SUDDEN UNITY ON A WINDOWING STANDARD/58

A NEW WAY TO MOVE AI INTO THE MAINSTREAM/90

1987 OVERSEAS MARKET REPORT
PAGE 65

JANUARY 22, 1987

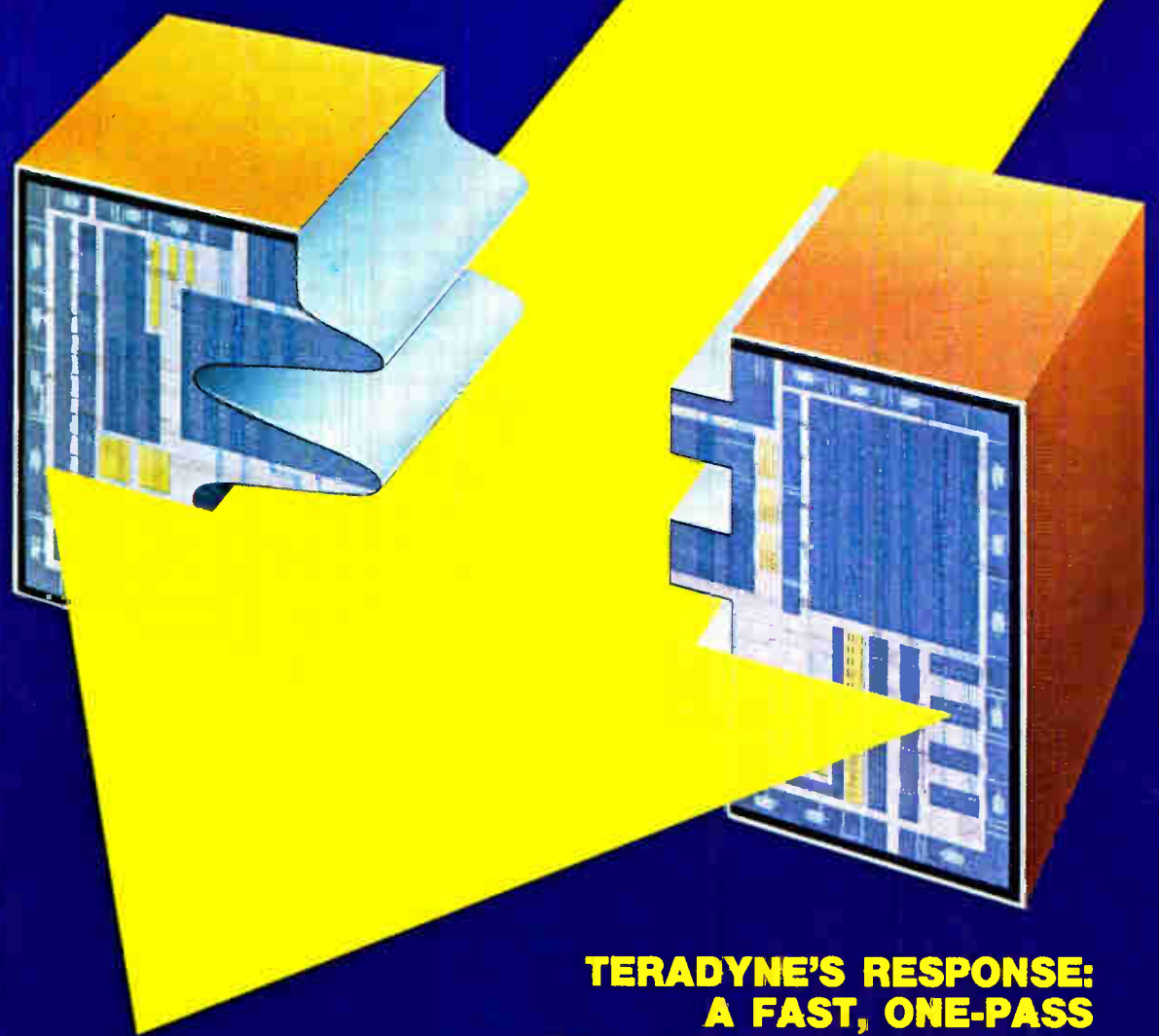
A McGRAW-HILL PUBLICATION

SIX DOLLARS

Electronics®

CAN TESTERS CATCH UP WITH COMPLEX CHIPS?

PAGE 49



TERADYNE'S RESPONSE: A FAST, ONE-PASS ANALOG-DIGITAL IC TESTER

PAGE 55

National Semiconductor

"This isn't going to be easy."

"And because we had the edge from the very beginning."

"Who else offers a true 32-bit microprocessor supporting Ada over the full temp range with rad hardening?"

"The important ones never are. But that's why we won the bid — because we can make the tough decisions."

"You mean the Military Series 32000?"

"No one. That's why National was the easiest part of the decision."

Military Series 32000. When there's more at stake than the fate of your product.

The Military Series 32000® is the only complete 32-bit military solution.

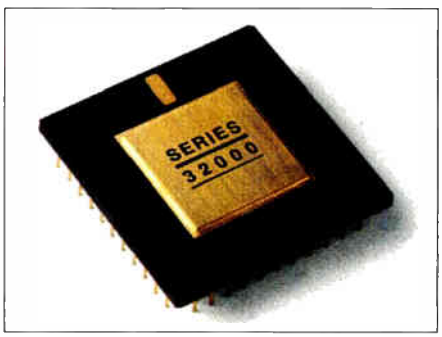
It offers you a rad-hard, JAN, high-performance engine with a full complement of design tools and high-level language support.

Each CPU in the family is 100% compatible with all the other members, so you can migrate your designs to higher performance levels while protecting your software investment.

Each CPU also supports separate floating-point, timing-control, and interrupt-control operations, so you can design exactly the type of advanced system you need.

In today's defense environment, you need the full range of capabilities offered by the Military Series 32000:

Rad-Hard. Sandia National Laboratories selected the Series 32000 over all other 32-bit microprocessors to develop a special CMOS 10^6 radiation-hardened cluster.



Ada.™ The Verdix Ada Development System (VADS™) supports the Series 32000, making it a complete hardware and software package for military applications.

883C. The Series 32000 microprocessor family is designed to comply with MIL-STD-883 Rev. C, including the full temp range of −55°C to +125°C with low-power advanced CMOS fabrication. And, for early prototyping, National has implemented its unique Military Screening Program (MSP), a rigorous new-device testing program that ensures you of fast delivery of high-pedigree devices.

38510. The Series 32000 is also the only 32-bit microprocessor to be selected under a contract from RADC to Boeing Aerospace for characterization of MIL-M-38510 JAN slash sheets.

Which means that *every* 32-bit microprocessor intended for military applications will have to measure up to the Series 32000.

So why trust your design to a microprocessor that has to *meet* the standard — rather than the one that has *set* the standard?

You can't afford to settle for less than the Series 32000. Because the fate of your product — and possibly the fate of a lot more than your product — is resting on your decision.

So make the right one. Contact National Semiconductor today.

National Semiconductor
Series 32000, MS 23-200
P.O. Box 58090
Santa Clara, CA 95052-8090

National Semiconductor

Circle 1 on reader service card

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- Minimum wages.
- High compatibility a must!
- Works unsupervised after hours.
- Able to travel.

MITEL CMOS MODEM ICs FIT THE JOB!

Today's modems must be more durable, smaller and, of course, more cost-effective than before. Mitel fills these requirements with 300 or 1200 bps CMOS modems that meet Bell 103/113 and 212A standards for North American products and also CCITT V.21 and V.22 standards for international markets.

The MT3530 Monolithic 300 bps Modem
The MT3530 is an ISO²-CMOS ™ single-chip, full duplex, asynchronous, FSK modem. For complete applications flexibility, this IC operates in many modes:

- Auto-Answer/Originate modes for smart modem applications.
- Manual mode for stand-alone RS-232C modem applications.
- Pass-through mode for protocol independence.
- Test mode for analog and digital loopback.

This IC has on-chip transmit and receive filters, a 4.8 KHz UART clock output, and is TTL compatible.

The MT35213/212A 1200 bps Modem Set
The MT35213 is a single-chip, full duplex 1200 bps, PSK modem with a 300 bps FSK fallback mode for operating in adverse signal conditions. This IC has a 48 dB dynamic range and has loopback capability in both analog and digital.

The MT35212A Modem Filter uses switched capacitor techniques to implement both the filtering and equalization requirements of Bell 212A and CCITT V.22 modems. For CCITT V.22 applications, this device supplies a notch filter that provides selectable 1800 or 550 Hz rejection. This IC offers on-chip answer/originate mode selection and includes half-channel compromise amplitude and group delay equalizers; two uncommitted op amps can be used for anti-alias filtering.

These parts are available in plastic or ceramic dual-in-line packages. Contact your local Mitel sales office for further information.

Circle 2 on reader service card

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Electronics

PUBLISHER'S LETTER

For most of us, the period from about the middle of December to Jan. 1 means the holidays: first the hustle and bustle of preparing for them, and then the enjoyment of extra time away from the job to spend with family and friends. But for a group of hard-working *Electronics* editors, that fortnight also brings with it extra pressure-filled hours and days of work on our two big market reports.

Now that both have appeared—the domestic report on Jan. 8 and the overseas one in this issue on p. 65—all involved can take a deep breath and catch up with some of the business of everyday life that had to be put off as both 24-page features were researched, written, edited, and sent to the printer.

For market reports, hard work pays off

The results are worth the work. Amid the clutter of January forecasts and economic reviews of every size and shape that fills not only the lay press but the electronics magazines and tabloid newspapers, we like to think ours stands head and shoulders above the rest. As telephone callers and letter writers tell us, it is still the leader, the one most sought after and quoted by the electronics industry's decision makers. No other publication spends the time and money to collect its own figures and solicit the views of so many industry people in the process. Nor does any other publication submit the results to such rigorous review and painstaking editing.

It would be easy simply to borrow the figures that are circulated at this time of the year by a wide variety of forecasters, repackage them, and print them—that's what our competitors do. But we feel that the responsibility we have assumed during 30 years of market forecasting means our cadre of experienced editors must make sure that the reputation of *Electronics* continues to mean accuracy and authoritativeness.

So in order to achieve that accuracy in the overseas report, executive news editor Art Erikson—a man who spent 18 years covering Europe for *Electronics* before returning to headquarters five years ago—spent the month of November on the Continent collecting figures and interviewing company chiefs in London, Eindhoven, Paris, and Milan. Says Art, "We couldn't cover the whole continent, but we got the whole picture."

Helping to fill in that picture were our European bureau chiefs, Steve Rogerson in London and John Gosch in Frankfurt, as well as Lois Bolton of McGraw-Hill World News in Milan. Then Art, back in New York, formulated the European tables and put together the articles that go with them.

At the same time, our man in Tokyo, Charlie Cohen, was roaming Japan and talking to industry leaders there. He was aided by Mike Berger, McGraw-Hill World News' Tokyo bureau chief. Their reporting was pulled together in New York by assistant managing editor Howard Wolff, who also put together the Japanese statistics.

Laurence Altman

January 22, 1987 Volume 60, Number 1
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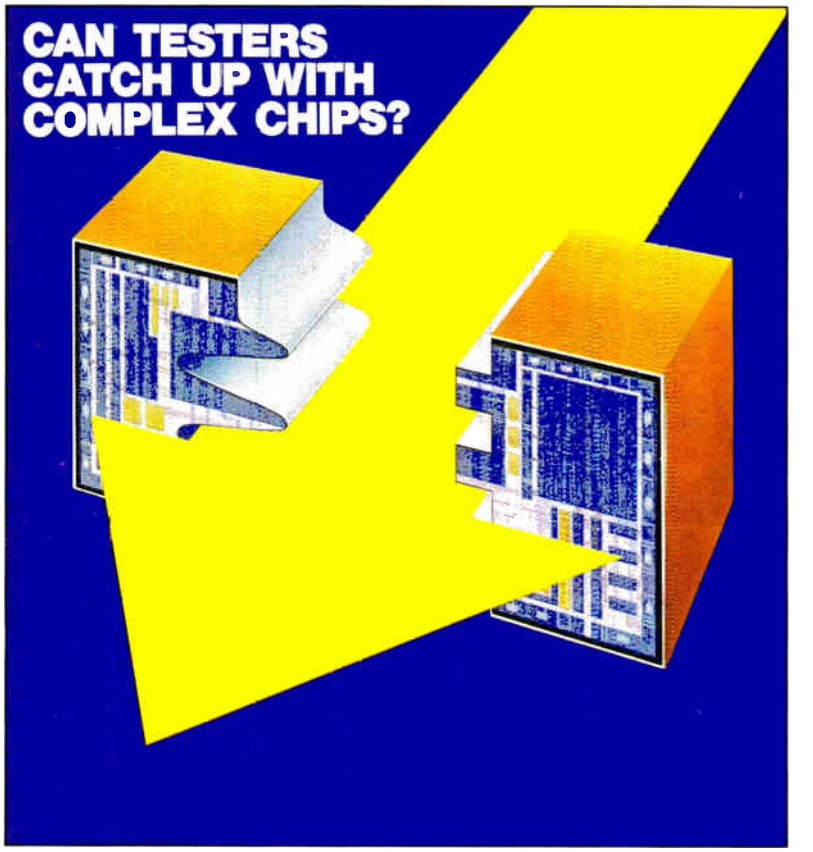
JANUARY 22, 1987

Electronics

NEWS

INSIDE TECHNOLOGY

COVER: DAVID MYERS



PAGE 49

NEW PRODUCTS

DEPARTMENTS

MOTOROLA

HDS-300

Emulate in real time. Debug in record time.

Supercharge your system design with industry's most powerful development system.

If you've just designed-in the industry-leading MC68000/010/020 family of 16/32-bit processors, we can help you slash development time and get your product to market in record time.

The new Motorola HDS-300™ Hardware/Software Development Station can give you this important edge. It simplifies and speeds up debugging and testing of your MPU hardware and software. When used with an appropriate host, the HDS-300 station can also provide the new *source-level debug* to reduce development time still further.

8-, 16- and 32-bit emulation & analysis

The HDS-300 development station is your ultimate emulation and analysis tool for system designs based upon Motorola's 8-, 16- and 32-bit families. It supports development of systems based on the MC68020, MC68010, MC68000, and MC68008 as well as the MC6801/03, MC6809, MC68HC05C4/C8 and MC68HC11 microprocessors.

Cost efficiency is achieved with a modular approach which permits you to utilize the basic HDS-300 station with any in a series of available emulator modules.

An array of labor-saving features includes real-time emulation to 25 MHz, coprocessor support, system performance analysis, and the unique ability to perform "C" language source-level debugging.

Powerful analysis/debugging capabilities, precise duplication of the application system configuration, and accurate, real-time, zero wait-state emulation generate great system-development versatility.

Source-level approach enables high-level language debug.

HDS-300 source-level debug capability allows debugging of user code at the "C" statement level rather than the machine or assembly language level. And, debugging is enhanced with break-points and other references made using labels, variable names, or statement numbers of the source code. Debugging is faster, since the familiar name of the variable can be used and the value of the variable is presented in the same type as the variable is declared. The emulator in mixed mode can also break "C" statements down to assembly language for even closer code inspection and debug.

Host options are available.

The complete HDS-300 system includes a host, system hardware-development station and an emulator for the specific M68000 family processor in your target system. Available options include:

- **PC/68000™ Coprocessor**
  A coprocessor board with UNIX® SYSTEM V/68™ system software which plugs directly into an IBM-PC (or true hardware equivalent).
- **VMEsystem 1131™DVLP**
  A 32-bit microcomputer and software package based on VMEbus architecture and UNIX SYSTEM V/68, suitable for up to 8 users.

Host-independent instrumentation.

The HDS-300 station looks like a simple asynchronous ASCII terminal to the host computer when in stand-alone operation, so the connection is common and convenient for most host systems. The HDS-300 control station provides a host-independent vehicle to support the emulator and provide a common user debug interface. This same friendly interface is provided across the complete family of emulators. The time you save here, alone, can substantially reduce time-to-market for your new design.

UNIX SYSTEM V-hosted support.

Motorola provides a variety of cross-support software operating under the SYSTEM V/68 operating system. The supported hosts currently include the IBM-PC using our PC/68000 coprocessor module and the new SYS1131DVLP VME-based system.

One-on-one design-in help.

Get an engineer-to-engineer update on the HDS-300 Hardware/Software Development Station. Call toll-free,

1-800-521-6274

any weekday, from 8:00 a.m. to 4:30 p.m. MST from anywhere in the U.S. or Canada.

Or, for additional information, fill out the coupon and send it to Motorola Semiconductor Products, Inc., P. O. Box 20912, Phoenix, Arizona 85036.

We're on your design-in team.

MOTOROLA

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To: Motorola Semiconductor Products, Inc., P. O. Box 20912, Phoenix, AZ 85036

Please send me technical information on Motorola's HDS-300 Development Station and real-time emulator modules.

313ELEX012287

Name _____

Title _____

Company _____

Address _____

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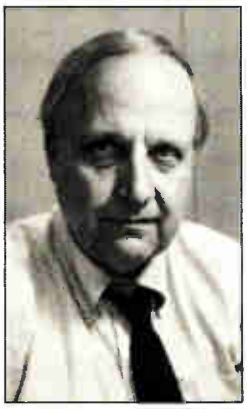
Call me (_____) _____

FYI

We aren't totally against the semiconductor manufacturing consortium, yet there are several issues that need to be kept in mind while dreaming of this white-knight project



Whether it's a dynamite new idea or just another bad one, the semiconductor manufacturing consortium is moving ahead. One stumbling block—where to get the money—seems likely to be solved by the new House and Senate. Democrats, anxious to add constituents and looking ahead to the Presidential elections, will likely move quickly to support the Pentagon project. We aren't totally against such an idea, yet there are several issues that need to be raised and kept in mind while dreaming of this white-knight consortium. First, U.S. chip makers don't have a good record when it comes to cooperation. Look at all the second-source and joint development partnerships that never lived up to their hype. They involved only two chip makers, so you can imagine the problems that a dozen firms would have working together.

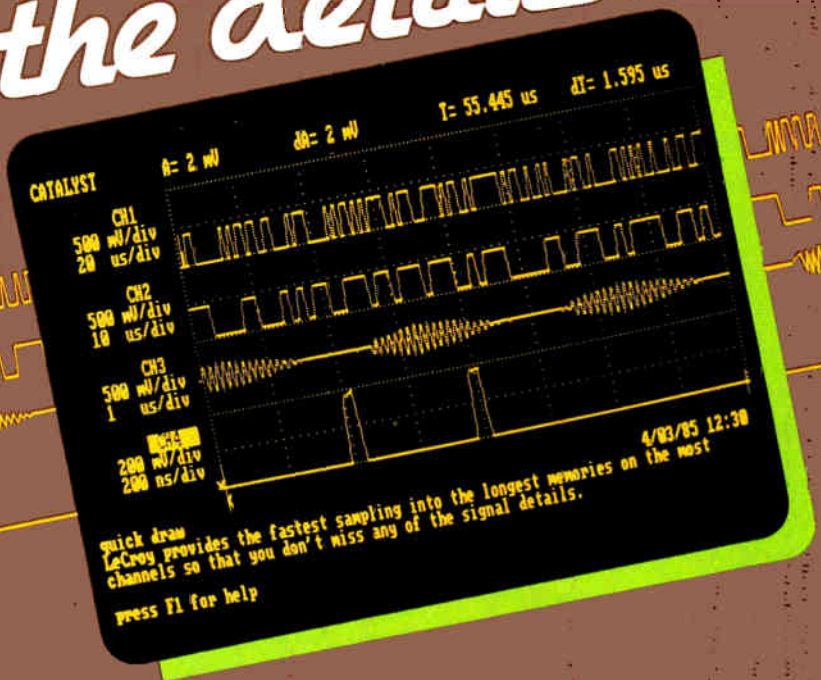
Deciding exactly what the consortium will do is not a trivial matter. Will it make DRAMs—if so, for what reason? Develop the next-generation process for logic? Make a profit? Both goals require high volumes, and the consortium would end up competing with other U.S. makers. Where do you draw the line on what companies can benefit from a U.S. chip consortium? Is the aim to beat back the Japanese? Would that include Fairchild? What about Texas Instruments, which would probably use any technology in its Japanese plants?

Getting such a consortium to work "is going to be very difficult," declares Bobby Inman, former chief of the Microelectronics & Computer Technology Corp. (see p. 29). Success will not come until technology is handed off to commercial houses. And this requires real expertise—officials at MCC say it has been the chip R&D co-op's biggest problem.

The military connection also worries people. Not too long ago, the Pentagon yanked papers out of conferences to stop the transfer of technology offshore. What will keep it from blocking the flow of information once the military-backed consortium starts building advanced parts? Inman worries that the project could backfire and turn U.S. chip making into a captive segment of the defense business. Finally, is the U.S. putting all of its eggs in one basket? Until now, most every company raced to develop a better process of its own to gain a competitive edge. There is something to be said for that kind of redundant R&D effort. After all, that's what gave the U.S. its chipmaking leadership in the first place.

ROBERT W. HENKEL

Don't miss the details!



Let LeCroy help you make sure you capture all the detail of every signal every time with WAVEFORM-CATALYST PC-Based Multichannel Oscilloscope

- The Fastest Sampling ... to 200 megasamples/sec
- Into The Longest Memories ... 8K to 2M samples
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Circle 10 for information

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16K CMOS SRAMs	
Device	Access Times
IMS1403 (x1) IMS1423 (x4)	20, 25, 35, 45ns 25, 35, 45ns

64K CMOS SRAMs	
Device	Access Times
IMS1600 (x1) IMS1620 (x4) IMS1624 (OE, x4) IMS1630 (x8)	35, 45, 55ns 35, 45, 55ns 35, 45, 55ns 45, 55, 70ns

LOW POWER DATA RETENTION CMOS SRAMs		
Device	Access Times	Idr*
IMS1403L (x1)	25, 35, 45ns	0.5µA
IMS1601L (x1)	45, 55, 70ns	10µA
IMS1620L (x4)	45, 55, 70ns	10µA
IMS1624L (OE, x4)	45, 55, 70ns	10µA

All above products are available in MIL-STD-883C. *Idr = Typical Icc at 2V at 25° centigrade. inmos, and iMS are trademarks of the INMOS Group of Companies.

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Circle 11 on reader service card

MEETINGS

NEPCON West, Cahners Exposition Group (1350 East Touhy Ave., P.O. Box 5060, White Plains, Ill. 60017), Anaheim Convention Center, Anaheim, Calif., Feb. 24-26.

IEEE International Solid-State Circuits Conference, IEEE Solid-State Circuits Council, *et al.* (345 East 47th St., New York, N.Y. 10017), New York Hilton, New York, Feb. 25-27.

Santa Clara Symposium on Microlithography, SPIE (P.O. Box 10, Bellingham, Wash., 98227-0010), Santa Clara, Calif., March 1-6.

Spring National Design Engineering Show, Banner & Greif Ltd. (110 East 42nd St., New York, N.Y. 10017), McCormick Place, Chicago, Ill., March 2-5.

APEC '87 Applied Power Electronics Conference, IEEE Power Electronics Council (655 Fifteenth Street, N.W., Suite 300, Washington, D.C. 20005), Town and Country Hotel, San Diego, Calif., March 2-6.

DEXPO Europe '87, Expoconsul International Inc. (3 Independence Way, Princeton, N.J. 08540), Olympia 2, London, March 3-5.

7th Symposium and Technical Exhibition on Electromagnetic Compatibility, EMC Symposium & Exhibition Zurich (ETH Zentrum-IKT, 8092 Zurich, Switzerland), Swiss Federal Institute of Technology, Zurich, March 3-5.

Laserobotics 2, Society of Manufacturing Engineers (One SME Drive, P.O. Box 930, Dearborn, Mich. 48121), Michigan Inn, Southfield, Mich., March 3-5.

Second International Conference on CD ROM Technology, Microsoft Corp. (16011 NE 36th Way, Box 97017, Redmond, Wash. 98073-9717), Seattle Sheraton Hotel & Towers, Seattle, Wash., March 3-5.

COMDEX in JAPAN '87, The Interface Group Inc. (300 First Ave., Needham, Mass. 02194), Harumi Exhibition Center, Tokyo, March 3-5.

Hannover Fair-CeBIT '87, Hannover Fairs USA Inc. (103 Carnegie Center, P.O. Box 7066, Princeton, N.J. 08540), Hannover Fairgrounds, Hannover, West Germany, March 4-11.

Automated Manufacturing Computers, Communications & Controls, Frost & Sullivan Inc. (106 Fulton St., New York, N.Y. 10038), Don Cesar Beach Resort, St. Petersburg, Fla., March 9-10.

Federal Computer Graphics Conference and Exposition, National Trade Productions Inc. (2111 Eisenhower Ave., Suite 400, Alexandria, Va. 22314), Washington Convention Center, Washington, D.C., March 9-12.

1987 Pittsburgh Conference & Exposition, The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy Inc. (12 Federal Drive, Suite 322, Pittsburgh, Pa. 15235), Convention Center, Atlantic City, N.J. March 9-13.

Semicon Europa '87, SEMI (625 Ellis St., Suite 212, Mountain View, Calif. 94043), Zuspa Convention Centre, Zurich, Switzerland, March 10-12.

AES '87, Audio Engineering Society (60 East 42nd St., New York, N.Y. 10165), Queen Elizabeth II Convention Center, London, March 10-13.

Fourth Topical Meeting on Optical Data Storage, IEEE Lasers and Electro-Optics Society, *et al.* (Optical Society of America, 1816 Jefferson Place, N.W., Washington, D.C. 20036), Harvey's Lake Tahoe, Stateline, Nev., March 11-13.

International Switching Symposium 1987, IEEE Communications Society and the IEEE Phoenix Section (445 Hoes Lane, Piscataway, N.J. 08854), Phoenix Civic Plaza, Phoenix, Arizona, March 15-20.

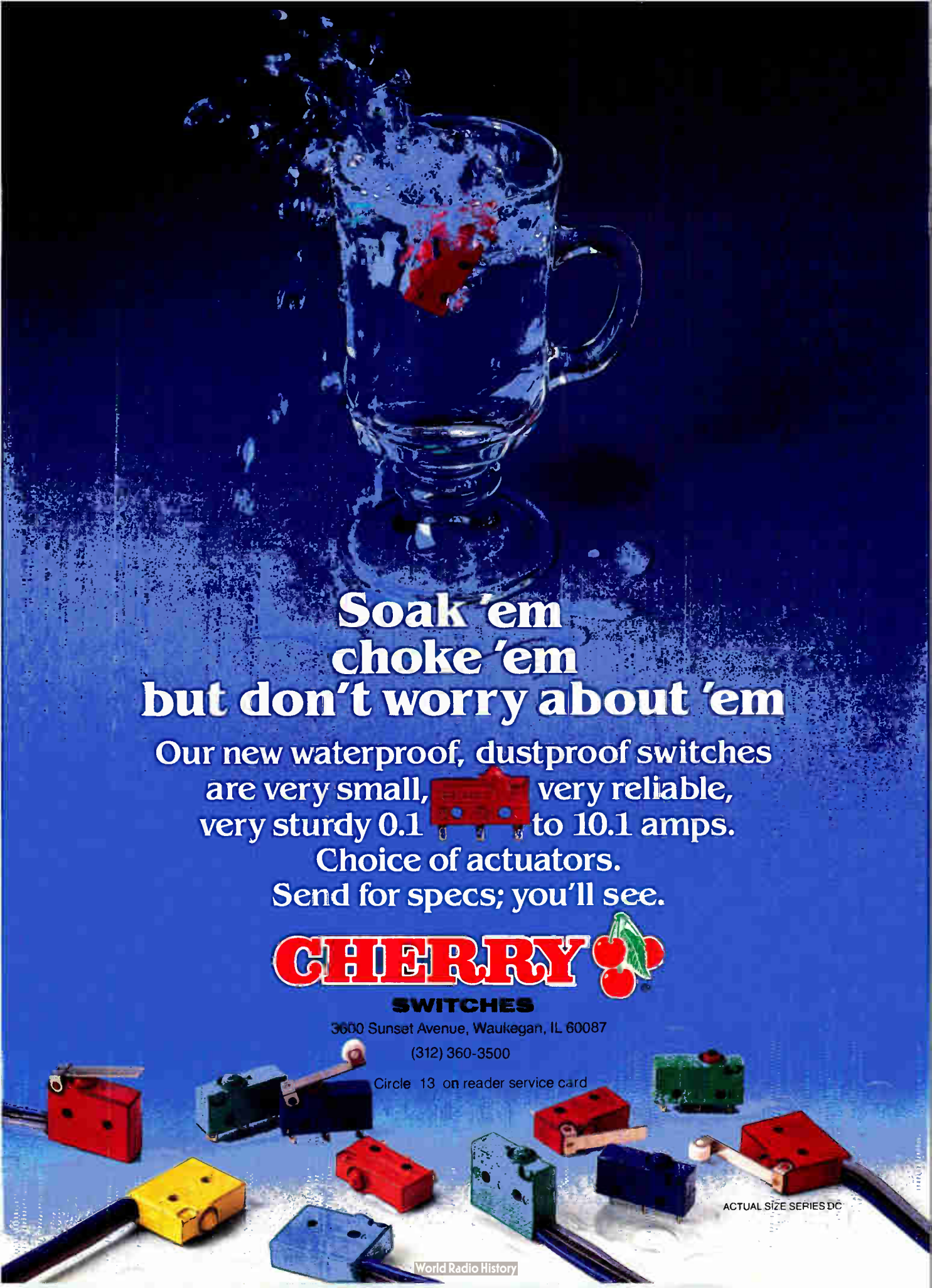
MFOC-87 The First International Military Fiber Optics and Communications Exposition, Information Gatekeepers Inc. (214 Harvard Ave., Boston, Mass. 02134), Hyatt Crystal City, Washington, D.C., March 16-19.

Defence Asia '87, CEMS (1 Maritime Square #09-15, World Trade Center, Singapore 0409), Bangkok International Exposition Centre, Bangkok, Thailand, March 18-22.

CASA/SME's Seminar, Computer and Automated Systems Association of SME (One SME Drive, P.O. Box 930, Dearborn, Mich. 48121), Chicago, Ill., March 23-25.

Lasers in Manufacturing: SPOT '87, Society of Manufacturing Engineers (One SME Drive, P.O. Box 930, Dearborn, Mich. 48121), Biltmore Hotel, Los Angeles, Calif., March 23-26.

Stanford Conference on Advanced Research in VLSI, Stanford Center for Integrated Systems (Stanford University, Stanford, Calif. 94305), Room 110, Stanford, Calif., March 23-26.



One reason Sharp components are found in so many different products is that there are so many different Sharp components. Over 2000, in fact.

And if we don't already have exactly what you need, we'll work with you to custom-design it.

Of course, the quality of our components has a lot to do with our success. You don't get to be one of the world's leading component suppliers unless your products help your customer's products earn a reputation for reliability.

And you don't keep growing in today's

SOME OF THE BEST RE SHARP COMPONENTS A AROUND YO

Is there a computer in your office? *Then chances are you know our components, since a number of major computer manufacturers use them.*

Opto: *Sharp is one of the largest manufacturers of photocouplers, photointerrupters, solid-state relays, rotary encoders and photodiodes.*

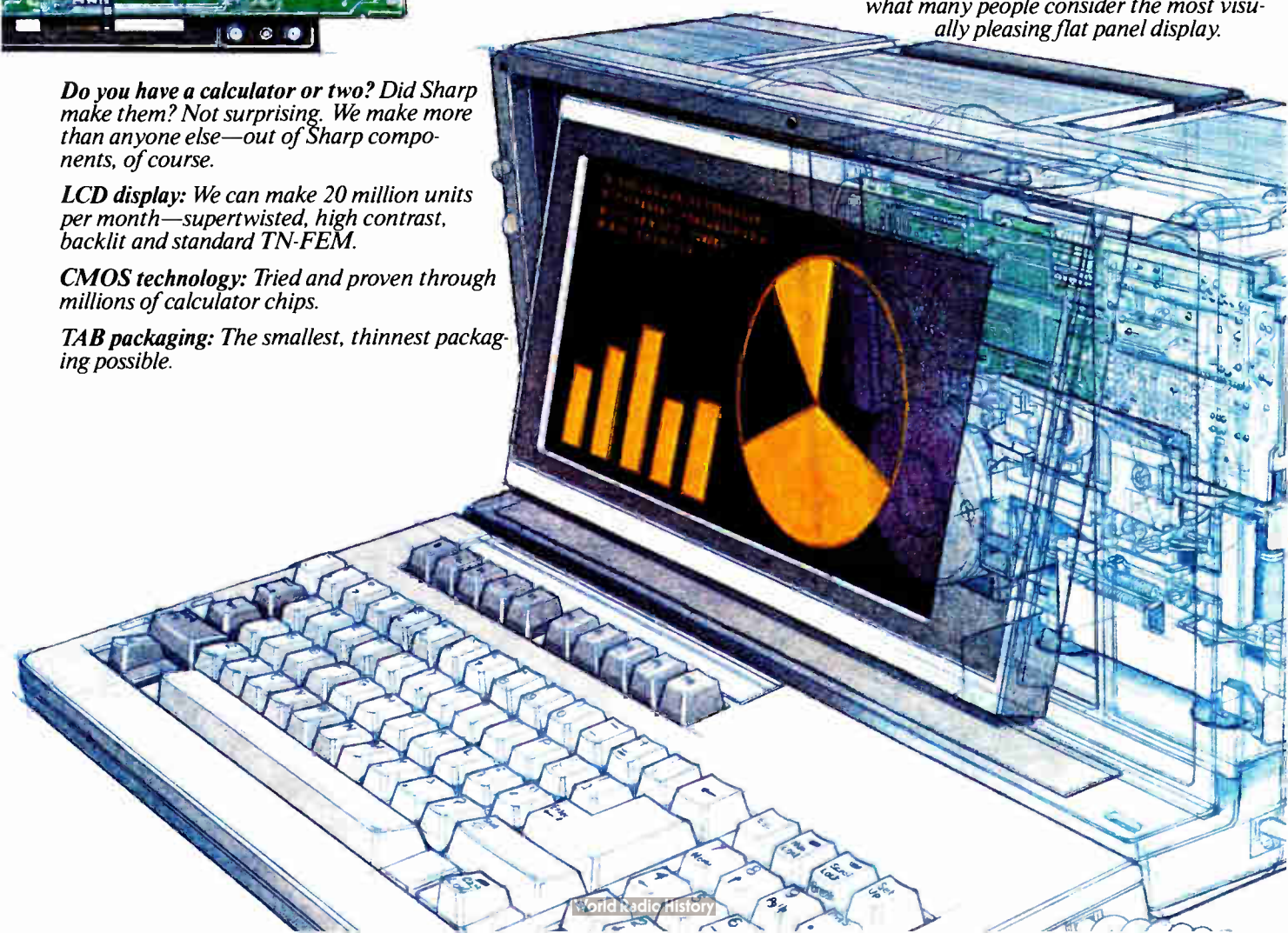
EL display: *We're the #1 manufacturer of what many people consider the most visually pleasing flat panel display.*

Do you have a calculator or two? *Did Sharp make them? Not surprising. We make more than anyone else—out of Sharp components, of course.*

LCD display: *We can make 20 million units per month—supertwisted, high contrast, backlit and standard TN-FEM.*

CMOS technology: *Tried and proven through millions of calculator chips.*

TAB packaging: *The smallest, thinnest packaging possible.*



market unless you have the technological advances the market's asking for.

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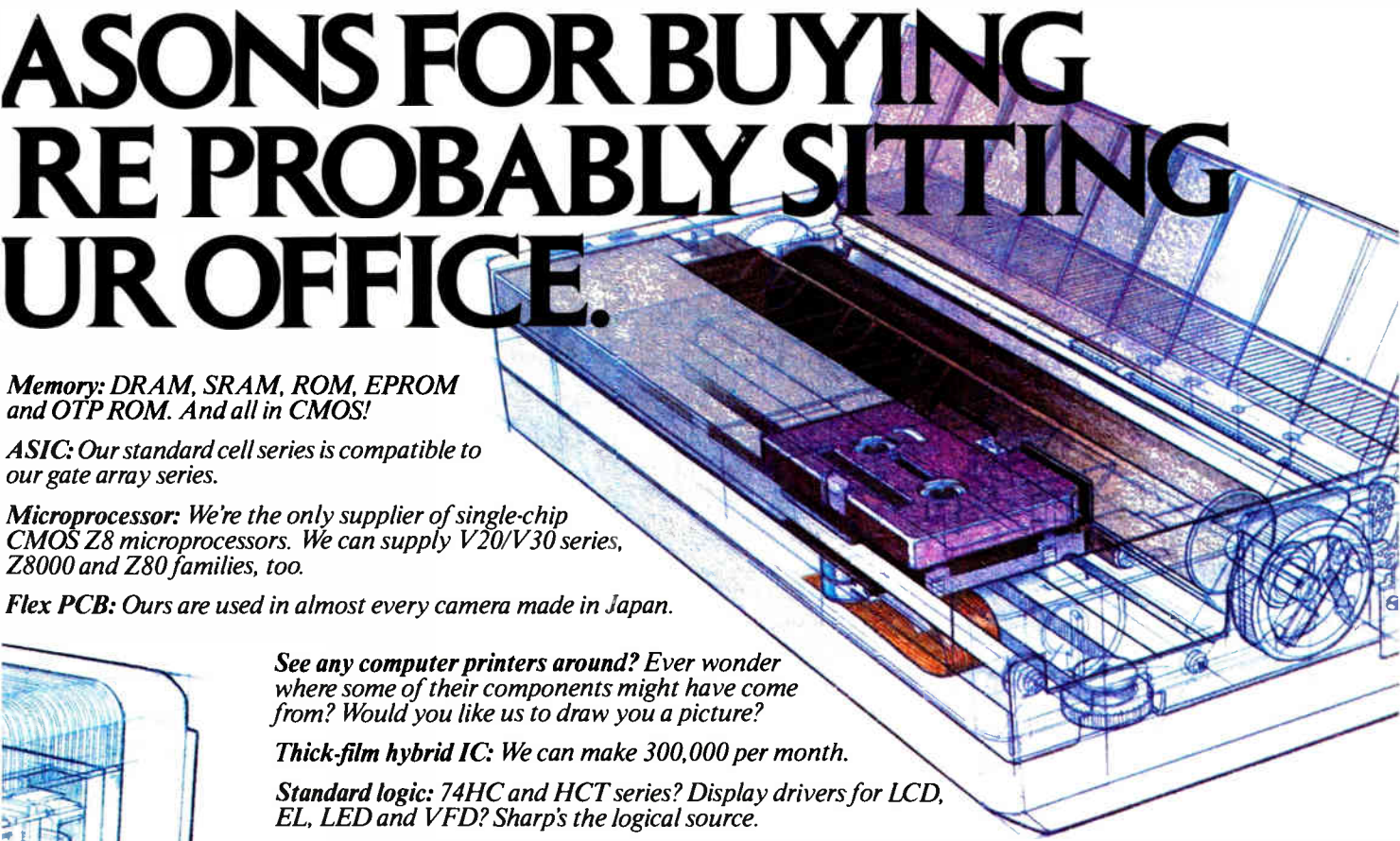

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HÖFFLINGER, WHO'S DONE IT ALL, TO RUN R&D SHOP

STUTTGART, WEST GERMANY

Bernd Höfflinger is one of a rare breed in electronics: he made his mark in both the contemplative environment of university research and administration and in the rough-and-tumble world of company management. As a researcher, he invented the ion-implanted n-well technology in 1977 that makes CMOS compatible with bipolar techniques; as an administrator, he established university departments and laboratories on both sides of the Atlantic; and as a manager, he set up a corporate product division in West Germany.

Now back in his native West Germany after several sojourns in the U. S., Höfflinger faces perhaps the biggest and most interesting challenge of his career: heading the Institute for Microelectronics Stuttgart, a public institution dedicated to applied research. Although it only opened last November, the institute already ranks among the largest of its kind.

HÖFFLINGER. The challenge is getting everyone to work together.

Höfflinger says that the $50 million facility, financed by the government of the state of Baden-Württemberg, is on the same level in terms of initial investment and full-time staff as the Stanford Center for Integrated Circuits in Palo Alto, Calif.; the Microelectronics Center of North Carolina in Research Triangle Park, N. C.; and a similar center in Leuven, Belgium. Its staff of 54 microelectronics experts will eventually grow to 80.

But unlike its counterparts in the U. S. and elsewhere whose raison d'être is primarily basic research or education, the Stuttgart institute concentrates on prototyping application-specific integrated circuits, mainly for small- and medium-sized companies. It develops, lays out, and simulates ASICs and paves the way toward a production agreement between the chip maker and its customers. More than 70 electronics companies already have agreed to support the institute by granting contracts and providing counseling and services.

WORKING TOGETHER. The greatest challenge of his job, Höfflinger says, "is trying to get industry, research, and government to work together in a common effort." In the U. S., he adds, "we have learned how important such cooperation is. We want to promote it [in West Germany]." What also drives the institute and its director is the opportunity to help small systems makers sharpen their competitive edge in international markets with products using advanced electronics.

Höfflinger, 47, has all the credentials for running an electronics institute. He earned his doctoral degree in physics from the Technical University in Munich in 1967, and after a three-year stint as an assistant professor at Cornell University he helped launch the MOS circuits department at Siemens AG in Munich. In 1972 he founded the electrical engineering department at the University of Dortmund in West Germany.

His other activities in the U. S. have included a half-year sabbatical with the Electronics Research Laboratory at the University of California at Berkeley, and two years as head of the department of electrical engineering at the University of Minnesota, where he helped expand the Microelectronics and Information Sciences Center. In 1984, he became head of the school of electrical engineering at Purdue University, where he set up VLSI and optics laboratories.

Among the many prizes he has received is a share of the 1980 Darlington Prize, awarded by the Institute of Electrical and Electronics Engineers' Circuits and Systems Society for his work on switched-capacitor filters.

2 MICRONS BY MARCH. Höfflinger has definite ideas on where, technologically, he wants to take his institute. The timetable is to introduce ASICs with 2-μm lines and more than 100,000 transistors by March. One-micron devices with more than half a million transistors are planned for 1988. Eventually, the institute will be able to prototype 1-million-transistor chips.

The area of ASICs holds the greatest opportunities for growth for the European electronics industry, Höfflinger notes. "In close cooperation with systems makers, we must strengthen our capabilities, before American and Japanese producers take over still another field in microelectronics." *–John Gosch*

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Now, Silicon Systems has achieved a major technological breakthrough with the SSI K222L. This high-performance 1200 bps, single-chip modem IC requires only a single +5 volt supply and dissipates less than 40mW of power.

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The K222L makes possible a variety of new applications. It is ideal for low-power, low-voltage modems; battery-powered, portable modems; power-sensitive laptop PC's; and telephone-line-powered modems—or any application where space and power is at a premium.

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For more information on the K222L, or the other K-Series modem IC's, contact: **Silicon Systems,** 14351 Myford Road, Tustin, California 92680, phone: (714) 731-7110, Ext. 575.

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ELECTRONICS NEWSLETTER

TI WILL GET DRAM ROYALTIES ON A PER-UNIT BASIS

In a highly unusual settlement, Fujitsu Ltd. and Sharp Corp. have agreed to pay Texas Instruments Inc. royalties on a per-chip basis for dynamic random-access memories. The agreements are the first to arise out of a series of federal suits and trade complaints that TI filed a year ago against nine Asian DRAM makers [*Electronics*, Feb. 3, 1986, p. 19]. In effect through 1990, the settlements mark a rare twist in the otherwise common business of cross-licensing chip technology. Such pacts usually entail a fixed payment to the holder of the stronger patent portfolio, after which the companies swap rights to each other's technology. But Fujitsu and Sharp agreed to pay TI a per-unit fee in addition to fixed "significant royalty payments," the Dallas chip maker says. Analysts believe the per-unit clause may strengthen TI's competitive position against Asian manufacturers, but few are sure what impact, if any, the royalties will have on overall market prices. □

A NEW BREED OF FUNCTION-SPECIFIC CONTROLLERS IS COMING

A new breed of function-specific controllers will emerge this spring from a technology agreement between two California firms: Altera Corp. of Santa Clara and Waferscale Integration Inc. of Fremont. The deal mixes Altera's 2910-based microsequencer architecture with WSI's proprietary split-gate erasable programmable read-only memory process, a method of building fast, high-density EPROMs. Altera also gains access to the 1.2-m CMOS technology WSI gets from Sharp Corp. WSI will include parts of the new joint products in its semicustom-cell library. Altera president Rodney Smith says the products will be user-configurable and will be tailored for specific functions, such as custom processors, state machines, or stand-alone controllers. □

BOOK-TO-BILL IS UP, BUT DON'T HOLD YOUR BREATH

Don't expect a spectacular rebound in the semiconductor industry to follow the surprisingly strong jump, from 0.99 to 1.08, in the December book-to-bill ratio. Orders and shipments to the U. S. market were both up in December, and the ratio climbed past 1.0 for the first time since June. But even the usually optimistic Semiconductor Industry Association, which released the figures, referred cautiously to an "apparent improvement" in business conditions. Analyst Mel Phelps of Hambrecht and Quist Inc. says the upturn had been expected. "I think it will continue in January," Phelps says, "but bookings won't increase dramatically, so the book-to-bill may actually decline." According to Adam Cuhney, of Kidder Peabody Inc., the increase results from new business in microcomputers. "It's not a cyclical or technical upturn," Cuhney says. "It's a segmented market and is not beneficial to the industry as a whole." □

BATTELLE SEEKS PARTNER TO DEVELOP DEPTH COMPUTER FOR DIVERS

Battelle Memorial Institute, Columbus, Ohio, is looking for a partner to help develop a commercial version of a wristwatch-sized amphibious computer for deep-sea divers. Battelle's prototype relies on an off-the-shelf CMOS microprocessor and associated circuitry built into a 1.5-in. hybrid circuit; in addition, the unit has a numeric display and a pressure sensor that can measure the depth of a dive with an accuracy of ±2.5 ft down to a depth of 300 ft. The dive computer also keeps track of elapsed time underwater, and it is equipped with software that can help divers maintain a controlled ascent rate in order to avoid aeroembolism, commonly known as "the bends." Battelle says a commercial version costing less than $1,000 could be developed within two years. □

ELECTRONICS NEWSLETTER

A COMEBACK FOR JET PROPULSION LABS

The Jet Propulsion Laboratory is getting a new lease on life with the establishment of a Center for Space Microelectronics Technology at its Pasadena, Calif. site. The new center ensures that JPL, which pioneered in the development of equipment for U. S. space activities, will continue to play a major research role for space applications. The lab's space research has suffered in recent years as government funding has flagged, but the new center is benefiting from renewed interest in space spurred by the Strategic Defense Initiative. Scheduled for completion early next year at a cost of about $9 million, the center will do research and development work for both the National Aeronautics and Space Administration and the Defense Department. Officials say all work conducted there will be unclassified. □

HIGH-PURITY ALUMINUM HELPS REDUCE SOFT ERRORS IN VLSI DYNAMIC RAMs

As the densities of dynamic random-access memories continue to increase, so do chip makers' problems in getting sufficiently high-quality RAM materials so they can avoid the soft errors and malfunctions that impurities can cause. Materials Research Corp. is trying to fill that need with its high-purity Ultramarz aluminum, one of several high-purity materials the Orangeburg, N. Y. company is bringing to market. The aluminum was developed primarily for use in contacts and interconnections in high-density DRAMs and is guaranteed to be 99.9995% pure. The material is particularly free of traces of thorium and uranium, elements that, when exposed to radiation, can emit alpha particles that can cause soft errors in highly integrated devices. An independent materials analyst, the Atomic Energy Research Laboratory at the Musashi Institute of Technology in Kawasaki, Japan, says Ultramarz aluminum has less than 0.1 parts per billion of the radioactive elements, roughly one tenth of the maximum allowable level for 256-K DRAMs. □

SUPPLIER FORECASTS WINNING YEAR FOR VIDEO-GAME INDUSTRY

Video-game suppliers are hoping that renewed vigor in their market last year will continue as they try to expand the game market. The industry, which boomed to $3 billion in sales in 1982, bottomed out to $200 million in 1985 before rebounding to $300 million last year, say officials at Nintendo of America Inc., a leading player. Nintendo expects a strong 1987, projecting sales of about $600 million for this year. Games aimed at physical fitness and home crafts were among the more interesting items shown at this month's Winter Consumer Electronics Show in Las Vegas, where Bandai America Inc. of Allendale, N. J., unveiled its Family Fun Fitness Program, and Nintendo, of Redmond, Wash., showed a prototype video knitting tool. The fitness program is designed for use with game systems supplied by Nintendo, and the home-knitting machine attaches to the same game system. □

DEC TO DELIVER ANOTHER PRODUCT PUNCH WITH A PRECLUSTERED VAX

High-flying Digital Equipment Corp. is expected to keep up its rapid pace of product introductions this week with a powerful preclustered VAX computer. DEC's clusters, which link groups of minicomputers to provide common disk access for the end user, have played a major role in the Maynard, Mass., company's skyrocketing profits, which jumped 98% in the second quarter ended Dec. 27 to nearly $270 million. DEC says revenue rose 22% to $2.3 billion. Meanwhile, Wang Laboratories Inc., Lowell, Mass., is hoping that a clustering capability of its own, along with a revamped line of minicomputers, and a 25% boost in its sales force will return it to profitability. □

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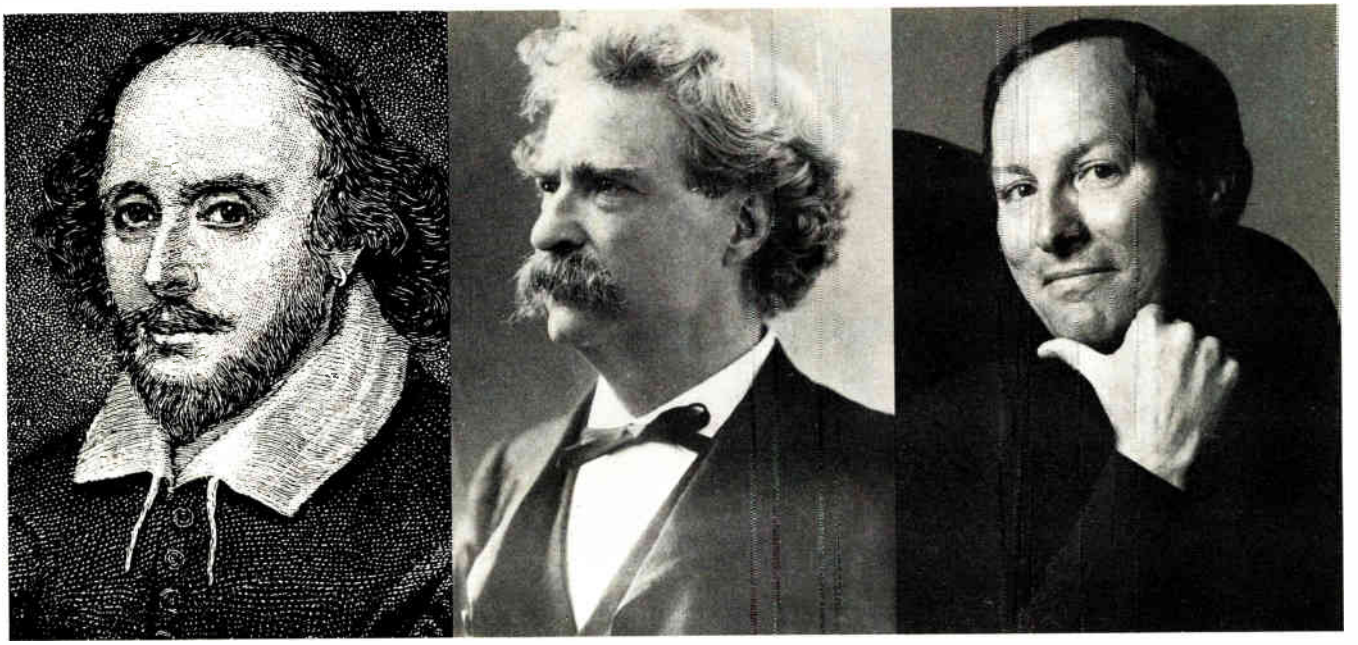

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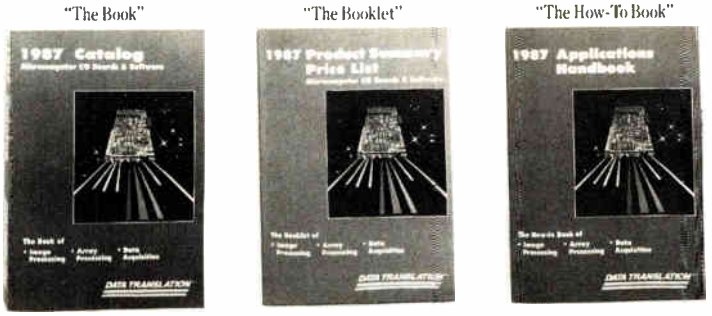

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PRODUCTS NEWSLETTER

INTEL'S $35 CHIP SET HAS HAYES MODEM COMMANDS IN FIRMWARE

Intel Corp. is offering samples of a 2,400-baud modem chip set it claims will drop the resulting modem's retail price to less than $200. The 89024 set puts the Hayes commands in firmware and is priced at $35 in quantities of 25,000. It consists of the 89026 16-bit digital signal processor and the 89027 analog front end for signal filtering [*Electronics,* Jan. 8, 1987, p. 84]. For interfacing the chip set to IBM Corp. Personal Computers and compatibles, Intel has also introduced a universal asynchronous receiver/transmitter, the 82050, which it bills as a replacement for the National Semiconductor 8250. The UART, available in production quantities now, is priced at $4.50 in lots of 10,000. The modem chip set will be in full production by the second quarter of this year, the company says. It will support the V.22bis standard and includes a full set of RS-232-C and V.24 terminal interface signals. The MEK69024 evaluation kit—a fully functioning modem with extra area for breadboarding—is also available, for $395. □

HARRIS BOOSTS INPUT/OUTPUT WITH DUAL VMEBUS IN NEW SUPERMINI

Harris Corp. is using a dual-VMEbus architecture in its new 32-bit superminicomputer to greatly boost input/ouput rates. To be introduced at this week's Uniforum '87 show in Washington, the HCX-9 offers throughput of 40 megabytes/s on each I/O bus—four times faster than Harris's previous high-end offering, the single-Versabus HCX-7. The HCX-9 operates at 8 million instructions/s using the C language or 7.5 million Whetstones/s with Fortran. The 42-inch-high unit can have up to 128 megabytes of physical memory, 4 gigabytes of virtual storage, and more than 17 gigabytes of on-line disk capacity. Priced at $195,500, a basic HCX-9 has a 32-bit processor, an eight-slot VMEbus I/O port, 4 megabytes of memory, an I/O controller with eight serial ports, a C compiler, and a 32-user license for the HCX/UX operating system, based on AT&T Co.'s Unix. Shipments begin in March. □

ATARI UNVEILS A PC CLONE FOR $499—INCLUDING A MOUSE

Atari Corp. has served notice that it covets the business segment of the personal computer market. The company rolled out its first IBM Corp. Personal Computer clone at this month's Winter Consumer Electronics Show in Las Vegas. In the style typical of Jack Tramiel, who took over Atari in 1984, the company is attacking at the low end of the market. The Atari PC will cost $499 for a version that includes a central processing unit, an IBM-style keyboard, a mouse and port, 512-K bytes of memory, and a 5¼-in. floppy-disk drive. Adding a monochrome monitor and built-in support for Enhanced Graphics Adapter operation boosts the price to $699. Both versions of the 8088-based, MS-DOS machine feature switchable clock-speed operation—4.77 and 8 MHz—and will be available in April. Atari plans to add IBM PC/XT- and PC AT-compatible machines later this year. □

STORING 2,300 MEGABYTES OF COMPUTER DATA ON AN 8-mm TV CASSETTE

A mass-storage system that employs an 8-mm videotape drive can store and retrieve up to 2,300 megabytes of data on a standard videotape cassette. Exabyte Corp. claims its EXB-8200 is the first system of its kind. The unit is the same size as a full-height, 5¼-in. floppy-disk drive and comes with a SCSI interface. It reaches a peak transfer rate of 1.5 megabytes/s—and 246-K bytes/s sustained. The tape-cartridge subsystem's error-correcting and recovery capabilities yield a nonrecoverable error rate of less than one for each 10^{13} bits read. The Boulder, Colo., startup will sell the system for less than $1,000 in OEM volumes and will begin shipping in March. □

PRODUCTS NEWSLETTER

ENCORE BOOSTS ITS HIGH-END PROCESSOR PERFORMANCE TO 40 MIPS

Encore Computer Corp. has upped the high-end performance of its Multimax parallel processing systems to 40 million instructions/s by switching to National Semiconductor Corp.'s NS32332 processor. The Marlborough, Mass., company had been achieving processing speeds of 15 mips using National's 32032 processor. Encore emphasizes that the upgrade has been achieved by designing just one new board, which means that owners of the company's earlier Multimax line can go to Multimax 320 systems just by swapping processor cards. Other aspects of the system, such as the Multimax system's proprietary 100-megabyte/s Nanobus and basic architecture, were designed to ease microprocessor upgrades of this type. The Multimax 320 family now ranges from a basic configuration using two microprocessors, which can execute at 4 mips, up to a 20-processor model with 40-mips capability. Also available is a new floating-point accelerator for each processor, providing a top-of-the-line system with the ability to execute 40 million Whetstones/s. Prices for the Multimax 320 range from $131,000 to more than $500,000. Prices have not been established for the system upgrade. All the systems will be available in April. □

SOFTWARE RUNS DOS, UNIX CONCURRENTLY

Workstations based on Motorola's 32-bit 68000 series microprocessors can now run Microsoft Corp.'s MS-DOS and AT&T Co.'s Unix operating systems concurrently. Insignia Solutions turned the trick with Soft PC, a program that emulates IBM Corp. Personal Computer XTs and ATs using 350-K of the work station's main memory. PC Soft reacts at speeds comparable to MS-DOS running on PCs, the company claims. Applications programs can be viewed on separate windows on the Unix host. On 16-MHz work stations, it emulates a PC XT; on 25-MHz machines, a PC AT. Sold through OEMs, PC Soft will cost less than a single-board add-on and will be available in the second quarter of this year. □

UNIX FOR 80386 UNVEILED AT UNIFORUM

An operating system making its debut at this week's Uniforum show in Washington exploits the full capabilities of Intel Corp.'s powerful 32-bit 80386 microprocessor, according to its creators, Interactive Systems Corp., Santa Monica, Calif., and Phoenix Technologies Ltd. in Norwood, Mass. VP/ix combines the standard microcomputer operating system MS-DOS with AT&T Co.'s Unix so that multiple users can run multiple Unix and DOS applications simultaneously on a single machine. Available now to original equipment manufacturers, VP/ix runs on an IBM Personal Computer AT fitted with an add-on 80386 processor. It will cost about $400. Another version that runs on 80386-based systems built from the ground up is also on the way, the companies say. □

ENMASSE TRANSACTION SYSTEM HANDLES UP TO 2,880 USERS

The latest on-line transaction-processing system from EnMasse Computer boosts the maximum capacity of the company's multiprocessor transaction-processing systems from 768 to 2,880 users. By swapping the Motorola Inc. 68010 chips used in earlier models for 68020s, the Acton, Mass., company's new system also hikes processing speeds. The largest configuration incorporates 24 of the more powerful chips and can execute 200 million instructions/s. The entry-level, Unix-V-based ECS2000 system, which can accommodate eight users, costs $29,900, with additional eight-user increments priced at $3,200 each. The ECS2000 is available now. □

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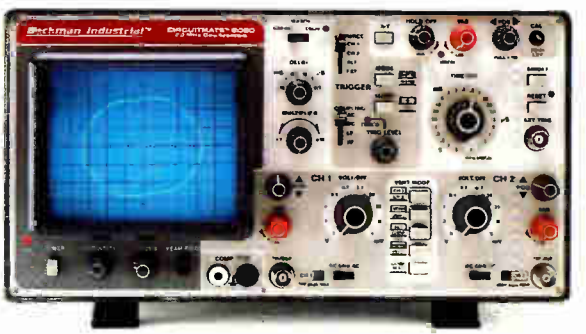
Scopemate 2 compares components known to be good with those to be tested, giving you a very accurate and fast way to identify bad devices. The voltage vs. current plot from a known good device is compared to the device under test. In fact, since there's no complex numerical test data to interpret, Scopemate 2 is ideal for less experienced personnel.

And, at $495 it doesn't take too long to figure that Scopemate 2 may pay for itself in saved testing time. Real soon. Scopemate 2 comes with a simple yet comprehensive operator's manual, a complete set of leads, interconnect cables and plug-in transformer.

Although Scopemate 2 will work with just about any X-Y oscilloscope,



9020 20MHz Delayed Sweep Oscilloscope $495.00

Vertical Accuracy: ±3%
Time-based accuracy: ±3%
Input Impedance: 1M ohm 35pF (2%)
Input Max. Voltage: 400V (DC + pos. peak AC)
Sweep Delay Ranges: 10,1,0.1ms; 10,1,0.1μs
Mode: Normal, search, delay

Beckman Industrial Circuitmate™ Model 9020 offers capabilities seldom found on other scopes costing less than $500.

Proven capabilities such as **delayed sweep** for easy bandwidth analysis, zoom-in for short-duration events, a variable holdoff function for a stable display of non-periodic signals—even beam finding to locate and return trace to view regardless of control settings. And switchable X1/X10 probes give you more sensitivity for low frequency measurements, less circuit loading for high frequency measurements.

Scopemate 2™ IC/Component Tester $495.00

Test Method: Direct Visual Comparison (known good vs. device under test)
Test Sockets/Interface: 20 and 40-pin ZIF IC sockets; banana jacks
Power: 120 or 220VAC, 50/60Hz, 5VA max. (specify)
Circuit Test Voltage/Current: 14VAC RMS (voltage, approx.); 300μA AC RMS (current, approx.)
Pin Test selection: Push-button switch per pin.

For real value, combine the 9020 and Scopemate 2 for performance and flexibility unmatched by systems costing $1,500 or more. For less than $1,000.

Both Scopemate 2 and our Circuitmate Model 9020 illustrate a simple commitment by Beckman Industrial—to provide service test instruments that meet your needs. Whether through advanced technology or value-oriented applications of proven technology, Beckman Industrial gives you the right features at the right price, with service test instruments built to rigorous standards of quality and reliability.

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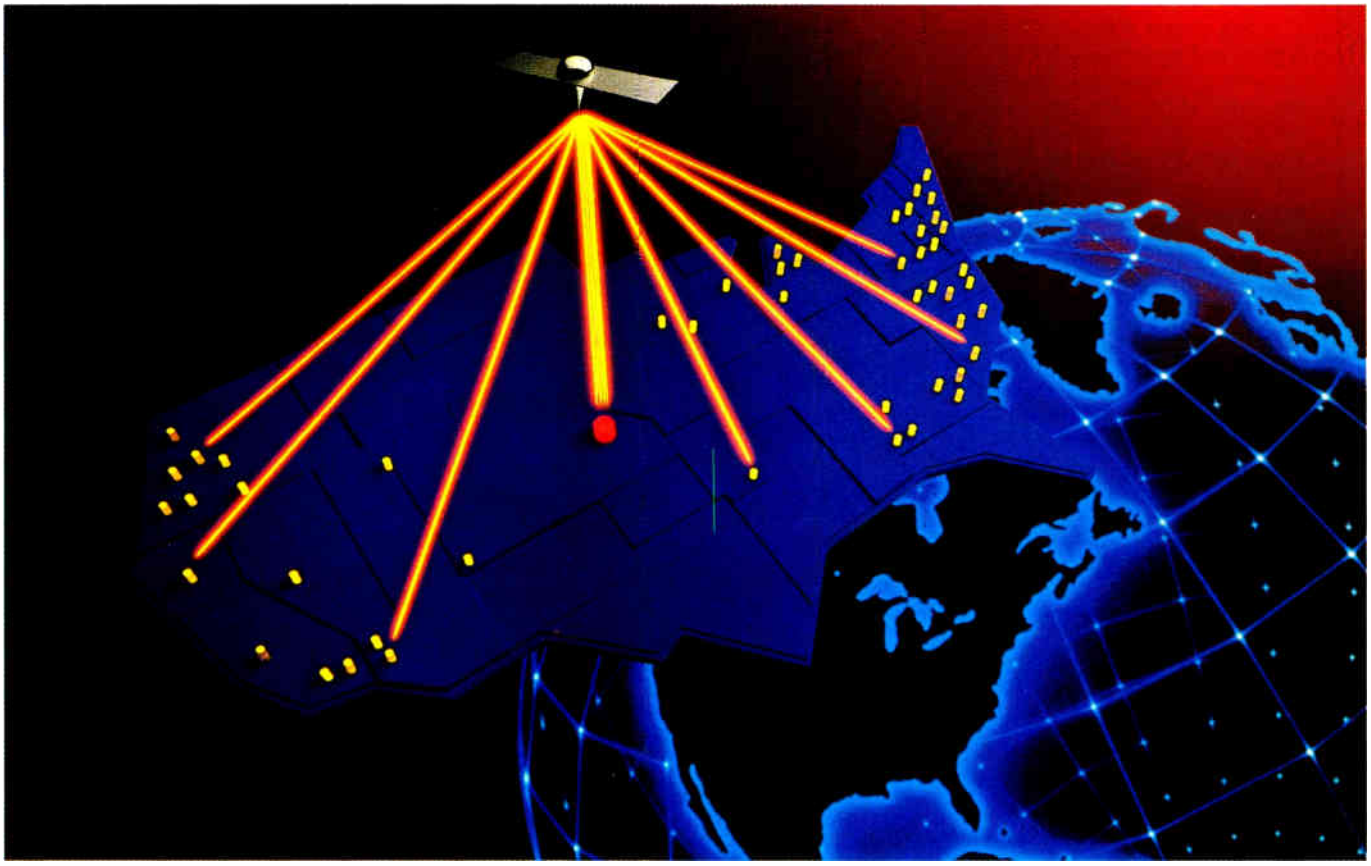
Circle 25 on reader service card



"NEXTAR" MINI EARTH STATION NETWORK.

Private Ku-band satellite communications networks using mini earth stations on customer premises are poised to take off in the US.

Our advanced mini earth station networking system "NEXTAR" offers unprecedented flexibility for transaction-oriented businesses typically using POS, ECR and ATM systems.

The NEXTAR provides interactive data communications between a central hub and many widely-dispersed remote mini earth stations in a "star" network topology. Our exclusive Adaptive Assignment TDMA system automatically assigns the best pathway for each data message to minimize response time for short interactive messages and increase throughput during long batch transmission. NEXTAR transparently interconnects existing remote terminals and the host's front-end processor thanks to its intelligent network features.

The mini earth station, a 1.2 or 1.8m antenna with an integral RF package and compact indoor unit, takes less than a workday to install. Site selection and licensing are also simplified with the Ku-band. The central hub station with comprehensive monitoring, control and diagnostic capabilities can be located adjacent to a data center or at a shared site.

The NEXTAR network can be custom-tailored to a user's exacting needs—data rates from 75bps to 56Kbps plus voice and video capability. It eliminates the wasted transmission capacity and high cost of traditional alternatives.

NUMBER 137

1.3-MICRON OEICs FOR GIGA-BIT LINKS.

Scientists at the NEC Optoelectronics Research Laboratory have successfully tested the world's first optoelectronic ICs to operate in the 1.3μm band at data rates of 1.2Gbps.

The optical transmitter and receiver chip pair set records of a 12-km communication at 1.2Gbps with a 7.7dB margin, and 22-km transmission at 565Mbps with a 9.9dB margin in the experiment using a single-mode fiber.

The new light-emitting chip incorporates a 1.3μm DC-PBH(double-channel planar buried heterostructure) laser diode and three InGaAsP/InP hetero-junction bipolar transistors on the same InP substrate. Modulation up to 2Gbps is possible in NRZ mode. A peak output of 20mW was marked at 1Gbps.

The optical receiver integrates a PIN photo diode and three low-noise InGaAsP junction FETs on a single chip for sensitivity of $-$14dBm at 1.2Gbps.

NEC's new OEIC pair will be the ideal workhorse in medium- or short-distance ultra-high speed links including LANs, local subscriber loops and interconnections of computers and peripherals because it promises much lower cost and smaller size than prevalent discrete devices.

These OEIC devices will reach the market within a few years.

NEAX61 NOW IN SERVICE AT 1,002 EXCHANGES.

Our NEAX61 digital switching system continues to play a key role in the phenomenal expansion of digital networks around the world.

Since its implementation in 1979 the NEAX61 has captured the attention of telecommunications administrators globewide for its sophisticated modular hardware and software, advanced service features, and full operation and maintenance support.

Today there are NEAX61 switches in service at 1,002 exchanges in 37 nations—more than 5 million equivalent subscriber lines in all. With recent orders from New Zealand (400,000 lines), Hong Kong (600,000 lines) and Venezuela (330,000 lines) the aggregate orders received now exceeds 10 million equivalent subscriber lines.

NEC OPTICAL REPEATERS GO TRANSPACIFIC AND SUBMARINE.

The trend in transoceanic submarine cable systems is undeniably "optical". The use of fiber optic transmission technology increases capacity, extends repeater span and ensures compatibility with land-based digital networks.

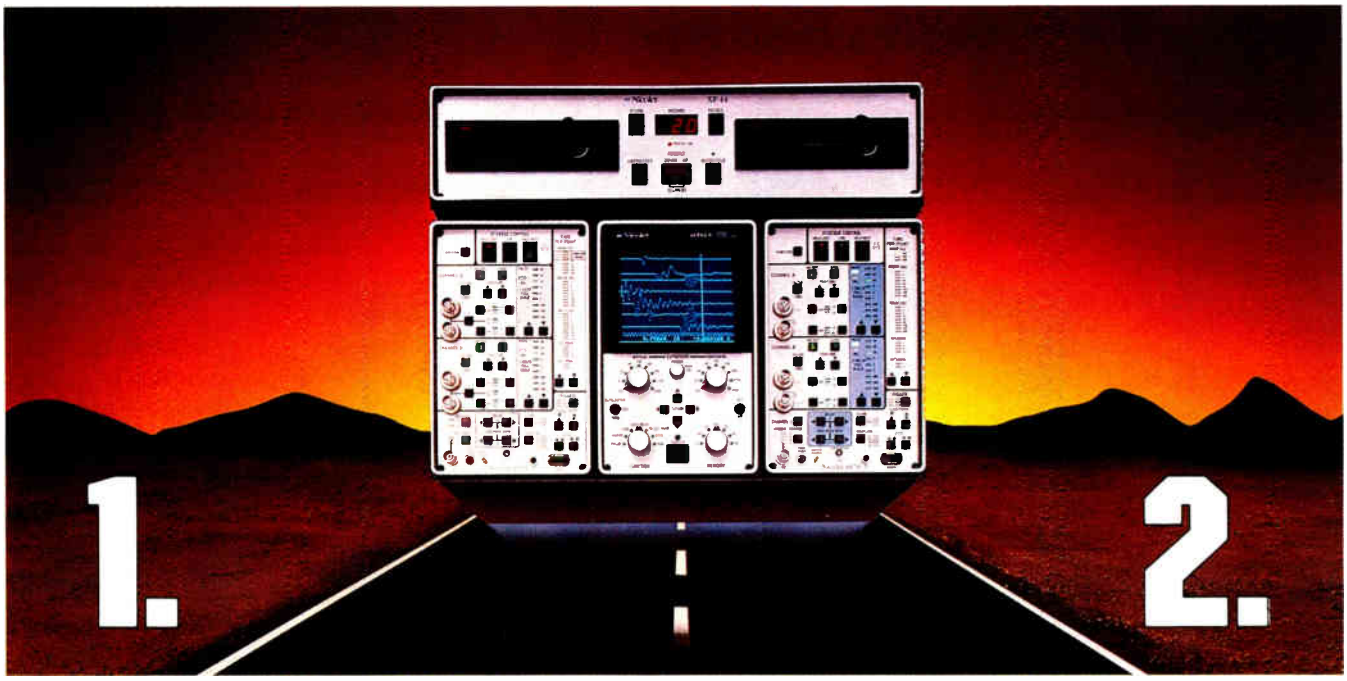
Under a contract awarded by KDD, Japan's leading international telecommunications network, NEC is manufacturing optical submersible repeaters and optical terminal equipment for the third Trans-Pacific Cable (TPC-3) which will link Hawaii and Japan with a branch to Guam.

The TPC-3, to be completed in 1988 and owned by 22 telephone operating companies in 10 countries, will have two 280Mbps systems, offering a total capacity equivalent to7,560 telephone channels—a dramatic increase from 138 channels with TPC-1 and 845 channels with TPC-2.

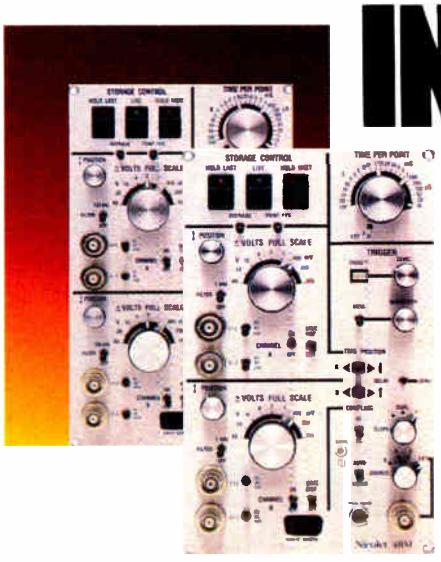
Incorporating our 1.3μm DC-PBH (double-channel planar buried heterostructure) laser diodes and newly-developed high-speed monolithic ICs, the optical repeaters are designed to maintain high reliability on the ocean floor at a depth up to 8,000 meters.

NEC

THE FIRST NAME IN DIGITAL SCOPES



TWO DIGITAL SCOPES IN ONE.



The Acquisition.

With sweep speeds from days to nanoseconds and resolution up to 15 bits, the 4094 digital 'scope can capture the most elusive signals. Every plug-in has 16K of memory, viewable trigger set-up and independent pre- or post-trigger delay on each channel. Signal averaging is standard and our latest 10 MHz/12-bit plug-in even offers real time manipulation of the incoming signals. With two plug-ins the 4094 can record four channels simultaneously. Or even monitor two slow signals and capture high speed glitches at the same time. All under computer control or via manual operation: whatever your application demands.

The Analysis.

Expand and examine any waveform feature in detail. Use the dual cursors and numerics to measure the time or voltage of any point. Compare live or stored waveforms with each other or with pre-recorded references. Store signals on disk manually or automatically. Use pushbutton programs to manipulate the data or send it to your computer via GPIB or RS232 interface. Complete your report with a hardcopy plot using the XY/YT recorder or digital plotter outputs.

First Time, Everytime.

Don't miss important data because of set-up errors. From the World's first in 1973 to the latest models, Nicolet 'scopes are easy to use. Find out how they can be the quickest solution to your signal problems. For more information call 608/273-5008, or write Nicolet Test Instruments Division, P.O. Box 4288, 5225 Verona Road, Madison, WI 53711-0288.

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Circle 28 on reader service card

Electronics

AN ANXIOUS IC INDUSTRY LOOKS TO THE PENTAGON FOR HELP

BUT A DOD-FUNDED CO-OP FACES LEGAL AND PRACTICAL HURDLES

SAN MATEO, CALIF.

The U. S. semiconductor industry and the Defense Department are quietly but almost desperately trying to reach a consensus on how the Pentagon can help the ailing chip makers—without stifling them in the process.

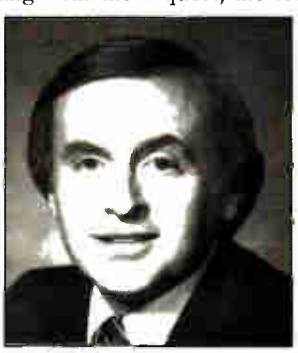
Both sides are worried about the U. S. losing technical and economic leadership to Japan and other Far Eastern countries: the military because it fears becoming dependent on foreign suppliers; the companies because they fear losing their businesses to them. Both sides are working behind the scenes on plans for a Pentagon-supported manufacturing consortium [*Electronics*, Dec. 18, 1986, p. 22]. But the legal and practical difficulties of setting up such a consortium could rival those of competing with the Asian countries in the first place.

Even if the antitrust barriers can be removed, many observers see a Defense Department-backed manufacturing consortium as a mixed blessing. The fear is that Pentagon financial support would mean Pentagon control, diverting the consortium from its announced purpose of support for commercial manufacturing.

"I would hope we are not going to go down the road we have gone in shipbuilding and military aircraft, where we have a totally captive defense industry," warns B. R. (Bobby) Inman, former chief of another consortium, the Microelectronics & Computer Technology Corp. (see p. 30). MCC pioneered the concept of a cooperative, supported by many companies, that is devoted to research and development. Inman says that he wants to see the semiconductor industry strengthened, but so far he has not been able to support any of the proposals for helping it.

One of those proposals—a five-year, billion-dollar program for a Semiconductor Manufacturing Technology Institute—will be unveiled in a Defense Science Board report due to be made public in a few weeks. Its counterpart is a plan now being hatched by the Semiconductor Industry Association that will call for an undetermined amount of Pentagon support for a similar manufacturing cooperative.

The Pentagon opened the bidding this month with a modest request for $50 million in each of the fiscal 1988 and 1989 budgets, to support semiconductor manufacturing technology. Though this is far short of the science board's request, the source of the money indicated a sensitivity to industry fears: the funds would be provided by the Very High Speed Integrated Circuits program, a Defense Department activity that has chalked up an impressive record of cooperation with industry.



SUMNEY: A consortium must get under way during 1987 or "it may be useless to try."

INMAN: "I hope we are not going to . . . have a totally captive defense industry."

Other funding for the proposal would probably have to come from existing appropriations, since the Pentagon expects to be on a short rein from Congress this year (see p. 32). One proposal made by the science board is that the military buy top-quality commercial semiconductors instead of expensive MIL-STD parts, and use the savings to fund the consortium.

MUM'S THE WORD. The proposed SIA consortium, known as Sematech, is taking shape under almost military secrecy. The SIA itself will admit to nothing beyond the bare fact that it has a task force that is studying the financial and technical aspects of a manufacturing consortium.

"The SIA and the Defense Science Board agree that a major effort to support manufacturing competitiveness is imperative," says John Cornell, senior vice president of Harris Semiconductor Corp. and an SIA board member. "How to manage it is what we are now contemplating. We are clearly in a consensus-building process, and until we do a good job of that, it is dysfunctional to get into speculation about how it will come out."

They don't have a lot of time. A Japanese paper on a 16-megabit dynamic random-access memory, one of the target technologies for the manufacturing consortium, will be given at the International Solid State Circuits Conference in New York next month. If the manufacturing consortium doesn't get under way in 1987, "it may be useless to try," says Larry Sumney, head of the Semiconductor Research Corp. and a member of both the Defense Science Board and SIA panels.

The SIA task force will make its initial report at its annual meeting in Washington March 3 and 4. By that time, the science board's report—now being circulated inside the Defense Department and widely reported in the press—will have been released, and the debate over the fate of the U. S. chip industry will go public.–*Clifford Barney*

COOPERATIVE R&D

CAN MCC SURVIVE THE LATEST DEFECTIONS?

AUSTIN, TEXAS

The nation's pioneering electronics research cooperative, Microelectronics & Computer Technology Corp., once again faces a serious test. The months ahead, just as the year behind, will test the concept of cooperative research and the resiliency of MCC's bylaws, says B. R. (Bobby) Inman, the consortium's former chief, whose planned departure at the end of last month raised speculation over the viability of the operation.

Not only has the four-year-old consortium been conducting a search for a new chairman, but it must deal for the second year in a row with the prospect of losing three consortium members.

Inman insists that MCC is making "superb research progress" and is on the verge of making new technologies available to its shareholders.

But skepticism concerning MCC's ability to function has risen in recent weeks with one-year departure notices from Unisys, Allied Signal, and Lockheed. And General Electric has notified MCC that it is no longer interested in the two programs in which its RCA subsidiary has been participating. GE did not resign its membership, because it may join some other MCC program in 1988; if it doesn't, it has given the required notice.

Last year, three others gave notice, although two of those sold their membership to new companies. Mostek Corp. sold its share to Hewlett-Packard Co., and BMC Industries Inc. sold its share to Westinghouse Corp. The third, Gould Inc., is no longer an active member and is trying to sell its share. Gould has the option to sell it back to MCC.

Just as last year, MCC officials maintain that the latest round of departures is not a trend but a result of mergers, divestitures, and internal belt-tightening as the industry undergoes dramatic changes during the current business slump. In 1986, changes in the group's structure were made; changes for this year, if any, have not been announced.

"Last year we had three [leaving], but I did not announce it because I did not know how to deal with it," recalls Inman. He and the directors had to wrestle with the new procedures of replacing departing shareholding companies. MCC also slashed the price of joining—that is, of one share—from $1 million to $250,000. The higher price was set in 1984 to keep membership at about 20 participating companies.

"It took us months to get the price back down and move away from the mechanisms of not wanting any additional members to getting out and recruiting new companies," says Inman.

PAYMENTS CUT. Additional changes were made to reduce the size of retroactive payments charged to a new member joining one of its four research programs. Previously, MCC bylaws required a joining member to pay what would have been its share of program costs since work began. Now, the retroactive time is limited to two years.

Additional royalty payments, however, will be collected by the co-op if a new member brings to market new technologies that were developed and delivered to MCC members before that company joined the organization, says Palle F. Smidt, its senior vice president of programs and plans. "We have taken a little off one end and added on another," Smidt says. *–J. Robert Lineback*

CONSUMER

BATTLE LOOMS OVER DIGITAL TAPE

LAS VEGAS

Consumer audio manufacturers face a battle over a new digital tape-cassette format that could rival for high-stakes drama the war on the video side between VHS and 8 mm. But unlike the video rivalry, which pits one format against another for dominance of a market, the new audio wars line up Japan's consumer electronics giants against the international recording industry over copyright issues. And the outcome could dictate when—or whether—digital audio tape players develop into a mass-market consumer item.

Based on action at this month's Winter Consumer Electronics Show in Las Vegas, where about a dozen manufacturers showed prototype DAT hardware, it appears likely that the first DAT players will hit U. S. store shelves for Christmas. Big-name suppliers such as JVC, Sanyo, Sony, and Technics were careful not to quote prices or introduction schedules. But smaller vendors, including Sansui and Clarion, were promising second-half 1987 hardware deliveries. Play-only DAT car units are expected to retail initially at about $600, while play/record units for the home will come in between $1,000 and $2,000.

As a digital-tape replacement for audio cassettes, DAT promises a dynamic range of more than 96 dB and high-quality sound equivalent to that of digital compact disks. Initial DAT hardware will be based on the rotary DAT format, one of two standards adopted in 1985 by an industry committee made up of some 80 companies [*Electronics*, Jan. 20, 1986, p. 19]. The R-DAT cassettes, 2.875 by 2.167 by 0.375 in., will provide two hours of play/record time.

LOOKING AND LISTENING. Digital audio tape dominated the Winter Consumer Electronics Show as Sony's display draws a crowd.

But if DAT manufacturers can't iron out their differences with the record companies, they may face a boycott from major-label producers, which could hamper the format's acceptance. Polygram International, for one, announced last fall that it does not plan to put any of its titles on DAT. And at CBS Records Group in New York, a spokesman says, "Our position is simple. CBS Records has no current plans to make its music available on DAT."

For one thing, some record officials fear that DAT could hurt the current boom in CD sales. But a more basic issue is

that unlike CD—a play-only medium—DAT will allow consumers to make an unlimited number of high-quality digital copies of records, analog tapes, and perhaps CDs with no degradation of quality.

PROTECTION SOUGHT. The record industry wants chips built into DAT machines to prevent copying of material bearing a special code. But top officials of the Electronic Industries Association of Japan turned down that idea last month.

As a result of the stalemate, the record industry will continue to push this year for a federal law mandating protective chips in all DAT players sold in the U. S., says Stanley M. Gortikov, president of the Recording Industry Association of America in New York. A similar bill died in Congress last year, as did legislation that would have imposed a 35% tariff on DAT players not equipped with the chip.

Some observers predict that the resistance will backfire, and hardware vendors will retaliate with DAT recorders that can copy directly from CDs. That possibility was originally precluded by the DAT standard, which calls for a 48-KHz sampling rate for DAT line inputs, incompatible with the 44.1-KHz rate used on CDs.

But at last September's Japan Audio Fair and again this month in Las Vegas, a few manufacturers showed up with DAT-recorder prototypes equipped for optional 44.1-KHz direct-input sampling. Some sources say the sampling rate may now be left to the discretion of individual vendors. Says David Lachenbruch, editorial director for the trade publication *Television Digest*, "I think they [DAT vendors] are all going to do it. I think one of the big selling points of DAT is that you'll be able to record digital-to-digital."

While prerecorded software may be lacking at DAT introduction, blank tape apparently will be plentiful. Companies including Denon, Fuji, Maxell, Memorex, Sony, and TDK all had prototype rotary-DAT cassettes at Las Vegas and say they can move quickly to production.

DEAL NEEDED. But at Denon America Inc., Fairfield, N. J., senior vice president Robert Heiblim believes that DAT's long-term success hinges on reaching some agreement with software producers. "Unless there's some hope for prerecorded music, there's no hope for a mass market," says Heiblim. Denon will supply DAT player/recorders as well as blank and prerecorded tapes.

However, others aren't so worried. "The availability of software would certainly enhance the format," concedes John Briesch, president of Sony Corp. of America's Consumer Audio Products Division in Park Ridge, N. J. But unlike CD, Briesch maintains, DAT's viability is "not predicated on prerecorded material." *-Wesley R. Iversen*

OPTICAL PROCESSING

A FASTER WAY TO LINK OPTICAL FIBER

FOUNTAIN VALLEY, CALIF.

A quick, inexpensive way to connect optical fibers when building systems in volume has eluded both users and component suppliers and has slowed the growth of high-volume aerospace and industrial applications. So the first public demonstration this week of just such a technique from ITT Corp.'s connector making subsidiary, Cannon Electric Co., has raised the industry's hopes that it can speed things up.

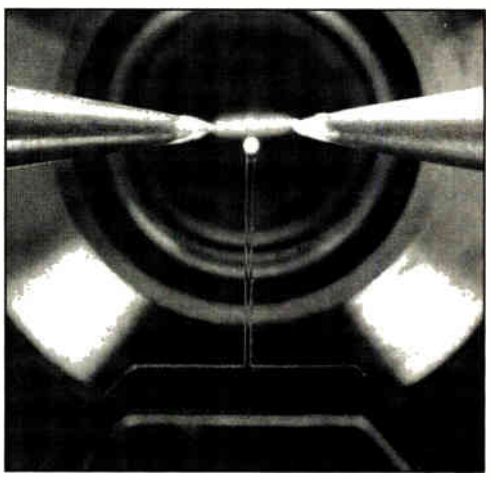
ITT/Cannon calls its new rapid-termination technology "fiber-lens fusing," and says it has the speed and simplicity to help cut the high costs associated with fiber-optic connections. The process gets around the biggest obstacle—the requirement that connections have optically perfect surfaces on the ends of both cables.

The ITT/Cannon technique differs radically from existing methods such as grind-and-polish or crimp-and-cleave. It employs a fusing unit in which a high-voltage arc melts the end of the fiber and forms a lens (see photo). Two ceramic contacts then link lenses to form an optical connection.

GOOD AND PLENTY. The advantages are speed and accuracy. By using the fusing unit, an average production worker easily can turn out up to 30 such connections an hour, all identical, the company claims. By comparison, a skilled technician using the standard grind-and-polish method has the tedious job of holding the fiber's end on a rotating wheel to get an unflawed optical mating surface and then checking it through a microscope. About nine connections an hour is considered a good output. The crimp-and-cleave method, which involves cutting the fiber with a special tool, is also fast, ITT/Cannon says, but does not get consistently clean cuts.

The company thinks its technique hits the mark on all counts. "It takes the human element out of fiber-optic termination," says Les Borsuk, director of new products, fiber-optics technology, at ITT/Cannon's Microtech Division, Fountain Valley, Calif. "One of its beauties is repeatability, which remains a major barrier in high-volume fiber optics."

Fiber-lens fusing made its debut at the Optical Fiber Communications Conference/87 in Reno, Nev., this week. One showgoer who was impressed is an engineer at a major aircraft company developing an avionics system with thousands of fiber cables. The new technique finally makes terminating fiber-optic cabling as easy as splicing copper wire, says the engineer, who declined to be identified. In building systems in volume, he says, "time becomes paramount, and the termination technique can't be complex." The prevailing attitude in the industry is summed up by William C. Young, district manager of lightguide-technology research at Bell Communications Research Inc. in Red Bank, N. J.: "If it increases the speed of end-finishing and improves the quality, it's good."



HOT SPOT. In the fusing technique, an arc melts the end of a fiber-optic cable held between electrodes.

ITT/Cannon's Borsuk notes that the idea of melting the cable's end into a lens "has been kicking around laboratories throughout the industry for years, but no one knew quite how to do it right." His team came up with the workable solution of using a high-frequency arc of about 6,500 V ac flashed between two electrodes. The arc melts the glass tip, which cools to form a spherical lens, "nearly ideal for the transmission of optical signals," says Borsuk.

The lenses do not actually touch when the two fork-shaped ceramic contacts are mated, but keep a gap of about 100 μm to compensate for a "pistoning" effect. However, optical characteristics are not degraded. For 50-μm core fibers, coupling loss is typically 1.2 dB; for 100-μm fibers, typically 0.8 dB.

Striving for simplicity, the ITT/-Cannon engineers have kept adjust-

ments of the fiber-lens fusing unit to a minimum. After the fiber is inserted through the contact and both are positioned by the unit, only the time and intensity of the arc function need be set on thumbwheels by the operator. Both parameters vary according to fiber size and the contact style, and appropriate settings are suggested. The unit, at 9 by 7 by 8 in., is portable and may be powered by an ac line or an internal 12-V dc battery.

Borsuk says the fusing setup sells for nearly $10,000, about as much as a grind-and-polish unit. The connectors cost about the same as ITT/Cannon's present fiber-optic line. The real savings for users, he points out, will come from shortened and simplified production runs. *-Larry Waller*

THE BUDGET

DEFENSE CONTRACTORS FACE A FLAT BUDGET

NEW YORK

Trying to convince the Congress that it is not a spendthrift, the Defense Department has reduced, postponed, stretched out, and even eliminated some programs in its $312 billion fiscal 1988 budget request. The upshot is that defense-electronics companies are looking at a flat landscape, but one still with some opportunities. In two other agencies of interest to the electronics community, the budgets of the National Aeronautics and Space Administration and the Federal Aviation Administration offer some promise.

"The DOD will be lucky to get any real growth," says Don Weaver, chairman of the Ten-Year Forecast Subcommittee of the Electronic Industries Association's Government Division and market research manager for Aerojet TechSystems of Sacramento, Calif. Initial signals tend to confirm Weaver's view: the indications are that the Pentagon would do well to stay even with inflation, at about $300 billion for fiscal 1988, which starts Oct. 1.

IMPETUS. Of that $300 billion, the EIA in its forecast identifies $53.5 billion for electronics, down 3.7% from fiscal 1987's $55.6 billion. Of that, $30 billion will be for procurement, off from $30.2 billion this year; $16.9 billion for research, development, test, and engineering, compared with $17.3 billion this year; and $6.1 billion for operations and maintenance, the same as this year.

Still, the few new weapons systems that are likely to enter full-scale production over the next few years rely heavily on electronics. Byron K. Callan, defense-electronics analyst for Prudential-Bache Securities, New York, believes that defense-electronics companies can prosper in a lean, flat budget environment. "Technological advances continue to provide powerful impetus for new systems and upgrades to existing ones," he says. Even the Strategic Defense Initiative, which Callan says won't have a significant impact on contractors' business until the early 1990s, can provide some opportunities now, he adds.

In fact, SDI is the biggest R&D item in the Pentagon's proposed budget. It climbs 41% from fiscal 1987's $3.7 billion allotment to $5.2 billion in fiscal 1988, and then jumps to $6.3 billion in fiscal 1989. Also, the DOD has submitted a supplemental budget request of $500 million for SDI in fiscal 1987.

In addition, the Navy seeks $1.4 billion for another Trident submarine, plus $3.5 billion for 66 multi-warhead Trident II missiles. The Navy was authorized to spend $1.7 billion on the subs and $3 billion on the missiles in fiscal 1987.

The Pentagon also seeks a 94% increase for the $45 billion Midgetman, a small intercontinental ballistic missile. And funding for the 10-warhead MX missile would climb to $1.9 billion from $1.5 billion, including study of a plan to base missiles on rail cars. The DOD wants another $1.1 billion for cruise missiles designed to be launched from the ground, ships, or aircraft. The most expensive of the low-flying missiles would be the Tomahawk sea-launched version, for which the Navy seeks $1.1 billion, up from $824 million this year.

Total research, which includes electronics research, would go up by 20% to $43 billion, and some leading R&D would go up even more. In addition to strategic missile defenses, including SDI (see chart), the Air Force wants to double 1987 R&D spending on the next generation of advanced tactical fighter jets. The program is pegged at $536.8 million, compared with $248.8 million this year. The Army wants a hefty increase for the new, high-technology LHX attack helicopter: $408 million, against the current $142.9 million. The Army plans to select a contractor in fiscal 1989, when it hopes for an outlay of $606 million. The Navy, however, is asking for reduced outlays for its big R&D program, the Joint Tactical Information Distribution System: $91.2 million, compared with $219.9 million this year. In fiscal '89, the proposal is for $69.3 million.

AWAY FROM BASICS. Most of the spending, though, will be for development and engineering rather than basic research. "You have to take a careful look at what R&D means in this budget," says Robert Fraser, who heads the defense/aerospace group at Arthur D. Little Inc., the Cambridge, Mass., market research firm. "In the 1960s, there were over 10 major weapons-program starts a year. In the 1970s, it was in the single digits. Now, we're down to less than one major weapons-program start a year," he says.

At NASA, the fiscal 1988 request of $9.5 billion is less than this year's $10.5 billion. But $2.1 billion of the fiscal 1987 request was a one-time expense for replacing the space shuttle Challenger. NASA is seeking $767 million for the space-station program in 1988, a rise over the $420 million allotted this year. The FAA, meanwhile, is seeking a $500 million increase for new air-traffic-control systems for the improved National Airspace System. *-Ron Schneiderman*

MAJOR WEAPONS PROGRAMS IN RESEARCH AND DEVELOPMENT ($ million)

	Fiscal 1987	Fiscal 1988	Fiscal 1989
Army			
Advanced Antitank Weapon System	46.9	59.1	231.6
LHX Helicopter	142.9	408.0	616.0
Navy			
Joint Tactical Information Distribution System (JTIDS)	219.9	91.2	69.3
Air Force			
Advanced Strategic Missile Systems (ASMS)	145.0	134.2	152.0
Advanced Tactical Fighter	248.8	536.8	703.0
Aircraft Engine Component Improvement Program	152.1	136.5	166.1
Short-Range Attack Missile (SRAM II)	66.5	220.4	231.6
Joint Programs			
Strategic Defense Initiative	3,743.4	5,230.8	6,292.3

SOURCE: DEPARTMENT OF DEFENSE

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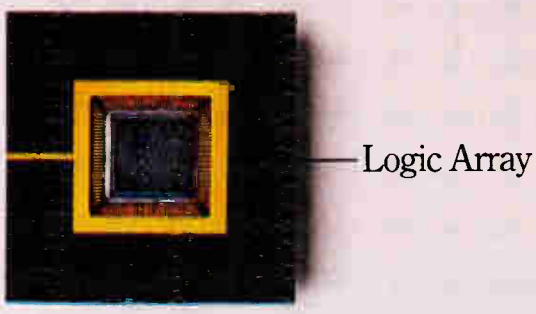
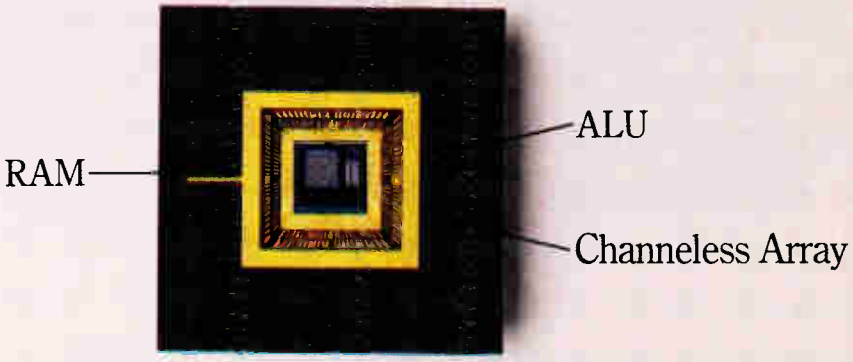


Current Logic



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THE SUPERCONDUCTOR RACE HEATS UP

NEW YORK

In just a few short weeks, scientists the world over have accomplished what no one had been able to do in more than a decade of trying: produce a superconductor that can operate at temperatures higher than 23 K. In a spree that began in Zurich, researchers from Japan, the U. S., and, most recently, China have eclipsed that 13-year-old record, and new highs are being claimed almost weekly.

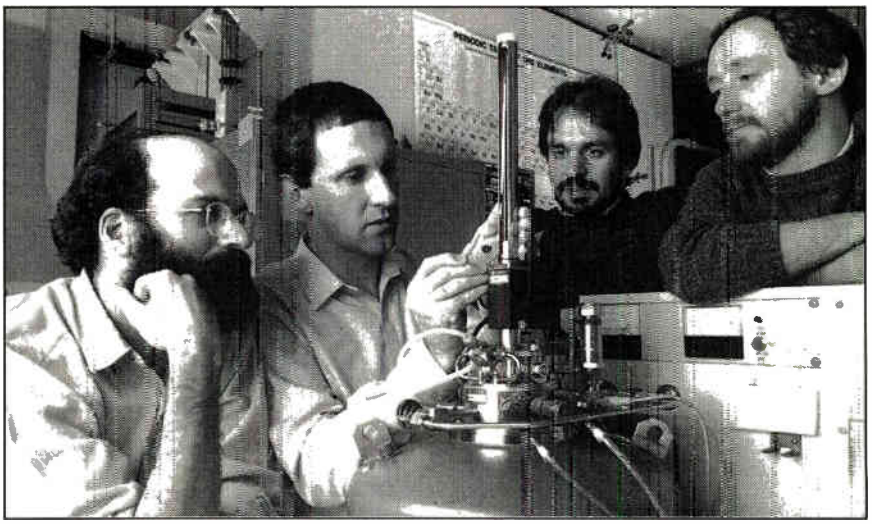
"I'm as amazed by this as anybody," says Robert Dynes, director of chemical physics research at AT&T Bell Laboratories in Murray Hill, N. J. "I find it absolutely astounding, [yet] one has to believe this is only the beginning."

The new advances began with the discovery that certain oxide materials can act as superconductors. Superconductivity eliminates electrical resistance and makes it possible to create very powerful magnetic fields. The materials therefore could eventually be used for high-speed interconnects on ICs and printed-circuit boards. The new superconductors were discovered last winter at IBM Corp.'s laboratories in Zurich, Switzerland. IBM's results, based on a compound of barium, lanthanum, copper, and oxygen, were announced last April.

FLOODGATES. In December, IBM's findings were confirmed by researchers at the University of Tokyo, who achieved superconductivity at 28 K. Since then, Bell Labs, the University of Houston, and IBM have all claimed records. Bell says that in late December its scientists developed a lanthanum strontium copper oxide compound that becomes superconductive at about 36 K. At the same time, the Houston team says, it achieved superconductivity at about 40 K by keeping its material under very high pressure. IBM will release a paper this week showing its latest results—superconductivity at about 39 K.

And now, a group of scientists at the Institute of Physics at the Chinese Academy of Sciences in Beijing reports it has developed a material that reaches superconductivity at 70 K. The Chinese team's work is not yet fully documented, but if its results are confirmed, the breakthrough could have tremendous impact.

At that temperature, superconducting techniques would be far less expensive to implement. The eventual payoff could be huge for the semiconductor, computer, and telecommunications industries, as well as in high-speed rail travel, nuclear fusion, and power transmission. Raising the temperature at which superconductivity occurs makes cooling the material much simpler.



COOLING. Bell Labs' Bertram Batlogg prepares material for testing in a supercooled container. Collaborators are, from left, Edward Reitman, Robert Cava, and Robert van Dover.

However, all the recent reports leave some researchers wary of a numbers race. "In this business you have to be very careful in measuring the temperatures and everything else," says Karl Alex Müller, one of the two IBM researchers who made the initial discovery. "At this moment, one should not be making too much of an issue over a difference of two degrees either way."

Critical to the issue, Müller says, is at what point researchers decide a material is becoming a superconductor. Although data is generally reported for the point at which superconductivity starts, he says, "it's not necessarily a sharp point." Also, it remains to be proven whether the new materials can be produced in thin-film form—which is essential if semiconductor and computer technologies are to use the materials.

If they can, superconducting interconnects linking ICs on computer boards could have significant advantages over optical interconnects, says AT&T's Dynes. Optical interconnects must be at least 1 μm in diameter, he explains, whereas electrical interconnects can be much narrower, conceivably as narrow as 100 Å.

"With these new materials, the way has been opened up for other oxides, which may be even better," Müller says. "The prospects are really good" that superconductivity can be achieved at even higher temperatures. *–Tobias Naegele*

TI STRETCHES CELLS TO GET A SPEEDY EPROM

HOUSTON

In a new thrust that's part of a strategy to increase its presence in the nonvolatile-memory marketplace, Texas Instruments Inc. is moving into fast, low-density CMOS erasable programmable read-only memories. To make these parts, TI's designers have stretched the cells of an established process.

With their new stretch-cell layout, TI has turned a CMOS process for dense EPROMs into an equally suitable technology for fast 16-K EPROMs. The new technique is making its debut in two 35-ns 2-K-by-8-bit EPROMs designated TMS27C291 and 27C292 [*Electronics*, Nov. 27, 1986, p. 20].

The new circuit layout gets most of its speed from a true differential sensing technique that uses two transistors per cell, rather than the one transistor used in most conventional EPROMs. Generally, EPROMs use a dummy cell for differential references, but the true-differential two-transistor cell allows the bit-line voltage swing to be cut in half, which thereby reduces the time it takes to sense a bit condition.

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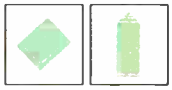

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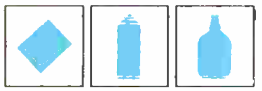

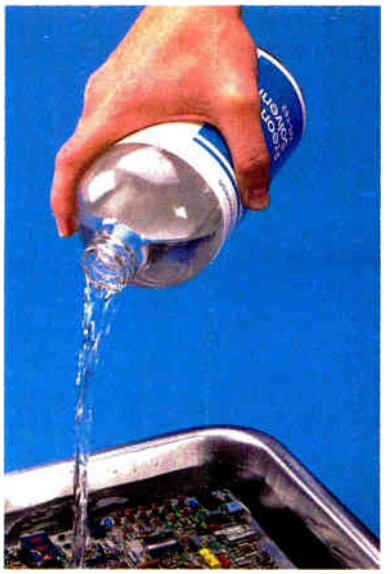

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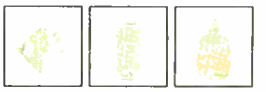

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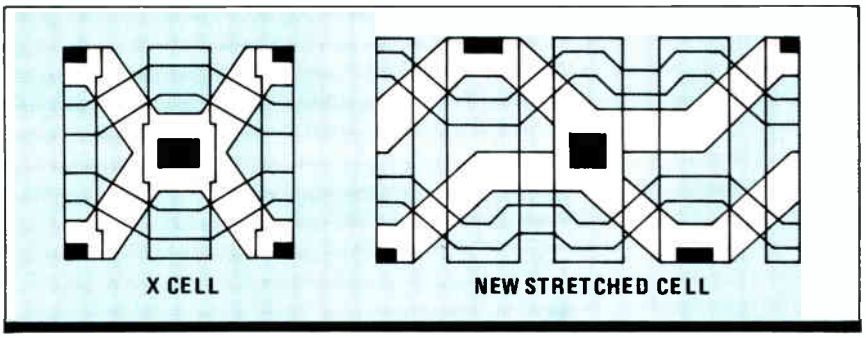

WIDENED CELL. TI has stretched its X cell for a new line of fast 16-K EPROMs.

Calif., have increased transistor count to gain access speed. Cypress uses a four-transistor cell with separate read and write functions for greater control in a 1.5-μm n-well CMOS process. TI stays with an older, 2-μm CMOS method, now used on slower but higher-density 128-K, 256-K, and 512-K EPROMs. But managers in Houston maintain that the real trick is stretching a cell to increase EPROM speeds without changing the process. That, they add, will mean higher production yields right now than more aggressive technologies.

"This product is an ideal example of a 'rider' following right on the track of a process-driver product," says Pradeep Shah, product manager for EPROMs in Houston. "These [fast EPROMs] really push the technology to its ultimate limits." Shah says the concept appears suited for future finer-geometry EPROM processes, once they are established with still higher-density memories.

TI managers readily admit that at 35 ns the chips aren't the fastest, but they believe that the bulk of the market is at that speed. Still, Shah speculates that future stretch-cell EPROMs might be tailored to speeds of less than 20 ns or to lower power dissipation.

SERPENTINE. The stretched cell minimizes access delays from the increased word-line lengths inherent to multiple-transistor cells. Instead, it has interlaced word lines between transistors, giving the path a serpentine shape (see figure). And instead of doubling the length of the chip's word lines, TI's engineers have increased paths by one half compared with EPROMs with one-transistor cells. That alone saves about 10 to 15 ns, Shah estimates.

The oblong layout of the cell also enlarges some areas of the storage circuit, increasing the overlap of floating-gate and control-gate elements. Shah says the result is much better drive and coefficient coupling between those gates with the same process. The alternative would have been to compress the dielectric layer sandwiched between the gates, which would have made the CMOS process much more difficult to control. Some speed has also been gained by making improvements in the circuit design of sense amplifiers and input-output drivers in the peripheral circuitry of the chips.

When TI introduced the twin-well high-voltage CMOS technology more than a year ago in a move to get back in the market for high-density EPROMs [*Electronics*, Sept. 30, 1985, p. 16], it used space-saving X-shaped cells that have access speeds as fast as 150 ns for 128-K parts. By changing only the circuit layout, TI is now making a run at the market for lower-density high-speed CMOS EPROMs. As speeds increase, these low-power parts are steadily stealing away business from one-time-programmable bipolar read-only memories.

Also, the chips enter the market with a maximum power dissipation of 394 mW, which Shah says is 20% less than competing fast CMOS EPROMs running at similar speeds. He credits the lower power dissipation to the use of the two transistors per cell and the layout of the peripheral circuitry.

The TMS27C291 is housed in a 300-mil-wide dual in-line package; the 27C292 comes in a 600-mil DIP. They will be available at the end of March; prices have yet to be determined.

–J. Robert Lineback

COMPANIES

COUNTERPOINT GAINS LITTLE IN ALLIANCE

SAN JOSE, CALIF.

Counterpoint Computers' grand alliance, launched with so much hope and promise a year ago, is looking a little less grand these days. The strategy pursued by Counterpoint founder Pauline Alker was to forge a strategic alliance with three giant international partners—AT&T Information Systems, Kyocera Ltd. of Japan, and British & Commonwealth Shipping Co. of the UK [*Electronics*, Jan. 27, 1986, p. 60]. A year later the agreements remain, but they have not proved to be the key to market acceptance as Alker had hoped.

AT&T has stopped distributing the Unix-based Counterpoint 68020 platform, the System 19K, apparently in favor of a closer relationship with Ing. C. Olivetti & Co. SpA of Italy, in which it owns a 23.5% stake. Kyocera also has not provided the entry into Japanese markets that Alker had expected. And British & Commonwealth's role in the alliance, unclear from the beginning, has yet to be defined, although the conglomerate did help Counterpoint open its European office last April.

Alker is candid about the performance of the alliances. Plans for Kyocera to distribute Counterpoint products in Japan have foundered on the Japanese resistance to imports—"a major disappointment to me," Alker says, though she continues to regard Kyocera as a "tremendous partner and very supportive of us." With British & Commonwealth, "We are still groping for ways" to cooperate, she says—such as in a joint development project.

CHANGING. AT&T signaled its foot-dragging on distribution of the System 19 as early as the second quarter of 1986, forcing Counterpoint to defer its own expansion plans. "They are constantly undergoing major changes in organization and strategic directions in the computer industry," Alker says. "That makes partnership with them rather difficult; you are never on solid ground."

There has been some progress. Counterpoint signed five distributors in the U. S. and two each in Europe and Asia, introduced an upgrade to its original platform, shipped some 300 systems, and developed an original-equipment-manufacturer agreement with Multitech Industrial Corp. of Taiwan [*Electronics*, Nov. 13, 1986, p. 112]. In addition, Counterpoint found a U. S. manufacturer for its products, Apco Electronics of Huntsville, Ala., a Textron subsidiary.

Perhaps the biggest change in direction for Counterpoint was the formation of a special business-development unit to focus on Taiwan, Hong Kong, and China. Headed by longtime Alker associate Li-Ho (Raymond) Hou, who was instrumental in setting up the Multitech deal, the unit represents a major effort to crack the Chinese market.

Despite the setbacks, Alker has not given up on alliances. This year, she says, Counterpoint will sign at least one major new one. *–Clifford Barney*

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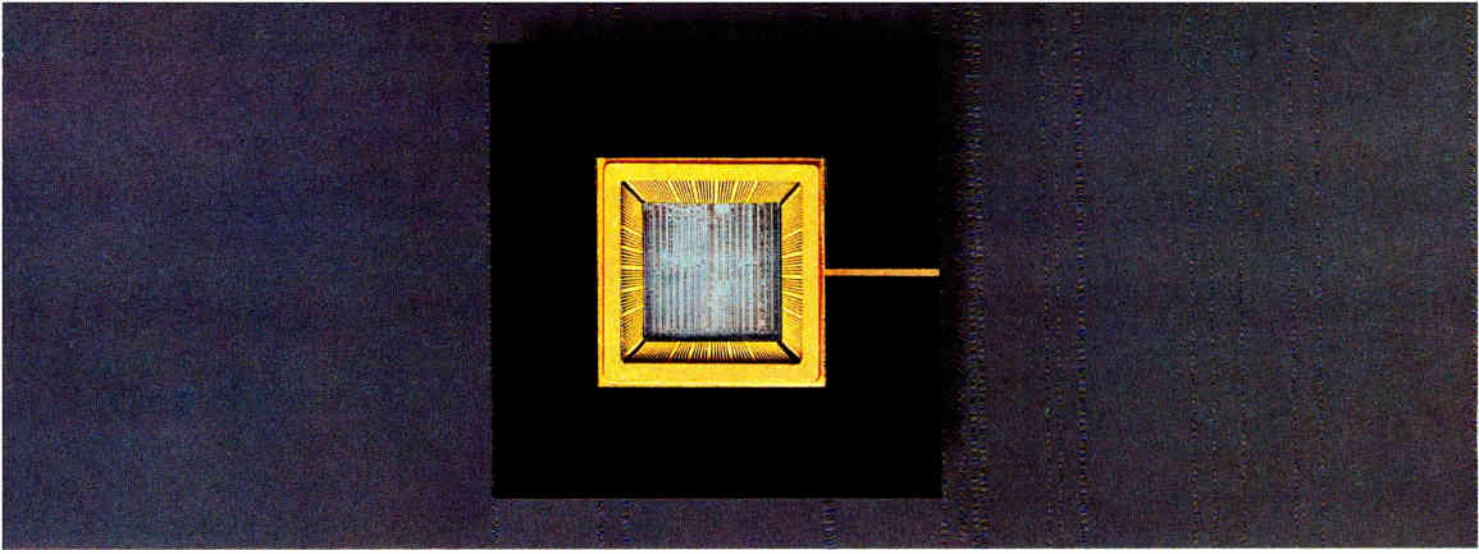

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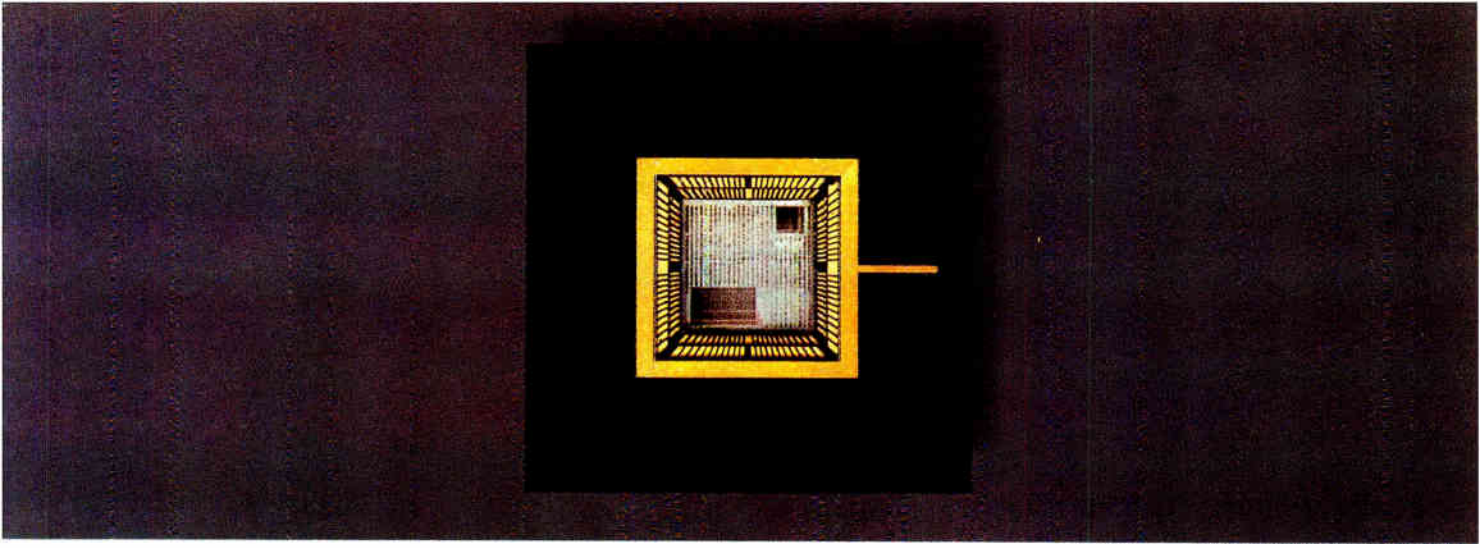

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INTERNATIONAL NEWSLETTER

JVC READIES LAUNCH OF HIGH-RESOLUTION VHS-COMPATIBLE FORMAT...

A new video-cassette recording format that offers both higher resolution and upward compatibility with the prevailing VHS standard could hit the consumer market by summer. Victor Company of Japan says it expects this spring to iron out all the details of the new format with the other four original VHS players—Hitachi, Matsushita, Mitsubishi, and Sharp. The new format will use a cassette that is nearly identical to VHS, save for an identification hole and improved tape. Horizontal resolution will be at least 400 TV lines, compared with 230 to 240 for standard VHS; the exact resolution has yet to be determined. Such resolution is similar to that of the enhanced-definition TV system under development by the Japanese [*Electronics*, Nov. 4, 1985, p. 41], and is well-suited to the popular large-screen TVs that measure more than 26 in. diagonally. □

...AS SAMSUNG UNVEILS ITS OWN COMPACT 4-mm VIDEO STANDARD

Anxious to shed its image as a copy-cat manufacturer, Samsung Electronics Co. is aiming to break new ground with a 4-mm video-cassette format it demonstrated at the Winter Consumer Electronics Show in Las Vegas earlier this month. The South Korean company showed two prototype 4-mm camcorders there that use the same type of microcassette cartridge developed for digital audio tape [see p.30]. Although potentially smaller and lighter than camcorders for other VCR formats, the new system has one major drawback: for now, at least, recording/playback time is limited to just 60 min. The first camcorder units will be marketed in Korea this summer for about $1,300, and they should hit the U. S. market late next year. Samsung is betting that by using the DAT cartridges, its 4-mm video system will attract a strong following. The multipurpose cassettes offer the promise of dual-purpose home cassette decks capable of playing back digital audio and 4-mm video from a single unit. Samsung has filed for seven patents on the technology, which it hopes to license to other manufacturers. □

PHILIPS STARTS JAPANESE JOINT VENTURE TO PROMOTE INTERACTIVE CDs

As it prepares to bring its interactive compact-disk (CD-I) players to market, Philips International NV is making sure that when the machines are ready, the material to play on them will be, too. The Dutch electronics powerhouse has joined with one of Japan's biggest printing firms, Toppan Printing Co., Tokyo, to establish Denshi Media Services Co., a Tokyo-based joint venture that will help Far Eastern companies develop products for use with the CD-I players. The system is expected to be used in such applications as electronic dictionaries and encyclopedias, complete with video and audio aids. Last year, Philips made a similar arrangement with R. R. Donnelley and Sons Co., a Chicago-based publisher, to offer the same services in the U. S. and Europe. Denshi will aid publishers, software firms, and others to design, program, and premaster programs for the 650-megabyte disks. □

UNLIKE MOST OTHERS, NIXDORF COMPUTER IS EXPANDING RAPIDLY

While most electronics companies are tightening their financial belts, Nixdorf Computer AG remains buoyantly confident in the long-term prospects of the data-processing industry. The West German company is creating about 200 to 250 new jobs a month worldwide, and it is investing heavily in both plants and equipment. Besides expanding its facilities in West Germany and Ireland, Paderborn-based Nixdorf is to open a new computer factory in Singapore, and it has earmarked $150 million over the next five years for the construction of a production and development center in West Berlin. □

INTERNATIONAL NEWSLETTER

SIEMENS AND ARCO ARE LIKELY TO LAUNCH THIN-FILM SOLAR-CELL BUSINESS

Siemens AG and Atlantic Richfield Co. are expected this spring to sign a cooperative agreement to study photovoltaic energy conversion. The deal, if finalized, calls for the West German company's affiliate Siemens Solar GmbH to put up a $60 million plant to fabricate solar modules for both partners, using cells based on thin-film technology developed at ARCO Solar Inc. Siemens says the ARCO technology can cut the costs associated with manufacturing solar modules by as much as five times, compared with conventional thick-film technology. The companies say their goal is to produce modules within the next five to 10 years that are capable of generating 1 Kwh of energy for about $10, roughly half the cost of generating power with today's solar modules. □

NEC AND KDD COMBINE TO DEVELOP INTERNATIONAL ISDN SWITCHBOARDS

Two Tokyo-based giants are teaming up to develop switchboards for an integrated services digital network that will connect Japan, the U. S., and the U K. The equipment, which will be installed in Tokyo, will be jointly developed by Japan's leading international telecommunications carrier, Kokusai Denshin Denwa Co., and NEC Corp. KDD agreed last February with AT&T Co. and British Telecom to establish ISDN links among the three countries. AT&T is providing equipment in the U. S., and British Telecom will produce switchboards to be based in London. The Japanese equipment will handle both analog and digital communications and will include international and local switchboards. The local switchboard will operate at 144-K bits/s, the standard recommended by the CCITT. The international switchboard data rates have not been set yet. □

UK FIRM SEEKS U. S. PARTNER TO PEDDLE PC-BASED CAD DRAFTING PROGRAM

Integrated Vision Systems Ltd. is shopping for a U. S. distributor for its new InterCAD microcomputer-based drafting system. The Peterborough, UK, company, which devoted most of its four-year history to developing InterCAD, claims the system can run on about 150 processors. "The U. S. is a dangerous market," says Richard Roper, the company's marketing director, alluding to the past difficulties British companies have faced trying to break into that market. "We want to get into the U. S. as quickly as possible." The company is considering asking the British government's Department of Trade and Industry to help find a suitor. InterCAD, which supports up to 16 terminals and sells for almost $18,000 in the UK, can run on computers ranging from the new 32-bit supermicros to IBM Corp.'s Personal Computer AT and compatibles. Roper says Integrated Vision Systems, which already has agents in Greece, will soon sign up a distributor in Norway. He says he is confident that deals for the rest of Europe will come through in the near future. □

STC AND GEISCO INTERNATIONAL SET UP UK NETWORK SERVICES VENTURE

STC International Computers Ltd., formerly ICL, has entered into a joint venture with Geisco Ltd., a subsidiary of the General Electric Information Systems Co. Neither parent would disclose their investment in the new company, called International Network Services Ltd., which will combine the value-added network services of STC with Geisco's international service and marketing strength. Both partners gain from the venture, which will be owned 60% by STC and 40% by Geisco, says Chris de Courcy-Bower, business strategy manager at INS. "Geisco has the international contacts which we need, and they need [STC's] Tradanet, the UK's biggest electronic data interchange," he says. □

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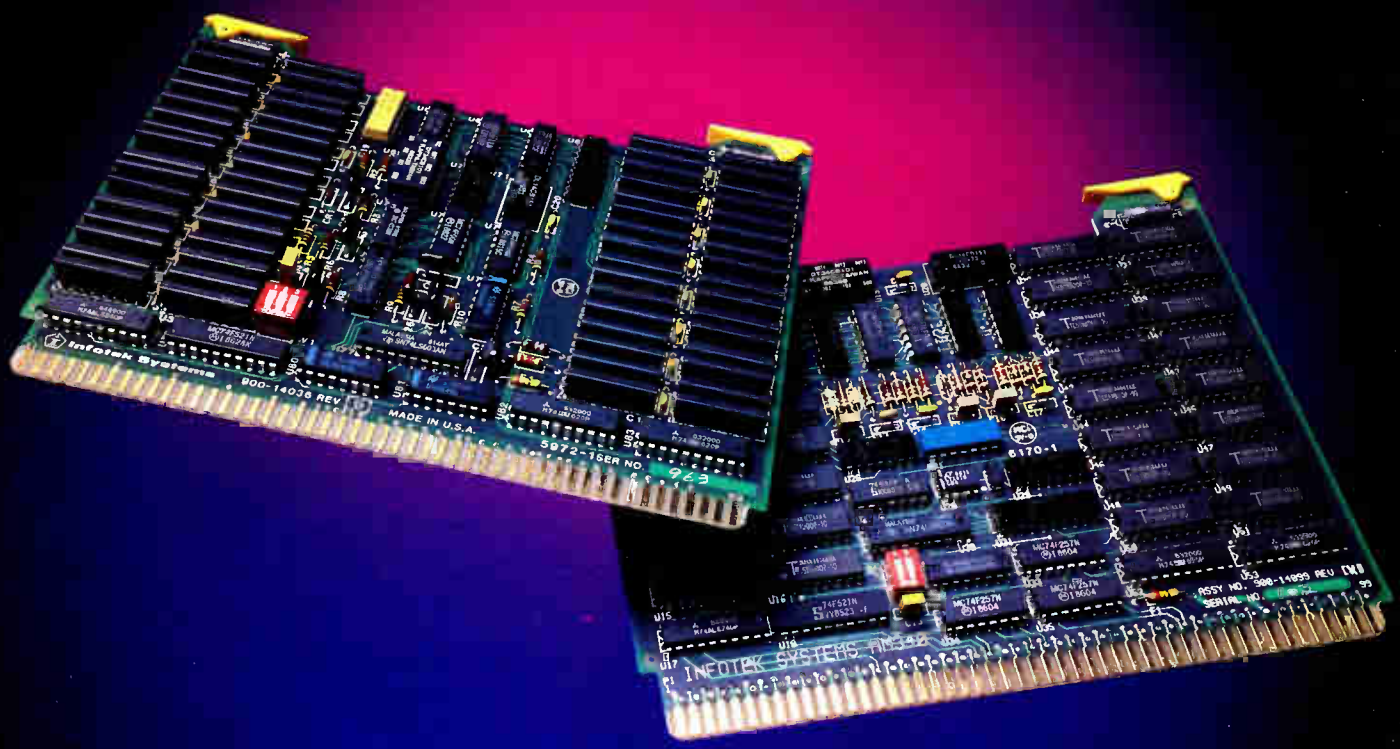

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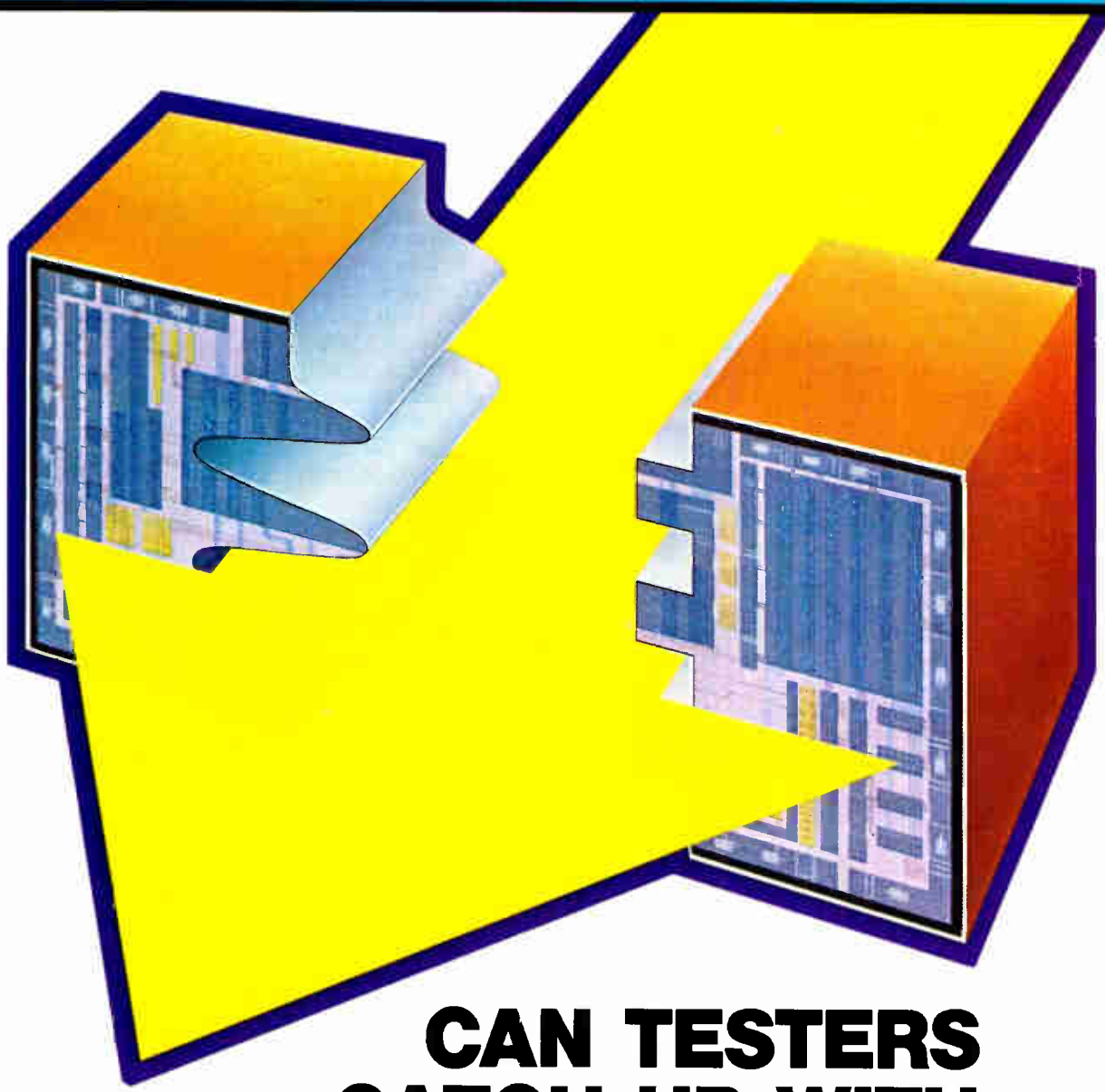


CAN TESTERS CATCH UP WITH COMPLEX CHIPS?

by Jonah McLeod

A new class of mixed-signal chips is posing a particularly nasty set of problems to the test-systems community. Not only do these chips make greater demands on testers in the analog domain, in terms of frequency and resolution, than

WORLDWIDE SHIPMENTS OF MIXED-SIGNAL ICs TO GROW RAPIDLY

Chip type	(Millions of units)		Compound annual growth rate
	1986	1988	
DACs	1,158	1,773	24%
ADCs	905	1,439	27%
Codecs	163	309	38%
Modems	29	61	45%
ISDN chips and others	2,682	4,076	23%

SOURCE: VLSI RESEARCH INC.

mixed-signal integrated circuits have in the past, but many of them carry much more complex digital circuitry than standard mixed-signal test systems are equipped to handle.

The big question for the tester community is how to handle such parts as the new chips for integrated services digital networks, with their combination of high-speed analog and digital functions. Another class of problem chips is microcontrollers with data converters on chip, which become difficult to test as higher-resolution conversion is brought into the picture. And application-specific ICs are carrying an increasingly complex mix of analog and digital functions.

Such chips may pose major new testing problems, but tester vendors are confident they can meet the challenge. They are attacking the problem on two fronts: first, by enhancing their systems with high-performance digital signal processors, and second, by adding digital capabili-

New and upgraded test systems are combining high-performance digital signal processing for mixed-signal circuits with the ability to test complex digital logic

ties to mixed-signal testers. And at least one test-equipment maker is taking a fresh approach: Teradyne Inc. has designed a tester from the ground up to handle complex mixed-signal chips. The A500 Analog Very Large Scale Integration test system tightly links sophisticated digital signal processing in its mixed-signal tester with a full VLSI digital test system (p. 55).

Other makers are already taking the first approach for their stand-alone mixed-signal testers by making better use of digital signal processors, which can generate and analyze either a mixture of pure analog signals or digital representations of analog signals. The new breed of chips is forcing test-system vendors to beef up the performance of the DSPs in their products to handle higher-frequency analog signals and to bring higher-resolution stimulus and measurement to bear.

A second route that tester makers are taking to handle the new challenges is to give their mixed-signal systems the ability to handle the growing complexity of digital circuitry found on the chips they test. These systems must deal with large blocks of control logic, memory, and even entire central processing units. Standard mixed-signal systems generally have only rudimentary digital capabilities, but they now need to test logic with higher clock rates, higher timing resolution, and more digital pins per chip.

One way to do so is with expensive and complicated custom rack-and-stack systems composed of several separate computer-controlled instruments. Another way is to use two separate IC-test systems in combination. This approach enables a test-system vendor to offer both a standard mixed-signal system and a system designed for digital VLSI circuits—with multiplexing and other control circuitry at a single test head connected to both systems.

A third approach has been to combine increased digital test capabilities with mixed-signal functions in unified systems. Teradyne is the first to have done this integration of mixed-signal and digital capabilities within the test system itself; others are putting such capabilities together in a modular fashion, but the integration—the combination of analog and digital stimulus and response—is done out at the test head, not within the system. LTX Corp. of Westwood, Mass., for example, has designed digital modules that fit into its mixed-signal system. Others have added mixed-signal capabilities to digital test systems. In general, modular tester design makes it easier to offer systems with the right mix of functions for specific chips, and to upgrade the DSP-based mixed-signal side and the pure-digital side.

There is strong motivation for all the test makers' activity in mixed-signal systems. In a commodity-IC market that has been depressed for two years now, mixed-signal ICs are a welcome exception. According to market-research firm VLSI Research Inc. of San Jose, Calif., they make up the fastest-growing segment of the IC market (see table). Over the next two years, the subsegment including ISDN chips will experience the greatest volume of sales, says VLSI Research, but all mixed-signal devices will enjoy healthy growth rates and large volumes. The company predicts that the market for mixed-signal IC testers will grow from $234 million in 1986 to $305 million in 1988, at a compound annual rate of more than 14%.

LTX claims the lion's share of this healthy and growing market, but a number of others are nipping at its heels. LTX believes it has garnered about 70% of the market for mixed-signal testers. Advantest Corp. of Tokyo says it has nearly 20% of the market. Teradyne, Ando Electric, and ShibaSoku bring up the rear, and Hewlett-Packard Co., Palo Alto, Calif., has just introduced what it expects to be a strong entry.

Executives of these companies tend to agree

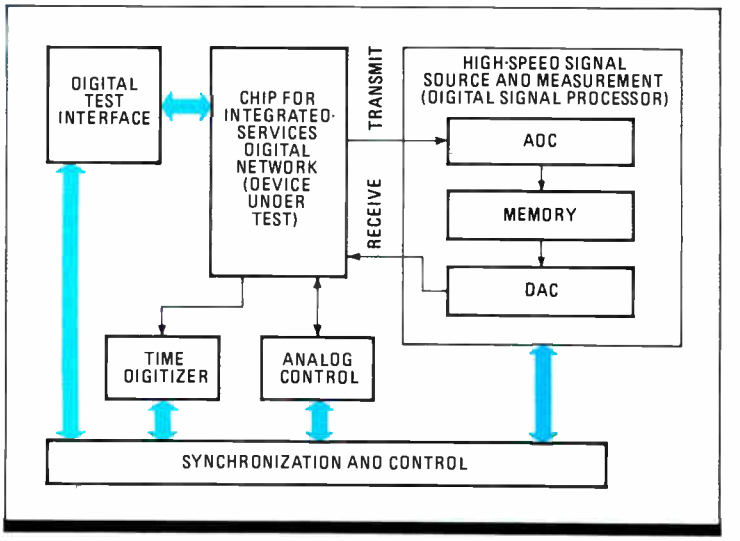
on one thing: Testing mixed-signal chips with racks of analog and digital stimulus and measurement instruments controlled by a central computer is no longer the best way. "Signals to test complex mixed-signal chips need to be generated using DSP techniques," says Roger Blethen, senior vice president of sales and support at LTX. And that's why the new A500 tester includes a DSP, says Michael Bradley, marketing manager at Teradyne in Boston. "With the DSP, the test engineer has such flexibility in what he can program that complex analog noise can easily be created. The DSP eliminates the need for a noise generator, pulse generators, and digital-signal-generator blocks."

LTX pioneered the use of DSPs to replace analog instruments more than five years ago. To upgrade the company's LTX-90 tester to handle the new ISDN chips, LTX has added a new DSP—based on the Analogic AP450 array processor—which contains a synthesizer and a digitizer and handles clock rates of up to 10 MHz. A computer provides synchronization and control. The DSP provides both a source and measurement of high-speed signals to the transmit and receive ports of an ISDN chip, for example (Fig. 1). A high-resolution analog signal as well as a digital data stream is applied to the chip to simulate the simultaneous voice and data communications functions of ISDN systems. Time digitization provides the ability to measure sequential events. A set of structured commands directs the operation of the DSP.

Blethen of LTX says that with the advent of complex chips such as ISDN devices, DSP-based testers will have to provide 10 times the bandwidth of current systems. Whereas a tester of modem chips only had to handle transmission rates up to 19.2 kb/s, an ISDN chip's rate can be as high as 192 kb/s. Filter measurements for an ISDN device require signal bandwidths of up to 5 MHz.

To meet such needs, Advantest uses a proprietary approach to high-performance digital signal processing that combines Advanced Micro Device's 2900-series bit-slice processor chips and a chip designed by Advantest. The DSP can be programmed to produce a wide range of signals, from white noise to the pure sine waves (–100-dB distortion factor) needed to test parts for compact disk audio players. Sine waves can be generated with frequencies as high as 100 MHz, but the full range of complex waveforms can only be produced up to 10 MHz, says Katsuhiko Shirakawa, assistant manager of ATE sales.

Last month Advantest announced a higher-performance set of data converters that can produce 200-MHz sine waves in its systems. Higher-performance DSPs will be needed to test chips for high-definition television equipment, Shirakawa points out. Although no satellites are in orbit for HDTV as yet, he says there will soon be a demand for suitable test systems. He also points out that there is some demand for testing audio-component parts to 18-bit linearity for high-end systems.



1. TEST PROBLEM. Testing ISDN chips requires the mixed-signal capabilities of a fast DSP, plus a digital interface.

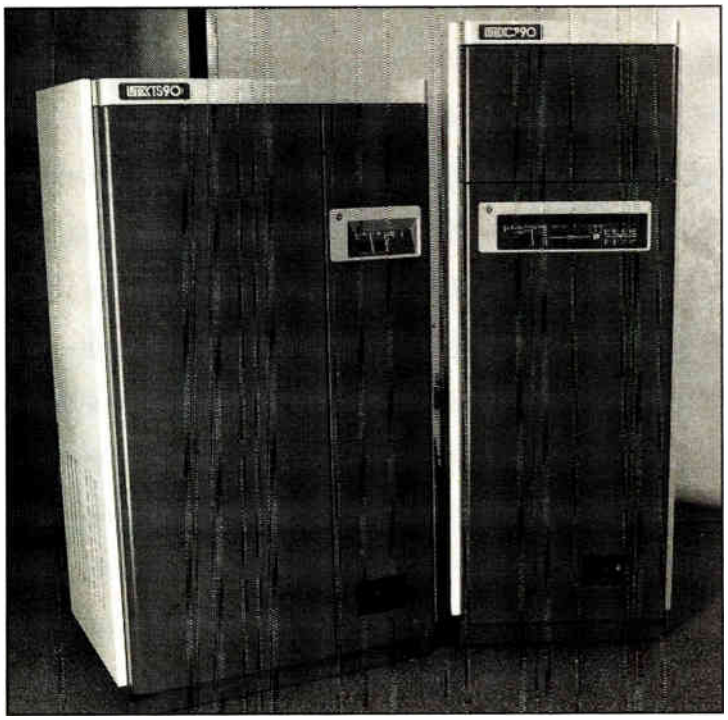
Teradyne's new A500 sophisticated high-performance DSP accurately produces analog waveforms. "For example, the manufacturer might want to generate a signal [emulating one] that had been corrupted by a bad telephone line to simulate the operating environment of an ISDN chip," says Bradley. With the DSP, generating such a signal is much easier than configuring an analog noise generator to do the job.

Current DSP technology in mixed-signal testers supports 12-bit analog-to-digital and digital-to-analog converters operating at signal frequencies up to 20 MHz. An example of a test system designed to test even faster ADCs and DACs is the newly announced HP 9480 from Hewlett-Packard [*Electronics*, Dec. 18, 1986, p. 129]. The system can stimulate a device under test at 128 MHz. Even high-performance digital VLSI testers currently can operate at only 80 MHz.

Another major performance advance in the HP system is its very low total harmonic distortion of –60 dB in the 128-MHz analog signal generator. Previous test systems could do no better than –50 dB, the company says. At some frequencies, the HP system can reach an even lower –80 dB. The high data rate and low distortion makes the system ideal for testing very fast devices, such as flash converters and high-speed video DACs.

HP achieved the 9480's low distortion by optically isolating the computer from the tester's instrumentation. The isolation eliminates ground loops between the computer and tester instrumentation, says Kuneo Hasebe, product marketing manager at HP. As a result, there is no more than 5 μV of system noise. "The next member of this new family of testers, due out in mid-1987, will broaden the system applications to include ISDN and other mixed-signal ICs," says Hasebe.

One function that will need to be added to mixed-signal testers like the HP system is a digi-



2. MAJOR PLAYER. The LTX-90, one of the most popular mixed-signal systems, will get an upgraded digital-test module in March.

tal stimulus and measurement capability. Over a year ago, LTX made available its integrated digital option, ID-88 for their family of mixed-signal testers, to add digital test capability. The extension provides 48 digital drivers and 48 comparators for testing the digital logic that has begun to appear on mixed-signal chips. A 20-MHz clock runs the two cards and allows a data rate at the pins of 5 MHz. Data pulses at the tester's pins have an edge-placement accuracy of 5 ns—the maximum difference between any two signals occurring simultaneously on any of the digital pins at the test head.

"In March this year we will announce an upgraded version of the integrated digital option, called the ID-90," says Neil Kelly, telecommunications business manager at LTX. It will allow the multiplexing of two pin drivers to achieve a data rate of 10 MHz.

Edge-placement accuracy on this new version will be improved to 2.5 ns, and the new unit comes with high-speed parametric measurement capability. For devices with large numbers of pins, this last feature will be important. "It cuts the time to make a parametric measurement of a pin by 5 to 6 milliseconds over the ID-88," says Kelly. "Test time and price are two characteristics of a test system of interest to a telecom buyer," he says. "They get concerned if the test system takes longer than 5 seconds to test a part and if the system costs more than $500,000."

Even with the new digital option, the LTX-90 (Fig. 2) will just nip under the $500,000 barrier. The base price of an LTX-90 runs about $350,000, and the price of the digital option will be $2,640 per pin in eight-pin increments.

The fast, high-pin-count digital capability that LTX will be adding is already on tap at the high end of Advantest's mixed-signal line. Two testers built around 128-pin digital systems—the T3740, which runs at a 40-MHz clock rate, and the 20-MHz T3720—can test microprocessors, ASICs, and DSPs with analog circuits on chip. They are also useful for video devices and high-performance data converters, which call for high speed, as well as audio devices, which require high precision.

Adding digital capabilities to mixed-signal testers is now being done with system modules by some vendors, but other companies do it by bringing together two separate systems for the job. For example, Ando Electric Co. of Tokyo combines its DIC-8060 mixed-signal system with its DIC-8030 digital tester. The DIC-8060 can test video and chroma circuits for TVs and very-high-frequency devices to 130 MHz. Ando's digital system can handle either 128 digital pins at 10-MHz clock rates or 64 pins at 20 MHz.

Like LTX, ShibaSoku Co. of Tokyo adds its digital-test options as modules on a mixed-signal system. It offers modules for dc, low-distortion audio, and radio-frequency and TV devices for its linear LSI testers. Modules adding up to 64 pins of digital-test capability at 15 MHz have been available since last September.

Other possible strategies can lower testing costs in some special cases. For example, Intel Corp. engineers added some custom analog capability to a digital VLSI tester to cope with the higher resolution of the ADCs on new versions of its 8096 one-chip microcomputer.

It was possible to test microcomputers with 8-bit ADCs on board, using the ±20-V range of the programmable measurement unit on testers such as the GenRad GR18, Teradyne Model 941, or Sentry 7, according to Steven M. McIntyre, Intel's senior technical marketing engineer at the Chandler Micro Division, Chandler, Ariz. But the new chips with 10-bit ADCs could not be tested with conventional digital VLSI test systems due to insufficient measurement resolution.

McIntyre devised a technique to use the 8096 itself to help test its on-board ADC. The technique requires an external circuit comprising a differential amplifier and a 12-bit reference DAC. During testing, the microcomputer is loaded with a small program such that it controls an external voltage source, to produce an analog input to its own ADC that represents the voltage it has been assigned to find.

For chips with more complex analog circuitry combined with substantial amounts of digital logic, strategies such as Intel's are not practical, however. The mixed-signal systems from LTX, Advantest, Teradyne, HP, and others are a more effective solution for ISDN chips and others. □

Additional reporting by Charles L. Cohen

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		V1	V2	V3		
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PMC15-2		5V・2.0A	15V・0.3A	−15V・0.2A		
PMC15-3		5V・2.0A	12V・0.3A	− 5V・0.2A		
PMC30-1	DC110~340V	5V・3.0A	12V・1.2A	−12V・0.3A	30W	38.5×60×145
PMC30-2		5V・3.0A	15V・0.7A	−15V・0.5A		

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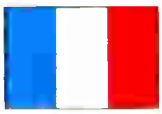

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COMPLEX MIXED-SIGNAL CHIPS GET A UNIFIED TESTER

Teradyne's A500 system incorporates a VLSI tester and a mixed-signal tester in the same package; its high-speed bus unifies their operation

by Jonah McLeod

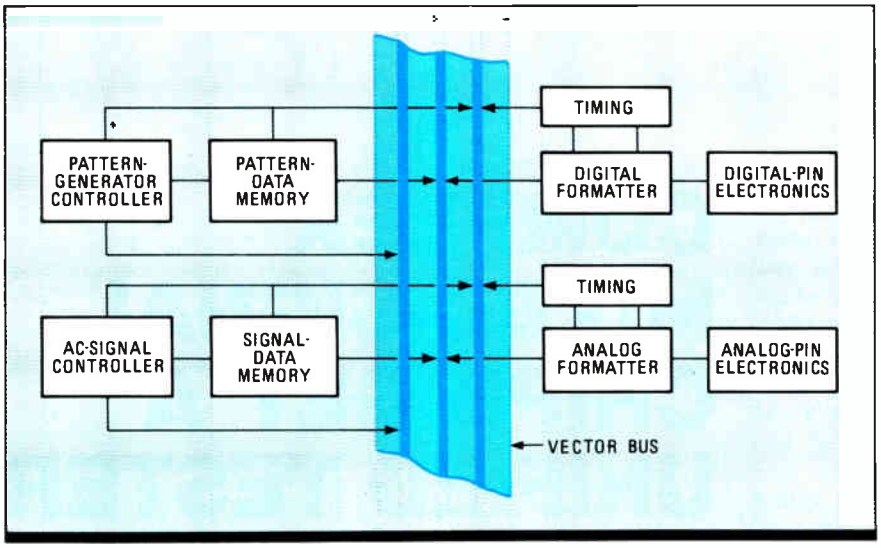
Testing the first analog-digital VLSI circuits that are starting to come off industry production lines has been a real nightmare. It takes months, for example, to develop the test programs and put together the hardware kludge needed to make these complex tests. Now Teradyne Inc. says that it has developed the first tester specifically designed to handle this difficult mixed-signal test problem, all in one pass.

Until now, chip makers have had to either move such complex products from one test head to another, or go through the costly and time-consuming process of tying two testers—a VLSI tester and a mixed-signal tester—together at a single test head. This approach requires the development of custom test-head hardware for switching and control, since pin assignments vary from one chip manufacturer to another. In such configurations, the digital and mixed signals must be multiplexed at the test head.

There are many ways to test complex mixed-signal chips (see p. 49). But Teradyne's A500 Analog Very Large Scale Integration test system is way out ahead—it has both of the required testers on board, and digital and mixed signals are precisely multiplexed on the system's internal bus before being delivered to a simple, universal 120-pin test head. The test head requires no custom hardware, because it can be dynamically reconfigured in software, and it features interchangeable device-interface boards for handling a variety of test functions. For example, a test engineer can quickly switch boards from wafer probing to production testing of packaged chips. The test package is rounded out by Teradyne's Image software, designed to speed test development.

The Boston company claims that by eliminating the need for custom hardware and streamlining the software, it has made a tester that can cut the test-development cycle for complex mixed-signal chips in half. And thanks to a powerful on-board digital signal processor, extensive filtering, and internal signal multiplexing, the A500 provides the precision needed to accurately and quickly test this new generation of chips.

1. FULL PACKAGE. Teradyne's A500 mixed-signal test system includes a universal 120-pin test head, two Sun Microsystems work stations, and the Image test-development software.



2. DYNAMIC DUO. Vector Bus II links a VLSI digital tester, for checking random logic and memory, and a mixed-signal tester, for checking digitized analog signals.

The A500 test system includes the test head, two Sun Microsystems Inc. work stations—one controlling the A500's operation and the other controlling the interface with the outside world—and the proprietary Image programming system (Fig. 1). Marketing manager Michael Bradley says the package will sell for between $850,000 and $2 million, with delivery slated to start in the second quarter of 1987.

The A500 unifies its two testers into a single architecture. Although the two testers work independently, the A500's bus, called Vector Bus II, coordinates their operation so that to the device under test the two appear as one (Fig. 2).

The VLSI tester checks the pure digital signals, and the mixed-signal tester checks the digitized analog signals. The digital VLSI tester includes a pattern generator and pattern memory, along with a digital formatter containing the comparators for comparing expected responses with the responses received from the devices under test. In the mixed-signal tester, a high-performance DSP generates the analog waveform stimuli that are applied to the device under test. The DSP is a single, highly accurate source of analog stimulation. It replaces the rack of signal and noise generators and other analog instrumentation used in older mixed-signal testers. The DSP can generate almost any analog waveform the tester might require, from dc to 20 MHz. A user can define up to 512 different ac waveforms simultaneously.

The ac waveform starts out as a digital bit stream and moves over the bus to the analog formatter, where a high-performance digital-to-analog converter in an ac source module produces an accurate ac signal. The source module sends the ac waveform as a differential signal to the test head. A differential amplifier in the test head rejects common-mode noise, ensuring a low-noise, high-quality signal at the device under test. To provide a wide range of mixed-signal applications, the source module provides two types of ac waveforms: low frequency—dc to 256 kHz, with up to 16-bit resolution—and high frequency, dc to 10 MHz with up to 12-bit resolution. Extensive filtering enhances waveform quality.

To evaluate an analog-signal response from the device under test, the process is the reverse of the synthesis procedure. An analog signal received at the test head is amplified or attenuated as needed and sent as a differential ac signal to the ac waveform digitizer in the analog formatter. To service a wide range of mixed-signal applications, the tester provides two types of waveform digitizers, with the same low- and high-frequency specifications as the source module. The digitizer also has the same bank of low-pass and high-pass filters as found in the source module. From the digitizer, the digital bit stream is stored in a capture memory that is 1 megasample deep by 20 bits wide. From there, the stored response is applied at the rate of 3 megabytes/s to a special array processor. The array processor can run at 8 million floating-point operations per second.

To evaluate the digitized signal, the analog formatter captures the digital bit stream and stores it in the capture memory. Normally, the formatter can collect data at a 25-MHz rate; but by multiplexing—ORing odd and even channels—it can do so at a 50-MHz rate. The stored response is then presented to the array processor for processing.

The A500 mixes digital and analog signals and coordinates tester operations internally via the Vector Bus II. The bus times the generation of analog and digital stimuli, and it allows stimuli to be generated and responses evaluated by different test instruments. Though the stimuli and responses are generated and acquired by individual instruments, the operation of these instruments can be controlled by the test-system programmer to simulate the integrated operation of mixed-signal chips, such as the multiplexing of digitized analog with digital data in an integrated services digital network chip.

TWO TESTERS ACT AS ONE

The Vector Bus II eliminates the need for custom hardware and software for coordinating the operation of the two testers. The bus implements three functions that allow the analog and digital testers to be integrated and synchronized: the Timemaster synchronizer, mixed-signal microcode, and multisource data mixing.

The Timemaster function synchronizes events and data on the bus to the same clock. It consists of a high-frequency clock designed for low

jitter and low noise. The clock controls the rate at which analog and digital patterns are generated, routed through the tester, and applied to the device under test. The master clock is generated from a frequency synthesizer and is programmable from 100 to 125 MHz with 1-Hz resolution.

The mixed-signal microcode control function allows the test programmer to write microcode that directs the operation of all the instruments, timing generators, and associated logic functions on the bus. With it, the programmer can simulate the actual environment of a device under test.

With the A500, any event at any digital vector is programmable in software. Written in the high-level Image language, mixed-signal microcode in the tester's digital pattern controller controls both digital pattern flow and the generation and capture of analog waveforms. Because the test engineer can synchronize not just to a common clock but also to a specific vector, the technique is called "vector locking."

The third function implemented by Vector Bus II, multisource data mixing, multiplexes digitized analog data with the purely digital data. The A500 allows independent sourcing and processing of both types of digital information by different functions in the tester. There is no need to manually mix the two in a separate memory before applying the stimulus to the device under test. Rather, the vector bus allows the two, using mixed-signal microcode, to be mixed on the fly at precise vectors. This saves development time and simplifies postprocessing of data from CAE and CAD tools.

Having mixed-signal microcode within the tester enables the use of a simpler, more general-purpose test head than was heretofore possible. Previous two-tester architectures required much of the coordination and multiplexing of analog and digital signals to occur at the test head.

The test head's device interface board is dedicated to a specific test setup, such as manual testing, wafer probe, or automatic-handler testing. A proprietary Iso-pin connection system allows delivery of low-distortion analog waveforms in the presence of high-speed digital edges.

The test head owes its simplicity to the A500's unified system architecture, with the high-speed Vector Bus II coordinating the operation of the two testers. Now, as ISDN, digital TV, and high-speed modem chips begin to proliferate, chip makers have a quicker, easier way to test them. □

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.*

HOW TERADYNE BUILT A TESTER TO HANDLE COMPLEX MIXED-SIGNAL ICs

As complex mixed-signal very large-scale integrated circuits—such as high-speed modems and chips for the integrated services digital network—began to appear, they proved to be a real challenge to test engineers. Standard testers just weren't capable of handling these chips, so test systems had to be cobbled together, always at a great cost in time and money. Michael Bradley, marketing manager at Teradyne Inc., says that three years ago the Boston company foresaw the need for a tester suited to these new chips. A design team, including engineering project manager Timothy Higgins, engineering managers David Sulman and Ernest Paul Walker, and applications manager Yves Destenaves, got right to work.

"Knowing we were going to build a tester for future generations of mixed-signal chips, we brought in applications engineers early in the design cycle," says Bradley. Destenaves says the team first determined "what features to include in the final tester—for example, a 6.1-MHz phase-linear filter to handle chips used in video applications."

Recognizing that the tester would require both a VLSI digital component tester and a functional tester for the analog circuitry, the design team quickly determined that the new tester had to be designed from the ground up. Moreover, the team decided that if the new product were going to cost less than two testers strapped together, it would be necessary to share common circuit elements where possible, to reduce design time and to make the tester cost-effective. To make the test system flexible enough to handle a wide range of mixed-signal components, it had to be highly programmable as well.

"The solution was to build a tester with an analog section that mirrored the digital section and had the same programmability," says Sulman. So the team built the analog section using digital signal processors to generate analog stimuli and a high-speed array processor for analyzing analog responses.

One of the early tasks was to decide what computer system to use as the tester's central control element. "We opted for two Sun Microsystems Inc. work stations, one for controlling the test system and one for interfacing with the user," says Walker.

The A500 test system took only three years to go from idea to product. "Design began in the fall of 1983, and we had schematics a year later," says Bradley. "By the first part of 1986 we had a prototype system." Most of the major components worked the first time, he says, "and the rest of 1986 was spent getting the smaller bugs out and getting ready for production."

THE A500 DESIGN TEAM. Key members, front row left to right: Sulman, Higgins, and Bradley; second row: Walker and Destenaves.

SUDDENLY, WORK-STATION MAKERS UNITE ON A WINDOWING STANDARD

Major vendors push MIT's X Windows System, promising support—and products

by Tom Manuel

A sudden wave of support for a work-station windowing system is sweeping the computer industry, with some of the biggest names among work-station vendors signing up to promote the X Windows System from the Massachusetts Institute of Technology as a global standard. Hewlett-Packard, Digital Equipment, and Apollo Computer got things started just before Christmas, when they agreed to back MIT's system. Since then, Data General, Siemens, Sony, Masscomp, Stellar Computer, Dana Computers, Adobe Systems, and Applix have chimed in—they all joined HP, DEC, Apollo, and MIT at a press conference in Cambridge on Jan. 15 to promote the system. Few industry standards have had such powerful backing at the starting gate.

Windowing is a screen display and user-interface technique for user control of multitasking and multiprogramming. A window system displays the activity of multiple applications on one screen at the same time. Users can change the size and shape of the windows and move data and graphics among them.

The makers pushing X Windows as a standard are urging that all work-station vendors help to set final specifications, further develop and enhance it, lobby the world's standards-making bodies to adopt it—and, most important, that they use X Windows in their products. Of the companies supporting the system, some already have commercial products that use it, and others expect to have products available soon.

Widespread adoption of a windowing standard, in conjunction with an operating system standard such as Unix and a network file system such as the Sun Microsystems Network File System, would allow applications programs written for one type of hardware to be easily ported to any other. Furthermore, applications would operate the same way on any work station over any network, making it easier to train users to work with new application programs.

Until now, the only candidate for a windowing standard has been the Network-extensible Window System, or NeWS, from Sun Microsystems, Mountain View, Calif. Sun has been promoting it since November and had won the backing of Intel Corp., which endorsed NeWS as the system of choice for 80386-based work stations. The move to X Windows lessens the chances for NeWS becoming a widely accepted standard, although Sun feels the two can coexist.

The X Window System is rapidly gaining support as a standard for two reasons: it is a proven system with all the features deemed necessary for a complete windowing system, and it is the only available system satisfying these criteria that is also in the public domain. The system has been under development since the summer of 1984 as part of Project Athena, a network work-station project at MIT's Laboratory for Computer Science. Project Athena was aided by funds from both Digital and IBM. MIT imposes no licensing restriction, distributes source code, and encourages both academic and commercial contributions to extend X Windows. As a result, X Windows has already undergone rigorous evaluation and extensive refinement, through its use at universities and within computer companies.

Another characteristic helped X Windows gain its sudden popularity. It can easily be extended, so work-station companies and application-software vendors can adopt the standard but add features to

LEADING COMPANIES LEND PRODUCT SUPPORT

A sizable group of work-station and software vendors are supporting, with their products, the X Windows System as a standard for writing window-based application software. Startups Dana Computers Inc., Sunnyvale, Calif., and Stellar Computers, Newton, Mass., will adopt the system for their first products. Already on the bandwagon are:

- **Apollo Computer Inc.:** Apollo's work stations now support applications programs that use X Windows.
- **Applix Inc.:** Applix's Alis office automation product uses X Windows now on MicroVAX II.
- **Data General Corp.:** DG just started shipping X Windows on its work stations. Some DG development tools now use it. No user applications are ready.
- **Digital Equipment Corp.:** X Windows has been available in Ultrix for a year; products using X Windows are due soon.
- **Hewlett-Packard Co.:** HP is unveiling an X Windows package for its HP 9000 Series 300 work stations. It includes the first commercial toolbox for developing user interfaces in X Windows.
- **IBM Corp.:** IBM will put X Windows in its academic version of the Andrew network distributed processing system.
- **Masscomp:** X Windows has not yet been shipped with any product, but version 10 is available in Masscomp's library. By year end, the company will support it across its product line.
- **Sony Corp.:** The NEWS 32-bit work station is designed to use X Windows.

distinguish their own products without compromising that standard. "A good analogy is car racing," says Bernie Toth, marketing programs manager at Digital's Ultrix marketing group. "What we are doing is agreeing on the standards for the racetrack but allowing freedom for the racers to design their own cars for competition."

Hardware vendors, software vendors, and users all stand to benefit from the acceptance of a windowing standard. But "the greatest reason for supporting a windowing standard is the user benefits to be obtained in terms of a richer multivendor environment," says Delmer E. Hunter, manager of advanced technology product marketing for the product marketing division of Data General Corp. "In reality, nearly all users have multiple vendors, and having standards among them is key to the industry."

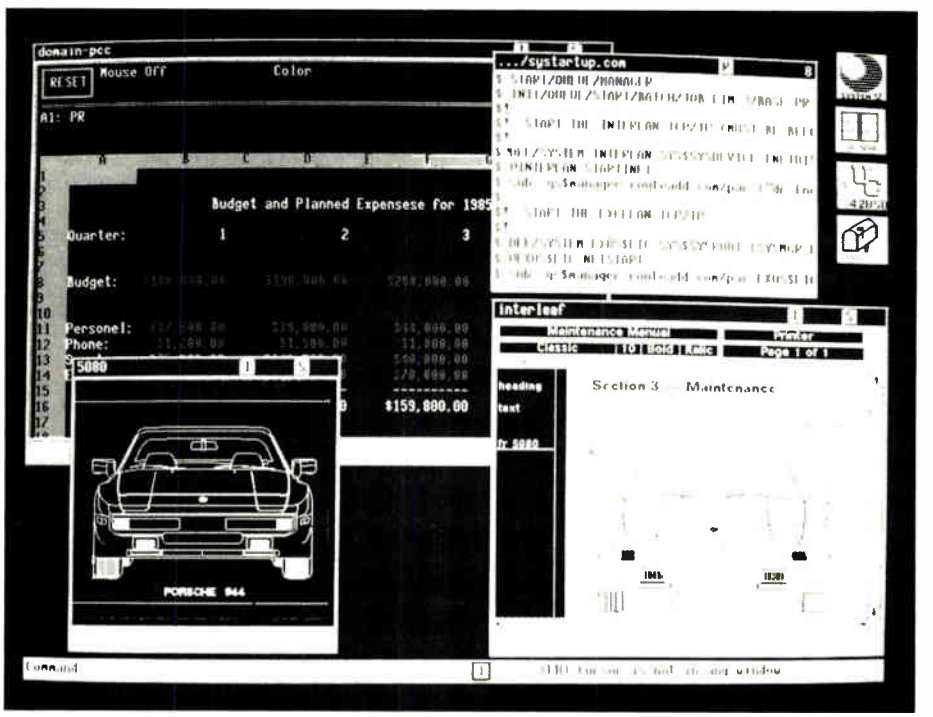
Adoption of a windowing standard will provide the next level of program portability after Unix, says Mark Hatch, marketing manager for Domain products at Apollo Computer Inc., Chelmsford, Mass. Unix, the de facto standard for work-station operating systems, provided the first level. "One of the more unusual things that has happened is the industry coming together so suddenly," he says. "It will compress the same leap forward that Unix represented into a much shorter time."

To get things going, the sponsoring group has proposed specifications for a set of high-level tools that applications developers can use in writing X Windows user environments and interfaces for their programs. The tools are available along with X Windows from MIT.

Even without formal adoption as a standard, commercial use of X Windows has begun. For example, Digital, in Maynard, Mass., has been offering the current version—Version 10—for all VAX systems in Ultrix, Digital's version of Unix for VAX systems, for a year. BB&N Advanced Computer Inc. of Boston offers X Windows on its Butterfly parallel computer. At Sony Corp., Tokyo, Dr. Toshi T. Doi, general manager of the super micro division, says, "X Windows is used in Sony's new Network Station 32-bit work station because X Windows excels in functions, features, and performance, and it's important to have an interface standard." Sony had its own windowing system but gave it up for X Windows. Doi says, "Sony will use X Windows in all future [work-station] products." X Windows is also available from several other work-station companies, including Apollo, Sun Microsystems, Data General, HP, and Masscomp. And IBM has announced that X Windows will be used in its version of Andrew, the advanced distributed computing network system developed jointly by IBM and Carnegie Mellon University, Pittsburgh. IBM will be offering its version of Andrew to the academic community later this year. All told, applications programs using X Windows have been ported to at least 7 machine architectures from more than 12 manufacturers using 16 different display environments.

The competition, Sun Microsystem's NeWS, is also an open system that operates on a range of computer systems, such as Sun's 68020-based work stations and 80386-based microcomputers and work stations. NeWS supports different user interfaces and window-based applications across a network of computers ranging from supercomputers to work stations.

Michelle Arden, product manager for NeWS at Sun, says, "NeWS and X Windows don't really compete at one level. NeWS is a functional superset of X." According to Arden, X Windows applications can run on top of NeWS, and people implementing NeWS will be able to deal with X Windows too, if they want. Sun is dedicated to NeWS, which it will begin shipping in March. They have had a lot of interest in it, according to Arden. "We had over 100 requests for the beta-test version," she says. Sun was asked to join the group supporting X Windows but has not yet decided what to do. The company believes that NeWS, because it is newer than X Windows, solves some problems with extendability and device independence better than X Windows and that there is room for both in the market. □



THROUGH THE WINDOW. Windowing systems such as X Windows allow users to work with multiple applications simultaneously and to move files and data back and forth among them.

UPDATE: COAX PC BOARDS GO TO PROTOTYPE


EMBEDDED COAXIAL WIRES SPEED PRINTED-CIRCUIT BOARD

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

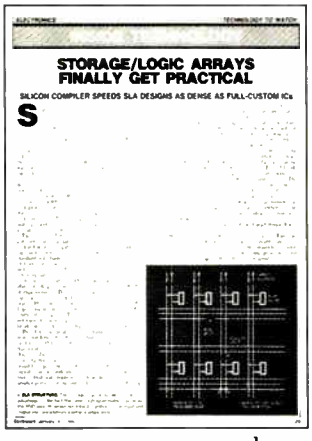
The coaxial interconnection board from Multiwire called CoAxe is still at the prototype stage a year after its introduction, but it is getting more and more attention. "We are making boards for about five different clients, and we are getting inquiries practically every day," says Leonard Schieber, product development manager for CoAxe. "A year ago, people simply wanted to inquire about the technique. Now, they want boards built."

The board was developed by the Advanced Manufacturing Group of the Hicksville, N. Y., division of Kollmorgen Corp. to overcome the limitations imposed by printed-circuit-board wiring, which can cause delays in sending signals from one chip to another.

The CoAxe board uses a microminiature coaxial cable with a low-dielectric-constant insulator to increase signal speed. It has an outer diameter of 9.5 mils and an inner conductor of 3.1 mils. There are two versions—one insulated with PTFE (polytetrafluoroethylene) Teflon, and one with expanded Teflon. The former has a dielectric constant of 2.2, the latter a dielectric constant of 1.3 [*Electronics*, Jan. 27, 1986, p. 56].

Most of the prototype boards now being made use a PTFE-coated wire. Schieber says that the boards' applications generally call for operation at 1 to 4 GHz, so the higher-dielectric-constant material is good enough. Most of them are test vehicles for single gallium arsenide IC chips, the market for which Multiwire originally targeted CoAxe. As a result, the success of CoAxe appears to be linked to the future of GaAs ICs. Schieber says the next big step—moving from prototypes to full production—will come when, and if, GaAs activity builds up. *–Jerry Lyman*

UPDATE: CIRRUS COMPILER IS A YEAR AHEAD OF PLAN


STORAGE/LOGIC ARRAYS FINALLY GET PRACTICAL

SILICON COMPILER SPEEDS SLA DESIGNS AS DENSE AS FULL-CUSTOM ICs

A year ago, Cirrus Logic Inc. introduced a silicon compiler that it said would allow a designer to create chips with the density of handcrafted, very-large-scale-integration designs in weeks, not months. Today, the company is at least a year ahead of the growth projections it made at the time of the introduction, says its president, Michael Hackworth. Besides winning as customers a number of systems houses, Hackworth says, the company has developed a working relationship with several semiconductor companies that use the company's methods to quickly turn around VLSI-level standard products.

The Cirrus compiler is based on a proprietary gate-array technology called the storage/logic array, in which localized and distributed gates are used. By using the distributed gates to perform both logic and interconnection functions, the arrays eliminate the need to set aside wide channels for interconnections. The compiler was developed to ease design of the arrays, which otherwise would require specialized computer-aided design systems [*Electronics*, Jan. 20, 1986, p. 29].

The first demonstration of the compiler's effectiveness came shortly after its introduction, when Cirrus took on a challenge from Advanced Micro Devices Inc. of Santa Clara, Calif., to develop a compiled version of the company's 29C10 microsequencer. Cirrus met the challenge not once but three times.

In the first try, Cirrus recompiled the 29C10 without any modifications and produced a working design in eight weeks that was just as fast as the original and 5% smaller. On a second go-around, some logic changes were requested, and the new design was recompiled in less than two weeks, came out 20% faster, yet added only 6% to the total chip area. In a third effort, changes to the process data base were required. The recompilation took only another two weeks and produced a circuit that was 30% faster and only 10% larger.

Since then, interest has spread rapidly. Originally, Cirrus had planned to offer what it called "silicon templates"—generic circuits in software targeted at specific markets, such as data communications, mass storage, and display-graphics applications. Customers could modify the circuits using what the company called "concept specification."

The concept-specification approach that Cirrus began with has now evolved into what Hackworth calls the "semistandard" circuit. "Basically, we found that when we went to a potential customer with a concept spec for a data-commu-

nications or mass-storage circuit and told them we would build what they wanted based on their modifications, they wanted to see something concrete," he says. "They wanted to see the actual device in the spec sheet. So, we have developed actual semistandard devices based on the concept spec that potential customers can use as is, or with modifications based on changes to the specification."

The first such product to emerge from the company is a Winchester-drive controller semistandard IC, which the company says outperforms the industry standard and can be modified to a particular customer's requirements in a matter of weeks. In development over the past year, says Hackworth, have been perhaps a dozen other semistandard designs. Still in the early phases of development are at least a dozen more. "And these are more than just taking a netlist and generating a design," he says. "These are efforts that we started from scratch, from product definition, to design, to product spec to actual semistandard silicon."

In terms of actual shipments of parts, Hackworth says that "in September 1986, we had a party celebrating the shipment of our 100,000th part. The next month, we shipped a total of 80,000 circuits. And the curve has not stopped ramping upward. Things are pretty crazy around here. They should settle down to a 'normal' growth rate any time now. But not yet, please, not yet." *–Bernard Conrad Cole*

TECHNOLOGY TO WATCH

UPDATE: FAIL-SAFE CHIP 'PRETTY MUCH' ON TIME

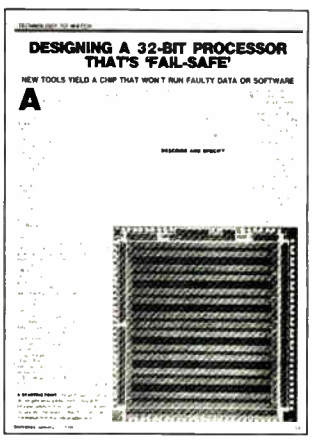
The effort by the UK's Royal Signals and Radar Establishment to produce a 32-bit microprocessor that won't run faulty data or software is on schedule and should produce commercial chips early this year. John Cullyer, the development team leader, sums up his team's work simply: "We are pretty much on time."

Called Viper, for Verifiable Integrated Processor for Enhanced Reliability, the chip is being developed by the RSRE's high-integrity computer group in Malvern. The group set out more than a year ago to produce a chip that could prevent malfunctioning in applications where glitches could literally be fatal: military, aircraft, nuclear power, medical, and robotic applications [*Electronics*, Jan. 27, p. 53].

In fact, the project not only has produced prototypes and promises to deliver commercial versions soon—it also has come up with a new version of the chip that monitors its own performance. Called Viper 1A, it works by coupling two Viper chips.

The original Viper was designed by the RSRE, which then licensed Marconi Electronic Devices Ltd. and Ferranti Electronics Ltd. to produce prototypes. After working throughout the first three quarters of 1986, each delivered 10 samples in October. The prototypes had some fabrication problems, but "there was nothing wrong at the higher levels, such as in the math. There were some problems, but nothing serious. These chips largely worked but did not fully work," says Cullyer. Ferranti and Marconi are now reworking the chips, and Cullyer says he is confident that this time fully functional chips will be produced.

The next stage is for the fully functional chips to undergo a peer review by 14 independent laboratories. Single-board computers were delivered to the labs last month. "We shall supply in mid-January the fully functional chips to plug into these boards," Cullyer says. "The peer review will begin in February and last for three months, followed by one month to write up the reports."


DESIGNING A 32-BIT PROCESSOR THAT'S 'FAIL-SAFE'

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

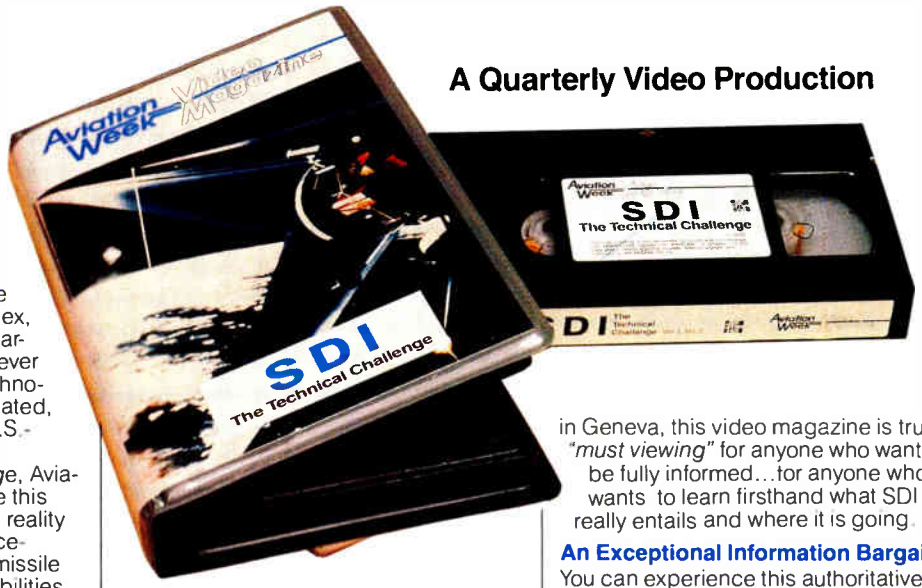
A

These reports will be compiled into a summary that will be available in June, Cullyer says. Meanwhile, Marconi and Ferranti are going ahead with commercial versions of the chip. Both are taking orders for commercial-specification prototypes and expect to go into full production fairly soon.

The one stumbling block so far is the planned language for Viper called NewSpeak, which is not running on schedule. The language will contain built-in checks to guard against program errors. A year ago, it was expected that NewSpeak would be ready for the full commercial launch in the late 1980s. Cullyer now does not expect it to be ready until 1990 or 1991. He says the setback is not serious. The RSRE has developed a stopgap language called Vista, for Viper Standard Assembly Language, on which all the early chips will run. NewSpeak has been evolving slowly, Cullyer says, "so Vista will have a significant life."

On the positive side, an unexpected development will lead to a new version of Viper. A research firm, Cambridge Consultants Ltd., started a study in May to see if Viper chips could be linked together. Its work led to Viper 1A, which is still on the drawing board. Eventually, it will become an upwardly compatible version of Viper, in which the chips do cross-checks on each other. For example, a slave Viper will monitor the master Viper; if there is a problem, the slave will shut down the system. Cullyer expects commercial versions of Viper 1A to be available in the first quarter of 1988. *–Steve Rogerson*

Let the Editors of Aviation Week take you *inside* the complex, challenging world of SDI. In a new Aviation Week Video Magazine.



A Quarterly Video Production

Must Viewing!

The Strategic Defense Initiative ...it's the biggest, most complex, challenging, and by a wide margin, expensive defense program ever conceived. And even while its technological feasibility is still being debated, it has become the core issue in U.S.-Soviet relations.

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- Where does SDI stand today? Where is it going?
- What technologies are most promising at this point? When can each reasonably be deployed?
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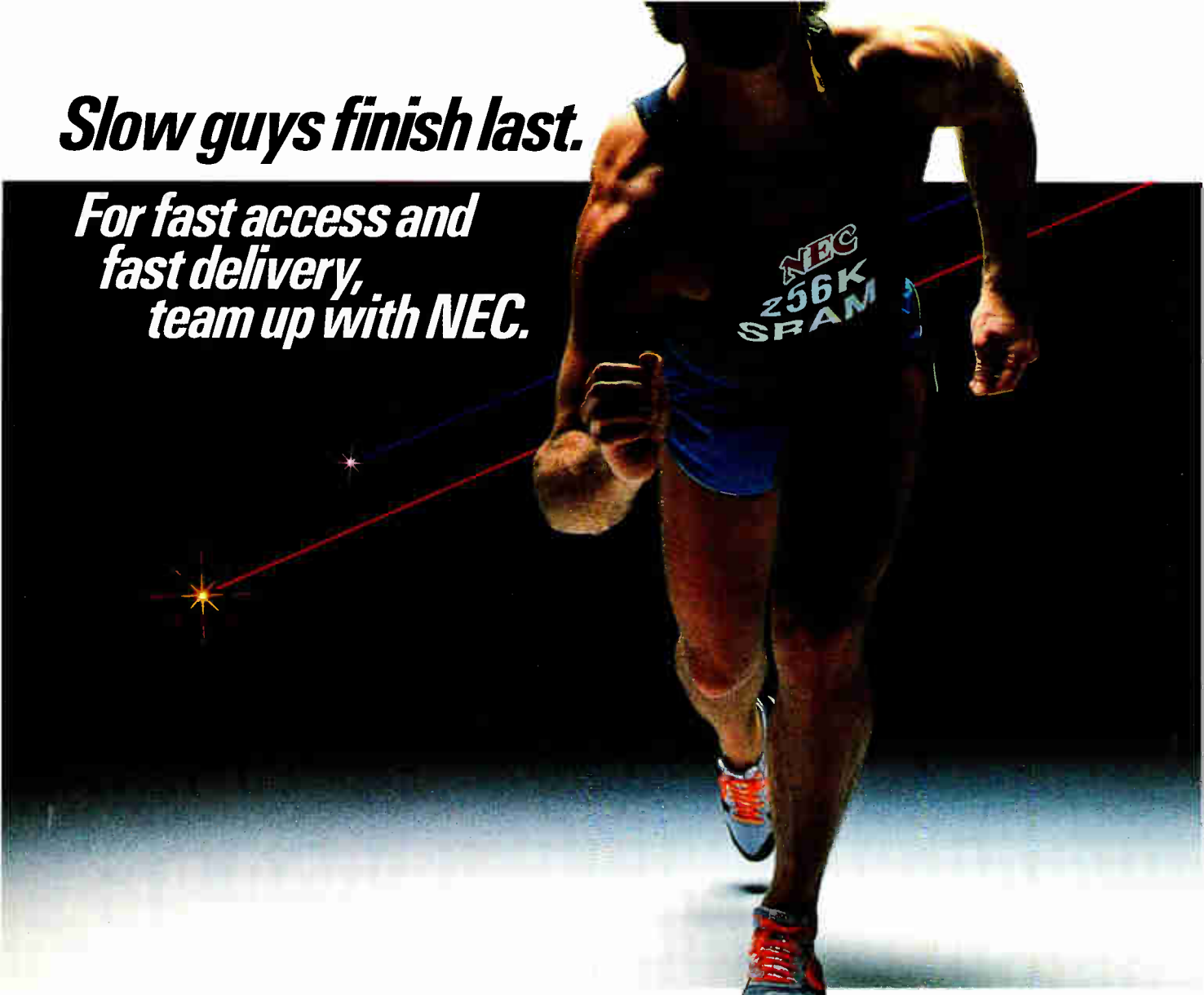

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OVERSEAS MARKET REPORT

ANOTHER TOUGH YEAR

INTRODUCTION

EQUIPMENT MARKETS STEADY, COMPONENTS COMING BACK

Steady growth for equipment makers and a welcome comeback for components makers is the word for 1987 in the top five overseas electronics markets: Japan, West Germany, the UK, France, and Italy.

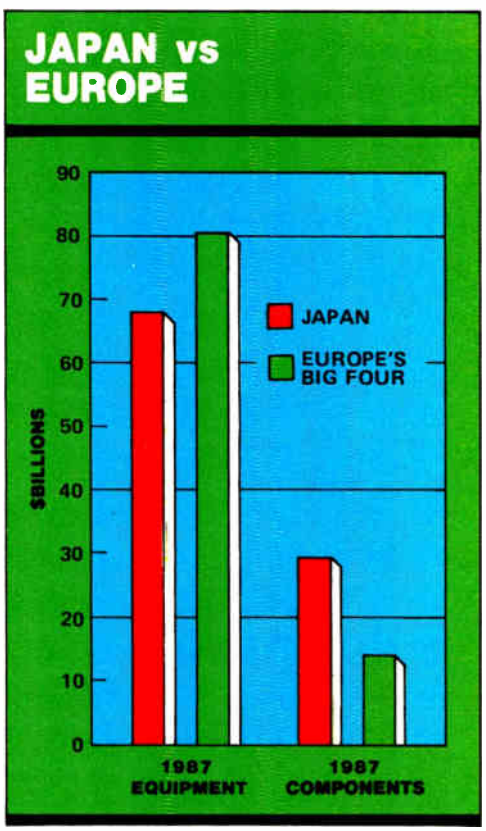
All told, sales of electronics gear in these five nations will total $149 billion this year, according to *Electronics*' annual overseas market survey. That works out to nearly a 10% rise over the $136 billion estimated for 1986, a year that saw almost a 9% increase. The rise in the 1987 growth rate will keep the overseas equipment markets in pace with U.S. markets, which are expected to grow 10%. But even together, the five can't match the U.S. equipment consumption—an estimated $166 billion.

In components, total sales of $43 billion are in the offing for the five overseas markets. Although that is only a gain of 4%, it is nonetheless a welcome bound upward from the barely perceptible 1% increase logged last year. Chiefly because of the large quantities of export equipment produced in Japan, component sales in the five overseas countries actually will top those in the U.S., reckoned at $34 billion. The U.S. report [*Electronics*, Jan. 8, 1987, p. 51] shows over $12.4 billion in semiconductor sales for 1986 and over $21 billion for other components.

Japan, of course, far outstrips any one of the four major European markets. Equipment sales in Japan should be good for $68 billion this year, whereas all four European markets should log a total of $80 billion. The contrast is even more striking in components: the 1987 forecast is $29 billion in Japan and $14 billion in Europe.

For equipment suppliers in Japan, the 1987 script reads much like 1986's, with 11% growth after a 10% hike last year. Data processing and office equipment, the largest market sector, will set the pace with 16% growth. Consumer electronics, however, will remain relatively static with only 6% growth. Communications-equipment makers will see their home-market growth slow to 5% after last year's exceptional 16%. The market for industrial-electronics gear will accelerate by 7% after a no-growth year in 1986, largely because of a rebound in semiconductor production equipment. Test and measurement equipment makers will score gains of 9%, and computer-aided-design and engineering gear will most likely wind up as the 1987 growth champion. It could shoot up by nearly 50%, but it will remain the smallest category in *Electronics*' survey.

Components suppliers can expect a slightly improved market in Japan this year: up 4% to $29 billion after a flat 1986. This slight increase will come mostly from semiconductors, particularly integrated circuits. The consensus among semiconductor houses is an 8% gain for ICs this year, in part because the inventory overhang that cast long shadows on the market last year has largely disappeared. Passives and hybrids are flat, tubes slightly down.



All told, the four top European economies are expected to grow slightly less than 3% this year, the same as 1986—indicating that equipment makers can expect much the same growth patterns this year as last. *Electronics* forecasts that European equipment markets will total $80 billion—almost $33 billion for West Germany, more than $18 billion for the UK, $17 billion for France, and more than $12 billion for Italy. The projected gain, therefore, is 8% over the estimated $74 billion in 1986, also a year of 8% gain.

European components suppliers should find 1987 more encouraging than last year. Their markets should come back nicely from last year's slight 2% gain; the survey projects an 8% in-

crease to almost $14 billion.

As in the U.S. and Japan, computers and office equipment will set the tone of the equipment markets in West Germany, the UK, France and Italy. Together, they are expected to grow nearly 11%, a gain of some $4 billion, and two thirds of the equipment market gain among the "Top Four" of Europe will come from data processing and office gear. Personal computers and computers priced up to $20,000 will climb the fastest.

Consumer products, the No. 2 sector, won't do nearly as well. An increase of nearly 3%, pushing the sector to $15 billion, appears likely. Market penetration of color-TV sets now runs 85% in Western Europe, which translates into a low-growth replacement market. Growth in audio is almost flat, except for compact-disk players.

As for communications equipment, 1987 should see a rise of just over 4% to $14 billion for the top four European markets. But little growth is just one preoccupation with European communications-gear makers. "Turbulent markets are in store for telecommunications and defense electronics over the next five years," says Cees Klap, of the corporate strategic-planning department at Philips International BV Eindhoven, the Netherlands. In his view, too many companies are vying in telecommunications, and a shakeout is in the offing.

Industrial-electronics equipment, although a much smaller market than computers, consumer electronics, or communications gear, will show lustier growth in the four leading European nations. A 13% climb will carry the sector to $5 billion, the survey forecasts. The gain is largely due to automation, particularly at automakers and producers of electronics gear. "Competition from the Japanese is driving companies to revive [their production facilities]," says Piet van Dalen, managing director of Philips' Industrial and Electro-Acoustic Systems Division in Eindhoven.

The related test and measurement category will log a respectable near-6% growth, for a total of $1.3 billion, according to the *Electronics* survey.

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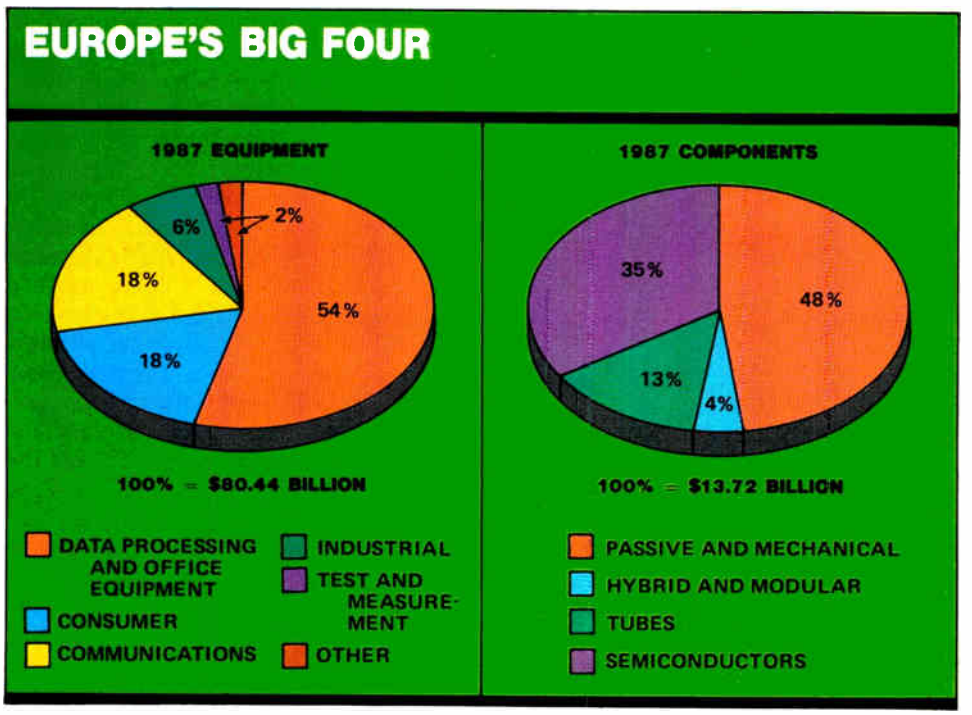
The forecasts in *Electronics*' overseas market report are based primarily on questionnaires filled out by marketing executives at companies in Japan, West Germany, the UK, France, and Italy that manufacture the equipment and components listed in the country-by-country charts. In addition to these primary sources, *Electronics*' staff consulted industry trade associations and market-research houses such as the Bureau d'Informations et de Prévisions Economiques in France; Teknibank SpA in Italy; Dataquest UK Ltd. and Benn Electronics Publications Ltd., publishers of the Mackintosh Yearbook, in the UK; and IDC Deutschland GmbH in West Germany.

Respondents were asked to estimate in local currencies the consumption for national markets, taking inflation into account. Consumption was defined as sales by importers and by domestic vendors, not including exports. The survey was conducted in October and November, so the figures for 1986 are estimates rather than full-year data.

Forecasts based on the survey were calculated in local currencies and converted to U.S. dollars using the same exchange rates for all three years (see table). Because foreign currencies have strengthened against the dollar over the past 15 months, this year's charts show higher totals than those published in 1986. The difference is particularly noticeable in the charts for Japan, (235 yen equalled $1 last year, and 163 equal $1 this year) and West Germany, (2.75 marks equalled $1 last year and 2 marks equal $1 this year).

Some product categories have been added in this year's survey, some definitions changed, and other categories deleted. So totals may not be directly comparable with those of previous *Electronics* market reports.



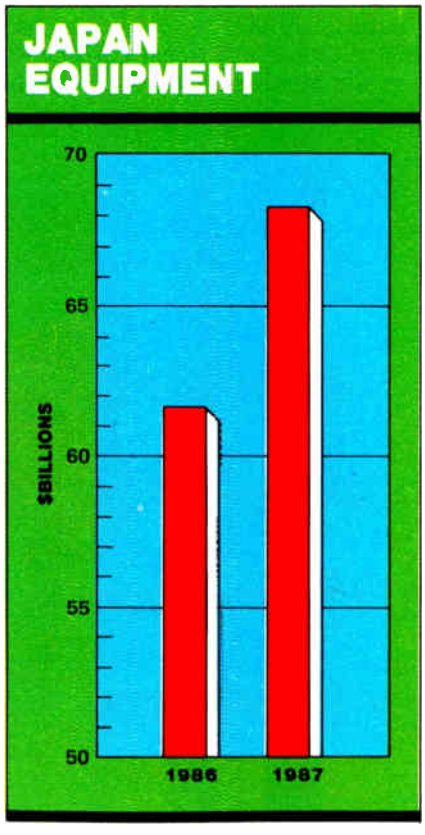
JAPAN

WITH COMPUTERS LEADING THE WAY, EQUIPMENT WILL RISE 11%

Japanese equipment makers are looking at another year of moderate growth, with sales rising 11% to $68.3 billion overall. The overall 1987 rise will be roughly equivalent to last year's, when sales of $61.6 billion worked out to an increase of 10%.

Just over half of the total 1987 equipment consumption will be allotted to data-processing systems, where consumption will rise 16% to $34.3 billion on the heels of a 14% increase last year. Among individual systems, personal computers used in fast-selling office and engineering work stations, will make the most impressive gain, up 21% to $2 billion following a 16% jump last year. But the really eye-popping increase will be in data-storage subsystems. Propelled by the seemingly unquenchable thirst for more storage, this category will soar 30% to $4.7 billion, with optical-disk systems alone climbing 69% to $132 million. All this activity is rooted in the rush to catch up with the U.S. in personal computers, which are replacing stand-alone word processors and terminals. Once those PCs are installed in an office, a need develops for department-level computers and higher.

In consumer electronics, the boom days are over. Dragged down by saturation and some mature products, the sector will grow only 6% to $19.3 billion. Negative results will be seen in some mature areas: consumption of phonographs will be down 12% to $61 million; and tape recorders and players will be off 4% to $906 million. Home video equipment will increase just 7% to $4.3 billion. Within that category, ½-in.-format video cassette recorders will show the effects of the 8-mm attack and drop 2% to $2.8 billion. The 8-mm products are coming on strong, though from a small base: they will be up 40% to $172 million. However, plans announced this month for development of a higher-resolution VCR format compatible with VHS could hurt 8-mm. Meanwhile, the camcorder market looks strong for both formats: ½-in. models will rise 17% to $387 million and 8-mm products will increase 55% to $380 million.



With semiconductor production showing only a little life and investment for big-ticket test systems decreasing, prospects for component and board testers have manufacturers of test and measuring gear hoping for an improved growth rate in 1987. Overall, *Electronics* shows a gain of 9% to $1.4 billion, just slightly better than 1986's 6% increase.

Independent communications companies are in place, and everyone is waiting for the Japanese version of the integrated services digital network, so investment in communications equipment will cool off considerably from the 1986 rate of 16%. The survey indicates just a 5% gain to $7.1 billion. Growth will be reduced virtually across the board, though there will be increases in a few categories, including fiber optics, up 20% to $309 million, and satellite earth stations, up 24% to $31 million.

Smiles should return to the faces of the folks who make industrial electronics equipment. The reason is a 7% growth rate for 1987 to $4.8 billion, with semiconductor-production equipment leading a new cycle of replacement purchasing. Though modest, this rise is remarkable coming off a flat 1986. *Electronics* forecasts the semiconductor-gear segment rising 9% to $1.9 billion, after a 3% decline last year.

One segment that will show substantial percentage gains, though still relatively small in dollar volume, is computer-aided design and engineering. There, the survey pegs 1987 sales at $280 million, up 43%.

But whatever happens to the equipment business in Japan, it's the computer industry that will call the tune. A bullish Yuichi Murano, computer industry analyst for Dataquest Inc., Japan, says

Japanese computer sales have outperformed the world for the past two years and will continue to do so in 1987. Murano sees the Japanese computer market growing some 50% between 1985 and 1990. By that time, he says, the business-computer share of the market will decrease from 66% to 61%, with the

JAPAN EQUIPMENT

	(millions of dollars) 1985	1986	1987
Communications equipment, total	5,829	6,780	7,098
Data communications equipment	382	451	491
Facsimile terminal equipment	1,063	1,127	1,190
Fiber-optic communications systems	166	258	309
Intercom systems	108	136	144
Paging systems, public and private	140	155	166
Radio, total	1,453	1,683	1,724
Broadcast equipment	337	344	350
Microwave systems	643	833	826
Mobile, land	337	380	417
Mobile, marine	113	101	98
Satellite earth stations	23	25	31
Telecommunications systems	1,060	1,147	1,178
Telephone and data switching, private (PABX)	350	380	423
Telephone and data switching, public	699	839	804
Television equipment, total	408	604	669
Broadcast (studio)	190	198	209
CCTV (including educational, industrial, and medical)	218	406	460
Data processing and office equipment, total	25,925	29,539	34,246
Data processing systems, total	11,249	12,757	14,569
Personal computers (less than $5,000)	1,403	1,627	1,969
Work stations	1,933	2,276	2,656
Office computers	1,880	2,067	2,267
Minicomputers ($20,000 to $100,000)	589	604	626
Superminicomputers ($100,000 to $400,000)	903	1,067	1,241
Mainframe computers ($400,000 to $1 million)	4,385	4,920	5,607
Supercomputers (greater than $1 million)	156	196	203
Data input peripherals	531	552	578
Data output peripherals, total	3,451	4,001	4,741
Displays	963	1,137	1,364
Impact-type printers	1,848	2,131	2,515
Nonimpact-type printers	442	510	620
Other data-output peripherals	198	223	242
Data storage subsystems, total	3,016	3,628	4,322
Flexible disks	706	951	1,135
Hard disks	1,756	2,019	2,679
Magnetic tapes	455	531	719
Optical disk systems	56	78	132
Other data storage subsystems	43	49	57
Data terminals, total	3,258	3,681	4,233
CRT	1,325	1,497	1,724
Other (teleprinters, remote job entry, etc.)	1,933	2,184	2,509
Electronic office equipment, total	4,420	4,920	5,403
Calculators (nonconsumer)	798	801	834
Copying equipment	1,448	1,479	1,533
Facsimile transmission systems	1,111	1,374	1,558
Kanji word processors	791	1,022	1,250
Billing and accounting equipment	272	244	228
Industrial electronic equipment, total	4,499	4,488	4,794
Inspection systems	136	145	152
Machine-tool controls	500	509	510
Motor controls	258	264	265
Process-control equipment	1,750	1,780	1,898
Semiconductor production equipment, total	1,742	1,698	1,856
Assembly (wire bonders, etc.)	394	325	360
Lithography	554	448	515
Mask-generation	102	121	141
Wafer-processing	692	804	840
Ultrasonic cleaning equipment	113	92	113
Power supplies (noncaptive), total	1,132	1,197	1,268
Bench and lab	52	58	61
Industrial (heavy duty)	117	124	129
OEM and modular, total	963	1,015	1,078
Linear	30	33	35
Switching	933	982	1,043

	(millions of dollars) 1985	1986	1987
Consumer products, total	17,291	18,147	19,283
Audio equipment, total	4,666	4,709	4,879
Car audio	930	988	1,135
Stereo equipment, total	1,214	1,246	1,295
Components (including tuners, turntables)	999	1,013	1,031
Consoles and compact systems	215	233	264
Phonographs and radio-phono combinations	76	69	61
Radios (including table, clock, and portable)	118	111	110
Radio/recorder combinations, portable	933	933	943
Tape recorders and players	996	945	906
Compact disk players	399	417	429
Television receivers, total	3,430	3,687	3,852
Color	3,393	3,650	3,816
Monochrome	37	37	36
Other consumer electronic products, total	9,195	9,751	10,552
Home video equipment, total	3,685	3,998	4,284
Cassette players and recorders	2,754	2,884	2,871
Cameras	299	256	367
Camcorders, total	362	576	767
8-mm	178	245	380
1/2-inch	184	331	387
Videodisk players	242	256	367
Projectors	28	26	32
Home satellite receiving stations	1,043	920	1,104
Electronic musical instruments	344	319	307
Microwave ovens	644	724	755
Telephone answering devices	19	17	14
Home computers	736	871	988
Home computer peripherals	264	313	393
Home kanji word processors	503	546	571
Intrusion alarms	276	276	276
Electronic games (video and nonvideo)	460	583	675
Calculators (personal and professional)	258	233	227
Electronic watches and clocks	963	951	958
Test and measuring instruments, total	1,182	1,257	1,367
Amplifiers, lab	68	74	80
Analog voltmeters, ammeters and multimeters	23	21	19
Automatic test equipment, total	437	478	522
Component testers	71	81	92
IC testers	284	307	331
PC-board testers	82	90	99
Calibrators and standards, active and passive	20	28	42
Counters, time and frequency	26	27	28
Digital multimeters	39	33	37
Digital signal analyzers	35	37	38
Logic analyzers	35	34	35
Microprocessor development systems	104	106	120
Microwave test and measuring instruments	43	48	50
Network analyzers	21	23	31
Oscillators	30	31	34
Oscilloscopes (including accessories)	114	120	123
Power meters (below microwave frequencies)	21	21	21
Recorders (including chart and X-Y types)	62	66	71
Signal generators (pulse, sweep, and function)	60	61	61
Spectrum analyzers	44	49	55
CAD/CAE equipment, total	150	196	280
IC design work stations	40	58	74
PC-board design work stations	49	67	104
Other engineering work stations	61	71	102
EQUIPMENT, TOTAL	56,008	61,604	68,336

All figures in current U.S. dollars.
The figures in this chart, based on a survey made by Electronics in October and November 1986, estimate the noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
Exchange rate: 163 yen to $1.

slack taken up by personal computers (going from 18% to 21%) and work stations (going from 16% to 18%). He also forecasts spectacular growth in technical work stations, which he sees growing faster than the *Electronics* survey would indicate. He pegs the annual compounded rate from 1985 to 1990 at 49.2%. *Electronics* forecasts 17% growth to $2.7 billion in 1987 for work stations, against 18% growth to $2.3 billion last year.

But *Electronics* shows personal computers as the best single system performer next year, with a 21% rise to $1.9 billion on top of a 16% gain to $1.6 billion last year. A survey by Nikkei Computer magazine shows that NEC Corp. is still No. 1 in personal computers purchased by small and medium businesses since the beginning of 1985, with IBM Japan second and Fujitsu third. Although NEC sold more than twice as many systems as IBM, those sales are split between two Intel 80286-based MS-DOS families whose architectural differences render them largely incompatible. IBM has a single MS-DOS family also designed around the 80286.

One foreign player in the Japanese market that is using its own technology to piggyback the NEC dominance in personal computers is Control Data Japan Ltd. The company is marketing its Plato computer-based training system with the NEC series 9800 in the fast-growing computer-aided-instruction market. Ed Schaffner, executive assistant to the president at Control Data Japan, says the CAI market was worth $200 million last year, will increase to $300 million in 1987, and hit $1 billion by 1990.

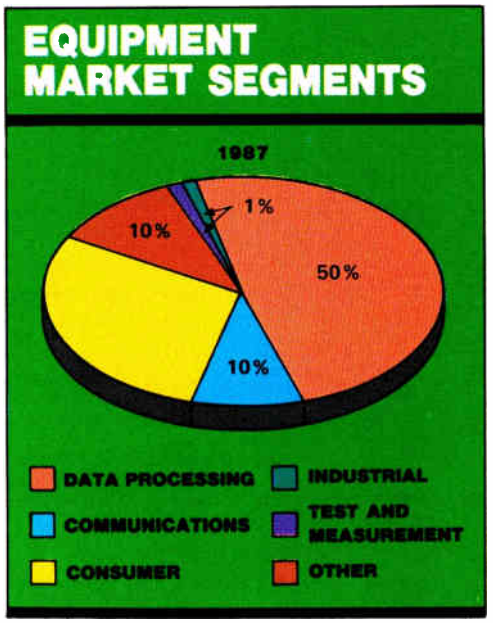
Storage systems will revel in an outstanding year, with sales zooming 30% to $4.7 billion. Impetus comes from firm computer demand; for floppy disks, the gradual changeover to 3½-in. drives, led by IBM Corp.'s commitment to the standard last spring, will buoy sales. They are expected to increase 19% to $1.1 billion. Typical is major parts supplier Alps Electric Co., half of whose floppy sales are now 3½-in. versions. Production almost tripled in 1986, the company says.

If the computer industry is rosy, the consumer business is another story. One major problem is that there simply isn't another big product in sight to fuel growth. The saturation rate for color TVs in Japan is 92%; even though the VCR figure is only at 30% plus, manufacturers looking for the next blockbuster are finding the cupboard bare. "There just aren't any blockbuster consumer products out there anymore," says analyst Darrel E. Whitten of Prudential-Bache Securities (Japan Research) in Tokyo.

Electronics projects a 6% rise to $19.3 billion for consumer electronics overall, following a 5% gain to $18.1 billion last year. "My gut feeling is that... we're going to have only modest recovery," says Whitten. He sees growth in consumer electronics overall at 3%, only half that calculated by *Electronics*. The usually conservative Electronic Industries Association of Japan is living up to its reputation with a forecast of 2% growth.

The 8-mm camcorder is growing—and *Electronics* shows the rise at an impressive 55% this year—but the market will be a relatively small $380 million. Surprisingly, the domestic market for compact-disk players is having problems because of overproduction. *Electronics* forecasts a 3% gain to $429 million for CD players—however, manufacturers of these machines can still count on substantial growth in the U. S. market, where they are the principal suppliers.

The product all consumer-electronics makers are looking to for future growth is 8-mm video, where Matsushita predicts 25% growth in its 1987 sales in unit terms (5% in value). Meanwhile, in VCR players and equipment, Matsushita, which had predicted modest 4.5% growth this year in its ½-in. VCR sales, now says it will be more like 15%, spurred by a 20% growth in domestic market shipments, including 2.8 million camcorder units, almost double the 1.44 million shipped in 1985. *Electronics* predicts no growth industry-wide in VCRs but a 33% jump in camcorders to $767 million. Victor Co. of Japan agrees, pegging 1987 camcorder growth at 32%. Accordingly, it is increasing production from 100,000 units a month to 120,000 by next spring.



Sony Corp., which sold 1.3 million 8-mm video units worldwide in its fiscal year ending October 1986 (about 400,000 of them in Japan), also predicts 30% to 40% market growth in 1987, though 8-mm sales still are only about 10% of the company's total.

The only near-term bright spot in color TVs is the growth of models whose screens have diameters of 22 in. or more. Only 8.3% of total sales in Japan in 1985, these large-screen sets increased to 13.1% of the total in 1986 and should reach 16% this year. Overall, color-TV receivers will climb 5% to $3.8 billion, after an 8% climb last year.

It says something about the audio market in Japan when growth of 4% in 1987 to $4.9 billion can be called a comeback, but after the virtually static 1% of 1986, that is the case. The reason is strong sales of compact systems, which include CDs, cassette decks, AM/FM radios, and speakers. Sony Corp.'s audio sales in its third quarter of 1986 surpassed slumping television sales.

Digital audio tape players likely will go into production this year, and they may be a future bright spot. But most industry executives say it will be two

to three years at least before any significant growth will appear, in part because makers are trying to make the most of the current demand for systems combining conventional tape decks with CD players.

Last year was a rough one for Japanese makers of test and measurement equipment, who realized just 6% growth to almost $1.3 billion. This year promises to be slightly better, with 9% growth to $1.4 billion. Semiconductor production was lower than expected, and manufacturers decreased investment in T&M gear, says Koichi Niwa, manager of the corporate planning group at Advantest Corp. This reduced sales of memory testers more than those of logic testers, he says. This year, automatic test equipment will register a 9% advance, the same as 1986, to $522 million. Component testers will chalk up another 14% rise to $92 million, and printed-circuit-board testers will also repeat 1986's 10% rise, to $99 million.

Testers for research and development kept selling at the expected rate, but that isn't much compared with the large quantities used on production lines. Even though Niwa expects IC production and tester demand to pick up after the middle of the year, this year will not be a joyful one. The survey shows consumption of IC testers increasing 8%, the same as last year, to $331 million.

On the basis of their digitizing scopes, Sony/-Tektronix and Yokogawa/Hewlett-Packard have strong positions in a not very dynamic oscilloscope market. *Electronics* shows scopes rising just 3%, to $123 million, compared with a 5% rise last year.

Communications equipment grew by 16% in 1986, but the slowdown in capital investment for this gear will keep 1987's rise to only 5%, for $7.1 billion in consumption. Last year, there was considerable purchasing by new competitors in the long-distance market. Meanwhile, Nippon Telegraph & Telephone Corp. continues to install facilities needed for the upcoming era of the integrated services digital network, which it calls Information Network System.

In facsimile, the fast Group 3 systems continue to flourish, and it is a rare office that doesn't have one or more machines. Sales are spiraling upward as users upgrade to the latest models and new users join the crowd, but falling prices have kept revenues down. *Electronics* projects a growth rate of only 6% this year to $1.2 billion for all facsimile equipment. By way of comparison, a 20% to 30% increase is expected in unit sales, says Matsushita.

What should help is the newest hit product, personal facsimile for letter-size (metric A4) documents, which includes a copier function and telephone handset. Manufacturers bill it as an integrated office machine. Shinji Shimokawa, a member of the president's office at Hitachi, says that the price must be halved from the current level of around $1,250 before it will sell to the average household.

The test and measurement market should start to improve, growing 9% to $1.4 billion, after last year's gain of 6% and sales of $1.3 billion

Investment continues for alternate long-distance communications systems, but at a lower rate than last year. Japan Telecom, Daini Denden, and Teleway Japan have begun competing with NTT. Initially they will provide only leased-line service to large- and medium-size companies. Services include telephone, facsimile, data communications, and picture transmission for video conferences, and charges are about 20% to 30% cheaper than NTT's. Home telephone dial-up long-distance services will begin next fall, also at rates about 20% to 30% below NTT's.

SEMICONDUCTORS WILL BOUNCE BACK WITH AN 8% INCREASE

For semiconductors in Japan, 1986 was a year of uncustomarily low growth, but 1987 will be somewhat better. The *Electronics* survey shows that semiconductor consumption will bounce back, increasing 8% to $13.2 billion, after a rise of only 3% in 1986, as the precipitous decline in prices of memory chips comes to an end and new applications spur demand. In fact, integrated circuits will climb 10% to $9.2 billion, following a 4% rise in 1986. However, the components market as a whole will not do quite so well: up just 4% in 1987 to almost $29.3 billion, slightly better than the 1% rise of 1986.

In other component areas, passive and mechanical devices will be almost flat—up a meager 2% to $13 billion—and hybrids will also score only a 2% gain for $1.2 billion in sales. Edged out by newer technology, tubes will fall, dipping 3% to $1.8 billion on the heels of a 4% drop last year. Their replacements are optoelectronic devices, which will be up 10% to $1.5 billion. That's less than last year's 16%, but still a respectable growth rate in a recovering market.

The new year will see a new product mix in semiconductors. Demand for office- and factory-automation components will pick up—manufacturers of data-processing and office equipment expect a 16% increase in their business. But many consumer products will be made in newly industrialized countries, decreasing the demand for components.

Last year closed with dynamic random-access memories in a minus growth pattern. RAMs as a whole were down 6% for the year, a dip largely explained by a precipitous drop in demand for 64-K chips. This year, RAMs should rise 5% to $1.1 billion, on the strength of demand for the denser chips—including the start of 1-Mb sales in real volume.

Hisao Kanamaru, deputy general manager of the Electronic Devices Sales Office of Hitachi Ltd., says that Toshiba and Hitachi are the only manufacturers shipping 1-Mb DRAM chips, and they sold less than a half million units in Japan. This year Fujitsu, Mitsu-

bishi, NEC, and other manufacturers will ramp up production. Besides use in mainframes, Kanamaru says, the chips will also turn up in personal and office computers and in minicomputers. Both 1-Mb-by-1-bit and 256-K-by-4-bit types will be available.

Susumu Sumitomo, who manages the planning department at the Electronic Device Marketing Division of NEC Corp., foresees special-purpose DRAMs, using 1-Mb technology, going into video memory subsystems. Sumitomo says he expects increases in line- and field-memory devices and in the analog-to-digital and digital-to-analog converters needed to use them.

Hitoshi Hoshi of Toshiba Corp.'s marketing and sales management staff says that about 10% of the approximately 30 million video cassette recorders produced in Japan last year feature field memories for playback of still pictures and at nonstandard speeds. That figure is expected to be larger this year, making this an attractive new market. Combinations of 64-K and 64-K-by-4 RAMs and of special-purpose chips using 256-K DRAM technology are used. A Matsushita spokesman says that this year should see the beginning of widespread use of video memory in TV receivers.

The biggest sellers by unit among the SRAMs will be 16-K models—large numbers are used in compact-disk players, for example. Running a close second will be 64-K chips, with 256-K SRAMs selling slowly because they are still quite expensive. Less expensive pseudo- and virtually-static devices could give SRAMs a run for their money in some applications.

Unlike RAMs, read-only memories enjoyed robust growth of 16% last year and should do even better in 1987: *Electronics* projects a 24% gain, to $736 million, pushed by the growth in office automation. Toshiba's Hoshi says he has big hopes for a flash electrically erasable programmable ROM. However, NEC's Sumitomo says that there will not be much demand for EEPROMs until smart cards take off.

Sumitomo is bullish on the one-time programmable EPROMs that are included on microprocessor controller chips. He says the trend has been pioneered by Hitachi and NEC, with others following. The advantage of using EPROMs on microprocessor chips, and

JAPAN COMPONENTS

(millions of dollars)

	1985	1986	1987
Passive and mechanical, total	**12,690**	**12,735**	**13,004**
Capacitors, total	2,390	2,359	2,402
Fixed	2,331	2,301	2,344
Variable	59	58	58
Connectors, plugs and sockets	1,840	1,853	1,896
Filters, networks and delay lines	163	166	172
Loudspeakers (OEM-type)	438	436	442
Microwave components	327	333	344
Printed circuits and interconnections	1,287	1,356	1,534
Quartz crystals (including mounts and ovens)	313	307	313
Relays (for communications and electronics)	307	313	325
Resistors, total	1,295	1,256	1,231
Fixed	663	650	626
Potentiometers and trimmers, total	632	606	605
Composition	613	589	589
Wirewound	19	17	16
Servos, synchros, and resolvers	174	178	179
Switches and keyboards (for electronics)	969	1,074	1,117
Transformers, chokes, and coils (including TV yokes and flybacks)	1,721	1,687	1,656
Wire and cable	1,466	1,417	1,393
Hybrid and modular, total	**1,203**	**1,209**	**1,239**
Standard (ADCs, op amps, etc.)	295	307	313
Custom	908	902	926
Tubes, total	**1,910**	**1,837**	**1,785**
Cathode ray (except TV)	441	401	369
Image sensing (including camera tubes and intensifiers)	118	190	239
Light sensing (including photomultipiers)	135	87	69
Power tubes (below 1 GHz)	44	30	21
Microwave (including cooking)	117	110	92
Receiving	17	17	14
TV picture tubes, total	1,038	1,002	981
Color	994	982	972
Monochrome	44	20	9

(millions of dollars)

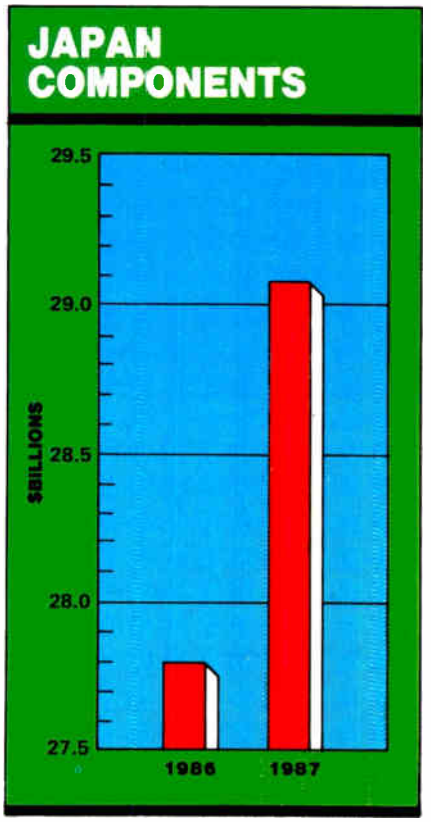
	1985	1986	1987
Semiconductors, total	**11,870**	**12,224**	**13,227**
Discrete, total	2,584	2,394	2,444
Diodes, total	801	741	759
Microwave (above 1 GHz), all types	25	22	22
Rectifiers and rectifier assemblies	399	388	393
Small-signal (less than 100 mA, including arrays)	236	189	192
Varactor (tuning)	72	77	86
Zener and reference	69	65	66
Thyristors (SCRs, Triacs, etc.)	184	142	147
Transistors, total	1,599	1,511	1,538
Bipolar, total	1,389	1,295	1,300
Power (more than 1 W dissipation)	639	589	613
Small-signal (including duals and arrays)	750	706	687
Field effect (including power MOS)	101	106	123
Rf and microwave (bipolar and FET, including GaAs)	109	110	115
ICs, total	8,074	8,429	9,242
Linear, total	2,108	2,152	2,230
Communications (including telecom —codecs, etc.)	141	149	160
Consumer	1,319	1,350	1,380
Interface (drivers, buffers, etc.)	460	460	491
Op amps (monolithic only)	188	193	199
Digital, total	5,966	6,277	7,012
Standard logic families, total	1,218	1,399	1,521
Bipolar (TTL, Schottky, ECL, etc.)	1,009	1,184	1,288
CMOS	209	215	233
Memories, total	1,668	1,675	1,865
RAMs	1,153	1,080	1,129
ROMs	515	595	736
Microprocessor and microcomputer chips	1,178	1,264	1,350
Special-purpose circuits	982	951	988
Semicustom logic (gate arrays)	920	988	1,288
Optoelectronic devices, total	1,212	1,401	1,541
Discrete light-emitting diodes	356	374	388
Image-sensing arrays	57	120	77
Laser diodes	61	80	104
Optically coupled isolators	53	56	60
Photodiodes and phototransistors	53	60	63
Readouts, total	564	634	751
Liquid crystal displays	288	312	374
Others (including vacuum fluorescents, plasma displays, and LED displays)	276	322	377
Solar (photovoltaic) cells	68	77	98
COMPONENTS, TOTAL	**27,673**	**28,005**	**29,255**

All figures in current U.S. dollars.
The figures in this chart, based on a survey made by Electronics in October and November 1986, estimate the consumption of components, valued at factory prices for domestic products and landed cost for imported products.
Exchange rate: 163 yen to $1.

in other microprocessor applications, is short turnaround time. And one-time programming saves on the cost of the ceramic package and quartz window usually used for devices with EPROM.

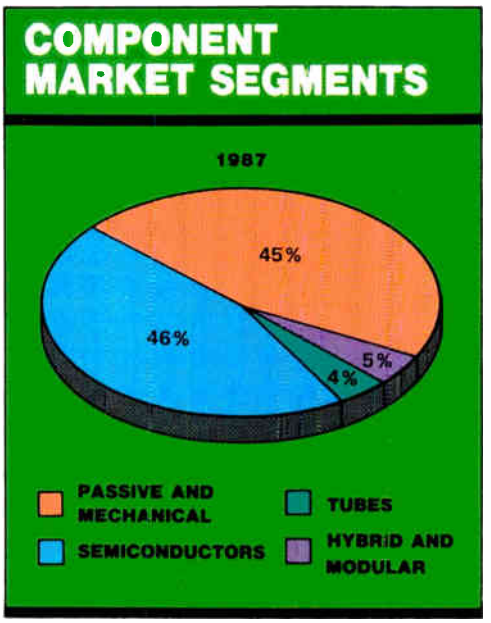
One market for mask ROMs is undergoing determined assault by EPROMs, Sumitomo says. Manufacturers of microcomputers increasingly are shifting from mask ROMs to EPROMs because of the latter's programmability. However, mask ROMs still are more economical in high-volume microcomputers. Another exception to the trend toward EPROM is pattern generators for Kanji word processors, Sumitomo says. Several 4-Mb CMOS mask ROMs are needed for the more than 7,000 Japanese characters in a complete set.

In microprocessors overall, 1987 will see a 7% increase, identical to last year's gain, with sales totaling almost $1.4 billion as the trend to more costly higher-performance chips makes up for the downward drift in prices of older parts. The largest single category is still 4-bit microcontrollers, but demand is flat, and 8-bit types are catching up as their prices come down.



Much of the potential demand for standard logic chips is being siphoned off by application-specific ICs, so the standards are showing only a 9% increase to $1.5 billion after the 15% growth experienced last year. Led by TTL, bipolar continues to retain a much bigger market share than high-speed CMOS: bipolar should rack up $1.3 billion in sales next year, compared with $233 million for CMOS. But many companies are emphasizing the latter technology, and ASICs are predominantly CMOS gate arrays. In fact, semicustom logic will race to a whopping 30% increase to $1.3 billion, against 7% last year, as prices drop and manufacturers learn to turn around users' designs faster. Most special-purpose chips go into products such as watches and calculators that are not selling well, so these parts will inch up only 4% to $988 million after sagging 3% last year.

The markets for discrete semiconductors and linear ICs will improve after a bad year for both in 1986. Discretes, which dipped 7% last year, will rise 2% to $2.4 billion, while linears will rise 4% to $2.2 billion, against a 2% gain last year.



Both device types promise to become smaller fractions of the total as time goes by and as many old end products go digital.

Also, single-chip signal-processing ICs for black and white TV receivers are also being made in Korea, though the equivalent device for color sets and microprocessors still are coming from Japan.

In optoelectronics, laser diodes will grow 30% this year to $104 million, on the heels of a 31% gain last year. They're needed in high volumes for CD and video-disk players, and there should be an increased demand for laser-disk document files and the true start of volume use of laser-disk data files for computers.

Sales of image-sensing arrays, spurred last year by increased sales of camcorders and facsimile systems, more than doubled their 1985 sales. Though that growth rate cannot be sustained, the 1987 total will still be some 30% better than the 1985 number. TV imagers being introduced this year feature more pixels than ever before, along with 0.0015/s electronic shutter facility for clearer pickup of fast-moving action in bright surroundings. Hajime Sasaki, vice president of NEC, says his leading-edge product in 1986 was a ½-in. imager with 200,000 pixels; in 1987 it will be a ½-in. imager with 250,000 pixels and an electronic shutter.

Demand should also rise for liquid-crystal displays as hand-held TVs gain popularity and LCD manufacturers turn out readable 80-column-by-25-line displays for laptop personal computers. After 8% growth last year, this market will be up 20% to $374 million.

Other displays—vacuum fluorescents, plasma, and light-emitting diodes—should do almost as well. *Electronics* shows this group increasing 17% to $377 million, a growth rate identical to that of 1986. Plasma displays are in increasing demand—for example, one from Matsushita is in the popular IBM AT-compatible laptop computer from Toshiba. Vacuum fluorescents continue to be used widely, including in automobile instrumentation, and a variety of pixel-addressable matrix displays is available. The flip side is bad news for cathode-ray tubes, which will be off 8% to $369 million, following a 9% decline last year.

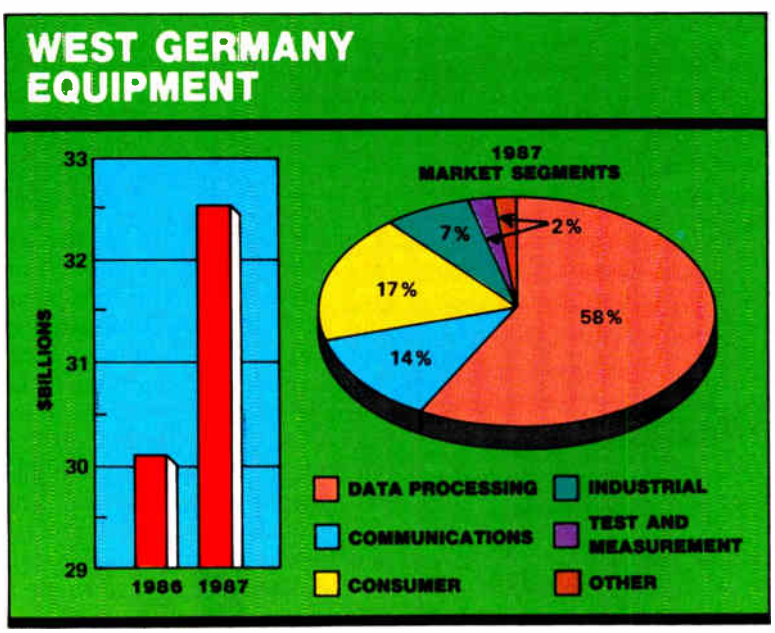
WEST GERMANY

EQUIPMENT MAKERS CAN LOOK FOR A STEADY 8% GROWTH RATE

The West German economy has a reassuring air about it these days, and that translates into reasonably brisk business in 1987 for the electronics industries. Equipment makers can count on markets that will reach almost $32.6 billion in 1987, *Electronics* forecasts, a growth rate identical to last year's 8%.

With the country's factories clanging to keep the overall economy growing at about 3%, industrial equipment figures to be the fastest-growing sector. It will score a rise of 16% to $2.2 billion on the heels of a 16% gain last year.

Look for a substantial gain, too, in data processing and office equipment, similarly buoyed by corporate capital spending. A 10% rise will boost this sector to $18.8 billion, a growth rate identical to last year's. A solid 8% growth will carry test and measurement gear to $586 million, bettering last year's 6% increase. The nearly saturated consumer-electronics market should stay on its $5.6 billion plateau, a meager 1% gain over 1986. Communications-equipment makers, by contrast, will see a slide in growth, largely because spending by the state telecommunications agency has slowed to 3% from the 8% logged last year. They should wind up with markets totaling $4.6 billion.



That industrial equipment will set the pace this year comes as no surprise to Manfred Beinder, chief economist at Standard Elektrik Lorenz AG, Stuttgart. The country's gross national product should grow at the same near-3% rate it logged in 1986, and that will include a 7% climb in plant investment, Beinder points out. "That should spell good business for producers of industrial electronics gear and automation equipment," he says. The *Electronics* survey estimates a rise of 15% to $1.4 billion for process-control equipment, the big-money category in industrial electronics. A 20% spurt will lift sales of machine-tool controls to $207 million; and a similar hike will carry motor controls to $265 million.

The plant-investment programs should mean a good year, too, for suppliers of data-processing systems. But exactly how good is subject to debate. One school puts the market gain well above 10%, close to the *Electronics* projection of 11% growth to $12.2 billion. Add-on peripherals will boost that total by perhaps $2 billion. (Because it is difficult to distinguish between peripherals shipped with systems and those shipped as add-ons, there is some double counting in the table.) But Hartmut von Voigt, an executive in the Communications and Information Systems Group of Siemens AG, Munich, predicts the market will do much better because of the overall strength of the economy. His forecast: 15% growth.

The fastest-growing data-processing sector will be top-of-the-line networked personal computers, suggests Jochen Rössner, senior marketing specialist at Unisys Deutschland GmbH in Sulzbach, near Frankfurt. He sees the market for such machines soaring between 16% and 17%. *Electronics* forecasts that personal computers, all told, will spurt 19% to $1.4 billion. Largely responsible for this sharp rise, Rössner maintains, is AT&T Co.'s Unix operating system. After a hesitant start, it is "now firmly entrenched in the industry," he says.

Also giving a lift to the small-systems market, says von Voigt, are expert systems and hardware for computer-aided manufacturing and computer-integrated manufacturing, where computers link

equipment used in manufacturing and administration.

The euphoria among small-computer and networking specialists is not shared, however, by producers of larger systems. While there is still growth for medium-sized computers—those priced between $150,000 and $1 million—says Rössner of Unisys, selling systems above that range "has become a toilsome business, with much effort needed to persuade customers. That market is largely a replacement business."

As for West Germany's software market, it went up 20% last year to about $8 billion, according to the Office and Information Technologies Association in Frankfurt. This expansion rate is expected through the end of the decade, so that by 1990 hardware and software sales will be roughly the same.

Stalled at near-saturation levels for most big-money products, the market for consumer electronics in West Germany showed steep losses in 1983, 1984, and 1985. But last year, the market held steady at $5.6 billion. "By and large, 1986 did not turn out to be all that bad," says Johanna von Ronai-Horvath, a market researcher at SEL's Consumer Products Group in Pforzheim. Although *Electronics* projects only a 1% gain for 1987, she expects 3% to 4% growth, based on estimates that consumer spending

WEST GERMANY EQUIPMENT

(millions of dollars)

	1985	1986	1987
Data processing and office equipment, total	**15,418**	**16,993**	**18,759**
Data processing systems, total	9,878	10,971	12,198
Personal computers (under $5,000)	945	1,153	1,376
Microcomputers ($5,000 to $20,000)	375	447	545
Minicomputers ($20,000 to $100,000)	1,883	2,150	2,488
Superminicomputers ($100,000 to $400,000)	1,925	2,151	2,320
Mainframe computers ($400,000 to $1 million)	1,800	1,943	2,061
Supercomputers (over $1 million)	2,950	3,127	3,408
Data input peripherals	326	362	400
Data output peripherals	950	1,053	1,168
Data storage subsystems	1,808	1,998	2,245
Data terminals	1,075	1,226	1,403
Electronic office equipment, total	1,381	1,383	1,345
Copying equipment	700	725	715
Electronic typewriters	258	250	240
Billing and accounting equipment	243	243	240
Word processing equipment (standalone and clustered)	180	165	150
Test and measuring instruments, total	**514**	**545**	**586**
Amplifiers, lab	7	7	7
Analog voltmeters, ammeters, and multimeters	8	8	9
Automatic test equipment, total	118	128	143
IC testers	65	68	75
PC board testers	53	60	68
Calibrators and standards, active and passive	5	5	5
Counters, time and frequency	17	18	19
Digital multimeters (including probes and accessories)	25	25	27
Logic analyzers	22	24	26
Microprocessor development systems	73	74	74
Microwave test and measuring instruments	50	55	61
Oscillators	15	16	16
Oscilloscopes	85	94	103
Power meters (below microwave frequencies)	5	5	5
Recorders (including chart and X-Y types)	42	43	45
Signal generators (pulse, sweep, and function), total	19	18	19
Analog	10	9	9
Synthesized	9	9	10
Spectrum analyzers	23	25	27
CAD/CAE equipment, total	**246**	**345**	**450**
Industrial electronic equipment, total	**1,625**	**1,891**	**2,203**
Inspection systems	25	33	39
Machine-tool controls (including all numerical control systems)	146	172	207
Motor controls	185	221	265
Photoelectric controls	83	88	101
Process-control equipment (including computers, loggers, consoles)	1,065	1,225	1,409
Semiconductor production equipment	121	152	182
Consumer products, total	**5,637**	**5,618**	**5,666**
Audio equipment, total	2,113	2,109	2,148
Car audio	350	350	335
Stereo equipment, total	800	800	808
Components (including tuners, turntables)	575	580	588
Consoles and compact systems (including TV-audio combinations)	225	220	220
Phonographs and radio-phono combinations	240	240	243
Radios (including table, clock, and portable)	128	125	123
Radio/recorder combinations, portable	242	243	243
Tape recorders and players	273	245	243
Compact disk players	80	106	153
Television receivers, total	1,394	1,402	1,404
Color	1,350	1,358	1,360
Monochrome	44	44	44
Other consumer electronic products, total	2,130	2,107	2,114
Home video equipment, total	974	1,020	1,080
Cassette players and recorders	829	870	922
Cameras	145	150	158
Electronic musical instruments	95	99	99
Microwave ovens	110	143	170
Electronic games (video and nonvideo)	80	75	70
Calculators (personal and professional)	58	54	50
Electronic watches and clocks	300	306	310
Home computers (under $1,000)	513	410	335
Communications equipment, total	**4,180**	**4,499**	**4,638**
Data communications equipment	145	150	158
Facsimile terminals	54	63	71
Fiber-optic communications systems	28	50	68
Intercom systems	45	45	48
Navigation aids, except radar	325	315	325
Paging systems, public and private	36	39	41
Radar—air, land, and marine	198	219	205
Radio, total	457	512	540
Broadcast equipment	69	82	96
Microwave systems	160	177	175
Mobile, land	175	200	208
Satellite earth stations	53	53	61
Telecommunications equipment, total	2,753	2,946	2,996
Telephone and data switching, private (PABX)	803	763	790
Telephone and data switching, public	1,025	1,045	1,088
Telephone and telegraph carrier	925	1,138	1,118
Television equipment, total	139	160	186
Broadcast (studio) equipment (including cameras, recorders, and monitors)	54	60	66
CCTV (including educational, industrial, and medical)	85	100	120
Power supplies (noncaptive), total	**210**	**233**	**258**
Bench and lab	16	17	17
Industrial (heavy duty)	46	48	51
OEM and modular, total	148	168	190
Linear	53	53	50
Switching	95	115	140
EQUIPMENT, TOTAL	**27,830**	**30,124**	**32,560**

All figures in current U.S. dollars. Exchange rate: 2 marks to $1.

will run about 4% higher this year than last. Manfred König, a market researcher at Bosch-Siemens Hausgeräte GmbH, a household-equipment joint venture based in Munich, sees 1987 in much the same light. He figures that consumers satisfied their pent-up demand for new cars last year and will now turn to household equipment, including electronics. He expects the market to grow around 5%.

Von Ronai says the consumer market in 1987 will stand on three legs: color TV sets, video cassette recorders, and compact-disk players. Unit sales of color TVs will rise, she expects, but measured in deutschemarks the market will stagnate. Indeed, *Electronics* shows this market perfectly flat, at $1.4 billion. Replacement sales of sets with new tube-face shapes—flat and square—will provide a prop. VCR sales are mostly to first-time buyers, who will lift the market 6% to $922 million. CD players will soar 44%, hitting $153 million. In unit sales of CD players, König foresees a jump to at least 750,000 units, three times the number sold in 1985.

The signals for West Germany's communications-equipment makers point to another year of growth, but at a much slower rate than in 1986: *Electronics* forecasts a 3% rise to $4.6 billion following 8% growth to $4.5 billion last year. "The period of massive expansion is behind us," says SEL's Beinder. "We are now in the transition-to-digital phase, and a big push in investments cannot be expected soon."

Against this background, Beinder predicts the domestic communications business will rise between 4% and 5% in 1987. This comes close to the estimate from Erwin Biermeier of the communications marketing department at Siemens AG. Biermeier expects 5% growth, "a rate of expansion that should hold for the next five years," he says. A major player in this market, as always, will be the Bundespost, the federal agency that runs the country's public communications lines. For 1987, it is budgeting a 3% rise to $7.85 billion for telecommunications.

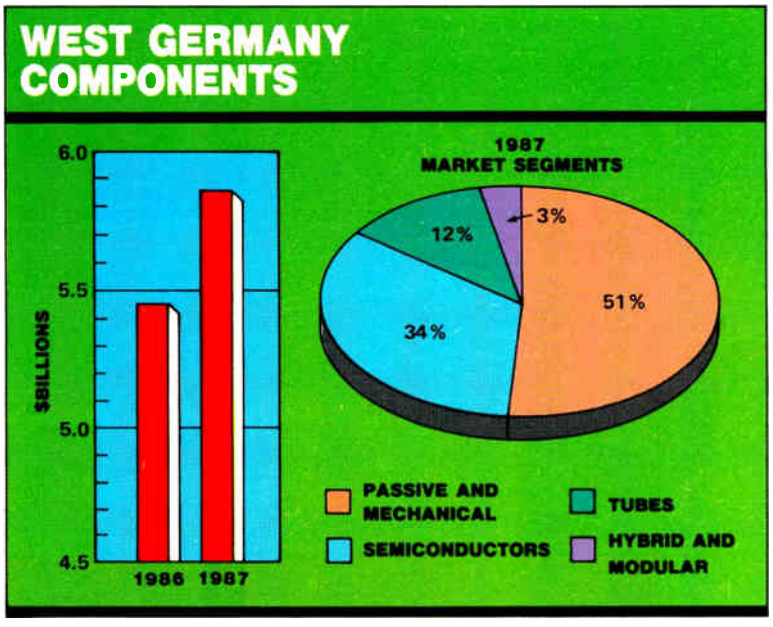
AFTER A NO-GROWTH 1986, THE COMPONENTS BUSINESS WILL RISE 7%

West German components suppliers weathered a rough passage during the past two years, but now they feel that the bad times are behind them. "We are optimistic enough to say that a 7.2% market revival could occur in 1987," reports Friedrich Ruf, a spokesman for the Central Association of the Electrotechnical Industry in Frankfurt.

Industry watchers generally concur with this upbeat assessment, and so does the *Electronics* market survey: it predicts a rise to $5.9 billion for the country's components business, up 7% over the $5.5 billion logged during a no-growth 1986. All major product categories will share the wealth. Semiconductors should check in with a 12% climb to almost $2 billion; passive and electromechanical parts will grow 5% to $3 billion; and tubes will trail the other sectors with a modest 3% rise to $693 million. A full quarter of the components sold will wind up in industrial electronics equipment; communications gear will swallow up nearly 23%, and entertainment products 21%, the industry association says.

Semiconductors stand out as the sector that will bounce back most dramatically. Last year, semiconductor markets shrank by 9%, according to the *Electronics* figures. Integrated circuits were particularly hard hit: standard logic and memory chips dropped 21% and 30%, respectively, leading the sector to an 11% overall dip.

This year should see a resurgence, largely because equipment makers have absorbed the heavy inventories of parts they carried last year. The survey projects a spurt of 14% for ICs, lifting them to $1.4 billion. Memories will outdo other main-line categories with a leap of 20%. But because this segment plummeted 30% last year, the projected sales figure of $248 million will be below the 1985 total of $295 million.



Among markets just beginning to burgeon, application-specific ICs should continue to make their mark. Gate arrays managed solid 16% growth last year and look set to leap another 30% to $83 million, according to the survey. Some observers see a much higher overall market for ASICs—chips based on standard cells, as well as gate arrays. They credit West Germany with a $195 million share of a $750 million West European market last year. They predict an annual growth rate of 30% to 40%.

Another small but thriving market is digital signal processors. Experts figure the market ran only $4 million in 1985 but say it could multiply tenfold by 1990 as equipment designers switch from general-purpose microprocessors to the speedier

DSPs. Right now, some three quarters of the chips go into telecommunications gear. But the bulk of the future growth is more likely to come in automotive systems, consumer electronics, and industrial controls.

Also expected to thrive are surface-mounted devices. After a fast start and optimistic forecasts—based on its potential to cut board assembly costs—surface-mounting technology slowed a little in the past two years. Soldering and testing the new packages was one holdup; adapting place-and-route programs for computer-aided design systems was another. And the high cost of setting up production lines slowed acceptance of the new technology. Components makers now consider these problems solved, and they expect that by 1990 more than half of all electronics equipment will be fabricated with SMDs. To reach that level, more than 40% of all components will have to be suitable for surface-mounting.

Of growing importance, too, is the sensor market. Having passed from a first generation of discrete sensors to a second generation of sensor systems, the industry has now moved to the third generation—integrated solutions. But with this shift, the market has passed beyond the financial reach of many small firms. To help them get into integrated sensors, Bonn's Ministry for Research and Technology is bankrolling the multimillion-dollar "microperipherals" research and development effort.

Meanwhile, Siemens and Philips are mounting a major effort of their own in memory R&D. They are pressing for a presence in leading-edge memory technology—crucial to major players in the IC market. Now that the market is turning around, it should keep growing at 10% to 15% a year until the end of the decade, says Manfred Schmidt, a director at Philips GmbH in Hamburg and president of Valvo GmbH, the German components subsidiary of the Dutch giant. Unfortunately, some 70% of the business will escape European companies. European subsidiaries of U. S. semiconductor companies will bag 60% of the business and the Japanese another 10%.

The situation has made European suppliers sensitive to the pricing practices of Japanese memory-chip makers. The upshot was an anti-dumping complaint against Japanese companies, lodged by the major European chip makers with the European Communities Commission in Brussels late last year.

While they await action on the complaint, Siemens and Philips are hard at work on new memories. Siemens expects to have 1-Mb DRAMs in full production this year, fruit of the Megaproject launched with Philips in 1984 with partial funding from the Dutch and West German governments. The $2 million project calls for 4-Mb DRAMs from Siemens and for 1-Mb static RAMs from Philips by 1989.

WEST GERMANY COMPONENTS

	(millions of dollars) 1985	1986	1987
Semiconductors, total	**1,945**	**1,774**	**1,984**
Discrete, total	423	412	434
Diodes, total	170	161	164
Microwave (less than 1 GHz)	9	9	9
Rectifiers and rectifier assemblies	86	86	88
Signal (less than 100 mA, including arrays)	37	32	32
Varactor (tuning)	9	8	9
Zener and reference	29	26	26
Thyristors (including SCRs and triacs)	63	71	71
Transistors, total	190	180	199
Bipolar, total	171	161	178
Power (more than 1 W dissipation)	98	96	109
Small-signal (including duals and arrays)	73	65	69
Field effect	13	13	14
RF and microwave (bipolar and FET, including GaAs)	6	6	7
Integrated circuits, total	1,408	1,255	1,435
Linear ICs, total	342	339	373
Communications (including telecom—codecs, etc.)	88	85	101
Entertainment	165	165	172
Interface (drivers, buffers, translators, etc.)	41	41	47
Op amps (monolithic only)	48	48	53
Digital ICs, total	1,066	916	1,062
Standard logic families, total	378	299	328
Bipolar	253	205	220
CMOS	125	94	108
Memories, total	295	206	248
RAM	190	128	155
ROM	105	78	93
Microprocessor and microcomputer chips	226	230	272
Special-purpose circuits	112	117	131
Semicustom logic (gate arrays)	55	64	83
Optoelectronic devices	114	107	115

	(millions of dollars) 1985	1986	1987
Passive and mechanical, total	**2,730**	**2,847**	**2,988**
Capacitors, total	478	489	499
Fixed	463	475	485
Variable	15	14	14
Connectors, plugs, and sockets	625	675	710
Filters, delay networks, and delay lines	59	60	60
Loudspeakers (OEM type)	105	110	116
Printed circuits and interconnections	600	650	703
Quartz crystals	53	56	59
Readouts (optoelectronic and LCD)	31	32	35
Relays (for communications and electronics)	175	184	193
Resistors, total	206	211	220
Fixed	123	125	130
Potentiometers and trimmers	83	86	90
Switches and keyboards (for electronics)	190	180	180
Transformers, chokes, and coils	208	200	213
Hybrid and modular components, total	**158**	**175**	**194**
Tubes, total	**661**	**673**	**693**
Cathode ray (except for TV)	24	26	30
Image sensing (including camera tubes and intensifiers)	46	47	49
Light sensing (including photomultipliers)	13	13	14
Power tubes (less than 1 GHz)	30	32	33
Microwave (including cooking)	103	104	108
Receiving	3	2	1
TV picture, total	442	449	458
Color	433	441	450
Monochrome	9	8	8
COMPONENTS, TOTAL	**5,494**	**5,469**	**5,859**

All figures in current U.S. dollars
The figures in this chart, based on a survey made by Electronics in October and November 1986, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products. **Exchange rate: 2 marks to $1.**

UNITED KINGDOM

EQUIPMENT SALES COULD GROW 7%, DOWN A BIT FROM 1986

British economic forecasters are having a tough time calling 1987, and their difficulties extend to the electronics business. Besides the usual economic uncertainties, the UK must cope with political unknowns that could cloud the outlook until summer. Still, the *Electronics* market report forecasts a modest 7% gain to $18.5 billion overall, a percentage point under the 1986 increase. Last year, sales totaled $17.3 billion.

The data-processing and office-equipment sector, far and away the largest, will expand by 9%, the same growth rate as last year, to $9.7 billion, according to the survey. Communications equipment, the No. 2 market, is pegged to hold its 6% growth rate to hit $3.7 billion. Consumer electronics will slip to a 2% gain, for $3.5 billion in sales, compared with a 5% rise in 1986.

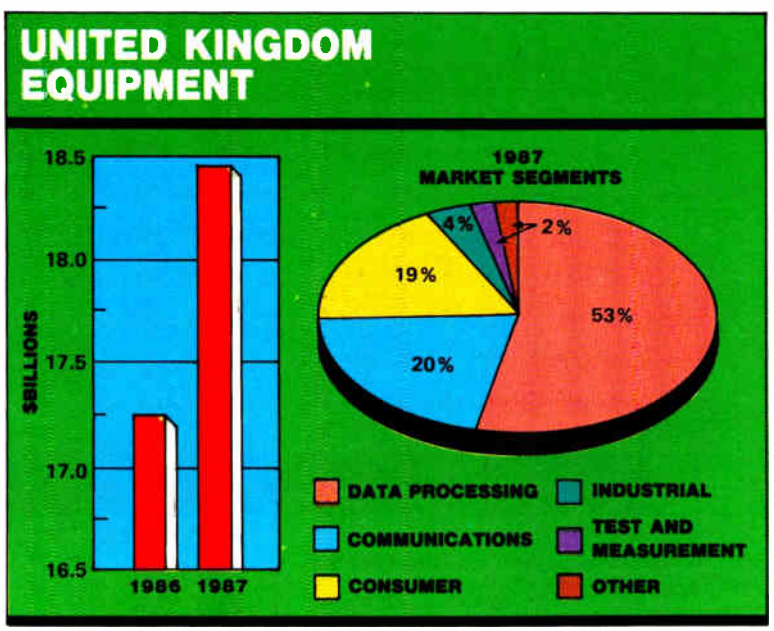
Industrial electronics will grow 8% to $828 million, a slide from last year's 12% growth rate, while test and measurement equipment will rise 8% this year, to $293 million, a distinct improvement over the 3% gain in 1986. Credit that largely to a surge in automatic test gear.

All forecasts may need revision after midyear. Prime Minister Margaret Thatcher could call an early general election in May or June. At the moment, her Conservative Party and the opposition Labour Party are neck and neck in the polls. There is a gut feeling among businessmen that they always do better under the Conservatives, but a closer look at Labour's policies reveals that this may not always be true, especially in one segment of the electronics business, communications.

In the data-processing and office-equipment market, computer systems will grow 10% this year, to $6.6 billion. This rise, a point under last year's, reflects the sluggish British economy, stalled at a growth rate of some 2.5%. What's more, personal computers figure to dampen this sector's outlook. Personal computers will remain flat at $781 million, the same sales figure reached last year on a 4% rise. Industry watchers say that unit sales of personal computers are, in fact, increasing, but profits are not, mainly because of one company—Amstrad Ltd., London. Its low-cost personal computer dominates the UK market.

But, says Mike O'Riordan, UK director of marketing for Unisys Ltd. in London, the flat market for personal computers will not affect higher-price, higher-performance, multiuser machines. "The market [for them] will grow in terms of money and number of units," he says. For example, the *Electronics* survey predicts that the mainframe market should remain strong, with 12% growth to $1.6 billion on top of 13% growth last year. O'Riordan says there's a greater demand for mainframes by the nation's busy airlines and by financial institutions, which are expanding into such areas as investment advice, real estate, and insurance. "The amount of contact with customers is increasing along with their facilities, so they need more computing power," he notes. Together, O'Riordan believes, the airline and financial demand for mainframes will grow 15% next year. Less promising, though, are the commercial and manufacturing sectors, which O'Riordan says are growing slowly.

For superminicomputers, the market is far more unpredictable, because this class competes with mainframe systems. "It all depends on the application," says O'Riordan, "but mainframes are holding their



own at the moment." Still, *Electronics* projects a 12% rise for superminis to $1.2 billion, on the heels of an identical growth rate last year.

One sector of the equipment market that will be watching political developments with more than its usual interest is telecommunications. Colin Gaskell, managing director of Marconi Instruments Ltd., notes that the Conservative Party's denationalization policy has been bad for his company, which produces telecommunications test gear. Denationalized British Telecom plc, he says, "is starting to behave like a customer. It is demanding value for money. It is going overseas for products, and so on." The Labour Party has pledged to buy back British Telecom and put it once again under government control. Among other things, that would mean that BT would be forced to buy British products wherever possible. But the move would probably also cause a rise in consumer phone bills, and some observers believe Labour may back out of its pledge.

Meanwhile, budgets for the major equipment sectors show only moderate growth. Public switching gear, for example, will rise 6% this year to $1 billion. There's also little growth in sight for UK military budgets. Radar, for example, is projected to grow only 3% to $815 million, and navigation aids are ex-

UNITED KINGDOM EQUIPMENT

(millions of dollars)

	1985	1986	1987
Data processing and office equipment, total	**8,157**	**8,928**	**9,697**
Data processing systems, total	5,389	6,004	6,632
Personal computers (under $5,000)	753	781	781
Microcomputers ($5,000 to $20,000)	720	798	895
Minicomputers ($20,000 to $100,000)	483	561	628
Superminicomputers ($100,000 to $400,000)	951	1,068	1,196
Mainframe computers ($400,000 to $1 million)	1,299	1,464	1,640
Supercomputers (over $1 million)	1,183	1,332	1,492
Data input peripherals	95	107	118
Data output peripherals	372	416	459
Data storage subsystems	880	984	1,072
Data terminals	625	639	653
Electronic office equipment, total	796	778	763
Copying equipment	400	395	398
Electronic typewriters	159	165	162
Billing and accounting equipment	101	104	105
Word processing equipment (standalone and clustered)	136	114	98
Test and measuring instruments, total	**263**	**271**	**293**
Amplifiers, lab	1	1	1
Analog voltmeters, ammeters, and multimeters	9	9	10
Automatic test equipment, total	52	50	57
IC testers	16	14	16
PC board testers	36	36	41
Calibrators and standards, active and passive	3	3	3
Counters, time and frequency	17	17	18
Digital multimeters (including probes and accessories)	17	17	18
Logic analyzers	7	9	10
Microprocessor development systems	30	27	28
Microwave test and measuring instruments	13	14	16
Oscillators	3	3	3
Oscilloscopes	40	41	44
Power meters (below microwave frequencies)	1	1	1
Recorders (including chart and X-Y types)	28	30	31
Signal generators (pulse, sweep, and function), total	31	33	36
Analog	14	16	16
Synthesized	17	17	20
Spectrum analyzers	11	16	17
CAD/CAE equipment, total	**189**	**230**	**280**
Industrial electronic equipment, total	**684**	**764**	**828**
Inspection systems	4	4	6
Machine-tool controls (including all numerical control systems)	24	26	28
Motor controls	148	178	200
Photoelectric controls	17	18	20
Process-control equipment (including computers, loggers, consoles)	454	497	531
Semiconductor production equipment	37	41	43
Consumer products, total	**3,267**	**3,434**	**3,511**
Audio equipment, total	865	895	952
Car audio	111	117	115
Stereo equipment, total	240	241	237
Components (including tuners, turntables)	148	146	145
Consoles and compact systems (including TV-audio combinations)	92	95	92
Phonographs and radio-phono combinations	149	146	146
Radios (including table, clock, and portable)	53	50	53
Radio/recorder combinations, portable	145	146	148
Tape recorders and players	136	133	128
Compact disk players	31	62	125
Television receivers, total	842	882	903
Color	809	851	873
Monochrome	33	31	30
Other consumer electronic products, total	1,560	1,657	1,656
Home video equipment, total	668	683	681
Cassette players and recorders	638	642	636
Cameras	30	41	45
Electronic musical instruments	59	62	64
Microwave ovens	256	369	372
Electronic games (video and nonvideo)	16	16	16
Calculators (personal and professional)	51	53	53
Electronic watches and clocks	155	162	186
Home computers (under $1,000)	355	312	284
Communications equipment, total	**3,310**	**3,524**	**3,743**
Data communications equipment	94	114	139
Facsimile terminals	30	31	37
Fiber-optic communications systems	18	26	36
Intercom systems	14	18	21
Navigation aids, except radar	378	388	403
Paging systems, public and private	40	43	44
Radar—air, land, and marine	758	788	815
Radio, total	267	292	319
Broadcast equipment	74	78	84
Microwave systems	24	28	34
Mobile, land	153	166	175
Satellite earth stations	16	20	26
Telecommunications equipment, total	1,604	1,709	1,811
Telephone and data switching, private (PABX)	283	301	318
Telephone and data switching, public	895	954	1,010
Telephone and telegraph carrier	426	454	483
Television equipment, total	107	115	118
Broadcast (studio) equipment (including cameras, recorders, and monitors)	80	84	85
CCTV (including educational, industrial, and medical)	27	31	33
Power supplies (noncaptive), total	**97**	**102**	**110**
Bench and lab	11	11	11
Industrial (heavy duty)	24	24	27
OEM and modular, total	62	67	72
Linear	26	27	27
Switching	36	40	45
EQUIPMENT, TOTAL	**15,967**	**17,253**	**18,462**

All figures in current U.S. dollars. Exchange rate: $1.42 to 1 pound.

pected to rise a meager 4% to $403 million.

In consumer electronics, slow, steady growth is the best that manufacturers can expect in a largely saturated market. The *Electronics* survey spots 1987 sales as rising just 2% overall, to $3.51 billion, against a 5% rise to $3.43 billion last year. Demand for color TV receivers should grow 3%, to $873 million, compared with a 5% rise last year. Some observers think the TV market would perk up if set makers could bring down prices for digital TVs, which offer features such as picture-in-picture and freeze-frame. So far, despite claims by semiconductor makers that the digital chips don't add to production costs, 28-in. sets containing them carry price tags close to $1,300, some $300 more than same-size conventional sets.

As for audio, there should be a surge of more than 100% growth in compact-disk players. The survey pegs CD sales at $125 million, twice last year's figure, and some market watchers deem that a low call. Largely because of the growth in CD players, the volume in the audio business will be turned up 6%, with sales of $952 million.

Prospects for industrial electronics range from modest overall to bleak for some categories. This sector will rise 8% to $828 million, after a 12% hike in 1986. Motor-control gear, where British industry has a lot of expertise, will continue to grow: a 12% gain to $200 million is the forecast, against a 20% rise last year. The drop in demand comes from the downturn in UK processing industries.

For oil-related industries, any urge to automate has been swamped by oceans of low-cost oil, much to the chagrin of makers of process controls. The survey predicts a gain of only 7%, to $531 million, for process controls, compared with a 9% rise in 1986. "The 1985 market [in oil-related industries] was £40 million; in 1986 it is £20 million. It will probably be even worse next year," says an executive of a major supplier of process controls to oil-related industries, who asked that he not be identified.

As for the test and measurement sector, *Electronics'* survey suggests an 8% gain to $293 million. Chalk up the improvement to a strong projected performance in automatic test equipment, due for a 14% rise to $57 million following a 4% dip to $50 million last year. Because the fortunes of chip makers are on the rise, the strong comeback in ATE is in IC testers, which last year dipped and this year should climb back to their 1985 level of $16 million. Computer-aided design and engineering equipment is set for another strong rise this year, as it is elsewhere in Europe: up 22% to $280 million.

COMPONENTS ARE IN FOR A SATISFYING 8% GAIN

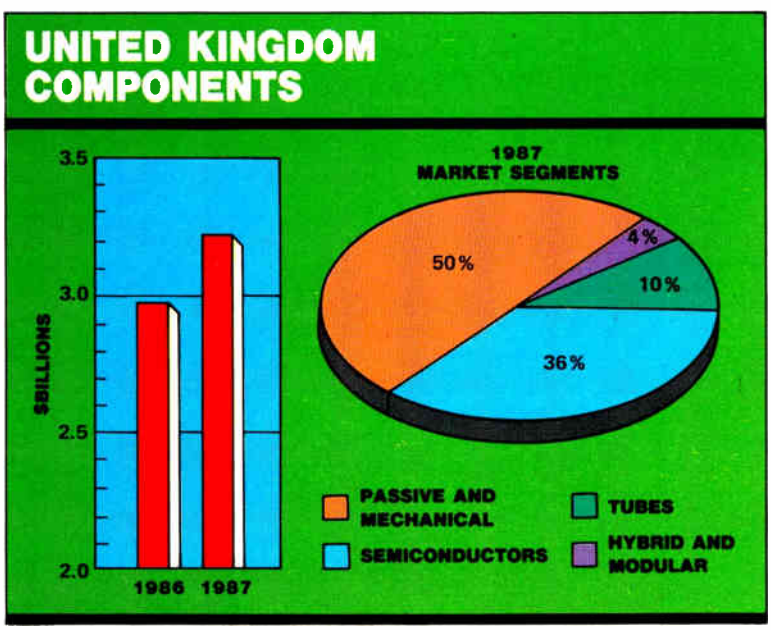
British component vendors last year exchanged the stiff upper lips developed during the difficult days of 1985 for faint smiles of satisfaction. This year, the smiles should broaden a bit as UK markets push beyond the $3 billion mark for the first time. In fact, sales of passive components, semiconductors, and tubes will total $3.2 billion in 1987, the *Electronics* survey has found, a gain of 8% over the $2.98 billion estimated for 1986, where the gain was 6%. Passives top the list for sheer volume, weighing in at $1.6 billion; semiconductors line up next at almost $1.2 billion; and tubes are far behind, in third position at $324 million.

Semiconductors should set the pace in growth, with a projected 13% gain. Trouble is, most of the $1.2 billion of sales will go to U. S. and Japanese companies. About the only niche where UK companies have a chance to shine, analysts think, is in application-specific integrated circuits.

Therefore, the increase in the memory market projected for the year ahead won't do UK semiconductor makers much good. The survey puts memories at $184 million, up 16% over 1986. Some forecasters predict 50% gains for random-access memories, but *Electronics* predicts 14% growth, to $119 million.

Whatever the numbers turn out to be, there is widespread belief that the market has come out of the slide that occurred in 1985. "The UK semiconductor market is seeing slow growth, but it is growing," says Jan Calen, vice-president and director of marketing at Motorola Inc.'s European headquarters in Geneva. "But as government spending [which had fallen to very low levels in recent years] is now being addressed, the situation may improve. . . . On the whole, the UK is not too encouraging, but it is not too bad, either."

Especially strong is the outlook for microprocessors and microcomputer chips, which continue their expansion into equipment of all sorts. *Electronics* predicts a 17% increase to $122 million, compared



with a 13% gain last year. Mike Andrews, regional manager for Motorola, comes in even higher. "It will be 20% to 25% in 1987," he says.

The ASIC market is moving up fast as equipment designers switch from standard logic packages to gate arrays, and the survey predicts a 17% increase next year for semicustom logic, to $88 million, a marked advance over the 9% gain recorded last year. Again, Motorola's Andrews is more confident. He believes the ASICs market will grow enormously: "It could even double, but it will be more than 50%."

Ferranti Electronics Ltd., Oldham, was the first UK company to get into the business seriously and now offers a full line of Uncommitted Logic Arrays. And in November, Ferranti strengthened its position with its $1,500 Digilin work station for computer-aided design of its ULA chips.

But Plessey Semiconductors Ltd., Swindon, has thrown up a challenge. Its Megacell approach, in which semicustom circuits are assembled from large functional blocks, has been stealing the spotlight. Besides selling the design process to outsiders, Plessey is using Megacell for its own complex-chip designs "so we can get them to market quickly," says Ray Gleason, worldwide marketing manager. "We have 70 products in the pipeline to be introduced over the next six months." By then, Plessey will have emitter-coupled-logic versions of Megacell.

The British players, however, face more competition from overseas than they do from each other. For example, European Silicon Structures, an ASIC house begun last year with European capital, will join forces with the British subsidiary of Texas Instruments Inc. in Bedford. And LSI Logic Corp., Milpitas, Calif., is taking over the new STC Components wafer fab line in Foots Cray.

Among the smaller semiconductor markets, optoelectronics will remain flat, edging up just 2% to $55 million—even though there is likely to be a strong upward bound in optical-fiber systems, in which optoelectronic components are used. "The market is undoubtedly dominated by telecommunication transmission," says Craig Stewart, marketing director of Plessey Three Five Group Ltd. in Towcester. "But there is a move for putting [optical fiber systems] into local distribution." British Telecom also plans to extend glass-fiber connections into customers' premises.

All this, says Stewart, is leading to an increase "in demand for light-emitting-diode transmitters, p-i-n field-effect receivers, and, to a lesser extent, lasers." But as the volume of components shipped increases, unit prices drop—too fast, in Stewart's view. "I think this has gone too far," says Stewart. "The prices have come down too fast. The volumes will continue to increase, but I think the prices will become more stable."

UNITED KINGDOM COMPONENTS

	(millions of dollars) 1985	1986	1987
Semiconductors, total	**979**	**1,027**	**1,159**
Discrete, total	191	191	209
Diodes, total	72	75	80
Microwave (less than 1 GHz)	13	13	14
Rectifiers and rectifier assemblies	40	43	45
Signal (less than 100 mA, including arrays)	9	9	10
Varactor (tuning)	1	1	1
Zener and reference	9	9	10
Thyristors (including SCRs and triacs)	21	21	24
Transistors, total	98	95	105
Bipolar, total	83	82	88
Power (more than 1 W dissipation)	45	45	50
Small-signal (including duals and arrays)	38	37	38
Field effect	9	8	11
RF and microwave (bipolar and FET, including GaAs)	6	5	6
Integrated circuits, total	737	782	895
Linear ICs, total	142	138	144
Communications (including telecom—codecs, etc.)	38	37	40
Entertainment	35	33	34
Interface (drivers, buffers, translators, etc.)	31	31	33
Op amps (monolithic only)	38	37	37
Digital ICs, total	595	644	751
Standard logic families, total	251	278	326
Bipolar	152	160	187
CMOS	99	118	139
Memories, total	152	159	184
RAM	98	104	119
ROM	54	55	65
Microprocessor and microcomputer chips	92	104	122
Special-purpose circuits	31	28	31
Semicustom logic (gate arrays)	69	75	88
Optoelectronic devices	51	54	55

	(millions of dollars) 1985	1986	1987
Passive and mechanical, total	**1,415**	**1,514**	**1,608**
Capacitors, total	216	236	255
Fixed	209	227	246
Variable	7	9	9
Connectors, plugs, and sockets	293	305	332
Filters, delay networks, and delay lines	20	20	21
Loudspeakers (OEM type)	54	57	58
Printed circuits and interconnections	426	464	498
Quartz crystals	18	21	20
Readouts (optoelectronic and LCD)	21	24	27
Relays (for communications and electronics)	88	92	95
Resistors, total	79	84	87
Fixed	34	36	37
Potentiometers and trimmers	45	48	50
Switches and keyboards (for electronics)	102	108	111
Transformers, chokes, and coils	98	103	104
Hybrid and modular components, total	**116**	**126**	**119**
Tubes, total	**295**	**318**	**324**
Cathode ray (except for TV)	34	41	40
Image sensing (including camera tubes and intensifiers)	16	16	17
Light sensing (including photomultipliers)	1	1	1
Power tubes (less than 1 GHz)	7	7	9
Microwave (including cooking)	55	60	57
Receiving	1	1	1
TV picture, total	181	192	199
Color	178	189	196
Monochrome	3	3	3
COMPONENTS, TOTAL	**2,805**	**2,985**	**3,210**

All figures in current U.S. dollars.
The figures in this chart, based on a survey made by Electronics in October and November 1986, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products. **Exchange rate: $1.42 to 1 pound.**

FRANCE

GROWTH COULD HIT 7%—BUT EQUIPMENT MAKERS ARE UNEASY

This year, forecasters figure, the French gross national product will take only a slight uptick over the 2.1% expansion registered in 1986. Therefore, makers of electronic equipment can only count on measured growth. The *Electronics* market survey points to a $17 billion year, a 7% gain over 1986 and a percentage point better than the growth rate last year.

"We are uneasy about professional [non-consumer] equipment," says Jean Caillot, president of Thomson International SA, a subsidiary of the nationalized conglomerate Thomson SA, and president of the Groupement des Industries Electroniques (GIEL), the umbrella trade association for the equipment and components industries.

If the forecast is on the mark, data-processing and office equipment will edge to the front of a slow-moving pack with a 10% increase to $8.8 billion. Industrial equipment won't be too far behind at 8%, to just over $1 billion. Communications gear will move up 4% in 1987, achieving $3.5 billion in sales. Consumer equipment, surprisingly strong in 1986 with 10% growth, will log only 3% this year, to $3.1 billion. Test and measurement gear, the survey projects, will come back from an outright decline in 1986, cancelling the 3% dip with a 3% gain to arrive back where it was two years ago at $295 million.

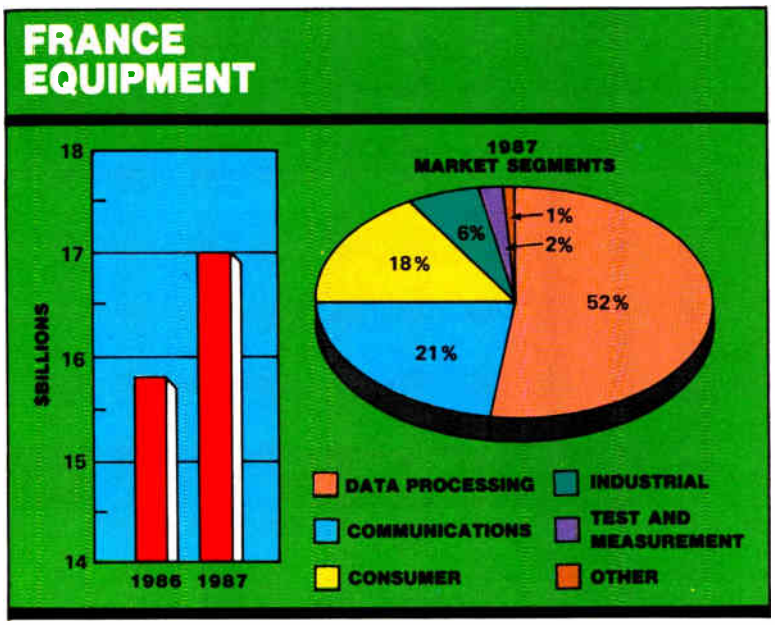
At first glance, the forecast figures for data-processing systems look reassuring: they predict a 1987 gain of 13% to $6 billion. But a closer look at the market uncovers a long-standing cause of uneasiness: a distinctly foreign flavor. "Only a third of the computers come from French companies," says Philippe Frémeaux, an economist who follows new technologies for the Bureau d'Informations et de Prévisions Economiques (BIPE), a government-supported forecasting organization in the Paris suburb of Neuilly. By the BIPE's count, U. S. computer firms have nailed down 62% of the French market. Groupe Bull, the nationalized top native computer maker, has 17%, and smaller producers add another 8.5% to the national share of 25%. Other European firms and Far East suppliers account for the balance.

No one expects the lineup to change much. However, Bull presumably can tack on a little more market share now that it has joined with Honeywell Inc. and NEC Corp. in a new company that will take over the business of Honeywell Information Systems and be run by Bull.

Like all its competitors, Bull this year will pay close attention to the flourishing market for microcomputers—top-of-the-line personal computers and work stations. They should be good for a rise of 23% for the second year in a row, achieving $682 million in sales. With networking keeping the market moving, microcomputers should register strong gains through the remainder of the century, the BIPE projects.

Less spectacular gains—12% in each case—are predicted by the survey for minicomputers and superminis this year, to $886 million and $1 billion, respectively. And at the low end, it looks like a 12% rise as well for personal computers, to $895 million. "The personal-computer market here lags the U. S. market by 1½ to 2 years," says Berangère de Lestapis, the BIPE's data-processing analyst. "But when the crisis comes, it won't hit as hard as it did in the U. S."

Slow growth has become a way of life in the past two years for many French makers of communications equipment.



France now has the most up-to-date digital network in Western Europe, and the Direction Générale des Télécommunications, which runs the network, has eased off on equipment orders. What's more, the French armed forces, heavy buyers of hardware, have a flat budget for the year ahead.

This adds up to an anemic outlook for communications markets. For example, telecommunications is last on a list of billings that the GIEL made public last fall (medical and X-ray equipment, at 35%, topped the list). The 3% overall gain GIEL cites for communications is pretty much in line with the *Electronics* survey. It lists a 2% gain to $3.4 billion in 1986 and predicts a 4% rise this year to $3.5 billion.

However, a couple of world-class export orders (not counted as part of the French market in this survey) will boost the country's hardware output. Thomson will start deliveries this year on a $5.3 billion ground-air defense network for Saudi Arabia; the deliveries will continue for seven years. Thomson also starts delivery this year on a contract, shared with U. S. partner GTE Corp., for a $4.3 billion battlefield-communications system for the U. S. Army.

Traditionally, the French electronics industries have counted on communications equipment and military gear as their bread-and-butter sectors. When

FRANCE EQUIPMENT

(millions of dollars)

	1985	1986	1987
Data processing and office equipment, total	**7,472**	**7,968**	**8,795**
Data processing systems, total	5,020	5,371	6,046
Personal computers (under $5,000)	742	798	895
Microcomputers ($5,000 to $20,000)	448	553	682
Minicomputers ($20,000 to $100,000)	758	788	886
Superminicomputers ($100,000 to $400,000)	852	894	1,000
Mainframe computers ($400,000 to $1 million)	1,159	1,224	1,348
Supercomputers (over $1 million)	1,061	1,114	1,235
Data input peripherals	91	95	102
Data output peripherals	318	355	379
Data storage subsystems	512	571	645
Data terminals	621	667	727
Electronic office equipment, total	910	909	896
Copying equipment	519	524	527
Electronic typewriters	197	203	206
Billing and accounting equipment	68	68	68
Word processing equipment (standalone and clustered)	126	114	95
Test and measuring instruments, total	**294**	**286**	**295**
Amplifiers, lab	4	4	4
Analog voltmeters, ammeters, and multimeters	13	13	13
Automatic test equipment, total	40	40	42
IC testers	15	16	17
PC board testers	25	24	25
Calibrators and standards, active and passive	3	2	2
Counters, time and frequency	10	9	9
Digital multimeters (including probes and accessories)	17	15	16
Logic analyzers	10	11	11
Microprocessor development systems	42	38	39
Microwave test and measuring instruments	32	30	31
Oscillators	7	7	7
Oscilloscopes	42	42	44
Power meters (below microwave frequencies)	2	2	2
Recorders (including chart and X-Y types)	49	51	53
Signal generators (pulse, sweep, and function), total	17	15	15
Analog	11	9	8
Synthesized	6	6	7
Spectrum analyzers	6	7	7
CAD/CAE equipment, total	**75**	**103**	**136**
Industrial electronic equipment, total	**862**	**938**	**1,014**
Inspection systems	15	17	18
Machine-tool controls (including all numerical control systems)	19	20	20
Motor controls	31	33	36
Photoelectric controls	14	15	17
Process-control equipment (including computers, loggers, consoles)	712	782	844
Semiconductor production equipment	71	71	79
Consumer products, total	**2,751**	**3,024**	**3,105**
Audio equipment, total	767	823	853
Car audio	136	150	157
Stereo equipment, total	253	257	257
Components (including tuners, turntables)	195	198	198
Consoles and compact systems (including TV-audio combinations)	58	59	59
Phonographs and radio-phono combinations	31	31	31
Radios (including table, clock, and portable)	72	74	74
Radio/recorder combinations, portable	103	106	106
Tape recorders and players	142	152	152
Compact disk players	30	53	76
Television receivers, total	998	1,090	1,090
Color	955	1,045	1,045
Monochrome	43	45	45
Other consumer electronic products, total	986	1,111	1,162
Home video equipment, total	443	545	589
Cassette players and recorders	378	454	480
Cameras	65	91	109
Electronic musical instruments	40	41	41
Microwave ovens	129	155	170
Electronic games (video and nonvideo)	3	2	2
Calculators (personal and professional)	48	47	46
Electronic watches and clocks	179	185	185
Home computers (under $1,000)	144	136	129
Communications equipment, total	**3,309**	**3,386**	**3,516**
Data communications equipment	185	194	204
Facsimile terminals	49	55	59
Fiber-optic communications systems	53	64	76
Intercom systems	38	40	42
Navigation aids, except radar	114	117	123
Paging systems, public and private	25	26	27
Radar—air, land, and marine	658	705	736
Radio, total	258	277	295
Broadcast equipment	96	102	108
Microwave systems	56	59	62
Mobile, land	106	116	125
Satellite earth stations	n/a	n/a	n/a
Telecommunications equipment, total	1,864	1,840	1,880
Telephone and data switching, private (PABX)	273	270	274
Telephone and data switching, public	1,197	1,191	1,227
Telephone and telegraph carrier	394	379	379
Television equipment, total	65	68	74
Broadcast (studio) equipment (including cameras, recorders, and monitors)	38	40	44
CCTV (including educational, industrial, and medical)	27	28	30
Power supplies (noncaptive), total	**88**	**92**	**97**
Bench and lab	17	17	17
Industrial (heavy duty)	22	23	24
OEM and modular, total	49	52	56
Linear	25	25	26
Switching	24	27	30
EQUIPMENT, TOTAL	**14,851**	**15,797**	**16,958**

All figures in current U.S. dollars. Exchange rate: 6.6 francs to $1.

they slipped last year, consumer electronics shored up the equipment markets. Manufacturers of consumer products saw their business climb 10% to $3 billion. This year, *Electronics* projects a trailing off to 3%, which would put the market at $3.1 billion. The only sprightly segment is compact-disk players. From a very low base, they will shoot up 43% to $76 million, according to the survey.

Last year, color-TV receivers powered the market, bouncing up 9% to $1 billion. Consumption will remain essentially flat, the *Electronics* figures suggest, with no growth projected. Some market observers see a chance for a slight gain—just under 3%—despite the saturated market. Their reasoning: new-look sets with square-face tubes are coming on the market, and the program offerings have been augmented by an increase in the number of networks from four to six. In addition, cable-TV networks are in the offing; the government decided last summer that private companies could set them up.

The dreaded designation of hardest-hit equipment sector went last year to test and measurement. The market took a drop of 3% and ended up at $286 million. However, the *Electronics* survey projects a 3% rise for the year ahead to $295 million.

One reason for last year's poor performance was the tighter budgets for government agencies such as DGT, the gas and electric utilities, and for the armed forces. Another reason was uncertainty early in the year at nationalized electronics companies about being "reprivatized." All the nationalized companies are slated to be sold back to private investors, but it probably will be years before companies in the electronics sector are sold.

Finally, points out Guy Leborgne, director of the Science and Industry Division of SA Philips Industrielle et Commerciale in the Paris suburb Bobigny, "Investments have become more profitable than manufacturing. Companies are paying off debt rather than investing in plants." Tight government budgets and low plant investment will dampen this year's instrument markets as well.

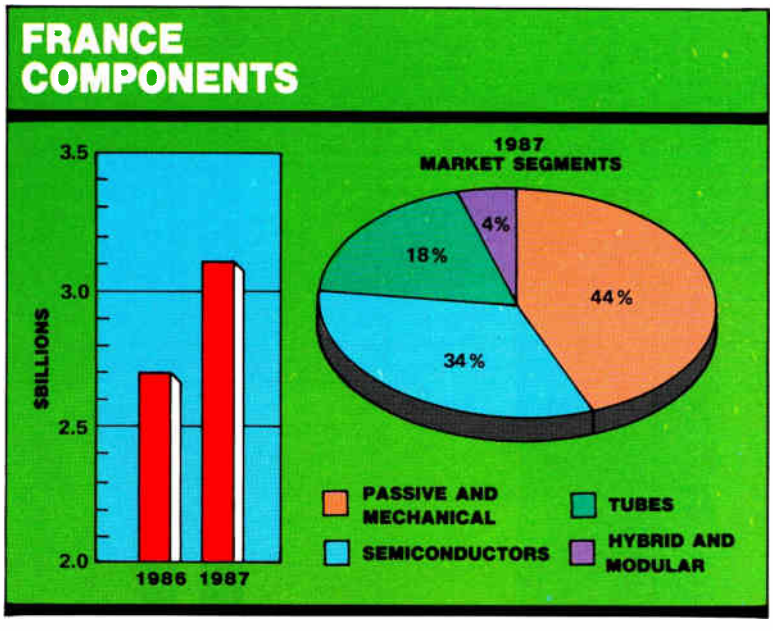
A 10% CLIMB WILL SIGNAL A SOLID COMEBACK FOR COMPONENTS

Last year at this time, French components suppliers figured they would do reasonably well in 1986. They didn't. But once burned is not always twice shy, and this year components makers again see a chance for good gains, particularly in the semiconductor sector.

For 1987, the call is a market climb of 10% to $3.1 billion, a solid comeback from the scant 1% rise to $2.9 billion logged in 1986. But there's always a chance that history could repeat itself. "There's no clear vision for 1987," says Jacques Bouyer, president and general manager of RTC-Compélec SA, the major components-producing company in France for the Philips Group.

Although the *Electronics* forecasts point to a reasonably good 1987, many executives in the French components business are troubled by the stunted growth in the markets of their equipment-making customers. Also troubling is a constant pressure on prices, partly because of the drop in the value of the dollar that benefits U. S. suppliers and partly because of strong competition from the Far East—including dumping, French components-industry executives maintain. "But the biggest problem is the lack of growth," RTC's Bouyer says. "If growth stays around zero or goes negative, some companies will have to go out of business."

Growth is also a major concern of Jacques Noels, managing director of Thomson's Branche Composants Electroniques. "The key to the market is the computer sector. But its growth rate slipped [in 1986] from 15% to 18% a year to about 5%." Noels expects the consumer electronics sector will take up some of the slack during the first half of the year, but he's concerned that the makers of TV sets may lose zip later if the government moves to cut consumer spending. Another of Noels' concerns is the overcapacity in semiconductor plants around the world. "It will persist for another two years," he says.



Despite the clouded crystal balls, it's reasonably safe to project a turnaround for passive and mechanical components. They registered an absolute decline of almost 1% in 1986, down from $1.267 billion to $1.255 billion. "It was the first time ever," says Jean Caillot, president of Thomson International SA, a subsidiary of the nationalized conglomerate Thomson SA, and president of the Groupement des Industries Electroniques (GIEL), the umbrella trade association for the equipment and components industries. Now compo-

nents makers figure that the market bottomed out last year and will turn up again this year. According to the *Electronics* survey, the sector will bounce back to nearly $1.4 billion, a respectable 9% gain.

For all their vicissitudes last year, passive and electromechanical parts managed to maintain their rank as the country's largest components sector. But semiconductors keep coming closer and closer. They edged up 2% last year to $928 million, and they could make it past the $1 billion mark this year if the vision of the *Electronics*' survey respondents turns out to be in focus. That would mean a 14% gain. Tubes, the third-ranking sector, should weigh in at $558 million, according to the survey, a gain of 4%. How close to the mark this figure turns out to be depends heavily on how well TV-set makers fare. Color-TV picture tubes are the mainstay of the sector; the survey predicts a modest gain of 4% to $305 million, but some forecasters see a slight drop.

As always, the semiconductor sector, and particularly integrated circuits, will come in for the most attention. Sales of ICs slipped 2% last year to $668 million. This year, chip consumption should turn around sharply, with a 16% gain that will carry it to a level of $772 million, the *Electronics* survey shows.

This year's prospects are perplexing, but IC houses by and large agree that there will be an upturn this year. Jan Calen, marketing director at Motorola Inc.'s European headquarters in Geneva, for example, is looking at a 14% rise for France, following a 4% dip for 1986.

Whatever the final figure, there's little doubt that memories will fare much better than they did last year. Prices have firmed and excess inventories at equipment makers have been worked off. Random-access memories will advance 15% to $143 million after a 4% decline last year. Read-only memories also should grow 15% to $38 million after falling 20% in 1986. However, ROM consumption still won't top 1985's $41 million.

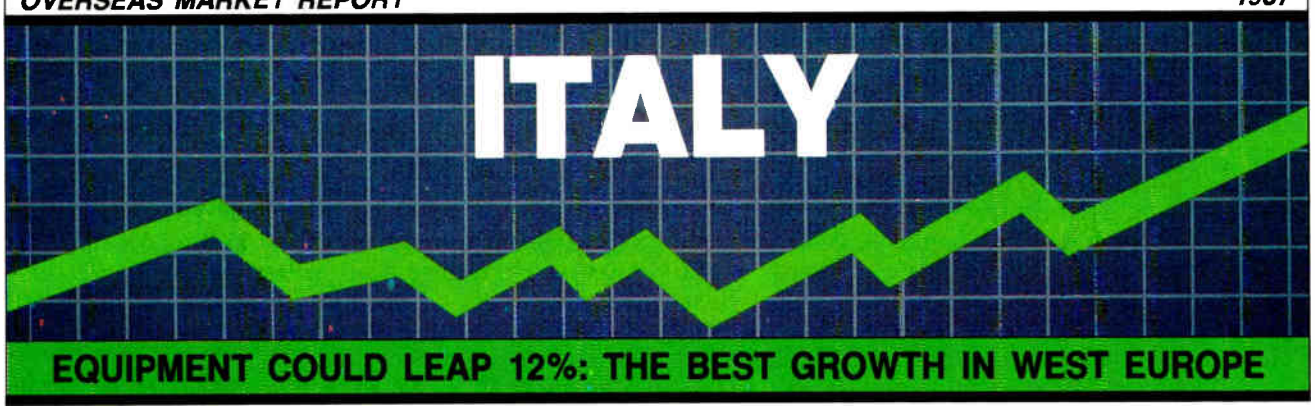
And there's no doubt that microprocessors will do well. They still are finding their way into new kinds of equipment, and consumption will grow 18% to $148 million. Moreover, semicustom circuits, constantly supplanting standard logic in new equipment designs, will make a strong run. Last year, they were only a $20 million business in France, according to the survey, which pegs them for a 10% gain in 1987. But Daniel Leveille-Nizerolle, commercial director of RTC's Microelectronics Division, is convinced that eventually they will account for 20% of the market, with gate arrays developing faster than cell-based semicustom designs. For the moment, however, they are dwarfed by standard logic at roughly $253 million, up 19%, and by microprocessors.

FRANCE COMPONENTS

	(millions of dollars) 1985	1986	1987
Semiconductors, total	**908**	**928**	**1,056**
Discrete, total	188	202	217
Diodes, total	80	86	94
Microwave (less than 1 GHz)	8	9	10
Rectifiers and rectifier assemblies	41	43	47
Signal (less than 100 mA, including arrays)	15	16	18
Varactor (tuning)	4	5	5
Zener and reference	12	13	14
Thyristors (including SCRs and triacs)	24	26	29
Transistors, total	84	90	94
Bipolar, total	63	68	71
Power (more than 1 W dissipation)	44	48	50
Small-signal (including duals and arrays)	19	20	21
Field effect	8	8	9
RF and microwave (bipolar and FET, including GaAs)	13	14	14
Integrated circuits, total	680	668	772
Linear ICs, total	132	125	136
Communications (including telecom—codecs, etc.)	29	28	31
Entertainment	61	56	63
Interface (drivers, buffers, translators, etc.)	14	14	14
Op amps (monolithic only)	28	27	28
Digital ICs, total	548	543	636
Standard logic families, total	227	212	253
Bipolar	129	116	139
CMOS	98	96	114
Memories, total	170	157	181
RAM	129	124	143
ROM	41	33	38
Microprocessor and microcomputer chips	105	125	148
Special-purpose circuits	27	29	32
Semicustom logic (gate arrays)	19	20	22
Optoelectronic devices	40	58	67

	(millions of dollars) 1985	1986	1987
Passive and mechanical, total	**1,267**	**1,255**	**1,369**
Capacitors, total	159	144	172
Fixed	152	137	164
Variable	7	7	8
Connectors, plugs, and sockets	289	299	332
Filters, delay networks, and delay lines	23	23	23
Loudspeakers (OEM type)	98	99	104
Printed circuits and interconnections	273	275	298
Quartz crystals	46	48	53
Readouts (optoelectronic and LCD)	15	14	17
Relays (for communications and electronics)	83	83	83
Resistors, total	118	120	127
Fixed	82	84	89
Potentiometers and trimmers	36	36	38
Switches and keyboards (for electronics)	68	71	80
Transformers, chokes, and coils	95	79	80
Hybrid and modular components, total	**132**	**138**	**148**
Tubes, total	**512**	**534**	**558**
Cathode ray (except for TV)	33	35	36
Image sensing (including camera tubes and intensifiers)	27	27	30
Light sensing (including photomultipliers)	8	8	8
Power tubes (less than 1 GHz)	30	29	30
Microwave (including cooking)	109	117	125
Receiving	2	2	1
TV picture, total	303	316	328
Color	280	293	305
Monochrome	23	23	23
COMPONENTS, TOTAL	2,819	2,855	3,131

All figures in current U.S. dollars.
The figures in this chart, based on a survey made by Electronics in October and November 1986, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products. **Exchange rate: 6.6 francs to $1.**



The Italian equipment industry could well benefit from an industrial boom that appears to be in the making. For electronics equipment makers, this translates into a 12% gain to almost $12.5 billion, the best growth among the four Western European nations tracked in the *Electronics* market survey.

Italy has reined in the high inflation that plagued it through the last decade, flipped from deficit to surplus in foreign trade, and brought its budget deficit under control. "The financial situation of Italian companies is much improved compared to the recent past," says Alberto De Macchi of the economic research department of Ing. C. Olivetti & Co. "They're structured now to think about expansion."

Food for such thought will be fairly easy to come by in 1987. De Macchi forecasts a "moderately positive" year, with the gross national product growing slightly more than 3%. At that level, Italy will be the economic-growth leader in Europe, notes Roberto Taranto at Teknibank SpA, a market-research firm in Milan.

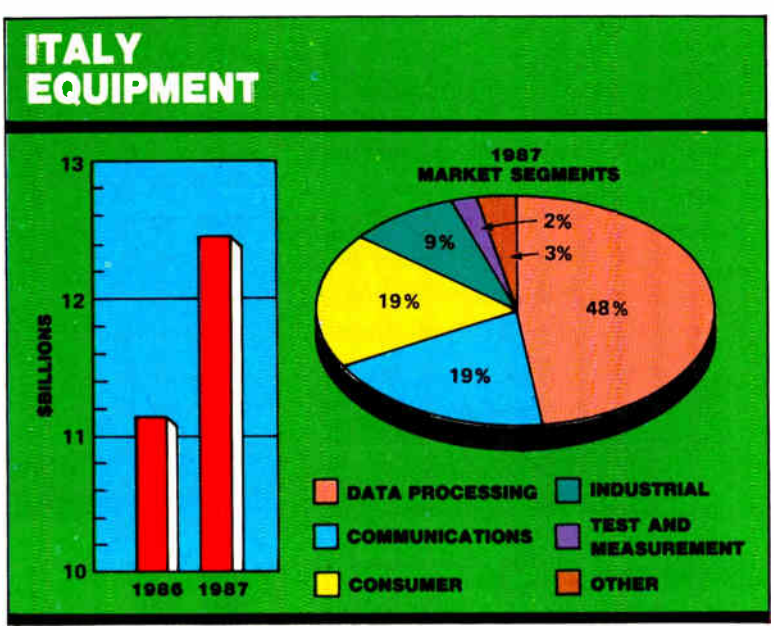
Much of the growth in the equipment sector will come from the data processing markets; they will quickstep at a 16% rate to top $6 billion this year, according to the survey. A look at the chart shows industrial electronics as a second strong sector, in for a 15% climb to almost $1.1 billion. Consumer electronics checks in at $2.4 billion, up 8%.

Communications equipment, because of flat military and telecommunications budgets, will trail the other major sectors with 4% growth to $2.4 billion. "The telecommunications industry is midway between pessimism and optimism," says Carlo Delle Piane, manager for strategic planning at Telettra SpA in the Milan suburb of Cinisello Balsamo.

Among computer makers, though, optimism is the order of the day. Personal computers, minicomputers, and mainframes are all poised for gains of better than 20%. Personal computers, an Olivetti specialty, will expand 21% to $731 million on top of 23% growth in 1986. "Last year, we had a 35% [domestic] market share in personal computers, higher than IBM at 33%. We're the only country in Europe where IBM does not come first in personal computers," says Alessandro De Maria of Olivetti's corporate market and business analysis group. Adding to the Olivetti's rosy profile is the fact that AT&T Co., which owns 25% of the Ivrea firm, has stopped producing personal computers and work stations, leaving Olivetti as its sole supplier.

Both personal computers and minicomputers will benefit from the push to automate at small manufacturing companies, says Renato Levrero, a market researcher for Honeywell Information Systems Italia, Milan. "Only 52% of manufacturers with between 10 and 200 employees have computers," he says. Levrero has great expectations for the education market too, as secondary schools and the universities buy networked personal computers. Among larger systems, minicomputers should do best. The forecast is 29% growth to $860 million, following last year's 30%.

Makers of industrial electronics gear have great expectations as well. The improved cash flow at large corporations has spurred plant investments, partially accounting for the 15% rise forecast to $1.1 billion, on the heels of 13% growth last year. The government has provided a lift for computer-aided manufacturing by subsidizing companies that buy CAM gear through partial rebates of value-added



taxes. Major firms have set their sights on the market. IBM and the government telecommunications holding company STET have teamed for factory automation, for example, and so have automaker Fiat and Digital Equipment Corp. There is room for smaller companies, too, says Guglielmo Cattelan, engineering market development manager for Hewlett-Packard Italiana, Cernusco sul Naviglio. One of them, Digital Electronics Automation SpA of Turin, has sold some 1,000 robots to IBM, Cattelan reports.

Consumer electronics remains comparatively lackluster. TV sets, the mainstay of the sector, should rise 9% to $948 million, bettering the 3% gain of last year. But the increase will come mainly from price hikes, not from a rush to the showrooms. The audio market will rise to $588 million, a gain of just 3%. Compact-disk players should continue to soar—they're pegged for 125% growth—but will account for only $36 million in sales.

COMPONENTS SHOULD CLIMB 9%

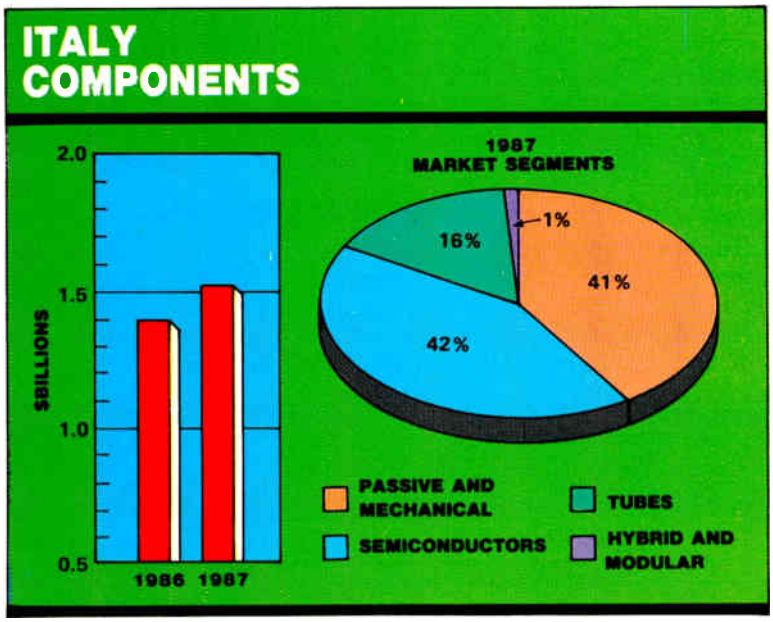
The components markets in Italy are set for an upward tick this year, with sales reaching $1.52 billion overall, up 9% over the $1.4 billion achieved in 1986. Semiconductors will set the pace with a 10% rise, while passives and tubes will hover near 8%.

ITALY EQUIPMENT

	(millions of dollars) 1985	1986	1987
Data processing and office equipment, total	**4,453**	**5,225**	**6,040**
Data processing systems, total	2,603	3,201	3,870
Personal computers (under $5,000)	491	605	731
Microcomputers ($5,000 to $20,000)	109	138	162
Minicomputers ($20,000 to $100,000)	515	667	860
Superminicomputers ($100,000 to $400,000)	681	839	989
Mainframe computers ($400,000 to $1 million)	388	470	573
Supercomputers (over $1 million)	419	482	555
Data input penpherals	48	52	56
Data output peripherals	222	258	299
Data storage subsystems	531	622	715
Data terminals	377	373	380
Electronic office equipment, total	672	719	720
Copying equipment	358	384	387
Electronic typewriters	183	204	204
Billing and accounting equipment	68	68	66
Word processing equipment (standalone and clustered)	63	63	63
Test and measuring instruments, total	**138**	**153**	**173**
Amplifiers, lab	1	1	1
Analog voltmeters, ammeters, and multimeters	5	6	6
Automatic test equipment, total	34	37	42
IC testers	13	15	18
Pc board testers	21	22	24
Calibrators and standards, active and passive	n/a	n/a	n/a
Counters, time and frequency	4	4	4
Digital multimeters (including probes and accessories)	9	9	10
Logic analyzers	4	5	6
Microprocessor development systems	13	14	16
Microwave test and measuring instruments	18	24	29
Oscillators	1	1	1
Oscilloscopes	22	23	25
Power meters (below microwave frequencies)	1	1	2
Recorders (including chart and X-Y types)	16	16	19
Signal generators (pulse, sweep, and function), total	5	6	6
Analog	4	4	4
Synthesized	1	2	2
Spectrum analyzers	5	6	6
CAD/CAE equipment, total	**179**	**233**	**294**
Industrial electronic equipment, total	**830**	**937**	**1,076**
Inspection systems	13	14	16
Machine-tool controls (including all numerical control systems)	62	72	80
Motor controls	92	106	122
Photoelectric controls	n/a	n/a	n/a
Process-control equipment (including computers, loggers, consoles)	645	723	832
Semiconductor production equipment	18	22	26

All figures in current U.S. dollars. Exchange rate: 1,395 lire to $1.

	(millions of dollars) 1985	1986	1987
Consumer products, total	**2,130**	**2,252**	**2,421**
Audio equipment, total	548	570	588
Car audio	93	108	102
Stereo equipment, total	152	153	157
Components (including tuners, turntables)	97	97	100
Consoles and compact systems (including TV-audio combinations)	55	56	57
Phonographs and radio-phono combinations	27	27	27
Radios (including table, clock, and portable)	73	72	65
Radio/recorder combinations, portable	97	99	106
Tape recorders and players	95	95	95
Compact disk players	11	16	36
Television receivers, total	837	866	948
Color	794	824	906
Monochrome	43	42	42
Other consumer electronic products, total	745	816	885
Home video equipment, total	151	248	316
Cassette players and recorders	122	211	269
Cameras	29	37	47
Electronic musical instruments	35	36	36
Microwave ovens	22	37	46
Electronic games (video and nonvideo)	16	14	14
Calculators (personal and professional)	50	45	41
Electronic watches and clocks	199	204	204
Home computers (under $1,000)	272	232	228
Communications equipment, total	**2,201**	**2,289**	**2,391**
Data communications equipment	54	59	65
Facsimile terminals	40	48	55
Fiber-optic communications systems	n/a	n/a	n/a
Intercom systems	29	30	31
Navigation aids, except radar	204	214	219
Paging systems, public and private	25	27	28
Radar—air, land, and marine	123	128	136
Radio, total	213	229	251
Broadcast equipment	73	79	84
Microwave systems	61	65	72
Mobile, land	79	85	95
Satellite earth stations	n/a	n/a	n/a
Telecommunications equipment, total	1,466	1,504	1,554
Telephone and data switching, private (PABX)	190	199	207
Telephone and data switching, public	1,039	1,054	1,082
Telephone and telegraph carrier	237	251	265
Television equipment, total	47	50	52
Broadcast (studio) equipment (including cameras, recorders, and monitors)	22	23	24
CCTV (including educational, industrial, and medical)	25	27	28
Power supplies (noncaptive), total	**50**	**55**	**63**
Bench and lab	4	4	5
Industrial (heavy duty)	14	15	17
OEM and modular, total	32	36	41
Linear	12	13	14
Switching	20	23	27
EQUIPMENT, TOTAL	**9,981**	**11,144**	**12,45E**



The 12% rise and $468 million market in sight for integrated circuits is a welcome change: last year ICs dipped 6%. "I'm confident we have reached the bottom," says Enrico Villa, director of external technological coordination for SGS Microelettronica SpA, Italy's largest semiconductor house. Still, he cautions, "there is just too much overcapacity for prices to bounce way back."

In Villa's view, automakers will be good customers. And computer makers worked off their parts inventories last year, so chip makers figure business will pick up in 1987.

A recovery is in the cards for chips for entertainment equipment, with a 6% increase to $34 million. TV-set production should hold at about 1.5 million sets, and chip prices should firm up. And 1987 should see a lift from the startup of video-cassette-recorder production by Standard Elektrik Lorenz AG of West Germany and REL SpA, Italy's state-owned consumer-electronics company.

Discretes won't do nearly as well as ICs. The survey puts the market at $142 million—up 4%, a shade under last year's 5% growth rate. □

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ITALY COMPONENTS

	(millions of dollars) 1985	1986	1987
Semiconductors, total	**599**	**577**	**637**
Discrete, total	129	136	142
Diodes, total	48	48	50
Microwave (less than 1 GHz)	4	4	4
Rectifiers and rectifier assemblies	30	31	32
Signal (less than 100 mA, including arrays)	7	6	6
Varactor (tuning)	1	1	1
Zener and reference	6	6	7
Thyristors (including SCRs and triacs)	16	17	18
Transistors, total	65	71	74
Bipolar, total	57	58	61
Power (more than 1 W dissipation)	32	34	37
Small-signal (including duals and arrays)	25	24	24
Field effect	2	3	3
RF and microwave (bipolar and FET, including GaAs)	6	10	10
Integrated circuits, total	445	417	468
Linear ICs, total	104	96	104
Communications (including telecom—codecs, etc.)	29	26	29
Entertainment	34	32	34
Interface (drivers, buffers, translators, etc.)	22	20	22
Op amps (monolithic only)	19	18	19
Digital ICs, total	341	321	364
Standard logic families, total	107	96	106
Bipolar	85	77	82
CMOS	22	19	24
Memories, total	109	96	115
RAM	75	68	80
ROM	34	28	35
Microprocessor and microcomputer chips	57	56	63
Special-purpose circuits	54	58	62
Semicustom logic (gate arrays)	14	15	18
Optoelectronic devices	25	24	27

	(millions of dollars) 1985	1986	1987
Passive and mechanical, total	**523**	**572**	**618**
Capacitors, total	120	132	144
Fixed	115	126	138
Variable	5	6	6
Connectors, plugs, and sockets	100	108	112
Filters, delay networks, and delay lines	8	9	9
Loudspeakers (OEM type)	30	34	37
Printed circuits and interconnections	85	95	106
Quartz crystals	11	11	12
Readouts (optoelectronic and LCD)	10	11	11
Relays (for communications and electronics)	45	49	54
Resistors, total	32	35	38
Fixed	16	17	19
Potentiometers and trimmers	16	18	19
Switches and keyboards (for electronics)	39	42	46
Transformers, chokes, and coils	43	46	49
Hybrid and modular components, total	**18**	**20**	**22**
Tubes, total	**209**	**226**	**244**
Cathode ray (except for TV)	3	3	3
Image sensing (including camera tubes and intensifiers)	3	3	3
Light sensing (including photomultipliers)	1	1	2
Power tubes (less than 1 GHz)	10	11	11
Microwave (including cooking)	10	11	11
Receiving	2	2	2
TV picture, total	180	195	212
Color	161	176	193
Monochrome	19	19	19
COMPONENTS, TOTAL	**1,349**	**1,395**	**1,521**

All figures in current U.S. dollars.
The figures in this chart, based on a survey made by Electronics in October and November 1986, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products. **Exchange rate: 1,395 lire to $1.**

Germanium Rectifiers: Oliver gives you the facts.

Device	Peak Vf at 1000A	Rel. Eff. % at 5kW output	Input V at 1000A	Relative dc ripple mV
Germanium	0.60	86.5	188.8	80
Schottky	1.00	85.0	190.0	150
Silicon A	1.20	76.0	200.0	100
Silicon B	1.25	74.0	202.0	95

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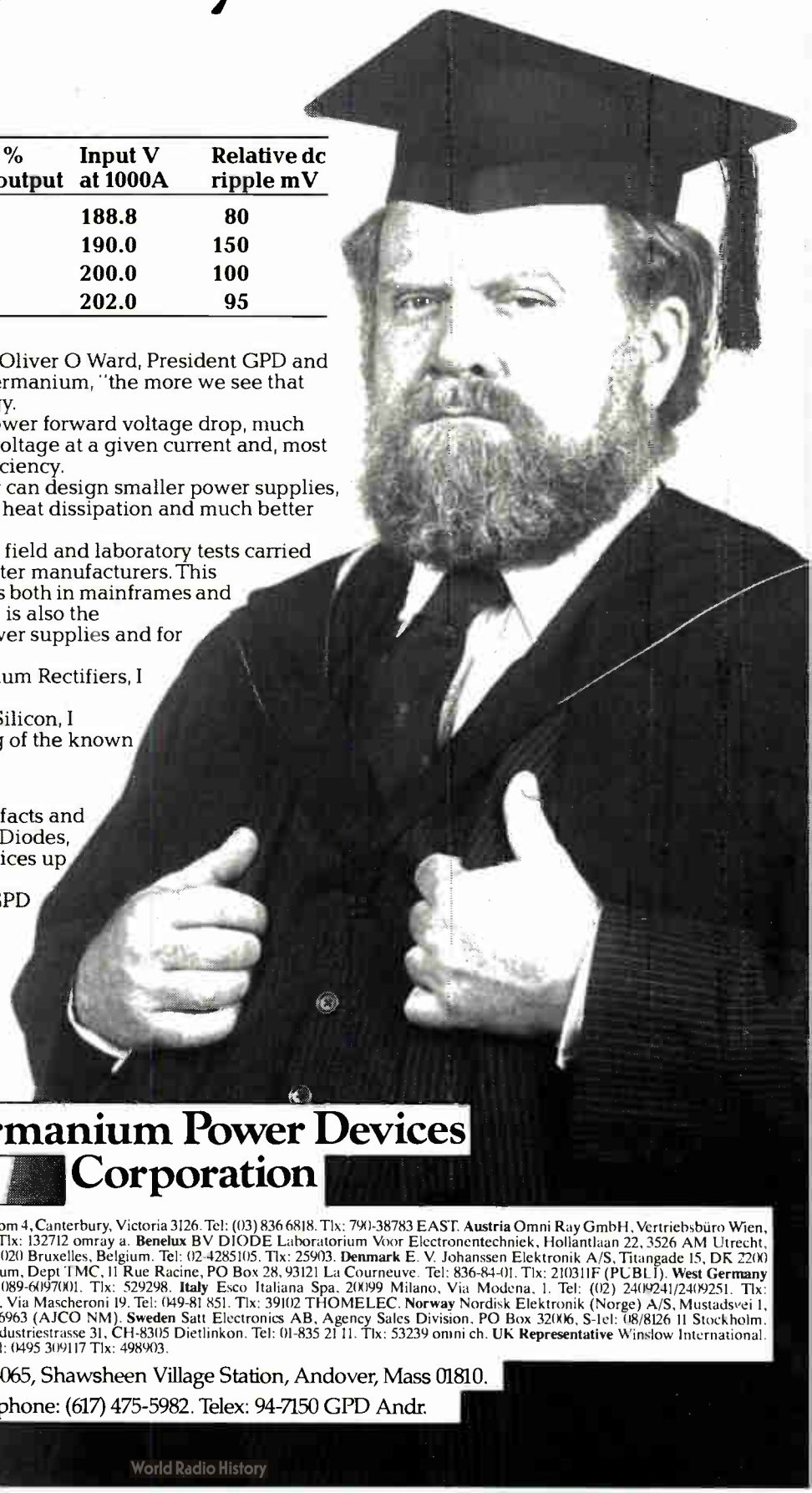

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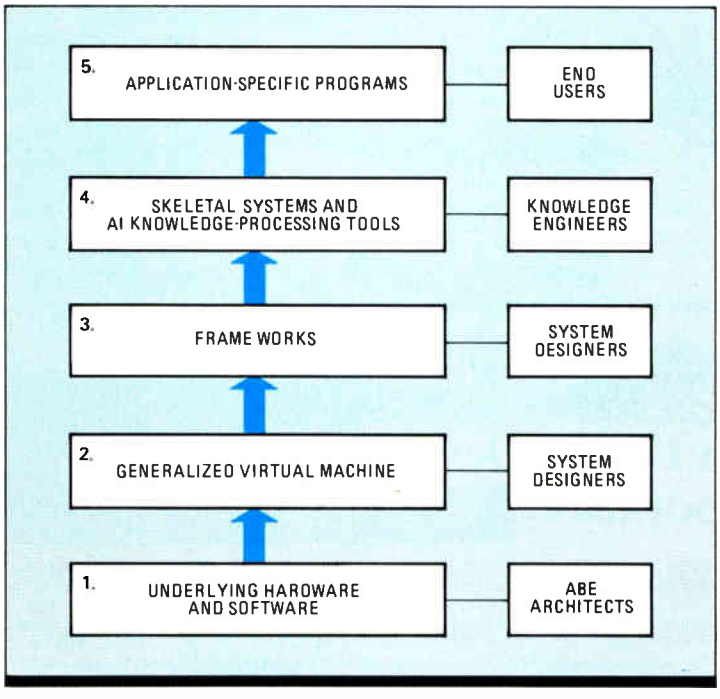
A NEW WAY TO MOVE AI INTO THE MAINSTREAM

Teknowledge is readying a powerful programming architecture that will streamline the creation of applications combining AI and conventional programs



1. ABE'S FIVE LEVELS. At the upper levels, systems designers assemble frameworks that knowledge engineers use to build AI tools for end users.

The task of assembling complex systems that integrate conventional and artificial-intelligence programs soon will emerge from the realm of AI specialists. Working for the Pentagon, Teknowledge Inc. has devised an AI-based architecture, called Abe, that aims to move AI into the mainstream of programming.

Up until now, a complex program marrying AI software with conventional software required a team of AI engineers with expertise in systems programming. Moreover, each complex program had to be built from the ground up. Abe attacks both these drawbacks by providing a global architecture within which engineers can design programming environments for general applications and then customize specific applications.

Abe's architecture is a five-level hierarchy (Fig. 1). Level 1 is the basic programming language, running on a Symbolics Inc. work station. The language is Common Lisp, augmented by Teknowledge's Coral, an object-oriented language. Level 2 is formed by a virtual machine that links together problem-solving modules. Each module comprises combinations of different programs, which may be conventional software packages, other AI programs, or programs previously created with Abe. Level 3 consists of seven frameworks, which provide structures that a system designer uses to configure various software tools and problem-solving modules in a skeletal system. The skeletal system forms the foundation for specific applications—for example, it might be a general planning system, from which an application for planning artillery strikes will later be derived. Level 4 includes both skeletal systems and what is essentially a shopping list of knowledge-engineering tools created in the underlying levels or imported from outside the system. These include various AI components, such as rule interpreters, that can be used to customize the skeletal systems. Level 5 consists of the applications programs that are formed by customizing the skeletal systems.

In February, Teknowledge will release its first prototype of Abe to selected users within the Department of Defense. The Palo Alto, Calif., AI toolmaker has also tentatively scheduled a mid-year introduction of a commercial product called Copernicus based in part on Abe.

Abe is a project for the Air Force's Rome Air Development Center and the Defense Advanced Research Projects Agency's Strategic Computing Program. The Pentagon wanted an AI-based architecture that would provide a special kind of environment—one in which AI would act as "in-

telligent glue" to tie together all the existing and future programming tools and languages used by the U. S. military. Ultimately, the architecture will be used to create applications programs that can advise users on strategies as simple as tank maintenance and as complex as a battle-management plan.

What Teknowlege came up with in Abe—the name comes from the tag the project got in house, "a better environment"—is an architecture that not only ties together a wide range of diverse software but can configure it in different modules that can be used again and again. "Abe is an architecture for building systems intelligently—using what we know about AI to build systems that are perhaps 20% AI and 80% conventional software through what we call knowledge-processing functions," says Frederick Hayes-Roth, principal scientist at Teknowledge. Those functions are embodied in Abe's five operating levels.

The functions of the first two levels are relatively straightforward. The first provides the hardware platform and the programming language with which system designers will work as they use Abe. Besides Common Lisp, an early version of Abe will support several other powerful knowledge-engineering tools to supplement Common Lisp: MRS from Stanford University; Carnegie Representation Language, OPS5, and Prolog, all based on Carnegie Group's general-purpose shell, KnowledgeCraft; and S.1, a Teknowledge product. Abe will allow systems architects to change language in mid-design if another language seems better suited to the module being created.

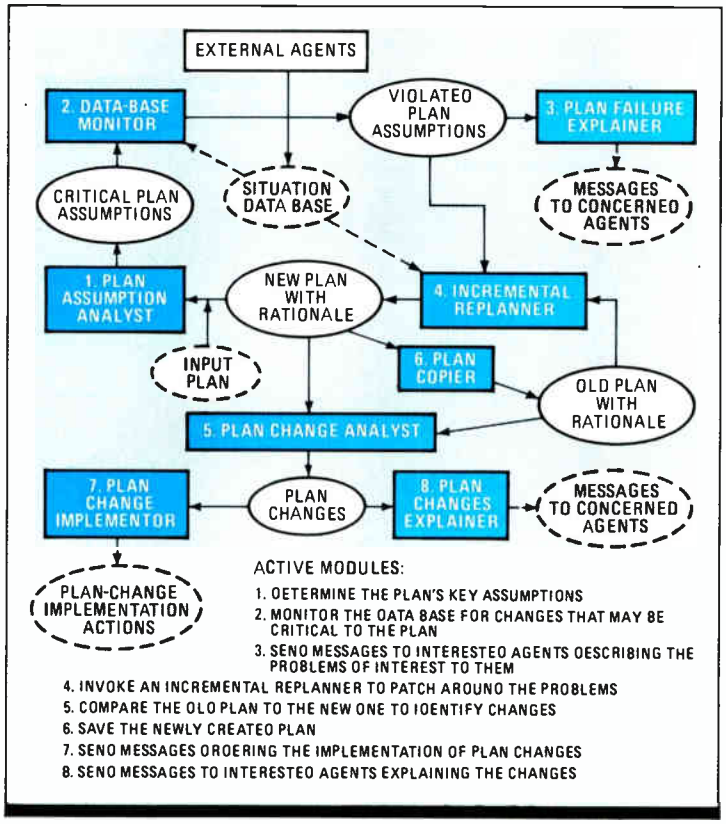
The second level provides an environment in which the systems designer can work with a wide number of different programs. Using the languages and the work station that form the first level, the designer assembles the programs and software tools he has chosen to solve the problem presented by the system he is creating. These programs and tools are combined in problem-solving modules. The modules become part of Abe, to be reused in future systems.

The virtual machine embodied in the second level provides a way to interface the modules, allowing the designer to use them collectively to build his system. Standardized interfaces make pre-Abe packages compatible with Abe's protocols. Modules communicate through an operating system called Kiosk.

It is on the third level, where systems architects work with problem-solving frameworks, that Abe's power and flexibility become evident. Here, systems architects work with a menu of seven frameworks, chosing them through a graphical interface according to which will most efficiently solve the problems inherent in the systems they are building. More than one framework may be incorporated in a single system.

The frameworks provide structures for the various problem-solving modules the systems architect has collected. The structure imposed by each of the seven frameworks represents a particular approach to building the system. Within this structure the systems architect configures the modules and the different software tools described in the fourth level. This configuration represents the most efficient way to use the modules and tools to build a particular system. Once used, the entire structure can be stored as a problem-solving module for future use.

The seven frameworks include one called Blackboard, an AI tool that defines a global, shared data base operated upon by independent, cooperating problem solvers that respond to changes to the data base and form a new one. Dataflow, which is derived from systems engineering, defines a system as being made up of processes, each with a number of required inputs that produce one or more ouputs. The Transaction framework resembles a data-base server. Blackbox deals with modules that are not created using Abe's graphical programming technique—those written in assembly language, for example. Importer is a special version of Blackbox that provides standard interfaces, so that existing or external modules can look like Abe modules. Catalog is available so a systems architect can create a catalog of problem-solving tools suited to his particular needs. Finally, a framework for abstract data types facilitates data exchange between dissimilar modules.



2. FRAMEWORKS. A plan-monitoring and replanning system built with Abe combines the Dataflow, Blackboard, and Transaction frameworks.

The abstract data types play a key role in Abe's engineering strategy. Using this framework, the systems architect defines how questions about the data are to be answered and how commands involving the data are to be implemented, and by doing so creates a module of abstract data types. Such modules don't solve problems themselves, but they are used extensively in other frameworks.

The fourth level is a list of knowledge-engineering tools, including languages, created in the underlying levels or imported from outside the system. These tools come in two types: the application-oriented skeletal systems developed using frameworks, and knowledge-processing modules. Creating an intelligent system—composed mostly of conventional software, and directed by AI—requires only a selection of skeletal systems, knowledge-processing tools, and the standardized interface facility, which allows the use of existing software packages, says Hayes-Roth.

The skeletal systems are created by structuring and controlling knowledge-processing tools and such facilities as data bases. "Abe takes a manufacturing approach," says Hayes-Roth. "Skeletal systems are the application-oriented tool, and the module-oriented programming are the components from which we assemble these tools. We're trying to get an enormous productivity increase by standardizing the components and agreeing on ways to assemble them."

The knowledge-processing tools are the AI component of Abe's knowledge-engineering tools. They include program modules that interpret rules, maintain data bases, provide English-like translations of rules, run cases, and explain system behavior. "They are the essence of AI reduced to reusable, specific functions," says Hayes-Roth. "If you want to store and retrieve predicate calculus expressions, you will use a functional module. You shouldn't have to import a complex AI tool. These modules are the AI equivalent of a statistical library."

For example, one of the first skeletal systems created with Abe was a plan monitoring and replanning system (Fig. 2). It can be customized to form two quite different applications—a military system for planning air strikes and a civilian system for selecting travel itineries on commercial airlines.

A research version of another skeletal sytem has already been tested by Darpa. The system was used to develop applications for a naval battle-management system. In doing so, Darpa put to the test Abe's capability for using previously developed software. The system incorporates a vast array of existing software—data-management systems, graphics, simulation and modeling packages, and command and control software.

Apparently, the agency was impressed by the results. Commander Allen Sears, Darpa's project manager for Abe, says that the architecture's greatest strength is that other systems can be used within it—Abe provides a common interface to the entire computing world. "In a way, it's revolutionary," he says. "We are very carefully defining steps to gather knowledge, which is typical of all AI, but we are also trying to make systems that can be scaled up, systems that reuse knowledge and procedures." □

HAYES-ROTH: BUILDING A BRAIN FOR THE BODY OF PROGRAMMING

Teknowledge Inc.'s chief scientist Frederick Hayes-Roth likens the Palo Alto company's Abe programming architecture to the human body. "We're made up primarily of primitive, nerve-level functions and 20% intelligence that organizes it all," he says. Likewise, Abe is made up of 80% conventional programming, and the rest is artificial intelligence that coordinates it in a modular fashion.

By endowing Abe with the capability of manufacturing intelligent systems from reusable modules, Teknowledge is attacking the shortcomings of today's AI tools, says Hayes-Roth. As single-purpose packages, even the best of these tools cannot be expanded beyond their dedicated domains. Although some allow a wide range of choices, they must be implemented in a single, restrictive architecture.

In addition, he notes that present tools have low-level capabilities that require the specialized skills of a systems architect. They balk at integration into conventional data-processing and computer technologies. They are inflexible, each supporting limited data types and inference schemes. Finally, Hayes-Roth says, they cannot support large-scale applications, and their uniprocessor implementations make nonportability a serious limitation.

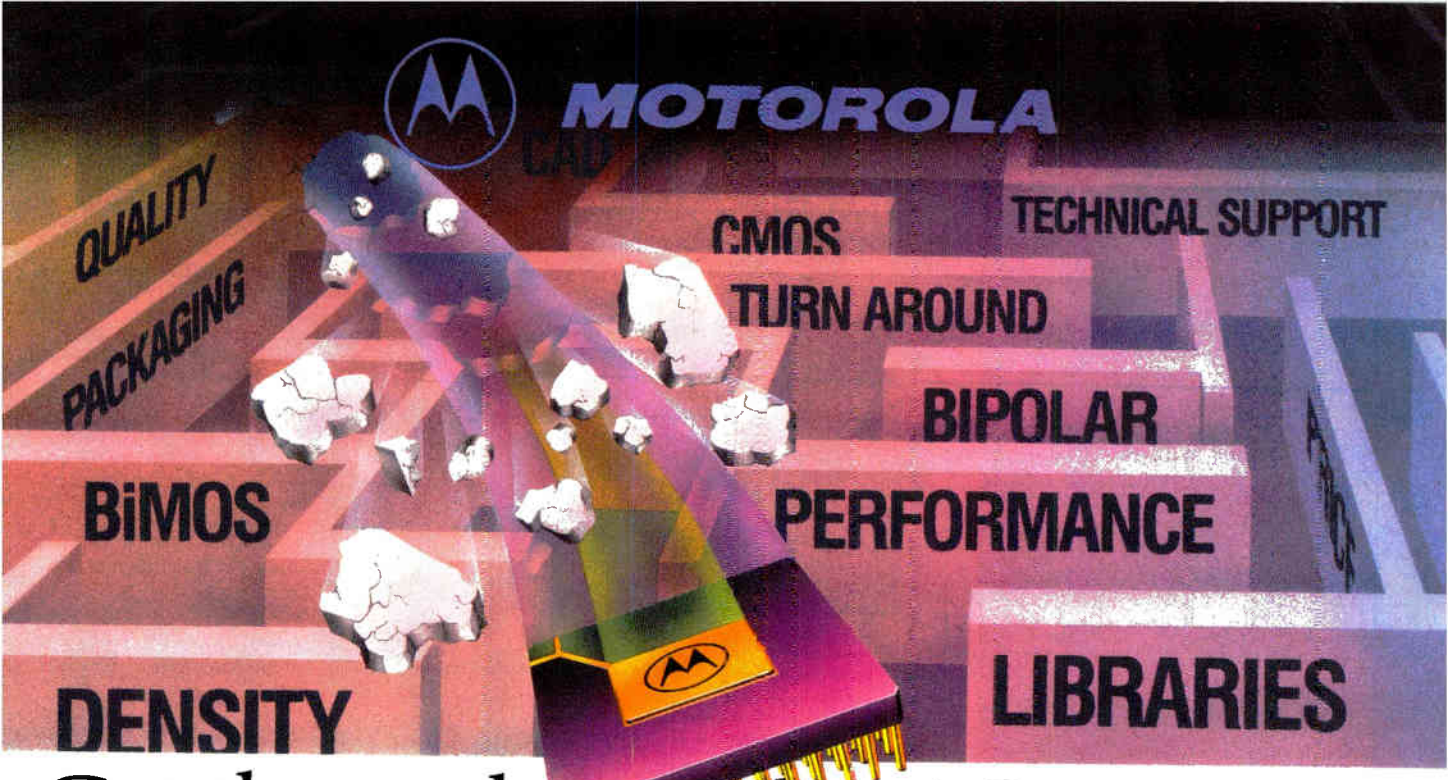
AI ARCHITECTS. Hayes-Roth (left), Lark (center), and Erman worked together to design Abe.

Abe's three major systems architects had worked together to build S.1, Teknowledge's AI tool for building diagnosis/prescription expert systems.

Hayes-Roth, who cofounded Teknowledge in 1981, directed development of both S.1 and Abe. He holds a B.A. in applied mathematics from Harvard University and an M.S. in computer and communication sciences from the University of Michigan, where he also earned his Ph.D. in mathematical psychology.

Lee D. Erman, S.1's principal systems architect, joined Teknowledge in 1982. He earned his B.S. in mathematics at the University of Michigan and his Ph.D. in computer science at Stanford.

Jay S. Lark was S.1's manager of system-interface development. He received his B.S. in mechanical engineering from McGill University in Canada and studied toward a master's degree in artificial intelligence at Stanford.



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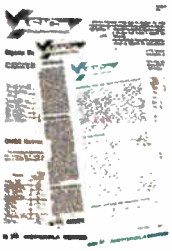

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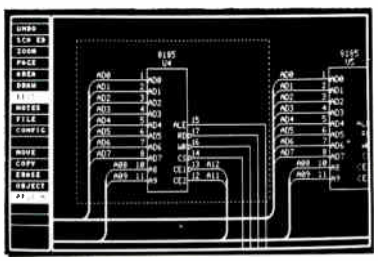

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MILITARY/AEROSPACE NEWSLETTER

TRW DROPS BIPOLAR PAIR IN 'SUPERCHIP' SET

Designers of next-generation military-electronics gear, like their commercial hardware counterparts, strongly opt for CMOS chips over bipolar equivalents, according to a poll taken by TRW Inc.'s Electronic Systems Group. As a result, the Redondo Beach, Calif., TRW unit has decided to drop the two bipolar devices in its "superchip" set and concentrate on the four CMOS versions under a contract in the Very High Speed Integrated Circuit Phase 2 program. An executive at TRW says prospective buyers of the chips, which feature software reconfiguration and self-diagnosis, in fact expressed "overwhelming preference" for CMOS devices, and the VHSIC office quickly agreed. Although development of bipolar ICs was slowed by the delayed delivery of an Aeble 150 electron-beam system from Perkin-Elmer Corp., both bipolar and CMOS process work were at about the same stage of development when the decision was made, according to the company. TRW is working on the CMOS superchips—a 2-Mb static random-access memory, a signal processor, a data processor, and an associative processor—along with Motorola Inc., under a $60 million contract that was awarded in 1984 [*Electronics*, July 10, 1986, p. 49]. □

HUGHES TAPPED TO DEVELOP GaAs V-BAND PARTS FOR AIR FORCE

Although specific applications are not yet fully defined, the Air Force figures that the seldom-used V-Band (50 to 75 GHz) will play a key role in control circuits for satellite-to-satellite communications and space-borne imaging radar arrays. Trouble is, hardware to build V-band equipment is practically nonexistent. To remedy that shortcoming, the Avionics Laboratory, at Wright-Patterson Air Force Base, Dayton, Ohio, has tapped GMHE/Hughes Aircraft Co. Its Microwave Products Division, situated in Torrance, Calif., has started work on V-band parts, primarily in gallium arsenide. Under a $3.6 million contract, Hughes will develop transmit/receive switches, analog and digital phase shifters, and multifunction millimeter-wave integrated circuits. □

EIA PROJECTS MULTIBILLION-DOLLAR GOVERNMENT SECURITY MARKET

The Electronic Industries Association's Government Division says the federal market for security equipment should reach $1.62 billion this year, up from $1.47 billion in 1986. The EIA projects that the market will climb about 10% annually, reaching $3.3 billion in 1995. The EIA bases its estimates on an analysis of goverment documents and interviews with 28 government agencies. The projections don't include Tempest-enhanced equipment—computer and communications gear shielded to prevent detectable radiation emissions—or the classified security programs that are hidden in other budget items. But they do take into consideration security costs that are often buried in total information-technology outlays because of budget-cut fears; such hidden expenditures account for 1.5% of EIA's market estimates. □

NAVAL LAB FABRICATES FETS IN SILICON CARBIDE

Scientists at the Naval Research Laboratory in Washington, D. C., now see high promise for high-temperature, radiation-hard microwave devices and integrated circuits made with silicon carbide. NRL has fabricated both buried-junction field-effect transistors and metal-semiconductor FETs in thin-films of beta (cubic structure) SiC grown epitaxially on silicon substrates. Experimental SiC Schottky diodes with evaporated gold contacts remained rectifying at temperatures to at least 700°C; the reverse leakage current for the Schottky barrier is 10 microamperes at 3 V. The work was part of an Office of Naval Research program to develop microwave components for military needs. □

MILITARY/AEROSPACE NEWSLETTER

WILL NASA MAKE ROOM FOR UNMANNED SPACE VEHICLES?

A long-range study by the National Aeronautics and Space Administration and the Defense Department, due for release within the next few weeks, may call for substantial expenditures for expendable spacecraft. If so, NASA Administrator James C. Fletcher will have to decide whether to increase NASA's budget request or redirect some of its spending plans. For fiscal 1988, NASA has asked for $9.5 billion, up from $7.9 billion, largely because of a one-time allocation of $2.1 billion to build a replacement for the Challenger shuttle. But despite findings by several study panels this year that NASA has been overly dependent on the shuttle program, the 1988 request includes no funds for unmanned space vehicles. □

PROPOSALS DUE SOON TO DESIGN ENGINEERING INFORMATION SYSTEM

The Pentagon is now leaning toward selecting a team of hardware and software vendors, rather than a single company, to get both the hardware and the software expertise to produce reference specifications and a prototype system for its proposed Engineering Information System. EIS program managers at the Aeronautical Systems Division, Wright-Patterson Air Force Base, Dayton, Ohio, say that the deadline for proposals is Jan. 26 and that they expect the contract to be awarded by April. Program goals include development of a set of reference specifications for integrating varied computer-aided-design systems into the system, for data exchange, and for engineering management. Initially, EIS is expected to be used to design VHSIC devices for the military, but the Air Force says the system eventually will have to support industrial and government vendors and users. □

UP TO 14 STUDY CONTRACTS COMING FROM THE PENTAGON'S MIMIC EFFORT

As many as 14 of the nearly 20 teams that submitted proposals for the Pentagon's microwave and millimeter-wave monolithic integrated-circuits program (Mimic) could be awarded nine-month definition study contracts within the next two weeks. That's the word from contracting officers at the Army Electronics Technology and Devices Laboratory, Ft. Monmouth, N. J. Originally, only nine or so teams were expected to win study contracts; the Army would not disclose why the number was increased, but presumably the Pentagon wants to disseminate Mimic technology as widely as possible. Mimic's goal is to produce a reliable and affordable supply of complex GaAs chips for the next generation of communications and weapons-sensor hardware. Among the bidding teams are General Electric/Hughes Aircraft, Raytheon/Texas Instruments, TRW/Honeywell, and Westinghouse/Rockwell International. Preliminary Defense Department budget proposals call for large increases in Mimic funding—from $10.3 million this year to $49.2 million in fiscal 1988 and $86 million in fiscal 1989. □

SPECIFICATIONS FOR MILITARY HIGH-SPEED DATA-BUS MOVE AHEAD

A Society of Automotive Engineers subcommittee is meeting next week to consider changes in the initial version of the specification it has under development for a military-standard high-speed data bus. The definitive version is still some two years off and must be able to accommodate advances in fiber-optic technology. The bus, which is expected to replace MIL-STD-1553 in mission-critical avionics applications, is a 50-Mb/s token-passing bus using wire or fiber-optic media in a passive-star layout. One modification of the SAE bus will turn up in the Advanced Tactical Fighter prototype that will be built by the team of Lockheed-Georgia Co., General Dynamics Corp., and Boeing Co. Lockheed modified the SAE spec to improve fault tolerance. □

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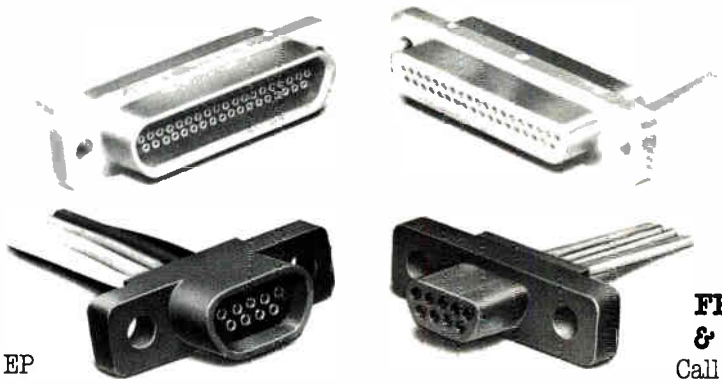

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Circle 97 on reader service card

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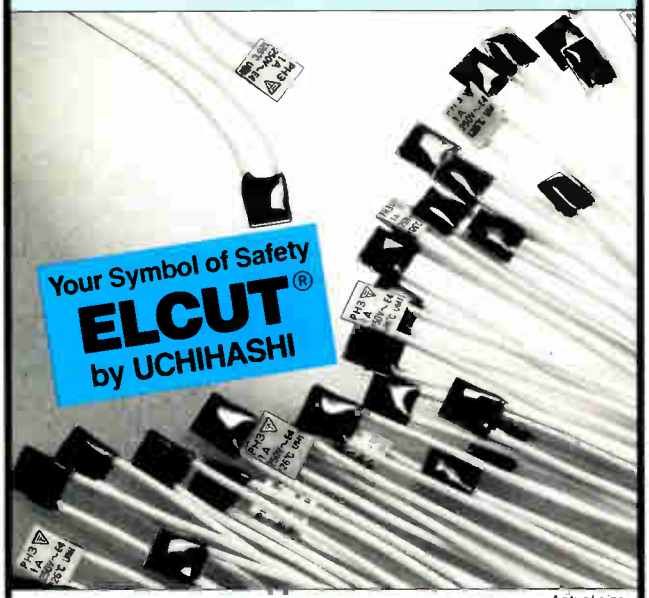

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Circle 98 on reader service card

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NEW PRODUCTS

HARDWARE-BASED ACCELERATOR SIMULATES 1.1 BILLION EVENTS/S

ZYCAD CLAIMS IT'S THE FASTEST CAD/CAE SIMULATOR ON THE MARKET

A hardware-based simulation accelerator from Zycad Corp. uses a parallel-processor design to run simulations on 1.1 million modeling elements at a blazing 1.1 billion events/s.

The $2.5 million System Development Engine is about 80 times faster than its predecessor, Zycad's Logic Evaluator model LE-1032 [*Electronics*, Jan. 8, 1987, p. 28]. That makes it the fastest simulator available for the computer-aided-design and engineering market, says Bruce Erickson, SDE product manager for the St. Paul, Minn., company.

Since the simulator runs so fast, software development can begin before a functional central processing unit is available. This could slash at least a year off the three to five years typically required to develop a large-scale system, says Erickson.

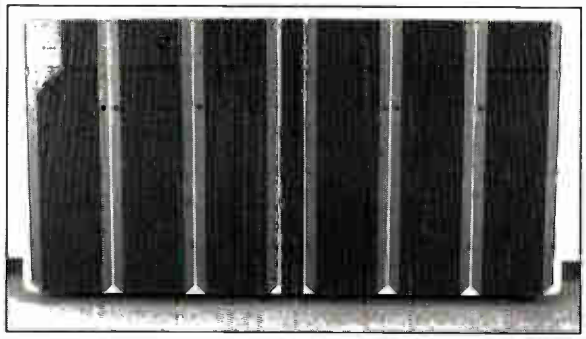
TRADEOFFS. A design team developing a central processing unit intended to run at 1 million instructions/s, for example, can count on the simulator taking 100 s to run a set of instructions that would take 1 s on the hardware being developed. Executing the instructions would take three hours on the LE-1032 or 12 days on a software simulator.

The System Development Engine owes its speed largely to its highly parallel design. Fully configured, it features 256 five-stage parallel pipelines. Each can process 4,096 modeling elements at 5 million events/s. High-speed programmable array logic also helps boost processing speed.

Zycad traded off some timing accuracy to sustain its performance, Erickson concedes. Unlike the LE-1032, which allows users to specify delays for individual gates, it can accommodate only zero and unit delay timing.

Reduced timing flexibility should pose few problems for large-system developers, he says, since most large CPUs rely on synchronous, clock-controlled designs that this simulator can accommodate.

With an eye toward large-scale software development jobs, Zycad designed the simulator with up to 64 megabytes of memory. This memory can be used for modeling various random-access-memory and read-only-memory systems in the simulated machine, ranging from a small instruction cache or ROM diagnostic memory up to a large CPU main memory. Many memories can be modeled, including multiport memory banks, and edge-sensitive and level-sensitive memory designs.



PARALLELISM. System Development Engine's 9-by-5-ft. cabinet houses 16 simulation modules and three data buses.

The Engine supports logic simulation of both unidirectional modeling elements and wired-gate functions. Input and output pins of each modeling element can be simulated at any of three logic levels and four logic strengths, providing 12-state simulation capability.

Like other Zycad accelerators, the simulator is built to work as a peripheral connected to a host by a high-speed 16-bit data bus. That host can be anything from an individual work station to a large mainframe. Zycad will initially provide host support for Digital Equipment Corp.'s VAX series and machines built by IBM, Apollo, and Daisy.

The 106-by-28-by-56-in. cabinet contains 18 slots. The first two are occupied by a clock distribution module and a multifunction module that handles system control, self-diagnostics, host communication, and other tasks. The remaining slots are used for identical simulation modules, each of which houses a hardware implementation of the simulation algorithm and 16 pipelines, with 4 megabytes of memory. Communication among modules occurs over three buses at up to 39 million events/s.

The Engine is offered in two models. The $2.5 million SDE-8032 uses 16 simulation modules. The $1.7 million SDE-8016 employs eight simulation modules to process up to 512,000 modeling elements at 500 million events/s. Four 8032s will be shipped in February. Orders received now will be shipped in September. *–Wesley R. Iversen*

[Circle 381]

SIMULATOR RUNS DESIGNS WITH MIXED SIGNALS

Daisy System Corp.'s A-D Lab simulation software gives circuit designers the capability to create and verify printed-circuit-board schematics that contain both analog and digital components. Both jobs are accomplished on the company's Logician work station, or its IBM Corp. Personal Computer AT-based work stations.

A-D Lab is one of the first simulators to handle mixed analog-digital designs with an extensive, integrated data base, according to the company. It contains Daisy's library of 750 analog and 2,700 digital components, including a set of basic models for digital-to-analog and analog-to-digital conversions. Daisy is developing an optional library of conversion models for the specific part numbers of various manufacturers.

"Because the results are achieved by closely integrating proven technologies, the simulation is very accurate," says Jean-Noel Lebrun, A-D Lab product marketing manager.

Daisy automated the mixed analog-digital simulation process by having the simulation results from one circuit stage

drive the next. The analog-to-digital and digital-to-analog conversion process is handled transparently to the user.

Two key techniques are used to maintain simulation accuracy between analog and digital components. First, A-D Lab automatically adjusts the impedance of the digital circuits seen by the analog components and ensures the proper shape of signals between analog and digital blocks. Daisy has implemented virtual oscilloscopes and logic analyzers in software, so designers can view waveforms on their work stations.

Second, the voltage supply levels and the fan-in/fan-out voltages of the various analog and digital devices are fine-tuned for process technologies such as CMOS, emitter-coupled logic, and transistor-transistor logic.

Although automated simulation is A-D Lab's main feature, Daisy gives designers the option of simulating at the component level for both analog and digital circuit elements. Moreover, complex devices such as microprocessors and digital signal processors can be included in the simulation by using Daisy's PMX physical modeling extension.

After simulation, a schematic containing analog and digital circuits can be used for documentation and pc-board layout. The designer has a consistent data base from schematic capture to layout, so he has fewer chances of introducing errors, Lebrun says.

The A-D Lab will be available as a software option to Daisy's Logician and IBM PC AT-based Personal Logician and Personal Analog work stations.

If the simulator is bought as an option along with either work station, the price is $10,000. If it is purchased as an add-on to a customer's existing work station, the A-D Lab's price is $11,000.

If the software is purchased with a Logician work station, the price is $13,000. The price of an upgrade to an existing Logician is $14,000. The optional A-D Lab DAC-ADC library costs $7,500. The simulator is available 90 days after order.

– *Jonah McLeod*

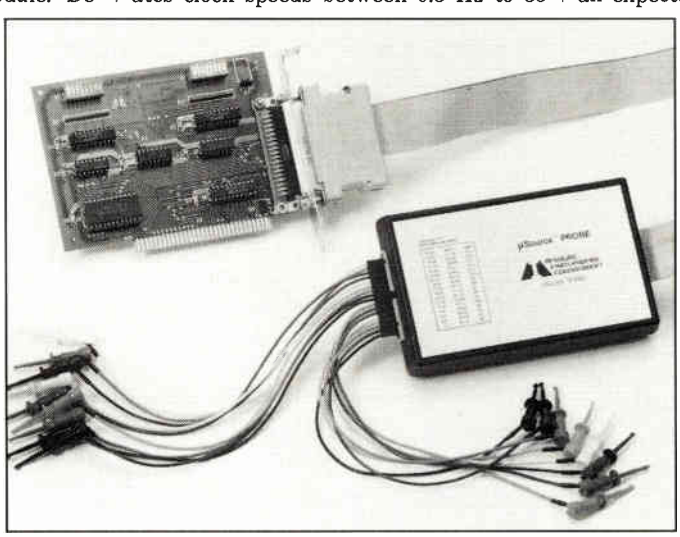
[Circle 380]

DIGITAL PATTERN TESTER IS PC-BASED

The programmability of personal computers and the speed of dedicated signal-generating hardware have been combined by Analytic Instruments Corp. into a digital-pattern test system for debugging prototypes or for exercising production chips.

Analytic Instruments' Datasource package contains a half-card communications interface to IBM Corp.'s PC bus, interactive graphics software, and a nine-slot signal-generation module. Depending on the particular configuration chosen, the system costs about one-third less than similar high-performance products, says Carl Dreher, an Analytic Instruments vice president.

QUICK RESPONSE. The company's proprietary interface enables the system to produce digital patterns immediately after they have been graphically created or edited on the IBM PC or compatible computer screen, says Dreher: "As soon as you hit a key on the personal computer, the change is made at the probe." Digital patterns may be created and edited from keyboard or mouse.



PROBES. DataSource includes probes to measure CMOS-level signals and TTL-level signals as well as control-and-compare measurements.

The interactive graphics software, called WaveEdit, includes many of the attributes of popular word-processing packages, including pop-up help windows and the ability to move or copy entire blocks of digital signal patterns. WaveEdit software runs under Microsoft Corp.'s DOS operating system and requires 256-K bytes of memory. The package features waveform-design macro commands that may be used to create clocks, counters, and Boolean-logic signals.

Digital signal patterns may be created, edited, and stored on personal computers for later transmission to the signal tester's chassis time. The patterns can be printed out for documentation. The software can also display bit patterns of the signal patterns of each test channel on monochrome screens, or in color with the use of standard PC color-graphics adapter cards.

The chassis, which may sit atop a table or be mounted in a 7-in. rack, generates clock speeds between 0.3 Hz to 35 MHz over 16 to 72 data channels. It uses the company's own F-30 frequency synthesizer, which is accurate to 0.01%. The system can also produce maximum emitter-coupled-logic signal bursts of 75 MHz. Each test channel can supply a 25-mA drive current.

EIGHT CHANNELS. As many as nine 8-channel signal cards for digital pattern storage can be loaded into Datasource's chassis. Each channel has 64-K bytes of memory that can be addressed from 8-K bytes of the PC's main memory.

Two probes with cables 48 in. in length are provided with the chassis. One probe measures CMOS-level signals. The second handles TTL levels. Besides being used for output and input signals, the probes can be used for real-time, tri-state control-and-compare measurements. In this configuration, the system can record responses to signals and compare the results in real time against an expected pattern.

In its standard 16-channel configuration, Datasource costs $6,995 in single-unit quantities. Analytic Instruments sells add-on channel cards for $1,500 each in single quantities.

A fully loaded 72-channel system will sell for $15,000, compared with equivalent systems on the market priced at $35,000 to $45,000, says Dreher. Volume shipments will start next month.

A lower-cost pattern-generation system, using similar interactive software, is also available for $895. The low-cost package, called μSource, consists of interactive graphics software, an interface card, and a CMOS-TTL probe unit that attaches directly to the back of the PC.

With μSource, a PC's host microprocessor generates signal patterns. Personal computers based on an Intel Corp. 8088 microprocessor will generate 15-KHz signals. Intel 80286-based AT-compatible machines will generate signals that are two to three times faster, Dreher says. μSource has 6-K of pattern memory for each of the 16 channels.

– *Robert J. Lineback*

[Circle 383]

SCSI DISK CONTROLLER DOES JOB FOR 25% LESS

WESTERN DIGITAL BOARD TRANSFERS DATA AT A SPEED OF 15 MHZ AND GOES FOR $120 IN LARGE QUANTITIES

Western Digital Corp.'s Winchester disk-drive controller offers full compatibility with the standard small-computer-systems interface at a price considerably lower than competing controllers with the same capabilities.

The ADS-D200S costs $120 each in 10,000-unit purchases and $155 in 1,000-unit purchases. The price is about 25% lower than comparable boards, says the company.

High performance in data- and bus-transfer speeds makes SCSI a natural for Winchester drives, but until now, controllers compatible with the interface have had correspondingly high prices. Western Digital's controller offers a host of performance improvements over its predecessor, the ADSI-200, which costs $190. Data-transfer speed is boosted from 10 MHz to 15 MHz, while the interface data transfer can reach speeds of 4 megabytes/s in synchronous mode or 2 megabytes/s in asynchronous mode. It is important to increase data rates so that the wider bus bandwidths on the new generation of peripherals can be used effectively, the company says.

Another improvement is that SCSI command processing time has been shaved from the predecessor board's 1.3 ms down to 860 μs. Furthermore, a simplified "chaining" feature reduces the number of command operations required by the SCSI overhead. In some instances, a single command replaces the 11 commands that were previously required. Both queued and linked SCSI commands are offered, as are standard and extended commands.

The board can be configured for a wide choice of applications, the company claims. It can control four drives, for example, that address from 150 megabytes to as many as 3 gigabytes. This means it can control four of the new generation of very large 750-megabyte, 5.25-in. disk drives that are coming to market. The drives can operate at as low as 16-ms access times.

The ADS-D200S also has error-tolerant identification and a data-synchronization field to cope with media defects. It provides 48-bit error detection and correction.

Other features include: bus arbitration with disconnect and reconnect; user-selectable device address; programmable sector sizes of 256, 512, and 1,024 bytes; a 64-K on-board data buffer with full-through parity for dynamic random-access memory or static RAM, and internal diagnosis algorithms. The board will be in volume production in March.

–Larry Waller

[Circle 441]

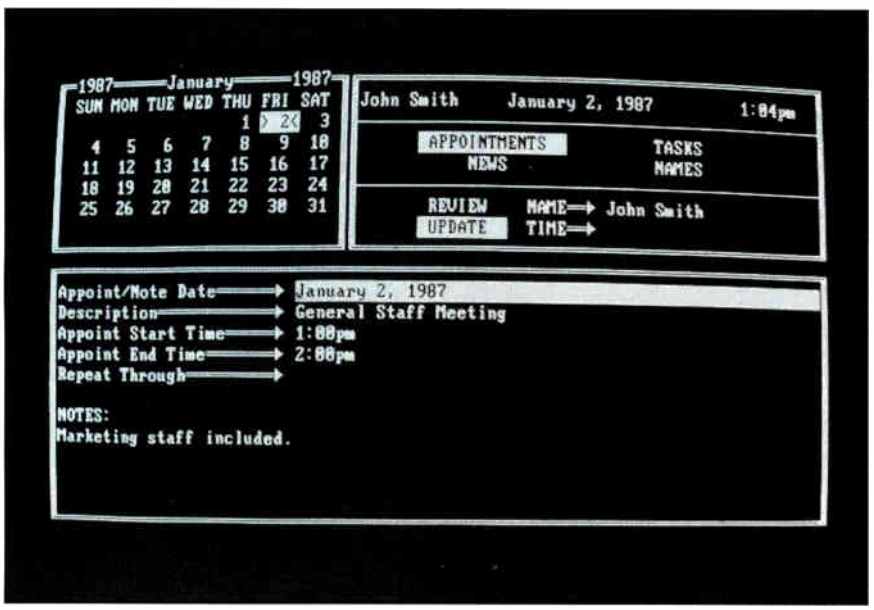
$100 SOFTWARE LINKS PC TO IBM LAN

Server Technology Inc.'s EasyLan local networking software for personal computers brings down the cost to about $100 for a connection to Netbios, IBM Corp.'s network standard.

Although the newest EasyLan costs 10% less than previous versions, its biggest benefit is adding Netbios compatibility. As long as the PCs on the network have RS-232-C serial communications ports, users can configure a LAN so that any Netbios-compatible application program can transfer files and share resources, such as printers and disk drives.

As an illustration of compatability, the company has introduced a time-management program called EasyCalendar. With it, users can schedule meetings, write notes for each appointment, create lists of things to do, and tap the central PC's data base for new items. The software will run on any Netbios-compatible LAN.

To save system RAM, EasyLan implements Netbios in software, rather than in firmware on an add-on card.



APPOINTMENTS. EasyCalendar helps a LAN's workgroup manage its time.

The software can connect small clusters of up to 20 IBM Corp. Personal Computers, XTs, ATs, or compatible machines. The limit does not constitute much of a drawback, contends Carrel Ewing, president of the Sunnyvale, Calif., company. "Over 60% of PCs [purchased by businesses] are installed in work-group clusters, and the average number is six PCs per cluster."

Six-conductor RS-232-C cables connect the ports of the PCs. Cables can be run as far as 1,000 ft. without repeaters, transferring data at 19.2 kb/s—or up to 56 kb/s, if PC ATs are used. Modems may be used to bridge long distances. PCs can also be connected through a digital private branch exchange using the standard twisted-pair wires.

When three or more computers are in the network, one PC must be designated as the hub, to which each of the others is connected. The hub PC therefore needs one RS-232-C port for each of the other computers.

A single EasyLan program costs $99.95. Two programs, along with a 30-ft. connecting cable, cost $219.95. Deliveries of EasyLan Version 3.0 are scheduled to start Jan. 26.

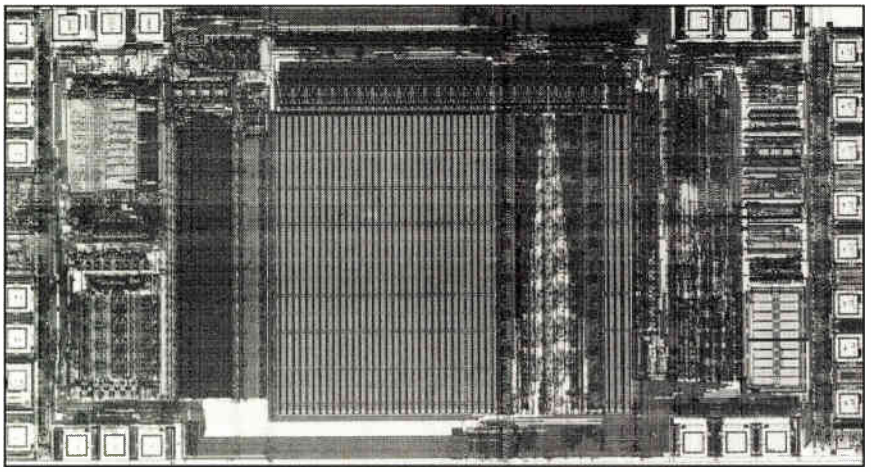
Deliveries of EasyCalendar start Feb. 27. Software supporting 10 users costs $199.95.

–Terry Feldt

[Circle 440]

COP CONTROLLER LINE EXPANDS TO 8-BIT MODEL

DEVELOPED BY NATIONAL-SIERRA TEAM, THE CMOS CHIP WILL COMPETE WITH INTEL 8-BIT MICROCONTROLLERS



USES. The controllers target automotive, telecommunications, and industrial-control markets.

A family of low-cost, high-performance CMOS microcontroller chips developed jointly by National Semiconductor Corp. and Sierra Semiconductor Corp. extends National's industry-standard 4-bit COP controller series to 8 bits and creates a new standard cell for the application-specific IC libraries of both companies.

Fabricated using a 2-μm double-level metal-silicon-gate CMOS process, the parts offer about the same specifications and performance level as Intel Corp.'s 8-bit microcontrollers.

All of the National-Sierra products feature 1-K bytes of on-chip read-only memory; 64 bytes of on-chip random-access memory; a flexible 16-bit read/-write timer/counter with a capture register; an 8-bit stack pointer; and a multisourced interrupt structure.

Aimed at automotive, telecommunications, consumer, and industrial-control applications, the parts have a serial input/output capability using National's Microwire protocol. They operate from 2.5 V to 6 V and have an instruction-cycle execution time of 1 μs.

The instruction set is a recompiled 8-bit extension of that used in the COP400 family of 4-bit microcontrollers manufactured by National.

Designed for use in customizable microcomputer applications, the COPS820C standard cell incorporates features not available in the standard parts, including an internal data bus that interfaces on-chip customer-designed peripheral logic. The number of signals accessible at the cell border has been increased from a maximum of 28 for the standard parts to 60 for the standard cell, to allow users more flexibility in interfacing the standard cell to the user-defined logic.

The standard cell also allows users to create multiple 8-bit ports by using a soft macro that allows the ports to be mapped into the data memory-address space. In addition, the halt signal has been brought out as a pin so that user logic can be powered down while the processor is in the halt state.

A special bank-enable signal has been added to the RAM decoder to allow a bank switching scheme to be implemented for applications requiring addressing space in excess of 192 bytes.

Future members of the family of standard products from the companies will include increased amounts of RAM, read-only memory, and electrically erasable programmable ROM in varying combinations, as well as additional I/O capability. On-chip additions will include universal asynchronous receiver/transmitters, analog-to-digital converters, timers, and other custom features.

National's part numbers for the 24- and 20-pin microcontrollers are COP820C, COP821C, and COP822C. Sierra's part numbers for the same devices are SC44820, SC44821, and SC44822. Both companies will denote the ASIC building block as COPS820C.

Available now, the first three parts can be obtained in SO, PLCC, and standard DIP form, with prices ranging from 99¢ for low-pin-count standard parts in high volume (100,000 and up) to $13 each for high-pin-count and low-volume (100 or more) quantities. The cost of the standard cell depends on the application. *–Bernard Conrad Cole*

[Circle 360]

CACHE-TAG CHIP CUTS COSTS, BOOSTS SPEED

A 16-K static random-access-memory chip from Thomson Components-Mostek Corp. cuts cache-tag memory costs and increases performance by integrating more functions onto a single chip.

With a 4-bit comparator residing on the 127-by-240 mil die to check addresses against the content of a cache subsystem, the fastest version of the MK41H80 chip, nicknamed Tagram, takes only 20 ns to determine if accessed data resides in cache.

Thomas J. Tyson, memory marketing manager for Mostek in Carrollton, Texas, says the 4-K-by-4-b CMOS chip will primarily be used to speed up computers and to offload host processors. The 20-ns MK41H80 provides a 30% improvement in address-to-compare speeds compared with cache systems that use discrete comparators and standard fast SRAMs, says Tyson. In such discrete designs, performance suffers from off-chip interconnection delays.

The 20-ns address-to-compare access time of the MK41H80 is sufficient to keep 16-MHz and 25-MHz processors speeding along, he adds. The MK41H80 also can be read like a conventional SRAM and has comparable access times of about 20 ns.

The chip can clear all of its bits to a zero state within 40 ns. This flash-clear function is useful during host system initialization, when cache-memory content is often reset.

Like Mostek's conventional MK41H68 4-K-by-4-b SRAMs, the cache-tag chip has a speedy memory array made up of full-CMOS six-transistor cells. The 22-pin chip runs from a single power supply of +5 V, ±10%. Standby power dissipation is 50 μA.

In 100-piece quantities, the 20-ns MK41H80N20 chips cost $22.50 each in 22-pin plastic dual in-line packages. The 25-ns MK41H80N25 sells for $13.94, and the 35-ns MK41H80N35 costs $10.19 apiece in 100-piece lots.

–J. Robert Lineback

[Circle 361]

Electronics 1987 Recruitment Editorial Calendar

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DISTRIBUTION WEEK

NEDA'S DISTRIBUTOR INVENTORY INDEX POINTS TOWARD CONTINUED STAGNATION

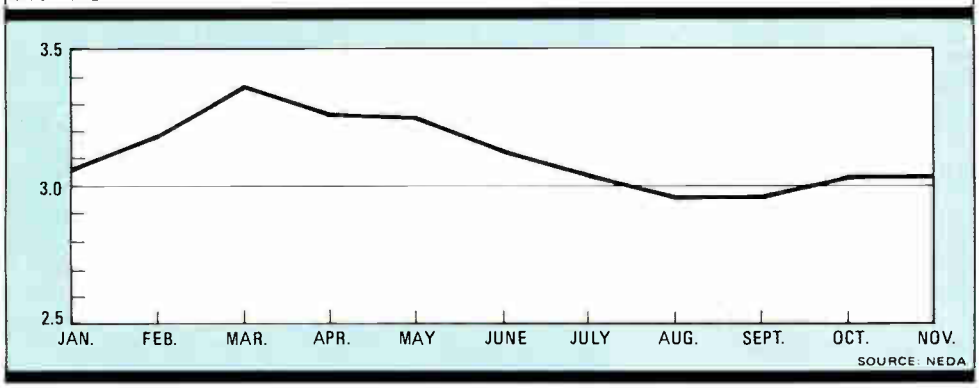
Inventory levels at U. S. distribution houses remain uncomfortably high, a sure sign of a continuing profitability squeeze for distributors that will inevitably lead to declining distribution orders for manufacturers.

The index of inventory turnover compiled by the National Electronic Distributors Association in Chicago tells the story. The index is a three-month average of the reporting month and the two previous months. It is calculated by dividing the distributor's cost of goods sold by his average inventory value over the three months. Adjusted to provide figures on an annual basis, the inventory turnover index reflects how effectively distributors are managing their inventory assets, and provides one strong indicator of distributor profitability, says Toby Mack, NEDA executive vice president.

Conventional wisdom says the index should be at 4.0 for good distributor return on inventory investment, says Mack. But during a lackluster 1986, the inventory turnover index peaked at 3.38 in March and has been hovering around 3.0 since mid-year (see figure).

Barring an unexpected jump in distributor sales early this year, that means continued restraints on inventory growth. "This is bad news for component manufacturers," says Mack. "Distributors will probably be ordering less from manufacturers over the next three to six months." *–Wesley R. Iversen*

INVENTORY TURNOVER INDEX: JANUARY TO NOVEMBER 1986



WYLE POSTS GAINS IN ASIC REVENUES

Solid evidence that distributors can play a major role in application-specific integrated circuits is offered by the Wyle Electronic Marketing Group in its fiscal results for the final two months of 1986.

The Irvine, Calif., unit of Wyle Laboratories Inc. had $1 million in ASIC revenues for each month—a first, says Rick Timmins, vice president for semicustom ICs. Wyle, the pioneer in ASIC distribution [*Electronics*, Aug. 7, 1986, p. 124], had semicustom sales of only $5 million annual rate in mid-1986.

The improvement comes not only from winning more design business, notes Timmins, but from more ASIC projects actually moving into production as industry conditions improve. The ratio of initial designs getting into production now stands at one in three, compared with one in six a year ago.

PLESSEY SIGNS TERMINAL MAKER

Micro-Term Inc., a graphics terminal manufacturer based in St. Louis, has signed an agreement with Plessey Peripheral Systems Inc., giving the Irvine, Calif., company worldwide distribution rights for its terminals.

The contract is for a minimum of two years and is renewable. A dollar value was not disclosed, but the agreement could easily exceed 2,000 terminals, says Plessey.

The agreement includes Micro-Term's Foresight Model 4560, a high-performance terminal that displays dark characters on a white background.

ANTHEM POSTS BIG 4th QUARTER LOSS

It was a lean year for distributors, all right. Anthem Electronics Inc., one of the top 10 U. S. distributors, posted a 36% drop in net income despite a 61% increase in revenues.

Anthem, which distributes a wide range of semiconductors and subsystems to OEMs, reported a net income of $447,000 for the third quarter, compared with $699,000 for the second quarter. Its revenues for the quarter were $40,695,000.

FLEXSTAR FOLLOWS THE RISING SUN

Flexstar, a leading distributor of Winchester disk-drive test equipment in the U. S., has signed a multiyear, open-ended contract with Toyo Corp. in Tokyo for exclusive distribution of its full line of test equipment in Japan. Toyo's instrument division has a greater than 50% share of Japanese disk-drive test equipment in conventional testing. The strategic move is to leverage Flexstar's leadership in SCSI test equipment, to capture the majority of market share in conventional and SCSI testing in Japan.

TALLGRASS CUTS DRIVE PRICES

Lower manufacturing costs prompted Tallgrass Technologies Corp., a leading manufacturer and supplier of information storage systems, to reduce by 45% the price of its tape and disk/tape subsystems. The company cut its production costs by consolidating its manufacturing operations—moving its tape manufacturing facility from Boulder, Colo., to its Overland Park, Kan., headquarters last August.

GI DROPS ARROW, ADDS 4 OTHERS

General Instrument Microelectronics, Chandler, Ariz., terminated its distribution pact with Arrow Electronics of Melville, N. Y., which had served all North American locations. GI signed on Milgray Electronics to serve the area east of the Mississippi, Reptron Electronics for the Midwest and Florida, Cronin Electronics for Boston, and Vantage Electronics for Long Island.

CORRECTION

In an article titled "Lean Times Continue for Distributors," [Electronics, Jan. 8, 1987, p. 129], the definition of book-to-bill ratio should have indicated that each month's figures were being compared with the previous month in 1986—not with the corresponding month of the previous year, as stated in the article.

ELECTRONICS WEEK

AT&T FAB LINES BAN PREGNANT WOMEN

AT&T Co. has temporarily banned pregnant women from its semiconductor production lines. It is evaluating a study released late last month by Digital Equipment Corp. that warned of a high risk of miscarriage to women working in chip manufacturing [*Electronics*, Jan. 8, 1987, p. 24]. For now, all 15 pregnant women working on the company's chip fabrication lines have voluntarily moved to new positions. However, an AT&T spokeswoman emphasizes that had they wanted to stay on the lines, they would have been transferred anyway.

FLEXIBLE IS SUED OVER REVENUE CUTS

Flexible Computer Corp. has been hit with a lawsuit over its revision of reported revenues. Revenues in 1985 were cut from $2.47 million to less than $800,000, and revenues for 1986's first nine months plummeted from $4.19 million to $1.03 million. Losses were also restated: to $8.67 million from $7.65 million in 1985 and to $5.04 million from $3.23 million in the 1986 period. The reason for the adjustments, the company claims, is that it had reported sales before it had completed the terms of certain contracts. The Dallas parallel-processing computer maker confirmed that both it and its independent auditor, Arthur Andersen & Co., have been charged with conspiring to inflate stock prices. Both companies decline comment on the charges.

LOTUS FILES COPYRIGHT SUITS

Lotus Development Corp., Cambridge, Mass., has charged Paperback Software of Berkeley, Calif., and Mosaic Software of Cambridge with copyright infringement, false advertising, and unfair trade practices. The suits, filed in U. S. District Court in Boston, charge that Paperback's VP Planner and Mosaic's The Twin deliberately recreate the "look and feel" of the bestselling Lotus 1-2-3 spreadsheet software.

U. S. PHONE DEAL DRAWS BIG BIDDERS

Bidding has begun for the giant task of upgrading the federal government's long-distance telephone network. Competition for the lucrative 10-year contract, expected to be worth more than $4 billion, has most recently drawn a bid from a team made up of General Motors Corp.'s subsidiary Electronic Data System Corp. and US Sprint Communications Co. The other players are a team consisting of AT&T and Boeing and a third group combining Martin Marietta, Northern Telecom, and MCI Communications. The contract, for the design, installation, and operation of a network handling voice, data, and video, will be awarded by year's end.

LORAL BUYS GOODYEAR UNIT

Loral Corp. will buy the aerospace operations of the Goodyear Tire & Rubber Co. for about $640 million, creating what might be the nation's biggest defense-electronics company. The deal, which is subject to regulatory approval, effectively doubles the size of Loral to a company that should top $1.4 billion in sales this year—90% of that in defense electronics.

PACBELL TESTS GIGABIT LOOP

In San Diego, Pacific Bell is testing a 1.12-gigabit/s fiber-optic communications loop that doubles the highest speed previously used for transmission over telephone lines. To make the system, two existing 560-Mb/s optical line-termination multiplexers were upgraded by replacing circuit cards, transmitters, receivers, and the control linking system. Now a single pair of optical fibers in the loop accommodates 16,128 circuits, and a second fiber pair has been freed up for possible wideband use.

IBM DROPS ITS INSTRUMENTS UNIT

Over the next six months IBM Corp., Armonk, N. Y., will phase out its IBM Instruments subsidiary, which has marketed analytical instruments in the U. S. since 1980. The Danbury, Conn., subsidiary has sold its interests in Bruker Instruments and Spectrospin back to the shareholders of these companies, which manufacture some of the instruments IBM marketed.

ROBOTICS GROUP IS OPTIMISTIC

Citing growth in non-automotive sectors, the Robotics Industries Association foresees steady growth ahead, even though automotive purchases—the largest source of robotics sales—have been down. Donald A. Vincent, executive vice president of the RIA, says that even though sales figures for the industry were down in 1986 from the previous year, the fact that robots now cost less has led to sales growth in the electronics, aerospace, appliance manufacturing, food processing, and other industries.

DOD TO TEST DIGITAL MOBILE TELEPHONE

The Department of Defense will begin testing an all-digital mobile telephone system in April. Ultraphone [*Electronics*, March 31, 1986, p. 21] provides secure communications for both voice and data. The digital system can also be used with encryption schemes. It is a development of International Mobile Machines Corp., a Philadelphia startup.

HEARING AIDS ARE GOING DIGITAL

Nicolet Instrument Corp. of Madison, Wis., expects to introduce a digital hearing aid by late this year. The low-power CMOS unit will use digital filtering and selective amplification to eliminate background noise. It will be programmable to meet individuals' needs. The unit and its battery are too big to be worn in the ear, and will be carried on the body. However, ear-worn digital hearing aids may not be far away. The nonprofit Central Institute for the Deaf, St. Louis, will soon announce a project to develop a tiny unit based on a custom VLSI CMOS chip.

FORD, VITESSE INK GaAs PACT...

Ford Microelectronics Inc., Colorado Springs, and Vitesse Electronics Corp., Camarillo, Calif., are finalizing a second-source contract that both believe is the first to cover large-scale integrated circuits made in gallium arsenide technology [*Electronics*, Jan. 8, 1987, p. 24]. An agreement in principle calls for the two to provide fully compatible foundry services for custom LSI digital GaAs chips fabricated with enhancement/depletion-mode technology.

...AS GE TACKLES CRYSTAL MAKING

General Electric Corp. will seek to develop an "intelligent control system" for production of gallium arsenide crystals. GE's Research and Development Center in Schenectady, N. Y., will attempt to integrate expert systems with factory automation and control technology into a system that will allow even relatively unskilled workers to grow high-quality GaAs crystals. It is doing the work under a $4.4 million contract from the U. S. Defense Advanced Research Projects Agency.

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		C2012		2.0	1.25	0.6 0.85 1.25	C: 0.5~1,800pF C: 470~100,000pF
		C3216		3.2	1.6	0.6 0.85 1.1	C: 0.5~270pF C: 470~220,000pF
		C3225		3.2	2.5	< 1.9	C: 750~8,200pF, 56,000~470,000pF
		C4532		4.5	3.2	< 1.9	C: 2,400~18,000pF, 180,000pF~1μF
		C5650		5.6	5.0	< 1.9	C: 5,100~33,000pF, 270,000pF~1.5μF
Multilayer Ceramic Chip Capacitor (High Frequency, Low Loss)		FC1414		1.4	1.4	1.6	C: 0.5~100pF, 150~3,300pF
		FC2828		2.8	2.8	2.8	C: 0.5~1,000pF 470~22 000pF
		FR1414		1.4	1.4	1.6	C: 0.5~100pF, 150~3,300pF
		FR2828		2.8	2.8	2.8	C: 0.5~1,000pF 470~22 000pF
Leadless Inductor (Wound Chip Inductor)		NL322522		3.2	2.5	2.2	L: 0.01~220μH
		NL453232		4.5	3.2	3.2	L: 1.0~1,000μH
		NL565050		5.6	5.0	5.0	L: 1,200~10,000μH
		NLF453232		4.5	3.2	3.2	L: 1.0~1,000μH (Shielded Inductor)
Multilayer Chip Inductor		MLF321606		3.2	1.6	0.6	L:0.047~220μH
		MLF321611		3.2	1.6	1.1	
		MLF322511		3.2	2.5	1.1	
		MLF322518		3.2	2.5	1.8	
		MLF322525		3.2	2.5	2.5	
Multilayer Chip Transformer		MTT4532		4.5	3.2	2.8 max.	L: 10~200μH
Multilayer Chip IFT		MIA4532		4.5	3.2	2.8	F:455, 459, 464kHz
		MIF4532		4.5	3.2	2.2	F: 10.7MHz
Multilayer Chip LC Trap		MXT4532		4.5	3.2	2.8 max.	F: fo ±2%
Multilayer Chip LC Filter	HPF (Tuner)	MXF4532H		4.5	3.2	2.8 max.	Electrical characteristics are representative, please specify value when ordering.
	BPF (FM radio)	MXF4532B		4.5	3.2	2.8 max.	
	BPF (VCR)	MXB5050B		5.0	5.0	2.8 max.	
	LPF (VCR)	MXB5050L		5.0	5.0	2.8 max.	
	Equalizer (VCR)	MXB5050E		5.0	5.0	2.8 max.	
	Delay Line (VCR)	MXB5050D		5.0	5.0	2.8 max.	
Multilayer Chip Capacitor Network		MCN7575		7.5	7.5	0.9	C: 1~1,000pF (TC:CH) (10 capacitors) C:10~1,000pF (TC:SL) (10 capacitors)
Ferrite Chip Beads		CB201209		2.0	1.25	0.9	Zo: 7, 10, 11Ω
		CB321611		3.2	1.6	1.1	Zo: 19, 26, 31Ω
		CB322513		3.2	2.5	1.3	Zo: 31, 52, 60Ω
		CB453215		4.5	3.2	1.5	Zo: 70, 120, 125Ω
SM Active Delay Line		FDL		12.0	9.5	5.6	Delay time: 20~250 nsec.
SM Transformer/ Inductor		EE5		7.4	5.3	4.75	Electrical characteristics are representative, please specify value when ordering.
		ER9.5		11.5	9.5	6.3	
		ER11		12.5	11.0	6.3	
		T2		7.0	5.0	2.2	
Step-up Inductor (Piezo Buzzer)		OL3.3×1.6		5.6	5.3	1.6	Inductance values are representative, please specify value when ordering.
		OL3.3×2.1		5.6	3.3	2.1	

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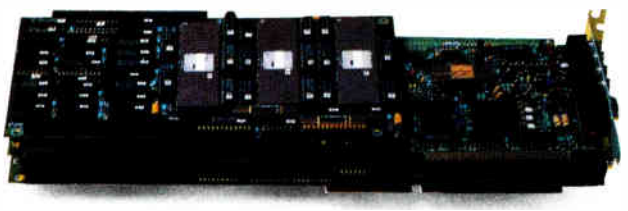

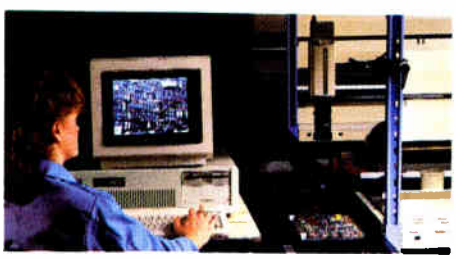

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