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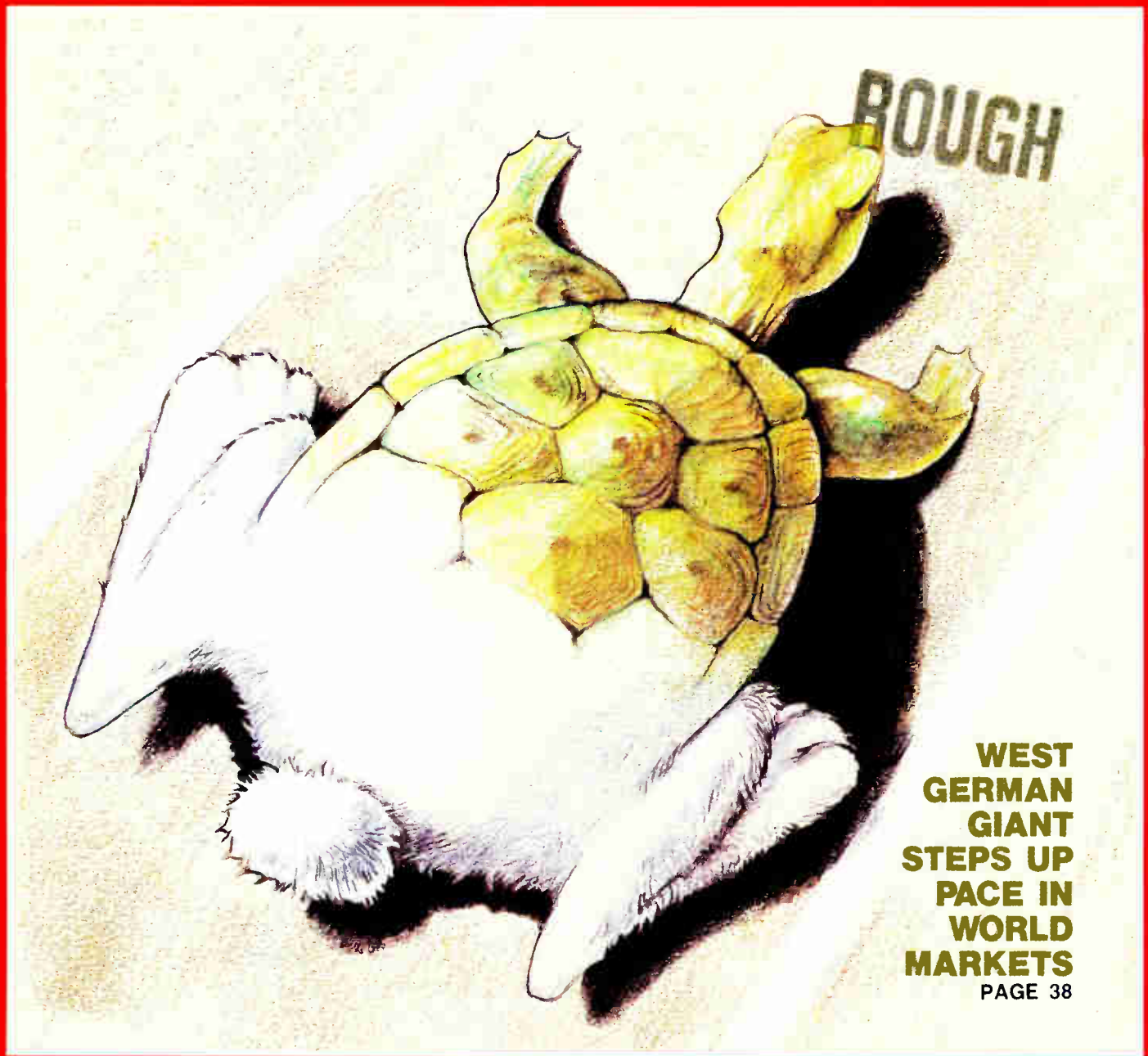
Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY

JUNE 2, 1986

SIEMENS: CHANGING A TORTOISE TO A HARE



WEST GERMAN GIANT STEPS UP PACE IN WORLD MARKETS

PAGE 38

ARK OF NATIONAL SEMICONDUC CORPORATION
STEMS SERIES 32000

"Another order."

"Certainly, we've covered all their needs today, and well into the future."

"There is no doubt—Series 32000 was the right decision. National was on target from the beginning..."

"Systems with our kind of power and upgrade potential are difficult to resist."

"And that's good for us, too. Software re-writes are totally unnecessary."

"...And now, so are we."

How Siemens builds multi-user systems compatible with the future. Using National's Series 32000® family.

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Such a demanding objective required demanding specifications: true 32-bit architecture; a complete computing cluster, including memory management and floating point coprocessors; full software compatibility, both upward and downward; high level language support; and comprehensive development tools.

The Siemens design team investigated a range of 32-bit solutions, and found only one that met all their needs: National's Series 32000 family.

Unlike other 8- and 16-bit processors being extended upward, the Series 32000 has no programmer-visible changes in architecture—throughout the entire family. So Siemens could develop any application the market demanded, now or in the future, without depreciating its existing software investment.

Which means the Series 32000 was not only the right *engineering* decision for today, but was also the right *business* decision for tomorrow.

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Feature Size: 2μ CMOS

	N-Channel	P-Channel
VTEO	0.5–1.0V	0.5–1.0V
BVDSS	>10V	>10V
$K^1 = \frac{\mu c}{2}$ linear region	21–25	6.5—8.5
B_E(Long Channel)	$0.8–1.2_V^{1/2}$	$0.4—0.6_V^{1/2}$
Cap. Gate 10^4 PF/cm^2	8–10	8–10
Cap. Poly to Sub 10^4 PF/cm^2	0.55–0.65	0.55–0.65
Cap. Metal to Sub 10^4 PF/cm^2	0.27–0.32	0.27–0.32
Junction Depth	0.4μ–0.6μ	0.2μ–0.4μ
P-Well Junction	2.5μ–3.5μ	
Poly P_S	15–30Ω/□	15–30Ω/□
Diffusion P_S	20–40Ω/□	60–100Ω/□
VTF Poly	>10V	>10V
ΔW	—1.0μ	—1.2μ
LEFF	1.0μ–1.4μ	1.3μ–1.7μ
Substrate Resistivity	2.5KΩ/□	1.2Ω/cm

Feature Size: 3μ CMOS

	N-Channel	P-Channel
VTEO	0.5-1.0V	0.5–1.0V
BVDSS	>10V	>10V
$K^1 = \frac{\mu c}{2}$ linear region	18–21	6–8
B_E(Long Channel)	$0.8–1.4_V^{1/2}$	$0.4—0.6_V^{1/2}$
Cap. Gate 10^4 PF/cm^2	5.9–7.0	5.9– 7.0
Cap. Poly to Sub 10^4 PF/cm^2	0.45–0.55	0.45–0.55
Cap. Metal to Sub 10^4 PF/cm^2	0.2–0.25	0.2–0.25
Junction Depth	0.6μ–1.0μ	0.4μ–0.8μ
P-Well Junction	3.5μ–4.5μ	
Poly P_S	15–30Ω/□	15–30Ω/□
Diffusion P_S	10–30Ω/□	30–70Ω/□
VTF Poly	>10V	>10V
ΔW	—1.0μ	—1.0μ
LEFF	1.4μ–2.0μ	1.8μ–2.4μ
Substrate Resistivity	2.5KΩ/□	1.0–1.5Ω/cm

2μ or 3μ Engineering Prototypes: We deliver on time or we absorb 30% of your fabrication cost.

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JUNE 2, 1986 VOLUME 59, NO. 22

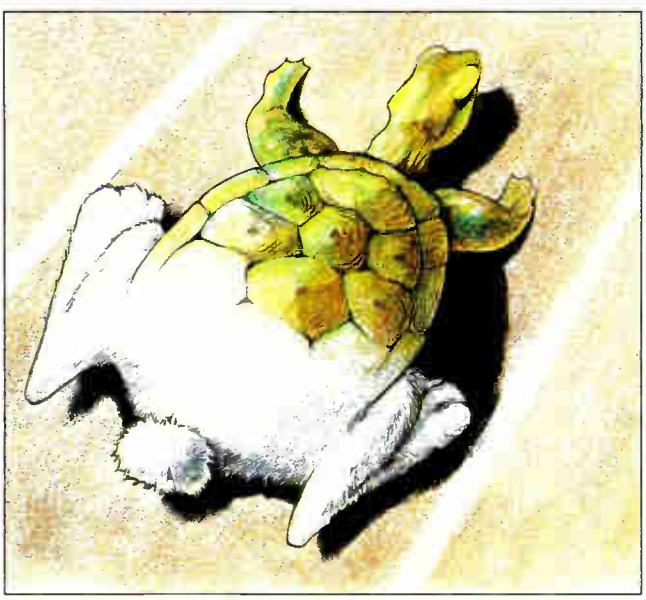
Electronics

NEWS

INSIDE TECHNOLOGY

PROBING THE NEWS

COVER



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For more than two decades, John Gosch has been describing what is new in the thriving West German electronics industry for *Electronics* magazine. And in all that time, the 60-year-old journalist says, he has never seen so many officials at Siemens so willing to talk about their company. In fact, says John, "I even got to speak to some executives who aren't used to talking to journalists, which is valuable when doing a company story because these fresh sources often provide a perspective that no one had thought of before."

JOHN GOSCH: Digging out stories from Frankfurt.

The Siemens people welcomed John because they were eager to tell the world that the company just about everyone in the electronics industry thinks of as stodgy is no longer content to sit in Munich and count its money. Rather, it has been easing itself into the fast track of worldwide electronics competition. The story of how and where the company is doing it, and an examination of its strategies in various technologies, begins on p. 38.

John reports that, for an article the magnitude of the Siemens report, the logistics were surprisingly uncomplicated. "It took me several days to set up the interviews, and then about a week to 10 days to do the reporting. I had to go to Munich, which is about 250 miles from my headquarters in Frankfurt, only twice. The company tried hard to cooperate."

That is relatively high praise from an observer as experienced as Gosch, whose beat includes East Germany and whose calm, unflappable personality is legendary among his fellow journalists. Such demeanor undoubtedly comes in handy for someone whose patience is often tested by European companies that believe what they do and what technology they use to do it are no one's business but their own.

John's calm, deliberate attitude is probably a reflection of his background as an electronics engineer. Before joining the magazine and being assigned to Germany, he worked in New York's Long Island electronics belt for the now-defunct Republic Aviation Corp. as well as for Reeves Instrument Co. "But I wanted to write," he says, "so everything has worked out pretty well."

Even as John was describing the tortoise-to-hare transformation of Siemens, art director Fred Sklenar was inventing for his cover illustration a combination creature that appears to be making that transformation right before your eyes. Which came first? In the case of Siemens, of course, it was the tortoise. But where he started for the cover painting, Fred won't say.

Laurence Altman

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WEEK 32

There are two things every mother board should have: The 82C54 CMOS Counter Timer and the security of knowing there's a complete second source mother board kit to the Intel 286 PC/AT package. And AMD is proud to hold high the banner for motherhood by announcing both.

82C54

Every mother needs them.

The 82C54 is a general purpose microprocessor peripheral. With low CMOS power, dissipation is only 6% of NMOS parts. The 82C54 is also very fast—it operates at 8 and 10MHz. And naturally, it's a plug-in replacement for Intel's part.

But just as important as the 82C54 CMOS Counter Timer is the fact that you finally have a second source for the 286PC/AT mother board kit. Along with the Counter Timer, the kit contains an 82284 Clock Generator, an 82C288 Bus Controller and an 80286 CPU. But best of all, once you're in production, you don't have to worry about availability, quick delivery and all the other things you worry about when you don't have a second source.

So get up and call AMD: The mother board's little helper.

WEEK 33

If you hate waiting around crowded registers, AMD's new Am29524 Dual 7-Deep Pipeline Register is for you. It's designed for applications that need ground or data pass-through. So now your input data can fly directly to the output or your output can be all zeroes.

Am29524

Direct flights.

The Am29524 has 14, not 16, registers like the Am29525. But it shares many of the same attributes. With the Am29524 you can dip into the data registers in any order, at any time. You could think of it as a random access register. It's programmed by microcode instructions to hold, shift or load data. Its internal ECL technology gives the Am29524 incredible speed (it has a 21ns propagation delay) and the I/O is three-state TTL compatible.

Need to get rid of some excess baggage like a register and bus buffer? The Am29524 does the work of both. And we packed it all in a 28-pin DIP package.

Flying the Am29524 isn't for just everyone. Only the people who want to travel direct.

WEEK 34

AMD wants to put power back where it belongs: In your hands.

We're proud to announce the Am29C821 10-bit CMOS Bus Interface Register. It's a member of the high performance Am29C800 Family: The family that delivers the performance you expect from the bipolar Am29800 Family but with stingy power demands.

Am29C821

Seize power.

The register requires a low power stand-by current of 80 microAmps. But AMD promises that taking power from it won't slow it to molasses. The Am29C821 has a propagation delay of 12ns.

You can also use it in place of, or along with, the Am29800 bipolar counterpart to match your drive and power requirements. Used where an Am29821 provides 48mA drive, the Am29C821 provides 24mA drive.

Get yourself the Am29C821. And then give the leftover power to someone who can really use it.

You.

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

Circle 151 on reader service card

Circle 152 on reader service card

Circle 153 on reader service card

WEEK 35

Announcing the Am29C116: The 16-Bit CMOS Microprocessor that uses only 25 percent of the power of its bipolar counterpart. The rest of the power is yours. And the Am29C116 costs less than the bipolar. The savings are yours.

Am29C116

Satisfy your lust for money and power.

The Am29C116 is one more member of AMD's CMOS Microprocessor Family. It's the pin- and function-compatible version of the bipolar Am29116. Coming from such a heritage, you'd expect the Am29C116 to have the same computing power and flexibility. It does. And it has a system cycle time of 125ns.

It's microprogrammable so you have the flexibility of designing your own instruction codes. Plus, its architecture provides powerful insert/extract and bit manipulation capabilities for complex bit control. It has a three input ALU, barrel shifter and a priority encoder.

If you want to build in blazing speed, another member of the Am29100 Microprocessor Family might be for you. Like the high speed bipolar Am29116A with a system cycle time of 80ns.

And once you've acquired all that power and money from using the Am29C116, you can lust for something else.

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

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MEETINGS

PUTTING CIM INTO PRACTICE

Practically every aspect of automating the factory will get an airing at the Advanced Manufacturing Systems Conference, to be held June 24-26 in Chicago. The conference's 80 sessions will include robotics, control systems, and computer-aided design and manufacturing, and designers from a completely automated IBM Corp. plant will offer a case history of a successful switchover.

For the first time, the conference will also incorporate two international meetings—the Automated Guided Vehicle Systems Conference and the Simulation in Manufacturing Conference.

Kicking off will be a 13-session overview of computer-integrated manufacturing, says Virginia McWaters, conference director for AMS and its sponsor, Cahners Exposition Group. Following those will be six sessions each on CAD and CAM, where such topics as graphics, raster-based CAD technology, and design of manufacturing cells will be explored. At 2 of the 21 sessions on manufacturing, planning, and control systems, designers from IBM's typewriter plant in Lexington, Ky., will describe the changeover to an operation that relies exclusively on CIM technology.

Seven sessions focus on robots—one on vision systems—and 17 on computing technology, where the emphasis is on the Manufacturing Automation Protocol. Multiple data bases and CIM expert systems will also be examined. Another key session will focus on voice recognition.

In the international conferences, executives from Sweden's Volvo Autocarrier System will give the keynote address at the AGVS meet, while Canada's Northern Telecom, Ontario, will lead a session on CIM in electronics plants. At the six SIM sessions, speakers from Europe, Canada, and the U.S. will discuss the use of simulation in control systems and process evaluation.

17th Power Modulator Symposium, IEEE (Leslie Gallo, Palisades Institute for Research Services Inc., 2011 Crystal Dr., Arlington, Va. 22202), Hyatt Seattle, Seattle, June 23-25.

1986 Power Electronics Specialists Conference, IEEE (William Dunford, Department of Electrical Engineering, University of British Columbia, Vancouver, B.C., Canada V6T 1W5), University of British Columbia, Vancouver, June 23-27.

Advanced Manufacturing Systems Conference, Cahners Exposition Group (1350 E. Touhy Ave., Des Plaines, Ill. 60017-5060), McCormick Place, Chicago, June 24-26.

28th Electronic Materials Conference, Metallurgical Society (B. W. Wessels, Technological Institute, Northwestern University, Evanston, Ill. 60201), University of Massachusetts, Amherst, Mass., June 25-27.

Design Automation Conference, IEEE (J. D. Nash, Raytheon Co., Bedford, Mass. 01730), Las Vegas Hilton, Las Vegas, June 29-July 2.

FTCS-16: The 16th International Symposium on Fault Tolerant Computing, IEEE Computer Society (H. Kopetz, Interconvention Hofburg, P. O. Box 80, A-1107, Vienna, Austria), University of Vienna, Vienna, July 1-3.

International Conference on Radio Receivers, Institution of Electronic and Radio Engineers (99 Gower St., London, WC1E 6AZ, England), University College of North Wales, Bangor, England, July 1-4.

14th International Optical Computing Conference, IEEE Computer Society (Joseph Shamir, Department of Electrical Engineering, Technion, Haifa 32000, Israel), Hebrew University, Jerusalem, July 7-11.

Ausgraph 86, The Australasian Computer Graphics Association Inc. (Ausgraph 86 Secretariat, P. O. Box 29, Parkville, Victoria, 3052, Australia), Queen Victoria Building, Sydney, July 7-11.

Compass '86: Computer Assurance Conference, IEEE (Albert W. Friend, P. O. Box 3815, Gaithersburg, Md. 20878), Georgetown University, Washington, July 7-11.

PC Expo, PC Expo (Steven Gross, 333 Sylvan Ave., Englewood Cliffs, N. J. 07632), Jacob K. Javits Convention Center, New York, July 9-11.

Britec 1986: British Information Technology Exhibition and Conference on Engineering Software, Computational Mechanics Ltd. (Elaine Taylor, Computational Mechanics Ltd., Ashurst Lodge, Ashurst, Southampton, SO4 2AA, England), Hilton at Colonial Route 128, Wakefield, Mass., July 14-16.

Net/Comm Security '86, Computer Security Institute (360 Church St., Northborough, Mass. 01532), Marriott Crystal Gateway, Arlington, Va., July 14-16.

International Computers in Engineering Conference, American Society of Mechanical Engineers (ASME, 345 E. 47th St., New York, N. Y. 10017), Hyatt Regency, Chicago, July 20-24.

TECHNOLOGY NEWSLETTER

THE FIRST FLEXIBLE AUTOMATED ASSEMBLY LINE FOR CHIPS IS COMING SOON

The first flexible automated assembly system for integrated circuits is expected to be running, at least partly, by the end of the year. Unlike fixed-purpose automated lines, it will be able to handle more than one type of package. National Semiconductor Corp., with the aid of the Jade Corp., Huntingdon Valley, Pa., and Digital Equipment Corp., is building a system called Odyssey that will use intelligent process machines to take sorted silicon wafers through assembly and testing. The system will use tape-automated bonding and other assembly techniques to put chips in dual in-line packages, plastic leaded chip carriers, small-outline IC packages, and National's Tape Pak packages. The system will have an intelligent handling system consisting of a track system and an assortment of pallets and elevators. A computer hierarchy will control the overall work flow. □

VOICE/DATA TRANSCEIVER CHIP WILL HANDLE 160 KB/S OVER TWISTED PAIR

New transceiver chips from Motorola Inc. will transmit voice and data at rates up to 160 kb/s over a single twisted-pair phone wire. Making it possible are enhanced low-impedance operational-amplifier drives aboard the 24-pin devices. The 3.5-μm CMOS transceivers are aimed at voice and computer communication systems, which are migrating towards, but not fully embracing, the still-evolving standard for digital telephony, the integrated services digital network (ISDN). The second-generation Universal Digital-Loop Transceivers, known as UDLT-2, contain two 64-kb/s channels (one for voice, one for data), as well as two 16-kb/s signaling channels. The UDLT-2 doubles the number of channels and speed of Motorola's current 80-kb/s UDLT chip set [*Electronics,* Sept. 22, 1982, p. 125]. The new MC145421/25 master-slave chip set also contains one more 16-kb/s signaling channel than the ISDN specification for terminal interfaces that use two twisted pairs. A Motorola spokesman in Austin, Texas, says the extra channel could be used by systems houses to offer an extra data path or additional proprietary controls while staying with a single twisted pair. Samples of the UDLT-2 chips are available now from Motorola, and they will be demonstrated for the first time at this month's National Computer Conference in Las Vegas. □

LASER DEPOSITION CONNECTS UNPACKAGED CHIPS

General Electric Co. researchers are using direct laser deposition to connect unpackaged semiconductor chips mounted directly on polyimide or other thermoplastic boards. Funded by a two-year, $790,000 federal contract that is part of the Strategic Defense Initiative, the study is being performed at GE's Research and Development Center in Schenectady, N. Y. The scheme offers a number of advantages, including fast-turnaround prototyping, increased board density, and compatibility with multilayer and three-dimensional circuit boards, according to Lionel Levinson, program manager for the laser study. Using either epoxy or solder as an adhesive, unpackaged chips are mounted directly onto the plastic circuit boards. Then, with the board in a gas-tight chamber filled with a metal-carrying gas, either an argon ion laser or a higher-frequency excimer laser is beamed onto the substrate, depositing traces as narrow as 1 μm. GE researchers are studying the use of tungsten, aluminum, and gold, and other metals for use as interconnection materials. Despite its link to the Star Wars program, Levinson says the project has commercial applications, and that the time required to produce boards is competitive with current circuit-board processes. "While the driving force behind the technology right now is leading-edge circuits, ultimately this packaging technology has the ability to serve high-volume, low-cost markets as well," he says. □

ELECTRONICS NEWSLETTER

U. S.-JAPAN TRADE TALKS STILL MUST SETTLE MAJOR ISSUES

Japan and the U. S. still have a long way to go before they can reach an agreement on semiconductor trade. Although the Japanese advertised last week's talks as a breakthrough, sources close to the negotiations say that nothing more than a broad framework of agreement was reached between U. S. Trade Representative Clayton Yeutter and Japanese Minister of International Trade and Industry Michio Watanabe. The talks were convened just as the International Trade Commission issued its final ruling, which had not been expected until later this week, in the first of four dumping petitions against Japanese chip makers. The ruling, in favor of petitioner Micron Technology Inc., Boise, Idaho, means that previously determined Commerce Department antidumping duties ranging from 11.87% to 35.34% will be imposed on Japanese 64-K dynamic random-access memories. A U. S.-Japan agreement would settle the three remaining trade complaints. □

TI SHIFTS MEMORY-CHIP MANAGEMENT TO JAPAN SUBSIDIARY

The road to MOS memory management at Texas Instruments Inc. now leads to Japan. The Dallas semiconductor giant has reorganized its memory-chip management structure, consolidating what had been separate U. S. and Japanese operations. TI's memory-making front-ends in Dallas and Lubbock, Texas, and MOS memory engineering and support activities in Houston now report to Japan-based management through a U. S.-based manager. Heading the newly created Worldwide Memory Operations is Akira Ishikawa, a senior vice president in the Semiconductor Group who remains president of the wholly owned TI-Japan subsidiary in Miho. Ishikawa reports directly to William N. Sick, president of the Semiconductor Group in Dallas. Since the early 1980s, TI-Japan has produced most of the company's high-density dynamic random-access memories. TI's 1-Mb DRAM program is now under Toyotaro Horiuchi in Japan; he reports to Ishikawa. □

SONY LAUNCHES NEW CAMPAIGN FOR 8-MM VCR FORMAT

Sony Corp. is stepping up its drive to market in 8-mm video cassette equipment as a format battle shapes up with Victor Co. of Japan. Two new camcorders and one VCR from Sony will soon be introduced at prices more than 15% lower than those on earlier models. As part of Sony's game plan, Kyocera Corp. and Fuji Photo Film Co. will both sell private-label versions of Sony's 8-mm camcorders, and they have already announced their models. Lower 8-mm product prices are an attempt to stimulate sales in preparation for camcorder format battles sure to come as more companies manufacture and market the compact Video Home System-C camcorder that was developed by JVC (see story, p. 44). □

NEW DAY DAWNS FOR MORROW

Less than three months after seeing Morrow Designs go into bankruptcy, founder George Morrow has announced plans for a new company, Intelligent Access Inc. Morrow's new venture will develop technology for fast and flexible disk access for personal computers. It will build disk controllers with integral parallel and serial ports, large buffer memories, and on-board intelligence (initially an NEC V.40 microprocessor) for data management. First products will be available by fall. Eventually, the design will be reduced to silicon and offered to drive makers. Morrow is chief scientist of the new company, which is based in Oakland, Calif. Morrow Designs folded early this year despite the success of its latest product, the Pivot portable computer, which has been licensed by Zenith Data Systems. □

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DT2851 + DT2858 High Resolution Frame Grabber and Auxiliary Frame Processor	IBM PC AT	512x512	256			Yes	8*			2 buffers, 512x512x8 each (512 Kbytes), and 1 buffer, 512x512x16 (512 Kbytes)	Yes	Yes	Yes	Yes	DT-IRIS	DT2851 $2995 DT2858 $1495
DT2603 Low Cost Frame Grabber	MicroVAX II	256x256	64	▼	▼		4	▼	▼	1 buffer 256x256x8 (64 Kbytes)					Coming Soon	$1895

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PRODUCTS NEWSLETTER

RICOH INTRODUCES A WRITE-ONCE OPTICAL-DISK DRIVE FOR PCs

Ricoh Co. will start shipping samples late this year of a 5-in. write-once optical-disk drive for image storage on personal computers that will sell for a little less than $3,000. Volume production should begin by the second quarter of next year. The Tokyo company's 800-megabyte disk uses a plastic-like dye film as a recording surface, rather than the amorphous telluride film used by the larger optical disks offered by other companies. A similar system from Toshiba Corp. will be available in sample quantities this summer. □

ACCELERATOR CARD ADDS DUAL TASKING TO IBM PC

An accelerator board being introduced by Alloy Computer Products Inc. will add dual tasking to the IBM Personal Computer, PC/XT, and PC AT. The Bi-Turbo card from the Framingham, Mass., company gives users a processor for each task, with no loss in overall system performance. It sells for $995 and combines NEC Corp.'s 8-MHz 8088-compatible V20 processor, 640-K bytes of RAM, plus 256-K bytes of RAM for disk caching. □

CARD SUPPORTS ALL IBM PC GRAPHICS FORMATS

Software written in any of the three graphics formats for IBM Personal Computers will run on Paradise Systems Inc.'s new graphics card, which can switch among the formats automatically. Priced at $599, the Autoswitch EGA board is fully compatible with software written for the IBM monochrome and Color Graphics Adapter formats, as well as for the newer Enhanced Graphics Adapter format. Other EGA boards can't run all the software written for CGA software. The AutoSwitch EGA board contains 256-K bytes of dual-port RAM and displays 16 colors from a palette of 64. The board's PEGA 1 chip switches automatically between EGA and non-EGA formats through its own Basic Input/Output System (BIOS). AutoSwitch EGA is available now from the South San Francisco, Calif., company. □

HP UNVEILS SECOND LINE OF RISC MACHINES....

The second line of Hewlett-Packard Co.'s new Precision reduced-instruction-set computers, the HP 9000 series 800 model 840, signals the convergence of two of the Palo Alto, Calif., company's engineering computer lines. In merging the 9000 and 1000 lines, HP is responding to an industry trend toward integrated design- and factory-automation systems. For users of the HP 9000 work-station family, migration to the new Unix-based 840, which runs at 4.5 million instructions/s, simply requires the recompilation of existing software. Users of the HP 1000 real-time scientific and process-control family will need to rework their software with Port/HP-UX, HP's software-development aid. The basic system will sell for $113,000 when available at the end of the year. The first use of the Precision architecture was in the HP 3000 series 930 and 950 business computers [*Electronics*, March 3, 1986, p. 47]. □

....AND SOFTWARE OPENS ITS DATA BASES TO PCs

Data contained in HP's HPSQL or Oracle Corp.'s Oracle data-base systems—both of which run on the new HP 9000 model 840 and the HP 3000—will be available to users of HP's Vectra personal computer, the IBM Personal Computer, and PC compatibles, thanks to Network Innovations Corp.'s Multiplex. The new version from the Cupertino, Calif., company gives users of popular applications software, such as Lotus 1-2-3 and dBase, access to data running on the model 840. Multiplex, which sells for $695, also features file transfer, network file management, and terminal emulation. □

Electronics

LOCAL NET ENCRYPTS ALL DATA, ENFORCES SECURITY CLEARANCES

SECURE NETWORK FROM VERDIX IS BUILT TO PENTAGON REQUIREMENTS

WASHINGTON

Local-area networks in their current form are a nightmare to organizations seeking to transfer sensitive data. Provisions for preventing eavesdropping are far from robust; transmissions can potentially be picked off a net at any node. Among those working on LAN security is Verdix Corp., the computer security and Ada-software development company in Chantilly, Va.

Verdix unveiled what it bills as the first multilevel-secure LAN at last week's Armed Forces Communications and Electronics Association convention in Washington. The LAN is said to meet Defense Department requirements for secure computer communications and is undergoing developmental evaluation at the DOD's National Computer Security Center to determine whether it meets A1-level, the government's highest rating for secure communications.

The secure LAN consists of a Verdix network security center—a dedicated work station with security and control software on floppy disks—and multiple Verdix network-security devices, interface boards that handle access control, encryption, and communications. In addition, the system includes a secure LAN interface that acts as a communications server for encrypting all transmitted data from other systems.

DES ENCRYPTION. The Verdix LAN encrypts each data packet transmitted on the network using the Data Encryption Standard developed by the National Bureau of Standards and IBM Corp. However, the National Security Agency, which oversees secure computer communications as a result of the September 1984 National Security Decision Directive 145, is considering replacing the DES algorithm with a new standard [*Electronics*, Feb. 3, 1986, p. 27].

Verdix says it is monitoring encryption technologies and would incorporate any new standard into its secure LAN once the standard is available in silicon form. Aside from software modifications required by a new encryption standard, "we really don't anticipate any problems," says secure-products marketing manager Guarang Shah. He says Verdix expects the new LAN will get the NSA's A1-level security rating by the third quarter of 1987.

"NSDD 145 is going to open up an outside market," Shah maintains. Besides aerospace and defense contractors and government agencies, Verdix is targeting the banking, brokerage, and insurance industries.

To use the LAN, each network security device must be authenticated by something known as a data key, which is generated by the network security center. Then the center downloads data-access rules that define "security windows." The windows determine the levels or categories of data that may be transmitted or received. Receive security windows define what data a node may receive from the LAN; transmit security windows determine what data nodes may transmit to the LAN.

The network security device also enforces data-access rules specified by the network center while ensuring that data supplied by users is consistent with both windows. By checking the transmit security window, it can prevent users from changing the information's classification—from secret to unclassified, for example. Checking the receive window prevents users at the destination from reading information above their designated clearance levels.

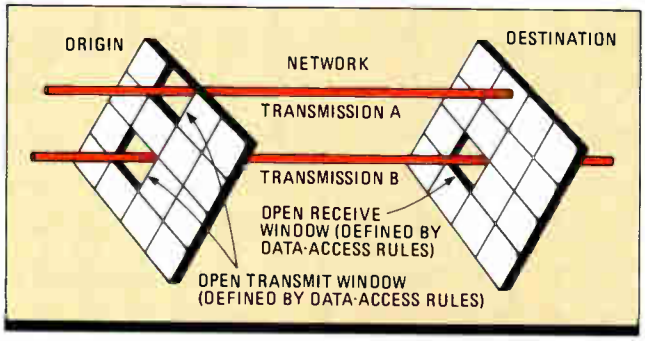
Initially, the Verdix LAN will support the Ethernet 802.3 media-access protocol. But it will also permit system integrators to add protocols operating at higher layers of the International Organization for Standardization's open-systems interconnection model. It also provides external interfaces to IBM Corp. and compatible machines using a standard Multibus backplane.

The network-security-device hardware will be made available in two board-level configurations: a standard Multibus I board and a board compatible with the expansion bus of the IBM Personal Computer. The security center contains a communications interface, a data-separation kernel, an authentication-key interface, encryption hardware, a processor, and memory. It is driven by an Intel 16-bit 80286 microprocessor and uses an Intel 82586 microcontroller to provide 802.3 media access. It includes 512-K bytes of memory divided into two separate 128-K-byte banks of dual-ported local random-access memory plus 128-K bytes for the Ethernet interface and a 128-K-byte space reserved for erasable programmable read-only memory.

The LAN interface is a stand-alone communications server that links the LAN to terminals or mainframes. Installed at the user's end, it checks every attempted data transmission against the data-access rules specified by the security center. It also encrypts all data transmitted on the network, including user data, control data, security markings, and messages sent between interfaces and to and from control centers.

Prices are set at $21,500 for the security control center, $5,150 each for the network security devices, and $6,750 for the LAN interface. Verdix is now taking orders for the LAN. Beta testing should begin in the fall and shipments are expected by year end, says Shah.

In addition to the Ethernet protocols, Verdix is looking to implement other standard LAN protocols, higher-level software, and gateways in future secure networks. *–George Leopold*



CLEARANCES. A secure local network from Verdix lets encrypted data go only to destinations cleared for a given security level.

COMPUTERS

BURROUGHS, SPERRY SEARCH FOR A FIT

NEW YORK

Sperry Corp. finally said "I do" to Burroughs Corp.'s $76.50-per-share merger proposal—nearly 12 months after Detroit-based Burroughs made its first overtures with a $65 offer. Sperry fought off the advances, first friendly, then hostile, by seeking another, more accommodating partner; but in the end Burroughs triumphed when it boosted its final offer $6.50 above the $70 it proposed in early May.

"The most difficult issue was the issue of price," Burroughs chairman W. Michael Blumenthal told a gathering of reporters in New York last week. In fact, he added, "price was the only issue."

Now, however, comes the even harder part: combining two large corporations with unlike computer architectures into a single company capable of knocking heads with the likes of the five-times-bigger IBM Corp. Neither company will spell out plans for the future, but among industry analysts, opinions on the merged company's prospects range from downright skeptical to optimistic. But both camps are intently watching the merger, which will make Burroughs-Sperry the second-largest U. S. computer company.

"There are a lot of things that don't fit," says Gary Bosak, vice president for research at New York investment firm Eberstadt Fleming Inc. "I'm skeptical. I'm forcing myself to be open-minded." Bosak questions whether the combination is additive—whether, in this case, one plus one equals two, or whether it equals something else. "While one plus one may equal less than two," he says, "that might equal more than if they hadn't merged. I think Sperry came to that conclusion."

MORE COMPETITION? In the other camp is Kimball Brown, an industry analyst for San Jose, Calif., market researcher Dataquest Inc. Combining Sperry's 5.4% share of the U. S. mainframe market (in terms of units) with Burroughs's 12.5% will strengthen the two, he says, giving IBM more competition. He points out that "IBM owns the [U. S.] mainframe market, with 56.6% of the units sold. I think the price IBM can command is going to drop, and the new Sperry-Burroughs company will be able to get a little more money for their machines."

Whether that will happen, however, will rest heavily on Blumenthal's ability to smooth out the wrinkles in the management structure at Sperry. The hostile takeover bid did not sit well with Sperry executives. Chairman Gerald Probst declines to comment on the board's vote, but Sperry watchers are convinced several directors strongly opposed the deal.

Probst, who hardly seemed jubilant about the deal, told a New York press gathering that "as a public company, you aren't always master of your own destiny. We would have continued to be a viable organization without the merger."

OPTIMISTIC. Blumenthal is convinced Burroughs and Sperry together can stand up to IBM.

Technology will compound the friction between Burroughs and Sperry personalities as Blumenthal tries to piece the two companies together. Each relies on a proprietary operating system and architecture across its entire product line, making the lines all but totally incompatible. And there are no immediate plans to discontinue either line. "We are totally committed to maintain, develop, and grow the mainframe architectures of the two companies," Blumenthal says.

Dataquest's Brown, however, believes that the two architectures cannot continue forever. "They'll maintain the ability to run the programs that run on the old systems," he says, but they will eventually develop hardware that can accept applications written for either system. "What Blumenthal means is that he's going to support the applications programs—that's the major investment customers have in their systems." Brown figures that the parallel lines will be offered only for the next five years or so, after which time the new generation will come.

In the meantime, he says, the new company will concentrate on developing a line of midrange computers, work stations, and minicomputers that is network-compatible with their other systems, much as IBM did with its System 36 and 38 computers.

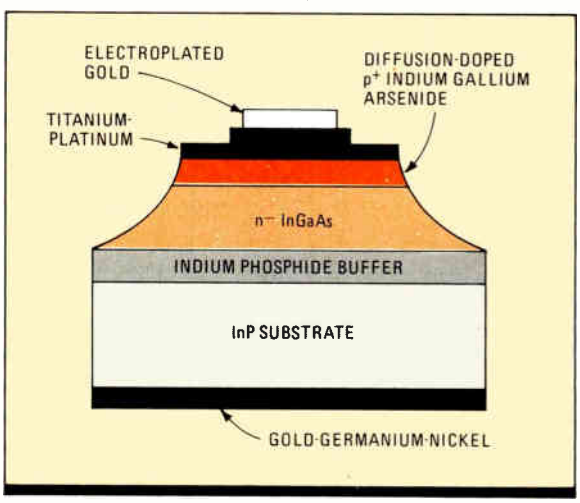
Despite $4.5 billion in liabilities for the two companies and a sluggish mainframe market, Blumenthal is optimistic. "We engaged in some hard bargaining . . . but that is behind us. We're looking to the future now." *–Tobias Naegele*

FIBER OPTICS

FRENCH FIND EASIER WAY TO BUILD FAST PHOTODIODE

LIMEIL-BRÉVANNES, FRANCE

A team of French engineers has developed what it claims is the first indium gallium arsenide/indium phosphide p-i-n photodiode using metal-organic vapor-phase epitaxy (MOVPE). The breakthrough could well open the way for a commodity that until now has been difficult to manufacture: photodetectors fast enough to operate in the 1.3- and 1.55-μm transmission windows, where attenuation in optical fibers is at its lowest.



MESA. The LEP's photodiode, made with vapor-phase epitaxy, is easier to produce than competing devices.

Developed at the Laboratoires d'Électronique et de Physique Appliquée (LEP) in Limeil-Brévannes, the main French research laboratory of Dutch multinational Philips, the diode offers technical specifications at least equivalent to those available from liquid-phase

epitaxy (LPE), says project head Jean-Louis Gentner. It also solves the major production problems encountered in attempts to produce such diodes using LPE.

Because it is difficult to grow InGaAs and InP with low background doping, for example, few LPE diodes can meet stringent capacitance requirements without resorting to complex structures. In addition, the use of LPE is limited to small substrates, a fact that makes the potential yield of MOVPE significantly higher.

CLASSIC. The LEP's diode is of a classic mesa structure and is based on an InGaAs/InP heterostructure. One of the key points of the company's technology is that it begins with a very high-quality InP substrate made in-house, a result of the LEP's effort over the years aimed at producing III/V materials without dislocations. Epitaxial layers grown on such materials tend to be more homogeneous and thus provide superior performance.

The diode in question is formed by growing on the InP substrate an InP buffer layer 1 μm thick followed by a 4-μm n⁻ doped InGaAs layer. The pn junction is formed by zinc diffusion, and the back side of the structure is metalized with gold, germanium, and nickel. After a titanium and platinum ohmic contact is deposited on the front side and the mesa defined by selective etching, this top contact is further reinforced by gold electroplating. On the portion of the mesa not covered by metal, which measures some 80 μm in diameter, a layer of silicon dioxide is deposited as a passivation and antireflection coating.

The diode boasts a dark current of as little as 1 nA with a capacitance of only 0.4 pF at a 10-V reverse bias. Responsivity, on the other hand, measures as high as 0.8 A/W, with an electrical bandwidth of some 3 GHz at 1.3 μm.

In a device-life test, the LEP found no degradation of the dark-current specification after 4,000 hours at 65°C and a 10-V reverse bias. The lab has also successfully tested the parts coupled with high-impedance FET preamplifiers in 1.3-μm communications systems operating at 140 and 565 Mb/s. *–Robert T. Gallagher*

AUTOMOTIVE

POWER MOS FETS FIND THEIR WAY INTO CARS

LOS ANGELES

New markets of any size have been hard to find lately for hard-pressed semiconductor companies. So it's big news when one appears. A market for power MOS FETs in automobiles has developed, and two companies already have staked out some solid leads there.

"The automotive market is the single largest additive market for power FETs," says Derek Lidow, vice president of marketing and administration at International Rectifier Corp. Late last month, IR announced it had become qualified to supply its Hexfet line of power MOS FETs to Ford Motor Co. It already has similar status with General Motors Corp. and Chrysler Corp., and that means the El Segundo, Calif., company has established itself early with these volume users, Lidow notes. Motorola Inc.'s Semiconductor Sector—the leading supplier of semiconductors to the car business—is the Big Three's other major MOS FET source.

IR's market projections for worldwide automotive power MOS FET consumption underscore how fast the device will make inroads over the next five years. From only some $10 million this year, MOS FETs will take off and reach about $100 million by 1990, IR estimates. Moreover, the importance of automotive customers will balloon, from only 6% of the $160 million sales this year to 22% of an estimated $450 million total in 1990.

Lidow suspects other projections of how much automakers will spend on discrete semiconductors have overlooked the steep slope of this MOS FET growth. For instance, In-Stat Inc., a Scottsdale, Ariz., market consultant, forecasts some $450 million total discrete sales to U. S. auto manufacturers in 1990. That could well be low, given the speed at which the automotive MOS FET business is taking off, Lidow says.

Paul V. White, vice president of marketing at Motorola's Discrete Semiconductor Group, generally agrees with IR's numbers, with one caveat. The Phoenix-based White thinks that instead of stand-alone MOS FETs, "smart power"—the combination of power switching and logic either on the same chip or in a hybrid package—will play a larger role. Smart-power MOS FETs "might come a lot faster and more pervasively than anybody now thinks," he adds.

MOS FETs are just now starting to penetrate the car business significantly, despite their long-demonstrated superiority in speed, reliability, and size over the largely electromechanical and transistor components. One reason for the delay is that, until recently, the devices commanded premium unit prices of several dollars and up, far too high for automakers even with volume discounts. Auto companies "are as cost-conscious as any end-user consumer company," ob-

HOW PC MAKERS ARE TRYING TO HIKE OVERSEAS SALES

Personal computer makers are leaving no stones unturned in their quest for new markets. More and more U. S. companies are trying hard to sell their machines in Japan to American customers who want access to the latest American IBM-compatible software, while the Japanese are trying to do the same thing in reverse in the U. S. with their systems, which support Japanese software.

Hewlett-Packard Co. is setting up to compete with IBM Corp. in Japanese markets with a dual-language system. AT&T Co. is bringing in a single-language system that could evolve into a dual-language one. NEC Corp., Tokyo, aims to serve Japanese companies with subsidiaries in the U. S., a market where IBM Japan Ltd. has been selling its 5550 multistation.

In Japan, the IBM Personal Computer, PC/XT, and PC AT have been available for some time. Now a Japanese version of HP's AT-compatible Vectra is being marketed by joint venture Yokogawa-Hewlett-Packard Ltd., Hachioji, as a key product in HP's Asian strategy. Many users want PC AT compatibility to use programs that are available only for that environment. Some software is available earlier for AT compatibles or in more advanced versions.

The dual-language Vectra operates under either the AT-compatible MS-DOS 3.1 operating system for English or a unique Japanese version of MS-DOS 3.1. The system, whose display board supports a 1,024-by-768-pixel screen for Japanese applications and a 640-by-400-pixel monitor for English software, sells for about $1,200 more than the English-only version. Vectra versions for the People's Republic of China, Taiwan, and Korea are also available.

AT&T International (Japan) Ltd., Tokyo, is offering its PC6300 and PC AT-compatible 6300-plus in Japan at 10% above U. S. list prices. It is possible that the company will offer Japanese and other Asian-language capabilities as Unix tasks in the future.

NEC has started sales in the U. S. of the PC-9801-VM2E, which is compatible with its 16-bit PC-9801 line, a big seller in the Japanese market. The new system has a power supply for U. S. line voltages and will permit the use of familiar Japanese-language MS-DOS software in the U. S. *–Charles L. Cohen*

serves consultant Will Strauss of Forward Concepts Inc., Tempe, Ariz. "It's right up there with reliability and delivery." Learning-curve improvements and price cutting have made MOS FETs affordable.

First MOS FET uses in autos have been confined to high-end-option power-accessory features, notes Lidow, such as for a cooling-fan control in Cadillacs, and for regulating lights on digital-display dashboards. But increasingly, mainstream applications will appear, such as the fuel-injection systems for some 1987 GM models.

Lidow and White say the next uses will include engine control, anti-skid braking, and alternator control. Furthermore, power MOS FETs will control the small motors that operate such accessories as door locks, windows, seats, and wipers. "By 1990, high-end models could have more than 100 FETs each," Lidow predicts.

TOUGH SELL. All hands agree that selling to automakers is much tougher than selling to other component customers. For openers, their multiyear product-design cycles result in auto engineers being more thorough and demanding. "You just have to keep pounding on those three doors, telling them you're there," observes Strauss. International Rectifier's Lidow confirms that his company called on GM for nearly six years before getting a high-volume order, which he defines as "anything more than a million pieces."

Competitors, especially those based offshore, keep eyeing the MOS FET business because of its potential, and they're making runs at getting more of it. Sources say these companies include Siemens, SGS Microelettronica, and Thomson-CSF.

But once established, proven suppliers are hard to dislodge, notes Motorola's White, whose company has been in this game longer than anyone. IR's Lidow, too, deems it unlikely that automakers will add suppliers as long as present ones perform, because Detroit's move to just-in-time delivery requires only a select few. This bodes well for the two leaders, IR and Motorola, in his opinion. "If you're not there now, you're not there at all," he quips. *–Larry Waller*

IC PROCESSING

X RAYS FABRICATE 1.2-GHz MOS FETS

HEILBRONN, WEST GERMANY

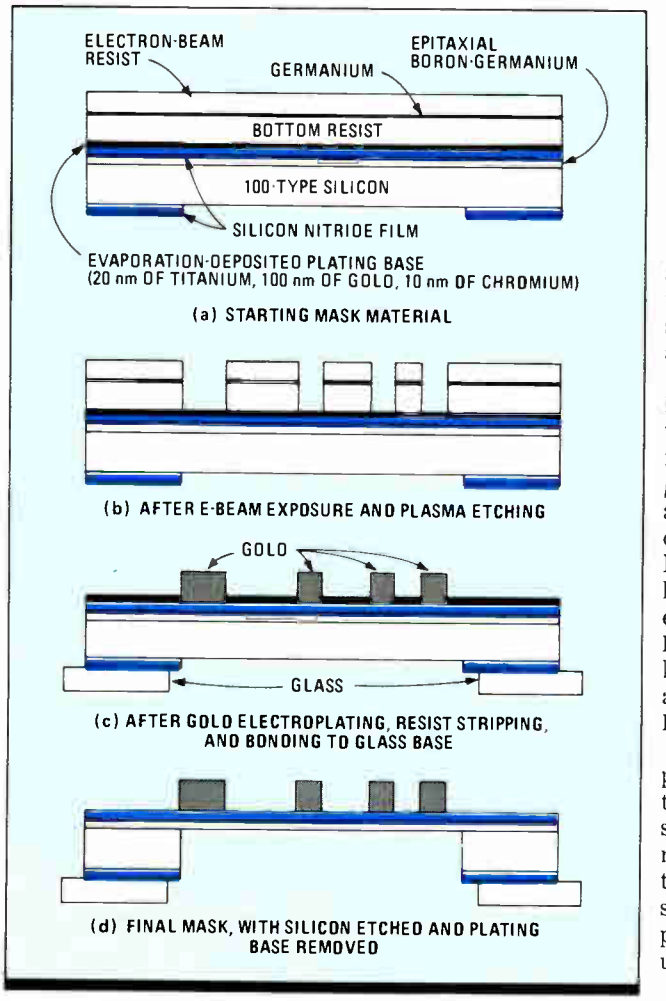
West Germany's government-supported X-ray lithography project is bearing fruit—and about a year ahead of schedule. Tapping an experimental synchrotron radiation source at the Fraunhofer Institute for Microstructure Technology in West Berlin, engineers from Telefunken electronic GmbH have fabricated MOS FETs for operation at up to 1.2 GHz—the world's first commercial parts made by X-ray exposure.

Telefunken electronic has also come up with a clever X-ray mask design that uses boron- and germanium-doped epitaxial layers to meet the tough demands imposed by the high-intensity X rays.

Assisting in mask design was the AEG Research Laboratory in Ulm. Munich's Karl Süss GmbH built the X-ray stepper, which uses an alignment scheme worked out at Siemens AG, also of Munich. In fact, virtually all West German companies in semiconductor design and fabrication technology are part of the government-supported project.

X-ray lithography is a promising technique for fabricating the submicron, ultralarge-scale integrated circuits of the 1990s. When based on parallel synchrotron radiation [*Electronics*, March 17, 1986, p. 46], the technique provides image resolution down to 0.1 μm, thanks to the X rays' short wavelength of 0.2 to 2 nm.

Other advantages are the low energy of the X rays, which minimizes scattering effects in the resist and the substrate, as well as diffraction and absorption in the resist. Thus, images can be accurately reproduced in thick resist layers and with mask-to-wafer gaps of 40 to 60 μm. Such large gaps help protect the mask. And the parallel rays allow a one-to-one transfer of the mask structure to the wafer.



THE MASK. Telefunken electronic's answer to the tough X-ray mask problem involves a thin layer doped with boron and germanium.

The Germans are rushing ahead in the X-ray field because "the Japanese are pushing us," says Gerhard K. Lässing, manager for process engineering of discrete devices at Telefunken electronic. "We have reports that they are stepping up their efforts. To keep our lead, we put more people on the project, and that helped us to come up with practical devices now instead of at the end of this year as originally planned."

The company's dual-gate n-MOS FETs suit applications in tuners, mixers, and amplifiers, for example. The chips, with 1-μm gate lengths, measure about 0.5 by 0.5 mm and are obtained "at a good yield," Lässing says. By the second half of next year, Telefunken electronic hopes to have MOS FETs with a 0.5-μm gate length and marketable gallium arsenide metal-semiconductor FETs with 0.3-μm gates.

The Heilbronn engineers applied X-ray technology only to those of the 10-odd masking steps critical to device performance—for example, the steps that determine the gate dimensions. All noncritical steps are performed with conventional ultraviolet light lithography.

It makes no sense economi-

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The IMS T414 is the first transputer, integrating a 32 bit microprocessor, four inter-transputer communication links, 2 Kbytes of RAM, a 32 bit memory interface and a memory controller onto a CMOS chip.

The microprocessor runs at 10 MIPS and is designed specifically for the execution of high level languages. It combines direct support for multi-tasking, floating point, block transfer and record handling with sub-microsecond procedure call and task switching.

Each transputer link provides a full duplex, 10 Mbits/sec, point to point connection with an on chip DMA controller. Links are used for inter-transputer communication or, via an INMOS Link Adaptor, interfacing to industry standard byte wide peripherals.

The memory interface provides access to a linear 4 Gbyte address space at a data transfer rate of up to 25 Mbytes/sec.

Transputers are designed for ease of engineering. All transputer family devices operate from a single 5 MHz clock input, which is used to derive high speed internal clocks for all on chip systems.

When transputers are directly connected via links, additional components are not necessary. Independent or common clocking can be used, regardless of timing skew.

The configurable memory controller also requires no external components. It provides all the necessary timing and refresh signals for memory systems, comprising any mix of ROM, SRAM, DRAM and memory mapped peripherals.

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IMS T212	**16 Bit, 2 Kbyte RAM, 4 Transputer links**
IMS C001	Transputer Link Adaptor, Separate 8-Bit input and output
IMS C002	Transputer Link Adaptor, Multiplexed 8-Bit input/output

DEVELOPMENT TOOLS	
IMS D100	INMOS Transputer Development System
IMS D600	Transputer Development Software, VAX-VMS
IMS D700	Transputer Development Software, IBM-PC

EVALUATION BOARDS	
IMS B001	Double Eurocard, IMS T414, 64 Kbyte RAM, 2 x RS232C ports
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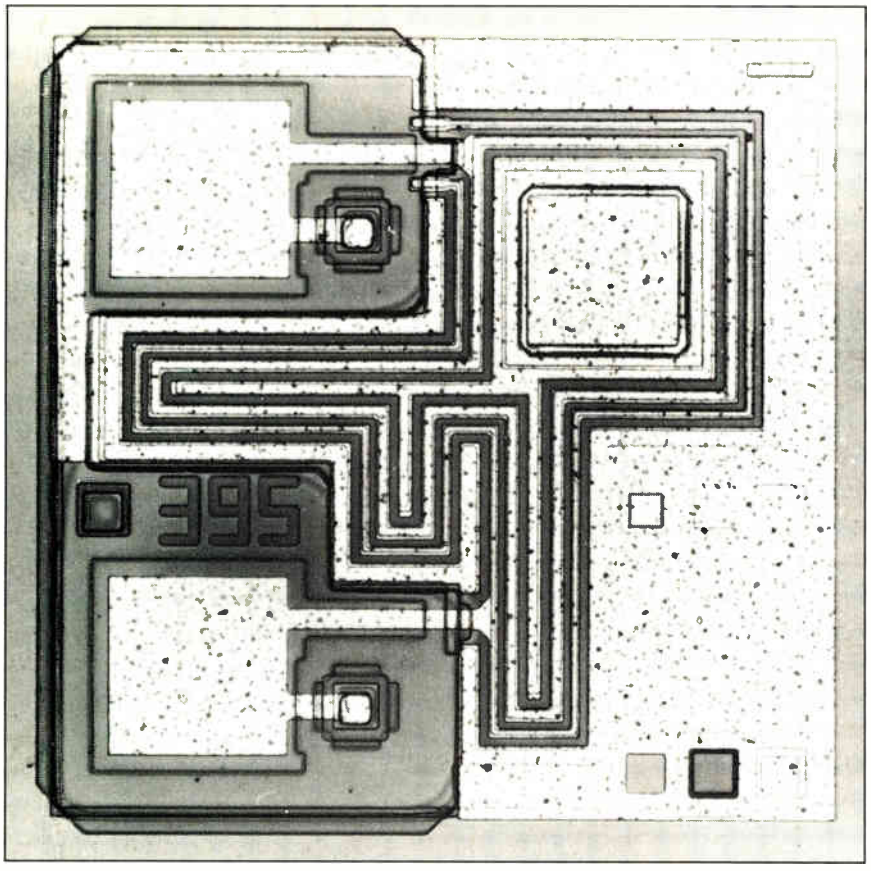


SHOWING IT OFF. Telefunken electronic chose to demonstrate the commercial feasibility of its synchrotron X-ray lithography technology by producing MOS FETs with 1-μm gate lengths.

cally to apply costlier X-ray methods to steps that can be handled more cheaply by standard processes, Lässing says. Still, the present MOS FETs are being offered at the same price as conventionally made parts. They will cost much less, however, once X-ray techniques are used in volume production.

In X-ray technology, Lässing says, "it is the mask that determines whether or not devices can be successfully made." The major problem is getting a high enough X-ray dose at the resist areas that are not masked by the X-ray absorber patterns. This calls for a thin silicon membrane, on the order of a few microns thick, as a mask substrate.

But mask deformations result from the different expansion coefficients of the silicon, the membrane, and the absorber material, which is usually gold. This means that accurately dimensioned fine lines cannot be obtained on the chip. Telefunken electronic's solution is an X-ray mask consisting of a gold absorber electroplated on a substrate formed by a simultaneously boron- and germanium-doped epi layer on a 3-in.-diameter n-type silicon wafer.

For rigidity, the mask substrate is bonded on a Pyrex quartz-glass ring 100 mm in diameter. Then, with an anisotropic etchant, the silicon is removed at the masking area so that only a thin membrane is left standing. X rays can easily penetrate the membrane, which is optically transparent to facilitate mask-to-wafer alignment.

A simultaneously boron- and germanium-doped epi layer has three major advantages over a silicon membrane with only a boron-doped layer, Lässing explains. First, germanium-codoping reduces tensile stress in the membrane, which is caused by the high boron concentration needed to stop the thinning process.

Second, the additional germanium reduces crystal defects in the membrane. This makes for a smooth membrane surface, which, in turn, improves transparency. Finally, germanium codoping cuts the lateral distortions that the thinning process causes in the membrane.

Mask fabrication first involves depositing a 2.5-μm boron- and germanium-doped epi layer on the silicon wafer. Then, through low-pressure chemical vapor deposition, an 80-nm silicon nitride film is put on both sides of the wafer.

That film is an interdiffusion barrier layer between the silicon and the subsequently deposited titanium, gold, and chromium plating base materials. It also serves as an antireflection layer for improving the membrane's transparency for optical alignment. A three-level special electron-beam resist is deposited, consisting of polymer, germanium, and a top layer of polymethylmethacrylate (PMMA).

The PMMA is exposed by electron-beam lithography and developed, and plasma-etching steps transfer the pattern to levels below it. The gold patterns are then electroplated using a resist stencil. The resist stencil and the plating base are removed, and the silicon wafer is then thinned in the mask area using an anisotropic etchant.

The Karl Süss KG GmbH stepper used for fabricating the MOS FETs has a step field of 25 by 25 mm, and its optical-alignment system boasts an accuracy of 0.02 μm. *–John Gosch*

PERIPHERALS

4-CHIP CONTROLLER IS KEY TO SCSI HARD DISK DRIVE

LONGMONT, COLO.

The Small Computer Systems Interface is moving into the small but potentially vast market for 3½-in. hard-disk drives. Among the first to venture into the untested market waters will be Miniscribe Corp. The Longmont company this week will introduce its 25.5-megabyte 8425S drive, which has a fully integrated controller attached to its side. The integrated SCSI controller is made possible by using a four-chip set and surface-mounting technology.

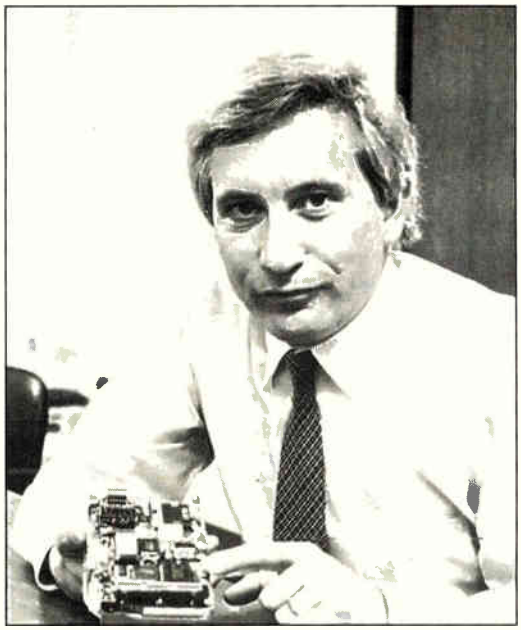
Other disk makers are expected to dive into the market during the summer. A company launched a year ago by former Miniscribe engineers, Codata Memory Corp.—now merged with Conner Peripherals Inc., San Jose—will soon introduce a 40-megabyte, 3½-in. SCSI hard disk. And Rodime plc of Glenrothes, Scotland, reportedly is readying a 3½-in. SCSI hard disk for introduction later this summer.

Some hard-disk makers are holding back, however. Microscience International Corp., Mountain View, Calif., had been interested in 3½-in. SCSI hard-disk products, but delayed plans after a survey of potential customers. Instead of rolling out a 3½-in. SCSI hard disk, Microscience will focus on what it believes will be a more active market for higher-density 5¼-in. SCSI products, says Ron Schlitzkus, director of marketing.

Though the going will be slow at the start, the 3½-in. SCSI market is expected to take off within a year, says indus-

try analyst Robert Katzive, vice president of Disk/Trend Inc. in Los Altos, Calif. He notes a migration to 3½-in. form factors by such companies as Apple, Hewlett-Packard, and IBM, the latter with its recent laptop computer introduction. Another influence: SCSI standards are finally becoming nailed down [*Electronics*, May 26, 1986, p. 46].

For Miniscribe, this summer's dash for early market share in 3½-in. SCSI drives is being propelled by an emerging need for standard peripheral interfaces inside transportable and laptop computer systems, says Nicholas C. Assouad, manager of controller development. "With the expectation that IBM will introduce a 3½-in. hard disk, we are seeing a fairly strong demand in the market today. We hope 1987 will be the year for the 3½-in. [SCSI hard-disk], and further down the road they will occupy the low end of the hard-disk market."



IN DEMAND. Assouad of Miniscribe sees strong demand for its 25.5-megabyte 3½-in. hard-disk drive.

FOUR-CHIP CONTROLLER. Miniscribe's drive has a four-chip controller design. Three of the chips are produced for Miniscribe by three custom- and semicustom-silicon houses. The fourth is an off-the-shelf programmable data sequencer with on-board error correction marketed by Adaptec Inc., Milpitas, Calif.

"We elected to integrate our own chip set instead of using available SCSI integrated circuits because of the limited real estate," notes Assouad. "You must stay within the 3½-in. form factor, otherwise customers will find it hard to use your product."

The work began a year ago last March with Miniscribe enlisting the help of semicustom-chip makers NCR, VLSI Technology, and Taiyo Yuden. NCR Corp.'s Microelectronics Division, Fort Collins, Colo., is fabricating Miniscribe's design of an integrated SCSI adapter IC. The 3-μm single-level-metal CMOS chip contains not only the complete SCSI adapter, but also drivers, a dual-ported sector buffer (1,024 bytes of random-access memory), a buffered direct-memory-access controller, and a microprocessor interface. About 45% of the 68-pin chip is RAM, says Assouad.

"The challenge was finding a vendor that was capable of integrating 8-mA drivers with RAM and standard cells. Not many could do that on a single CMOS chip," says Assouad.

VLSI Technology Inc., San Jose, integrated the 2-μm CMOS encoder-decoder device that implements Miniscribe's proprietary address-mark generation and detection scheme in silicon. The address-mark generation and detection scheme boosts performance of the 3½-in. drive by first locating a known high-frequency field on the disks before locking the voltage-control oscillator on frequency when reading from and writing to the spinning tracks.

The 52-pin chip also uses an IBM Corp. 3370 format and compresses or decompresses the data with a 2 of 7 run-length-limited encoding scheme, enabling Miniscribe to use oxide media instead of more expensive thin-film media while maintaining a reliable 5-Mb/s data-transfer rate. The flux changes per inch are a third lower than other bit-packing techniques using modified frequency modulation. The chip has been designed to support up to 10-Mb/s transfer rates, and Miniscribe will eventually use the chip in its higher-performance 3½- and 5¼-in. hard disks.

TRIMMED. Taiyo Yuden Inc., a Japanese company with a subsidiary in Chicago, is handling the bipolar member of the chip set. The 44-pin device is a voltage-controlled oscillator containing laser-trimmed resistors and capacitors. The SCSI common set of 13 commands is contained in programmable read-only memory along with 11 other standard optional commands, including self-diagnostics features. The total power dissipation of the drive is 12.5 W—suitable for battery-powered portable computers.

Miniscribe, which is introducing the 8425S SCSI drive at a price of $375 each in quantities of 1,000, is ramping up production of the drive at a contract surface-mount assembly house in California most of this year. By early 1987, Miniscribe plans to transfer assembly to one of its plants in Singapore or Hong Kong, which will use the new 8425S controller of the SCSI drive as a technology driver for future products. *–J. Robert Lineback*

MATERIALS

USING GORE-TEX REDUCES SIGNAL DELAY IN PC BOARD

NEWARK, DEL.

High-performance printed-circuit boards for next-generation computers may have something in common with raincoats. The Electronic Products Division of W. L. Gore & Associates Inc. is betting that a material essentially the same as Gore-Tex, the product used to make fabrics water-repellent, can be used in a pc board offering a vastly improved dielectric constant.

As clock rates ramp up to ever higher speeds, computer designers are coming to recognize that as much as 50% of a system's delay can come from the connectors, cables, and pc boards it uses as a platform, says Gore's Dan Johnson, the leader of Gore's pc-board effort in Newark. The Electronic Products Division has developed a material that offers a low dielectric constant—about half that of conventional pc-board materials—which cuts propagation delays. Furthermore, it can be used with present processing techniques.

"To my knowledge, we have the only material with a dielectric constant less than 3—and the [manufacturing] reliability of a thermosetting resin," says Johnson, one of the originators of the plan to use Gore's expanded polytetrafluoroethyleneone, or PTFE, fibers, as a laminate or as the host material in pre-pregs for high-speed, multilayer pc boards. Prepregs are layers, usually glass fiber, impregnated with resins, such as epoxies, to gain the best possible balance of electrical and mechanical properties.

PTFE is the generic name for Teflon, which was developed by Gore's neighbor, the Du Pont Co., Wilmington, Del. The popular material is commonly found in everything from armor-piercing bullets to nonstick frying pans. What Gore adds is a proprietary method of stretching and heating the fibers to modify their electrical and mechanical properties. The process was developed about a decade ago by Robert Gore, the company's president and son of the chairman and founder, William Gore.

The company first exploited Gore-

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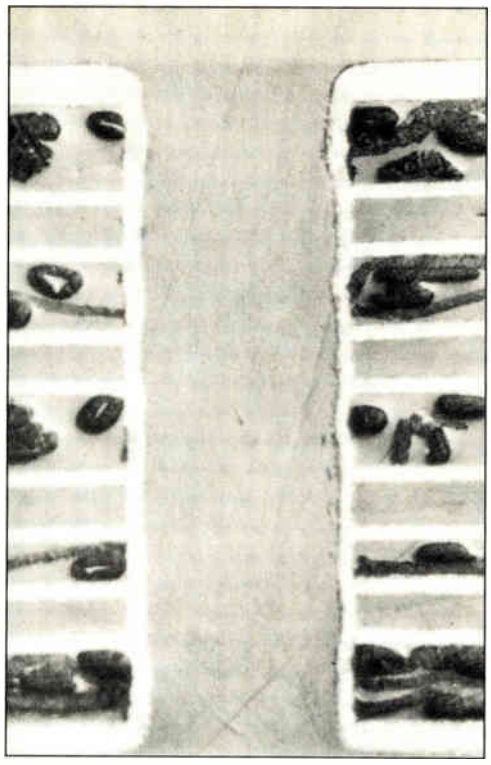
Tex's improved ability to shed water, but it has never before applied it to pc-board technology. Gore has marketed the material as an insulator for high-speed cable products; in that form, it has a dielectric constant of just 1.3.

Greater strength is one important advantage the expanded fiber has to offer, Johnson says. Whereas the tensile strength of PTFE resin is about 5,000 psi, the expanded fibers, which measure just 1 to 2 mils in diameter, are rated at 75,000 to 100,000 psi.

But strength alone is not the key to the use of the new Gore materials in pc boards; glass fiber and epoxy are equally strong. The main advantage of pure expanded PTFE is its low dielectric constant of just 2.0, compared with more than 6.0 for pure glass fiber and more than 3.7 for pure epoxy. Like all serious candidates for pc-board applications, the material is inert and immune to high temperatures.

Already the Gore material's low dielectric constant is sparking interest from pc-board users. Sperry Corp., for one, is investigating the Gore material for use in its next generation of high-speed mainframe computers. "There are four serious competitors fighting it out," says Donna Palmer, a supervisor in the Printed Circuit Development Group of the Sperry Corp. in Roseville, Minn. She wouldn't list the other three, however.



SPEED UP. Expanded PTFE reduces the dielectric constant of this experimental 10-layer board.

Other likely candidates are also based on Teflon. For example, Rogers Corp., Rogers, Conn., has a competitive material called RO-2800, which has a dielectric constant of about 2.8. The Rogers low-dielectric laminate [*Electronics*, May 26, 1986, p. 26] consists of PTFE reinforced with glass fiber plus a ceramic filler. Standard pc-board processing cannot be used with RO-2800; instead, its processing is closer to that used on PTFE-only pc boards. The main difficulties of such materials are short drill life and difficulties in multilayering. The Rogers material is available in sample quantities and is due to go commercial around September.

Palmer's group is studying the use of both the Gore-Clad laminate and the Gore-Ply pre-preg materials. Gore-Clad laminate is used solely as a bonding layer, acting as a glue between layers of either standard fiberglass and epoxy or even resin-impregnated PTFE. Dimensional stability of the individual layers can be a problem, but with a small sacrifice in dielectric performance, Gore-Clad can be manufactured with 11% quartz fibers, Johnson says. While the dielectric constant edges up to 2.8 (from Gore-Clad's normal 2.6 in this configuration), the shrinkage improves from 7 mils/in. to less than 0.5 mils/in. Overall stiffness is also improved when the quartz fibers are added.

EXISTING TECHNIQUES. As a pre-preg, where the interwoven strands of expanded PTFE are impregnated with standard processing resins—such as epoxies, polyimides, and Kevlar—the material can be metalized with copper and etched using existing processing techniques. "That's important because the pc-board industry has a great deal of invested capital in equipment and training," Johnson says. "They don't want to change." Board makers are unwilling to invest heavily in a new process that is essentially untried, he maintains.

Johnson says versatility is another reason Gore and its materials are so attractive. "We plan to work with the systems designers at the very start," he says. "We get involved early in the design phase to engineer our laminate to the customer's needs. We'll add some quartz; we'll add some Kevlar. There isn't anybody out there that provides that ability to tailor performance."

Sperry's Palmer agrees: "We are well pleased with what we're seeing—good electrical properties with all kinds of resins." She does say there have been some problems in drilling the multilayer PTFE pre-preg boards because the material requires "very specific drilling parameters in order to cut the fibers cleanly." *-Tobias Naegele*

TELEVISION

FRAME MEMORY ADDS NEW TV FEATURES

KYOTO, JAPAN

A digital memory that stores an entire TV frame will add a number of previously unavailable features to a line of 26-in. color receivers to be sold in the U. S. starting in August. The sets, from Mitsubishi Electric Corp., Tokyo, will enable a viewer to freeze a single frame or monitor a second channel within a window on the screen, for instance. Or nine different channels can be monitored simultaneously in separate screen windows, although the window for each channel will be updated only once every 4.5 seconds.

TV sets with full-frame memories have until now proven too expensive to market to consumers. Mitsubishi made a number of carefully chosen design compromises to implement the features with adequate quality without driving the price too high. The designers avoided high-speed high-resolution conversion, for example, and omitted interpolation in the freeze-frame feature.

The TV's developers—Ryukichi Wada, Yoshinori Ishii, and Harumi Tozuka at Mitsubishi's Kyoto Works in Kyoto and Julius Szakolczay in the U. S.—were able to build the frame memory with 10 standard 100-ns 64-K-by-4-bit (256-K) dynamic random-access memories. Ishii will describe the set at this week's International Conference on Consumer Electronics in Chicago.

The frame memory is not used in a digital-processing scheme that would improve picture quality. Such processing is expected to lower overall TV costs in the future by relaxing the demands made on analog TV circuitry, but right now it's too expensive, say Mitsubishi engineers.

For freeze-frame operation, the memory is big enough to display an entire noninterlaced still frame as 480 lines of 480 pixels each, but motion that occurs in the image between the first interlaced field and the second often makes the picture unattractive. So the Mitsubishi engineers made it possible to switch to a single-field display.

If there is motion within the frame, the single-field display improves the fro-

zen picture despite the sacrifice of resolution. Instead of using costly interpolation circuitry to generate the information for every other line, the set's designers chose to write an identical copy of the preceding line.

In what Mitsubishi calls the monitor-in-TV mode, a second channel can be displayed in 1/9 of the total screen area. There are three other modes that are extensions of the windowing technology used in the monitor mode.

One mode monitors up to nine separate channels at the same time, with each channel updated every 4.5 seconds. A second variation gives a stroboscopic spread of nine successive images from the same program. Updating is faster in this mode, with stroboscopic intervals of either 0.133 or 0.066 second between successive scenes. The third is a picture-editing mode that lets the viewer synthesize nine different 1/9-size images into one composite frame.

To help keep costs down, sampling for analog-to-digital conversion is performed on the demodulated luminance and chrominance signals rather than on the unaltered NTSC signal, as would be required for enhanced-definition sets [*Electronics*, July 22, 1985, p. 21]. As a result, there is no need to synchronize the sampling frequency with a multiple of the color subcarrier, and a lower sampling frequency can be used, as well as a lower-capacity frame memory.

Sampling at 10 MHz provides a bandwidth exceeding 4 MHz, which is sufficient for the 4.2-MHz NTSC signal. The ADC has a 5-bit output that is converted to a pseudo-6-bit signal by adding to the input signal a subharmonic of the clock with an amplitude of one half the least significant bit. This scheme lowers the cost of the ADC required as well as saving memory.

TV set monitors nine channels at a time

The two color-difference signals are sampled at half the rate of the luminance-signal sampling, which is sufficient because they have much lower resolution. Samples from the two color-difference signals are interleaved so that the effective sampling rate for the two signals is the same as that of the luminance signal. The chroma components of the signal can thus be stored in the same amount of memory taken up by the luminance components.

Sampling rates are also reduced for the windowed image in the monitor-in-TV mode and the three nine-image modes to allow complete frames to be stored within the limits set for memory capacity. *–Charles L. Cohen*

TELECOMMUNICATIONS

CHIP ADDS SIGNALS FOR PHONE CONFERENCING

AGRATE, ITALY

Italy's principal chip maker is about to market a product that could well make automatic telephone conferences a standard service in the next generation of digital exchanges.

Developed by SGS Microelettronica SpA, the product is a signal-processing chip that integrates all the circuitry necessary to add conference functions to any digital switching matrix. Such functions now require an entire printed-circuit board with an expensive assortment of some 50 integrated circuits, according to Angelo Pariani, SGS's telecommunications applications manager. Pariani believes a similar chip has been developed in the U. S. by AT&T Co. for use in its own exchanges, but to his knowledge the SGS part is the first such IC available on the market.

Designated the M116, the IC works in tandem with a digital telephone exchange's switching matrix to provide up to 10 conference calls among a total of 32 subscribers. For additional conferencing capacity, more of the 2.5-μm n-MOS chips can be added.

In essence, the M116 is a peripheral linked to a microprocessor by an 8-bit data bus with a total signal-processing capacity of 32 channels, 64-kb/s each. Its inputs are standard telephone-line pulse-code-modulation streams, from which it generates conference signals by adding digitally the signals from more than one subscriber. Each subscriber receives a version of the conference signal with all the signals but his own added together. That way, a subscriber won't hear an echo of his own voice but will be able to hear everyone who spoke at any given time.

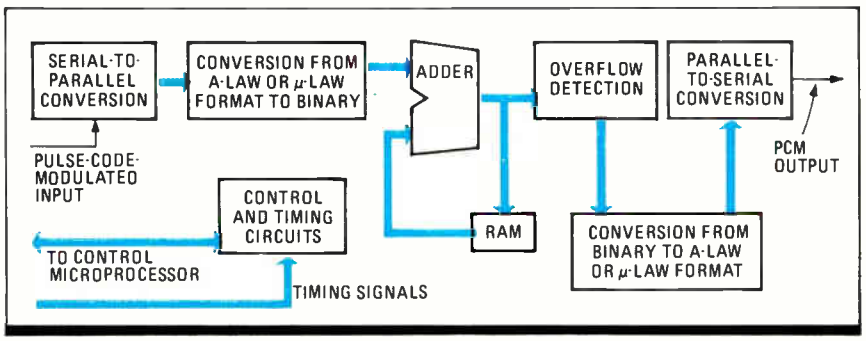
The chip first converts the incoming serial pcm streams into parallel form. The parallel data is then converted to 14-bit linear-coded binary words from the 8-bit nonlinear (compressed) format it was originally coded in—either the μ-law format or the A-law format, depending upon which standard is in use. Look-up tables in read-only memory are used for the conversion.

The linear-coded voice data from more than one source can then be summed in a standard adder circuit to create the composite conference signal. Following this addition, the M116 verifies that the sum does not overflow line capacity. If the sum is too high, the chip automatically attenuates the conference signal to a level the line can accept. The signal is then reconverted into either A- or μ-law encoding format and then from parallel form into a serial pcm bit stream.

OTHER FEATURES. The M116 offers other valuable features to telecommunications-exchange manufacturers. It is a universal circuit that can be used in systems complying with any of the world's telephone standards. In addition, a programmable noise-suppression function reduces background noise, which can become bothersome as it accumulates from the several channels summed for a conference call.

The basic conferencing module consists of the M116, a standard crosspoint switch, and an 8-bit microprocessor. SGS says the the M116 will work with any crosspoint switch, but the fact that the control interface is identical to that of its M088 switch simplifies the design process when the two are combined.

The M116 can also serve as a stand-alone low-capacity switching matrix. By creating the equivalent of two-channel conferences, it could be the heart of a 24-line private branch exchange, for example. The remaining eight channels would be used for common services such as dial and busy tones, synthesized voice messages, and the operator station. *–Robert T. Gallagher*



IN CONFERENCE. The SGS M116 is a chip dedicated to implementing conference-call capabilities in digital exchanges through a series of conversions and signal additions.

INSIDE TECHNOLOGY

SENSORS TAP IC TECHNOLOGY TO ADD MORE FUNCTIONS

MICROSENSORS ENHANCE AND CONDITION SIGNALS; ARRAYS ARE COMING

by Marce Eleccion

The electronics revolution may be digital, but the real world is analog. And such manifestations of natural law as temperature, pressure, and light provide the inputs for electronic systems. As electronics technology continues to spread pervasively into the industrial, military, and commercial sectors, sensors are getting an increasingly important role in mating the analog world with the digital. So it comes as no surprise that sensor technology is turning to integrated-circuit technology in order to add new capabilities. The integrated sensor, or microsensor, is looking more and more like an IC because it is adding electronic functions.

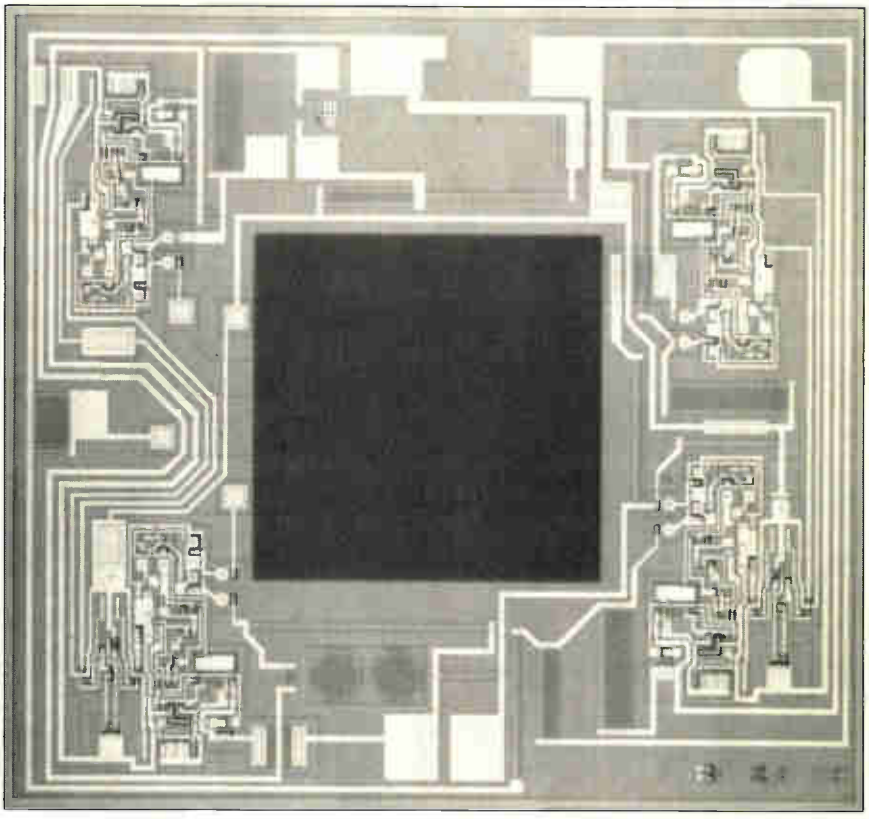
At a time when the total annual U.S. sensors market is approximately $1 billion and growing at a rate of around 15% each year, the solid-state sensor is beginning to claim about a fifth of the total market. Based on the same fabrication technologies that are the bread and butter of the $20 billion IC industry, microsensors have advantages that are only now being fully exploited by the industry.

Although silicon technology, because of the decades of experience with IC batch-fabrication techniques, offers the best immediate hope for lowering the cost of sensors, its current popularity stems from other reasons. For one, the material is ideal for quickly transducing physical phenomena of the world into electrical signals that can be digitally converted for use in microcomputers. Pressure, deflection, acceleration, chemical composition, temperature, light, sound, radiation, and magnetic waves—silicon responds to all these and more in predictable ways (see "Why sensor makers are using silicon," p. 28). The result is a host of applications ranging from simple pressure, temperature, and flow sensors, to more complex sensors that can continually monitor tire pressure in a moving vehicle or perform in-vivo blood pressure and flow measurements during operations.

A major factor that has led to the sensor's rapid development has been the emergence of the low-cost microprocessor. When computing power was expensive, the cost of sensors was small by comparison. Now that the microprocessor has precipitated an exponential decrease in system cost, however, the sensor has become a major cost factor in system design, causing an all-out search for inexpensive ways of interfacing a central processing unit.

Because silicon sensors are based on the same technology as ICs, it was only natural to expect that manufacturers would begin to design microsensors with electronic functions on the silicon die. The result—the integrated sensor—has begun to be widely used only within the last few years. Some makers also are building multiple sensors on a single chip, measuring dual variables such as pressure and temperature. Next up will be arrays of multiple sensors, such as tactile arrays, that can detect differential effects over a given area.

Integrating sensor and electronic functions on one chip not only cuts costs compared with separate implementations; it also opens a realm of possible applications. One clear advantage is that the relatively weak signals from the sensor can be enhanced in some way to simplify the problem of designing interfaces with computers. Manufacturers are offering signal-conditioned sensors with passive components that normalize the output signal, compensate for temperature variations and nonlinearities, and even calibrate the die to ensure that the wafers yield devices whose sensitivities are consistent with specifications. Other companies are integrating active compo-



MULTIPLE FUNCTIONS. Motorola's MPX3000 pressure sensor combines strain gauge, temperature compensation, calibration, and voltage amplification on one chip.

nents to produce higher signal-to-noise ratios, eliminating the ambient noise that may otherwise creep into the system.

The addition of new functions directly on the sensor chip takes a new technique called silicon micromachining. Put simply, micromachining is the sculpting of three-dimensional mechanical structures in silicon. Its purpose is to produce extremely small devices (typically measured in microns) of precise dimensions that can be used in one of two ways: as the basis of a sensor to measure some physical parameter or as a component—such as a valve, column, mirror, heat sink, and connector—that performs a purely mechanical function.

Micromachining begins the same way as IC fabrication, with standard photolithographic techniques transferring a mask pattern to the surface of a wafer. Instead of using the openings in the silicon dioxide to diffuse dopants into the exposed silicon wafer, however, the micromachinist applies a chemical etchant that excavates an opening in the silicon, with limits defined mainly by the SiO_2 mask but also by such factors as temperature and type of etchant.

SELECTIVE ETCHANT

Of the two types in use, anisotropic (orientation-dependent) etchants are the most common. They can create well-defined walls, edges, and corners because they etch at different rates along the three coordinate planes, known as the Miller indexes, that define a silicon crystal. Isotropic etchants etch at the same rate in all directions, creating rounded shapes. Because anisotropic etchants work selectively on a particular crystal plane, it is important that the fabricator carefully align the SiO_2 mask with that crystal plane to achieve the desired structure. Typical accuracy is within 1° to 2°.

Another technique for creating special structural shapes in silicon first alters the level of doping impurities, which controls the rate at which anisotropic etchants eat away at the wafer. This technique can be used to create fabrication layers that act as etch-stops. For example, pressure-sensitive membranes only microns thick are created by heavily doping the surface of a wafer (with boron, for example) and then etching the rear of the wafer with an anisotropic etchant (Fig. 1a).

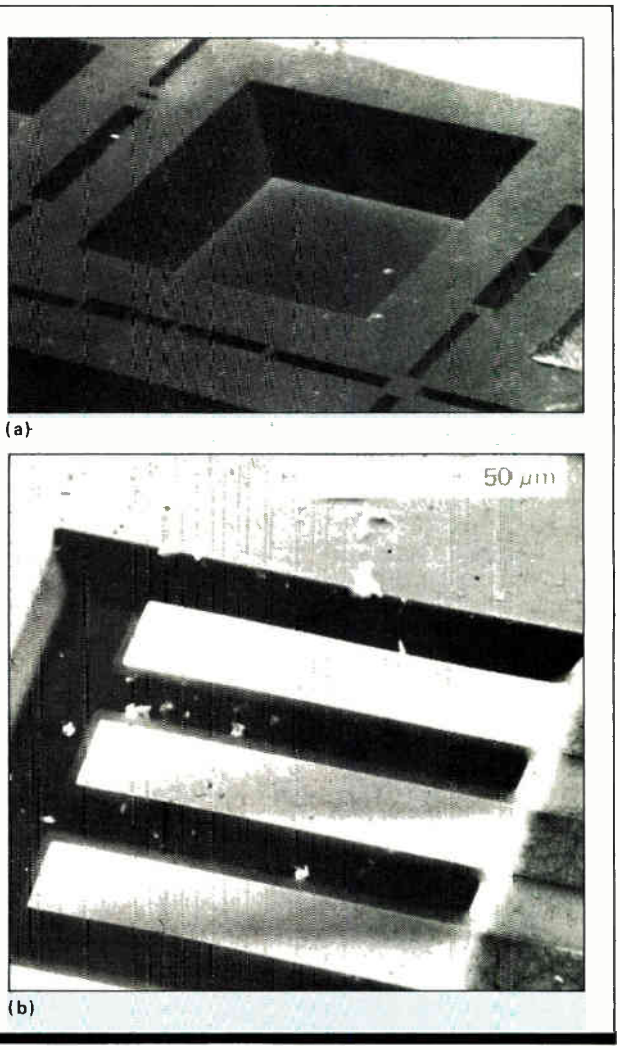
Etch-stop techniques also can make cantilever beams (Fig. 1b), the basis for detectors of acceleration, gravitational fields, vibration, and motion. In addition, it is possible to produce membranes and other structures, such as cantilevers, below the wafer's surface by growing epitaxial layers of silicon above the SiO_2 layer, then micromachining from above and below.

Other techniques and materials have enhanced the micromachinist's art. These include the use of polysilicon structures to grow diaphragms, polymer layers for chemical sensing, passivation layers (such as silicon nitrate), Pyrex etching, ultrasonic machining, and a host of different types of films (piezoelectric, special metals, and films that are stress-free).

Often, it is necessary to join a silicon wafer to a material such as Pyrex glass to form both a stable and a perfect seal. This kind of bond must be made without such standard sealants as epoxies for two reasons. For one, because micromachining results in structures that are measured in tens of microns, making such a bond could close up the microstructure. For another, in stress-sensitive devices such as membranes, the different expansion rates of epoxy and silicon would cause unwanted stress with temperature change.

As a result, hermetic methods such as anodic bonding, which join the two surfaces electrostatically by application of heat (400°C) and high voltage, are used widely by the micromachinist. Because silicon and glass have similar coefficients of thermal expansion, this assembly is used for stress isolation in devices that sense pressure, strain, and acceleration.

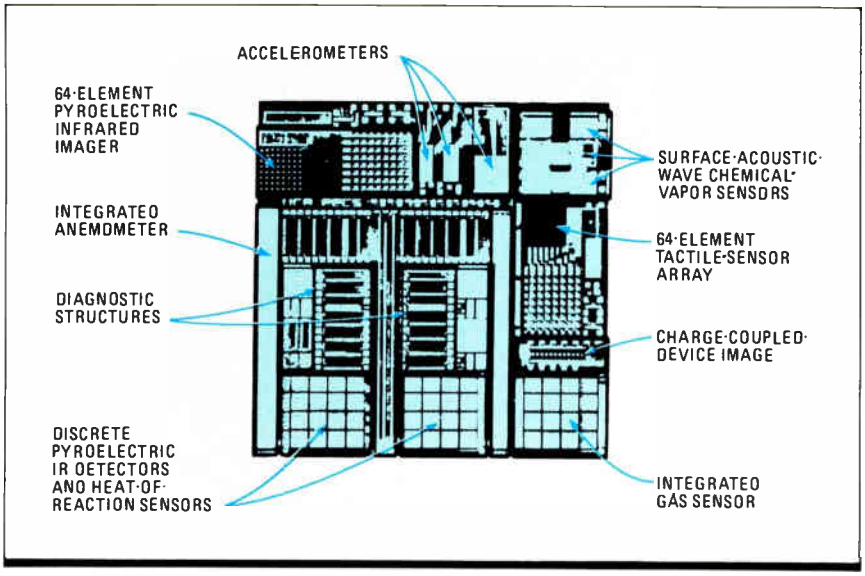
Perhaps the most ambitious effort to date of the micromachining technique is the single-chip multiple sensor (Fig. 2) developed by researchers at the University of California at Berkeley. This MOS chip combines silicon with zinc oxide depositions as active sensor elements. It can detect infrared radiation, contains a charge-coupled-device array for imaging, and functions as a 64-element tactile sensor, anemometer, multiple accelerometer, and chemical-vapor and gas sensor.



1. MICROMACHINING ART. Anisotropic etching achieves the sharp walls and corners of a Novasensor pressure sensor (a). At IBM, micromachining built cantilever-beam structures (b).

One way that sensor makers are cutting cost is to standardize both micromachining and sensor designs to fit as great a variety of applications as possible. Transensory Devices Inc., Fremont, Calif., for example, has established a computer-aided-design library of standard sensor structures, based on three-dimensional lithographic and etch processes, for its micromechanical structures and for a series of tactile sensors and arrays based on pressure-based piezoresistive strain gauges. Until now, the prime markets for the four-year-old company have been the robotics, military, and aerospace industries, says president James W. Knutti. Recently, however, Transensory Devices has begun production of pressure sensors for Concha Corp. (presently moving from Pebble Beach, Calif., to Fremont). Concha will begin manufacturing a tire-pressure monitor for the auto industry in July (see "Checking tire pressure automatically," p. 30).

The drive to develop silicon sensors began some 20 years ago when the military and aerospace industries needed small but rugged pressure transducers that could deliver high performance during jet-engine testing without interfering with the systems themselves. Two early developers of piezoresistive sen-



2. VERSATILITY. UC Berkeley micromachined a single-chip sensor that has an ir detector, tactile sensor, anemometer, multiple accelerometer, and gas sensor—as well as a CCD imager.

sors, Honeywell Inc. and Kulite Semiconductor Products Inc., have upgraded the technology considerably.

For example, Honeywell's Solid-State Electronics Division, South Minneapolis, Minn., is introducing a new generation of passive sensors that include both diffused and thin-film resistors for both calibration and temperature compensation. It has also developed a novel tape-automated-bonding technique that combines with a polymer coating for compatibility with liquid media. Honeywell's poly surface-cavity structure, offering increased levels of surface integration, is the first such device to be available commercially. Advanced versions of this technique developed by Henry Guckel and D. W. Burns of the University of Wisconsin have produced the smallest pressure-sensing devices realized to date. Consisting of poly diaphragms as thin as 2 μm deposited on a dielectric (SiO_2, for example) by a process known as low-pressure chemical-vapor deposition, surface-cavity devices are highly compatible with standard IC processes.

Other companies are beginning to use diffused and thin-film resistors as passive devices on silicon or to use thick-film resistors for passive hybrid structures. But thick-film technology does not allow deposition on silicon sensor devices, because it is used to make larger components. For example, IC Sensors Inc. and Sensym Inc., both of Milpitas, Calif., manufacture a variety of sensors suitable for biomedical applications. Distributed by such companies as Hewlett-Packard, Sorenson, Utah Medical, and others, disposable blood-pressure systems using such sensors have laser-trimmed thick-film resistors to provide 1% calibration and temperature compensation as well as simultaneous adjustment of both input and output resistance.

Kulite, Ridgefield, N.J., has adopted diffused and thin-film resistors for industrial and aerospace applications. Burr-Brown Corp., Tucson, Ariz., has developed calibrated and normalized disposable sensors that use a mixture of thin- and thick-film resistors. Both Gould Inc.'s Measurement Systems Division, Oxnard, Calif., and Deseret Medical Inc., Sandy, Utah, have introduced disposable blood pressure sensors that use thick-film resistors. One company—NovaSensor, Santa Clara, Calif.—thinks the advantages of ion-implanted resistors outweigh those of standard diffusion and film technologies. Not only does this technique eliminate stress instabilities caused by the diffusion process, but it also defeats reverse engineering.

One course that advanced sensor technology can follow is exemplified by the integrated sensors from Motorola Inc.'s Semiconductor Products Sector, Phoenix, Ariz. Introduced in

WHY SENSOR MAKERS ARE USING SILICON

As IC fabricators found out many years ago, single-crystal silicon displays excellent physical properties that are both predictable and reproducible. Though it is true that silicon wafers are brittle, the resulting integrated circuits have an elastic limit greater than stainless steel but with the density of aluminum. Moreover, unlike most polycrystalline metals, silicon can be repeatedly stressed without weakening. This results in a low-mass structure that can operate in the megahertz range of frequencies and withstand pressures greater than 50,000 psi and accelerations up to 100,000 g.

Silicon's well-known resistance to corrosion and tolerance of wide temperature ranges adds to its desirability as a sensor material. Typically, a silicon sensor will maintain measurement accuracy better than 0.1% over many years of continuous service.

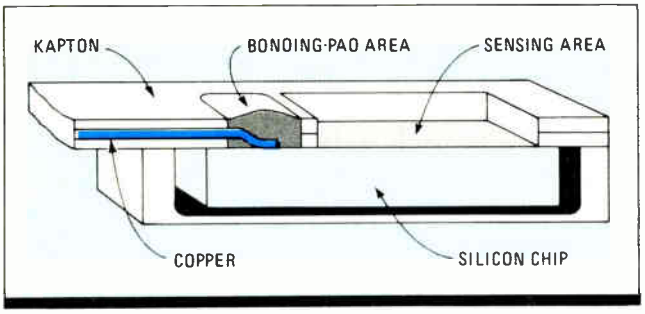
Because hundreds of silicon sensors can be batch-fabricated on wafers at the same time, using the most sophisticated materials and processing technologies known, their unit cost is considerably reduced. This mass-production capability, along with the precise control of patterns and dimensions made possible with silicon technology, enhance efforts to produce a sensor that is uniformly consistent from device to device. Such uniformity is, of course, a great advantage to users seeking devices that conform to specifications.

Because of silicon's great elasticity and fatigue resistance, its most prevalent application in the sensor industry is as a pressure transducer. Of the two techniques used to measure pressure, piezoresistive is the most common, with capacitance methods also widely used.

The basic piezoresistive pressure sensor consists of a micromachined silicon diaphragm (membrane) that varies in thickness according to the pressure range over which it operates. After the diaphragm is created, resistors are diffused, film-deposited, or ion-implanted onto the surface of the diaphragm to form a resistor network such as a four-element Wheatstone bridge. As pressure is applied to the diaphragm, it flexes—sensitivity is inversely proportional to the square of its thickness. The stress induced on the resistors causes a change in the output voltage. This technique is also used in sensors that measure such parameters as vibration, deflection, and acceleration.

In a capacitance pressure transducer, the basic structure can also be a silicon membrane or a cantilevered beam. In either case, one plate of the capacitor is deposited onto the pressure-sensitive membrane or movement-sensitive beam, and the other plate is deposited onto a mechanically stable platform (glass, for example). As pressure flexes the diaphragm, or some movement bends the cantilever beam, there is a corresponding change in the gap between the plates. This, in turn, results in a variable capacitance that controls the output signal of the sensor.

Generally, piezoresistive sensors are more easily manufactured than are capacitor sensors, so they are less costly to produce. On the other hand, capacitor sensors are theoretically less susceptible to temperature variations, so they are preferable in applications where long-term stability is required.



3. PROTECTION. Kapton protects Micromet's sensor as it measures changes in dielectric and electronic properties of drying fluids.

1980, its MPX100 series of pressure sensors offered the transducer only, based on a simple single-resistor configuration that made the device more reproducible and easier to temperature-compensate than four-resistor Wheatstone bridge designs. This was followed in late 1984 with the MPX2000 series that integrated passive resistors on the sensor chip, giving full temperature compensation and calibration, preempting the need to tailor each sensor with external circuitry, and increasing accuracy.

The MPX3000 series, shown in the opening photograph, goes one step further by adding signal amplification on the chip in the form of four operational amplifiers. Slated for introduction this fall, it incorporates a shear-stress strain gauge, temperature compensation, calibration, and voltage amplification on a single chip. Devices surrounding the central pressure diaphragm include multiple laser-trimmed thin-film resistors and the four op amps. The device will be introduced this fall at a price of around $60 for quantities of 100.

AN ACTIVE SEARCH

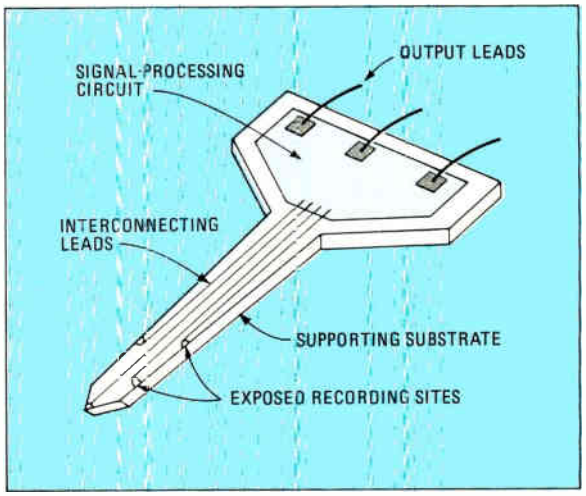
Actively integrated sensors that emit high-level signals have not yet reached the production stage (although hybrid integrated sensors have been available for some time). The first devices, such as the Motorola MPX3100, are due to appear this year. In 1982, Honeywell produced the first pressure sensors with three op amps and eight thin-film resistors in limited quantities to its aerospace customers, but high cost prevented volume production. In 1983, Transensory Devices came out with a sophisticated capacitive pressure sensor that included over 1,000 transistors, but this, too, was a development piece.

Not all sensor makers see much of a future in integrating active circuitry with sensors. Though both sensor and IC fabrication are based on the same technology, both are fine-tuned to enhance their respective characteristics for the highest performance at the lowest cost. When fabrication is combined, then, a certain amount of process detuning must occur for one of them, depending on which technology the fabricator favors. This detuning, in turn, reduces yields and, inevitably, increases the cost of the product.

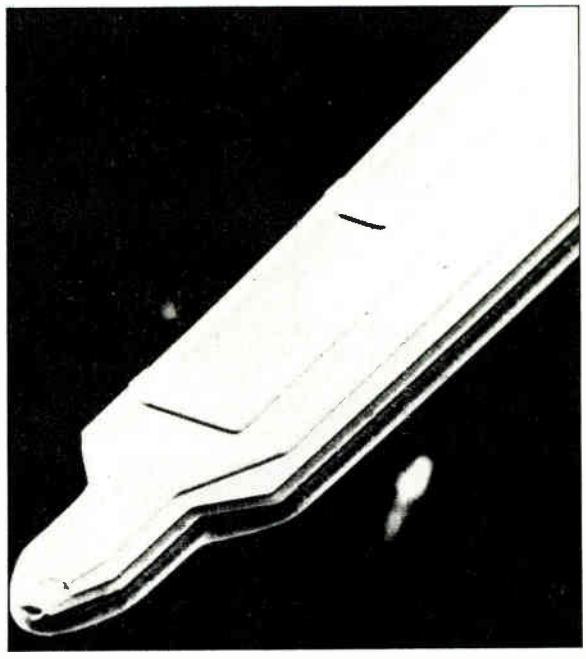
A second problem, also price-related, concerns the overall market acceptance of the more costly integrated sensor. When the standard IC, which is very marketable because it is a general-purpose product sold at low cost, is joined with a sensor, it becomes a more dedicated product aimed at a narrower market.

What might save the day is applications in consumer electronics, says NovaSensor's Joseph Mallon, chief operating officer and copresident. Such applications will open up as the prices of sensors with active circuitry drop from their present average of about $15, to an average of $1 or less. One original equipment manufacturer is reported to be putting pressure sensors into its microwave ovens to adjust cooking time for differences in altitude.

The appearance of functional integration that gives added performance to a silicon sensor is beginning to arouse the



(a)



(b)

4. PROBE. A miniature brain probe from the University of Michigan detects, amplifies, multiplexes, and transmits neuron signals.

imaginations of many sensor makers and users. Products envisioned include transducers with enormous overpressure ratings and shock resistance that can be used in such applications as process control. At present, typical pressure ratings for silicon transducers range from zero to tens to thousands of pounds per square inch, depending on the application, and can be temperature-compensated over an operating range from about −40°C to +125°C.

Because pressure sensitivity is inversely proportional to the square of the thickness of the diaphragm, it is important that the diaphragm have some protection in case it is dropped or exposed to pressures beyond its rating. One idea is to back up the diaphragm with an overrange stop that enables the device to endure sudden shocks as great as 10,000 g and pressures hundreds of times greater than the basic rating. Carried one step further, the stops themselves could be configured as part of the transduction system, activated whenever stressed by the diaphragm and extending the range of the device to hundreds of times beyond normal operation.

Trying to produce low-pressure transducers may be an even trickier problem. To measure pressures over an extremely low range, say from 0 to fractions of a pound per square inch, the diaphragm would have to be on the order of a micron thick. But so thin a diaphragm would be highly sensitive to the force of gravity, hence some means—perhaps a second sensor—would have to compensate for this unwanted effect. Work on extremely thin diaphragms has promulgated the possibility of a silicon audio sensor. Research at Honeywell has already created an audio microphone consisting of a layer of thin-film zinc oxide deposited on silicon, along with signal conditioning circuitry. The device uses two parallel-plate electrodes that act as capacitors, causing voltage changes as a result of a corresponding pyroelectric effect produced by temperature variations on the film.

DETECTING GASES

One example of the advances in integrated sensors is a chemical sensor from Microsensor Technology Inc. Using a gas chromatograph design developed at Stanford University, it incorporates a 40-cm-long sensing channel, several valves and vents, and detector connections on the surface of a 3-in. silicon wafer. The portable microprocessor-based instrument can identify up to 100 different gases (any 10 within 45 seconds) in concentrations as small as 1 ppm. Such a gas chromatograph works by injecting a sample of the mixture containing the gas into the channel, which is lined with a thin layer of a substance such as a polymer that absorbs different gases at varying rates. Flushed through the channel by an inert carrier gas such as helium, the unknown gas is identified by comparing its peak output retention time with those of known gases. Quantities are determined by calculating the area under the output peak.

The Fremont company, which was acquired by Tylan Corp. late last year, is now coming out with a model that will detect even more gases. Surprisingly, the design changes are largely in the software, which must be written to identify each gas. The integrated gas sensor will remain virtually unchanged.

One of the most active research areas in chemical sensors has been in developing materials that are sensitive to specific ions, gases, biological materials, and other substances. The most successful of these new sensors has been the chemically sensitive field-effect transistor or CHEM FET.

These devices work by overlaying materials sensitive to certain chemicals on the gate of an insulated-gate FET. Depending on the chemicals to be detected, the gate potential varies, modulating the electric field through the gate insulator and changing the transistor's channel conductivity. In addition to having an inherent impedance transformation, these devices are small enough to find potential use in the in-vivo monitoring of biological fluids and are rugged enough to be used in high-pressure environments.

Before such chemical sensors can go into widespread use, some serious problems must be solved: lack of calibration stability, chemical crosstalk, and the poor membrane adhesion of ion sensors that use a semipermeable membrane for a gate. Cardinal Scale Manufacturing Co., Webb City, Mo., is one company actively attacking these problems. "Integrating a voltage-follower circuit at each membrane site has led to significant improvements in calibration stability," says Richard B. Brown, a University of Michigan micromachinist working with Cardinal. "Since the method makes multisensor smart chips practical, algorithms compensating for chemical crosstalk can be devised."

Another problem that faces designers of chemical sensors is how to protect the electronic circuitry from contaminating and corrosive environments. One solution, by Micromet Inc., Cambridge, Mass., encapsulates a chip—called a microdielectrometer—in Kapton to protect it as it measures changes in the dielectric and electronic properties of glues, epoxies, and laminates while they are being cured (Fig. 3)

Surface-acoustic-wave filters have been proposed as chemical sensors. Polymers that can selectively absorb chemical vapors are deposited onto silicon, which acts as a unique identifier as the added mass dampens the acoustic wave traveling through the film. At the University of California at Berkeley, researchers use the resonant frequency of a vibrating poly bridge to determine chemical composition; a thin polymer that coats the bridge causes a change in frequency as it absorbs certain chemicals.

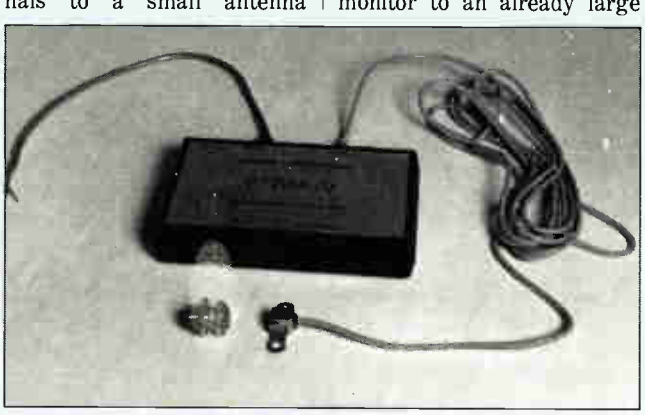
Medicine also will benefit from silicon-sensor development. For example, both the Massachusetts Institute of Technology and the University of Michigan have developed minute silicon probe arrays that can be embedded without cellular disruption into living neurons providing the ability to detect, amplify, and transmit small signals simultaneously emitted from clusters of interacting neurons (Fig. 4).

Applications include the control of artificial limbs and other prosthetic devices. Sensors are also being proposed for cancer therapy: Clini-Therm Corp., Dallas, is developing a temperature probe that could be inserted directly into a tumor, indicating whether applied radiation has hit its intended target. □

CHECKING TIRE PRESSURE AUTOMATICALLY

A low-cost silicon sensor is the key to the tire-pressure monitoring system that Concha Corp. will put into production next month. The ICS3009 monitoring system will warn a driver of any low-pressure condition. The system's pressure sensor, manufactured by Transensory Devices Inc., Fremont, Calif., is installed directly on the tire rim. It sends rf induced signals to a small antenna mounted on the brake assembly. An electronic transceiver monitor processes the signals and sends them directly to the dashboard. Concha's president, George Garcia, reports considerable interest in his company's system by U.S. firms, as well as major European and Japanese automobile makers.

"In our case, it's not just a matter of adding another monitor to an already large array of diagnostic and visual aids," says Garcia. "Since the auto industry has already committed itself to equipping future autos with the 'run-flat' tire, it must also provide a means of monitoring the pressure of those tires." The run-flat tire, allowing the driver to travel a distance of up to 50 miles on a tire that is completely deflated, is expected to save the cost of a spare tire. It also lightens the overall car load by 30 to 40 pounds, and creates an additional 2 ft^3 of trunk space.



Another important function of a tire-pressure monitoring system is in the successful operation of antiskid braking systems, which are beginning to crop up on cars, also can use tire-pressure monitor systems. The operation of the antiskid braking system can be adversely affected if one tire is underinflated.

NOW A UNIVERSAL SYSTEM THAT RUNS ALL VLSI TESTS

MOVING PIN ELECTRONICS INTO PARAMETRIC AND ANALOG TESTING

In the past, pin-electronics subsystems in automatic test equipment could be used for only digital functional testing. Now, a new architecture—universal pin electronics, or UPE—promises to expand the capability of device testing by combining analog and digital testing capabilities on every ATE pin. This design, which constitutes an almost universal testing architecture, offers the promise of much smaller test equipment, reduced cost, and increased reliability.

The architecture—implemented in a set of six very large-scale-integration CMOS chips designed for the Army by Giordano Associates Inc.—expands the current scope of pin electronics into analog testing and the more complex digital parametric testing. The architecture also incorporates a range of advances in hybrid packaging, microprocessors, analog-to-digital and digital-to-analog conversion techniques, and memory technology.

Typical ATE systems use a special test subsystem—the pin electronics—to perform functional digital testing. This subsystem consists of waveform generators, drivers, signal conditioners, and detectors, which are applied to the individual pins of the device under test to provide appropriate stimuli and determine the response to predetermined test patterns. In UPE, the stimulus spectrum of pin electronics has been expanded to encompass the complex waveforms generated by instruments such as pulse and waveform generators. Similarly, the measurement spectrum expands to include measurements such as those usually requiring a digital voltmeter, a timer/counter, a waveform analyzer, and similar equipment.

Much of the ATE now available is large, costly, and complex. Systems typically use multiple chassis of stimulus and measurement instrumentation and elaborate switching systems, and they require complex and costly interface devices. In addition, analog testing and the various types of digital testing require different tester subsystems. Even with their size, complexity, and cost, these testers are hard-pressed to accommodate the maximum repetition rates, vector or array sizes, and throughput necessary to test today's complex LSI and VLSI parts, plus chips built under the Defense Department's Very High Speed Integrated Circuits program—as well as the subsystems and systems built around them.

The UPE concept, by contrast, eliminates the need for costly stimulus and measurement instruments, notes the Franklin Lakes, N. J., company. In addition, it minimizes or eliminates complex switching systems and most adapters or interface devices between the ATE and the unit under test.

UPE uses common tester electronics for analog and digital parametric and functional stimulus and measurement. For digital functional testing, the architecture results in advancements in terms of maximum test repetition rate, maximum array size (vector depths), and overall tester throughput, the company says.

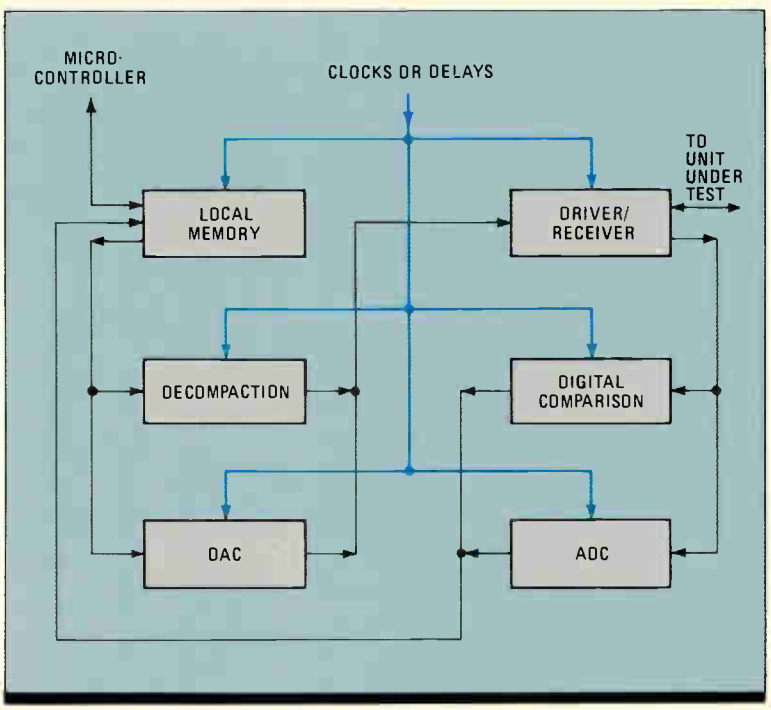
A tester-per-pin architecture already exists on several VLSI device-level machines, but it is intended only for functional testing. UPE has functional, parametric, and analog capability on every pin. Also, the use of custom VLSI chips for actual implementation of each channel reduces the distance between the test electronics and the unit under test, which minimizes many timing and pipeline problems encountered in other architectures.

INSIDE UNIVERSAL PIN ELECTRONICS

The UPE consists of a chassis containing up to 256 channels. The major elements in each UPE chassis are a backplane containing a microcontroller, clocks, delays, and up to 32 eight-channel boards of test electronics. Each UPE chassis provides for up to 512 pins for a unit under test. Multiple chassis may be synchronized for larger units with higher pin counts.

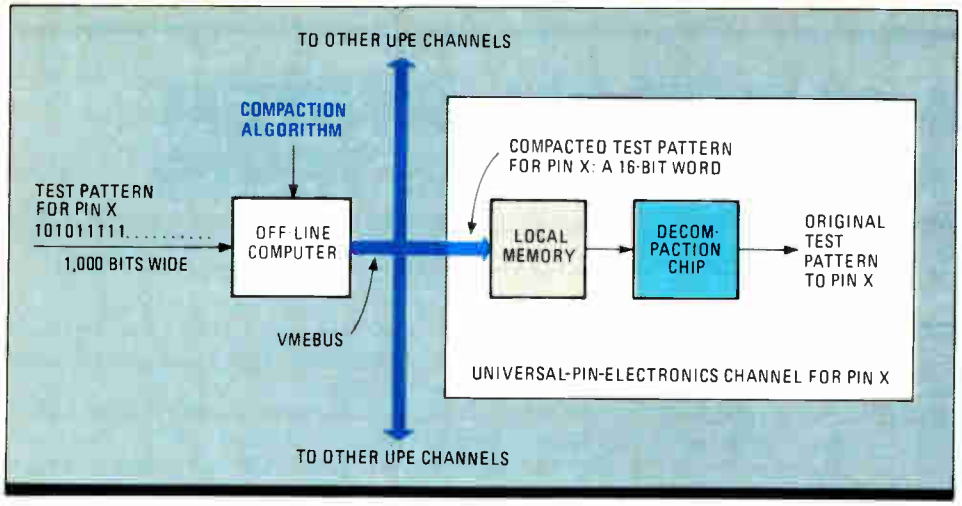
The major elements of each UPE channel are a local memory, a decompaction chip, a DAC with support circuitry, clocks or delays, a driver/receiver, a digital comparison element, and an ADC with support circuitry (Fig. 1).

Before a test is initiated, each channel can be programmed to implement an analog stimulus, an analog measurement, a functional digital stimulus, a functional digital measurement, functional digital stimulus and measurement, a parametric digital stimulus, or a parametric digital measurement.



1. UNIVERSAL PIN ELECTRONICS. All functions of a UPE channel have been integrated into six custom VLSI CMOS integrated circuits.

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.*



2. COMPACTION. A compaction and decompaction process, implemented with one of the UPE's CMOS chips, allows a large amount of data to be stored in a small amount of memory.

When a channel is in the functional testing mode, the local memory is filled before testing with compacted or coded data, including as a maximum the apply and/or expect bit, the bidirectional bit, and the mask bit. This data is directed to the decompaction chip, which decodes in real time.

In the analog and parametric stimulus modes, the local memory contains the patterns that will be directed to the DAC, which converts them to actual waveforms for application. In the analog and parametric measurement modes, local memory is filled during testing with digitized equivalents of outputs from the unit under test. The UPE microcontroller analyzes these digital equivalents and extracts the parameters called for by the test program. Analog stimuli and parametric digital stimuli are generated in much the same fashion. The bit-pattern equivalent of any periodic or aperiodic signal that the test program calls for is generated by the microcontroller from algorithms stored in read-only memory. The patterns are then stored in local memory. Under control of clocks, the patterns are directed to the DAC, where an electrical signal is generated. The signal is then applied through the channel driver to the pin of the unit under test. Implicit in the DAC chip is the appropriate ranging and filtering.

Analog measurement and parametric digital measurement are made in much the same manner. Output signals coming back from the unit under test are buffered by the pin electronics receiver and sent to the ADC in each channel. The ADC's output is then stored in local memory. Using ROM-resident analysis algorithms, the microcontroller extracts any one or more of the parameters such as rise time, fall time, pulse width, dc voltage, peak voltage, root-mean-square voltage, frequency, period, delay, phase shift between signals, events, and so on.

GRABBING THE WHOLE WAVEFORM

A significant feature of this architecture is its ability to capture an entire waveform and, under the direction of a local microcontroller, provide analysis from the most elementary to the most exhaustive. An output pulse from a unit under test can be captured, for example, and complete data such as rise time, fall time, and pulse width can be obtained locally from a single measurement. Multiple measurement instruments are not required. Both repetitive and one-shot waveforms are accommodated. For continuous-type signals, the memory snapshot (the digital "grid" when the conversions are halted) may be taken on an enable bit such as a zero crossing or simply under program control; that is, a waveform is sampled, digitized, and stored for analysis. For single-shot outputs, the snapshot may be effected through an external sync input from the unit under test or from another UPE channel.

Because functional digital testing is the most widely used type of testing today, the decompaction chip is a key UPE element. Decompaction is based on the fact that at each point in time there are relatively few level changes on the pins across the interface with the unit under test. There is a high probability that a pin will not change states for sequences of many test steps. Also, there is a high probability that specific bit sequences will be repeated during the test program. In short, most data is nonrandom in nature. The decompaction chip is a key to valid testing because it allows a tester to store the large test patterns required by today's complex, LSI- and VLSI-populated boards. It is also a key to operation at the high frequencies required by this class of board. Finally, it can drastically reduce overall test time by minimizing the time to transfer array data from the system's bulk-storage medium.

With the arrival of more complex chips, memory has become a critical issue in testing. Many of today's ATE digital subsystems have a maximum 16-K-deep memory per channel; many have only a single memory element per channel. Today's test programs often run up to 100,000 vectors to achieve reasonable fault coverage. Estimates for the near term range in excess of 500,000 vectors, especially when the impact of VLSI and VHSIC is considered. Thus real-time testing is impossible because large time gaps are required to refill local memory from mass storage. In short, valid testing results are in jeopardy, and the problem is rapidly becoming worse.

UPE eliminates the need for complex switching systems

The simple solution of merely inserting local memory with depths over 500,000 bits per channel is very expensive. The emitter-coupled-logic memory normally used is hot, expensive, and space-consuming.

For real-time bidirectional driver control and real-time masking of receivers—a realistic requirement for testing today's typical bus-type, LSI-populated boards—additional memory elements are required for each channel. Here, the tester must supply inputs from the unit under test (apply data), evaluate the unit's outputs (expect data), control the output impedance of the driver (bidirectional data), and cull irrelevant data (mask data), all in real time. This greatly increases the problem because a simplistic architecture would require in excess of 1.5 million bits of memory per channel.

Another design constraint that tends to limit maximum test rates is the cycle time of the local memory. Today's testers usually peak at 20 to 40 MHz, even though 100 MHz is often needed for valid test results. Current tester architecture ties the ATE and unit-under-test repetition rates directly to local memory cycle time.

Use of the decompaction chip addresses both of these design constraints. Data compaction and decompaction are done on a pin-by-pin basis (Fig. 2). Initially, software algorithms are used to compact the vectors or arrays off line. For example, the software can compact a pattern that puts 1,000 1s and 0s

on a particular pin to a coded 16-bit word. This compacted data is then stored in local memory prior to testing. As the test progresses, the compacted data is read from local memory and entered into the decompaction chip in real time. This chip decompacts the data—also in real time—into its original form for test purposes.

This approach allows a large amount of data to be stored in a smaller amount of memory both in mass storage and locally in the UPE. This same technique also frees the tester's repetition rate from the local memory's cycle time. In essence, the memory speed is multiplied by the compaction ratio insofar as test rates are concerned. For example, compacted data from a 15-MHz memory provides sufficient data to allow operation at repetition rates in excess of 100 MHz.

SPEED DICHOTOMY

The use of a wide memory word and the decompaction chip provides another design advantage in that the UPE channel is essentially divided into higher- and lower-speed sections. The higher-speed circuitry is restricted to areas such as the driver/receiver, clock, and comparator, whereas much of the UPE design (such as interface circuitry, level generation, local memory, and local microcontroller) can operate at much lower speed.

The UPE compaction scheme jams data into relatively little memory

Still another advantage gained by decompaction is a dramatic increase in overall test throughput. It usually takes a significant amount of time to transfer the large amounts of array or vector data from the test system's bulk-storage medium (a disk, for example) to the pin electronics over the system's input/output bus. The bit width and the transfer time of the I/O bus are major constraining factors. In many cases, the transfer time is much larger than the actual test time. Using the decompaction chip decreases this transfer time drastically because the data is expressed in coded form. It is decoded in real time as the test program progresses, so overall time (transfer plus actual execution) is reduced significantly.

The clock/delay subsystem is the central timing module in the UPE. It synchronizes virtually all subsystems in a channel and also coordinates channels when a unit-under-test measurement so requires—for example, skew between two digital output pulses and phase shift between two analog outputs.

In functional digital testing, the clocks are programmed to specific frequencies and widths, and they strobe test vectors to the unit under test. Any of the clocks can control any one or more UPE channels. The clocks can be synchronized among themselves or with respect to the clocks of any units under test in any combination. The clocks are also used to program the delay between a test vector applied to the unit under test and the unit's resultant output vector(s) that results in the comparison circuit. This programmed delay accounts for the internal propagation delay of the unit under test. Again, any UPE delay can be directed to any pin or pins under program control.

In the analog or parametric digital modes, the clocks strobe the stimulus data from local memory through the DAC circuitry to the unit under test. In the analog or parametric digital measurement modes, clocks strobe the output data of the unit under test through the ADC to the local memory.

UPE is an ongoing, multiphase program under the auspices of the Test, Measurement, and Diagnostic Technology Laboratory of the U.S. Army Communications Electronics Command at Fort Monmouth, N.J. The program was initiated in 1980. Various analyses were conducted, followed by hardware and software designs, brassboards of critical circuit elements, development of custom VLSI chips, and construction of an operational, multipin prototype. The effort to date has proven the feasibility of universal pin electronics. Functional digital, analog, and parametric digital stimulus and measurement capability have been implemented in each channel of test electronics. Features currently identified include:

- Functional digital frequencies to 100 MHz.
- Analog and parametric frequencies to 20 MHz.
- Vector depths in excess of 1 million.
- Individual voltage programmability of logic levels on each I/O pin for functional and digital testing.
- Bidirectional control of drivers along with real-time masking of receivers.
- Real-time selection of multiple clocks or delays.
- Self-contained voltage and timing calibration.
- Fault-tolerant capability through automatic reassignment of internal channels.
- Dual-mode capability; that is, 256 channels can accommodate up to 512 unit-under-test pins.

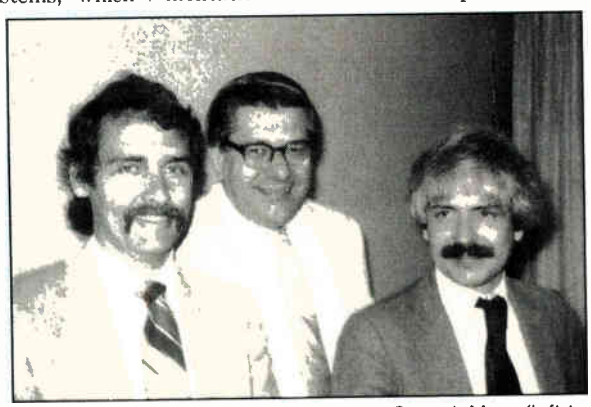
Each UPE channel is constructed with the same six custom VLSI chips. This contributes to standardization from tester to tester, and the volume fabrication that results reduces the recurring chip cost drastically. Because the use of the decompaction chip allows much of the circuitry to be lower-speed, extensive use is made of CMOS to achieve density, cost, and power-dissipation advantages.

Current applications for UPE include use as a field tester, thanks to a portable suitcase test unit, as a common core instrument in large ATE systems, and as a built-in test facility in prime systems. And if the current six-chip set should be implemented in VHSIC Phase I technology, even further reductions in size will be possible. □

LOOSENING THE KNOTS IN FUNCTIONAL TESTING

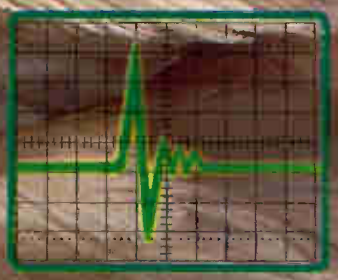
The Giordano Associates team that developed the universal-pin-electronics concept says it had two main goals: to improve the operating speeds, vector storage capability, and overall throughput of automatic test equipment—all of which currently restrict functional digital testing—and to minimize or eliminate the necessity for switching between test systems, which has always plagued users of analog and parametric digital test equipment. In the view of the developers, combining the entire system into custom chips is a natural evolution for ATE.

Phil Jackson, president of the company, performed the initial architectural design for the UPE system, and he holds the patents on the overall system as well as on such specific UPE parts as the decompaction circuits. Al Esser, president of the GAI's IE Division, directed the design of UPE when it entered the hardware-building stage. Greg deMare, vice president of advanced software, led the group designing the UPE's internal operating software system. Les Parker, vice president of engineering, was the key individual in the design and implementation of the custom chips.

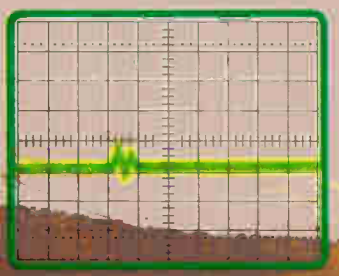


TEST KINGS. Les Parker, Al Esser, and Greg deMare (left to right) each handled major design aspects of the UPE.

FROM FT.-LBS.



TO FEATHERS



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A LOW-COST WAY TO BUILD A FIBER-OPTIC LOCAL-AREA NET

COUPLER HALVES THE CONNECTORS AND FIBERS NEEDED FOR 2-WAY LINK

What the world needs is a simple, low-cost fiber-optic system that doesn't trade off too much performance to get the cost down. ADC Fiber Optics Corp. says it has the answer. The Westboro, Mass., company has turned two-way single-fiber communications into a cost-effective technique for building such systems for local-area networks and process-control communications.

ADC Fiber Optics has done it by using wavelength division multiplexing, a means of transmitting signals bidirectionally at two wavelengths. And it has added the one component needed to make the system easy to implement: an inexpensive, easy-to-use coupler that contains a connector, emitter, and detector.

Another technique aimed at solving the same problem is a single-fiber bidirectional system that uses one wavelength for both transmission and reception. But this technique makes signals susceptible to interference from each other, or crosstalk, says Harold Roberts, manager of the company's Components Department. If additional connectors are placed within 30 ft of the transceiver, crosstalk becomes a problem. This keeps the system designer from using intermediate connectors or distribution panels. The ADC Fiber Optics coupler uses optical filters to keep crosstalk at about 30 dB optical (60 dB electrical) or better, regardless of the number, location, or type of connectors, says Roberts.

"The challenge of any single-fiber bidirectional solution is to realize the potential cost savings without limiting the usefulness of the communication link," Roberts explains. "Reflections are generally the culprit in limiting usefulness in a single-fiber system, though power-splitting losses in excess of 6 dB also can contribute to reducing system performance margins. A good single-fiber bidirectional link should be as indistinguishable from a dual-fiber link as possible."

Most fiber-optic systems currently use two fibers for bidirectional communication. ADC's Fiber Optics coupler requires only one fiber and cuts the number of connectors needed in half. The injection-molded coupler (Fig. 1) works by using three small paraboloidal mirrors molded into the coupler body that collimate and focus the light to and from the emitter, detector, and fiber. Dichroic filters, which transmit one wavelength and reflect the other, are used to channel the outgoing light to the fiber and the incoming light to the detector. The result is a reduction in power-splitting losses and the elimination of all significant crosstalk interference—the bane of single-fiber single-wavelength links. And because the active devices are inside the coupler, the user doesn't have to splice fibers and connect components.

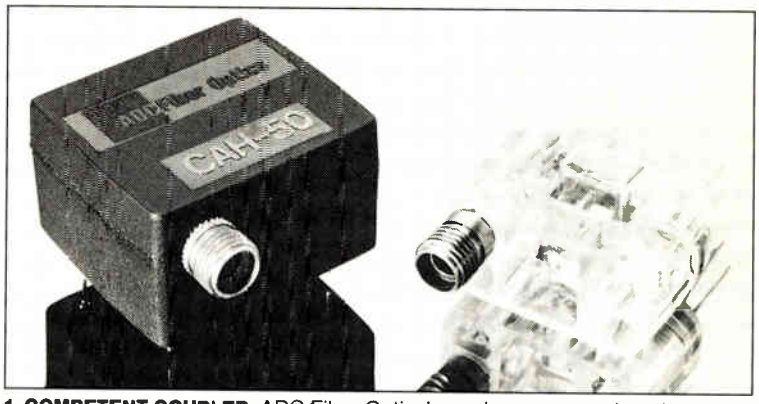
ADC is concentrating on fiber-optic components for LANs because "these applications are just beginning to unfold," Roberts says. "A number of factors are combining to make low-cost medium-performance components critical." Chief among these are the problems with traditional fiber-optic nets.

In keeping with this criterion and with the company's desire to keep costs and complexity to the minimum, Roberts and optical engineer Joseph Rando set several design goals for the coupler:

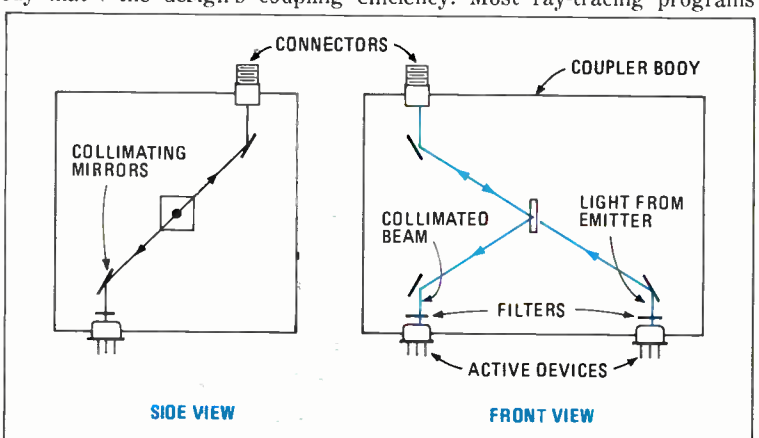
- The injection-molded body must contain active components, with emitter and detector built in.
- The coupler must have a built-in connector; it must be possible to mount the connector and the coupler on opposite sides of a bulkhead.
- Pockets and slots must be molded into the coupler and semiconductor devices; filters and connector must not require precise positioning.
- Collimating optics must be used to direct light to the filters for efficient filter performance.

They came up with an internal inclined Y design, in which light from the connector is collimated by paraboloidal mirrors (Fig. 2) molded into the surface of the coupler body and operate through total internal reflection. The collimated beam strikes a dichroic filter in the center of the coupler. The filter then reflects it to another paraboloidal mirror, which refocuses the light to a detector. The process works in the reverse direction as the light from the emitter is collimated through the dichroic filter and focused down onto the fiber connector.

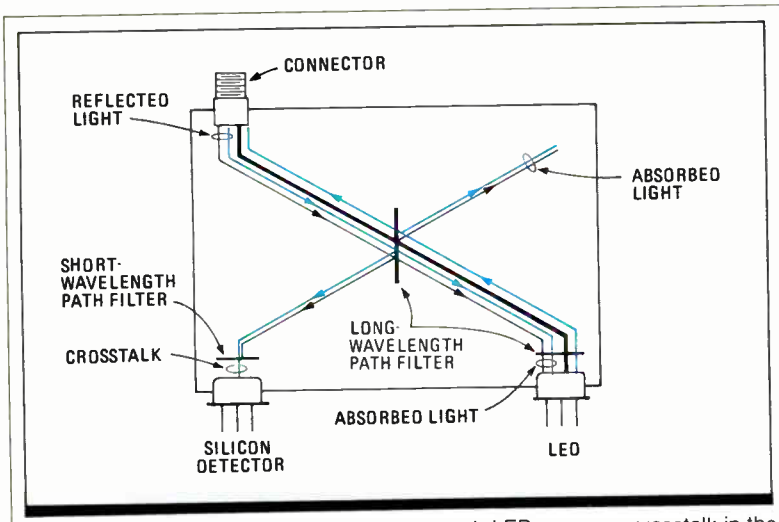
Roberts developed a custom ray-tracing program to model the design's coupling efficiency. Most ray-tracing programs



1. COMPETENT COUPLER. ADC Fiber Optics' coupler uses wavelength division multiplexing to tie together single-fiber optical links.



2. INCLINED Y. In the ADC coupler, paraboloidal mirrors collimate the light beam to form a Y, which is inclined because they cannot be molded in the same plane.



3. CROSSTALK FILTERS. Dichroic filters at each LED suppress crosstalk in the coupler. The source filter for one signal acts as the detector filter for the other.

concentrate on giving optimal imaging characteristics, but he wanted to check power transfers taking place in optical designs. He used the results of the ray-tracing simulation to refine his design so it would have maximum total internal reflection, yet would allow the active devices to be positioned on the opposite side of the coupler from the connectors.

"The program showed an emitter-to-fiber coupling efficiency of 0.7 dB," says Roberts. "When we built it, the coupler averaged about 0.9 dB. For fiber-to-detector, we got 0.5 dB efficiency. Our efficiency would have been less had we used the standard ray-tracing program used for imaging."

Using two wavelengths to distinguish between outgoing and incoming signals would eliminate the problem of crosstalk, but selecting the right ones was a balancing act between performance and cost of implementation, Rando recalls. "Separating the transmit and receive signals is fairly simple when spacing between the wavelengths is large—say, 840 and 1,300 nm. You don't need a sharp cutoff on your dichroic filter. Also, you can count on the fact that the indium gallium arsenide detector needed to detect a 1,300-nm signal has reduced sensitivity at 840 nm and that a silicon detector used at 840 nm cannot detect the 1,300-nm signal."

But the cost of such a design is prohibitive. Light-emitting diodes and detectors at the higher wavelengths typically cost twenty times more than at the short wavelengths, Rando points out.

Also considered were short-wave laser diodes, which are relatively inexpensive and have narrow operating wavelengths that would reduce the burden on the filter design. But these diodes proved impractical because modal noise, temperature sensitivity, and nonlinear response would have required extra circuitry.

The designers finally settled on 730- and 865-nm LEDs. The closeness of the two energy peaks, however, puts great demands on the design of the dichroic filter, says Rando, because the filter must have a sharp transmission-to-reflection cutoff.

"In the perfect filter design, all the light should be transmitted, and any reflections from the connector should be retransmitted and fall harmlessly on the emitter. Unfortunately, perfect dichroic filters cannot be made," Rando says. "Dichroic filters have a span of wavelengths between maximum transmission and reflection where they both transmit and reflect. What you must deal with is the overlap between the two functions, which is the source of crosstalk."

His solution was to use multiple filters (Fig. 3). "We begin by trimming the overlap of the LEDs with a dichroic filter before the light ever gets into the coupler. The central dichroic then takes over. It has a cut-on at a midpoint between the two transmission wavelengths. This allows most of the light from the source to be transmitted, but any light reflected from the connector that is not retransmitted falls toward the receiver. These reflections are taken care of with a third filter placed over the receiver. This filter rejects all wavelengths emitted from the source within that coupler."

Many LAN topologies would be simpler and cost less if implemented with the wavelength-division-multiplexing active coupler. Most multimode fiber systems could use the coupler because most require full duplex bidirectional capability.

The simplest and most common link is a point-to-point full-duplex system. It is also possible to double the capacity of a one-way link by putting the emitters in one coupler and the detectors in another. More complex nets can also be configured, such as an active-switched-star network. This net has an intelligent central node that can switch packets of information from one of its arms to one or more of its other arms. In this case, the number of fibers and connectors are halved, as is the density of the cables coming into the central node. Use of a single fiber also eliminates the confusion that can result in identifying receiver and transmitter cables. In the active star, the couplers for one wavelength are located at the central node and the complementary wavelength couplers are located at the terminations of the arms.

Another common LAN is the ring network, in which information generally flows in one direction around a ring. To keep a node failure from causing a system failure, the ring can have two fiber loops for counter-rotating information flow. Then if a cable is cut or a node fails, the net can communicate in the opposite rotation. Using the wavelength-division-multiplexing coupler, the double ring can have one fiber loop. □

MAKING A COUPLER FOR A FIBER-OPTIC LAN

Fiber optics is a long-time interest for Harold Roberts and Joseph Rando, developers of ADC Fiber Optics bidirectional coupler. Roberts, manager of the company's component department, designed the bidirectional coupler and wrote the ray-tracing program used in its design. He received a BS in physics from Colgate University and a master's in engineering from Dartmouth College in 1978.

"I was lucky to get a funded research assistantship in fiber optics at Dartmouth," says Roberts, who holds eight patents in the field. "I was even luckier to have as my adviser an old-time inventor named Fred Hoven. His expanded-beam fiber-optic connector was the basis of my thesis. He drove the KISS—keep it simple, stupid—principle home to me."

Rando joined ADC Fiber Optics as an optical engineer in 1985, after receiving a BS in physics from Southeastern Massachusetts University. He designed the coupler's dichroic filters and the computer model on which they are based. "I got involved in fiber optics at the suggestion of a researcher at Brookhaven National Laboratory, where I was working on a particle-physics experiment as part of my undergraduate studies," he says. Rando is finishing up unidirectional multiplexer/demultiplexer versions of the coupler that he says will double the capacity of a simplex fiber link. He's also working on a fully TTL-compatible version.

MISSING LINK. Rando and Roberts examine their low-cost coupler for fiber-optic LANs.

PROBING THE NEWS

SIEMENS: CHANGING FROM A TORTOISE TO A HARE

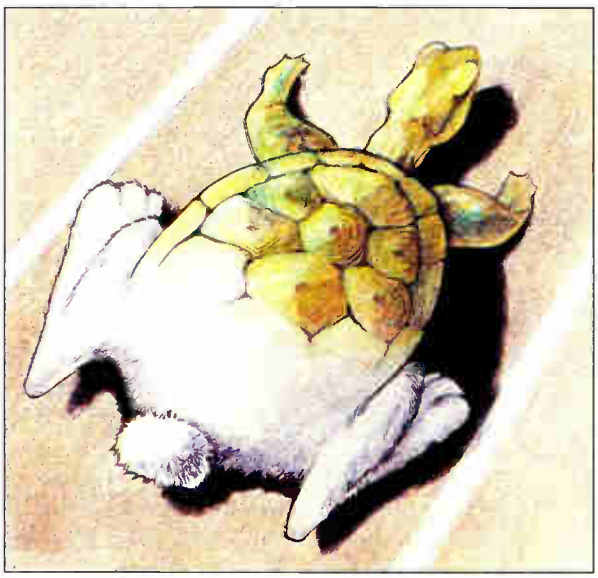
THE WEST GERMAN GIANT STEPS UP ITS PACE IN WORLD MARKETS

by John Gosch

MUNICH

Competitors and customers alike have pinned a wide variety of labels on Siemens AG in recent years. They called the West German electronics giant a big bank with a manufacturing operation attached, a sprawling civil service organization nurtured by the government, and a business that moved as slowly and deliberately as a tortoise. Exaggerated as they all might have been, each one contained an element of truth at the time.

But the company has changed dramatically in recent years, and industry insiders now see Siemens in a far different light: the tortoise is turning into a hare. Aware that its continued growth and international competitiveness—especially against U.S. and Japanese companies—depends on how fast it moves, the company is now working quickly to embrace several new technologies. Its biggest effort is in digital communications.



Already a world leader in medical electronics, Siemens is also trying to make major technology thrusts in office equipment, components, and microelectronics, as well as to combine its data-processing and communications technologies. And it is working hard to market these technologies in new areas. Not only that, but it has developed a new swagger in the computer business in West Germany, where it has sharpened its image and is ranked high among data-processing customers. Now it is expanding this business throughout the rest of Europe.

But it is in the world markets that Siemens is intent on increasing its presence, and that means boosting operations in the U.S. Siemens believes its U.S. expansion will yield continued corporate growth and the economy of scale needed for worldwide competition. To raise the effectiveness of its U.S. activities, the Munich company is loosening the reins on managers, giving them more freedom to make decisions on their own. The result is a new aggressiveness that is reflected not only in accelerated marketing and optimistic sales projections but also in the formation of strategic alliances.

Luckily, Siemens is immensely rich—rich enough to finance its various electronic development projects. Ranking among the world's six leading electrical and electronics producers, the company scored sales of about $20 billion in fiscal 1985, which ended September 30, and is reported to have $6 billion to $8 billion in the bank. But more important perhaps than money is the changed atmosphere at Siemens. A new breed of young managers in key positions is determined to close ranks technologically with the U.S. and Japan.

This new can-do spirit is beginning to get results. One example: early next year, Siemens will deliver a public digital exchange to Wisconsin Bell Inc. for the town of Sheboygan Falls, near Lake Michigan. At about $1 million for the 4,200-line switch, the order is not particularly big, but it is significant. It marks the first European entry into a market that always has been dominated by AT&T Co. and Canada's Northern Telecom Ltd.

Penetrating the market for digital switches is a key element in Siemens's broader strategy of expansion in the U.S. The company wants to move into other communications fields and also is preparing for a big push into office equipment, where it considers itself underrepresented. But at the same time, it has no intention of neglecting its bellwether businesses. It also aims to bolster its position in medical electronics and components.

The crucial U.S. market is "important to us because it is the world's biggest single and most homogeneous market, accounting for 36% of worldwide electrical/electronics equipment sales," says Karlheinz Kaske, Siemens's president and chief executive officer. The U.S. also represents more than one third of Siemens's potential world markets, discounting those regions—Japan and Communist-bloc countries, for example—that are more or less inaccessible because of restrictions on imports or because of political reasons.

Without a slice of the rich American electronics pie, the company will find it difficult to cover its growing expenditures for research and development and to finance mass production. And without strong sales in the U.S., Siemens will also find it harder to attain the economy of scale in equipment manufacturing needed to stay competitive in world markets.

PROVING GROUND. "The U.S. is also the most interesting area technologically," Kaske points out. "The company that succeeds there will be competitive anywhere." Indeed, adds Hans Baur, executive vice president and head of Siemens's Telecommunications Network and Security Systems Group in Munich, "The technological leadership of the U.S. forces us to develop products that must stand up to the best in the world."

Siemens already has a strong presence in foreign markets, one of the big factors in the long-term stability of the company. About 60% of direct and indirect sales are made abroad, and the U.S. has become the company's single largest foreign market. With hundreds of business outlets on all continents and 196 manufacturing facilities in 28 countries, Siemens is a presence virtually worldwide. Operating in this way, says Alexander Grossmann, a Siemens spokesman, "has helped us to enjoy steady growth and make us less dependent on economic conditions and exchange-rate variations in individual countries."

In pursuing this strategy, however, Siemens has only recently considered the U.S. a key country. After World War II, Siemens re-established itself primarily in European, Latin American, and Asian countries to which it previously had strong ties. But it shied away from the U.S. As prosperous as it was, Siemens believed that competing in America would eat up too much of its resources, and it believed that the return on investments would be too low and the gap in technology too big to successfully compete in the technologically most advanced nation.

Also viewed as an early barrier to greater U.S. penetration, Grossmann hints, was Siemens's guideline that no more than 5% of total business should be derived from any one country. The rule was adopted to avoid trade and political friction, but it has been discarded in the past two decades.

During that time, Siemens has made strides in its U.S. businesses, which in the past 10 years have expanded tenfold to more than $1.8 billion in fiscal 1985. That sum, which represents around 10% of total company sales, meant that the U.S. continued as Siemens's biggest foreign market, a position it took over from Austria in 1981. Keeping pace with the increase in sales, the U.S. has also become the company's biggest foreign manufacturing site, with about 16,000 employees at 28 plants. In addition to its own plants, Siemens has a stake in the U.S. semiconductor business through its 15% holding in Advanced Micro Devices Inc. of Sunnyvale, Calif., acquired in fiscal 1978.

ONE BAD YEAR. There is one blemish on Siemens's U.S. scorecard. For all the sales gains made, the company registered a loss in the U.S. of about $30 million last year. Company executives attribute the loss to the cost of restructuring the $700 million Siemens Energy and Automation Inc. affiliate (formerly called Siemens-Allis) in Atlanta, Ga. (see "Push in industrial automation," p. 40), but the overriding feeling about U.S. performance at Munich headquarters is optimism. This is underlined by forecasts that Siemens's business will grow faster than the average for U.S. electrical and electronics markets as a whole.

Its medical business is bigger in the U.S. than in Germany

Gains in market share are to come not only through internal growth but also by acquisitions. But even without some major company purchases and joint ventures Siemens is likely to undertake this year, it expects U.S. sales to rise about 20% in fiscal 1986. That would bring its American business to around $2.2 billion. And that is not the end of it. "Besides Europe, the U.S. will get increasing attention in the future," Grossmann says. "We have not yet sufficiently exploited our chances there."

Although the name Siemens often draws blank stares in the U.S., even in the engineering community, the company is well entrenched in some electronics markets. For example, Siemens Medical Systems Inc., its Iselin, N.J., affiliate, is a major supplier of medical electronics equipment, particularly in the high-tech fields of computerized axial tomography, nuclear magnetic resonance, and angiography. More than 70% of the 500-odd products sold by Siemens Medical Systems were developed during the past five years.

To point up the company's strength in the medical sector, president Kaske reports that "our U.S. business is already bigger than that in Germany." With the acquisition last year of Pacesetter Systems Inc., Sylmar, Calif., Siemens expects the medical systems business in the U.S. to top $700 million in fiscal 1986. Like its parent, the Sylmar affiliate is among the world's leading producers of cardiac pacemaker equipment. Its 1984 sales came to about $100 million.

An illustration of how serious the Siemens people are about their American strategy is another recent acquisition, Pelton & Crane in Charlotte, N.C. Though this $40 million company that employs 500 persons does not deal directly in electronic equipment—it specializes in dental equipment and systems such as dental chairs—it helps supple-

SIEMENS GETS ONLY 4% OF ITS R&D MONEY FROM WEST GERMANY

The perception among many industry observers is that Siemens AG is sustained by money from the West German government. But Bonn's role in Siemens's activities is not as big as is believed.

A case in point is research and development. Siemens will get an estimated $75 million from the government during fiscal 1986, which ends September 30. That's a lot of money, exceeding the revenues of many a medium-sized West German electronics company. But it is only 4% of the $2 billion or so that Siemens expects to spend for R&D, and just 2.5% of Bonn's total R&D outlay. So Siemens covers 96% of its R&D itself, while other companies get over 20% of their R&D cash from the government.

If the company is in the limelight when it comes to federal R&D, the reason is that it's active in so many areas—from components and medical electronics to telecommunications, computers, and office and industrial automation. So more often than not, it does get federal financing for particular projects.

As for the government's role as a customer, the figures prove that it is not so large as observers might think. Government-run operations such as the post office (the Bundespost, which is in charge of the country's communications lines), the railways, and the armed forces—as well as federal, state, and municipal governments themselves—accounted for less than $2 billion, or about 9%, of Siemens's overall fiscal 1985 sales.

To be sure, for the company's Telecommunication Network and Security Systems Group in Munich, the Bundespost plays a significant role. As the group's largest single customer, that agency will account for nearly one third of its expected fiscal 1986 sales of $4 billion.

Indeed, many of the group's products—public telephone switches among them—can be sold only to the Bundespost, as no private customers exist for them in West Germany. But compared with Siemens's overall sales, the Bundespost purchases take on a smaller dimension.

Siemens executives cry "false" to charges that German companies, and Siemens in particular, have the German telecommunications markets to themselves and that foreign companies are blocked from entering. Hans Baur, executive vice president and head of Siemens's telecommunications network and security systems group, says non-German companies are also active in those markets and points to ITT Corp. as an example. The Bundespost has picked ITT's System 12 digital exchange as one of two standard switches for the German telephone network. The other switch is Siemens's EWSD public switch.

ment the electronics portions of Siemens's medical operations and make it a vertical supplier. In fact, on the strength of its acquisitions as well as internal growth, Siemens Medical Systems has become the German company's second-largest operation in the U. S., following Siemens Energy & Automation in Atlanta.

If Siemens is determined to strengthen its American connection and grow at rates above the industry average, the big push will come in communications, the electronics sector it knows best. And no wonder: it is the company's oldest business, dating to 1847, when Werner von Siemens founded the company on the strength of a new type of telegraph machine he invented. With the company projecting $4 billion in communications sales in fiscal 1986, it ranks third in the world, behind AT&T and ITT Corp.

Siemens considers the U. S. particularly fertile ground in which to plant its communications equipment. Company analysts put demand at about 35% of total world sales, which amounts to $90 billion (including cables and some office systems, such as private branch exchanges, but not radio and TV distribution networks). The company calculates that Western Europe represents about a third of the global market and Japan 10%.

RESPECTABLE SALES. The West German company is not exactly starting from scratch in the U. S. communications business. Sales already are respectable: its subsidiaries and joint ventures in the U. S. should generate a total of $600 million in business with communications gear this year, according to executive vice president Baur. That sum represents about 14% of the telecommunications group's expected $4 billion fiscal 1986 total.

Through its affiliate Siemens Communications Systems Inc., Boca Raton, Fla., the company has carved out a sizable chunk in some sectors. For example, with 15 of the 22 Bell regional operating companies using Siemens's packet-switching systems, it has more than half of that market to itself. These systems come from the Siemens Communications Systems subsidiary Databit Inc., Hauppauge, N. Y., which, working with Siemens in Munich, modified European systems to suit U. S. needs. The equipment allows terminals with different speeds and protocols to work together and also makes for economical use of transmission lines.

KASKE: Siemens president covets a strong position in the U. S. market.

Also impressive is the company's U. S. performance in fiber-optic cables. Handling this activity is Siecor Corp., established jointly by Siemens and Corning Glass Works in the early 1970s and based in Hickory, N. C. After doubling production last year, Siecor has a nearly 40% share of the U. S. market for optical fiber cables, which puts it on a par with AT&T.

Siemens activities in packet switching and fiber cables place it at the hub of markets that are among the fastest-growing in the U. S. and worldwide. Market watchers estimate that global sales in packet-switching systems will rise between 20% and 25% a year. Sales of optical cables should increase even more steeply—between 25% and 50%, depending on the region. Because of the large distances and the widespread use of telecommunications in the U. S., Siemens puts the near-term annual growth in demand for such cables at 40%.

To expand even further in the U. S., the Siemens aims to become a full-line communication-systems supplier, adding switching equipment, microwave links, and such components as multiplexers and relays to its product spectrum. Toward that end, early this year it bought Potter & Brumfield, Princeton, Ind., a leading producer of relays for control systems and communications equipment [*Electronics*, Feb. 10, 1986, p. 51]. With about 3,000 people at four locations in the U. S. and Mexico, Potter & Brumfield chalked up sales of roughly $100 million last year, according to Siemens.

The biggest potential business in U. S. communications is yet to come, Siemens figures. For this to happen, the company is pinning its hopes on the EWSD public switch (the initials of the German words for digital electronic dialing system). Its applications range from small local exchanges for several hundred subscriber lines to large intercontinental exchanges that can number up to 100,000 lines.

Compared with some other communications houses, Siemens is a latecomer to digital switching. Throughout the 1970s, industry watchers thought the company was hopelessly behind its rivals in getting a digital system to market. But Siemens proved them wrong when it caught up, developing its EWSD system during the late 1970s and getting it to market by 1981.

Company executives attribute the delay to the cautious attitude of the Bundespost, the government agency that runs the post office and West Germany's communications lines—and Siemens's biggest single customer. The agency, they say, dragged its feet in planning the transition from analog to digital telephone switching.

"But being late has not been to our disadvantage," telecommunications chief Baur says. "It enabled us to use the latest technology

PUSH IN INDUSTRIAL AUTOMATION

Industrial automation is one area in which Siemens wants to strengthen its presence in the U. S. Toward that end, the company is restructuring its $700 million Siemens Energy and Automation Inc. affiliate in Atlanta, Ga., formerly the Siemens-Allis unit. As one of Europe's heavyweights in industrial automation—its Power Engineering and Automation Group in Erlangen accounts for roughly 25% of total company sales—Siemens believes it has the savvy to succeed in the U. S. market as well.

Siemens confidence comes from its ability to offer a complete systems program for industrial automation equipment: electronics, such as controls; electrotechnical, such as drives; data processing, such as process computers; and software.

At present, however, the Atlanta operation remains basically an energy company, supplying generators, high-voltage switches, turbines, and transformers. Siemens executives insist that they plan to put more emphasis on the automation end, but so far they have not offered any growth targets for the future.

The restructuring of the Atlanta division entails both relocation of manufacturing sites and a shift of emphasis in the product spectrum. Specifically, manufacturing operations have been moved from West Allis, Wis., to a brand new factory at Bradenton, Fla. And at the Atlanta facilities, automation technology will get more emphasis and form the key element in the product spectrum. What's more, by stressing engineering and development, the company is laying the cornerstone for future expansion in the automation field.

available." To get the EWSD system ready for future applications in ISDN (the integrated services digital network)—that is, for the simultaneous transmission of voice, video, text, and data—all that need be done is exchange the line cards and alter the software. The International Telephone and Telegraph Consultative Committee approved the largely European-proposed ISDN standards in October 1984.

A $1 billion development effort, the EWSD switch has so far found customers in 37 postal administrations and telephone operating companies in 21 nations. Of the 5.5 million EWSD subscriber lines ordered, 1.5 million to 2 million are in operation.

Potentially one of the biggest EWSD customers is the U.S. The company could corner 10% of the U.S. digital-switch market within five years, predicts Volker Jung, senior vice president and general manager of the public switching division at Siemens Communications Systems. "We hope to become the No. 3 supplier" behind AT&T and Northern Telecom, Baur says, basing his expectations in part on the ISDN-compatibility of the EWSD. That goal is reasonable in view of the way sales opportunities have burgeoned since AT&T was split into independent regional Bell operating companies in 1984, each of which pursues its own policies on equipment purchases.

But the Siemens executives are not kidding themselves into thinking that just because they are big and rich the U.S. market will simply open to them without a murmur. Baur, for one, considers it a tough market, "given the high standards in force in a country as technologically advanced as the U.S." To sell there, one must adapt to the conditions, he says, "and that's a challenge."

Together with R&D efforts in Munich, up to 300 engineers in Boca Raton were at times busy adapting the EWSD to U.S. networks. Baur notes, however, that "the potential rewards are worth it." Siemens marketing experts put U.S. demand for digital telephone exchanges at 7 million to 10 million subscriber lines a year in the near future.

Siemens scored a *coup de main* last summer when Siemens Communications Systems concluded a framework agreement with Wisconsin Bell for a three-year equipment project. The first go-round is the 4,200-line EWSD system for Sheboygan Falls, which will be delivered in February 1987 and be operational by mid-1987. Siemens president Kaske hopes the Wisconsin order "paves the way for the introduction of EWSD and for the ISDN concept, which is finding interest in the U.S. as well."

Siemens has made even further progress with the operating companies. Ameritech, one of seven regional telephone companies in the U.S., has accepted it as the third potential digital-switch supplier, along with AT&T and Northern Telecom. Further, three more operating companies—Nynex, Bell South, and Bell Atlantic—have signaled their interest in the digital switch, and have given Siemens letters of intent.

But some observers aren't so sure ISDN will succeed in America. Malcolm Ross, who watches communications markets for the consulting company Arthur D. Little International, Wiesbaden, West Germany, thinks Siemens has a moderate to good chance of selling its EWSD in the U.S. "If it does well it will not be on the strength of the system's ISDN capability but on the basis of it being a competitive digital switch," Ross says. At this point, he adds, nobody knows whether the U.S. will turn into a market for ISDN.

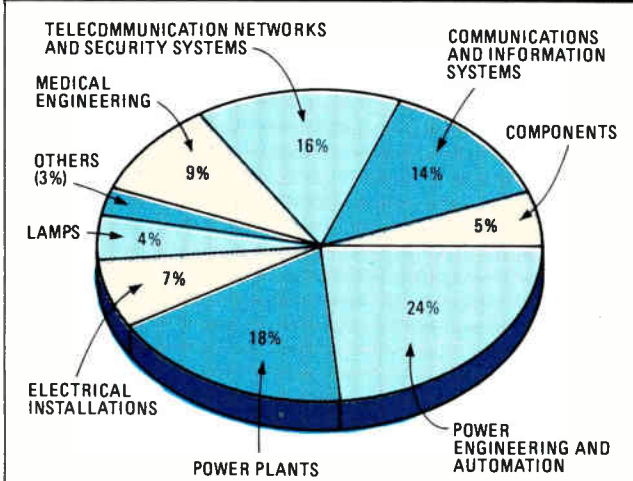
BIGGEST DEAL. What could turn out to be the biggest single communications deal for Siemens in the U.S. is a joint venture it is negotiating with GTE Corp., Stamford, Conn., to develop, produce, and market public exchange systems and transmission equipment. If the deal goes through—and neither side will comment about that likelihood—the venture would start with annual sales of an estimated $700 million and "considerably strengthen our position in the U.S. as well as in the world market," Kaske says.

As long as negotiations with GTE are under way, however, Siemens will not offer details of the deal. But one industry observer believes it could push the two companies into the No. 2 position on the world market for digital telephone exchanges. The German company would bring to the venture its ISDN switch technology; GTE would contribute its large U.S. customer base. GTE's telephone operating group, which accounted for $9.1 billion in business in 1984, runs 19 telephone operating companies in 31 states, all potential customers for ISDN exchanges.

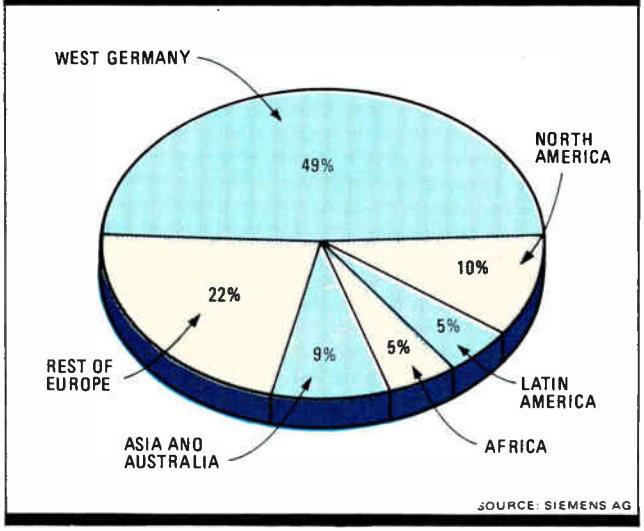
Ross of Arthur D. Little considers a Siemens-GTE linkup a "very interesting" partnership. "To get into the U.S. market, one must come from a position of strength, and the two companies together can certainly muster that strength. GTE is the best available partner," because it has a large captive market, Ross says. In addition, because it is also an equipment manufacturer, GTE has good technology of its own, he adds.

With all that activity in its communications businesses, it is only logical that Siemens should also consider today's office, which is more and more becoming a small communications hub of its own and thus a prime target for development. That effort is being handled by Siemens Information Systems Inc. The affiliate, which, like Siemens Communications Systems, is based in Boca Raton, handles U.S. business for the

SIEMENS PLANS TO EXPAND ITS ELECTRONICS OPERATIONS...



... AND BOOST ITS PRESENCE IN THE U.S.



SOURCE: SIEMENS AG

Information Systems Group in Munich. Albrecht Doehler, an executive director, figures that Siemens Information Systems will increase its sales at least 50% in 1986—from $100 million in fiscal 1985 to $150 million or better.

The product line includes such office equipment as PBX systems (which are developed in Boca Raton and produced in Cherry Hill, N. J.), terminals and peripherals for data-processing equipment, matrix and ink-jet printers, disk drives, and laser printers. With the latter, Doehler says, "we have been very successful." Models ND2 and ND3 high-speed laser printers—which print up to 200 letter-size pages per minute—share 28% of the world market in terms of shipments. In the U. S., nearly 1,500 units have been installed in the past eight years.

Doehler says his company is still underrepresented in the U. S. One step toward remedying that and gaining more exposure was made last year when Siemens raised its stake in the U. S. company Tel-Plus Communications from 20% to 35%. The Boca Raton company markets and services PBXs and related equipment for office communications. Revenue is about $250 million.

PUSH ON IN COMPONENTS. In components, too, Siemens appears underrepresented in the U. S., and the company seems determined to do something about it (see "Growing from a sideline to $200 million a year," p. 43). Handled by Siemens Components Inc., Iselin, N. J., this business took a beating in fiscal 1985 because of the slumping U. S. market. Still, the company suffered less than most others, "primarily because we are not as much engaged in standard devices as are other firms in the U. S.," says Gernot Oswald, executive director at Siemens's Components Group in Munich and head of marketing of semiconductor components.

At any rate, U. S. sales dipped last year to around $140 million, according to Oswald. But for the current year, he expects a double-digit increase. The range of products Siemens sells in the U. S. extends from discrete devices, optoelectronic parts, and microwave components to power semiconductors and integrated circuits for entertainment and professional applications.

Double-digit rise in component sales is expected this year

That, Oswald says, "does not make us a full-line supplier, but neither are we in the niche business," although that was the route the company took in the 1970s to get into the business. Most components are made at U. S. affiliates, among them Microwave Semiconductor Corp., Somerset, N. J.; Crystal Technology Inc., Palo Alto, (optical and optoacoustical crystals and surface-acoustic-wave devices); and the Optoelectronics Division (formerly Litronix), Cupertino, Calif. (displays, optical couplers and sensors, and infrared devices).

For all its diversified activities in the U. S., however, Siemens still sees plenty of room for business improvement, Oswald says. To exploit its potential, Siemens is banking on chips for telecommunications applications, which it is now promoting in the U. S. [*Electronics*, March 31, 1986, p. 76]. But not for another year or two does Oswald expect such chips to generate substantial sales.

What may bear fruit sooner, he says, are efforts to expand into the automotive sector. Here the company wants to draw on the know-how it has gained in Europe with devices for under-the-hood uses and antiskid braking systems. And Siemens Components is also making a push in the potentially lucrative field of gallium arsenide microwave semiconductors, according to Kaske, for which Siemens has earmarked nearly $50 million for R&D.

It is particularly its IC activities that Siemens wants to boost in America. "In this area we have some catching up to do," Oswald admits. "To succeed we must have a good position." Maintains Peter Savage, senior industry analyst and a components market watcher at Dataquest UK Ltd., London: "There is a good chance the company will succeed, given its overall strategy for the U. S. It has a good infrastructure."

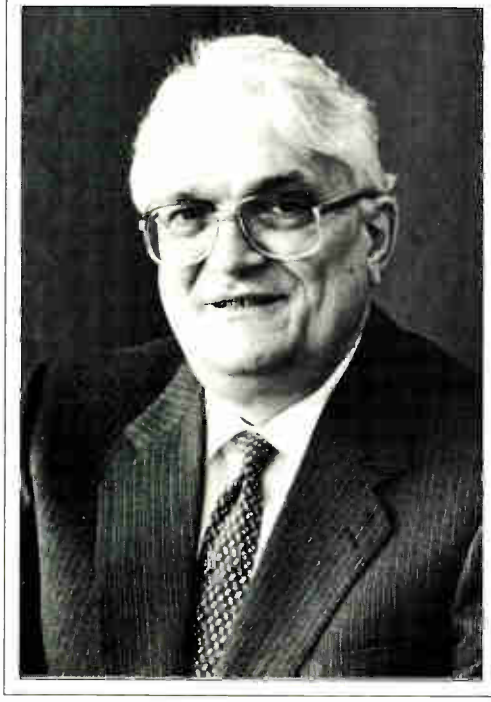
REAL KEY. But "beyond that Siemens must get into some form of manufacturing advanced devices in the U. S.," he says. "That's the real key to success." At present, its U. S. plants primarily make what Savage considers low-technology items. But if not yet producing high-tech parts in the U. S., Siemens has started to market them there. Of note are the ISDN telecom chips and the Adma (for advanced direct-memory access) controller, a very fast and complex device for microprocessor-controlled data-processing equipment [*Electronics*, Aug. 11, 1983, p. 121].

"What Siemens must also do is raise its profile in the U. S.," Savage says. At engineers' meetings he helped organize in California, he says, few people had heard of a European components maker, let alone Siemens.

Against this background of almost frenzied activity in the U. S. in the communications, components, and medical markets, one major market—perhaps larger than the other three—is missing from the hit list: computers. Company executives are unanimous in their desire to stay out of it.

Such a move, says a company executive in Munich, "would call for a huge investment in sales and service networks. Our financial resources, however, are not unlimited." Besides, he adds, "on IBM's home turf, we can't see an adequate return on a big invest-

CHASING SUCCESS. Hans Baur, left, says competing in the U. S. means products that must stand up to the best in the world. Gernot Oswald means to demonstrate that with his Components Group.



ment coming in."

But the situation at home is quite different. There, Siemens holds the No. 2 position in computers, with a 20% share of the domestic market behind IBM Corp., which has 50%.

For years, Siemens computers faced image problems both at home and abroad. In West Germany, says one industry observer, "Siemens was known as a company that promised more than it could deliver."

Elsewhere, its reputation suffered at the breakup of Unidata, the ill-fated computer combine Siemens formed in the 1970s with France's CII-Bull and Philips of the Netherlands. Under terms of the partnership, Siemens had to relinquish some control of its European sales organizations to Unidata. So when the combine fell apart, Siemens found itself underrepresented in big European markets.

But things started to change when computer activities came under the direction of Claus Kessler, who took over the company's Information Systems Group in Munich in 1981. At that time, the group was deep in the red and plagued by delays in a number of development projects, and few industry observers gave it much chance in Europe's highly competitive computer markets.

Kessler initiated a massive cost-reduction program without, however, resorting to layoffs. He brought in qualified managers from other companies and moved more aggressively into new areas of the market. Most important, he managed to motivate his engineers and restore their confidence in their products. Soon customers were no longer ashamed to admit they owned a Siemens computer, says one industry analyst who declined to be identified. By contrast, he adds, owners of IBM Corp. computers are proud to have a product from that company.

The result is that Siemens, which has an agreement with Hitachi Ltd., is now making money in computers and is among Europe's top five suppliers. "With its image in Germany repaired, Siemens is now making a major push in the direction of Europe," says Gerhard Adler, president of Diebold Deutschland GmbH, Frankfurt, an affiliate of the New York computer consultant and market researcher Diebold Inc. "At home, its reputation has much improved. Customers now feel Siemens is giving them good service."

Standing it in good stead is its know-how in communications, which is a prerequisite nowadays for successful data processing. That skill has helped make Siemens a leader in the field, Adler says.

RUNNER-UP. The Diebold president cites a recent survey of data-processing customers in which Siemens and Digital Equipment Corp. tied for third place among the most attractive computer suppliers in West Germany—behind IBM and West Germany's Nixdorf Computer AG. "Five years ago Siemens was not even among the first five," Adler points out.

Given the company's efforts and determination to expand its U.S. business—in communications, office equipment, medical electronics, and components—Siemens seems well on its way toward replacing its image as a plodding tortoise with that of a speedy hare as it makes itself better known in the world's biggest and most advanced market.

GROWING FROM A SIDELINE TO $200 MILLION A YEAR

Ten years ago, Siemens's U.S. electronic components business was a sideline to its main revenue producers in this country. But over the last decade, what started as a small distributorship for the German parent has evolved into an independent corporation with sales approaching $200 million a year.

Siemens has opened its own U.S. manufacturing facilities and invested heavily in a number of acquisitions. And the company is by no means finished, says Helmut Schwab, president and chief executive officer of Siemens Components Inc., Iselin, N.J.

Schwab says the rapid growth was achieved without any master plan. Acquisitions were made when the right opportunities presented themselves, he says, and the company's strategy has been to roll with the punches inherent in the components business rather than lock itself into a single, long-term corporate plan.

But there was method to Siemens's madness—this was no mad dash into unknown markets. Concentrating on niche areas it considered less susceptible to sudden market bursts and downturns, Siemens Components bought a bevy of suppliers in the late 1970s. Litronix, a Cupertino, Calif., startup now known as Siemens Optoelectronics, was the first. The acquisition that started in 1977, when Siemens bought 80% of the company, was completed the next year when it picked up the remainder. In 1979, Siemens added FMC Corp.'s Semiconductor Products Division in Broomfield, Colo., and Microwave Semiconductor Corp., Somerset, N.J. In 1980, it picked up Crystal Technology Inc., Palo Alto, a producer of advanced optical and opto-acoustic crystals as well as the devices that utilize those crystals.

With the exception of the FMC group, which was renamed the Colorado Components Division and sold early this year to the Coors Porcelain Co., these acquisitions have bonded to form the core of Siemens's components business in the U.S.

Schwab says that each company is given the utmost leeway to promote the fast-paced atmosphere of a startup and that great emphasis is placed on swift internal communications. Still, the company takes its Germanic heritage seriously and avoids rash decisions. "We may think a little longer before we act," Schwab says, "but when we act we do it right."

Schwab describes three stages in the evolution of the components group. In the 1950s and '60s when Siemens was trying to establish itself with products imported from Europe, "there was no strategy, no concept," he says. Later, as Siemens began to recognize the potential of the U.S. market, it moved into the acquisition phase of the mid-'70s, restructuring the companies it bought and strategically aiming them at emerging technologies where they might have the greatest impact. The third phase, now in its infancy, Schwab says, is to "establish substantial strength in selected areas."

One of those areas is high-speed gallium arsenide integrated circuits. Microwave Semiconductor is in the middle of a three-year, $45 million capital-equipment program that will enable it to wage war in the market for military GaAs chips. And about the same amount is being spent to lure the best available engineering and design personnel to the project [*Electronics*, Jan. 13, 1986, p. 62]. Similarly, Crystal Technology has begun a program to develop an expertise in integrated optic devices, another area Siemens expects to boom. "We didn't buy small companies to keep them small," says Schwab.

"We're approaching $200 million in sales at SCI. The next goal should be to get it up to $500 million, to be viable and strong," he says. Schwab says sheer size is not the objective, but strength in "good markets" is, "because you want to do things, to finance R&D."

He describes 1985 as "not a storm for us; it was a lull. The markets we are in are not affected by the fads and the ups and downs of the industry. We were not in jelly-bean commodity products during the [personal computer] boom; we were not in the [citizens' band radio] business; we were not involved in the video-game craze.

"We don't like to have a dependence on fad-related commodities," Schwab concludes. "We put our thrust into the long-term developments—the things of substance." *–Tobias S. Naegele*

THE FIGHT OVER FORMATS WILL BE FIERCE AT CES

IT'S VHS VS. 8-MM VIDEO AND DIGITAL AUDIO TAPE VS. COMPACT DISC

by Wesley Iversen

CHICAGO

Through upturns and downturns, the consumer electronics industry always seems to be fighting it out over product standards in the marketplace. The 20th annual Summer Consumer Electronics Show is no exception. It promises to be a big battleground for formats in the video and audio product categories—which together account for about three quarters of the projected $35 billion annual U.S. retail consumer electronics market.

In video, a face-off between the established Video Home System and upstart 8-mm video-cassette formats is likely to take center stage, and the sniping between the two camps could get lively. At stake is the hot market in video cassette recorders and cameras that's projected to total $6.5 billion by 1995. Japanese manufacturers such as Matsushita Electronics Corp., which have a huge stake in the VHS format based on conventional ½-in. tape, want to hold onto the bulk of the action for as long as they can. But Sony Corp., whose ½-in. Beta format was all but defeated by VHS in the last video format war, is determined to push the miniaturized 8-mm format to the forefront.

On the audio side, attendees at the June 1-4 summer CES are likely to get a glimpse of the soon-to-emerge digital tape cassette format, known as Rotary Digital Audio Tape, from Japan that some think could hurt recently booming Compact Disc sales. Prototype R-DAT recorders are almost certain to show up in vendor-sponsored hotel suites around Chicago, if not on the summer CES show floor. The miniaturized R-DAT cassette machines should hit dealer shelves sometime next year, priced around $1,000. CD vendors have the price edge, however: major-brand players based on the optical, 4.7-in. disk format are expected to show up on the show floor with suggested tags around $200. That's down $800 to $1,200 from when CD technology was introduced to consumers in 1983.

Though manufacturers and dealers may gripe about ever-shrinking margins, competition among video and audio formats and configurations will ultimately pay dividends to the consumer, notes David Wilkofsky, chairman of Wilkofsky Gruen Associates Inc., a New York entertainment-business consulting company. "The more of this [competition] that occurs, the better it is for consumers, because it causes manufacturers to strive to make their products more attractive, and that translates into lower pricing points."

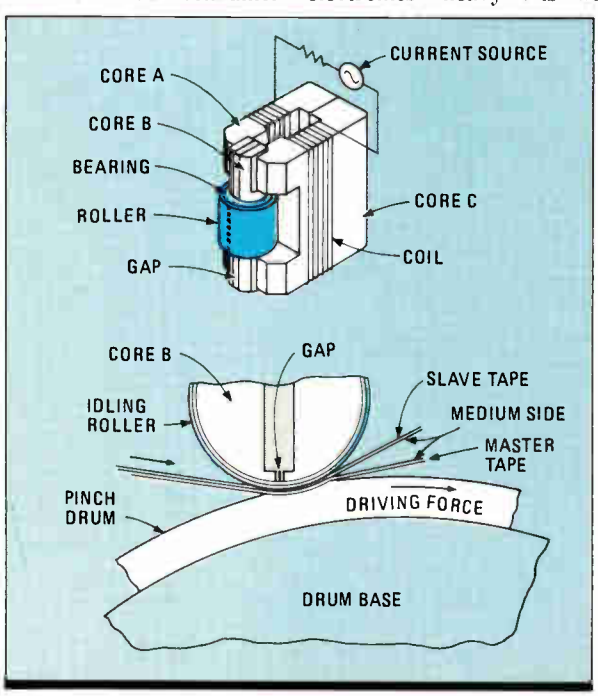
PRICES MUST DROP. At Eastman Kodak Co.'s Consumer Electronics Division, Rochester, N.Y., marketing general manager and vice president Richard D. Lorbach agrees. To make substantial volume inroads against ½-in. VHS hardware, he says, prices on 8-mm VCRs must drop from the $1,000 level into the $400 to $500 range typical of today's midrange VHS recorders. Lorbach sees that price drop happening "within a couple of years."

But consumer electronics heavyweight Sony is already pushing that frontier. Though Kodak was the first to introduce 8-mm products in 1984, using Matsushita-supplied hardware [*Electronics*, Jan. 26, 1984, p. 94], Sony is now leading the 8-mm charge. At the summer CES, Sony officials will promote a new 8-mm home deck introduced to dealers in April—the EV-A80—that carries a suggested $550 tag. That compares with a $1,395 suggested list price on Sony's next lowest-priced 8-mm VCR tabletop unit, the EVS-700 introduced last fall.

The expected emergence of prerecorded 8-mm software prompted the move to a lower-priced home playback unit, says R. Jay Sato, national sales manager for 8-mm products at Sony Corp. of America, Park Ridge, N.J. Last month, both Sony and Kodak announced deals with major video-software companies for production and distribution of prerecorded 8-mm music and movie programming. In all, at least 150 titles will be available on 8-mm by year end, Sato says.

HAND-TO-HAND COMBAT. But the real battle for dominance in the videotape market may be fought with camera/recorders and portable tape decks. Here is where the inherently smaller and lighter size possible in 8-mm could prove most attractive to consumers. Sony's model CCD-M8U Mini-8 Handycam camcorder introduced at last year's summer show is still the smallest on the market, weighing in at about 3 lb and measuring a mere 4.25 by 4.25 by 8.5 in. [*Electronics*, June 3, 1985, p. 27]. But, led by Matsushita affiliate JVC of America, Elmwood Park, N.J., the VHS side is fighting back.

This month, JVC began shipping its new GR-C7, a camcorder based on ½-in.-wide compact VHS tape (VHS-C) that features extreme miniaturization while solving earlier VHS-C camcorder shortcomings. Unlike the earlier 4.8-pound GR-C2, which could record for only 20 minutes, the GR-C7 weighs 3.5 lb (including battery pack and tape) and features an extended-play mode that allows up to 1



TESTING, TESTING. A prototype R-DAT duplicator with a roller-type magnetic bias head has been developed by Sony Corp.

hour of picture-shooting per VHS-C cassette.

And unlike Sony's 8-mm Handycam, which requires a separate portable deck for tape playback, the GR-C7 has a built-in playback capability, through a tiny cathode-ray tube in the eyepiece, for tape editing and review on the go. Also included in the GR-C7 but not found on the 8-mm Sony unit are a power zoom lens and a motorized adapter that allows playback on most conventional home VHS VCRs. With an EV-C8U portable recorder and playback deck and carrying case, JVC will offer the GR-C7 for $1,495, compared with the $1,745 suggested retail of the Sony Handycam.

A number of VHS vendors will market the new JVC camcorder under their own labels. Those vendors include Mitsubishi, Toshiba, Zenith, and perhaps Hitachi, Minolta, and Sharp. But by offering the new VHS-C camcorder for private-label use to a broad base of VHS vendors, Matsushita may actually be "playing into Sony's hands," says James Magid, a senior vice president at L. F. Rothschild Unterberg Towbin Inc. in New York.

AFTER THE CROWD. "Matsushita is trying to pander to a broad customer base to prevent defection [by other VHS] vendors to 8-mm this year. But by doing that, they have probably assured 8-mm's arrival next year," Magid says, because the GR-C7 is likely to be in short supply, while severe pricing competition on the unit may encourage VHS vendors to add 8-mm to their line. Besides Sony and Kodak, other vendors already offering 8-mm hardware include Canon, Kyocera, Pioneer, and Sanyo.

Specsmanship and posturing aside, most observers believe 8-mm is certain to make inroads in the VCR business. "It's not going to overwhelm VHS, but 8-mm is definitely a configuration that's going to click," says Wilkofsky. "We're assuming a 30% penetration [of all video cassette hardware and software sales, including ½-in. Beta] for 8-mm by 1995, assuming they get the price down significantly." The 8-mm format represents less than 2% of the video-cassette hardware business today, he says.

Though the video wars are likely to maintain a higher profile at the summer CES, the emergence of R-DAT on the audio side is also a topic sure to draw plenty of attention. Manufacturers aren't saying how much they'll reveal of their R-DAT product plans at the show. But six Japanese authors will be giving the first detailed look in a U. S. forum at recommended technical specifications for the new R-DAT format, during a Chicago technical symposium with overlapping dates—the June 3-6 International Conference on Consumer Electronics sponsored by the Institute of Electrical and Electronic Engineers—says ICCE technical program chairman David M. Lewis.

The specifications were drawn up last July in Japan by the DAT Conference, an organization formed in 1983 by the Electronic Industries Association of Japan to come up with a recommended DAT format for use in products ranging from specialized hi-fi to general audio. Its membership includes 81 manufacturers, 60 of them from Japan.

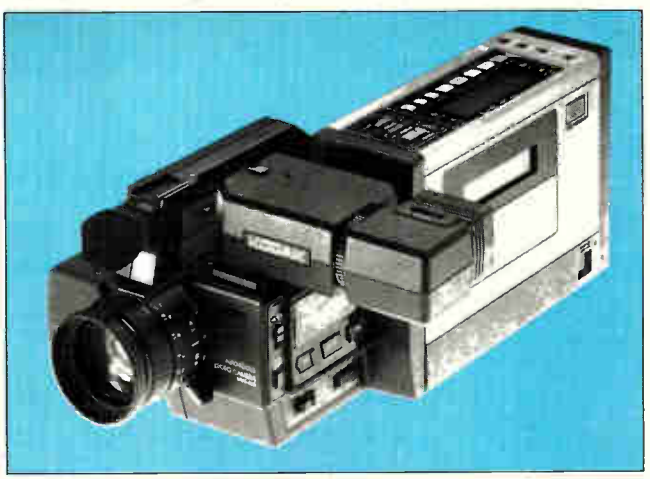
The DAT Conference looked at two approaches. One—R-DAT—is based on a rotating magnetic head that scans the magnetic tape helically in a technique similar to that used in an 8-mm VCR. The other is known as S-DAT, in which a multitrack stationary head would be used to scan the tape longitudinally.

The DAT conference cannot unilaterally recommend one proposed standard over the other, but the forum concluded last summer that R-DAT would be easier to adapt into near-term products. R-DAT features two channels of digital audio with 16-bit resolution and sampling frequencies of 48, 44.1, and 32 kHz. In addition to the digitized audio signal, R-DAT can record more than 300 kb/s of data such as digitized graphics, time code, table of contents, and the like, which will enhance its attractiveness in the market. The format will handle up to 2 hours of recording time using a miniaturized 2.875-by-2.167-by-0.375-in. tape cassette.

COMING ON MARKET. Most audio manufacturers are believed to be preparing R-DAT cassette units for consumer availability during 1987, and some prototypes are likely to make their first U. S. appearance in Chicago this week. "Most of the home audio companies are sort of agreed that we will not show R-DAT at SCES but will wait [for a full-blown product rollout] until the Japan Audio Fair next October in Tokyo," confides Terry Shimada, assistant general manager for the Audio and Information Systems Division at the Matsushita Technology Center in Secaucus, N. J. "But we might show it in the suite if anybody else starts showing it," Shimada is quick to add.

"None of the manufacturers will say if they're going to show [R-DAT prototypes] at SCES or not, but I think they're all going to have them under the beds in their suites," notes David Lachenbruch, editorial director for *Television Digest*, an industry newsletter. At last January's Winter Consumer Electronics Show in Las Vegas, Onkyo U.S.A. Corp. made private showings of an R-DAT prototype [*Electronics*, Jan. 20, 1986, p. 19]. Sony did the same thing at last April's National Association of Broadcasters convention in Dallas.

Because R-DAT can produce high fidelity nearly equaling that of CDs, some believe the record and playback capabilities of the new tape units could eventually provide competition for the CD, a playback-only medium. But given plummeting CD prices of late, most agree that R-DAT will have catching-up to do. □



NEW BREEDS. New equipment in the audio/video format battles are Kodak's 8-mm video camera and a prototype Rotary Digital Audio Tape player by Onkyo.

COMMODORE FACES A LONG ROAD BACK

BLOODIED BY LAGGING SALES IN ITS LOW-PRICE FIEFDOM, IT ALSO MUST REPOSITION ITS UPSCALE, SLOW-SELLING AMIGA

WEST CHESTER, PA.

What company shipped 2.25 million personal computers in 1985—more than any other manufacturer in the world—and isn't called IBM? Hint: despite its leading position, this company will have to declare at least a $130 million loss when its current fiscal year ends June 30.

The company is Commodore International Ltd., known on these shores primarily as a purveyor of low-priced computers. And that, in a nutshell, is the problem for a company looking for revitalization in its higher-priced, slick, multitasking Amiga machine.

THOMAS RATTIGAN: Profitability is just around the corner.

In announcing Commodore's fifth consecutive quarterly loss late last month, president and chief executive officer Thomas Rattigan issued a statement assuring that the company had rounded the bend toward a return to profitability. Not only was Commodore headed toward an even fourth quarter, he said, but it should enjoy a profitable fiscal 1987 as well.

"The turnaround did in fact start last September," says Nigel Shepherd, Commodore's general manager for North American operations. "We are confident we'll be pretty close to break-even in the June quarter, no more than 5% up or 5% down. And we're totally confident we'll be in the black for the next two quarters." Will Commodore return to the plus side in fiscal 1987? Shepherd gives an "unequivocal yes."

But returning Commodore to financial solvency won't be easy. The personal computer market is fraught with pitfalls and has yet to fully rebound from last year's catastrophic swoon.

Unit volume in Commodore's market niche—computers in the under-$1,000 bracket—declined by more than a third last year to 2 million units worldwide, says Norm DeWitt, director of the Personal Computer Industry Service at Dataquest Inc., San Jose, Calif. The market researcher projects that figure will slide to 1.9 million in 1986. U. S. consumers, though increasingly willing to pay more for the home computers they do buy, are purchasing fewer and fewer computers for the home.

The $36.7 million loss Commodore declared for its third quarter (ended March 31) was in fact the second smallest of the five. That figure, amazing as it may seem, comes nowhere near the $124 million the company lost in the fourth quarter of fiscal 1985. In total, Commodore spent $274 million more than it took in over the last 15 months.

So Shepherd and Rattigan, a former Pepsico marketing whiz, are facing more hard times and hard decisions as they try to turn their company around.

Rattigan moved up only two months ago, the heir to the situation former CEO Jack Tramiel left in his wake when he ended his stormy relationship with Commodore early in 1984. When Marshall Smith became an interim CEO shortly after Tramiel's departure, he found the company in confusion. Relations with dealers were on the rocks, future products were not even in the planning stage, and an enormous inventory of defunct products needed to be liquidated. Then came the personal computer industry's Christmas bust of 1984 to really put Commodore on the skids.

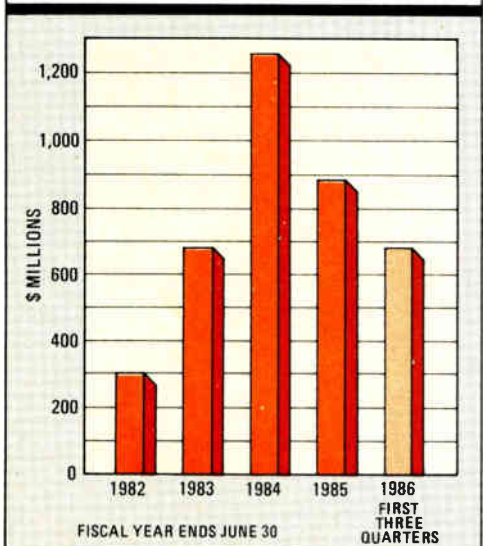
The company has been dealing with its difficulties the way most other electronics companies have: with layoffs. Last month, Commodore let go 120 employees of all levels at its West Chester headquarters and manufacturing site and about 20 others from the Amiga headquarters in Los Gatos, Calif. During the last year, Commodore has laid off 40% of its employees, leaving a total of 3,400.

PRODUCT CURE. Commodore also looked to product strategies to bring back its competitive edge. It plans to "re-skin" and upgrade the popular, $199 Commodore 64 by mid-1987 "so it can run in a Macintosh-like environment with pull-up icons and a mouse," Rattigan says, referring to the Apple Computer Corp. machine. Other plans call for the U. S. introduction of Commodore's IBM-compatible PC-10 and PC-20, which are already popular business machines in Europe. Shepherd says the U. S. introduction had been planned for this summer, but heavy orders in Europe have the machines back ordered.

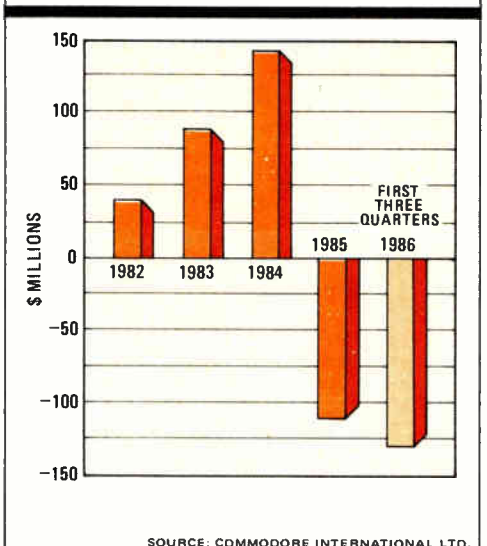
Commodore's most controversial move has long been cast in concrete: the decision to move upscale. The company went shopping for technology and found Amiga Inc., a small Los Gatos startup. Commodore bought Amiga for $26 million and renamed it Commodore-Amiga Inc. Last August, at a lavish party in New York, where reporters were treated to an impressive two-hour demonstration, it unveiled the Amiga computer as an under-$2,000 alternative to the Mac, aimed at families with some computer experience.

But Amiga sales have been

COMMODORE IMPERILED BY FALLING SALES . . .



. . . AND WHOPPING LOSSES



slow: DeWitt estimates Commodore shipped fewer than 40,000 units last year. (Commodore won't comment.) So the company is facing intense second-guessing from market analysts who think the machine is priced far too high for its intended niche.

Shepherd, however, says shipments are up in North America, with 6,000 to 7,000 units moved in April. And in Europe, where Commodore boasts a high-tech business computer reputation (as opposed to its tarnished U. S. image as a "toy computer" maker), the introduction of the Amiga was greeted enthusiastically last month, with the first shipment topping 5,000 units.

But at its present price—now $1,795, since a $1,295 special offer for the computer with a color monitor ended in May—even Shepherd agrees the Amiga is too expensive in a world where IBM clones are popping up everywhere for as little as $1,000. "We intend to continue to price-reduce the Amiga as quickly as we can," Shepherd says. "The target next year for the Amiga is to do two things simultaneously—enhance it and reduce its price."

The likely scenario for 1987, Shepherd suggests, is to cut the existing Amiga's price to $995 and introduce a new, upgraded Amiga that will reside in the $1,500 price range. The new machine, which inside sources promise will be out before Christmas, will feature a minimum of 2 megabytes of memory and built-in compatibility with IBM's line of MS-DOS-based Personal Computers. (Until then, IBM compatibility can be achieved through a $295 software emulator or a $750 hardware add-on called the Side Car, available late this year.)

Asked if he would consider cutting prices further to go head to head with Atari Inc., which is run by former Commodore CEO Tramiel, Shepherd replies: "I wouldn't go as low as $795," the price of the Sunnyvale, Calif., company's 520 ST. He might drop the Amiga to as low as $895, though.

If he draws the line there, Shepherd might not go far enough to solve the Amiga's problems, in the opinion of Dataquest's DeWitt. "Basically, the Amiga is a $1,800 box with a monitor, and at that price, it's too high for the home. But Commodore doesn't have the reputation to go after the business market. So I think the Amiga has to be around $700 for it to have any real market strength." DeWitt adds that "they have plenty of room to cut."

OLD WOUNDS. Much of that room, however, would have to come out of the pockets of dealers already leery of Commodore's past cost-cutting history. The company sold earlier machines at extremely low cost to mass merchandisers, which in turn undersold the computer specialty stores that had once handled the computers exclusively.

Since introducing the Amiga, Commodore has made a point of wooing those dealers back with an extra-sweet 35% gross margin against the suggested retail price. But for the Amiga's price to dive to just $700, those dealers would have to give up more than half of their commission, and many may become unwilling to sell the machine.

Rattigan, who is seldom available for comment and is exceedingly brief in his rare interviews, insists that relations with dealers have been good and that the media have made too much of Commodore's dependence on the Amiga. The older workhorses, the 64 and 128, are the real bread-and-butter revenue producers, he says. Shepherd agrees: "The scenario the media painted became, 'Commodore's future depends on Amiga,'" he says. "That wasn't fair."

The Amiga, they claim, will take time to find a home because it's unique. In comparison, they point to Apple's Macintosh, another critically acclaimed computer that utilized a proprietary architecture and operating system and was slow to garner market share because of slow software development.

Amiga is in the same boat, they admit, but gradually a useful base of programs for users is beginning to appear. "Compared with the Mac," says Shepherd, "the Amiga's been something of a success." *–Tobias Naegele*

ELUSIVE STARDOM. Despite early rave reviews, the Amiga has not done well in the market.

BOTTOM LINES

U. S. ROBOT SHIPMENTS CLIMBED 21% IN 1985

The use of robots by U. S. industry continued strong last year. According to the latest survey by the Robotic Industries Association, Ann Arbor, Mich., shipments by U. S.-based suppliers rose 21% to a record 6,209 units in 1985 from 1984's record 5,136 units. The value of the 1985 shipments rose 33% to a record $442.7 million from $332.5 million in 1984, also a record. RIA estimates that 20,000 robots had been installed in the U. S. by the end of 1985, with about 50% of those in the auto industry. Other leading end users include the electronics, off-road vehicle, aerospace, and home appliance industries, it said.

SOFTWARE PUBLISHING EXPECTS TO SHOW LOSS

Software Publishing Corp. says it expects to lose up to $2.5 million to $3 million in its third quarter, which ends June 30. That would amount to $1 million to $1.5 million after tax credits. President Fred M. Gibbons explains that $500,000 of the before-tax figure is the result of one of the Mountain View, Calif., company's major customers filing for protection under Chapter 11 of the bankruptcy laws. "We believe this loss is a result of the continuation of adverse market conditions," said Gibbons in a letter to shareholders. "Essentially, we have observed two important changes in the market: a shift in the retail channel toward corporate selling, and a shift in end-user demand toward high-performance software." Software publishing is a force in the low end of the market.

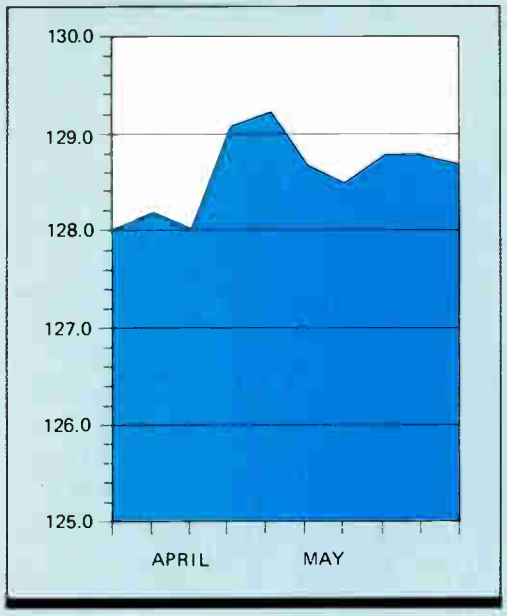
MULTIFLOW COMPUTER RAISES $10.6 MILLION

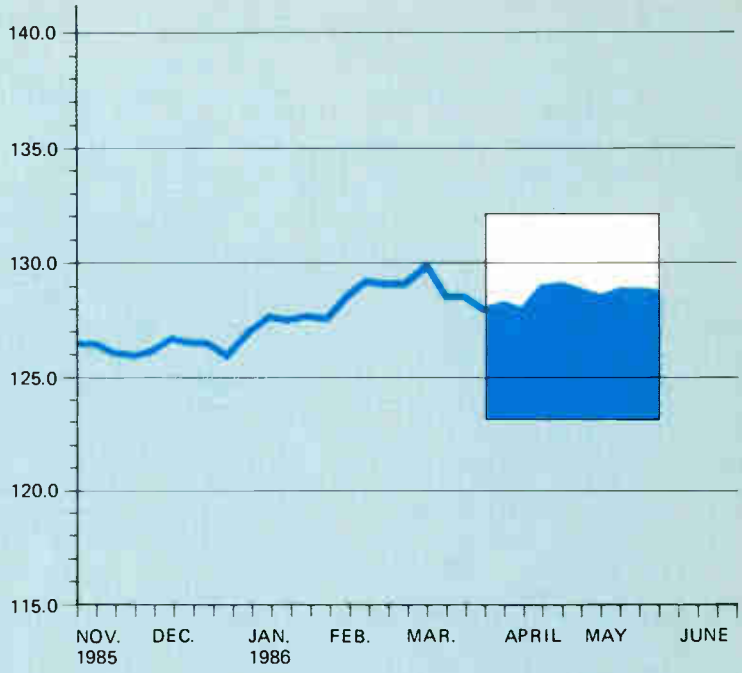
A second round of venture financing has yielded $10.6 million for Multiflow Computer Inc., a maker of advanced scientific/engineering computer systems. The Branford, Conn., company, which raised $7 million in its first financing in February 1985, was founded in 1984.

PENTRON TO BUY KOALA TECHNOLOGIES

Pentron Industries Inc. has agreed to acquire Koala Technologies Corp. for an undisclosed amount. Pentron, of Walnut Creek, Calif., makes and distributes accessories for personal computers, while Koala Technologies, San Jose, Calif., makes digitizing tablets. The latter products enable personal computer users to create and manipulate digital images on a computer monitor.

ELECTRONICS INDEX





THIS WEEK	= 128.7
LAST WEEK	= 128.8
YEAR AGO	= 129.0
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

	March 1986	February 1986	March 1985
Office and data-processing equipment	257.1	264.4	265.7
Communications equipment	218.3	217.9	219.7
Radio and TV equipment	159.4	152.3	155.0
Electronic and electrical instruments	142.5	141.8	139.0
Components	244.8	239.3	280.4

U. S. ELECTRONICS COMPONENTS PRODUCER PRICE INDEX

	April 1986	March 1986	April 1985
Digital bipolar integrated circuits	63.5	62.1	60.1
Digital MOS ICs	32.4	31.8	39.8
Linear ICs	56.6	58.1	62.3
Capacitors	183.6	184.9	189.8
Resistors	192.5	192.6	188.1
Relays	316.1	313.2	312.6
Connectors	240.8	238.0	233.4

There could be some good times ahead for the U. S. electronics industry, despite an overall 0.5% dip in production in March. The computer and office equipment sector was the only category to cut production; all others made sizable gains. For example, TV and radio production surged 4.7%, while communications gear output edged up 0.2%. Components production boomed 2.3%, the best gain in over two years. In addition, the 0.4% hike in prices of electronic components in April was the most sizable month-over-month increase the industry has seen in more than a year.

MARUYAMA GETS THE CALL FROM AILING DAINICHI KIKO

TOKYO

Just two years ago, Dainichi Kiko Co. was the fastest-growing robotics maker in the world. Today, the company is experiencing losses and decreasing revenues—and depending largely on the talents of a new manager with an atypical background to turn things around.

Tetsuo Maruyama, who took over administrative control a few weeks ago from founder and president Toshio Kohno, has an impressive history of turning around electronics-related businesses. But this time he's facing what he admits is a risky challenge.

After Dainichi Kiko boosted earnings from $5.2 million in 1980 to $42 million in 1984 [*Electronics*, Feb. 11, 1985, p. 45], industry analysts were predicting it would soon become the third largest robot maker in Japan. But the very next year, the Tokyo company lost $6.4 million as revenue plunged to $23 million. "It was a difficult year for all robot makers," says Maruyama, "but the established companies cut prices to maintain their edge."

COMPANY DOCTOR. Dainichi Kiko, a venture business once described as "a second Sony," soon found itself pushed to the edge. Dai-Ichi Seimei Co., a major insurance company and a heavy investor in Dainichi Kiko, was attracted by Maruyama's reputation as a company fixer-upper. They subsequently contacted him and offered him the job.

A graduate of Hokkaido University with a doctorate from Tokyo University in physical chemistry, the 49-year-old Maruyama is an atypical Japanese executive in that he has worked with several companies during his career. He began as an atomic reactor materials designer for Toshiba Corp. in 1958. But he wanted to get into the then-budding electronics field, so he joined Japan Electron Optics Laboratory (JEOL) in 1965 and later headed its U. S. operations.

MARUYAMA: Turning robots-maker Dainichi Kiko back into a success story.

When JEOL ran into irreversible financial troubles, Maruyama resigned and joined Kyocera Corp., a materials maker best known as a semiconductor packager, where he set up the company's first sales and marketing group for the U. S. East Coast. He quickly rose to senior vice president and was put in charge of establishing Kyocera's electronic parts and components group.

Then, as Kyocera began taking over other companies, Maruyama was asked to turn losers into winners. He reorganized desktop-printer maker Systec Corp. and added a plain-paper copier to its line. Within a year, Systec was turning a profit.

Then in 1979, he handled the Kyocera takeover of Cybernet Corp., a C-band transceiver maker, when it was losing more than $400,000 a month. In less than two years, it was in the black.

In 1982, feeling he was losing touch with technological developments in the marketplace, Maruyama left Kyocera to start up Thermovonics Co., the Japanese manufacturing arm of ECD Corp., an electronic cooling systems and amorphous silicon product developer in the U. S. In fact, he agreed to take over the direction of Dainichi Kiko on the condition that he be allowed to remain as president of Thermovonics. He also insisted that Dai-Ichi Seimei transfer one of its key financial officers to oversee Dainichi Kiko operations.

GETTING PRACTICAL. "They [Dainichi Kiko] were concentrating only on developing new products," says Maruyama. "There was virtually no internal financial control." His main task, he says, is to "change the mentality of the staff to a more practical, cost-saving one. Venture businesses may be exciting, but in Japan

PEOPLE ON THE MOVE

GWENDOLYN J. PETERSON

☐ The former director of Dataquest Inc.'s Business Computer Systems Industry Service has been promoted to vice president and director of Computer Products. Gwendolyn J. Peterson will oversee research across a broad range of computer industry segments for the San Jose, Calif., market researcher. Before joining Dataquest, she was market planning manager of the Information Systems Group at Hewlett-Packard Co.

JOSEPH J. BATTAGLIA

☐ Litton Industries' Electronic Warfare Systems Group has named Joseph J. Battaglia vice president for business development at its Laser Systems Division in Orlando, Fla. Battaglia, director of marketing for the division since 1984, has over 20 years experience in aerospace and electronics management and holds degrees in electrical engineering and applied physics from Adelphi University, Garden City, N. Y. Battaglia will oversee development and production of laser systems and subsystems.

KENT P. FRIEL

☐ Cincinnati-based systems integrator Access Corp. has named Kent P. Friel chief executive officer and chairman. Friel joined the company in 1980 as vice president of sales and marketing and became executive vice president and general manager in 1982. Before coming to Access, Friel was group vice president for operations at Burke Marketing Research Inc., also in Cincinnati.

DAVID M. BURWEN

☐ Robotic work-cell manufacturer Adaptive Intelligence Corp. has named David M. Burwen president and chief executive officer. He succeeds Donald Pedrotti, now chairman. Before joining the Milpitas, Calif., company, Burwen directed computer-integrated-manufacturing programs at Integrated Automation, an Alameda, Calif., manufacturer of machine-vision and automation systems, and he has worked at Data General Corp. and Digital Equipment Corp.

STEPHEN E. COOPER

☐ Silicon Systems Inc., Tustin, Calif., has named Stephen E. Cooper president and chief operating officer. He takes over from Carmelo J. Santoro, still board chairman and CEO. Cooper joined Silicon Systems in 1980 as vice president of wafer fabrication. In 1981, he became vice president of operations and was appointed senior vice president in 1984. A year later, he was appointed general manager of the Microperipheral Products Division.

they're almost always relatively small enterprises with limited capital resources, constantly living on the edge of disaster."

For the moment, stabilizing the business is Maruyama's main goal, but he plans other changes by the end of this year. "I see definite connections between the technology of my work in materials science at Thermovonics and robotics," says Maruyama. "If we can develop lighter, yet tougher, materials for robotics construction, we can create brand new markets where none yet exists." *–Michael Berger*

KATHOLING'S CHALLENGE: GROWING AT&T IN EUROPE

MUNICH

Günter Katholing faces what he candidly describes as a "tough challenge." As general manager in Europe for American Telephone & Telegraph Co.'s Components & Electronic Systems Division, his task is to build a sales and marketing organization "from zero," as he puts it, and get the company established in a market that is new territory to the U. S. communications giant.

The drive into Europe stems from the breakup of AT&T two years ago, which allowed it, among other things, to go international. Currently, the Western European market for the kind of components AT&T is offering is about $4 billion; it's predicted to rise 75% over the next five years, to $7 billion by 1990. "We are gunning for a 10% share," says Katholing, who estimates that the division's European business will be "between $500 million and $1 billion" by the end of the decade.

KATHOLING: Battling tough competition and an unknown image.

AT&T has already taken a successful plunge into the open market for components in the U. S. The bulk of its production—some 85%—is still for internal use, but last year AT&T marketed roughly 15% of the division's total production of $2.5 billion on the outside.

NO DOUBTS. Katholing has absolutely no doubts about the chances of success in a crowded market that has become a battlefield for U. S., Japanese, and European producers. Radiating confidence, Katholing ticks off two main reasons he thinks AT&T can make it in Europe: the spectrum of leading-edge products that Components & Electronic Systems is shipping across the Atlantic, and the backing in components technology provided by AT&T Bell Laboratories.

"We are not here with run-of-the mill integrated circuits, but with advanced professional devices in which AT&T is a leader," Katholing says.

This confidence is based on the fact that Katholing has started an operation from scratch before: at Siemens AG, where he spent 15 years, he built the West German company's worldwide marketing activities in MOS and automotive chips. He also helped get new components sales activities started overseas—in the African market, for example.

Electronics is not the field in which Katholing, 46, began his career. A 1968 graduate of the Frankfurt Engineering School for Electrotechnology, he first worked for several years as an engineer in power plants. He moved on to a metals company and then to Honeywell GmbH in Frankfurt, where he designed measuring and control systems before joining Siemens in 1970. He signed on with AT&T late last year.

From the Munich-based AT&T Microelectronics GmbH, the Components and Electronic Systems Division's European headquarters, Katholing oversees a sales and marketing operation with eight regional offices spotted from Milan in the south to Stockholm in the north and employing 40 people. More sales outlets and a production facility in Spain will be added in the next few years, and a design center for application-specific ICs is being established in Munich. By the end of this year, Katholing expects his European operations to total about 70 sales people and by 1990 "several hundred."

He prides himself in having put together a staff whose members have an average of 13 years of experience in component sales. In hiring, he says, he is "trying to avoid the mistakes other U. S. firms in Europe have made—that is, bringing American sales personnel over here." Instead, he says, his policy is to hire local sales people in the belief that "knowledge of their own country's culture makes for good customer relations." For product design and circuit application, however, AT&T will send Americans to Europe. *–John Gosch*

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NEW PRODUCTS

HP'S NEW LINE OF CAD TOOLS RUNS ON A SINGLE WORK STATION

TYING TOGETHER DESIGN, LAYOUT, AND SOFTWARE DEVELOPMENT

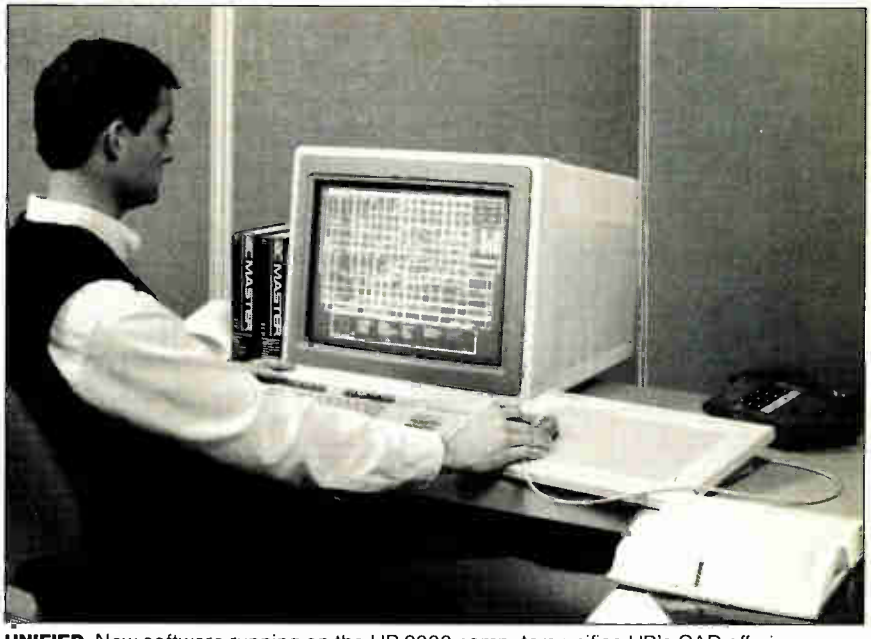
Hewlett-Packard Co. has finally unified its approach to design automation. The HP DesignCenter product family integrates circuit design, layout, and software development.

Up until now, HP addressed the design-automation process with a collection of disparate tools, each addressing a separate function. HP computer-aided engineering work stations enabled schematic capture and logic and timing simulation; then computer-aided-design work stations took a netlist contained on magnetic tape or disk and enabled layout designers to implement the design in an integrated circuit or printed-circuit board; software development systems allowed programmers to write software to control the design.

But the new HP products integrate all of these design tasks. DesignCenter automates individual product-design activities while linking them to increase productivity. All these software products run on the HP 9000 Series 300 work station as a platform, running under the HP-UX operating system, which was derived from AT&T Co.'s Unix System V interface definition. On this platform, the company has purchased outside software and adapted some existing HP software tools to create the integrated environment.

CAD SOLUTION. The new HP pc-board design system, which does not yet have a formal name, couples board layout to electrical engineering design, manufacturing, and testing. The Palo Alto company licensed the source code for the system from Northern Telecom Inc. and its subsidiary, Bell Northern Research, in October 1985. Since acquiring the license, HP has enhanced the software tool, which was written for a mainframe, to run in a networked work-station environment.

The software's design-file format eliminates redundant data entry and reduces chances for errors. The tool has packing, placing, and routing features that enable pc-board designers to automatically lay out digital, analog, and mixed digital/analog boards with through-hole and surface-mount technologies. The software also contains capabilities for thick-film hybrid design.



UNIFIED. New software running on the HP 9000 computers unifies HP's CAD offerings.

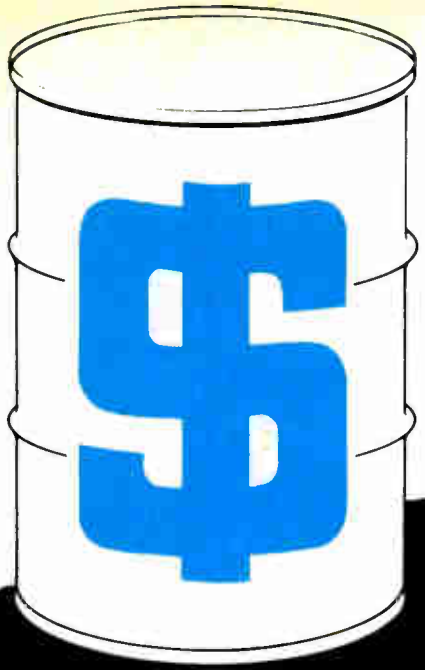
The pc-board design system links to the HP Logic Design System, where the designer captures a schematic and performs logic, timing, and fault simulation. With the two systems tightly coupled, the logic designer can transfer netlists and parts information to the layout designer, who in turn can communicate engineering changes and back-annotation data to the logic designer. The design system can also transfer logic-design information to other board layout systems, such as those from Racal-Redac Inc. and ComputerVision Corp.

AUTOMATIC REPORTS. The Logic Design System automatically generates a number of reports and files for manufacturing and test equipment. They include photoplotter instructions, numerical-control drilling tapes, and production reports. Electrical topology data can be generated automatically for the HP 3065 board-tester family to eliminate redundant data entry.

In addition, the company has enhanced the Logic Design System by adding gate-array libraries from NEC Electronics Inc. The libraries provide function cells describing NEC's most popular logic functions. Consisting of more than 150 cells, the libraries support NEC's full line of CMOS gate arrays in 2-μm geometries. The CMOS offerings comprise 20 device types ranging from 400 to 20,000 gates.

Another addition to the logic design system is the Analog Workbench software, which HP has licensed from Analog Design Tools Inc. With it, a designer can capture a design containing digital and analog circuitry using HP schematic-capture software and pass the analog portion to the Analog Workbench software for simulation and verification. Then, once the analog circuit design is complete, it can be reintegrated with the digital part of the circuit before being submitted for pc-board or IC layout.

In addition to integrating pc-board and logic-design systems, HP also has integrated its microprocessor software-design and -analysis tools into the design center. The HP 64000 software-development work station has been adapted into the design center environment and enhanced with links to the logic-design system. It comes with a selection



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of emulators for 40 different microprocessors. A new HP 64120A instrumentation module houses the HP 64000 emulators and analyzers.

Programmers can develop software specifications, produce object code using a selected cross-compiler or assembler, then analyze the software using high-level language and performance analyzers that reside in the HP 64120A instrumentation module. ROM images created during the software-design phase can be passed to the logic simulator running on the same work station. Thus, ROM initialization by hand is eliminated, errors are reduced, and design iterations are reduced.

Finally, the company has announced the HP Teamwork/Structured Analysis, the first in a series of products that help software developers create and manage software specifications. A companion product for the HP 64000 Logic Design System, the software product enables a project team to capture design requirements, organize them into models, and evaluate and maintain them for large- and small-system designs.

Various configurations of the HP Printed Circuit Design System range in price from $40,000 to $100,000 per work station. The new HP 64120A Software Design System instrumentation module ranges from $5,000 to $7,000. The Teamwork/Structured Analysis runs from $8,000 to $10,000. Delivery of these products is in 12 to 16 weeks after order. *–Jonah McLeod*

Hewlett-Packard Co., Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, Calif., 94303 [Circle reader service number 338]

ALCYON MATES UNIX TO REAL-TIME ENVIRONMENT

Alcyon Corp. has come up with a previously unheard-of combination: computers ideally suited for real-time process control that run in a Unix environment. The company is offering 10 products to factory-automation and industrial-process-control engineers looking to set up embedded real-time distributed processing. The computers, including five single- and five multiprocessor VMEbus-based systems, are built around a 68010 microprocessor and come in various cabinet types and with a variety of disk drives and I/O options.

What Alcyon has done is to combine the strengths of both software environments. Much of the factory-automation gear already in place is from vendors whose products don't talk to each other. Expansion is limited because engineers cannot pick the hardware that is best for their application if they are already locked into one vendor's proprietary operating system. Meanwhile, Unix, though designed for easily moving a software package from one computer to another, is not at all suited for real-time work, required for process control.

All of Alcyon's new products incorporate the company's proprietary Regulus operating system, real-time multitasking kernels, and fast C-language code for optimum performance on the 68010-based gear. Regulus is compatible with AT&T Co.'s Unix System 5.2.

TWO IN ONE. "The systems are really two systems in one. On one hand, they are Unix-5.2-compatible, providing a standard platform for application-software development," says William Hughes, vice president of sales and marketing. "On the other hand, they offer one or two real-time multitasking kernels for fast, predictable response in time-critical applications."

The ability to operate in real time is an absolute necessity in such technical applications as robotics in industrial automation, real-time data acquisition and control, medical and laboratory instrumentation, communications, graphics, and design automation. For applications in which the company's Regulus operating system real-time response is not fast enough, users can take advantage of one of the five multiprocessor computers, which have a second, faster real-time kernel called pSOS.

CONTROL TASKS. Alcyon aims its real-time Unix systems at embedded process-control and factory-automation applications.

The pSOS kernel schedules and allocates resources between processors and supervises and coordinates all real-time-driven, asynchronous processing by priority. On Alcyon's multiprocessor systems, Regulus runs on one processor and pSOS runs on the other.

Regulus provides 750-μs task-switching times on the 68010, the measure of how fast the CPU can go from one task to another in response to an external data interrupt or stimulus. The pSOS kernel boasts a 125-μs task-switching speed. According to Hughes, benchmarks his company has run on systems using the 68020 processor cut both Regulus and pSOS times in half.

These multiprocessor systems also feature RpIOS software, which provides interprocessor communication and synchronization across the VMEbus backplane. Efficient intertask communication for both real-time and non-real-time tasks is supported by shared memory segments that may be dynamically allocated during task execution.

RpIOS also enables a system engineer to develop pSOS tasks under Regulus' rich Unix development capabilities. "These tasks can be downloaded at very high speeds for faster operation on the pSOS board," Hughes says.

Alcyon has five pairs of computer systems, single-processor models and multiprocessor models with the MP designation. All single-processor models include the Regulus software, and all multiprocessor units add the pSOS and RpIOS software.

The desktop or rack-mountable models 20 and 20-MP support one or two users each and come with a 20-megabyte hard-disk drive and a 5¼-in. floppy-disk drive. The single-processor MP-20 sells for $7,490 and the multiprocessor 20-MP goes for $11,990.

The models 10/10 and 10/10-MP support one or two users each and come with a 10-megabyte hard disk and a 10-megabyte removable-cartridge disk. The 10/10 goes for $9,490 and the 10/10-MP for $13,990. Both of these are also available in desktop and rack-mountable versions.

The 80 and 80-MP pair of tower or rack-mountable systems can serve four to six users and are priced at $16,990 and $21,490, respectively. They have an 80-megabyte disk drive and 60-megabyte cartridge drive. The models 300 at $23,990 and 300-MP at $28,490 support 8 to 12 users and come with a 300-megabyte disk drive and a 60-megabyte cartridge drive for backup.

The models 450 and 450-MP are priced at $45,490 and $49,490 and serve 12 to 16 users. They have 450-megabyte disk drives and a 9-track tape drive for back-up. These come in cabinet and rack-mountable versions.

All the systems come with 1-megabyte of RAM, except the models 20 and 20-MP, which have ½-megabyte. Delivery on the systems takes from 30 to 60 days after receipt of order, depending on the model. *–Steve Zollo*

Alcyon Corp., 5010 Shoreham Pl., San Diego, Calif. 92122.
Phone (619) 587-1155 [Circle 341]

A VISION SYSTEM AS LOW AS $10,000

Itran Corp.'s MVP 1000 machine-vision processor halves the size and cost of a high-performance factory inspection system. Designed to be programmed by engineers on the factory floor, the MVP 1000 is a modular system consisting of a vision processor, the P 200 portable programmer, a camera, and a parallel I/O port.

The system is built around a single pc board, compared with as many as seven for comparable systems from Automatix, Machine Vision International, and Itran's own VIP I. The MVP 1000 measures 8 by 20 by 25 in., almost half the size of other systems, and sells for about $20,000 versus $45,000 for similar systems. In large quantities, the MVP 1000's price drops from $20,000 to $10,000 per system.

"The MVP 1000 provides proven technology in a standard, easy-to-use, low-cost product that companies can use to proliferate vision in their factories," says Itran president Stanley N. Lapidus. "We believe the MVP 1000 will do for the vision industry what the IBM Corp. Personal Computer and Lotus 1-2-3 did for personal computers."

The application-specific MVP 1000 is compatible with other Itran vision products and can run as many as six standard software tools at one time. It includes ½ megabyte of program memory and 76-K bytes for image storage. The MVP 1000 also operates in temperatures as high as 60°C.

INTUITIVE. Users with no knowledge of programming languages or image processing can typically learn to program and operate the MVP 1000 in just a few hours, thanks to its menu-driven user interface. "With the MVP 1000, English commands and the use of icons that represent tools make implementation of machine vision an intuitive process," says Lapidus.

The company credits the system's low cost to its modular nature. Customers buying multiple systems do not have to buy redundant gear; they can select only the equipment they need for a specific application. Manufacturers can use a single Itran P 200 programmer to set up an unlimited number of processors on the factory floor, for example, or use it to program any one of 14 daisy-chained vision processors.

The MVP 1000 uses 64 shades of gray to inspect parts with various features and contours. Speed of inspection depends on the complexity of the part, but can range from 60 parts per second to one part in 3 s. The system's resolution is 320 by 240 pixels.

By using up to 64 shades of gray to accurately judge part features and contours, the MVP 1000 recognizes and analyzes objects by their edge patterns,

even when shades or shadows affect light intensity. Many competing systems use binary imaging technology, a technique that is extremely sensitive to shadows and glare.

The P 200 portable programmer is the first intelligent programmer available with its own computer and image-analysis software, according to Lapidus. The unit features a light pen and a 1-megabyte disk.

The system's vision processor uses a Motorola 68010 microprocessor and 29116 proprietary bit-slice technology. The MVP 1000 controller can direct up to four cameras simultaneously at a distance of up to 200 ft. At high speeds, the processor performs complex image-processing algorithms for comparing the part under inspection to a model image that has been programmed into the system.

INEXPENSIVE EYES. Priced at as little as $10,000 each, Itran's machine-vision system is easy to program for inspection tasks.

Available as an option, the vision statistical processor provides on-going statistical measurements of parts for quality control. The VSP elevates machine vision from solely an inspection function to a feedback mechanism for evaluation of the manufacturing process itself.

The MVP 1000 and options are currently available. *–Debra Michals*

Itran Corp. 670 N. Commercial St. P. O. Box 607 Manchester, N. H. 03105. Phone (603) 669-6332 [Circle 339]

BIPOLAR ARRAY MIXES DIGITAL AND ANALOG

The latest addition to Tektronix's QuickChip family of bipolar arrays is a circuit that enables users to integrate digital and analog circuitry on a single die. The QuickChip 4, which is compatible with 100K ECL, provides a unity-gain bandwidth product of 6.5 GHz on the analog side and a clock rate of 500 MHz on the digital side.

With QuickChip 4, the system designer has the freedom to design high-performance custom analog circuitry and the ability to draw upon a full library of standard ECL digital functions. The chip boasts the equivalent of 300 gates and contains more than 290 npn transistors for analog designs. Digital functions include OR, NOR, AND, and NAND gates, multiplexers and decoders, buffers, latches, and inverters. The analog section comprises a total of 260 transistors and passive components and occupies about half the die area.

QuickChip provides a structured approach to mixing analog and digital circuitry. A mixed-function die makes possible monolithic integration of design blocks that would otherwise require separate chips, thereby lowering system cost and increasing performance. "The mixed-function die reduces the number of components, providing tighter packaging density and greater functionality and reliability," says Dale DeVries, general manager of Tektronix's Integrated Circuit Operation.

In addition, the combined analog and digital functions can be simulated on the company's Tspice and Tlogs software. The analog and digital portions can be tested together by virtue of a common input language.

Having both analog and digital on the same die is more important in high-performance systems, says Wink Gross, manager of IC design. "At low performance levels it doesn't matter if you have separate packages," he says. A typical application for the QuickChip is in optical communications. "It is a mixed system that needs to operate in the 500 Mb/s range," he says.

At its 6.5-GHz unity-gain bandwidth product, QuickChip is five times faster than other analog-only gate arrays—which are rated at about 1.5 GHz—and faster still than competitors' mixed analog and digital offerings, which top out at 1 GHz. On the digital side, QuickChip's 500-MHz rate is equal to the fastest digital-only arrays and exceeds the 80-MHz top rate of mixed arrays.

QuickChip 4 is built using the Tektronix Super High 3 process. The 4.9-by-4.9-mm chip has 66 bonding pads, 10 of which are dedicated to power supplies. The IC is suited to 68-pin chip-carrier and hybrid packaging.

Tektronix requires no minimum number of parts and promises turnaround—from plots to parts—in three weeks. Prototype wafers and packaged parts are priced at $26,500, plus nonrecurring engineering charges.

To aid engineers, Tektronix provides a host of software, including QuicKic software for graphics layout, design, and editing. QuicKic can be provided in CIF or Calma-stream data formats for use on engineer's equipment. The Tspice circuit simulator is an enhanced version of Spice2G with powerful graphics and data-reduction routines and improved convergence algorithms. Tspice uses the Teksim input format and runs under the Unix and VMS operating systems. Tlogs is a three-state logic and timing simulator and testability analyzer that also uses the Teksim input format and runs under Unix or VMS. *–Steve Zollo*

Tektronix Inc., Integrated Circuits Operation, P. O. Box 500, Beaverton, Ore. 97077. Phone (503) 627-2515 [Circle 340]

CMOS CUTS HEAT, SIZE OF ESDI WINCHESTER DRIVES

Miniscribe is rolling out a line of 5¼-in. Enhanced Small Disk Interface Winchester disk drives that dissipate about 60% less power than competing ESDI drives. CMOS large-scale integrated circuits, semicustom chips, and high-performance thin-film media get the credit and save space as well as power—all of the electronics for the interface fit onto a single pc board.

Samples of the new 6000E series are available now with unformatted storage

INTERFACE. Miniscribe enters the ESDI market with a drive that includes the interface.

capacities of 85.3, 128, and 170.6 megabytes. Miniscribe is using a 2:7 run-length-limited encoding method to achieve data transfer rates of 10 Mb/s. To handle those rates, the company uses a high-performance thin-film media in the drives.

"We feel the Winchester market is growing fast not only for higher densities, but also for higher throughput—and ESDI accomplishes both," says Warren Frebel, product marketing manager. The 6000E series is targeted at a wide range of high-performance computer applications, such as computer-aided design work stations, multiuser and multitasking computer systems, and file servers for local-area networks.

The ESDI Winchesters are an extension of Miniscribe's full-height 6000 series of hard-disk drives, which includes drives with up to 85.3 megabytes and data-transfer rates of 5 Mb/s. The new drives contain the same hard-disk assembly as Miniscribe's ST-412- and ST-506-compatible Winchester disks. For example, members of the ESDI series have the same positioning system of linear voice-coil actuators as the other 6000 drives. However, the faster ESDI drives have thin-film media instead of oxide disks, and the 6000E series incorporates the data separator as well as encoding and decoding functions on the drive, following the standards in the ESDI specification.

SELF-DIAGNOSTICS. The 6000E drives also contain a number of ESDI options, such as full support for self-diagnostics and the ability to do both soft and hard sectoring. In the hard-sector mode, the number of unformatted bytes per sector can be programmed.

The drive also supports the ESDI option of sequencing startup of a number of attached drives when 6000E disks are being powered up. A fail-safe automatic actuator-locking feature will pull the read-write heads off the disk and place them into a safe landing zone when power is turned off.

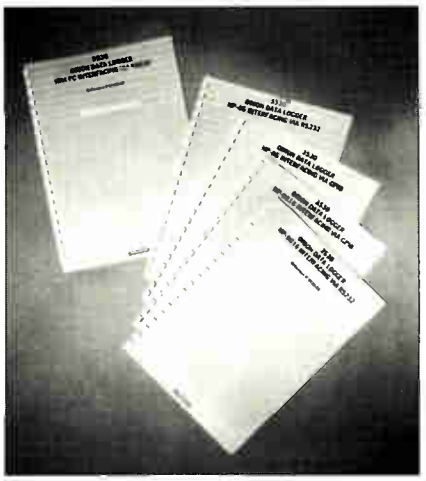
The 5¼-in. ESDI drives are specified to dissipate only 17 W of power on standby and 28 W during positioning. "With the low power requirements, systems integrators can use smaller power supplies, which can often cost less, as well as benefit from packing components together in smaller chassis without compromising reliability," Frebel says.

The 6000E disk drives have an average access time of 28 ms, including settling times. Maximum access times are rated at 50 ms. The drives have a soft read-error rate of only 1 per 10^{10} bits; seek errors are 1 per 10^{6} seeks. Typical dc power requirements are 1 A on the +5-V supply and 1 A on the 12-V supply. The drives measure 3¼ by 5¾ by 8 in. and weigh 6 lb.

In lots of 2,500, the 170.6-megabyte model 6170E is priced at $1,300 each. The 128-megabyte model 6128E and 85.3-megabyte 6085E go for $1,150 and $1,000 each, respectively, in like quantities. Samples are available this month, and production quantities will be shipped starting in late summer or early fall. *–J. Robert Lineback*

Miniscribe Corp., 1861 Lefthand Circle, Longmont, Colo. 80501.
Phone (303) 651-6000 [Circle 342]

NEW LITERATURE



INTERFACES. Five free programming guides show users how to link the Orion data logger with a personal computer by means of an RS-232-C interface or over the General Purpose Interface Bus (IEEE-488). Sample programs illustrate how a typical task setup is sent to the Orion for immediate execution, how data returns for display, and how users can send commands at any time to the Orion. The individual guides are for connecting to the IBM Corp. Personal Computer through RS-232-C, the HP-85 through RS-232-C or GPIB, and the HP-9816 through RS-232-C or GPIB. The Orion data logger simultaneously displays four of its 200 channels and monitors voltage and current sources, thermocouples, status and events, time periods, and frequency. The programming guides are available from Solartron Instruments, 2 Westchester Plaza, Elmsford, N. Y. 10523. Phone (914) 592-9168 [Circle reader service number 421]

ENGINEERING RESOURCES. Lotus Development Corp.'s Engineering and Scientific Products Division has a *Personal Engineering Resource Directory* that lists products compatible with Lotus software. The products, which generally can read and write compatible file formats or have special interfaces available, are listed by company under the following headings: data-acquisition and analysis systems; software for computer-aided design and manufacturing; engineering; graphics; mathematics; operations and production; and a number of statistical-analysis packages. A section on training and another on books and articles round out the 131-page paperback. Copies cost $4.95 each from Lotus at 55 Cambridge Pkwy., Cambridge, Mass. 02142. [Circle 422]

OPTICAL ENCODERS. To assist the engineer in specifying the proper encoder for a particular application, "Optical Encoders: A Complete Line of Industrial Optical Shaft Angle Encoders" assembles some basic information. The free 20-page color brochure includes specifications on light-, medium-, and heavy-duty industrial position sensors as well as various encoder options, including count multiplication. Applications for the encoders include robotics and process control. The literature is available from the Industrial Encoder Division of BEI Electronics Inc.'s Motion Systems Co. To receive a copy, call (805) 968-0782 or write to the division at 7230 Hollister Ave., Goleta, Calif. 93117. [Circle 423]

TEST STRATEGIES. An eight-page booklet details Kemon Co.'s Quality Impact analysis, a proprietary analysis tool that helps manufacturers of pc boards and components find the most economical test strategy by modeling various production-line test routings. QIA can be used to determine when present volume justifies further automation of test procedures and the best place in test routing to install additional test capacity. Free copies are available from the company at 25 Old Concord Rd., Lincoln, Mass. 01773. Phone (617) 259-9640. [Circle 424]

TESTING IMAGE SENSORS. An eight-page color brochure describes the A370 analog large-scale-integration test system for measuring the quality of image conversion in image sensors. The brochure details the A370's capabilities and enumerates the imager parameters used, including dark-level measurements and defect counting. It concludes with a description of instrument modules dedicated to imager device testing. Requests for the literature will be handled by Teradyne Inc., Inquiry Systems and Analysis, 25 Drydock Ave., Boston, Mass. 02210. [Circle 428]

CAD/CAM. "A Guided Tour of Quik Circuit" lets prospective users sample the computer-aided-design software for pc-board layout by means of a hands-on experience, since the guided tour consists of a demonstration floppy disk. Priced at $15, the disk takes 35 minutes to run, and users can stop the demonstration at any point to test the software. The demo, like the full-scale Quik Circuit software, runs on an Apple Macintosh personal computer. Quik Circuit designs boards up to 32 by 32 in. with multilayer and surface-mounting technology. The floppy disk, order no. 30008, is available from Bishop Graphics CAD Systems Corp., 5388 Sterling Center Dr., Westlake Village, Calif. 91359. Phone (800) 222-5808—in Alaska, Hawaii, and California, call (818) 991-2600. [Circle 429]

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ELECTRONICS WEEK

WANG, INTECOM AGREE TO MERGER

Wang Laboratories Inc. has reached a merger agreement with Intecom Inc. that would allow the Lowell, Mass., computer maker to acquire the majority of the stock in the private-branch-exchange manufacturer. Wang had been discussing the proposal with some of Intecom's founding shareholders, as well as with Exxon Corp., which owns stock in the Allen, Texas, company. The deal for 35% of Intecom stock, worth about $156 million, would give Wang controlling interest. The company has acquired about 20% of Intecom over the past two years. Wang says it will use the purchase to strengthen its efforts in integrated voice and data office systems.

HUGHES WILL CUT ITS WORK FORCE

Hughes Aircraft Co. plans to reduce its work force during the remainder of 1986. The Los Angeles company has set a staff cut of 5%—or about 4,000—as a guideline, which it expects to reach through normal attrition and discharge of substandard performers, says a representative. It will continue to recruit engineers, technicians, and others with skills the company needs.

ACTON COMPUTER TO BE SOLD

Computer & Communications Technology Corp. has signed a letter of intent to acquire Acton Computer Technology Inc., Goleta, Calif., subject to further negotiation and approval by Acton shareholders. Acton's shareholders will receive 2.45 million shares of the San Diego company's common stock with a market value of about $29.5 million. Both companies manufacture magnetic recording heads for the data-storage industry. Acton's strong low-end market position and Far East manufacturing capability complement Computer & Communications Technology's products in the high-end market.

DATAVUE PROTESTS POSTAL AWARD

Datavue Corp. has filed a protest with the Postmaster General charging that it was unfairly disqualified from bidding for the U. S. Postal Service's multimillion-dollar portable computer contract. The company's Data 25 portable computer was thrown out because it failed to meet one of three technical requirements, which was not specified: at least one hour of battery usage, commercial availability, or inclusion of a math coprocessor. In disputing these contentions, the Norcross, Ga., intelligent-systems maker says that the Postal Service "eliminated all other contenders [except the winning Grid Computer] by subjectively giving undue weighting to . . . inconsequential factors."

GERMANS SNAP UP RADIATION METERS

Last month's explosion and possible meltdown at the USSR's Chernobyl nuclear power plant have triggered a big demand in West Germany for a new pocket-sized radioactivity measuring device developed in Israel primarily for plant personnel. In the three weeks after the accident, Hamburg distributor Hansa Projekt GmbH has sold some 7,500 of the $175 X-Warning devices, and "we still can hardly keep up with the demand," a company executive says. The 80-gram unit was developed by the Nuclear Research Center in Negev.

SIEMENS WINS CHINA CONTRACT

After spirited bidding among U. S., Japanese, and European companies, West Germany's Siemens AG has won an order from the People's Republic of China for about $22 million worth of data-processing equipment for installation at 18 Chinese universities. The equipment includes 18 of the Munich company's 7.570C mainframe computers, 755 cathode-ray-tube displays, 19 computer-aided-design graphics systems, 26 PC-MX-2 personal computers, and 4 laser printers. Siemens will also train Chinese personnel. Unsuccessful bidders included Bull, Burroughs, Control Data, and Hitachi.

TI SELLS JAPAN LISP COMPUTER

Hoping to get an early toehold into Japanese's emerging artificial-intelligence markets, Texas Instruments Inc. has signed an agreement with C. Itoh & Co. Ltd. to market Explorer artificial-intelligence computers in Japan. TI and the Century Research Center Corp. subsidiary of Itoh, Japan's third-largest trading company, negotiated a three-year distribution deal covering the Dallas company's Lisp-based Explorer work stations. CRC officials expect the Japanese AI market to exceed $6 billion during the next five years.

COLLABORATION SET IN ISDN RESEARCH

Motorola Semiconductor Products Inc., Austin, Texas, and Northern Telecom Inc., Nashville, Tenn., will collaborate in the research and development of a family of semiconductor components for use in the integrated services digital network. The agreement covers development of the S/T- and U-interface transceiver integrated circuits for use in ISDN terminal, network termination, and line card applications. Also included is the adoption of a generic digital interface called Inter-chip Digital Link used as a high-speed digital input/output for the S/T-interface and U-interface transceivers and other ISDN family devices.

DEC's OLSEN GETS NEW IEEE AWARD

Kenneth H. Olsen, president of Digital Equipment Corp., has received the first Computer Entrepreneur Award from the Institute of Electrical and Electronics Engineers. The award was established to honor the industry's technical managers. Olsen was chosen for his pioneering work in the development of small computers and in the founding of the Maynard, Mass., company.

MASSCOMP AIMS AT OEM MARKET

Masscomp is reorganizing in an attempt to further exploit original-equipment manufacturer opportunities and maintain momentum generated from its recent components agreement with Harris Corp. The Westford, Mass., company will form two independent business units—a Scientific Products Group, which will target end-user sales, and an OEM Products Group to build its original-equipment markets. Masscomp will supply Harris with system components for its new MCX family of supermicrocomputers. The companies estimate the agreement's value at $30 million spread over over the next two years.

NEW PHILIPS PLANT FOR MICROSCOPY

Philips, among the world's biggest producers of electron-microscopy instrumentation, will consolidate its activities in this field in a new facility at Acht, near the Dutch company's headquarters in Eindhoven. The move, says a company representative, is to improve efficiency and streamline production. At present, development and production of such equipment is spread over nine plants.

HELLO, HARRY? TED FROM TEXAS HERE. WE'RE BEING KILLED DOWN HERE!!! NO, IT'S NOT A HURRICANE – IT'S AT&T. YOU'D BETTER BELIEVE IT! YEAH.... THEY'RE MOVING THEIR BUSINESS PHONES WITH THEIR NEW AT&T PUSH-BUTTON SAVINGS PLAN – RIGHT – UP TO 20% OFF ON A MULTI-YEAR LEASE, PLUS FINANCING IF YOU WANT TO BUY.... ALL SORTS OF WAYS TO SAVE MONEY.... ...WHADAYA MEAN I SHOULD START PUSHING OUR TOASTERS.....

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This toll-free number connects you to the office in your area.

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The right choice.

Circle 901 on reader service card

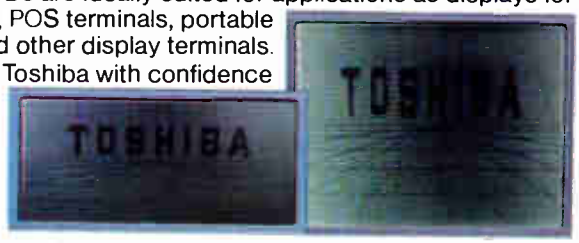
2,000 sharper-than-ever characters all on a portable LCD display.

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.

TOSHIBA

Toshiba America, Inc.: Electronic Components Business Sector: Head Office: 2692 Dow Avenue, Tustin, CA 92680, U.S.A. Tel. (714) 832-6300
Chicago Office: 1101 A Lake Cook Road, Deerfield, IL 60015, U.S.A. Tel. (312) 945-1500
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