. S. may be due simply to inertia, says Garth. "People don't want to give up technologies they are comfortable with."

In any case, surface mounting remains the most space-efficient and highest-performance method to connect present and future generations of high-speed very large-scale integrated circuits. Eventually, it will garner most of the U. S. pc-board business. But when that will occur depends on the worldwide economy and the progress of the U. S. electronics industry up the SMD learning curve. □

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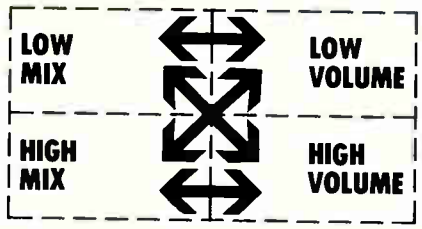

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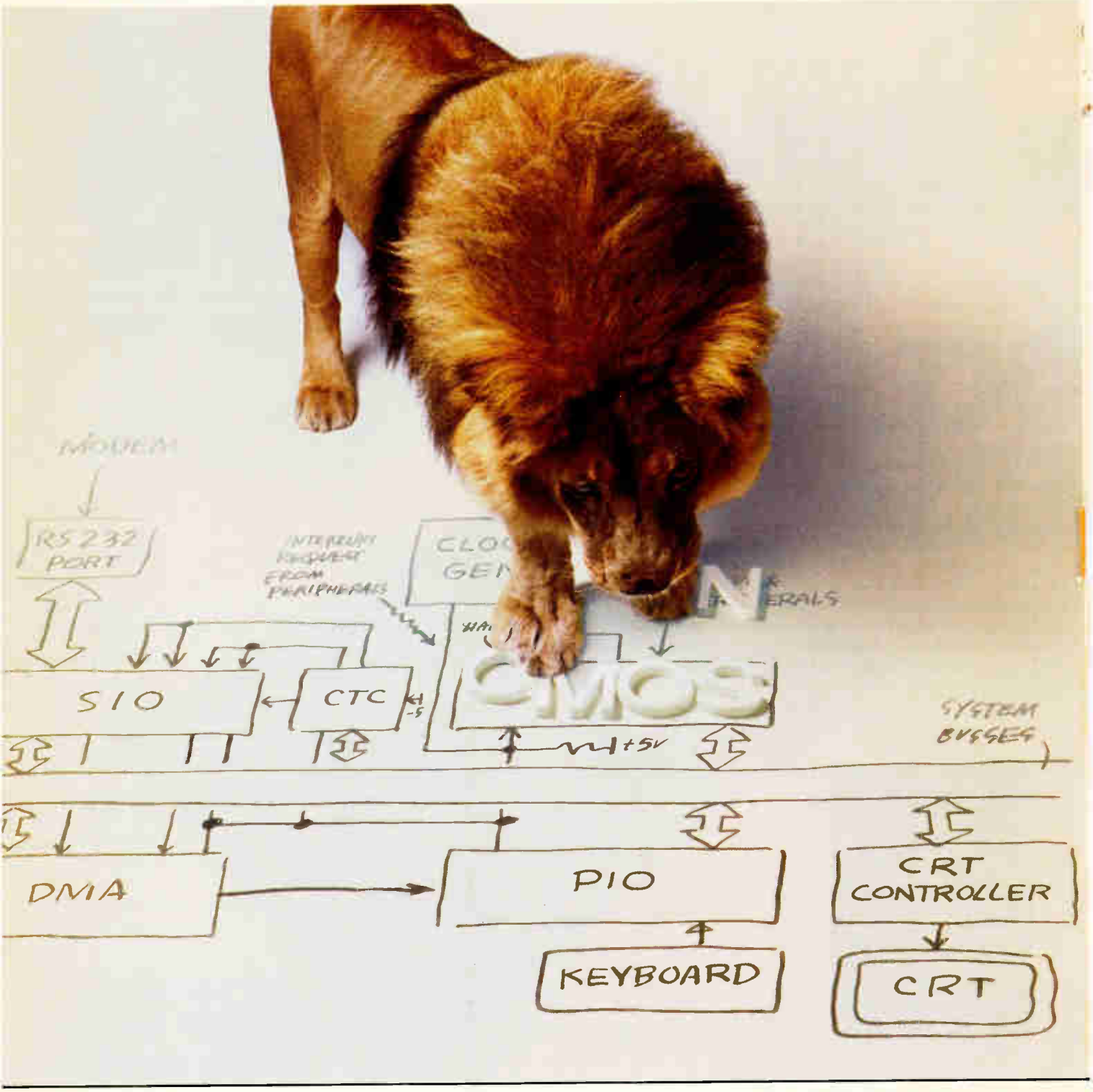

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TMPZ84C20	PIO: Parallel Input/Output Controller	CMOS	2mA	< 10μA
T6497	Clock Generator/Controller	CMOS	2mA	< 10μA
TMPZ84C40	SIO: Serial Input/Output Controller	CMOS	25mA	< 10μA
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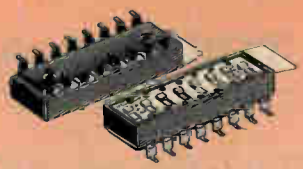

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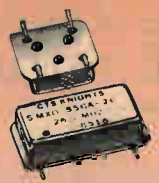

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SLOT ISOLATION YIELDS DENSEST BIPOLAR PROM YET

IMOX-III HALVES TRANSISTOR CELL SIZE FOR SPEED AND POWER GAINS

To create a faster, denser, bipolar programmable read-only memory, integrated-circuit designers at Advanced Micro Devices Inc. have turned to a new bipolar process that uses reactive-ion-etched slots to isolate implanted transistors. The Sunnyvale, Calif., company's IMOX III-Slot process makes possible transistor cells that are half the size of previous bipolar devices. The result is bipolar speed and significantly reduced power dissipation in dense ICs.

By coupling IMOX III-Slot, which is an enhancement of the company's earlier IMOX and IMOX II processes, with a silicide-fuse process, AMD designers have produced a 128-K TTL bipolar PROM, the densest of its kind. The Am27S51's maximum access time of 35 ns compares with an identical figure for 16-K CMOS PROMs. Even faster speeds will be possible when AMD applies the IMOX III-Slot process to lower-density PROMs and emitter-coupled-logic PROMs; the company is already using it in several random-access memories and programmable logic arrays.

128-K PROM is as fast as 16-K part but uses ⅛ of the power per bit

The IMOX III-Slot process maintains the high reliability and high drive capability inherent in bipolar devices. Another important advantage of the process is its low power consumption: the Am27S51 uses just one eighth the power per bit of a comparably fast bipolar 16-K PROM and has no latchup.

The process's key innovation is the separation of the transistor structures by a reactive-ion-etched slot less than 2 μm wide and more than 3 μm deep. This narrow, deep, vertically walled slot keeps each transistor separate from all others. Because the transistors do not depend on junctions for isolation, the depletion spread necessary in junction-isolated structures is not an issue. Furthermore, the depth to which slots can be sunk removes limitations on high-voltage structures ordinarily imposed by oxide-walled devices.

Elimination of the isolation structures around a transistor dramatically reduces the device size: IMOX III-Slot structures require less than half the area of similar structures produced in IMOX II. AMD expects those structures eventually to occupy less than one fifth the area of similar structures produced with IMOX II. Expected advances in lithography techniques could permit even further reductions to submicron geometries.

The IMOX III-Slot process is a major improvement over previous IMOX generations. Minimum feature size is 2 μm, with a pitch of 4.5 μm. IMOX III-Slot incorporates many of the features used in IMOX II for transistor structures and upper-level metals. It uses two independent layers of metal and silicides for both Schottky formation and fusible links in the array (Fig. 1). The array is a matrix of Schottky diodes and polysilicide fusible links. Titanium tungsten is used as a barrier metal to prevent aluminum spiking from shorting junctions.

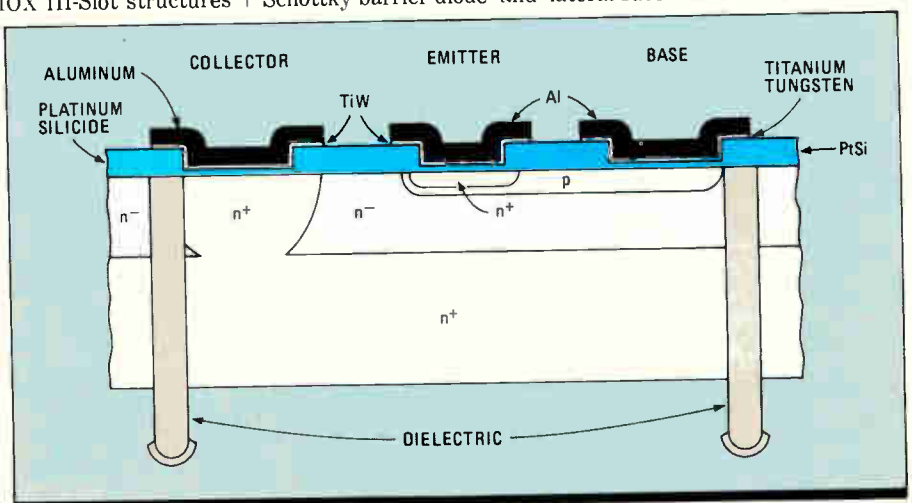
WALLED EMITTERS AND BASES

The two layers of metal are separated by dielectric glass that has been planarized by a plasma-etch process. The process uses shallow implanted transistors similar to those employed in previous IMOX generations (see "AMD's IMOX enters second decade," p. 36). These structures use walled emitters and bases to reduce the size of the transistors. Arsenic emitters and enhanced-conductivity extrinsic bases increase transistor speed. The transistor structure used in IMOX III has proven reliable over millions of hours of high-temperature operating-life tests on a variety of AMD products that use IMOX II.

The slot-etching process requires a subtle mix of techniques to achieve walled slots with smoothly shaped sides and bottoms. The surface topography after the completion and back filling of the slots also requires precise shaping (Fig. 2).

Walled slots must be etched carefully to avoid generating and propagating defects around the slot. Such defects can cause transistor pipes to develop through the base region, resulting in collector-to-emitter shorts. Even moderate densities of collector-to-emitter defects hinder the manufacture of small bipolar RAMs.

Use of a platinum silicide Schottky array cell ensures high yields. By carefully positioning the lateral fuse, the AMD team created cells comparable in size to those formed with avalanche-induced migration, and the yields associated with Schottky-barrier-diode and lateral-fuse structures have been



1. ISOLATION. In the IMOX III process, walled slot structures isolate transistors to permit greater density. Metalization consists of aluminum, titanium tungsten, and platinum silicide.

TECHNOLOGY TO WATCH is a regular feature of Electronics *that provides readers with exclusive, in-depth reports on important technical innovations from companies around the world. It covers significant technology, processes, and developments incorporated in major new products.*

AMD'S IMOX ENTERS SECOND DECADE

As the quest for smaller integrated-circuit geometries and lower power consumption progressed, early bipolar processes without oxide isolation posed significant problems. They involved an unwalled emitter structure that required considerable silicon area to isolate the collector and emitter regions. In 1978, Advanced Micro Devices Inc. introduced its first ion-implanted oxide-isolated process, called IMOX, which used oxide isolation to separate the transistors. With it, AMD shrank the device size dramatically for its 1-K bipolar random-access memory.

In 1979, AMD introduced a substantial enhancement to this process, called IMOX II, which used many of the same walled transistor features of the fully oxide-isolated process, but combined this feature with a junction-isolated diffusion that allowed thicker epitaxial layers and easier manufacturing. Minimum feature size was reduced to 3 μm, with a metal pitch of 8 μm. The Am29300 32-bit microprocessor family of functionally partitioned building blocks is fabricated using this process. AMD has also used the process for most of its bipolar programmable read-only memories and logic arrays.

maintained. In addition, the Schottky array cell is easier to repair than the avalanche-induced-migration cell array and requires that only simple redundancy be built in.

Unlike other companies making large bipolar PROMs, AMD chose to use lateral-fuse architecture, which permits miniaturization through diagonal elements and merged fusible-link Schottky structures. In addition to high speed, this structure offers high yields, and its simplicity makes it easy to manufacture. The platinum silicide fuse is the same fuse that is used on all AMD PROMs. It has an impressive reliability record—more than 126 billion fuse hours without a failure.

One advantage of Schottky fuse-link arrays is that defects show up as open circuits. Defects in the avalanche-induced-migration cell arrays show up as shorted devices, causing rows to short to columns and vice versa. Another advantage of the Schottky-barrier-diode structure is its brief programming time—typically less than 5 μs; most fuses blow in less than 300 ns.

Power limitations in the circuit design were overcome by using a proprietary multiplexing circuit to share power in the arrays between adjacent column lines. This lets large amounts of current drive the array lines up and down at high speeds without dissipating the current in each column. Temperature- and voltage-compensation networks also reduce the variation in ac performance, getting the most efficient use of the available current. Because the Am27S51 dissipates only 190 mA, it saves a tremendous amount of power compared with smaller PROMs.

Though bipolar PROMs do not suffer to the same extent as bipolar RAMs from collector-to-emitter defects, PROMs must have extremely good metal-film consistency to build chips with densities of 128-K and higher. This requires both extremely smooth surfaces and extremely clean film depositions. AMD's designers solved these problems after extensive experiments with the slot's location and the precise shaping of subsequent silicon dioxide depositions.

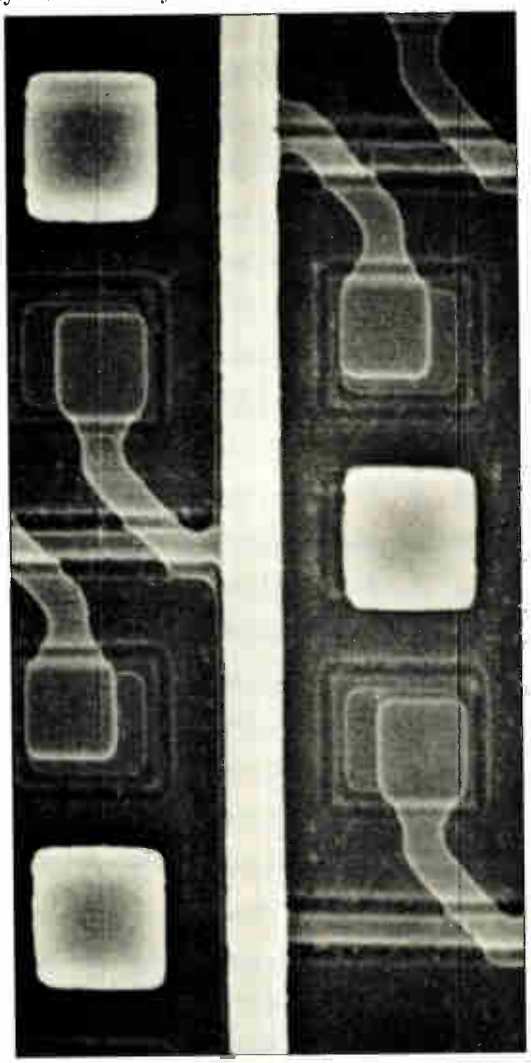
The fusible-link cell, though common in PROMs, has been less popular in large PROMs because it traditionally has taken more area than the vertical avalanche-induced-migration structure, which has an open base with a shortened pn junction at the collector diode. The AIM structure requires the use of a transistor, however, and so it is subject to the kinds of defects associated with a complex structure, especially at the 128-K level.

The Am27S51 comes in a 28-pin 600-mil ceramic dual-in-line format of 16-K words by 8 bits and contains extra test rows and columns (Fig. 3). The 128-K part is aimed at traditional bipolar PROM applications such as control store and microprogram machines, where a continuing trend to deeper stores will require depths of more than 8-K words. At those depths, the Am27S51 will provide the highest speeds available as well as attractive power-per-bit levels.

The IMOX III-Slot process technology has already been used to achieve high performance and reliability in a variety of other products at AMD. The advantages of its low sidewall capacitance, small and extremely fast transistors, and tight metal spacing make this process desirable for ECL as well as for TTL systems. It is particularly suited for high-density, high-performance bipolar RAMs, whose memory size has long been limited by the minimum transistor pitch. Slot isolation overcomes this limitation with a channel that is deep enough to completely penetrate and laterally isolate the n+ buried collector. So the antimony collector can simply be put down as an unmasked sheet layer. And because the slot doesn't change dimensions during subsequent heat treatment, the only potential source of variation is the manufacturing process itself.

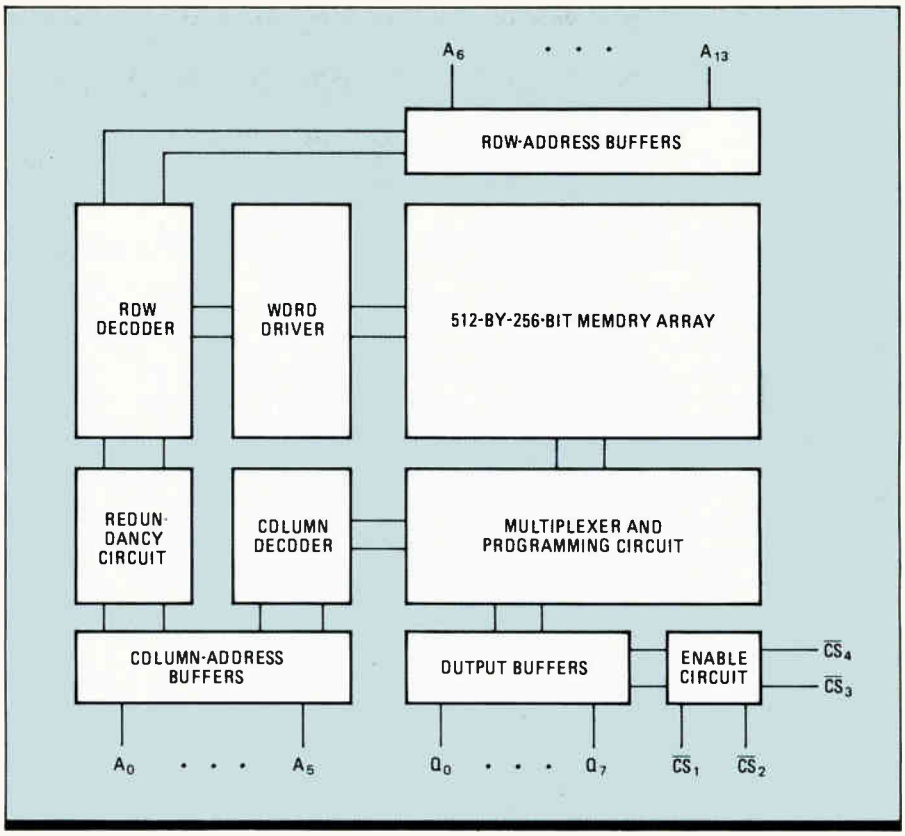
The use of active lateral pnp transistors in the memory cell, with their inherently low standby power (typically less than 1 μA), high noise immunity, and low impedance during cell access, creates a sense-to-standby current ratio of over 150 : 1 and results in a fast access time. Also, because with IMOX-III the RAM does not require high programming voltages, it can be built using shallower structures than those required for PROMs. Neither is fuse processing required unless redundancy techniques are used. Other than these differences, the PROM and RAM processes in IMOX III are identical.

A family of AMD ECL RAMs using the IMOX III-Slot process features fast access times over a wide temperature range. A complementary memory-cell design provides inherent resistance to errors that are induced by alpha parti-



2. TIGHT SPACING. Smoothly etched 2-μm-wide slots isolate devices in the Am27S51, a bipolar 128-K programmable read-only memory.

3. DENSER DESIGN. Advanced Micro Devices' bipolar 128-K PROM incorporates extra test rows and columns. It has an extremely fast programming time per fuse.



cles. All AMD ECL RAMs are configured for use with either 10K or 100K logic families.

Two ECL RAMs currently being produced with IMOX III are a 1-K-by-4-bit part with a 10-ns address-access time over the commercial temperature range of 0° to +85°C and a 16-K-by-1-bit RAM with a 15-ns address-access time. These parts are also designed to be used over the full military temperature range. In fact, the 1-K-by-4-bit part is the first ECL RAM to meet the 15-ns specification from −55° to +150°C, which is actually more than the military specification range of −55° to +125°C.

Products to be introduced in mid-1986 include a 4-K-by-4-bit RAM and a proprietary 512-K-by-9-bit part with on-chip logic for use in cache-memory systems.

AMD is also using the IMOX III-Slot process in the production of high-performance ECL PLAs. The AmEPAL20EV8 is a 24-pin part with 3,600 programmable fuses in a programmable AND/OR array. Offering architectural flexibility, high density, and speed, this device is designed to blend the advantages of gate arrays with the off-the-shelf availability of standard products.

The AmEPAL20EV8's eight combinatorial and registered macrocells let the designer individually customize the architecture of each output. Selective blowing of fusible links configures the output as either combinatorial or registered and controls the output's polarity.

With variable distribution of 80 logical product terms, the user can allocate complex functions to the outputs with the larger number of product terms. With a 6-ns propagation delay and 8-ns cycle time (3-ns clock-to-output plus 5-ns setup time), the AmEPAL20EV8 supports a 125-MHz system. □

AMD ENGINEERS SHARE MORE THAN JUST BIPOLAR DESIGN

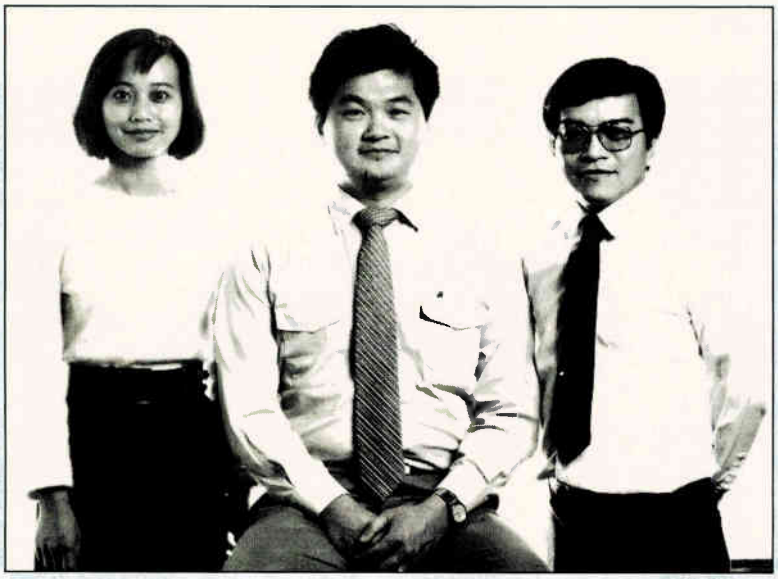
Three young design engineers in the Bipolar Memory Division of Advanced Micro Devices Inc. share more than their work on the company's IMOX III-Slot process and their Asian backgrounds. Their careers are all remarkably similar. All three—Phi Thai from Vietnam and S. C. Chang and Mann-chii Yang, both of Taiwan—have degrees in electrical engineering from California universities and have honed their design skills exclusively at AMD.

Phi Thai, the design team's leader, left Vietnam in 1971. After earning his BSEE from San Jose State University in 1975, he spent nine years at AMD and one as a consultant for Thomson-CSF in Paris. Now back at AMD, Thai supervises a 10-person group charged with developing bipolar programmable read-only memories.

Thai says the next step in his field is to focus on still higher-density TTL and emitter-coupled-logic designs—a view shared by his associates on the Am27S51 development project.

Yang says she had "theoretical experience with CMOS, but no other design experience before starting at AMD." She graduated with a BSEE from the University of California, Berkeley, in 1983.

Chang received a bachelor's degree in industrial management from the National Taiwan Institute of Technology in 1976. He then switched to electrical engineering and earned an MSEE from Thai's alma mater, San Jose State, in 1980. "I didn't like management," he says. "People are difficult to manage. At least in design engineering, a diode is a diode and you know what to do with it."



TIGHT TEAM. Yang, Thai, and Chang designed AMD's 128-K bipolar PROM using the IMOX III-Slot process. All three have spent their design careers at AMD.

SBS LAUNCHES PUBLIC SWITCHED ENCRYPTION SERVICE

COMMON CARRIER'S SATELLITE OFFERING MEETS DOD GUIDELINES

Maintaining the integrity of proprietary information is becoming critical to a growing number of companies. And these companies—typically government contractors required to protect sensitive traffic and smaller companies with valuable proprietary information—have been trying to find an inexpensive means to protect their sensitive voice and data traffic from interception. Encryption, long favored by the military to protect its traffic, is already protecting the networks of large corporations. But it is costly to implement and has not been generally available in public switched networks.

A solution to their problem may now be at hand. With Satellite Business Systems Inc.'s new Traffic Protection Service, these companies will have the means to secure their telecommunications traffic on a common-carrier subnetwork at costs competitive with nonencrypted services. The new service has significantly improved the economics of encryption, says the McLean, Va., company, because it treats large amounts of traffic in bulk through a single encryption unit before it enters the satellite transmission system.

Bulk-encrypting 1,000 voice channels keeps the costs down

Helping to keep prices low is that only one bulk-encryption unit per earth station is required on the SBS network. The encryption unit meets rigid federal standards for physical security and implements a variation of the government's Data Encryption Standard (DES) output-feedback mode using two keys—a master and a working key. The master key is used to decrypt a working key that is changed periodically.

Exacerbating the need for such a protection service for the corporate sector is mounting evidence that sophisticated foreign adversaries and criminals are intercepting U. S. domestic commercial communications, says Frank Stein, SBS project coordinator for communications protection. "The greatest weakness in our communications infrastructure is the long-distance telephone networks, because of the enormous amount of information passed and the networks' vulnerability to interception."

Long-distance telephone networks are particularly vulnerable to eavesdropping because they rely heavily on microwave and satellite transmission systems. A wiretap, the cheapest and easiest method of intercepting communications, also subjects the eavesdropper to the greatest risk of detection. But signals from a microwave tower or satellite can be monitored without physical access to telephone company equipment and without leaving telltale signs. Because it cannot be detected, it therefore is much more insidious.

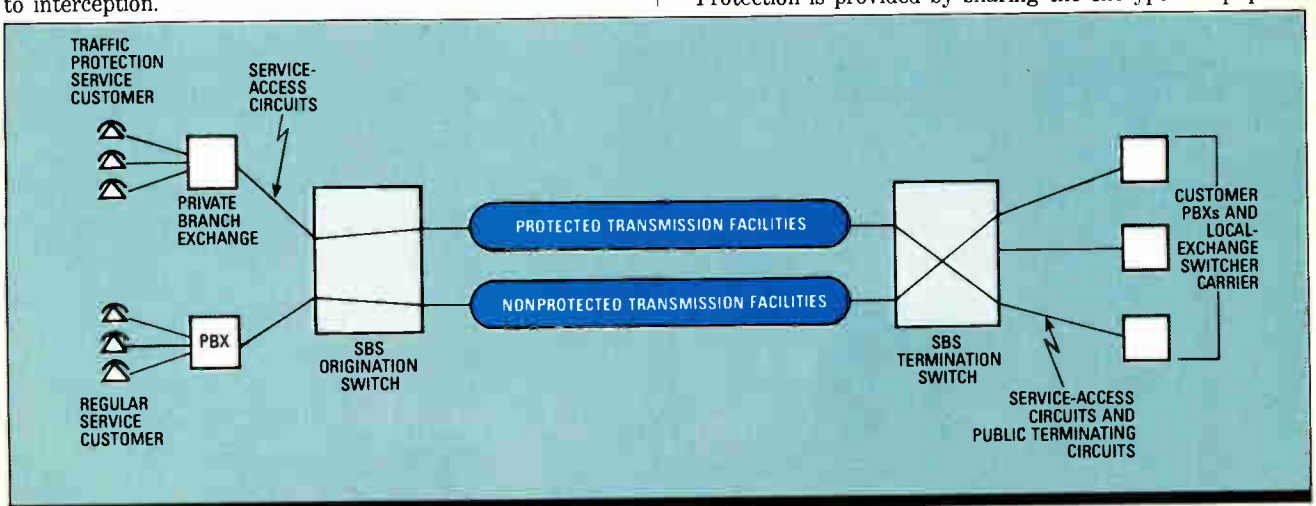
TRANSPARENT SERVICE

For federal contractors and companies concerned about protecting proprietary data, inexpensive encryption services have not been readily available. Secure telephone units are on the market, but generally they are too expensive to be distributed widely throughout a company. Very large corporations can build a private encrypted network, but most companies are not big enough to justify the expense involved. Even when a company does have the resources to build one, a private network does not connect it to its customers, suppliers, subcontractors, and government offices.

According to Stein, the Traffic Protection Service option was designed to be transparent to users, and the incremental cost of obtaining protection is low enough to make the service attractive. "Transparency implies that once customers subscribed to the option, end users would be unaware that their calls were protected," Stein says. "It prevents the type of security violations caused by employees who might inadvertently fail to protect sensitive data."

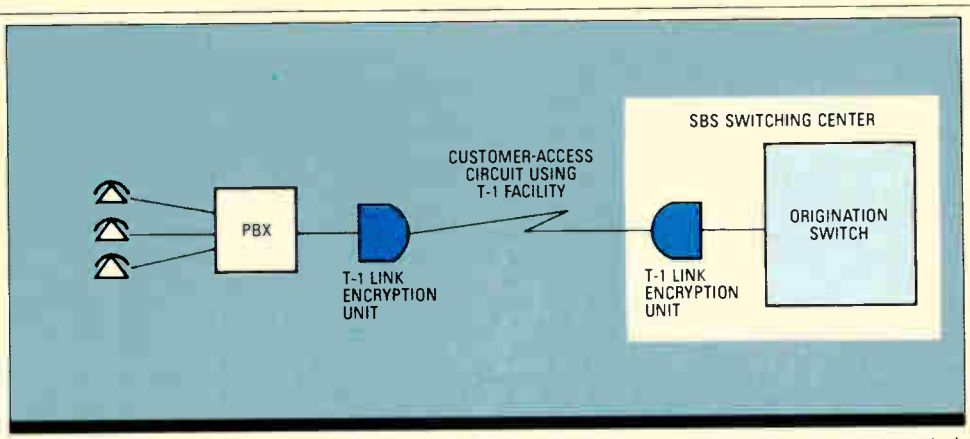
The Traffic Protection Service is overlaid on the basic SBS nationwide digital network, known as Skyline. The network consists of 25 switching centers in major U. S. cities, linked by the SBS time-division multiple-access (TDMA) satellite system. Additional cities are attached to the network by terrestrial facilities.

Protection is provided by sharing the encryption equipment



1. NETWORK ARCHITECTURE. Satellite Business Systems Inc. chose to share encryption equipment costs among several customers at each network switching center to yield economies of scale.

among several customers at each SBS network switching center (Fig. 1). Because the economies of scale offer significant savings in most telephone-equipment designs, including encryption equipment, sharing is a way to keep incremental costs down. SBS decided for economic reasons that, rather than protecting the entire network capacity, only enough capacity would be protected to meet forecasted demand for protected service. The switches are programmed to route calls coming from Traffic Protection Service customers only over protected facilities.



2. ACCESS CIRCUITS. Customers with dedicated linking circuits to a network node can augment their protection from wiretapping by placing link-encryption units at either end of the circuit.

WATS customers or others with T1 links have access to the nearest SBS switching center through the dedicated access circuits provided by the local exchange carrier. These circuits usually use twisted-pair wire or coaxial cable but could be on terrestrial microwave. Customers generally consider the wiretap threat to be sufficiently low that no further protection is required. Link encryption units at either end of the circuit can be used when the local link is by microwave or when maximum security is needed on a wire circuit (Fig. 2). Private network customers that lease their lines from SBS can protect transmissions between their private branch exchanges by encrypting the access circuits from all PBXs.

HIGH-SPEED ENCRYPTION

SBS decided the best approach to protect the satellite system was to bulk-encrypt transmissions from earth station to earth station using specially designed high-speed encryption units. As an alternative, SBS considered using off-the-shelf T1 (1.544 Mb/s) units to encrypt the earth-station traffic, but this would have required establishing fixed trunks.

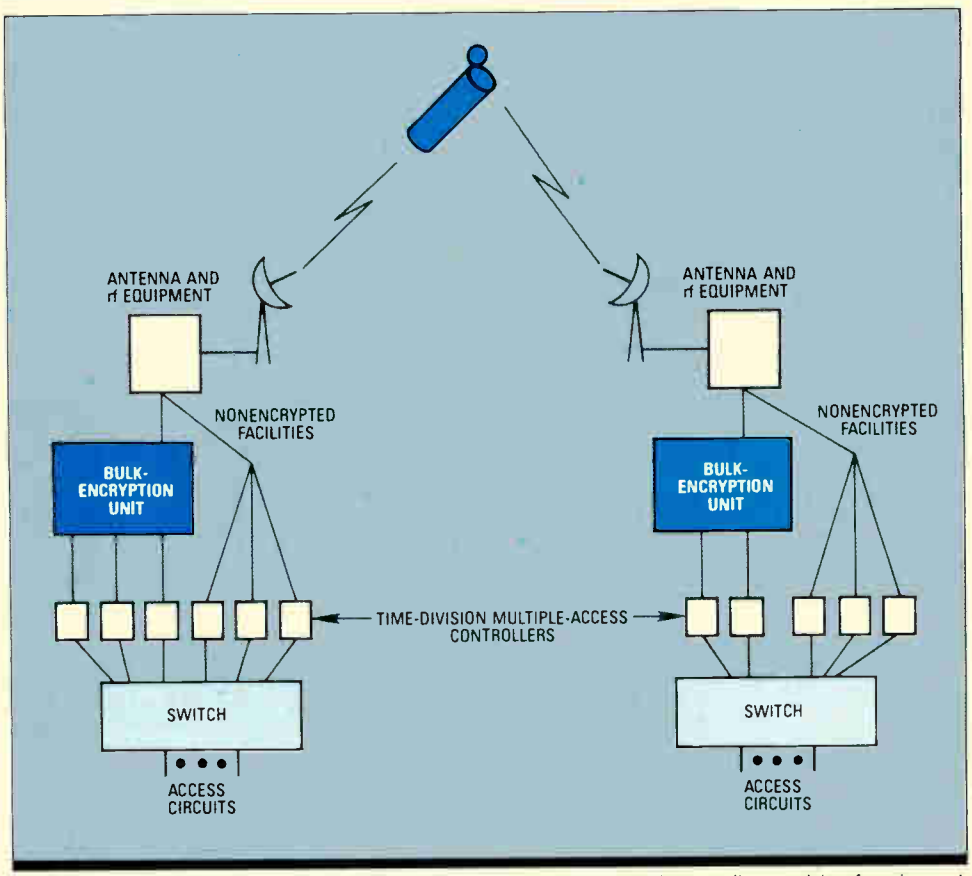
Because fixed-trunk capacity cannot be reallocated, the alternative was discarded. Other carriers are going this route to encrypt the terrestrial microwave transmission paths between their switching centers. This requires encrypting and decrypting at each modulation/demodulation point along each microwave route, however. With the SBS approach, only one encryption unit is needed at each earth station.

SBS's proprietary data-encryption unit handles the bulk encryption. Functionally, it sits between the TDMA controllers and the radio-frequency equipment (Fig. 3). The data-encryption unit operates at the earth-station burst rate of 48 Mb/s. In tandem with a data aggregator, it can encrypt and decrypt the traffic of up to three TDMA controllers, or about 1,000 voice channels.

With such high capacity, only one data-encryption unit is required per earth station. This offers significant savings, even though the cost per unit is slightly higher because of the higher data rate at which it must operate.

The data-encryption unit meets the federal DES requirements for equipment carrying government contractors' sensitive unclassified data. SBS has made proprietary enhancements to DES, including the use of multiple data-encrypting working keys, which are generated from the master keys and changed frequently.

SBS uses the DES output-feedback mode, which adds a block of pseudorandom data on a bit-for-bit basis with each block of plain text. This mode is preferred for satellite links because it does not extend errors—that is, a single transmission error will not result in multiple errors when decrypted. This is important for voice, facsimile, and video applications



3. BULK ENCRYPTION. The bulk-encryption units sit between the TDMA controllers and the rf equipment, handling the traffic of up to three TDMA controllers or about 1,000 voice channels.

WHAT THE GOVERNMENT IS DOING ABOUT DATA INTERCEPTION

Any information passed over the public switched telephone network—speech, data, facsimile, and teleconferences—is subject to interception. It becomes even more of a target if it includes data on military contracts, industrial research and development, or financial transactions. To the U.S. government and its contractors, the interception of sensitive information is a national-security concern [*Electronics*, Feb. 3, 1986, p. 27].

For example, a recent Pentagon report noted that the Soviet intelligence services have targeted information from defense contractors, manufacturers, foreign trading companies, and academic institutions in an attempt to improve their military technology. A widely held belief is that the Soviets and other foreign intelligence services secretly monitor telephone calls from U.S. diplomatic and United Nations properties. In 1978, a Soviet defector reported that the Soviet intelligence service has been monitoring and recording telephone calls from the Soviet UN ambassador's mansion in Glen Cove, N.Y. It is also believed that the Soviets monitor communications in the Silicon Valley from their consulate in San Francisco.

The U.S. government has already taken steps to improve telecommunications protection for sensitive telephone traffic. In 1982, the government issued "National Policy for Protection of Telecommunications Systems Handling Unclassified National Security-Related Information," better known as NCSC-11. This policy requires any government agency or government contractor to protect any transmission of unclassified information related to national security.

Last June, the Defense Department issued "Security of Defense Contractor Telecommunications," which made telecommunications protection an item in each DOD contract and established a procedure with which government contractors could charge back the costs. A modification to the federal acquisition regulations, expected during this quarter, will extend similar provisions through all government agencies and departments.

where the transmissions are in real time and are not protected by error-recovery schemes.

Other DES modes, which are error-extending, would degrade the customer's bit-error rate. For example, if the decryption method were to transform a 0.1% bit-error rate into 3.2%, as would happen using the DES cipher-block chaining mode, the system would not be usable.

But the output-feedback option has one potential disadvantage when compared with other modes. Although it is relatively insensitive to transmission errors, it is potentially sensitive to jitter, bit loss, and clock slippages. These conditions could produce loss of transmission synchronization and signal garbling until a resync signal is received.

In systems that do not use TDMA, this might cause a problem, but very precise bit timing is intrinsic in the SBS system. The TDMA clock at each earth station is stable to better than 10^{-9}, so that even a brief loss of signal does not cause loss of synchronization.

The data-encryption unit was also designed to exceed the requirements in Federal Standard 1027, "General Security Requirements for Equipment Using the Data Encryption Standard." This standard covers physical security, key variable entry, self-testing, and other physical parameters (see "What the government is doing about data interception"). For an encryption unit to meet the standard, it must be fail-safe—meaning that the unit will shut down rather than risk the transmission of unencrypted or incorrectly encrypted traffic—and highly reliable.

To ensure reliability, SBS has built extensive redundancy and diagnostics into the hardware, including a self-testing feature that compares the output of the online spare encryption/decryption board to the active encryption and decryption boards. A majority-vote rule determines which of the three boards has failed. The redundant unit is then switched automatically into its place.

Before the network could be used to protect government or government contractors' information, both the system and operational procedures had to be approved by the National Security Agency, the federal agency responsible for ensuring the security of communications under NCSC-11. SBS met the NSA's requirements by establishing procedures to securely manage the distribution of encryption keys to all field locations as well as to provide for the physical security and maintenance of the encryption equipment. □

ENCRYPTION SCRAMBLED STEIN'S WORKWEEK

Engineers are famous for working late into the night to meet project deadlines, but when Frank Stein and his crew began cutting over an encryption option to a public-switched satellite transmission service, the starting time was set for the wee hours of Sunday morning. "Because traffic on the network was lightest on the weekends, we found the hours from 1 to 4 a.m. the best time to do the installation," Stein says.

Stein, who holds a master's degree in electrical engineering from Stanford University and an MBA from George Washington University, is responsible for the implementation and introduction of Traffic Protection Service as well as coordination of Satellite Business Systems Inc. with the National Security Agency and other government bodies defining policies for the safeguarding of communications.

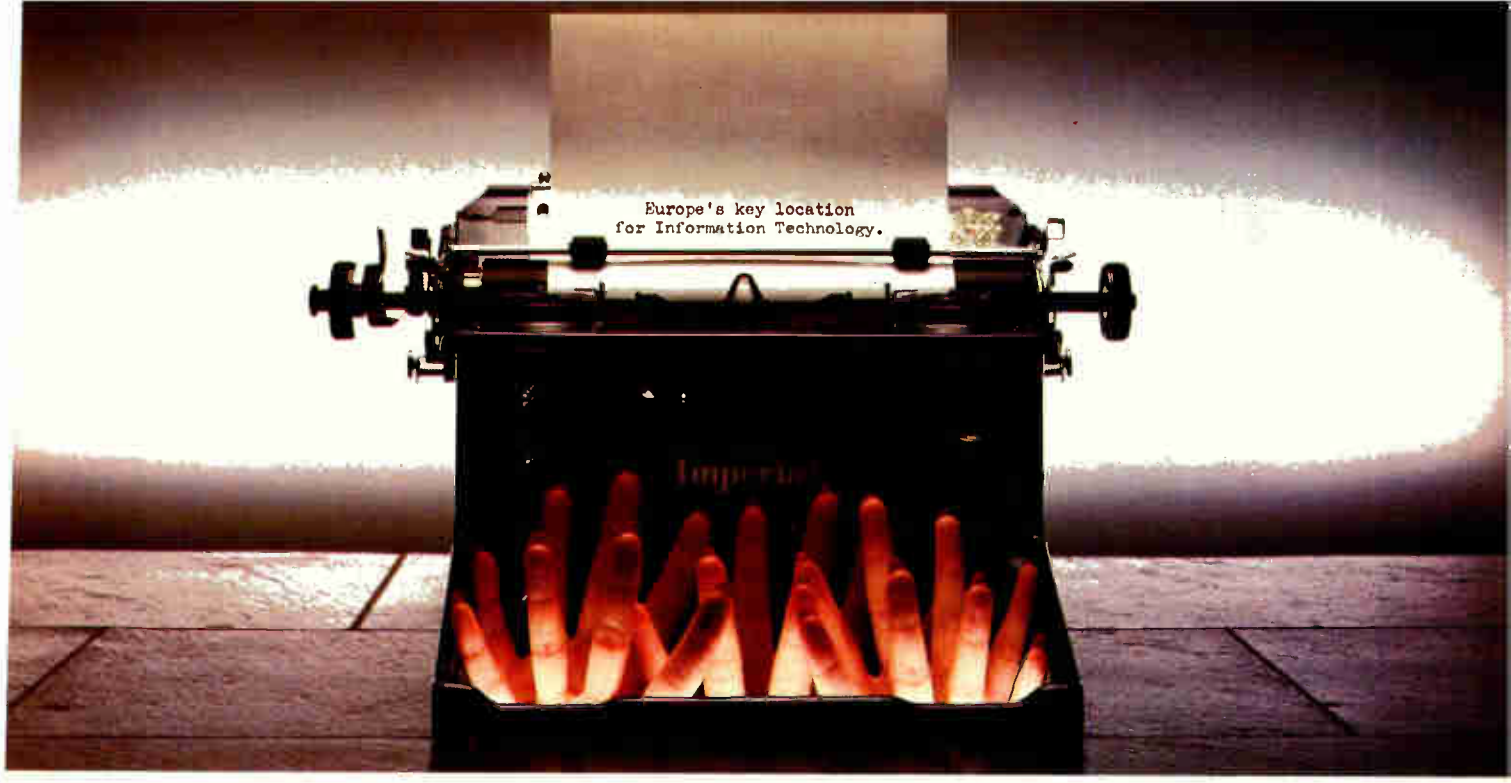
Stein led a 70-member team that cut over the new hardware. "It took several weekends to coordinate installation of the hardware, distribute the encryption keys, and assure their sequencing among our 25 network nodes," he says.

"We decided beforehand to cut off all work at 4 a.m. so as not to interfere with our customers' access to the network. On one weekend, we had 24 nodes up and running, but at 3:58 a.m. we still had that one node out of sync. We just couldn't get it right, so we finally came in the next weekend to get it right."

As a senior member of SBS's System Architecture Department, Stein helped define encryption equipment for the Traffic Protection Service and developed the operational plan of SBS's bulk-encryption system for its private network customers.

Stein joined SBS in 1980. He was previously a member of AT&T Bell Laboratories, where he designed functions and features for packet-switched networks.

WEEKEND WARRIOR. Frank Stein's work week began at 1 a.m. Sunday to add the SBS encryption option.



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PROBING THE NEWS

REAGAN'S BUDGET: HOW THE INDUSTRY WOULD FARE

DEFENSE ELECTRONICS CONTENT EXPECTED TO GROW

by George Leopold and Alexander Wolfe

WASHINGTON

With the Reagan Administration submitting a $994 billion fiscal 1987 budget that cuts domestic spending in favor of military increases, a battle is shaping up between congressional critics of military spending and the White House. But no matter which side wins, industry analysts predict that the defense electronics segment of the budget will continue to grow, albeit slowly, as the Pentagon's emphasis continues to swing toward high technology.

By contrast, the electronics industry will find little if any growth in the budget for the National Aeronautics and Space Administration, which will have to struggle just to maintain a steady funding level for its programs. And the other nondefense agencies that spend money with the electronics industry, such as the Federal Aviation Administration and the Energy Department, are asking for about the same funding levels as last year. But they will have to fight hard to maintain even that. This year, Reagan's budget reflects an attempt to keep the budget deficit below $144 billion, since a deficit any higher would kick in the automatic cuts called for by the Gramm-Rudman Act—cuts that would hit the Administration's military spending plans.

For the Defense Department, the big ticket item in the fiscal 1987 budget is the Strategic Defense Initiative—Star Wars. The Pentagon is seeking a 74% increase in Star Wars funding to $4.8 billion, and the program is loaded with electronics (see "How the Pentagon would carve up the Star Wars request," p. 43). That figure is part of the $311.6 billion defense-spending request unveiled by the Pentagon last week, a request that officials say represents a 3% increase after inflation.

However, budget watchers immediately challenged the Pentagon's estimate, saying that it misrepresents the size of the requested increase in real budget authority over fiscal 1986. The distinction is important because many observers believe the Pentagon may be hard-pressed just to break even with Congress. Of the $311.6 billion budget authority requested, $274.3 billion was requested for outlays. Overall, the Administration seeks $320.3 billion in military spending when defense expenditures at agencies such as the Department of Energy are included.

Using the fiscal 1986 budget resolution passed by Congress last August as a baseline, Defense Secretary Caspar W. Weinberger maintained last week that his request represents 3% real growth in defense spending. But when measured against the final fiscal 1986 budget that includes cuts totaling $11.7 billion mandated by Gramm-Rudman, the request represents a rise of more than 8%. And without a compromise, automatic spending cuts mandated by Gramm-Rudman could be triggered, perhaps affecting electronics-rich defense segments.

Of the $311.6 billion, military procurement again leads DOD spending, accounting for $95.8 billion (30.7%) of budget authority. Following are operations and maintenance, with $86.4 billion (27.7%); personnel, with $76.8 billion (24.6%); research, development, test, and evaluation (RDT&E), with $42 billion (13.5%); and other items, including housing and construction, $10.7 billion (3.4%).

Whatever the ultimate fate of the proposed defense budget, many observers say the outlook for electronics will remain solid. The Electronic Industries Association predicts continued growth in defense electronics despite a possible downward trend in overall defense spending. "There will be growth in electronics markets even

PROGRAMS IN RESEARCH AND DEVELOPMENT ONLY ($ millions)

Program	Fiscal 1985[1]	Fiscal 1986[2]	Fiscal 1987[3]
Army			
Advanced Antitank Weapon System	6.0	60.3	48.7
Advanced Rotorcraft Technology Integration Light HELO Family	51.6	44.3	44.4
Army Tactical Missile System	76.4	101.5	88.2
Navy			
Joint Services Advanced Vertical Lift Aircraft	178.2	559.7	391.8
Joint Tactical Information Distribution System	249.1	200.0	211.9
Relocatable Over-the-Horizon Radar	31.6	52.6	41.1
Air Force			
Advanced Strategic Missile Systems	99.5	159.8	176.9
Advanced Tactical Fighter	90.9	164.6	294.1
Aircraft Engine Component Improvement Program[4]	222.5	183.2	207.0
Small Intercontinental Ballistic Missile in Hard Mobile Basing	465.2	624.5	1,396.2
Short-Range Attack Missile	12.4	34.1	164.7
Very High-Speed Integrated Circuits	132.0	202.0	132.9
Joint Program			
Strategic Defense Initiative	1,397.3	2,769.2	4,812.9

[1] Actual [2] Planned [3] Proposed
[4] Navy and Air Force funding involved

SOURCE DEPARTMENT OF DEFENSE

if all else goes down," notes a recent EIA report. "That's because the modifications and upgrades of platforms and weapons systems are to be, in our opinion, mostly electronic."

Some observers are less optimistic, however. "Clearly there are going to be stretchouts and cancellations" in electronics content, predicts Bruce Lupatkin, senior technology analyst at Hambrecht & Quist Inc., San Francisco.

The defense electronics marketplace is not monolithic, however. In electronic warfare, notes Kidder Peabody & Co. analyst Charles Hill, "the trend line is pretty much intact." Says analyst James I. Magid of L. F. Rothschild Unterberg Towbin, New York, "I don't think Gramm-Rudman or any possible budget solutions are going to have a severe impact on the electronic components industry" during fiscal 1987. And in Strategic Defense Initiative-related research, the trend is definitely upward.

Out on the leading edge of technology, the DOD continues to emphasize research and development programs as the way to use advanced U.S. technology to overcome manpower and matériel advantages of Soviet and Warsaw Pact forces. To this end, the DOD is seeking $42 billion for fiscal 1987 RDT&E spending, up from the $33.8 billion of fiscal 1986.

The DOD's quest for high technology ripples through almost every program. Most notable, however, are programs that focus on advanced research. Here, the Defense Advanced Research Projects Agency, the Science and Technology program, and Star Wars lead the list.

Darpa had been reeling from 1986 budget cuts imposed in the wake of Gramm-Rudman. Last year's $770 million request was chopped down to a final authorization of $660 million. But Darpa wants to get back up to speed. This year's request is $838 million, though that could be chewed down during the budget process, given the fact that Weinberger and President Reagan have repeatedly said that SDI is the DOD's No. 1 priority.

'There will be growth in electronics even if all else goes down'

"I predict that Darpa won't take that big a hit," says Joseph L. Campbell, aerospace analyst at Paine Webber Inc., New York. A portion of what Darpa comes away with will go to recoup the FY '86 cutbacks, but it also will finance the development of much of SDI's technology base. Adds Campbell, "Darpa is going to get a lot of SDI money."

Darpa now has its fingers in several R&D pies. Most notable for the electronics industry is the Strategic Computing program, the flagship U.S. effort to develop highly advanced artificial-intelligence-based computing technology. The program also has significant commercial implications, as it seeks to beat the Japanese to the punch in developing a true fifth-generation computer.

Also within the Darpa sphere is the $500 million three-year Hypersonics Technology Program, which seeks to determine the feasibility of a transatmospheric vehicle development project. Such a vehicle—part rocket and part airplane—could deliver payloads into earth orbit or transport passengers coast-to-coast in less than two hours. After a $40 million kickoff in 1986, the program is requesting $140 million for fiscal 1987.

Another Darpa effort is usually discussed in hushed tones: the Advanced Technology Bomber, code-named Stealth. The highly classified program aims to deliver a plane that will be invisible to radar, with enough range to deliver missile payloads to Soviet targets. Reportedly, at least $5 billion has been spent on Stealth since 1981, with much of the work performed at Lockheed Corp. Latest information suggests that fiscal 1986 Stealth funding may be $2.7 billion, increasing to a stratospheric $5.7 billion in 1987.

In the Science and Technology program, the DOD is seeking $5.358 billion to fund myriad ventures such as the Air Force's Advanced Tactical Fighter, the Air Force-Navy advanced aircraft propulsion program, and the software re-

HOW THE PENTAGON WOULD CARVE UP THE STAR WARS REQUEST

Though Washington is tightening its belt, one program—the Strategic Defense Initiative—seems to be getting fatter. That's because President Reagan has given Star Wars the highest priority of all U.S. military programs. Reagan has asked for a whopping $4.8 billion for the research program, up 74% over fiscal 1986 spending.

How much of that amount the Defense Department will get is an open question. But the Electronic Industries Association figures the DOD could receive a 70% hike. Last year, the Pentagon asked for $3.7 billion and received just under $2.8 billion [*Electronics*, Oct. 21, 1985, p. 45].

A strong indication of administration support is that SDI was spared from the 1986 budget cuts mandated by the Gramm-Rudman deficit-reduction act. Although DOD spending for the rest of fiscal 1986 was cut 4.9%, all SDI money was exempt.

The SDI is still a research and development program only, consisting of five technology categories. Reagan is seeking $1.3 billion—or 26.2% of fiscal 1987's total—for the Surveillance, Acquisition, Tracking, and Kill Assessment (Satka) program, which in fiscal 1986 received $857 million. Much of the work involves electromagnetic and optical sensors.

The key Satka project is the Boost Surveillance and Tracking System, which will use focal-plane arrays and advanced optics. The budget wrangle could affect the Satka Active Imaging Discrimination Satellite project, forcing a choice between two proposed ways of detecting incoming warheads—the Laser Radar and the Millimeter Wave Radar.

The next two Star Wars categories are Kinetic Energy Weapons (KEW) and Directed Energy Weapons (DEW), which seek to destroy incoming missiles using projectiles and energy, respectively. For KEW, which received $596 million in fiscal 1986, Reagan is now asking $1 billion, or 20.8% of the total pie; spending on DEW is set to rise from $844 million in fiscal 1986 to $1.6 billion, or 33.6% of the total.

Current work on KEW—popularly known as smart rocks—includes five ground-based and four space-based projects. The earthbound KEW program least likely to be cut is the Low Endoatmospheric Interceptor. Logpro, which will launch low-g-force projectiles from space, is said to have been given a high priority.

In DEW weapons systems—the so-called death rays—there is a race between ground- and space-based laser systems. Funding is likely to continue for key support technologies such as beam pointing and control electronics and beam-bending mirror systems.

Systems Analysis and Battle Management, with $461 million versus fiscal 1986's $227 million, is to get 9.6% of SDI funding. Most of it goes for software.

Finally, Survivability, Lethality, and Key Technologies gets 9.8%, or $470 million, of the SDI budget for logistics, studies of program options, and critical technologies.

While research continues, the first rumblings of deployment are being heard. Last month, the Strategic Defense Initiative Organization requested proposals from industry for the SDI National Test Bed, which will tie the SDI technology groups into a proposed deployable system. Contracts for the Test Bed could be worth nearly $1 billion. *–A. W.*

ATTACK. Weinberger says that the buildup in defense spending represents only 3% in real growth.

search center, Software Engineering Institute [*Electronics*, Feb. 3, 1986, p. 50].

The flagship electronics technology effort under S&T remains VHSIC, the Very High-Speed Integrated Circuits program. DOD's push to place large-scale systems on a microchip is now entering its second phase with its initial technology already spilling over into the commercial sector. Now, $132.9 million is requested for fiscal 1987 to help develop 0.5-μm chip-fabrication technology. To date, 1.25-μm technology has been demonstrated in VHSIC's first phase, which was funded to the tune of $132 million in fiscal 1985. During fiscal 1986, actual spending should hit $202 million. The 1.25-μm chips will proceed to the insertion phase, where they will be used in working military equipment.

On the procurement side, benefits should accrue to the electronics industry from the $95.8 billion the DOD is seeking for fiscal 1987, largely to buy aircraft and missiles. In the fiscal 1986 budget, $92.6 billion is allocated.

CHALLENGER TRAGEDY CLOUDS NASA PLANNING

While the tragic end to the Challenger space shuttle's mission 51-L casts a dark cloud over the National Aeronautics and Space Administration's next budget, the agency will push forward if President Reagan has his way.

The administration is asking for $7.7 billion for NASA in fiscal 1987, a slight increase over fiscal 1986's $7.3 billion. The White House expects to increase this funding to $8.3 billion by fiscal 1989. Whether NASA gets everything it wants from Congress for next year is questionable. Another uncertainty for the electronics industry will be how the agency's money will be spent. Replacing Challenger could reduce funding for other programs that have been moving along. NASA's budget package was completed before the shuttle accident, so program plans may well change. "We have the entire NASA budget under review," says NASA acting administrator William R. Graham. "Everything isn't on hold, but it's a very, very dynamic situation that we're in, looking back at the accident."

James P. Samuels, space analyst at Shearson Lehman/American Express, New York, says, "In light of [the accident], it may be necessary for additional funds to be allocated to NASA simply to get the program back on track." If replacement funds are not forthcoming, the impact on NASA will be serious.

Here's how the Reagan budget hits NASA's four main categories: for Research and Development, $3 billion in spending authority is sought, up from $2.8 billion this year; for Space Flight, Control and Data Communications, $3.1 billion, down from $3.4 billion; for Research and Program Management, $1.44 billion, up slightly from $1.36 billion; and for Construction of Facilities, $181 million, up from $139 million.

The agency's most important R&D project by far is the space station, for which NASA seeks $410 million in 1987, double that being spent this year. Intended to provide a permanent manned presence in space, the station will serve as an orbiting research lab, factory, and observation platform. But few believe that Congress will permit anything near that kind of increase. "There's probably going to be a fair amount of congressional scrutiny this year over the goals and timing of the program," says Mark Oderman, vice president of the Center for Space Policy.

The Space Transportation Capability Development, for boosting shuttle payloads into high-earth orbits, would get $465 million. Also due to get funding is the Hubble Space Telescope and a gamma-ray observatory .

The Probes for Planetary Exploration category will get $323 million. This area provided one bright spot recently when the Voyager 2 unmanned probe sent back a wealth of data as it passed within 50,000 miles of Uranus. Upcoming are the Magellan mission (formerly the Venus radar mapper), the Galileo mission to Jupiter, and the Mars Observer.

Using $526.6 million in funding, the Space Applications R&D segment will emphasize experiments to study the earth—the Topex oceanography satellite is one example—and explore materials-processing techniques in space. Space science and research will develop advanced propulsion systems and other technologies with $376 million; another $180.2 million will go for additional space-systems technology research.

Other R&D subcategories include life-sciences experiments ($74.7 million), commercial technology utilization programs ($45.3 million), tracking and data advanced systems ($17.1 million), and the joint Defense Department-NASA transatmospheric vehicle ($45 million).

Under the $3.1 billion Space Flight, Control and Data Communications category, NASA is seeking $745.4 million for space shuttle operations. An additional $1.5 billion will go for flight, launch, and landing operations. And some $800 million is budgeted for the agency's vital communications links. *–A. W.*

A FLAT YEAR AT BEST FOR NONDEFENSE ELECTRONICS

The Reagan budget for nondefense agencies generally presents a no-growth bag of opportunities for the electronics industry. And that's before Congress gets its budget-cutting hands on it. Running about the same as their current budgets are White House requests for the Federal Aviation Administration and the Energy Department, thanks mostly to Gramm-Rudman.

One small but important budget request is up over fiscal 1986, however. The National Science Foundation has managed a moderate increase. Its fiscal 1987 request is $1.7 billion, an increase of $130 million, or 8.4%, over the current fiscal 1986 plan of $1.6 billion. Mandated cuts, however, could reduce the 1986 figure to $1.5 billion.

The NSF budget is only about 3% of

the total national effort in research and development, but it is the primary source of support for fundamental science and engineering research and education in U. S. universities. NSF officials gave high priority to technology that pays—"activities that contribute to national economic competitiveness and innovation," in their words—and to improve the physical plant for research.

The emphasis is on computational science, engineering, and advanced scientific computing. Research programs in computational science are down for a $27 million increase, up to a total of $84 million. The NSF hopes to establish new interdisciplinary teams for advanced research in many areas of science and engineering, enhance existing research centers, and provide equipment and training opportunities.

The fiscal 1987 request for engineering is $185.5 million, up 14% over 1986. Basic research in engineering will be entering fields such as robotics and expand in such areas as design, manufacturing, and computer engineering.

The NSF will accelerate the development of the national supercomputing centers and is asking for $53.6 million for advanced scientific computing, a 19% increase. It plans development work on software, numerical methods and graphics, and the development of a national science research network.

The Federal Aviation Administration is asking for about $4.8 billion, a mere $31 million increase over its estimated fiscal 1986 budget. Of the total requested, more than half—$2.8 billion—will go to operate the nation's air-traffic-control and navigation systems, security inspections, regulation enforcement, and airport grants. Planned facilities and equipment procurement will take $825 million, which would continue the multiyear National Airspace System update, which aims to replace obsolescent, labor-intensive facilities with solid-state equipment, and to provide new facilities to handle the air traffic of the 1990s.

Other major system expenditures planned by the FAA include modernization of airport traffic-control tower facilities, microwave landing systems, systems engineering and integration support, improvements to the radar-net microwave link system, enroute doppler weather radars, terminal doppler weather radars, remote maintenance monitoring, and adapting the Loran-C navigation system for civilian use. Requested funds for research, engineering, and development by the FAA amount to $135 million, compared to $190 million in fiscal 1986. On the boards are the final development phase of automation of some ATC and modernization of its communications systems.

The Energy Department is requesting a meager 1% hike for fiscal 1987. A $498 million increase in its defense activities accounts for most of the overall budget increase. The DOE's $12.1 billion request also includes a $330.5 million cut in research and development. As a result, the agency next year will explore cooperative R&D ventures with industry in such areas as renewable energy technology. Cooperative research "will improve our technology transfer areas," says Energy Secretary John S. Herrington.

Within its defense segment, Energy will seek $72 million for space and power systems, up from about $20 million in fiscal 1986. The power systems could find their way into space-based missile defense. It is also requesting $2.1 billion for weapons research, development, and testing. Fusion research programs, which may spawn technologies of interest to the electronics industry, are also being pursued. Funded to the tune of $333 million will be fusion research using the magnetic-confinement system. Photovoltaics research remains alive, but barely. This year's budget request for solar energy, $72 million, represents a 50% cut over last year. *–Jesse J. Leaf with George Leopold*

THE STRUGGLE TO COPE WITH GRAMM-RUDMAN

From privatization schemes at the energy and transportation departments designed as revenue generators to the shutdown of entire agencies, the government is struggling to cope with the Gramm-Rudman deficit-reduction law in fiscal 1987 budget requests.

Gramm-Rudman, formally the Balanced Budget and Emergency Control Act of 1985, mandates a fiscal 1987 deficit target of $144 billion with cuts roughly split between domestic and defense spending. The Defense Department, with its $311.6 billion budget request, would be hurt less than other agencies. Nevertheless, few take seriously the Reagan administration's insistence on a real annual growth rate of 3% for defense spending over the next five years.

The law already has generated proposed cuts of up to $11.7 billion in budget authority for fiscal 1986, among them a 4.9% cut in defense spending, including research. "Everybody has to suffer," says James I. Magid, an analyst at L. F. Rothschild Unterberg Towbin in New York.

That proposition is disputed vehemently by Secretary of Defense Caspar W. Weinberger. He says that he cannot accept the "peculiar and basically dangerous belief that defense is the equal of other government programs and must, therefore, share the burden of reducing the deficit."

FISCAL DIET. Sen. Warren Rudman (R., N. H.) aims to cut deficit.

COSPONSOR. Sen. Phil Gramm (R., Texas) helped write the bill.

Estimates of just how large a chunk Gramm-Rudman will take out of defense in fiscal 1987 vary widely. In early January, two congressional analyses predicted cuts of $65 billion to $90 billion in defense spending authority in fiscal 1987.

Thus far, the law has had little impact on defense spending, notes the Center on Budget and Policy Priorities. It concludes that the Pentagon will still record 3% real growth during the current fiscal year. Depending on the size of next year's budget deficit, however, the center predicts a $60 billion cut in defense spending authority in fiscal 1987.

One defense segment that appears most vulnerable to further budget cuts is research, development, test, and evaluation, which absorbed a $169 million congressional appropriations cut in December and a 9.5% cut in the first year of Gramm-Rudman. One source of government research contracts already hit hard by Gramm-Rudman is the Defense Advanced Research Projects Agency. It has lost nearly $76.7 million in authorized funds, translating into $35.4 million in outlays.

Still, some observers think the electronics segment of the defense budget will survive efforts to reduce the budget deficit. Says Frank Mitchell of the Electronic Industries Association, "Technology is not going to stop just because of Gramm-Rudman." *–G. L.*

DISCRETE DEVICE MARKET LOOKING BETTER THESE DAYS

SLOW BUT STEADY GROWTH PAYS OFF IN VOLATILE TIMES

by Larry Waller

LOS ANGELES

Discrete components, usually dismissed as the boring wallflowers of semiconductors, are moving onto the dance floor. Proof of the pickup in interest can be noted in the worldwide struggle for market leadership among four heavyweight discrete companies. Hitachi, Motorola, NEC, and Toshiba are running so close together, in fact, that market researchers cannot agree on rankings for 1985 (see "Who's ahead in discretes?").

The growth rate of discretes over the years may be much lower than that for integrated circuits—an annual increase in value of consumption of about 8%, as opposed to 22%—but it is steadier than the wild ups and downs of ICs. There are three principal reasons for this:

- Discretes fill many needs and therefore have a long product life.
- Once designed in, they tend to stay designed in.
- Markets are regional in nature, thus protecting local producers.

These pluses have become more seductive than ever, spurring competition during the current IC down cycle, especially from Japanese firms intent on penetrating deeper into the U. S. market.

This has raised anew the hackles of U. S. suppliers and could trigger accusations of dumping in a replay of the charges lodged against Japanese memory manufacturers, an issue still unsettled. Officials at the top U. S. discrete supplier, Motorola Inc.'s Discrete and Special Technologies Group, are considering just such an action. "We are gathering data and will take appropriate action," warns Paul V. White, vice president and director of group marketing.

Backing him up is Richard A. Anderson, National Semiconductor Corp.'s marketing director for discretes. "There is a lot of press about the dynamic-random-access-memory business, and the same thing happens daily in the [discrete] business." He says that offshore transistor suppliers (most of National's discrete business is in transistors) targeted the TV market, started cutting prices two years ago, "and wooed it away from historical suppliers such as National."

Toshiba Corp., the company that U. S. discrete suppliers say is most aggressively seeking market share, says it has no such strategy. With transistors and diodes, for example, "the main merit is price," and Toshiba Semiconductor Division general manager Akihiro Fujii doesn't think he can sell them cheaply enough in the U. S. "Even in Japan it is a tough business," he says.

At first glance, the fortunes of discrete semiconductors would seem to greatly resemble those of ICs, but basic differences keep them from being tightly coupled during business cycles. For openers, a discrete component is a single-function general-purpose device, in contrast to the more complex, multifunction IC.

An individual discrete product thus can satisfy many general socket needs, says Motorola's White. Except for the mass memories, ICs "are moving in the other direction, toward specific applications that require specific devices," he says. The upshot is that once simpler devices (transistors, power chips, diodes, rectifiers, and so on) from a given supplier have found their way into original equipment designs, they stay in place on printed-circuit boards long after generations of ICs come and go.

This longer product life confers benefits often overlooked by some IC companies, according to those who follow this business. "Product life that is double, maybe more, means more dollars on the profit curve," says Matt Crugnale of Crugnale & Associates, Mountain View, Calif., a marketing consultant. He estimates that companies that produce both types "have from 5% to 15% more margin on discretes." Moreover, product loyalty runs deeper because of longer associations between the customer and the discrete supplier, making them "not as easily displaced."

"Discretes provide stability, like the tail of a kite," according to Geno Ori of Motorola. As senior vice president and general manager of the Discrete and Special Technologies Group, he runs what is generally recognized as the worldwide discrete sales leader from his Phoenix, Ariz., headquarters.

The structure of the market for discretes looks little like that for ICs. For historical reasons, more types of discretes are sold within regional markets than globally, as is the case with ICs. Experts may disagree on how much of total worldwide sales goes to regional customers—Armin Baader of Siemens, Munich, thinks up to two thirds, others say half that—but the split poses problems for the largest companies.

Conversely, the regional nature of discrete markets gives local producers the huge piece of a quasi-protected local

WHO'S AHEAD IN DISCRETES?

Dataquest's 1985 ranking ($ millions)		ICE's 1985 ranking ($ millions)	
Motorola	531	Toshiba	580
Hitachi	392	NEC	570
Toshiba	368	Motorola	550
NEC	351	Hitachi	390
Philips	235	Matsushita	330
Matsushita	227	Siemens	250
Siemens	140	Philips	230

Worldwide sales. Includes captive sales and optoelectronic components

The disparity in 1985 worldwide discrete semiconductor sales figures from two respected market researchers, Dataquest Inc. and Integrated Circuit Engineering Corp., illustrates the difficulty in obtaining solid data on this market. By contrast, integrated-circuit sales results from the two track closely.

The problem lies in deriving reliable figures for consumption in Japan and Europe. Figures are not compiled by groups with the stature of the Semiconductor Industry Association in the U. S., where solid sales figures are readily available.

turf, where long-time supplier relationships and strong nationalistic preferences prevail. Thus outsiders are at a disadvantage, helping keep alive numerous smaller manufacturers. This setup contradicts the IC business. Quips Ori of Motorola, "ICs are like great white sharks fighting. Discretes are piranhas cutting everyone to pieces."

Nowhere are the fierce regional battles more pronounced than in the Japanese market. Toshiba holds the top spot, with slightly more than a 20% share, but is pushed hard by NEC Corp. Contention is so close between the two that "in any given month, NEC might be ahead," notes Toshiba's Fujii. Hitachi Ltd. and Matsushita Electronics Corp. compete for the No. 3 domestic slot, but this standing is hard to track because Matsushita sells perhaps half its products in-house, say observers.

WHO'S ON FIRST? Worldwide sales are no easier to track. Motorola tallied somewhere between $530 million and $550 million in sales on its broad-based product lines during 1985. Whether this led the pack depends on which marketing service is consulted. Motorola does not break out separate results for discretes; the estimate comes from internal company sources and industry consultants. Though down from record 1984 sales, Motorola followed the overall discrete market and remained profitable, thus emphatically outpacing ICs in its semiconductor sector. As did all similar U.S. companies, it plunged deeply into the red during the second half of the year.

Results from other heavyweight discrete suppliers worldwide tell the same story. At Siemens's Components Group, discrete business actually improved for the year, to about $250 million, according to Baader. The sales and marketing director for discrete semiconductor devices agrees that business cycles deal less serious blows to discretes. "The amplitudes are less pronounced."

Similarly, the Discrete Semiconductors Group of Philips, Eindhoven, the Netherlands, had improved sales, though not profits, during a down year for the industry. Even National Semiconductor—reporting more than $88 million in losses from ICs in the latest 28-week period—says its transistor-focused discrete operations "hovered at the break-even point," notes Anderson.

Comparing only sales of discretes to obtain relative company standings hides the fact that product lines are much less homogeneous than ICs. Among the Japanese firms particularly, these cover a wide spectrum, from expensive thyristors at the high end with ratings of 4,000 to 6,000 V and occupying an entire 75- to 100-mm-diameter wafer, down to transistors selling for 2.5c and diodes for 1c. Production quantities are huge for the small parts: Fujii puts Toshiba's monthly output at 300 million transistors and 250 million diodes rated under 1 A. His division also turns out some 150 million optoelectronic devices a month.

But even as the marketing drama plays itself out, there is a technological threat in the wings that could have an even wider influence: integration of power, switching, and radio-frequency functions, among others, into custom chips that will displace many separate parts. Long-predicted integration—with smart power as the best example to date—could be devastating to companies that can't make the transition.

Nevertheless, some do not see the integration trend as an immediate threat, among them semiconductor process specialist Will Strauss of Forward Concepts Inc., Tempe, Ariz. His conclusion on discretes—"like the poor, they'll be with us for a long time"—is echoed by Karl A. Williams, strategic planning and marketing manager for Fairchild Semiconductor Corp. "There's a lot of underlying dynamism to discretes." □

PILOTS. Marketer White, seated, and general manager Ori guide Motorola in discretes.

Additional reporting came from John Gosch in Europe, Charles L. Cohen in Japan, and Eve Bennett in Palo Alto.

BETTER TIMES AHEAD FOR DISCRETE COMPONENTS

	1983	1984	1985	1986	1987	1988	1989	1990
Value of world consumption ($ billion)								
U.S.	1.446	1.942	1.511	1.525	1.654	1.869	2.075	2.199
Japan	1.550	1.857	1.638	1.556	1.665	1.895	2.122	2.345
Europe	1.056	1.150	1.162	1.119	1.135	1.158	1.176	1.187
Rest of world	0.381	0.439	0.375	0.375	0.413	0.474	0.510	0.535
Total	4.433	5.388	4.686	4.575	4.867	5.396	5.883	6.266
Growth (%)	14.6	21.6	−13.0	−2.4	6.4	10.9	9.0	6.5
World consumption (millions of units)								
U.S.	8,261	10,380	9,748	10,164	11,408	12,462	14,067	15,434
Japan	24,602	29,757	27,763	26,829	28,707	31,580	35,969	41,140
Europe	6,815	6,950	8,605	8,287	8,111	7,988	8,397	8,795
Rest of world	6,191	6,857	5,855	6,000	6,600	7,298	7,968	8,636
Total	45,869	53,944	51,971	51,280	54,826	59,328	66,401	74,005
Growth (%)	25.3	17.6	−3.7	−1.3	6.9	8.2	11.9	11.5
Average selling price (cents)								
U.S.	18	19	16	15	15	15	15	14
Japan	6	6	6	6	6	6	6	6
Europe	16	17	14	14	14	15	14	14
Rest of world	6	6	6	6	6	7	6	6
World	10	10	9	9	9	9	9	8

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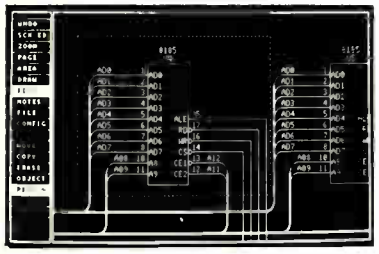

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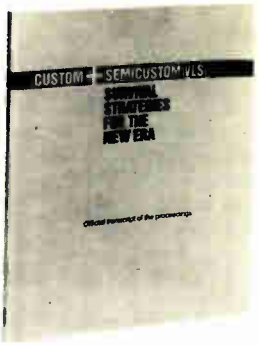

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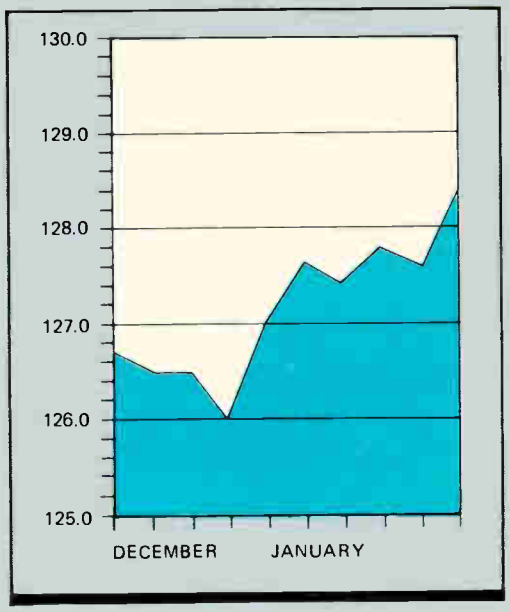
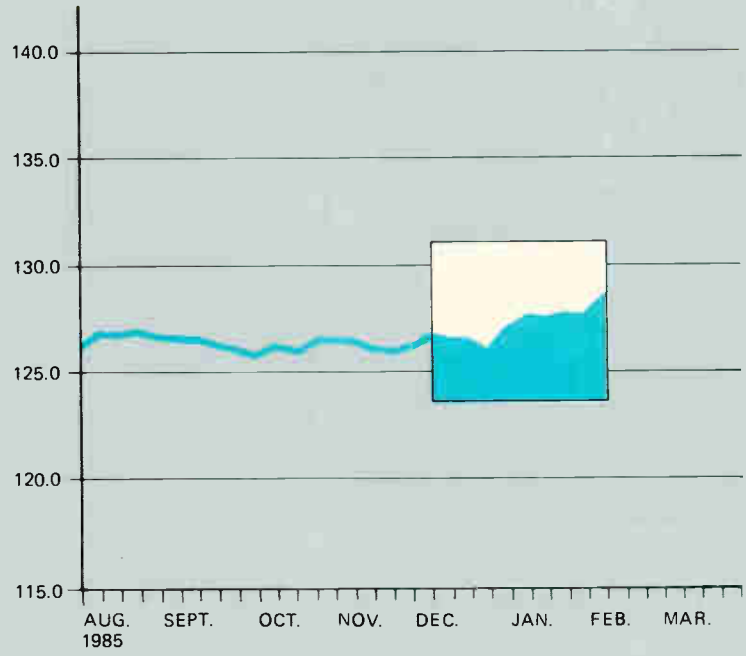


THIS WEEK = 128.4
LAST WEEK = 127.6
YEAR AGO = 129.6
1982 = 100.0



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 PRODUCTION INDEX

	November 1985	October 1985	November 1984
Office and data-processing equipment	260.7	252.1	262.1
Communications equipment	224.2	221.7	213.6
Radio and TV equipment	138.0 (estimate)	133.6	145.0
Electronic and electrical instruments	141.8	139.8	138.6
Components	240.3	240.6	301.9

Good news could be afoot for the U. S. electronics industry. Overall production of electronic equipment and components in the U. S. increased a healthy 2.3% in November, the latest month for which statistics are available. As a result, the *Electronics* Index posted its best increase in six months, growing 0.6% in the latest week.

The increase in equipment production was the largest monthly gain registered in more than a year by the domestic industry, bolstering the theory that the U. S. economy picked up considerable momentum in last year's fourth quarter. Except for components, every segment of the U. S. electronics industry racked up at least a 1% gain in production during the month. And even components didn't do so badly: production declined by only 0.1%.

November marked the 12th consecutive month of declines in U. S. output of semiconductors. But the drop in production is lessening considerably: the decline in November 1985 was the same as in November 1984, the month that production started to fall. With industry book-to-bill ratios growing steadily over the past few months, the U. S. components industry in general could start seeing production increase in the near future.

Another sector of the ailing U. S. electronics industry that could also be heralding a business upturn now is computers and office equipment. Not only was the 3.4% surge in production of this equipment the most vibrant in the overall electronics industry in November but it was also the headiest gain the industry has scored in more than a year.

All may not be so pleasant for computer producers in the months to come, however. November's gain followed a dramatic 5.1% decline in output in October, so production levels are still at record low levels. In addition, planned capital spending increases by U. S. business this year are expected to be low, according to a survey conducted by McGraw-Hill Inc.'s economic department.

Despite a relatively sluggish 1.1% gain in output for the month, the communications industry has been the sector least affected by the business slump, which has caused overall electronics output to drop 6% from November 1984. Output of communications equipment was up 5% for the same period. Production of electronic instruments—which increased 1.4% in November—was up 2.3% for the same 12-month period. Output of data-processing machines rose 3.4% in November 1985, but that figure is still down 0.5% from the year before. TV and radio-equipment production rose 3.3% in November but is off 5% from 12 months ago.

ARE THE WORST OF SEEQ'S TROUBLES BEHIND IT?

MAYBE—IF BUSINESS IMPROVES AND A NEW MANAGEMENT GETS THE CHIP MAKER BACK ON COURSE

SAN JOSE, CALIF.

Are the worst of Seeq Technology Inc.'s troubles behind it? Maybe, if its markets turn up and a new management team can execute its new game plan. The five-year-old chip maker's operations have been streamlined, and its sales strategies refocused in the markets for erasable and electrically erasable programmable read-only memories.

Launched with great fanfare and high expectations, Seeq saw its business boom during the semiconductor explosion of 1984. It recorded more revenue in the first quarter of fiscal 1984 than it did in all of the preceding year, and its startling success seemed to guarantee it a place in the venture-capital history books. "There was a time when they were considered the hottest startup," notes Paul Johnson, a semiconductor analyst with L. F. Rothschild Unterberg Towbin in New York.

That success didn't last. As the semiconductor boom turned into a bust, Seeq's fortunes reversed dramatically. Sales of EPROMs dropped before Seeq could build up its EEPROM business. Operating losses mounted and internal squabbles disrupted its management, with Gordon A. Campbell, the founding president, subsequently leaving.

For the past several months, a management team led by Floyd Kvamme, a veteran industry executive who is now a partner at San Francisco venture capitalists Kleiner Perkins Caufield & Byers, has been busily revamping Seeq operations. Refocused development activities should soon result in several important new products: a 256-K EEPROM and a 1-Mb EEPROM. What's more, the EEPROM business now shows signs of taking off, and Seeq has been winning several large orders. Investors have come through with another $14 million in financing. It's enough to cause management to think that the company could be profitable this year.

Industry analysts are not so sure. They view Seeq as sitting on a fence: which side it falls on will decide whether it will be an also-ran or an industry leader. A big part of Seeq's fate is out of the hands of its managers—namely, whether its markets continue to pick up.

NEW OUTLOOK. Seeq's McCranie sees better times ahead for the EEPROM maker.

But an equally big part is under Seeq's direct control—how well its management performs. "If they execute well, Seeq won't have any problems," notes Rothschild's Johnson. "A lot depends on us," agrees J. Daniel McCranie, vice president of sales and marketing at Seeq. "Some depends on God."

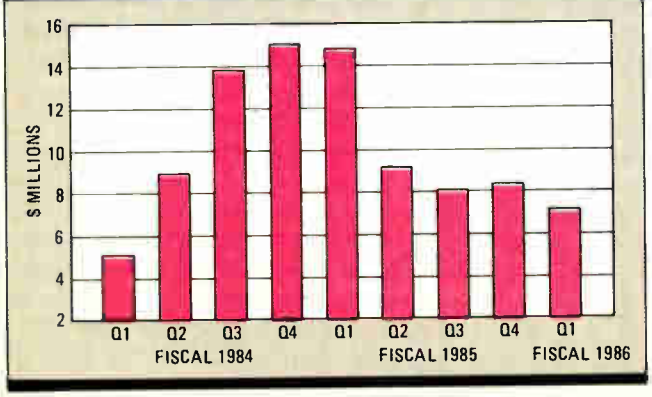
Seeq certainly appeared to be blessed in 1984. Helped by demand that seemed to reward any chip company that could simply deliver products, Seeq's revenue for the fiscal year jumped to $42.9 million from just $4.2 million the year before. But it still was an unprofitable performance, with a net loss of $3.7 million for fiscal 1984. That was much better than the net loss of $15.6 million in fiscal 1983.

Seeq's financial troubles intensified with the semiconductor swoon of 1985. Though its revenue slipped slightly to $40.3 million, its net loss grew to $12.9 million. "Seeq lost its shirt, shoes, and fanny in 1985," McCranie says, noting that it paid the price for a huge ramp-up in production capacity for its EPROMs. "We're starting to absorb some of that capacity," adds McCranie, a member of Seeq's office of the president with Kvamme and vice president of operations Gerald A. Robinson.

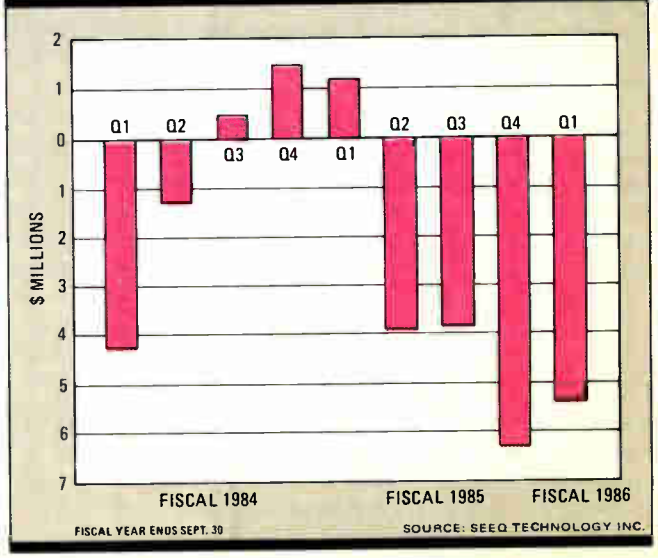
BIG MISTAKE. "They've always done a good job in the EEPROM area," says Michael J. Stark, a research analyst with Robertson, Colman & Stephens, San Francisco. "The problem is that the market hasn't grown as fast as they planned. That led to extra capacity. So they turned to EPROMs because EEPROMs didn't grow. That was a major mistake."

Seeq got involved with EPROMs in its early days for the simple reason that the market was there: it could sell EPROMs while it waited for the EEPROM market to develop. "EPROMs

SEEQ'S SALES HAVE FALLEN . . .



. . . AND LOSSES HAVE MOUNTED



caused us to go from $4 million in revenue in 1983 to $43 million in 1984 while we developed the EEPROM market," McCranie points out. Seeq's backlog in EEPROMs has grown steadily; it was the disastrous drop in the EPROM market that hurt (see chart).

Kvamme, installed last summer as chief executive officer, began cost-cutting measures that included reducing the staff from 700 to less than 400. He also put in place new efficiency measures that have enabled Seeq to boost its output and manufacturing yields by 50% above those of a year ago, even though the company uses only 30% of its capacity. "We were fat and disorganized" in manufacturing operations, Kvamme says. By doing this, analysts say, the company has cut its quarterly break-even point from about $14 million in revenue to about $11.5 million.

LOOKING FOR PROFITS. McCranie notes that Seeq's second fiscal quarter "will far surpass last quarter" in product shipments and reduced losses, and he predicts that Seeq will be profitable in the second half of fiscal 1986. Whether Seeq turns a profit for all of that year depends on "whether [profits in the second half] will be enough to offset the losses of the first half."

Company executives still believe Seeq's mainstream business will be EEPROMs, which can be reprogrammed without being removed from a product. "We are an EEPROM house," says Kvamme. "That's the basis on which Seeq was founded." Seeq describes its business as user-programmable integrated circuits, a market made up of its EEPROMs, microcontrollers with on-board nonvolatile memory, and customer-designed ICs. It also makes controller chips for Ethernet local-area networks.

Seeq is attacking these market segments with new products. It is developing a 256-K and a 1-Mb EEPROM. It already makes a version of Texas Instruments Inc.'s 72720 microprocessor with 2-K of on-board memory and is talking with other microcontroller vendors about making similar versions of their products. To penetrate the market for application-specific ICs, it has a tie-in with Silicon Compilers Inc., also of San Jose—Seeq's EEPROM library is included with Silicon Compilers' Genesil silicon-development software.

Seeq is in the mainstream EEPROM business, selling to automotive, telecommunications, and military customers. But it's not that big a business. Dataquest Inc., the San Jose market researcher, estimates that the EEPROM market hit $156 million in 1984 and inched up to $158 million last year. This year, Dataquest says, the market should grow 17% to $185 million; by 1987, it will explode by 76% to $525 million. By 1990, the EEPROM market should reach $700 million.

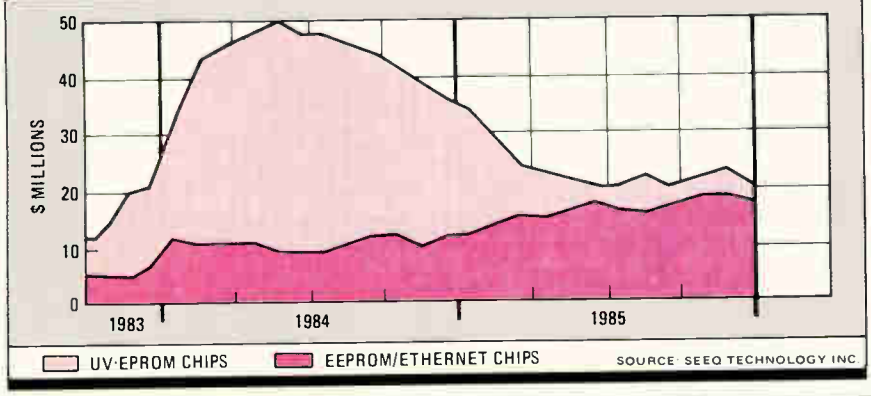
"It's interesting to talk about the market's growth in the next 10 years or so," says L. F. Rothschild's Johnson, but that isn't important for a young company such as Seeq or even its main competition in the EEPROM market, Xicor Inc., Milpitas, Calif. "The problem is how fast the market will grow this year and next. That's more important for a small company. If they don't survive the next two years, it won't matter what happens 10 years down the road."

Johnson notes that if both Seeq and Xicor do well in the EEPROM market, larger chip makers will want to get into the business. "That's neither good nor bad," Johnson says. "Big companies can help the market grow." McCranie agrees, adding that his main competition in a few years will come from Advanced Micro Devices Inc., though Johnson sees Intel Corp. as a bigger threat.

Robertson, Colman's Stark says the management team is "doing the right things. The question is, is it too little, too late? They're on the edge and they could go either way." However, he adds, "I'm confident they can do it."

So is the company. "Seeq enjoys a unique position in a unique market," says Kvamme. "If you have a unique product and serve the customers, your place is ensured for a long time." Adds McCranie: "We don't resemble the Seeq of old." *–Robert J. Kozma*

SEEQ'S BACKLOG: A DIFFERENT MIX



BOTTOM LINES

ONCE AGAIN, A BOOM SEEN FOR GaAs CHIPS

Demand for gallium arsenide integrated circuits will soar to over $5 billion in 1996 from only $240 million this year, according to Henderson Ventures. The Los Altos, Calif., market researcher notes that analog rather than digital ICs will dominate the GaAs chip market in the 1990s, especially for use in communications. Monolithic GaAs ICs will overtake GaAs hybrid ICs, the projected market leaders with a 52% share of the 1986, in 10 years. Monolithic GaAs ICs will grab a 79% share of the 1996 market, the study forecasts.

PC SALES LAG IN DECEMBER

The 1985 Christmas season was good for personal computer retailers, but not as good as the year before. InfoCorp, the Cupertino, Calif., market researcher, says its retail-channel tracking service, which keeps tabs on personal computer sales activity, found December the best sales month of 1985. Unit sales were up 63% over those of November and dollar sales increased 35%. "Compared to December of 1984, however, unit sales were down 37% and dollar sales were down 21%," the company says. Total personal computer sales for 1985 amounted to 1.9 million units, InfoCorp estimates, down 14% from 2.2 million in 1984.

RECORD CHIP SALES FORECAST FOR 1987

If chip vendors can hold on until next year, they will be rewarded with better demand than in the boom times of 1984, says Dataquest Inc., San Jose, Calif. The semiconductor industry in 1987 "will surpass the historic billings peak of 1984," says Howard Bogert, director of Dataquest's Semiconductor Group. As far as 1986 is concerned, he says, "we expect that the worldwide semiconductor industry will grow 9% to 12%, with Japan and Eastern Asia showing the greatest growth rates." The total worldwide chip market registered a 16.4% decline in 1985, Dataquest says.

SIEMENS BUYS POTTER & BRUMFIELD

Siemens Capital Corp. has acquired Potter & Brumfield, a Princeton, Ind., relay maker, from Minstar Inc. Terms of the transaction were not disclosed. Siemens Capital, of Iselin, N. J., is a holding company for U. S. companies owned by Siemens AG, Munich.

WHY IWASHITA IS TRYING TO CALM HIS COMPETITION

TOKYO

One of Tsuyoshi Iwashita's major chores these days is to walk softly and put his competition at ease. Even the big ones, it seems, are quite worried about his brand-new tiny startup.

While that may be somewhat surprising, this is no normal startup. Competitors shuddered when the word spread late last year that IBM-Japan Corp. and Nippon Telegraph & Telephone Corp. planned a 50-50 joint venture to go after Japan's emerging market for value-added networks. They worried that the combination of the world's largest computer maker and the world's No. 2 telephone company would squeeze them out of the game before it had begun.

TSUYOSHI IWASHITA: Calming the competition, for now.

Iwashita, president of the joint venture, is quick to downplay his new company, which is called Nippon Information & Communication Corp. "We do not even have a future vision of what we should be doing," he says mildly. "We have to just try to meet the expectations of these famous parents."

At first glance, the 58-year-old Iwashita is a surprising choice to run the joint venture. A graduate of Tokyo University in economics, he is the first to admit that he knows more about numbers than networks. But he has been a lifetime employee of NTT, where he still spends half his time as an executive vice president running the telephone service-development headquarters, which is charged with selling telephone services.

When pressed, Iwashita moves from calming words for the competition to talk of plans that could bring back their worries. Nippon Information & Communication has yet to sign up its first customer, but he says revenue this year could be $25 million and that it is "our target and dream" to have sales of $500 million in 1990. Half will come from network services.

The cornerstone of the IBM-NTT linkup, he says, will be development of software that will allow IBM's Systems Network Architecture-based machines to communicate with NTT's Data Communications Network Architecture. Joint work began in 1983, he says, and software should be available commercially by June. Iwashita also plans to sell IBM terminals to run the software.

The Tokyo company also expects to offer services under the new law allowing private companies to set up VANs. Iwashita says it will probably register in April to set up its VAN. Later, the company wants to set up direct international VAN links.

Off duty, too, Iwashita does not seem to fit the hard-driving role of runnning a startup. An avid gardener, he raises vegetables—which he enjoys whipping up into dishes for his wife and two sons. But like a good NTT man, he is never far from the phone. He has four in his home to keep in touch with both offices. *–Peter Hann*

'STAR WARS' WILL WORK, SAYS COHEN

MARINA DEL REY, CALIF.

For a computer scientist whose personal goals center on "making the really big systems work," Danny Cohen is certainly in the right place at the right time. He heads Computing in Support of Battle Management, the panel charged with judging whether the critical computer programming plans of the Strategic Defense Initiative, the Defense Department's space-based antimissile system, are on solid ground.

His duties go far beyond helping determine just what is technologically possible in a working system. The conflict between pro- and anti-SDI groups has become front-page controversy, giving Cohen, a native of Israel whose background is in academics and consulting,

PEOPLE ON THE MOVE

W. WALTER BOROWSKY

☐ Oregon Software Inc., Portland, Ore., intends to bolster its international presence by appointing W. Walter Borowsky as president and chief executive officer. Most recently, he operated his own consulting company for international business. Borowsky had been president of Servio Logic Development Corp., a Portland computer company, where he went in 1983 after 22 years with Control Data Corp. He left Control Data as vice president and managing director of China operations.

NORMAN R. AUGUSTINE

☐ A systems engineer with 27 years of experience in electronics, aerodynamics, and government has been named president and chief operating officer of Martin Marietta Corp. Norman R. Augustine, 50, moves up from the post of executive vice president, which he assumed last September. He has held various executive positions with the Bethesda, Md., company, which he joined in 1977. Before that, he was under secretary of the Army and held executive engineering posts with McDonnell Douglas Corp. and the LTV Aerospace Corp.

IRWIN H. SANDBERG

☐ The University of Texas in Austin has named a former researcher from AT&T Bell Laboratories to one of the $1 million endowed chairs for science and engineering. Before his appointment, Irwin H. Sandberg, 52, had worked for Bell Labs in Murray Hill, N.J., for 28 years where he was considered a leading systems theorist for his contributions in communications, electronic circuits, nonlinear feedback equipment, and networks. Sandberg will hold the Cockrell Family Regents Chair in Engineering.

JESÚS LEÓN

☐ The new director of engineering at Digital Transmission System Inc., Norcross, Ga., will wear two hats. "I'll be working not only on managing the technical people—I'll also be working on overall new-product development strategy," says Jesús León, who joined the company in mid-January after 11 years with Scientific-Atlanta Inc. The 41-year-old executive most recently was program manager for Scientific-Atlanta's Electro-Products Division. He has more than 15 years of experience in management, design, and research in communications, instrumentation products, and systems.

AKIO TANII

☐ Matsushita Electric Industrial Co., Osaka, Japan, announced that president Toshihiko Yamashita will resign on Feb. 19, to be succeeded by Akio Tanii, currently the company's executive vice president. Tanii, 57, joined the company in 1956 and was responsible for Matsushita's video tape recorder operations from 1972 to 1982. Yamashita, 66, began working for Matsushita in 1938 and became president in 1977.

DANNY COHEN: Trying to keep the Strategic Defense Initiative on solid ground.

an unwanted place in the public eye.

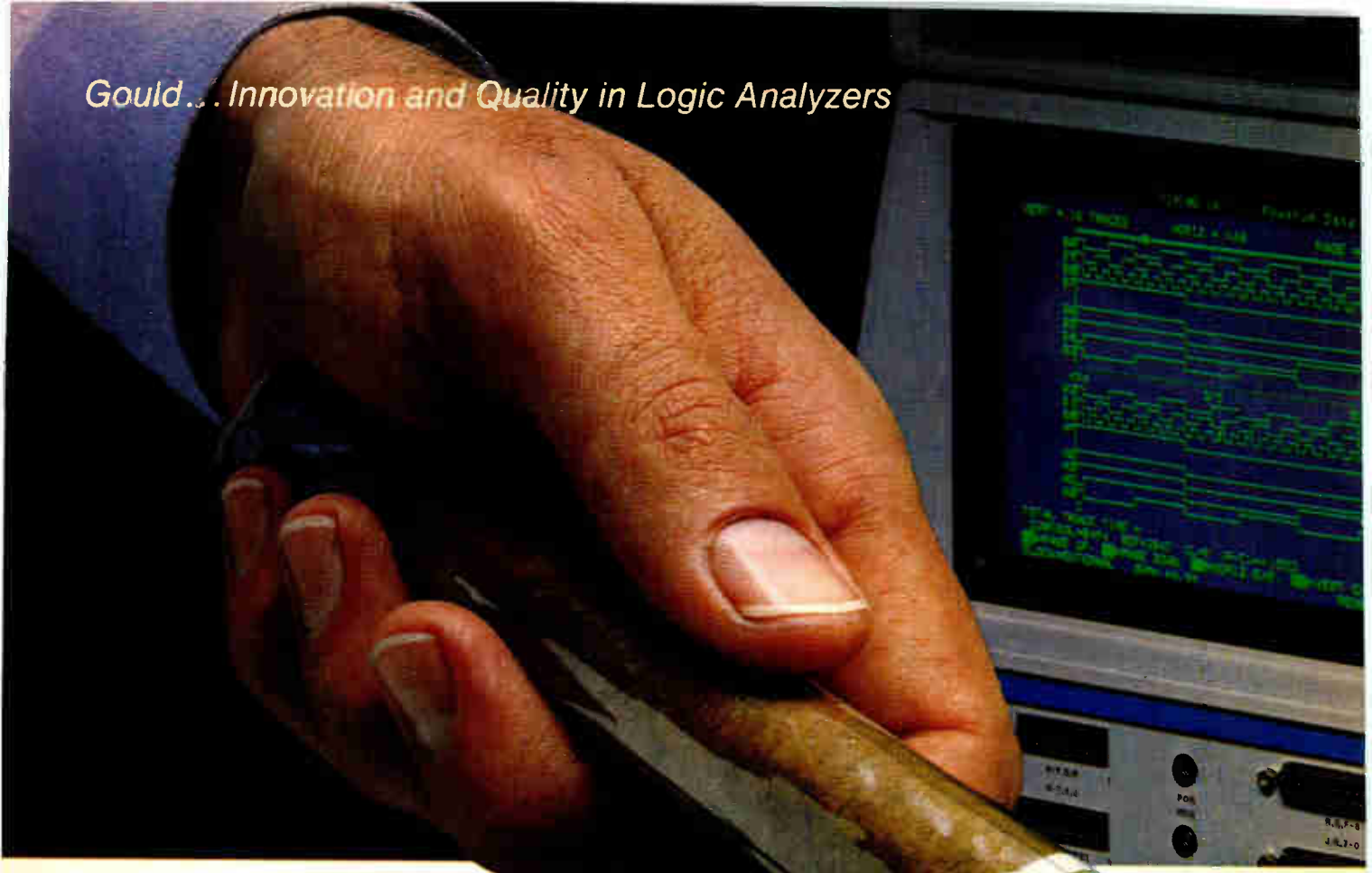
"I know it's part of the process [for reaching political decisions], but if somebody had described this to me in advance, I'd have said no," says Cohen. Despite this minor misgiving, tasks such as testifying before the Senate Armed Services Committee, and even being hounded for interviews by scores of publications, have been novel enough to be fun—so far.

For Cohen, the SDI panel work, which he says is taking far more time than he had anticipated, has to be meshed with duties as director of the Systems Division of the Information Sciences Institute. This adds up to a tight schedule. ISI is a part of the University of Southern California that handles numerous consulting projects for industry and the government.

COMPLICATIONS. Cohen's job of evaluating the numerous SDI studies is complicated by the fact that the program is still in its very early stages. For example, the overall system architecture for battle management of the various pieces of hardware is not yet set. Nevertheless, he is convinced that the loudest criticisms of software needs have little basis.

One of the most frequently repeated objections is that the 10 million lines of computer code necessary to operate SDI cannot be written without introducing errors. And any error in defending against ballistic missiles would be disastrous, critics say. Cohen disagrees strongly. "It does not have to be error-free. It will still work," he insists. "If you are careful, especially in design and testing, which together are about 90% of a major system job, that's what it takes to be successful."

Cohen did his undergraduate work at Technion University in Israel and in 1969 received a PhD in applied mathematics and computer science from Harvard University. He has been involved with computers since 1960, when he went to work as a programmer for IBM Corp. *–Larry Waller*



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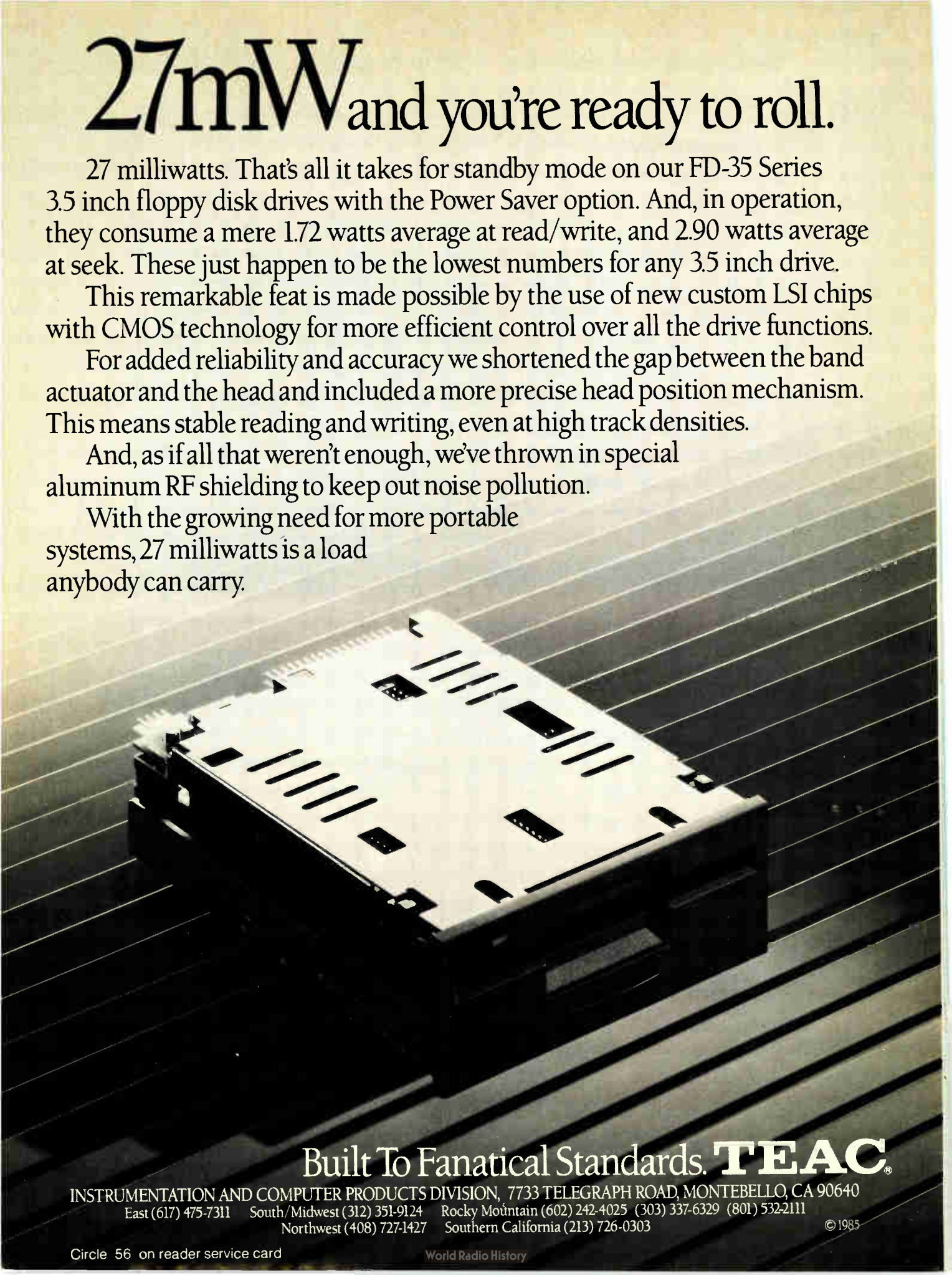

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NEW PRODUCTS

SOUPING UP AN ALREADY FAST 3-D GRAPHICS WORK STATION

SILICON GRAPHICS BOOSTS GRAPHICS SPEED OF IRIS FAMILY BY 44%

Silicon Graphics is dramatically improving the price/performance ratio in fast, high-resolution, three-dimensional, color-graphics work stations. It is speeding up the rate of graphics transformations by as much as 44% with its new Iris 3000 family and is slicing the price tag on its current line of work stations by about one third.

The jump in speed is due to new 8-MHz versions of the company's proprietary Geometry Engine and Accelerator chips, as well as a switch from the Motorola 68010 to the 68020 microprocessor. All the essential performance factors—CPU speed, geometry processing (graphics transformations), memory coupling, floating-point calculations, and file-system performance—have been enhanced in the 3000 family.

The 68020 processor board in the 3000 provides a full 32-bit data bus with a 16-MHz clock speed. Beefing up the Geometry Engine has sped 3-d graphics transformations 44% over the company's 68010-based Iris 2400 and 2300 systems from 69,000 to 86,300 transformations per second. This enables such real-time applications as flight simulation to run at realistic speeds.

Pricing is also aggressive on the new models, starting at $39,000—about the same price as high-end work stations that lack 3-d capabilities, the company claims. And the top-of-the-line 3-d model from its major competitor, Sun Microsystems Inc., can do only 45,000 transformations/s and is priced at about $45,000, according to Silicon Graphics.

PRICES CUT. The company is cutting the price of its Iris 2400 line of work stations by 33% and the Iris 2300s by 29%. These products are aimed at what is becoming the low end of the graphics-terminal market. The new prices mark the first time that a real-time, high-performance, 3-d work station will be available for less than $25,000, according to the company.

The Geometry Engine and its companion Geometry Accelerator, another of Silicon Graphics' custom very large-scale ICs, are responsible for the real-time graphics performance [*Electronics*, Oct. 20, 1983, p. 113]. A pipeline of 10 or 12 125-ns Geometry Engines handles such graphics transformations as object rotation, translation and scaling, four- or six-plane clipping, perspective or orthographic viewing, and scaling to screen coordinates. Geometry Accelerators at each end of the pipeline enable it to maintain its full speed by providing buffering and floating-point conversion.

AIR ACE. Silicon Graphics' new 3-d system does 86,000 transformations per second, suiting it for real-time graphics such as flight simulation and mechanical CAD.

Both the Iris 3000 memory system and the floating-point processor are tightly coupled to the 68020 CPU with a 32-bit data path. With the closely coupled memory, enough speed is attained so that cache memory built from faster RAMs is not needed. The system, which uses 120-ns RAMs, has 2 megabytes of main memory (expandable to 16 megabytes), eight planes of display buffer memory (expandable to 32), and a buffer to hold the coordinates for the Z axis.

A special addressing mode passes data to and from the floating-point processor at memory speeds—a significant departure from most floating-point systems that require time-consuming handshaking routines for coordination between the floating-point and main processors for every operation.

All the Iris graphics work stations are optimized for applications such as solids modeling, simulation, molecular modeling, seismic and fluid dynamics, and animation for movies and TV. The standard Iris Graphics Library II, an applications-development environment, is a set of subroutines that supports graphics programming.

The library features several capabilities that enhance applications development, including a window manager, depth cueing, Gouraud shading, faster polygon fill, high-resolution Z-buffer operations, and faster pixel access.

The Iris 3010 comes with a 20-megabyte disk drive, and the 3020 and the 3030 models sport 72- and 170-megabyte drives, respectively. The 3010 sells for $39,900, the 3020 for $44,900, and the 3030 for $54,000. All are available now. The Iris 3030 work station comes with

hardware for Ethernet connection and software that supports the Xerox Network System protocols. *–Tom Manuel*

Silicon Graphics Inc., 2011 Stierlin Rd., Mountain View, Calif. 94043. Phone (415) 960-1980 [Circle reader service number 338]

MAPWARE BUILDS CARRIER-BAND NETS

Concord Data Systems' MAPware hardware and software enables original-equipment manufacturers and systems integrators to develop systems compatible with the Manufacturing Automation Protocol for both broadband and carrier-band networks. The MAPware modular architecture includes a MAP interface board, MAP 2.1 software, and MAP modems.

"We're now able to offer all the tools we've offered for broadband modems immediately for carrier-band modems," says Anthony Helies, president of the Waltham, Mass., company. Carrier-band techniques are being applied to subnetworks in MAP environments to solve real-time control problems and cut the cost of network connections [*Electronics*, Nov. 11, 1985, p. 16].

"Because of its architecture, MAPware allows the OEM to choose whatever level of vertical integration he wants," Helies says. The MAP software offers interfaces to layers two through seven of the International Organization for Standardization's open-systems interconnection reference model. It gives OEMs the option of developing interfaces that operate at the bottom layers only or building a full seven-layer MAP 2.1 implementation.

HIGH-SPEED INTERFACE. The MAP Interface Board is a high-speed, intelligent communications controller that fits into the backplane of a programmable device or computer. The board's very large-scale-integration chip set directly implements all IEEE 802.4 requirements, as well as IEEE 802.3 Logic Link Control and Immediate Response Service, which aids in time-critical applications.

Concord's MAPware products can be combined with the company's existing Token/Net Interface Modules, head-end remodulators, and network-management and -diagnostic products to offer complete MAP networks. The MAP interface board uses an Intel 16-bit 80186 microprocessor and an extended iSBX bus. Comprehensive hardware diagnostics, including controller and modem loopbacks and watchdog timers, are also offered as part of the total package.

Along with 512-K bytes of parity-protected multiport RAM, the MAP interface board includes 8-K bytes of nonvolatile configuration memory and 256-K bytes of PROM. The board supports multiple host processors and byte-swap hardware, as well as flexible direct-memory-access control. In addition, all token-bus protocols run without burdening the processor.

Concord's MAPware carrier-band and broadband modems offer identical modem-to-controller interfaces, making them easily interchangeable with any MAPware board. The modems can be configured as a daughterboard assembly mounted next to the controller board or as a stand-alone system connected by a shielded flat cable. The broadband modem operates at 10 Mb/s, and the carrier-band modem runs at 5 Mb/s.

Prices for the MAPware board with software and modem range from $2,850 to $3,500. Shipments are scheduled to begin in April. *–Debra Michals*

Concord Data Systems Inc., 303 Bear Hill Rd., Waltham, Mass. 02154. Phone (617) 890-1394 [Circle 339]

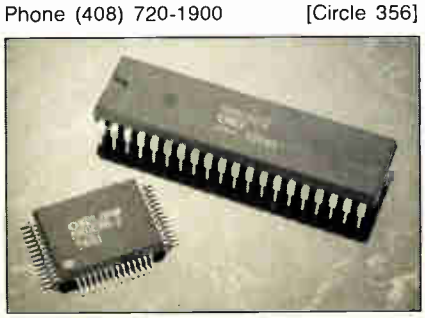
CMOS COPIES OF 8086 RUN AT 8 MHz

Two microprocessors have a 20-bit address bus enabling them to access up to 1 megabyte of RAM, eliminating floppy-disk storage in some designs. The MSM80C86-2 and MSM80C88-2 are the only CMOS versions of the 8086/8088 microprocessor that can operate at 8 MHz, their maker says. They are suitable for battery-operated equipment and other very small, low-power microsystems.

Other features include 24 operand-addressing modes and fourteen 16-bit registers. Both are manufactured in 40-pin plastic and 40-pin ceramic DIPs, and in 44-pin leadless chip carriers. They operate over the temperature range of –40° to +85°C.

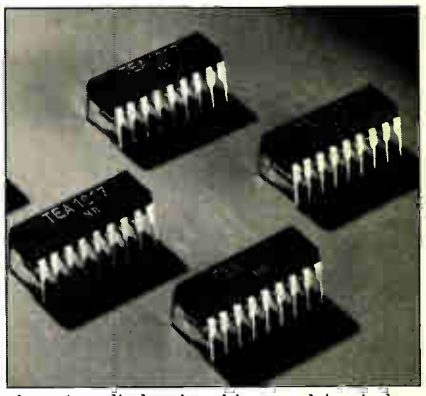
All models are available from stock. In plastic DIPs, the 86-2 and the 88-2 each sell for $20 in quantities of 100.

Oki Semiconductor, 650 N. Mary Ave., Sunnyvale, Calif. 94086. Phone (408) 720-1900 [Circle 356]



13-BIT CONVERTER DRIVES STEPPERS

A 13-bit serial-to-parallel converter drives such peripherals as small stepper motors, LED indicators, and triacs. Its wide voltage range—5 to 18 V—covers many battery-operated applications, and its 13 push-pull outputs can provide up to 80 mA of drive current in both directions. Because each output integrates a



clamping diode, the chip can drive inductive loads directly; this eliminates external diodes and saves board space.

The converter's three-line C-bus, consisting of clock burst, data-line enable, and data, has a clock frequency of up to 50 kHz. Inputs are both TTL- and CMOS-compatible.

Samples of the converter, model number TEA1017, are available immediately in 18-lead plastic DIPs. In lots of 100 to 999, the parts are $2.02 each.

Signetics Corp., 811 E. Arques Ave., P. O. Box 3409, Sunnyvale, Calif. 94088. Phone (408) 991-2000 [Circle 371]

PLA HAS WINDOW FOR REPROGRAMMING

The C 22V10 is a CMOS programmable-logic-array chip that comes with a window for reprogramming. Programmable macro cells let the user specify each of the 10 potential outputs as either registered or combinatorial. The 10 outputs can be reconfigured individually as inputs or used as combination I/O lines controlled by the programmable array. The part offers up to 22 input terms.

Code for the PLA chip can be developed in standard Cupl or Abel systems. Available in the commercial and military temperature ranges, the part has an 80-mA active current.

Delivery is from stock in quantities of 1,000 to 5,000 pieces. The 25-ns commercial version in a plastic DIP sells for $28.35 per 100; the military 30-ns model in Cerdip costs $72 per 100.

Cypress Semiconductor Corp., 3901 N. First St., San Jose, Calif. 95134. Phone (408) 943-2600 [Circle 357]

BOARD-CAD SYSTEM RUNS ON IBM PC

Rgraph is a computer-aided engineering and design system that turns the IBM Corp. Personal Computer into an end-to-end design system or the front end to batch-oriented CAD systems. It offers both schematic capture and physical layout of pc boards in a single graphics-editor system.

Features include a resolution of 1,024 by 768 pixels and a palette of 4,096 colors. Objects can be reflected and rotated with continuous pan and zoom. The data-base structure offers 50 layers of design, each of which can be viewed individually or in combination with other layers. Each data base carries with it its entire working environment: libraries, layers, color assignments, and more.

Rgraph costs less than $10,000; for the semicustom market, the company offers a nine-state digital simulator for less than $3,000. Shipping information was not available at press time.

Aptos Systems Corp., 4113 Scotts Valley Dr., Scotts Valley, Calif. 95066.
Phone (408) 438-2199 [Circle 355]

SWITCHES LINK VARIED HARDWARE

Distributed Data Switch connects computers and peripherals from virtually any manufacturer, the company says. The network uses coaxial cable of the type used for 3270 and cable-TV connections. Switches are available for models with from five to 80 ports, and in both baseband and broadband configurations.

Protocol and data-type conversion is performed by switches that are rated at 1.8 Mb/s. Networks in different parts of a campus can link up over telephone lines, because each switch contains a network bridge.

The price of a system is less than $200 per port. Delivery depends on the configuration.

Pacific Data Products, 8545 Arjons Dr., Suite 1, San Diego, Calif. 92126.
Phone (619) 549-0136 [Circle 367]

SERVER HALVES COST OF VAX CONNECTION

The Integrated VAX Ethernet Communications Server cuts in half the per-port price of connecting Digital Equipment Corp.'s VAX minicomputer to an Ethernet. The per-port connection price of the server is just $108, and the complete system sells for $6,900.

The single-board combination Unibus card and Ethernet server replaces multiple I/O cards inside the VAX host. It conserves Unibus slots and eliminates

multiple RS-232-C cables running to a communications server outside the host. What's more, it is transparent to the host's operating system.

The server also carries an annual software-license fee of $250. Units will ship 30 days after receipt of order.

Bridge Communications Inc., 2081 Stierlin Rd., Mountain View, Calif. 94043.
Phone (415) 969-4400 [Circle 366]

MULTIPLEXER HAS EIGHT INPUT PORTS

The model 570 short-haul multiplexer offers eight RS-232-C input ports, handling full-duplex data at up to 19,200 bits/s. Each port can operate at its own baud rate with any protocol and also support two handshake signals, one in each direction. A composite port, used to link multiplexers, communicates over 5,000 ft—10,000-ft links are optional.

Diagnostic features include visual dis-

plays of Receive Data and Transmit Data for each of the eight input ports, and Data Error and Data Loss for the composite port. The model 570, equipped with eight 25-ft modular cables and eight Plugaverters that convert the modular connector to the standard RS-232-C connector, costs $548; quantity discounts are available. The multiplexer is available now.

Telebyte Technology Inc., 270 E. Pulaski Rd., Greenlawn, N. Y. 11740.
Phone (516) 423-3232 [Circle 373]

COLOR VIDEO DAC RUNS AT 150 MHz

The model AH8304EC is a 4-bit video digital-to-analog converter that operates at 150-MHz pixel rates. Its three independent red-green-blue DACs have common synchronized, blanking, and strobe inputs—blanking is synchronous with strobe. Three independent video outputs drive 75-Ω terminations directly and are RS330/343-compatible.

Samples are available now in 24-pin, triple-width DIPs. The unit price is $49 in quantities of 100.

Analogic Corp., 8 Centennial Dr., Centennial Industrial Park, Peabody, Mass. 01961.
Phone (617) 246-0300 [Circle 369]

10-BIT ADC WORKS WITH PROCESSORS

A 10-bit analog-to-digital converter, model ADC-910, is designed specifically for interfacing with microprocessors. Three-state data outputs allow direct connnection to an 8-bit data bus; when connecting with a 16-bit bus, a single 10-bit-word parallel reading is possible.

The ADC completes a conversion in a maximum of 6 μs. When using an 8-bit data bus, the high and low bytes can be multiplexed onto a single 8-bit bus. Analog specifications include a maximum integral nonlinearity error of ±½ least-significant bit and ±½ LSB maximum zero error over the full operating temperature range. The manufacturer guarantees no missing codes.

The ADC-910 can operate in an interrupt-driven, memory-mapped, or stand-alone mode. Four input ranges are available: ±2.5, ±5.0, and 0 to 5.0 and 10 V. The part comes in a 28-pin DIP. Prices for 100 pieces start at $18.45 for the commercial, $40 for the industrial, and $61 for the military grades.

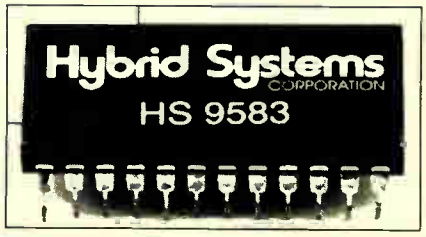
Precision Monolithics Inc., 1500 Space Park Dr., P. O. Box 58020, Santa Clara, Calif. 95052.
Phone (408) 727-9222 [Circle 372]

FLASH ADCs DRAW LESS THAN 300 mW

A line of 6- and 8-bit flash analog-to-digital converters samples at rates ranging from 5 MHz to 30 MHz. CMOS technology keeps the power of the ADCs below 300 mW.

The 6-bit HS9582 can replace RCA Corp.'s CA3300, the manufacturer says. The part consists of 64 autobalanced comparators, a resistor holder network, zener reference diode, decoder, and seven buffer storage registers. Prices for the parts in quantities of 100 range from $15.40 to $89 each.

The 8-bit model HS9583 is a two-step



flash ADC that converts the first three most-significant bits in the first segment and the five least-significant bits in the second segment. Prices range from $44.30 to $161 each in hundreds.

The 8-bit model HS9584 is a parallel flash ADC that consists of 255 clocked comparators, decoding logic, output buffers, and timing circuitry. With an aperture jitter of only 60 ps, it can sample up to the Nyquist frequency. Depending on sampling rate—10 MHz or 20 MHz—accuracy, and screening, units sell for $46.60 to $275.

The parts come in plastic DIPs. Those processed to meet MIL-STD-883 come in hermetically sealed Cerdips. Delivery is from stock and takes up to eight weeks.

Hybrid Systems Corp., 22 Linnell Circle, Suburban Industrial Park, Billerica, Mass. 01821. Phone (617) 667-8700 [Circle 368]

OSCILLATORS CLEAN NOISY SIGNALS

A line of miniature voltage-controlled crystal oscillators, when used in conjunction with a phase-sensitive detector, will regenerate carrier or clock signals that have been corrupted by noise. The line is available in frequencies of 0.5 to 33 MHz and features a minimum ±100

part per million tuning range with a control voltage of 2.5 ±1.5 V.

The oscillators come in four-pin metal DIPs. Samples are shipped in two weeks, production quantities in four weeks; prices range from $11 to $17.

AT&T Technology Systems, 1 Oak Way, Room 2WC-106, Berkeley Heights, N. J. 07922. Phone (800) 372-2447 [Circle 361]

OP AMP OFFERS FOUR SELECTABLE INPUTS

The HA-2406 operational amplifier offers four digitally selectable inputs tied to a single output stage. The component combines an analog switch and a quad op amp onto a monolithic chip, the manufacturer says.

Each input channel has a slew rate of 20 V/μs and a gain bandwidth of 30 MHz. Processed with the company's proprietary dielectric-isolation technology, the op amp offers a crosstalk rejection of −110 dB with an offset voltage of 7 mV and a bias current of 50 nA.

Offered for the commercial temperature range in both plastic and ceramic 16-pin DIPs, the HA-2406 sells for $2.40 each in quantities of 100. Delivery is from stock.

Harris Corp., Semiconductor Products Division, P. O. Box 883, Melbourne, Fla. 32919. Phone (305) 727-9100 [Circle 362]

BIPOLAR POWER SWITCH MATCHES FET'S SPEED

These third-generation bipolar switching transistors offer FET-like speed and ruggedness along with the bipolar's low collector-emitter saturation voltage—typically just 0.8 V at 100°C.

Inductive loads up to 500 V at 30 A can be switched with no degradation. Applications for the Switch Plus III models include off-line switching applications with frequencies up to 100 kHz.

Delivery is from stock to four weeks. The model 2N6922, which sustains collector-emitter voltage of 400 V, costs $12.60; the model 2N6923, which sustains collector-emitter voltage of 450 V, sells for $14.50. Military versions are also available.

General Semiconductor Industries Inc., 2001 W. 10th Place, Tempe, Ariz. 85281. Phone (602) 968-3101 [Circle 363]

SOFTWARE ELIMINATES DEVICE DRIVERS

GraphCap, graphics-device-management software based on the Unix operating system, eliminates separate hard-wired device-driver programs for every device in a system. It also cuts the time required to add to the system; the company says that GraphCap creates new device support in minutes to hours.

GraphCap consists of two parts. The graphics knowledge base contains information about general hardware technology and descriptions of how a specific machine functions. The intelligent virtual device interface reconfigures itself based on information received from the knowledge base and produces the appropriate character stream for control.

Users need only to enter into the knowledge base the device's name, its classification—terminal, plotter, and so forth—and specific functions—can do rectangles, can't do circles, for example.

GraphCap is being built into the line that includes GeniSys and other computer-aided design packages at no extra charge. The company will quote prices and delivery.

Visual Engineering, 2680 N. First St., Suite 200, San Jose, Calif. 95134. Phone (408) 945-9055 [Circle 352]

RUN-TIME ANALYZER FINDS SNEAKY BUGS

The Safe C run-time analyzer spots bugs that usually remain invisible until a program is ported to a new machine or is loaded into a different run-time environment. The analyzer consists of three parts—dynamic tracer, dynamic profiler, and run-time checker.

The interactive tracer provides real-time display of program execution; the profiler records the number of times each function and each statement evaluates test coverage; and the checker observes the program's syntax and structure. Price and shipping information were not available at press time.

Catalytix Corp., 55 Wheeler St., Cambridge, Mass. 02138. Phone (617) 497-2160 [Circle 350]

SOFTWARE PORTS CP/M 80 TO PC/XT

Without the expense of adding coprocessor boards, CP/EM version 1.2 puts CP/M 80 programs on the IBM Corp. Personal Computer/XT and PC AT and their compatibles. The software emulates the CP/M 8080 and Z80 environments, where it allows CP/M access to all standard MS-DOS devices and any installed device drivers.

Serial communications programs are included, as is file sharing between CP/M and MS-DOS. Priced at $79.95, it is available now.

The ICU Group, P. O. Box 10118, Rochester, N. Y. 14610. Phone (716) 425-2519 [Circle 351]

GRAPHICS ENGINE NEEDS NO HOST

The IMI-600 graphics engine performs solids modeling with all graphics stored internally—a host computer is not required for a picture update. The engine's architecture couples a floating-point accelerator to a graphics display generator yielding an update rate of 140,000 vectors/s or 30,000 polygons/s. Transport delay is just 50 ms.

The IMI-600 design lets users configure a system to fit their needs. The system starts at $80,000; deliveries will start in the third quarter.

Interactive Machines Inc., 733 Lakefield Rd., Westlake Village, Calif. 91361. Phone (818) 707-1880 [Circle 370]

PHYSICAL DESIGN CONFERENCE FILLS A GAP

The Physical Design Conference evolved from a workshop on physical design last year, says program chairman Nelson Brady, because organizers perceived a gap—there were no IEEE conferences dedicated to physical design. Brady says the Design Automation Conference, for example, is much broader in scope, and "we needed something to deal with just physical design, not simulation or testing."

Up to now, he adds, "if you want to see physical design papers, go to Design Automation Conference, International Conference on Computer Design, or International Conference on Computer-Aided Design, and you'll see a few papers. In this conference, everybody can attend every session." Proceedings will not be published, however, because organizers didn't have enough time to work out the logistics.

Most of the 40 papers deal with very large-scale integration, with a few on printed-circuit boards. "There's a lot more front-end research on VLSI," says Brady, manager of VLSI at Tektronix Inc., Beaverton, Ore. "Problems are tougher," he says, mainly because "people have been doing pc-board layout much longer."

Routing and placement will be the two biggest issues at the conference, says Brady. "Just from algorithm complexity, these are the hardest problems in physical design. Nobody can afford to do hundreds of hours of central-processor-unit time." With that in mind, Brady says, designers have to ask themselves: "What's an algorithm that runs in reasonable time and still gets a good solution?"

Brady reports that designers are beginning to use expert systems to help them route. "On a small job, with hundreds of parts, the designer can do a better job of routing. When you get up to thousands, a program can do better."

Compcon Spring '86, IEEE Computer Society (Glen Langdon, IBM Corp., 5600 Cottle Rd., San Jose, Calif. 95139), Cathedral Hill Hotel, San Francisco, March 3-6.

1st International Conference on CDROM, Microsoft Corp. (Travel Incentives, 650 Hampshire Rd., Suite 216, Westlake Village, Calif. 91361), Sheraton Hotel, Seattle, March 4-7.

Micro '86: Symposium on Microlithography, Society of Photo-Optical Instrumentation Engineers (P. O. Box 10, Bellingham, Wash. 98227-0010), Santa Clara Marriott Hotel, Santa Clara, Calif., March 9-14.

ESC '86: Eastern Simulation Conference, Society for Computer Simulation (P. O. Box 17900, San Diego, Calif. 92117), Omni International Hotel, Norfolk, Va., March 10-12.

Cimtech '86, Computer and Automated Systems of the Society of Manufacturing Engineers (Cheri Willets, SME, 1 SME Dr., Dearborn, Mich. 48121), Boston Sheraton, Boston, March 10-13.

Carts '86: 6th Capacitor and Resistor Technology Symposium (Leon Hamiter, Carts, 904 Bob Wallace Ave., Suite 117, Huntsville, Ala. 35801), Westin Hotel, New Orleans, March 10-14.

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.

IZS '86: International Zurich Seminar on Digital Communications, IEEE Computer Society *et al.* (Albert Kundig, Swiss Federal Institute of Technology, Gloriastrasse 35, Ch-8092, Zurich, Switzerland), Swiss Federal Institute of Technology, Zurich, March 11-13.

EPEE: Electronic Production Efficiency Exposition, United Kingdom Automatic Test Equipment Group *et al.* (Network Events Ltd., Printers Mews, Market Hill, Buckingham MK18 1JX, UK), Grand Hall Olympia, London, March 11-13.

Federal DP and Communications Conference and Exposition, The Interface Group Inc. (300 First Ave., Needham, Mass. 02194), Washington D. C. Convention Center, Washington, March 11-13.

PD '86: Physical Design '86 Conference, IEEE (Nelson Brady, Tektronix Inc., CAE Systems Division, 12303-A Technology Blvd., Austin, Texas 78727), Hyatt Regency, Houston, March 12-14.

11th AIAA Communications Satellite Systems Conference, American Institute of Aeronautics and Astronautics (Fred Dietrich, Ford Aerospace & Communications Corp., 3939 Fabian Way, Palo Alto, Calif. 94303), Town and Country Hotel, San Diego, March 16-20.

Work Station Technology & Systems Conference, IEEE (Helen Yonan, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa., 19104) Bally's Park Place Casino Hotel, Atlantic City, N. J., March 18-20.

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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
Has the End Come for European Chip Makers?
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ELECTRONICS WEEK

INTEL WARNS OF HIGHER LOSSES

Prompted by news that IBM Corp. might swap some of its Intel stock for convertible debentures [*Electronics*, Feb. 3, 1986, p. 15], Intel Corp. warned investors that its future isn't exactly rosy. The Santa Clara, Calif., chip maker said its operating losses in the first quarter of 1986 could be even worse than the $34.9 million pre-tax operating loss of 1985's fourth quarter. "The depressed industry conditions that characterized 1985 are continuing into 1986. Our backlog is very low and pricing continued at depressed levels," a representative said.

EUREKA STARTS 16 MORE PROJECTS

Advanced software technology, speedy third-generation robots, and a flexible automated factory for electronic cards are among the 16 collaborative projects under the Eureka initiative announced at the second meeting of Eureka representatives in January. Other projects approved include Cerise—the European Centre for Image Synthesis; automatic design and production of custom chips using direct printing on silicon; development of design and manufacturing processes for monolithic gallium arsenide microwave integrated circuits; and development of a complete set of gate-turnoff thyristors for railway traction systems.

FUJITSU TO TEST BIG OPTICS NET

Fujitsu America Inc. will start field trials next month of what it claims is the highest-capacity commercial fiber-optic system in the U.S. The company's optical-fiber transmission system transmits voice and data at 810 Mb/s along 12,096 telephone channels over two strands of optical cable. It supports up to 18 DS3 signals, according to the San Jose, Calif., company. The initial sites have not yet been announced.

THOMSON RETURNS TO PROFITABILITY

After four consecutive years of heavy—though diminishing—losses, Thomson SA, the giant French electronics conglomerate, returned to profitability in 1985. The group, which streamlined its operations significantly after its nationalization in 1981, showed a net profit of between $55 million and $70 million on total sales of just over $8 billion. Its largest loss was in 1982—over $300 million. Thomson-CSF, the company's principal subsidiary that has 49% of its common stock traded on the Paris stock exchange, more than doubled its profit to some $130 million on sales of $4.3 billion.

GTE OPENS VHSIC CENTER

GTE Government Systems Corp. plans to set up an Advanced Semiconductor Center in Tempe, Ariz., to process chips produced under the Defense Department's Very High Speed Integrated Circuits program for parent GTE Corp. and other suppliers. The Waltham, Mass., division says it will have a fully integrated capability to process 5-in. silicon wafers to VHSIC specifications with customer-furnished tooling.

OLIVETTI TO OPEN COMPUTER CHAIN

Ing. C. Olivetti & C., Ivrea, Italy, is setting up a joint venture with Micro Age Inc., a Tempe, Ariz., personal computer chain, to build a European network of retail computer outlets. At the outset, Olivetti will have a nearly 90% interest in Micro Age Europe, Milan—a share it intends to cut to less than a majority within the next year by selling portions of the new company to other investors. Olivetti owns a 46% interest in Micro Age in the U.S. as well as large shares of retail chains in the UK and West Germany.

TEST-GEAR MAKERS IN MERGER TALKS

Financially troubled test-equipment maker Computer Automation Inc., Irvine, Calif., is holding merger talks with fellow test-equipment maker Everett/Charles Test Equipment Inc., Pomona, Calif. Industry sources say that if a deal goes through, the surviving company would be Everett/Charles, with operations combined at Pomona. Both companies make automated test equipment for printed-circuit boards.

HARDCARD DROPS $200 IN PRICE

Citing manufacturing efficiencies and a desire to increase its market share, Plus Development Corp. cut the price of Hardcard, its 10-megabyte hard-disk drive on a card for IBM Corp. Personal Computers, from $1,095 to $895. The Milpitas, Calif., unit of Quantum Corp., also says it has added to its distribution network for Hardcard, which is now carried by 25 major retail chains.

CENTER TO STUDY IMAGE ENGINEERING

The University of California at Irvine will start an Image Engineering Research Center with the help of a $225,000 grant it has received from the W. M. Keck Foundation, Los Angeles. The center will study the relatively new branch of engineering concerned with developing image-manipulating machines for applications in medical radiography, industrial inspection, computer-aided design and manufacturing, pharmaceuticals, vehicular guidance, and navigation.

UNITED PICKS IBM TO BUILD SYSTEM

United Airlines has chosen IBM Corp. to develop a new, comprehensive travel agency management system, called Enterprise. IBM will provide System/370 hardware along with its Personal Computers tied together by its Token-Ring local-area networking scheme. IBM's Federal Systems Division will develop the applications software for Enterprise, which United calls "a multimillion dollar step in a billion-dollar, five-year program that will enable agents to improve their service."

IBM IMPROVES DATABASE 2

IBM Corp. has brought out a new version of its Database 2 relational data-base software that it says contains performance, capacity, and usability enhancements. IBM says Database 2, which has been used primarily for reports and queries, now can be used for a broad range of database management needs. IBM also announced a new release of its Structured Query Language/Data System (SQL/DS) relational data base, which provides improved recovery, availability, and error diagnosis.

STORE/FORWARD MARKET BOOMS

The fledgling voice store-and-forward industry is finally getting off the ground, says Probe Research Inc., a telecommunications researcher in Morristown, N.J. A growing number of applications may have put to rest the stereotype of an overgrown telephone answering machine. By 1990, the voice store-and-forward market should easily exceed $1 billion, claims Probe. Last year, it says, the market for equipment hit $150 million, with between $25 million and $30 million spent for services.

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Circle 901 on reader service card

2,000 sharper-than-ever characters all on a portable LCD display.

Toshiba's newest LCD modules give you 640 × 200 dot displays in a choice of two viewing sizes. One is approximately the size of a magazine, and the other about half that size.

Both sizes put an enormous amount of information on view . . . an array of 80 characters × 25 lines. But still bulk and power consumption are at a minimum. Battery powered, these slim modules interface with various systems through LCD controller without renewing software.

Toshiba's advanced technology has also eliminated surface reflection and developed a sharper contrast which gives a brighter and easier to read viewing screen. And for low light or dark viewing an optional backlightable LCD is available.

These versatile LCDs are ideally suited for applications as displays for personal computers, POS terminals, portable word processors and other display terminals. You can also look to Toshiba with confidence for a wide range of sizes and display capacity to suit your LCD requirements.

TLC-363 *TLC-402*

Specifications

		TLC-402	TLC-363B
Display			
Number of Characters		80×25 (2,000 characters)	80×25 (2,000 characters)
Dot Format		8×8, alpha-numeric	8×8, alpha-numeric
Overall Dimensions (W × H × D)		274.8×240.6×17.0 mm	275.0×126.0×15.0 mm
Maximum Ratings			
Storage Temperature		−20° – 70° C	−20° – 70° C
Operating Temperature		0° – 50° C	0° – 50° C
Supply Voltage	V_{DD}	7 V	7 V
	$V_{DD} - V_{EE}$	20 V	20 V
Input Voltage		$0 \leq V_{IN} \leq V_{DD}$	$V_{SS} \leq V_{IN} \leq V_{DD}$
Recommended Operating Conditions			
Supply Voltage	V_{DD}	5±0.25V	5±0.25V
	V_{EE}	−11±3V Var.	−11± 3V Var.
Input Voltage	High	V_{DD} – 0.5V min.	V_{DD} – 0.5V min.
	Low	0.5V max.	0.5V max.
Typical Characteristics (25°C)			
Response Time	Turn ON	300 ms	300 ms
	Turn OFF	300 ms	300 ms
Contrast Ratio		3	3
Viewing Angle		15 – 35 degrees	15 – 35 degrees

Design and specifications are subject to change without notice.

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