National Semiconductor

Finally, graphics to match your imagination...now more than ever.

INTRODUCING THE FIRST EFFECTIVELY PARTITIONED VLSI ARCHITECTURE FOR TRULY FLEXIBLE GRAPHICS SYSTEMS DESIGN

Imagine a graphics architecture so powerful, you can achieve 16K-by-16K resolution. So effective, you can add virtually unlimited planes of color without degrading performance. So flexible, you can integrate it into an existing design or use it to build an entire range of new systems.

That's the Advanced Graphics Chip Set from National Semiconductor.

By using a multiple-chip, modular approach, the Advanced Graphics Chip Set avoids the design compromises and limitations of single-chip solutions.

That gives you two unprecedented benefits: *performance* and *flexibility.*

Which means you can design exactly the type of system you need with exactly the level of performance your application demands.

For example, you can integrate part of the chip set with an existing general-purpose microprocessor for a low-end display.

Or you can utilize the chip set's full capabilities for a high-end, high-performance, high-resolution CAE/CAD workstation or laser printer—with virtually unlimited planes of color. Yet with the same high-speed performance as a black-and-white application.

In fact, you can design an entire range of graphics systems without having to "reinvent the wheel" each time, by using the same hardware building blocks and the same central software in each of the systems.

THE ADVANCED GRAPHICS CHIP SET

Now expanded for even more design flexibility and freedom.

2 **BitBlt Processing Units (BPUs).** 20-MHz devices that control data movements within their own dedicated memory planes or between those planes and other memory planes in multi-color systems. AVAILABLE NOW.

4 **Video Clock Generators (VCGs).** Timing and control generators providing all the synchronization signals needed by a graphics system. Pin-programmable pixel frequencies for both low-frequency (125 MHz) and high-frequency (225 MHz) applications. AVAILABLE NOW.

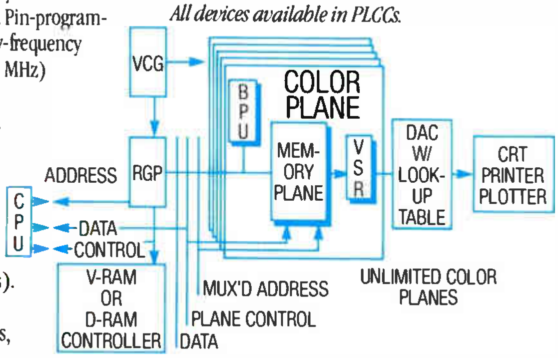
2 **Video Shift Registers (VSRs).** Parallel-to-serial shift registers capable of serial-output rates up to 225 MHz. Compatible with 10K ECL outputs or with 100K ECL outputs. AVAILABLE NOW.

3 **Video RAM Controllers (VRCs).** Memory-array controllers for dual-port video RAMs from 256K to 4 Mbits, including dual-access arbitration logic for multiple-CPU applications. AVAILABLE NOW.

A total of 11 chips—all introduced in a single year between Siggraph 1986 and Siggraph 1987. An unmatched commitment to graphics system design.

And soon another family member, now in beta-site testing: **Raster Graphics Processor (RGP).** A fully programmable, high-performance microprocessor specially tuned for graphics applications.

All devices available in PLCCs.



THE MULTIPLE-CHIP SECRET

The secret to all this flexibility and performance is our unique multiple-chip, modular approach. Rather than trying to squeeze all the important graphics functions onto a single chip—which would require some significant design and performance compromises—we've partitioned appropriate functions onto individual building-block ICs. This allows us to optimize the design of each chip, and allows you to optimize your own design for your particular application.

GRAPHICS WITHOUT LIMITS

What matters most about the Advanced Graphics Chip Set, of course, is what it does for *you.* And that answer is clear when you consider its high performance, its modular approach, its open architecture, and its programmability: It gives you graphics without limits. It gives you true design freedom. It gives you the opportunity, for the first time, to design a graphics system "custom fit" to your exact specifications.

So what are you waiting for? If you're tired of those limited single-chip solutions bogging down your designs, take a look at the Advanced Graphics Chip Set. And learn how you can design a graphics system to match your needs . . . as well as your imagination.

For more information and availabilities, just contact your local National Semiconductor Sales Engineer or write:

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

National Semiconductor

Circle 1 on reader service card

Jeremy Young's first reaction when he met with the people from Quantitative Technology Corp. to discuss their Software Foundry was, "This sounds really great—if it works!" So Jeremy, our Features Editor, did what any good editor should do: he contacted users as well as others in the industry to talk about the product. What he found out is that not only does the "foundry" work but it's "Almost too good to be true," as we title the cover package beginning on p. 47.

YOUNG: Finding out if it really is too good to be true.

"What the company has been able to do," says Jeremy, "is combine retargetability with high-level optimization." Or, to translate into shorter words, optimization work is normally done in the context of a fixed and specific architecture. But the designers at Quantitative Technology, a small company in Beaverton, Ore., have developed optimization techniques that work with any arbitrary microcoded architecture.

"The thing that grabs you at first," says Jeremy, "is that we have been talking for years about software driving hardware. Now, at last, here's a practical way to design a computer to run particular software. In effect, you build the computer around the software so that what you wind up with is an application-specific processor."

But that's not all. As Jeremy describes it, there is another equally important aspect to the tool set and the story. "The Software Foundry eases the horrendous task of writing microcode. The industry can't find enough people to do the job, and when it does they are screaming to get out after a few years. But since the Foundry produces optimized microcode from high-level languages it eliminates that tedious task. So the new tools could help reverse the trend away from the microcode approach."

There's also a considerable financial return to be gained from the Software Foundry. "When I was doing reporting for the Inside Technology piece, I was told by experts in the field that they estimate the cost of microcode as 50¢ to $2 a bit. Then figure that microcode instructions are 64 to 256 bits wide apiece with many fields in them, and that a system may have 10,000 such instructions when it leaves the plant. We're talking big money here."

In talking to users, Jeremy turned up companies—most asked that their names not be used—that "are trying to get their hands on these tools even before they are announced." One company that didn't mind being quoted by name, Pixar, of San Rafael, Calif., finds that Quantitative Technology's optimizer is performing well in tests. And another, a major vendor of graphics and simulation hardware, expects to be using the tools very soon.

In view of the savings in labor and cost, their interest is not difficult to fathom. "You can sum it all up by pointing out that Software Foundry reduces the time needed to develop equivalent tools for a new machine from about 10 man-years to an estimated 2 man-months—the time it takes to write a configuration file," says Jeremy. Or, as a Pixar manager puts it, "It's doing things that no human being in his right mind would want to do."

Here's another instance where *Electronics* provides the information that gives you, our readers, the first look at leading-edge technology.

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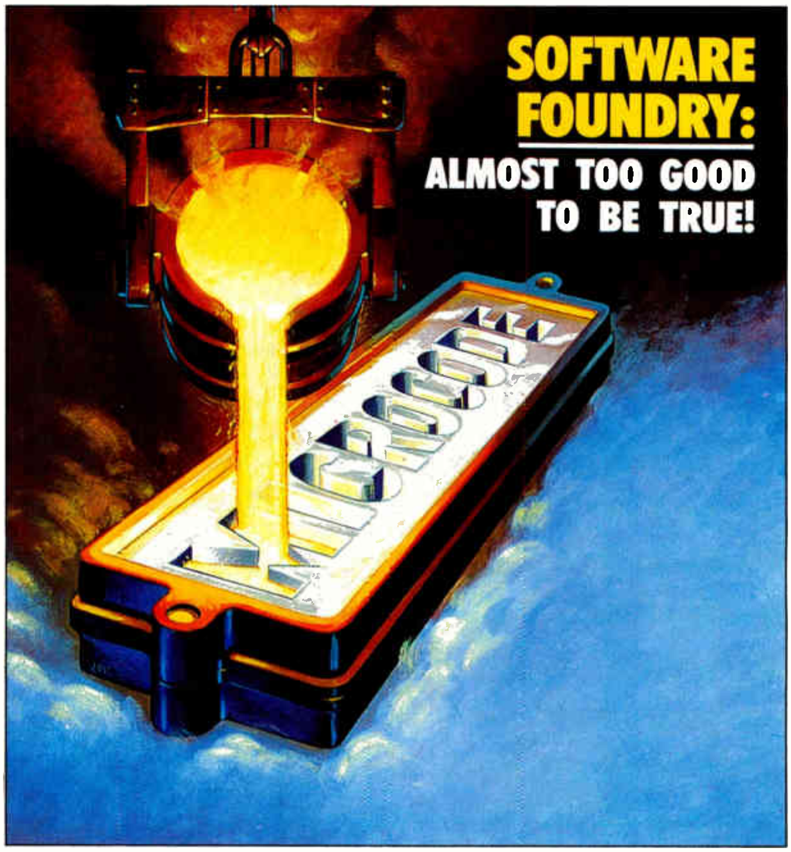
Electronics

NEWS

INSIDE TECHNOLOGY

COVER: JOEL NAPRSTEK



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NEW PRODUCTS

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- Ardent's software package makes it easy to integrate 3-d graphics
- Software from Minc Inc. cuts the design time for PLDs from months to weeks
- Fujitsu's ECL RAMs solve the pipeline-memory timing problem
- Fortran runs 15% to 30% faster with NKR's 68000 compiler
- Nikon uses a laser to cut pc-board line widths to 2.5 mils
- Micro Card boosts smart-card EPROM storage fourfold

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- Fast dynamic RAMs from Vitelic boast 70-ns speeds and can replace static RAMs in some 32-bit applications
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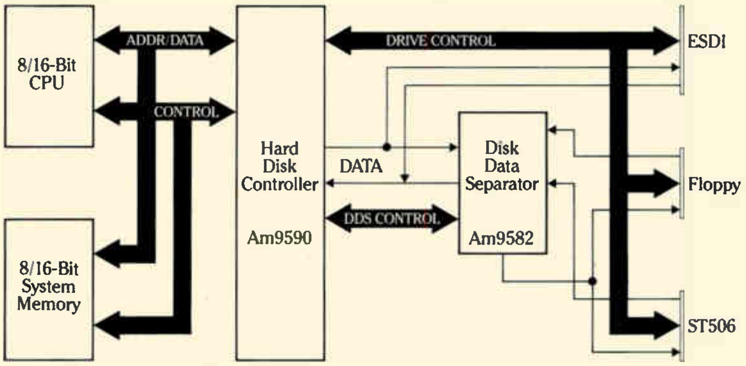
- . . . as a 3-d camcorder and a 3-d game make their debut
- NCR plans to consolidate its chip facilities in Colorado Springs and Fort Collins, Colo.

Narrow your horizons.

Put your hard disk controller on a single chip.

Twenty chips and a board is too much hardware for a hard disk controller. Any engineer would agree. So we focused our attention on turning all that into a single chip: the Am9590 Hard Disk Controller.

The Am9590 can control up to 4 drives allowing for any mix of hard and floppy drives. It supports ESDI, ST506/412 or standard double density floppy disk interfaces. Use the Am9590 with its companion chip the Am9582 Disk Data Separator to design your current ST506 system and you've got an easy upgrade to ESDI system performance for the next generation. Or you could always start that next generation now with the Am9590 as a stand alone.



On-chip DMA with data mapping.

We gave the Am9590 on-chip DMA with data mapping (which will come in handy when you're working with UNIX). Then we added dual on-board sector buffers to allow for Zero Sector Interleave. This simple way of organizing sectors means that access time is bounded by drive capabilities—not controller limitations. And it leaves the CPU free to do the things it does best.

On-board EDC.

The Am9590 even has on-board EDC. Select an error detection code (CRC-CCITT) or one of two error correction codes (Single or Double Burst Reed-Solomon). Or if you prefer, the Am9590 provides handshake interface to your own external ECC circuitry. All this adds up to maximum data integrity.

And it's easy to use. A comprehensive high level command set (with command chaining) allows for independent operation without constant CPU intervention.

You can even shorten your design cycle with an evaluation board, development software and a BIOS driver.

If all this sounds interesting, get in touch with us for more information. Once you've used the Am9590 Hard Disk Controller, you'll understand why the narrower view can be very broadening.

Advanced Micro Devices

901 Thompson Place, P.O. Box 3453, Sunnyvale, CA 94088
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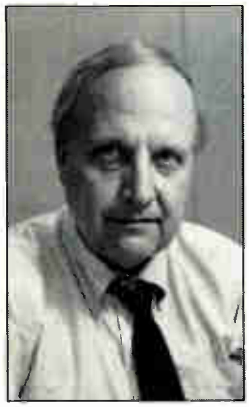
IT'S TIME TO BUY IN ON SEMATECH

Like it or not, Sematech is real; it's consensus time and we should take a leaf from the Japanese and close ranks now that the decision has been made



As far as the U.S. semiconductor industry is concerned, it's downright disloyal to question their manufacturing consortium. U.S. survival is at stake in this business, they say, and Sematech is one of the best ways to fix our production deficiencies. But many experts, good people for the most part, have criticized the plan ever since it was announced a year ago. I raised many of these issues last year [*Electronics*, Jan. 22, 1987, p. 8], and some of these arguments are just as valid today as they ever were. Some critics are still active. A day after Austin was announced as the site of the consortium, *The Wall Street Journal* quoted several of them, calling Sematech a government bail-out measure that's already lost its way.

I worry a lot too about the consortium working as planned, but I think it's counterproductive to keep trashing Sematech now that Congress has kicked in with its money and the consortium has started revving up in Austin (see p. 34). Now I think it's consensus time. Flawed or not, Sematech is real. We should take a leaf from the Japanese, who close ranks once the decision is made. So let's buy in on Sematech.

Sematech has already produced one result, says Charlie Sporck, National president and key man behind the consortium: increased industry cooperation. Early on, chip makers made it through some hairy negotiations: whether Sematech should sell its products and picking the technology driver. Then cooperation resulted in 13 competitors committing money and getting the U.S. government to participate. Not bad.

But the hard work has just begun. The first thing that chip makers have to do is to kick in with their own firm, hard-dollar commitments. It's time to ante up and make good on all this talk about cooperation. They also have to make the hard choices to provide their top production technologists and technologies.

A big step in the right direction will come from picking the right guy to run Sematech. The consortium most likely will rise or fall depending on who is ramrodding the operation. That a head hunter is now looking within member companies is another sign of cooperation. Charlie reports a solid candidate has been identified, but for my money, I'd like to see someone with the experience of a Fred Bucy, former Texas Instruments president. I would feel a lot better about Sematech if someone like Fred were running it. **ROBERT W. HENKEL**

THE SOFTWARE PROBLEM SOLVERS

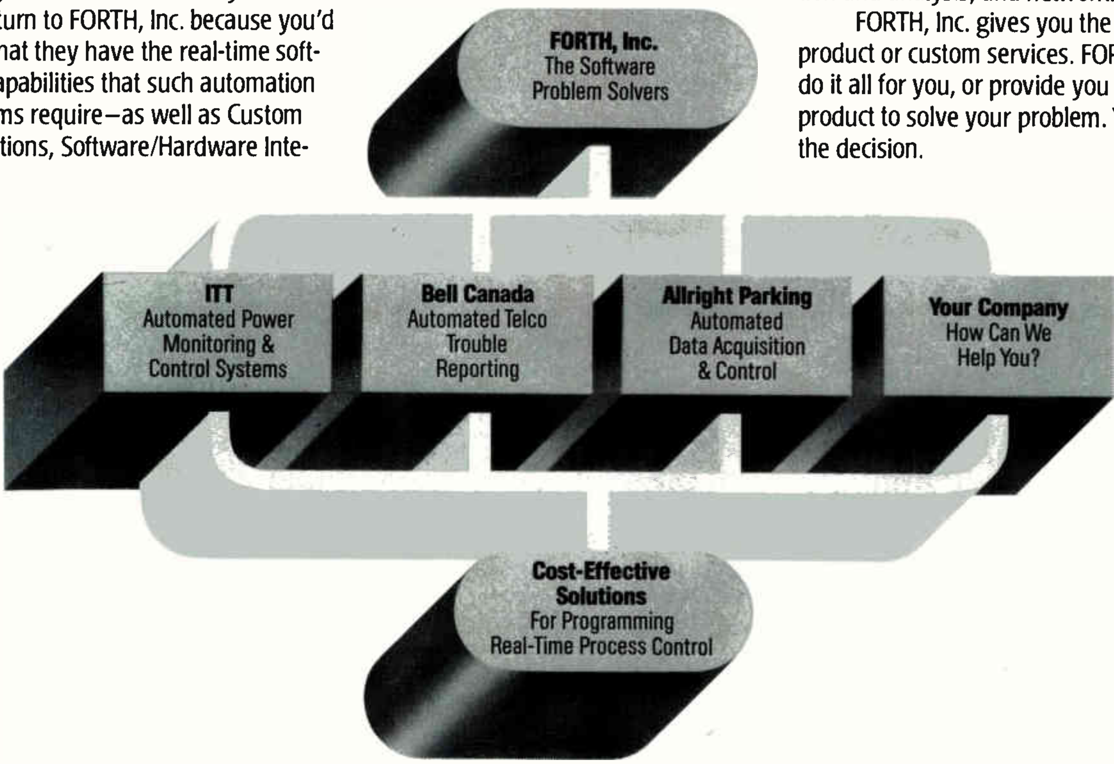
If you were ITT and had to automate power monitoring and control systems for telephone power plants, who would you turn to? And what if you were Bell Canada and your purpose was to automate the company's trouble reporting, analysis, and control procedures? Or suppose you were the Allright Parking Company and had to automate the data acquisition and distributed control of a large number of parking facilities?

If you knew what those companies know, you would do what they did. You would turn to FORTH, Inc. because you'd know that they have the real-time software capabilities that such automation programs require—as well as Custom Applications, Software/Hardware Integration, Installation and Training, Ongoing Maintenance, and Hot Line Support.

And if yours is not a custom application, FORTH, Inc. also offers its powerful family of polyFORTH software and related hardware products. These interactive development tools are compatible with the most popular computers from microprocessors to super-minis.

So, for applications-oriented products or expert help with your automation project, do what the major corporations are doing. Turn to FORTH, Inc., the "software problem solvers" who understand such real-time applications as process control, robotics, digital signal processing, machine vision, data acquisition and analysis, and networking.

FORTH, Inc. gives you the option—product or custom services. FORTH will do it all for you, or provide you with a product to solve your problem. You make the decision.



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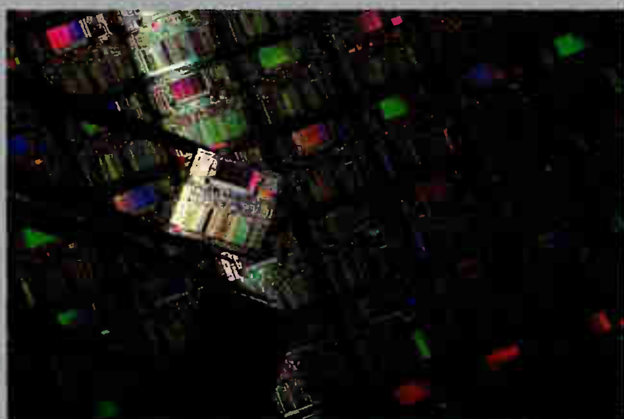
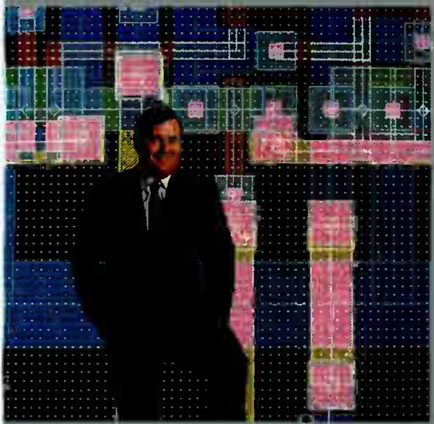
Digital has it now.



"Our Dracula™ layout design verification software was developed and based on Digital systems, and for very good reason," states ECAD President Jim Hill. "Our customers in Integrated Circuit design regard Digital's VAX™ systems as the standard. Recognizing that, we've developed a line of software products that have made us the standard of our industry."

According to Mr. Hill, Digital's unmatched software compatibility offers real benefits in creating customer acceptance. "We know that whatever Digital system the customer has purchased, our software will run on it successfully. That kind of confidence is rare in the IC design industry. And Digital's hardware and



"ECAD seized an 80% world market share – the key was writing our design software to the industry standard, Digital."

software consistency helps us deliver a better product, faster and at a lower cost."

"We're aggressively pursuing a worldwide market," Mr. Hill adds. "And Digital has the worldwide presence to help us sell each market with strong local support. Our software and Digital's systems sell each other. ECAD and Digital have evolved a strategic partnership, one that gives us a proven competitive advantage in the marketplace."

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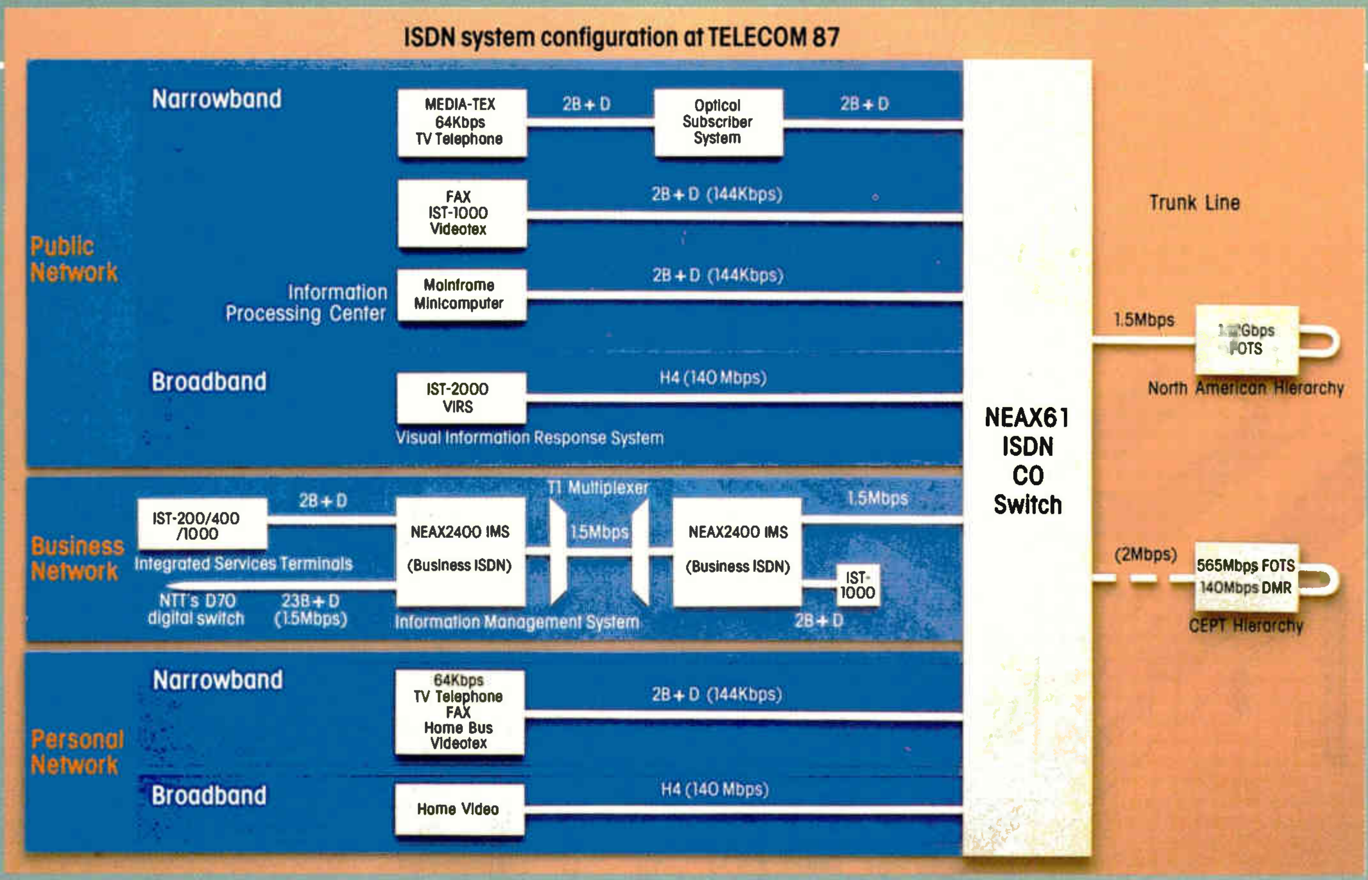


Digital switching system: NEAX61

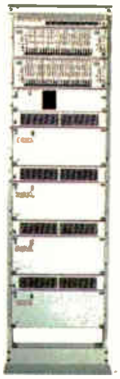
The core of the demonstration was the NEAX61. It displayed integrated broad- and narrowband switching capability, as well as 1.5Mbps high-speed packet switching.

Network management system (NMS)

The NMS efficiently monitors/controls switching and transmission networks. For easy trouble-shooting, it offers expert system technology which guides users to the source of system problems.

1.12Gbps FOTS

The 1.12Gbps Fiber Optic Transmission System (FOTS) demonstrated its ability to combine 16,128 voice channels into a single-mode fiber.



AT THE R&D ZONE

NEC's intensive R&D efforts, ranging from components to total systems, gave visitors a glimpse of many futuristic visions come true.

4Gbps FOTS

This ultra high-speed system utilizes 1.55μm DFB LDs and InGaAs APDs and transmits over 30km without repeaters.

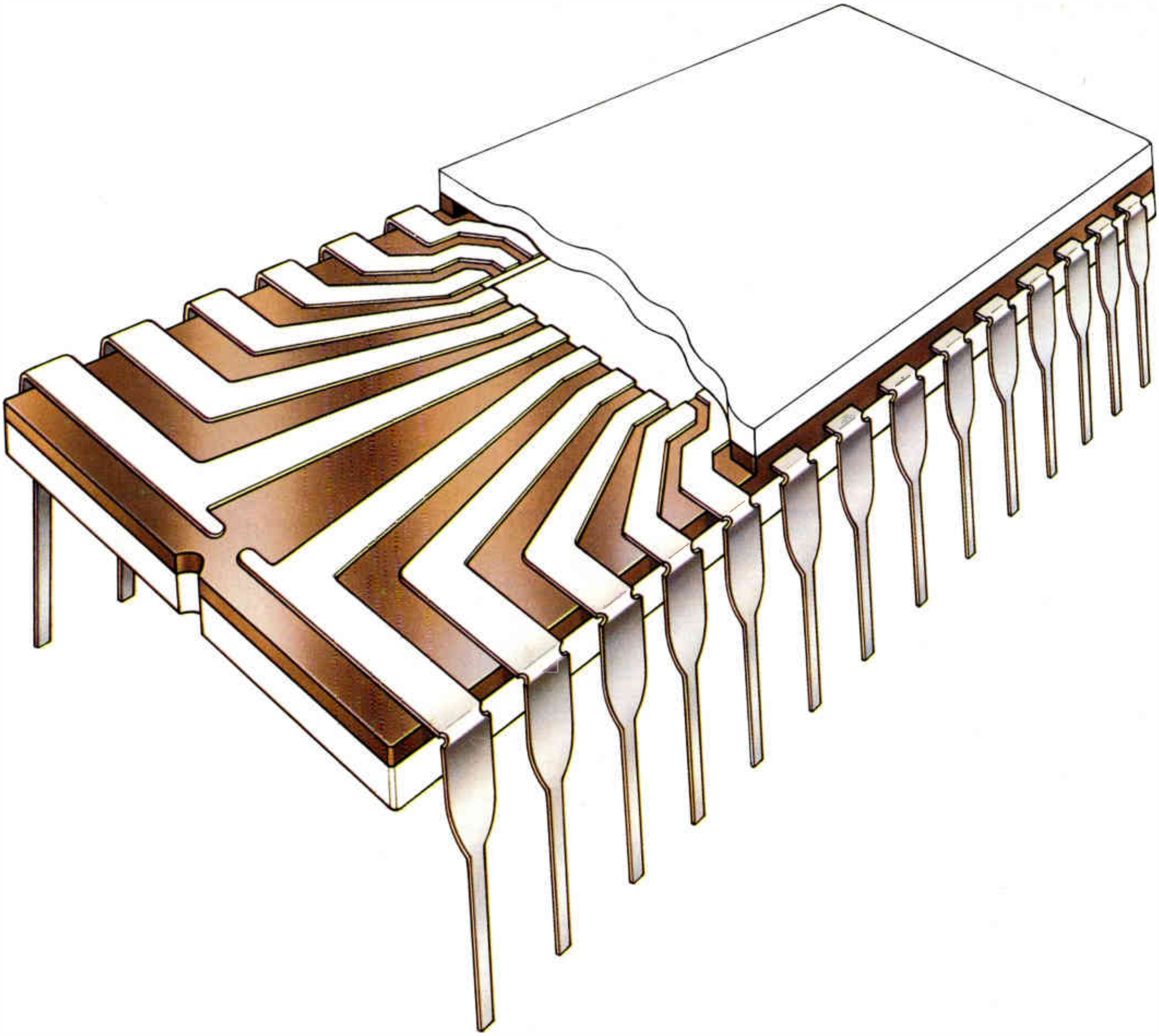
Photonic switching

NEC's display included a photonic switching system with 8×8 matrix optical switches. The system demonstrated 140Mbps broadband switching capability using IST-2000 video communication terminals.

High resolution CCD color camera

A compact HDTV camera, featuring 1.24-million pixel CCD chips, showed the latest advance in CCD technology.

NEC



LS-2010 Composite Sealing Glass

Passes 270°C solder dipping test without preheating

Whether you're dealing with millions of ICs a month or just a few hundred, when it comes to sealing ceramic packages, the two most important numbers are the sealing temperature and flexural strength of the sealing glass: 430°C and 720kg/cm² would be excellent.

Where can you find numbers like these? At Nippon Electric Glass, the world's largest supplier of sealing glasses and manufacturer of LS-2010 composite sealing glass.

LS-2010 also provides higher hermeticity even after solder dipping at a temperature of 270°C, and does so without preheating.

More numbers to think about...a short, 10-minute sealing time...a low thermal expansion coefficient of 65 and a low dielectric constant of 12.5. Together they add up to more consistent quality from lot to lot, higher packaging yields, and superior dependability and performance.

Contact NEG today. We'll show you how our numbers can help improve your numbers—the ones regarding package reliability.

For further information please contact the following:

Nippon Electric Glass Co.,Ltd.

Chicago Representative Office: 3158 Des Plaines Avenue, Suite 227, Des Plaines, Ilinois 60018. Phone: 312-297-7020 Fax: 312-390-0583

ELECTRONICS NEWSLETTER

ASHTON-TATE AND MICROSOFT TEAM UP—AND SYBASE IS THE WINNER

When two of the top names in personal-computer software team up to bring mainframe data-base performance to networked PCs, the biggest beneficiary may turn out to be Sybase Inc., of Berkeley, Calif. The two PC software giants, Ashton-Tate Corp. and Microsoft Corp., will jointly market SQL Server, a version of Sybase's relational data-base management system that's been modified to run on a local-area network server under Microsoft's OS/2 operating system. SQL Server will provide transaction-processing performance, data integrity, security facilities, and other features of minicomputer- and mainframe-based systems to personal computers on LANs. Ashton-Tate will offer a user-interface front-end product that maps its dBase language to SQL, or the structured query language—but other companies, including Sybase, will offer competing front ends. Users stand to win from the arrangement if the potent Ashton-Tate/Microsoft marketing combination establishes Sybase's superset of the ANSI SQL specifications as a de facto standard. ☐

EXTENDED-QUALITY FM STEREO MAY BE JUST AROUND THE CORNER

The first major improvement in FM stereo radio broadcasting since the service was authorized in 1961 may finally be implemented this year. Prototype receivers equipped for FMX Extended Range Stereo debuted this month from 10 different Japanese manufacturers at the Winter Consumer Electronics Show in Las Vegas. "We're hoping that by the Summer CES, receiver manufacturers will be taking orders," says Emil L. Torick, co-inventor of FMX. "We expect that at least 100 broadcasters will be on the air [with FMX] by the end of 1988." Developed jointly by CBS Inc. and the National Association of Broadcasters, FMX promises to significantly reduce noise and double FM stereo reception area, while maintaining compatibility with conventional FM stereo broadcasts [*Electronics*, April 16, 1987, p. 39]. Sanyo Semiconductor Corp. of Santa Clara, Calif., released the first FMX receiver/decoder chips in November, and Inovonics Inc. of Santa Cruz, Calif., will offer FMX broadcasting equipment beginning this month. ☐

DID FAILED CHIPS DELAY LAUNCHING OF JAPANESE ROCKET?

A swarm of controversy swept east from Japan into California last week when it was reported that some U. S.-made chips being used in a Japanese rocket failed inspection just prior to launching. The parts, apparently voltage regulators, were made from dice fabricated by National Semiconductor Corp., and later packaged and tested to S-level space standards by TRW Inc. The parts were tested and operational when they left TRW, says a company spokesman, but when tested prior to lift-off—a common practice with rocket-based equipment—alleged "anomalies" turned up. TRW says it is now working to resolve the matter, and although the company insists the chips did not fail, it will replace the chips if necessary. ☐

GM WILL OFFER ANTILOCK BRAKES ON MOST MODELS BY 1991

General Motors Corp. has finally developed its own computer-controlled anti-lock braking system, but the system—a $925 option on a select group of 1988 GM cars—doesn't yet bring the technology to the masses. GM figures to drive down the cost with specification modifications and high-volume production, so that by 1991 it can offer the systems for only $300 to $350. Current specifications for GM's system, which is based on a pair of customized Motorola 68HC11 8-bit microprocessors, require that it be able to handle driving speeds up to 185 miles per hour, but GM says the spec could be lowered to 120 MPH instead to limit the system's computational load. ☐

PRODUCTS NEWSLETTER

ARDENT'S SOFTWARE PACKAGE MAKES INTEGRATING 3-D GRAPHICS EASY

Look for Ardent Computer Corp. to make it easy for third-party developers of high-performance simulation and design applications to add dynamic three-dimensional visualization to their products—significantly increasing their value without investing thousands of programming worker-hours by computer-graphics experts. The Doré (for Dynamic Object Rendering Environment) software package is a high-level library of subroutines for drawing objects that includes an object-oriented scene data base and multiple levels of scene-rendering software. The Sunnyvale, Calif., company plans to license Doré for a one-time fee of $15,000, plus $5,000 a year after the first year for source-code maintenance. It will be available this month. □

SOFTWARE CUTS PLD DESIGN TIME FROM MONTHS TO WEEKS

Those ultra-dense, 30,000-fuse programmable logic devices that used to take months to design and program can be finished off in a couple of weeks even by inexperienced designers with the PLDesigner software from Minc Inc. The Colorado Springs, Colo., startup's tool boasts a library of more than 1,800 devices and automates the time-consuming, endlessly iterative process of deciding which fuses to blow to achieve the right logic. It accepts waveforms, Boolean equations, truth tables, and state-machine language as inputs and can be programmed with weighted priorities on cost, speed, and number of PLDs, depending on the solution the designer wants to use. Once the underlying logic is derived, six proprietary algorithms reduce the solution to its most efficient form—a step rarely taken now because of its complexity—and a fuse map is generated. PLDesigner runs on an IBM Corp. Personal Computer AT or compatible. Available now, it costs $1,950. □

FUJITSU'S ECL RAMS SOLVE THE PIPELINE-MEMORY TIMING PROBLEM

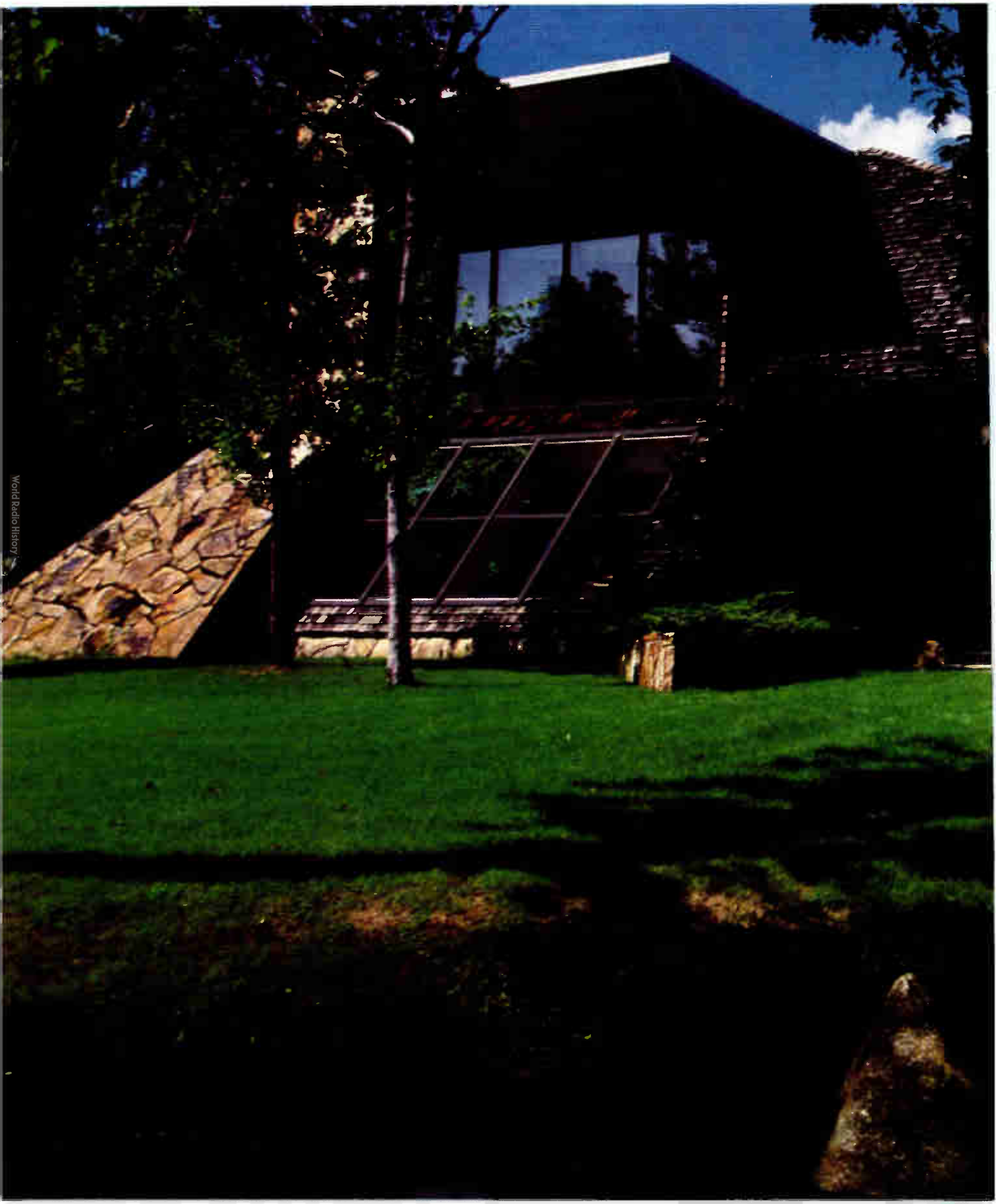
Designers working with pipelined-memory system architectures can simplify the knotty timing problems they present by using Fujitsu Microelectronics Inc.'s family of emitter-coupled-logic random-access memories that feature identical setup and hold times. Fujitsu's engineers turned the trick by teaming an on-board write-pulse generator with latched inputs and outputs. The MBM10476LL-9 and MBM100476LL-9 are organized as 1K by 4 bits and have 9-ns cycle times. The MBM10486LL-13 and MBM100486LL-13 are organized as 4K by 4 bits and have 13-ns cycle times. The chips are compatible with either the 10K or 100K ECL industry standards, says the Santa Clara, Calif., company. Available now in sample quantities, the 1-K-by-4-bit devices cost $55 each and the 4-K-by-4-bit devices, $75 each. Production quantities will be available later in the first quarter. □

FORTRAN RUNS 15% TO 30% FASTER WITH NKR'S COMPILER FOR 68000 FAMILY

Original-equipment manufacturers can deliver an immediate 15% to 30% boost in Fortran program performance—and get a head start in moving Fortran applications to new processor architectures—with NKR Research Inc.'s NKR Fortran compiler. The San Jose, Calif., company achieved its performance gains over other compilers by custom building an optimizer and its library instead of using an optimizer that is shared among languages. Aimed at work stations using Motorola Inc. 68000-family microprocessors, the compiler includes a Fortran extension used in Digital Equipment Corp.'s VAX/VMS environment. NKR's use of cutting-edge Automatic Code Generation technology means the complier can be retargeted to a new processor in less than six months, instead of a year or more. Evaluation copies are available now to OEMs for as little as $100 depending upon the platform. □

What do you need to build on a rough application concept?

AT&T. The comp



onents of success.

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INSTRUMENTS OF DISCOVERY

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On the business side, the fundamental question, one that is answered at the highest levels, is what architecture to chose for equipment. As analyst Crugnale puts it, "I don't see it. [Committing to TRON] represents incredible risk, with no commensurate payoff. What does it bring to the party?"

What's more, says Crugnale, the Japanese probably will fail to market the chips adequately in the U.S. because they do not understand the importance of an aggressive marketing campaign. To have a chance of establishing TRON, Crugnale estimates that a minimum of $50 million would be needed. But he predicts that less than $1 million will actually be devoted to selling it.

Historically, Japanese chip makers have fared poorly in the computer and operating-system side of the U.S. market, points out William Strauss, president of Forward Concepts Inc. in Tempe, Ariz. He recalls the effort surrounding the MSX operating system developed by Microsoft Corp. for use in Japan in the early 1980s. The Japanese then pushed it in the U.S. during 1985 as an alternative to MS-DOS, he recalls. "It died aborning," notes Strauss. He gives the TRON 32-bit chip family about the same chance of achieving success in the U.S.

INTEGRATED CIRCUITS

NEW CHOICE IN CROSSBAR SWITCHING: THE IC

SUNNYVALE, CALIF.

Standard digital-logic chip managers at Advanced Micro Devices Inc. think they've got a big winner that can thrive in the age of semicustom integrated circuits. The silicon plum is a digital crossbar-switch chip.

Similar in concept to the old relay arrays found in telephone central offices, the chips can act as a flexible, reconfigurable intersection of bidirectional ports tying together multiple buses, parallel processors, and memory banks. The AMD managers, like rival engineers at Texas Instruments Inc., give credit to parallel-processing trends for a chance to snare sales from both small-scale integrated logic and gate arrays as multiprocessor architectures proliferate in everything from low-end embedded microcontrollers to desktop work stations and supercomputers.

Roy Selinger, AMD's marketing manager for logic and interface products, says the market potential for multiple-bus connecting crossbars is about 5% of the world's $2.2 billion standard-logic business. "That means we are shooting at about $75 million to $100 million in 1988," he says, referring to the 1.2-μm CMOS parts. One reason for the high hopes is that gate-array implementation would use up a lot of silicon to match the output-drive capability of AMD's crossbar chips.

This month, AMD will become the first company to apply low-power CMOS to digital crossbar switching in its 4-bit-by-4-port Am29C982 and 9-bit-by-4-port Am29C983. The two are expected to be the first in a family of what AMD calls Multiple Bus Exchange chips. They are going up against a much larger 16-port bipolar digital crossbar switch introduced by TI last summer. TI's SN74S8840 has 64 input/output pins arranged in 16 separate 4-bit bidirectional ports. Both companies expect others to join them as the market grows.

The major differences between AMD and TI strategies center around how much complexity and how many bidirectional data ports should be fed to the infant parallel-processing movement. AMD managers in Sunnyvale believe 16 ports is overkill at this early stage; TI officials say they know best since they defined the 8840 based on their experiences with its close cousin, a three-port bipolar transceiver introduced in 1979 called the 74LS440. AMD spent three years defining its four-port chips' features with key customers in an attempt to find a smaller array oriented toward more applications, Selinger says.

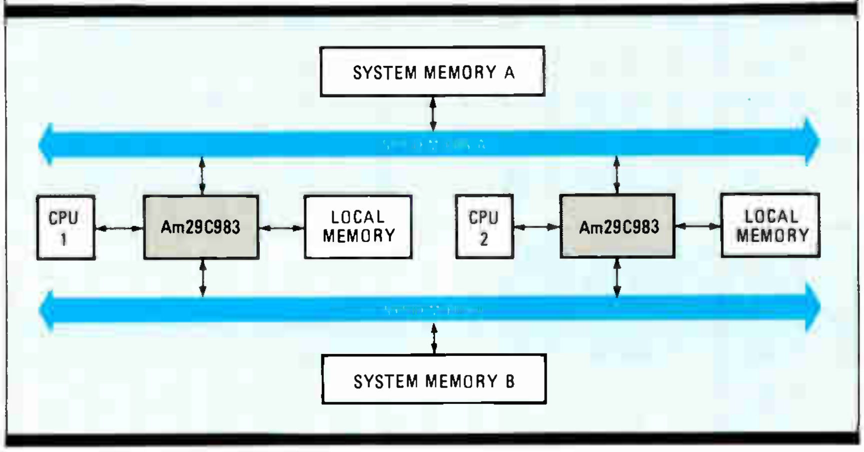
AMD's 29C982 is housed in a 28-pin plastic dual in-line package and sells for $8.50 each in 100-piece lots. The 29C983 comes in a 68-lead plastic chip-carrier for $24.50 in similar quantities. The TI 8840, which can have its 16 ports configured to serve sixteen 4-bit, eight 8-bit, or four 16-bit buses, is housed in a 156-pin ceramic grid array at $72 in 100-piece quantities.

TWO CHOICES. AMD's Multiple Bus Exchange chips are expected to replace up to 20 discrete logic devices apiece. The 4-bit 29C982, which has a die size of 23,000 mil^2, is for small systems, including embedded parallel-processing control architectures, Selinger says. The 9-bit 29C983 includes latches that can be used to provide byte-wide parity, system diagnostics, and byte-wide compression-expansion for communications between buses with different bandwidth.

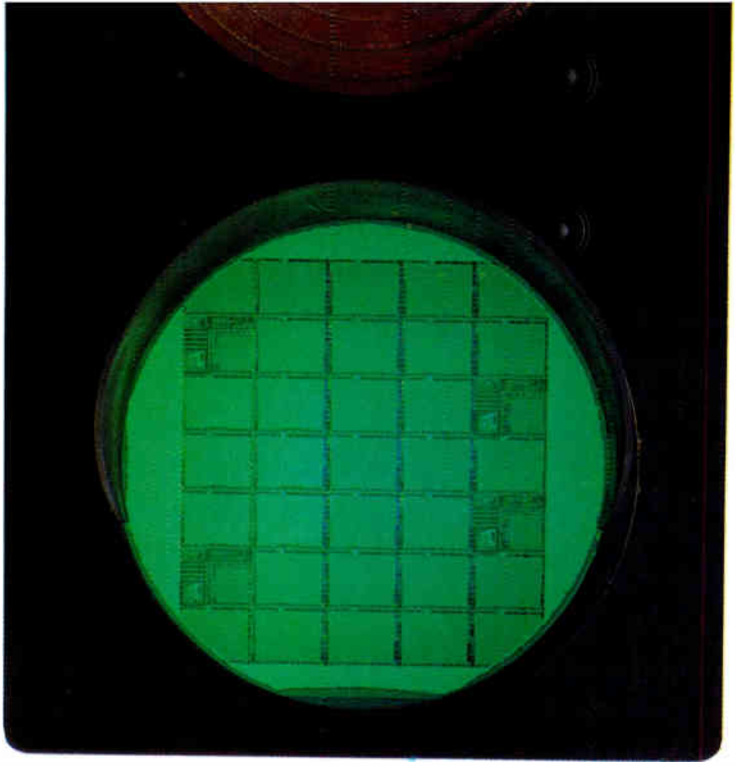
Although TI may differ with AMD on the means to make standard-logic digital crossbar switches a success story, it also believes they are poised to give semicustom ICs a run for their money. Christopher A. DeMonico, TI strategic marketing manager for VLSI advanced logic, says the six-month-old 8840 is already replacing gate-array-based crossbar designs, which often require up to four ICs to deliver the high percentage of metal interconnect needed to interface multiple buses. "It is a high-density metal function. And the bidirectional port is one feature not yet generally available in ASICs," he adds.

DeMonico says one of TI's telecom customers is using the 8840 in a new digital private branch exchange to switch connections to main trunk lines, replacing 240 SSI logic parts per crossbar chip. In a small computer system, the 8840 is being used to interface two incompatible microprocessors to five shared memory banks, eliminating 180 SSI devices per IC. *–J. Robert Lineback*

CROSSBAR CHIP



Advanced Micro Devices' digital crossbar-switch chip can be used to connect multiple buses. Along with a similar part from TI, it is aimed at an estimated $75 million to $100 million market.



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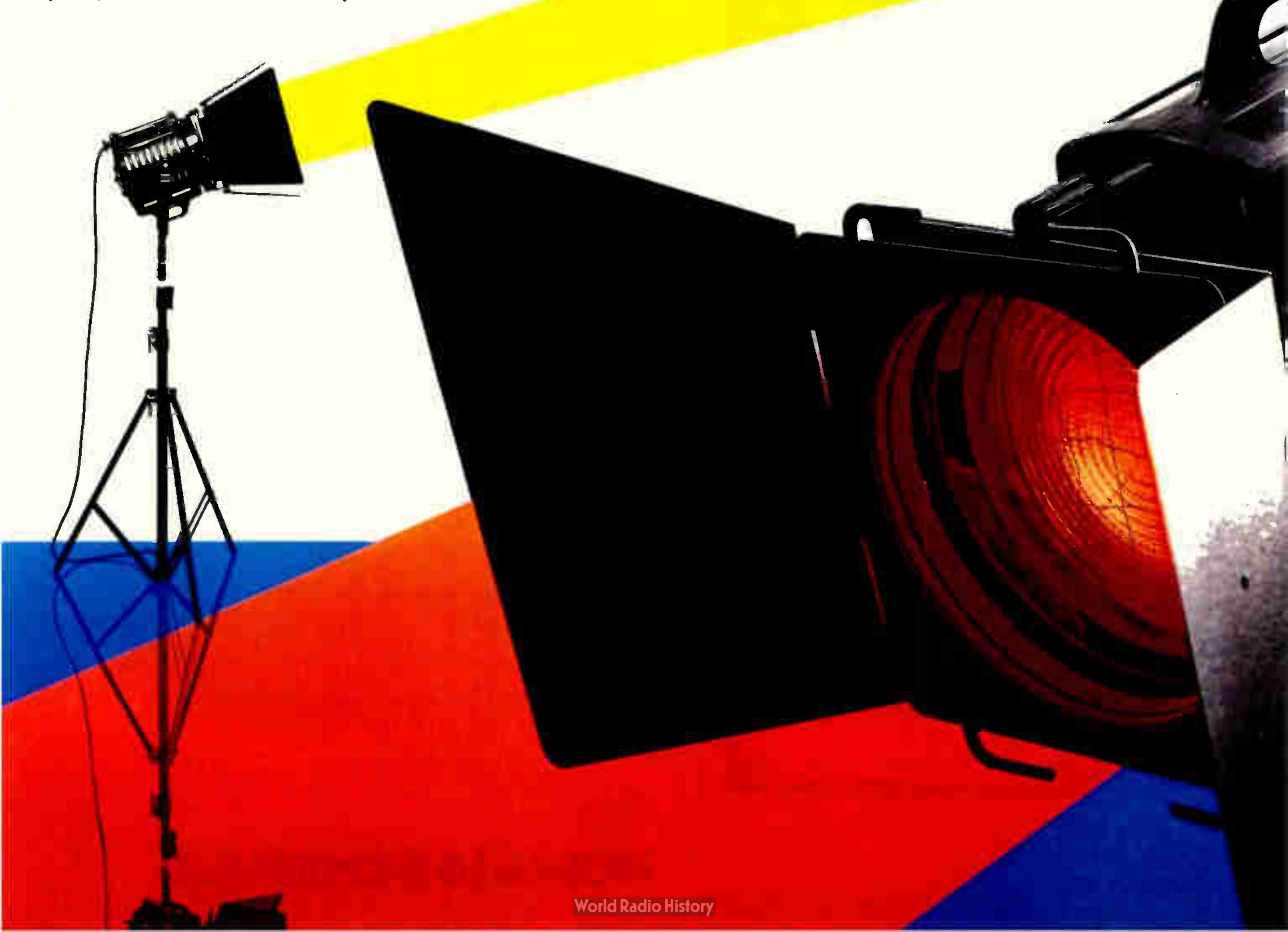

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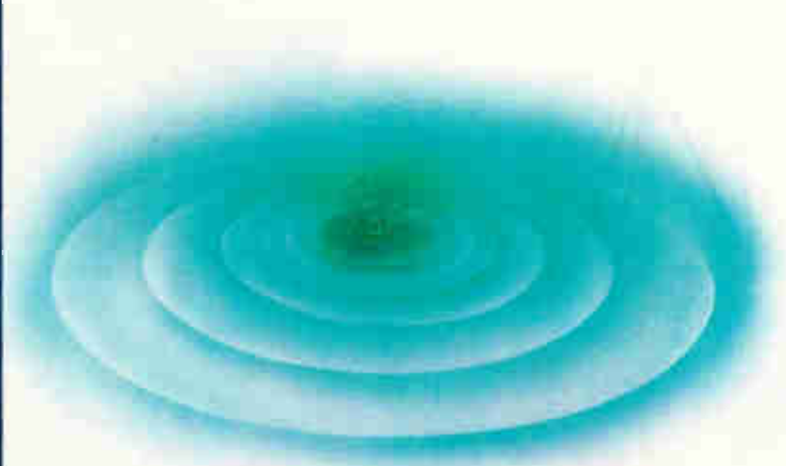

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Circle 95 on reader service card

INTERNATIONAL WEEK

HAMBURG R&D LAB STARTED BY PHILIPS

Philips has begun construction of a microelectronics development center, which represents the first construction phase of a $300 million megabit-memory circuit design and production facility planned in Hamburg, West Germany. When completed in early 1989, the five-story development center will employ some 250 engineers and technicians. The Dutch company expects to invest some $156 million in its new Hamburg facility this year alone.

NEC TO BUILD DISK DRIVES FOR SIEMENS

NEC Corp, Tokyo, will expand its cooperation with Siemens AG by supplying 9-inch hard-disk drives to the Munich company, beginning next April. Siemens will use the disk drives in its 7500 series of mainframe computers. NEC will supply two types of drives with memory capacities of 400 and 800 Mbytes. During the next four years, NEC expects to sell more than 12,000 units, worth 8.5 billion to 10 billion yen. NEC has been under contract with Siemens since 1985 to supply 5-inch hard-disk drives initially, and then 3.5-inch hard-disk drives, 5-inch floppy-disk drives, and laser-beam printers.

JAPAN FIRMS TO STUDY INDUSTRIAL HDTV USES

Eleven of Japan's leading electronics manufacturers will study jointly how high-definition TV can be applied to industrial uses, such as printing, cinema, audio-visual educational tools, and medical equipment. The two-year HDTV Study Committee, which is being set up this month by the government-supported Kansai Electronics Industry Development Center, Osaka, will standardize hardware and software for HDTV. The committee's first goal is to develop a standard for switching and transmission systems to handle HDTV image data. The standard will be the basis for the design and fabrication of VLSI chips needed to make equipment such as multiplexers and demultiplexers compact and inexpensive.

BOSCH IN ANTISKID DEAL WITH AKEBONO . . .

Robert Bosch GmbH, the Stuttgart, West Germany, automotive electronics and communications equipment maker, and Japan's Akebono Brake Industry Co., Tokyo, have agreed to cooperate in electronic anti-skid systems for commercial vehicles. According to the pact, Bosch will license Akebono to manufacture and sell its systems in Japan. The agreement also calls for common development of anti-skid systems for both air and hydraulic brakes, also for commercial vehicles.

. . . AND EXPANDING IN COMMUNICATIONS

Bosch GmbH also has beefed up its interests in telecommunications, by doubling its stake in ANT Nachrichtentechnik GmbH, a 7,000-employee, $800 million communications equipment maker in Backnang, West Germany. Bosch took over the 40.8% share that Mannesmann AG, a German steel pipe producer, held in ANT. Bosch's acquisition is still subject to approval by West Germany's Cartel Office.

CANDELA, MITSUI JOIN IN VENTURE

Candela Laser Corp., the Wayland, Mass., manufacturer of flashlamp-excited dye lasers, is teaming up with Mitsui & Co., the trading firm based in Tokyo, to form Candela International Corp. Taking advantage of the weak U. S. dollar, the joint venture, also in Wayland, expects to capitalize on its price advantage, particularly in Japan. The arrangement will give Candela Laser's engineering, medical, and scientific laser systems access to 213 Mitsui offices in 88 countries. In addition, Candela International will market high-technology medical equipment from other manufacturers.

JAPAN TO SET UP MAP TEST CENTER

The International Robotics and Factory Automation Center in Tokyo plans to establish a Manufacturing Automation Protocols test center in Japan in early 1989. The plan follows the World Federation of MAP Users' Group's decision to set a worldwide MAP standard and to make MAP tools interchangeable. The center will do conformance tests on manufacturers' MAP products. Similar test centers already have been established in the U. S., the UK, and West Germany.

U. S., CANADA GET IBM JAPAN'S LINK

IBM Japan's remote channel-to-channel system, which has been adopted as an IBM worldwide standard, has just made its debut in the U. S. and Canada. IBM Japan claims that computers connected by the RCTC system can efficiently send and receive large volumes of data at 1.536 Mbits/s on a high-speed digital circuit regardless of the distance between the two computers. The capacity is six times greater than the capacity of IBM Japan's time division multiplexer. The RCTC system became available in the domestic market last June for 1.2 million yen.

BRAZIL KILLS TARIFFS IN SOFTWARE BILL

In the face of U. S. threats of sanctions against Brazilian exports [*Electronics*, Nov. 26, 1987, p. 30] Brazil's President Jose Sarney has approved a bill extending copyright protection to software. Absent from the bill is a provision that would have imposed up to a 200% tariff on imported software, says the Computer and Business Equipment Manufacturers Association, Washington, which views the revised bill as a positive sign.

ERICSSON JOINS BROADBAND PROJECT

LM Ericsson, of Stockholm, Sweden, has joined the Research in Advanced Communication in Europe program. Sponsored by the European Communities, the program will develop a European broadband communication network for the 1990s. The Swedish telcommunications and information systems equipment maker will participate in nine RACE research and development projects in areas such as customer premises network, broadband customer access, broadband switching, optical switching, mobile engineering, and software. In three of the projects, worth $130 million over three years, Ericsson will play a major role.

CANON CAMERA GIVES BETTER PICTURES

An electronic still camera from Canon Inc., Tokyo, will boast greatly improved picture quality when it goes on the market next month. The single-lens reflex camera has a charge-coupled-device image sensor with 1,212 pixels horizontally, providing a total of almost 482 lines. Shutter speeds range from 1/8 to 1/2,000 second. The camera is designed to record either 50 TV fields or 25 TV frames on a standard 2-in. floppy disk. Despite the large number of pixels, the CCD has an effective imaging area equivalent to a 2/3-in. camera tube. The camera is priced at 590,000 yen for just the camera body.

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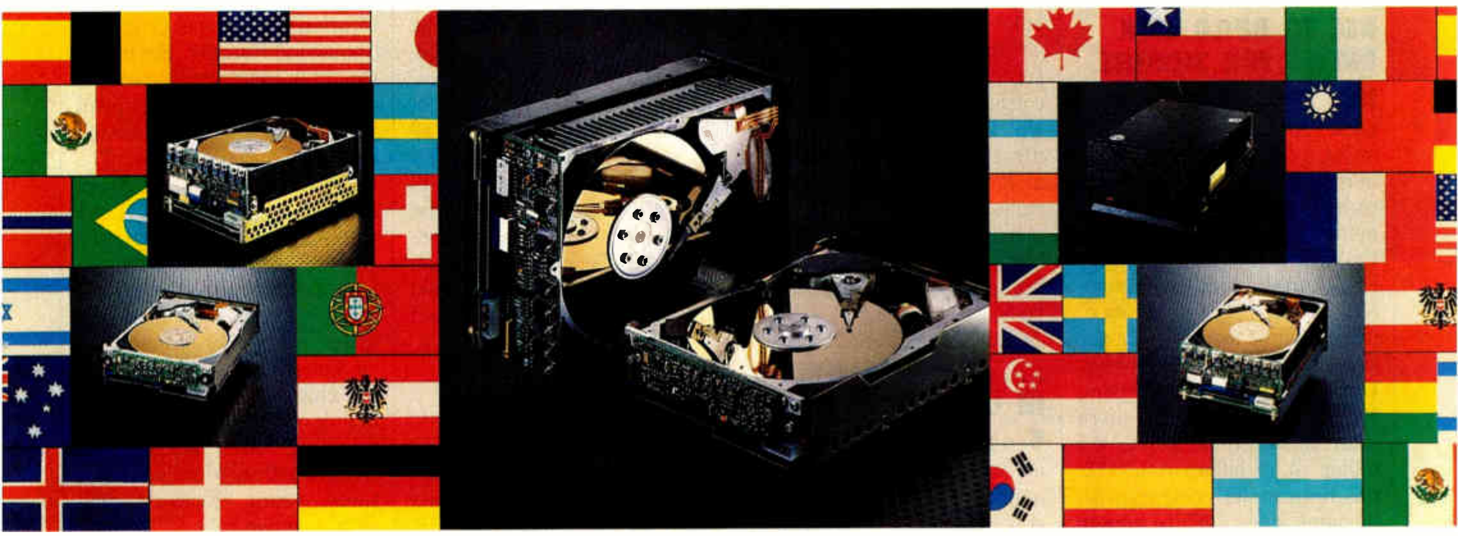

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Wren III H.H.	94	18	SCSI	10
Wren III	160.7	16.5	SCSI	10
Wren III	182	16.5	ESDI	10
Wren II H.H. RLL	65.8	28	ST506	7.5
Wren II H.H.	40.5	28	ST506	5
Wren II RLL	109	28	ST506	7.5
Wren II	75.5	28	ST506, ESDI, SASI	5

H.H. = Half High Models
All models list useable formatted capacity.
SCSI models formatted in 1024 Byte sectors
Wren III and IV models have 40,000 MTBF (others: 30,000 hr. MTBF)

CONTROL DATA

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INTERNATIONAL PRODUCTS

CONTROLLER CHIP CUTS KEYBOARD REDESIGN TO WEEKS

MATRA HARRIS COMBINES 8032-COMPATIBLE CONTROLLER WITH 4 KBYTES OF ROM

A new single-chip keyboard controller from Matra Harris Semiconductors SA combines 4 Kbytes of easily customizable read-only memory on-chip with a widely used microcontroller architecture. This combination gives manufacturers the best of two worlds: a standard solution that also lets them cut redesign time for software changes and hardware enhancements from months to a few weeks.

The 80C752 is fully compatible with the instruction set of Intel Corp.'s 8031 and 8032 microcontroller. It also packs input/output port multiplexers on-chip—replacing logic most keyboard controllers now implement in 10 or more additional small-scale integration and medium-scale integration discrete devices.

"Rather than having to redo everything from scratch and reinvesting, you do it once," says Stephane Schmoll, Matra Harris marketing manager. "And when you want to adjust the software, there is very little to modify."

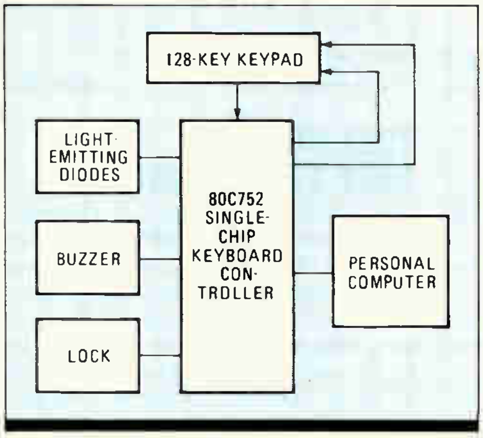
THREE WEEKS. The 4 Kbytes of Matra Harris' Quick ROM and some input/output options can be customized in three weeks instead of the two months generally required by foundries. That's because Matra Harris customizes at the end of the layering process, rather than the conventional method of customizing in the third or fourth layer.

"In our system," says Schmoll, "customizing takes place in the eleventh or twelfth layers, much like the gate array process. So you can build up, put it on the shelf, and when a client asks for something customized, do that in the last operation in a few days."

Fabricated in the company's advanced CMOS process that boasts an 0.8-μm effective gate length, the chip also includes 256 bytes of random-access memory, three 16-bit timers/counters, 32 input/output lines, and a programmable serial port.

In another design innovation for keyboard controllers, the St. Quentin Yvelines, France, company protects the program in ROM from pirating by integrating a fuse on chip that can be blown to frustrate all but the most costly reverse engineering methods.

The 80C752 has eight comparator inputs to directly interface with capacitive as well as mechanical types of keypads. "These are usually outside of the microcontroller but we included them in the chip," says Schmoll. Outputs are able to drive up to 12 mA for external light-emitting diodes, a buzzer, or serial transmission links several meters long. In a typical configuration with a personal computer keyboard, for example, the 80C752 might be customized to implement a standard key for a security lock, a buzzer to warn users when they do something wrong, and up to five LEDs, depending on the range of the equipment, for indicating the status of standard functions such as scroll or numerical locks.



EXTRAS. The 80C752 can control status LEDs, a buzzer, and security key besides the normal keypad.

The chip handles modifications and upgrades of every type of personal computer, terminal, point-of-sale or banking terminal, work station, or portable entry system. It fits with a variety of low-cost, low-to-high performance keyboards and easily accommodates the addition of accessories such as a mouse, LCD display or magnetic card or bar code readers, making potential application of the device virtually unlimited, says Schmoll.

The 80C752 can handle basic keyboards without need for additional circuitry. For more sophisticated systems, such as work stations, cash registers, or process control panels, the extra logic can be included in a single gate array or programmable logic device without having to modify the basic keypad scanning technique.

Matra Harris got the idea from several major keyboard manufacturers who separately asked the company to develop a customized solution to minimize costs, Schmell says. "Once we studied this we saw there was little difference in what was being requested so we asked [the companies] to instead let us put a new standard in our catalog that will meet 90% of everybody's needs," he says.

Matra Harris has also made it easy to develop specific applications by providing a version without ROM, the 80C732. This can be used for debugging or limited production by hitching it to external program memory and latches. Then, for lower cost full production, it can be directly replaced by the 80C752 by just removing external circuits and straps, says Schmoll. In both cases, the same printed-circuit board and software routines can be used.

Along with the circuit specifications, examples of applications and sample software routines are provided to customers, as is a schematic for a breadboard of the circuit. This breadboard is made with a standard 80C32 and standard external components such as latches and comparators so that designers can emulate their applications without a specific emulator.

LOW POWER. Power dissipation can be expected to be under 25 mA at 5 V, 12 MHz—no more than other electronic keyboard controllers for PCs. This benefits portable units, such as data entry terminals that run on batteries, where every milliwatt counts, says Schmoll.

Potential customers include both keyboard manufacturers and companies who design them for inhouse equipment. Since many applications use the Intel microcontroller's architecture—and others are likely to be tempted to switch to it—Schmoll sees the potential market as expanding quickly into millions of devices.

Samples of the 80C752 and the 80C732 will be available in the second quarter of 1988 in 44-pin plastic leadless chip carriers or 44-pin flatpack packages. The devices

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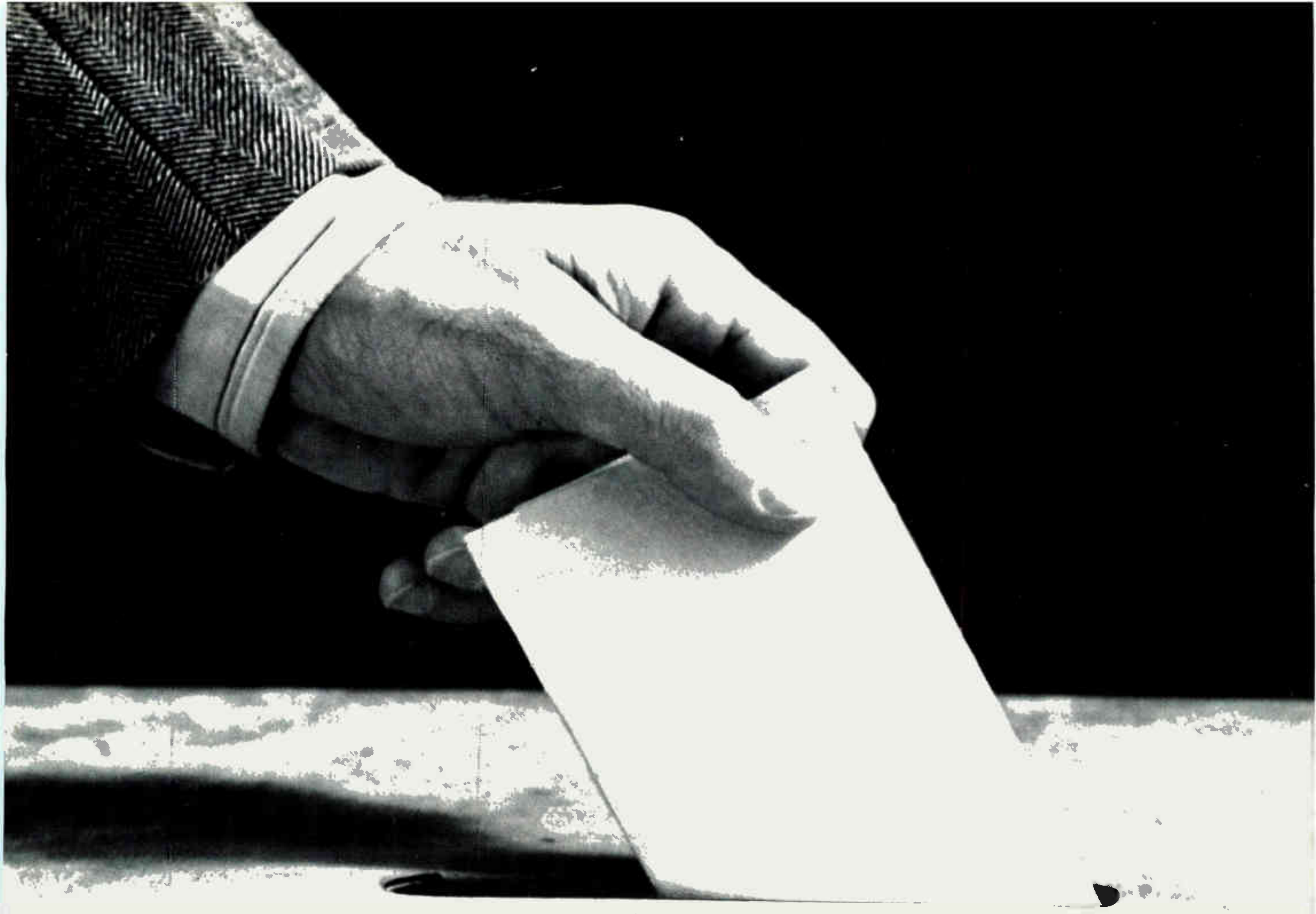

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THE SOFTWARE FOUNDRY: ALMOST TOO GOOD TO BE TRUE

Building an application-specific processor will become a more attractive option for many companies, thanks to QTC's new tool kit, which tunes a design for top speed and automates the tough, expensive task of writing the microcode

by Jeremy L. Young

A tool set from a small company in Beaverton, Ore., promises to change the way custom microcoded processors are designed and to vastly simplify the development of software for them. Quantitative Technology Corp.'s Software Foundry tools let their users see clearly the consequences of decisions made during the design of hardware and software for these specialized, high-performance processors—the majority of which are built with microcoded architectures like those dictated by the use of bit-slice chips.

These processors may also be built with unique combinations of other standard parts—such as digital signal processors or floating-point chips—or application-specific chips. The new tools will move them to market much faster, in large part by eliminating the expensive and agonizing process of writing microcode by hand.

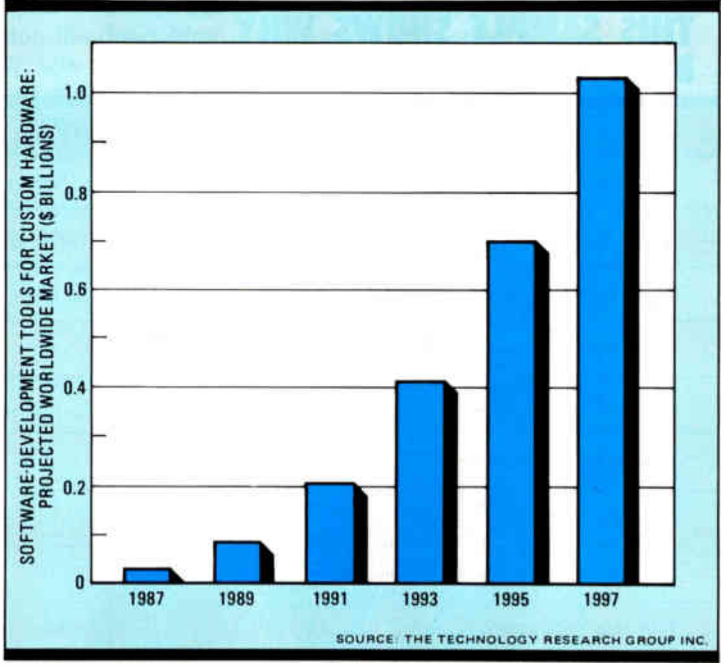
The QTC package includes a compiler, optimizer, assembler, simulator, debugger, and linker (see p. 49). Because these tools can be adapted to new and complex architectures, they can be used by designers and programmers of application-specific processors: graphics engines, embedded systems for avionics, flight simulators, machine-vision systems, and the like. These are systems designed to run a particular algorithm or set of algorithms. And they are systems for which speed is crucial: they do jobs for which general-purpose processors are not good enough.

The QTC tools squarely address the problems associated with writing the software for such hardware, thereby filling an important void in the software-engineering tool market. With them, hardware and software design can be tightly linked, and development can proceed on both fronts at the same time. Simulation tells the hardware team how design changes will affect software-execution speed—before a prototype is built. Software engineers will also be able to see how code modifications will work on the proposed hardware. Hardware changes can be explored without disrupting software development.

On the software side, the tools address the awesome difficulty of writing microcode. It is a painfully hard job—one that is now done "with stone axes and chisels," says an early user of one QTC tool: very few programmers do it well. And writing microcode for a given project is much more work than designing the hardware it runs on. With QTC's optimizing compiler, code can be written in a high-level language: C, to start, and next year, Fortran. This promises tremendous savings in project dollars and time to market.

Tools like those of the Software Foundry either simply have not been on the market before or have been piecemeal solutions, such as compilers written for one hardware architecture. As a result, the current market for software-development tools for custom hardware is not large: only about $30 million in 1987, estimates Andrew

QTC's TOOL KIT TARGETS A FAST-GROWING MARKET



SOURCE: THE TECHNOLOGY RESEARCH GROUP INC.

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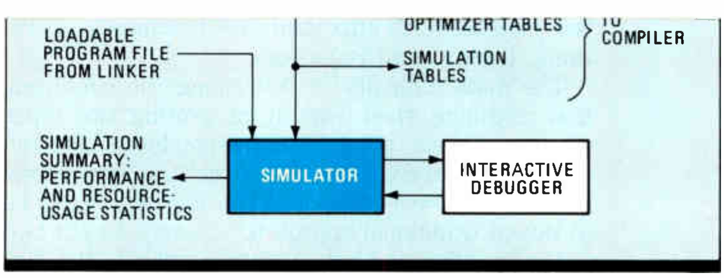

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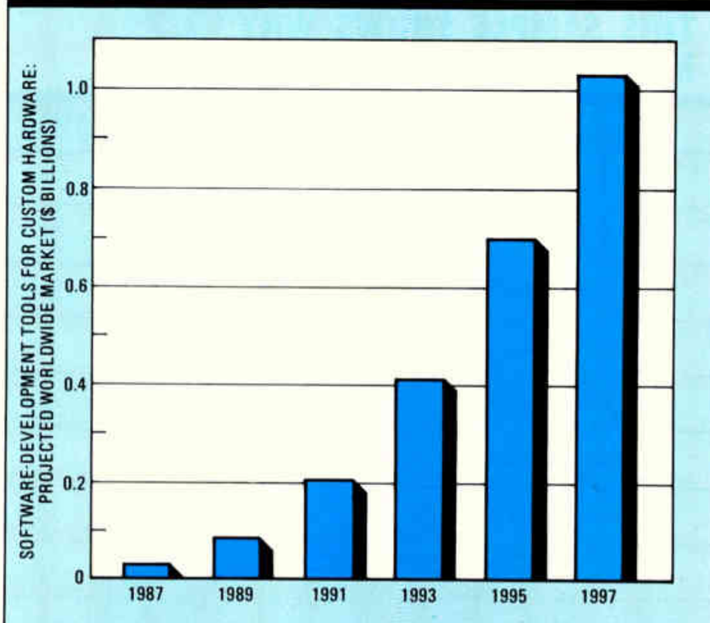


SOURCE: THE TECHNOLOGY RESEARCH GROUP INC.

Rappaport, president of the Technology Research Group Inc., Boston. But Rappaport thinks this market will grow fast as more capable tools—like QTC's—become available. He sees it passing the $200 million mark in 1991 and reaching $1 billion in 1997 (see chart).

And the introduction of the Software Foundry gives QTC a big jump on the competition. For tools directed at low-level microcode development, "this is a case where that company is the only company—at least for the time being—with a product like that," says Rappaport.

The Software Foundry could revolutionize the design of custom processors by making it possible to develop hardware and software simultaneously

Indeed, QTC "seems to have the jump in a lot of areas," says Robert Pendleton, a project engineer for microcode tools and software-engineering practices at a leading vendor of computer graphics and simulation hardware. "Everyone else is talking about writing a retargetable optimizer in 1988, starting from scratch," but QTC's product represents its third generation (following two prototype systems), and one that uses extremely sophisticated optimization techniques, he says. Pendleton's company underwrote two years of the university research the tools build upon.

What's more, says Pendleton, "no one else is even talking about producing a simulator generator"—a system that produces a simulation module from a hardware-configuration file. But as the major link between the hardware and software design processes, the simulation capability "is one of the key pieces" in the QTC package.

THIS SAMPLE SHOWS WHY MICROCODE CAUSES HEADACHES

Fields within instruction word	Length of field (bits)
Control of sequencer with stacks and pipelined-operation facilities	24
Cluster of arithmetic logic units and register banks	32
Cluster of multipliers	6
Address generation and address-register banks	16
Cluster of memory units	6
Input/output bus control	16
Internal bus control	16
Immediate field (for specifying constants or branch targets)	16
Total length of instruction word	132

If the market potential is vast, so is the potential of the Software Foundry to revolutionize the design of custom processors. "Coming up with the best system involves figuring out the best trade-offs between what you do in the hardware and what you do in the microcode," says Rappaport. With the arrival of application-specific chips, designers now have "the ability to do radically different architectures" quickly and economically, he adds. "All of a sudden you have a microcoding problem that doesn't necessarily target a static architecture. Development tightly intertwines hardware development and microcoding—and really creates a nightmare." With QTC's tools, "you can say, 'now let's simulate [code on] a hardware target we haven't implemented yet, and let's use simulation as a means to optimize without forcing iterative loops around hardware development.' And that's really interesting."

Pendleton agrees. The ability to simulate software as it will run on a proposed system means "you can test it before you have to build it—to see how well that chip will really perform and how much of the hardware is actually going to be used—and explore different configurations."

Even if the QTC tools are used to produce microcode for an existing machine, however, they still represent a major boon: slashing costs. Many firms rely on unique microcoded architectures to give them a competitive edge, but "microcode is expensive to write, expensive to design, expensive to maintain," says Pendleton. "And then when you build a new processor you throw it away and start over from scratch."

Pendleton estimates the cost of microcode as "between 50 cents and $2 per bit," which adds up quickly because microcode instructions tend to be very wide—from 64 to 256 or more bits each—with numerous fields within them controlling the many resources in the machine (see table, left). A system may contain 10,000 such instructions when it first goes out the door; and more come later to add new capabilities.

A programmer must keep track of what's going on in all those fields in the instruction word, which may involve multiple adders or multipliers in a single-instruction, multiple-data parallel architecture. And speed-enhancing pipelining means that things happening in one cycle affect what must happen in the next. "Pipelining makes programming these things very difficult," says Pendelton. "You get both pipelining and wide words and it gets very painful."

That's why the Software Foundry is so important, says Mickey Mantle, product software manager at Pixar, San Rafael, Calif. "People who can microcode correctly and keep in mind what the 60-odd assorted fields they're trying to track in the instruction word are all doing at the same time are scarce." QTC's optimizer works well in tests so far, says Mantle, and should save a lot of project time: "It's doing things that no human being in his right mind would want to do." □

QTC MAKES IT EASY TO DESIGN CUSTOM PROCESSORS

A complete tool kit tightly links the design of hardware and software for on-the-spot evaluation of changes and for automated microcode development

by Jeremy L. Young

Designers and programmers of specialized microcoded processors will find in the Software Foundry a product they have been sorely lacking—an integrated set of tools that tightly links hardware and software design. This tool kit from Quantitative Technology Corp. lets engineers evaluate design iterations—both hardware and software—as they make them, without waiting for a final version of either. And it makes the tedious and costly process of writing microcode by hand obsolete with a compiler that produces highly optimized microcode from code written in a high-level language.

Some of the tools, which run on Digital Equipment Corp. VAX systems, are available now, and others will arrive during the spring and later in the year. The full package is priced at $50,000 for a work-station-level system.

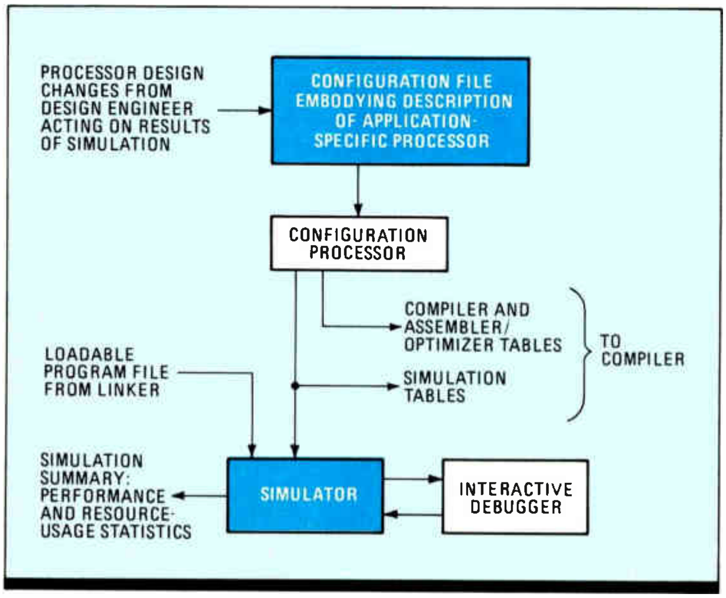
For these six tools—C compiler, optimizer, assembler, linker, simulator, and debugger—to work with any architecture, they must all be retargetable. That is, they must readily adapt to new and highly complex architectures, including those involving high degrees of parallelism (of the single-instruction, multiple-data type) and multiple-level pipelining. The Beaverton, Ore., company provides this adaptability by means of a configuration file. Written in a configuration language reminiscent of the Prolog artificial-intelligence language, the file describes the target hardware and all its peculiarities of resources, timing, and interconnection.

Once a file is written, the full QTC tool set is in business. Now the design team can compile software and simulate it as it will run on the hardware. Indeed, simulation is the key to integrating the two development processes: changes in hardware or software can be evaluated, and their interrelations seen. Designers can examine the performance trade-offs between implementing functions in hardware or software and make informed decisions about overall system design.

But teams working with existing microcoded systems, whether built with bit-slice and other standard chips or application-specific integrated circuits, will want to consider the Software Foundry simply for the leverage it brings to the microcode-development process. It's not hard to design an application-specific processor, says Andrew Rappaport, president of The Technology Research Group Inc., Boston: "What's really hard is to come up with a compiler that allows you to target relatively high-level code to that processor." And that is precisely what the Software Foundry makes possible: once a configuration file describing a processor exists, the compiler lets users write software for it in C (QTC is bringing out a Fortran front end next year).

To make it all work, QTC brings very advanced optimization techniques to bear within the family of tools. Many of the techniques work as well on hand-written assembly code, if the user prefers that to writing in C. Loop rolling and unrolling, trace scheduling, and the efficient use of parallel and pipelined hardware resources are among the forms of optimization carried out automatically.

The linchpin of the system is the configuration file with its description of the system under design, which is used by all the tools. To make such



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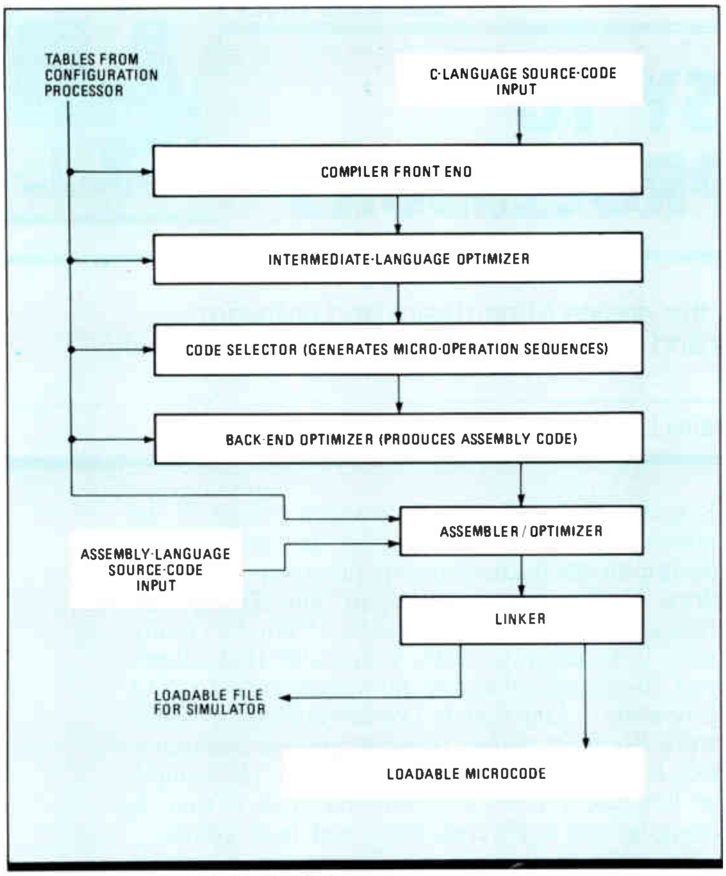

2. EASY MICROCODE. QTC's retargetable compiler generates highly optimized microcode for application-specific processors.

files possible, QTC developed a language to write them in, no small task itself. The compiler and simulator need very different kinds of data, and a big part of the accomplishment was "in putting together a unified language that handles all the information needed by the tools," says Bob Norin, QTC's vice president of product development.

"The compilation tends to look at the machine in what I would call a behavioral way, how the machine behaves," says Bob Mueller, director of research. For such a task, "you can often use higher levels of abstraction and work your way a little bit away from the details of the machine." But with the simulator, "you're interested in understanding exactly how the machine is reacting under the stimulus of microcode," Mueller continues. "This is low-level and structural rather than behavioral." The assembler also relies on low-level descriptive information on the microcode syntax and the machine's operations, timing, and resources.

The main difficulty in developing the configuration language, then, was in integrating two types of data. "There must be correspondence between the behavioral-level and the structural-level representations," says Mueller. "The cop-out would be to take a traditional approach," namely, to put two radically different kinds of information in the configuration file. "That's the easier way to do it," he says, "but it puts a substantial burden on the person doing configuration when it comes time to debug." And debugging is crucial—if the file is incorrect, the tools will generate incorrect code. "One of the goals of our system is to integrate the descriptive notation in such a way that it's easier to validate and see if there's correspondence" between the two kinds of data it contains, says Mueller. "I think that's a unique aspect of what we're doing."

The staff at QTC has programmed more than 30 hardware architectures, Norin points out. "Had we not seen the way that people are designing architectures, and had we not had some experience in developing configuration files, extracting information from schematics, and developing our own microcode languages, I don't think we would have had the perspective to build in a lot of the generality that we have."

That generality makes the Software Foundry applicable to the broadest possible range of microcoded processors, and should give designers of new systems tremendous flexibility in exploring possible hardware configurations. Such exploration could not be done without simulation.

Simulation technology is well understood, and creating QTC's simulator was not such a technical challenge as designing the retargetable optimizing compiler, says Mueller. But until now, no simulator has been "an integrated product in an integrated retargetable system," with a compiler, assembler, and other tools, he says.

Once a configuration file is written, a module called the configuration processor produces tables for the simulator, as well as the assembler and various stages of the compiler (see fig. 1). An application program written in C can then be compiled and an output file generated to drive the simulator. This output file contains information on the system's performance (how fast the program runs) and on how efficiently the hardware resources are being used.

It is the simulator that intimately links the hardware and software-development processes. The hardware designers on a project, for example, no longer have to guess about what effect hardware changes will have on the performance of the system: they can find out quantitatively through simulation of the very software their system is designed to execute.

Furthermore, the hardware team can keep making improvements, large and small, to their architecture while the writing of software proceeds without disruption. In the past, a change in the hardware often meant that all the microcode written up to that point was useless, and the software team had to go back to square one. With the Software Foundry, the configuration file can be changed to reflect a hardware modification and the software simply recompiled.

Then, too, the Software Foundry makes it much easier to deal with difficulties posed by ASICs. Often these chips don't work exactly as intended: the timing may be slightly off, per-

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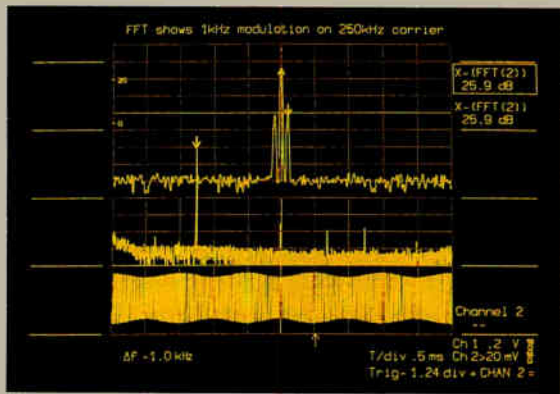

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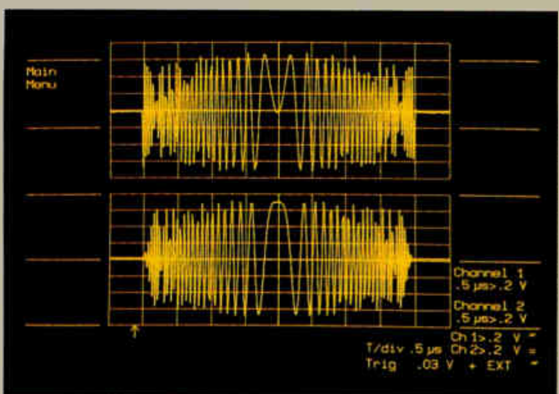

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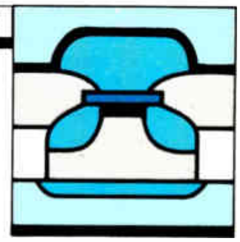


The new raster processor is the centerpiece of a family of graphics building blocks designed to remove the limited architectural options of the single-chip approach

Designers of graphics systems who feel constrained by the limited architectural options available with the current generation of "all-in-one" graphics chips will welcome a new raster graphics processor from National Semiconductor Corp., Santa Clara, Calif.

Designated the DP8500, it is the centerpiece and final element in a family of graphics building blocks that partition onto separate chips functions such as frame-buffer processing, bit-plane-data manipulation, video-data conversion, clock generation, and memory control. What makes this possible is the architecture of the DP8500 raster processor, which separates arithmetic logic units for addressing and data processing, functions normally combined into a single ALU in conventional designs.

As a result, system designers can build graphics systems which perform both pixel and bit-plane operations equally well, says Roger Reak, director of graphics processing at National. Pixel-oriented systems are used in high-resolution, three-dimensional, and color-graphics applications; bit-plane-based systems are important in such functions as byte-oriented and text-processing applications. With all-in-one chip solutions, graphics processors are usually optimized for one or the other.

At 20 MHz, the 2-μm CMOS 8500 is the fastest component of its type on the market, Reak says, featuring a 100-ns bus cycle time on back-to-back vector and block operations. With a line-drawing speed of 300 ns/pixel, four times faster than its closest competitor, typical system performance ranges from 10 million to 160 million pixels per second.

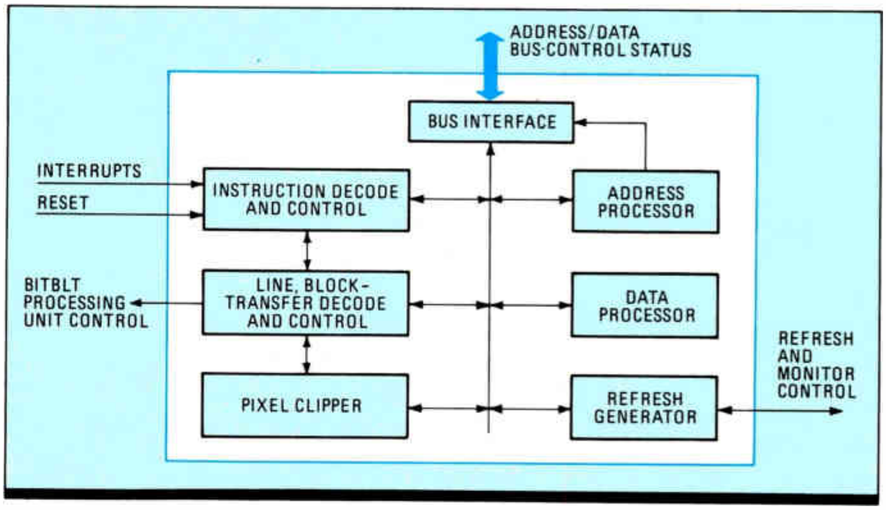
Being sampled now, with production quantities expected by the third quarter, it joins a family of devices which includes the already-introduced 20-MHz DP8510 bit-block transfer processor and the 225-MHz DP8512 video clock generator. The group is rounded out by the DP8515 family of video shift registers and a variety of standard dynamic random-access memory and video dynamic RAM controllers. Production pricing on the 8500 will be $95 in quantities of 10,000 or more.

What makes the partition building-block approach possible is the chip-level architecture of the DP8500, Reak says. One 100,000-mil² chip (see fig. 1) contains a general-purpose microcoded processor divided into two units, as well as a programmable video refresh generator, vector generator, bit-block transfer controller, and rectangle clipper.

The 8500's processor is divided into two blocks. Driven by a common microcoded instruction set, two arithmetic logic units—one each for addressing and data—operate concurrently.

The address processor consists of a 28-bit ALU with an instruction set and bank of sixteen 28-bit address registers. The data processor, on the other hand, is a 16-bit ALU with a relatively rich instruction set optimized for graphics applications and a bank of sixteen 16-bit registers. Other registers have dedicated functions in support of graphics or video refresh operations. In addition, certain graphics operations, notably bit-block transfers, line drawing, and clipping are implemented on chip with dedicated circuitry.

A single stream of instructions, fetched from external memory, serves both processors via mi-



1. DUAL PROCESSORS. The DP8500 graphics chip employs two processors, one for addressing and one for data, driven by a common microcoded instruction set and operate concurrently.

crocode control. The instructions include the register-to-register functions of both processors, and the load/store instructions for data transfers between the chip's registers and its memory. Additional instructions make use of both processors as well as other on-chip resources.

As a result of its dual ALU architecture, the 8500 can be adapted to a wide variety of system architectures without sacrificing performance, says Reak. In a work-station application, he says, it might execute a communications protocol with another processor upstream in the graphics pipeline, awaiting arrival of a display list to be executed. Upon receipt, the 8500 can either directly execute or interpret the display list, rasterizing graphics primitives into the display buffer. Upon executing the final display-list instruction, the processor signals completion, ending the exchange of protocols with the upstream processor and allowing the process to continue.

Alternatively, says Reak, in a stand-alone application such as a computer terminal, the 8500 enters a control program, servicing peripherals and executing a command interpreter. In this application, it would be responsible for the keyboard, mouse, and UART service, at the same time executing a graphics language interpreter, responding to host commands by maintaining the graphics environment, and drawing into the display buffer.

Unlike competitive integrated graphics processors, the 8500 is not limited to one type of graphics frame-buffer architecture. "It can be used not only in either of the two major approaches, pixel and plane, but also in a system that mixes the two," Reak says.

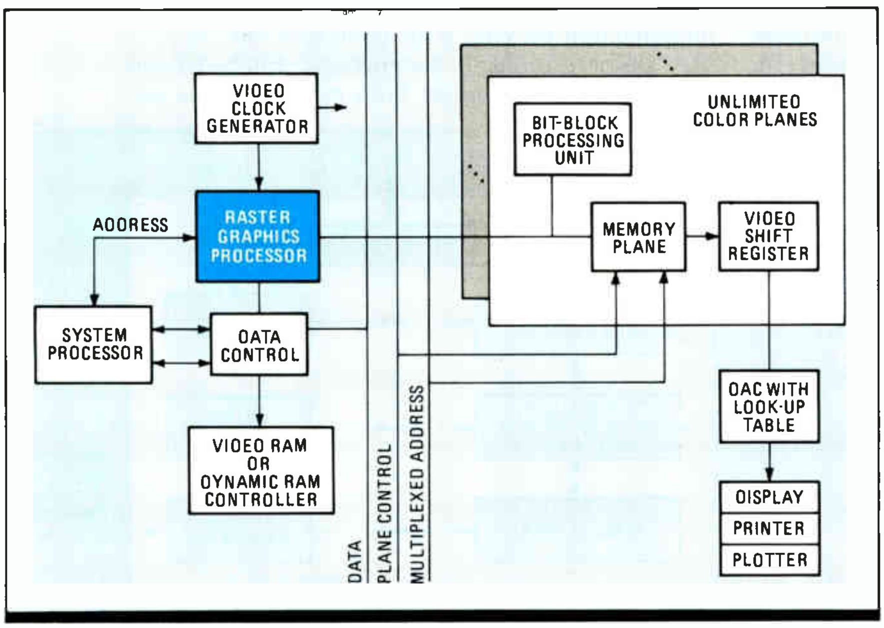
In a pixel-based architecture, frame-buffer data is handled one pixel at a time. For multiple planes, typical in color applications with one plane per color, the address to the frame buffer generates a data word composed of pixels at the same location across multiple planes. These applications often require 16 to 32 memory planes.

In a plane architecture, the frame buffer is manipulated a word at a time within each plane; each word is usually 16 bits long. To change 1 bit, the other 15 must be carried along. Also, a barrel shifter circuit is required if image placement and movement accuracy is needed down to the actual pixel level. Engineering and business applications often use plane architecture, because they require much data manipulation and image movement.

Many other graphics processors cannot work in pixel and plane architectures on the same chip. "In most cases, this has restricted the performance and applicability of these devices across the spectrum of graphics applications," Reak says. Because they are designed to support only up to 8 planes of memory, conventional graphics adapters require additional processors to accomplish transition to more planes, increasing system cost and degrading performance.

Most other graphics processing architectures have the main controller intimately involved with both frame buffer addressing and data manipulation. "This approach severely affects performance, especially as the number of planes increases," Reak says. National's solution is to separate the graphics processing function into two different chips with the 8500 processor performing all of the address and timing functions associated with the graphics frame buffer while maintaining the classical address and data interface with the system's host central processing unit. The actual data manipulation associated with each memory plane is assigned to a separate slave processor, the DP8510, responsible for masking, barrel shift operations, and bit-block boundary operations.

In a typical multiplane color graphics system (fig. 2), a control bus separate from the graphics processor passes all control and setup information to the slave manipulators in parallel with the control information via the data bus. Once this initial information is set up, and the graphics function is being implemented, the graphics processor is no longer involved in graphics manipulation. The slave processors can be configured via the control and data bus for exact destination, left and right asking, bit-block operations, and the barrel shift. When plane-to-plane transfers are required, one slave processor acts as the source and any combination of slave processors the destination. □



2. PLANE AND FANCY. National uses the DP8500 raster processor and the DP8510 slave processor, responsible for masking, barrel shift operations, and bit-block boundary operations.

For more information, circle 481 on the reader service card.

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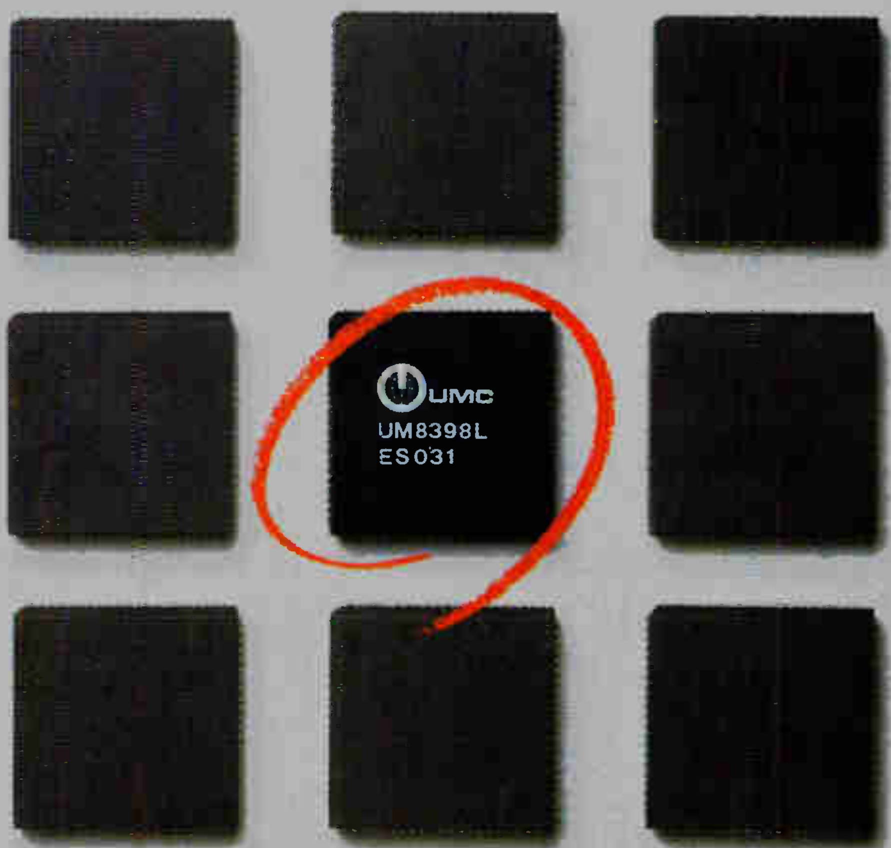

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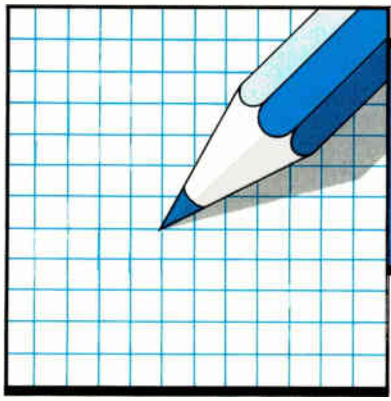


OVERSEAS MARKET REPORT

WORLDS APART: JAPAN SET FOR BRISK 13% GAIN AS GROWTH SLIPS SLIGHTLY FOR EUROPE'S BIG FOUR

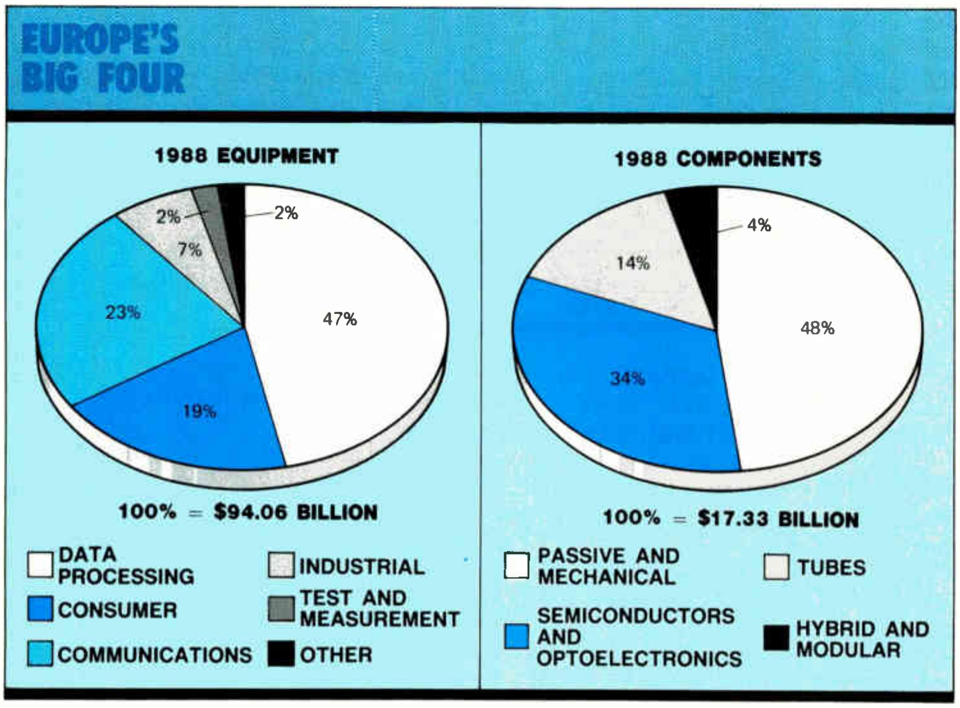
The Land of the Rising Sun will outshine the other major electronics markets around the world this year. *Electronics'* consensus forecast spots the growth of equipment sales in Japan at 13%, two percentage points better than the rise in sight in the U. S. and more than double the growth rate for the top four markets in Western Europe—West Germany, the United Kingdom, France, and Italy. And although Japanese markets for semiconductors and components won't match the 12% growth in store for the U. S., they remain the world's largest at $45.5 billion, some $5 billion more than in the U. S.

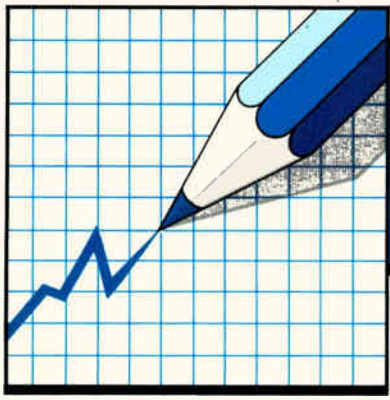
Largely because the Japanese market will do so well this year, the top five overseas equipment markets for the first time will top those of the U. S. All told, Japan and the West European quartet will rack up total consumption of $222 billion, a hefty $52 billion more than the U. S. mark [*Electronics*, Jan. 7, 1988, p. 63]. Credit the slide in the standing of the U. S. in large part to the weak dollar, which magnifies the value of the overseas markets, where sales are figured in local currencies (see "How exchange rates distort forecasts," next page).

Japan's markets loom as large as Mount Fuji compared to national markets of European countries, even though their currencies have largely held their own against the yen. Japan is forecast for hardware markets of $110.6 billion (plus an additional $17.7 billion for software), while all four European nations come in for a total of $94 billion in hardware. Because equipment makers in Japan export so heavily, the difference gets even greater in components: $45.5 billion for Japan; $17.3 billion for Western Europe. (The market figures throughout this forecast are for domestic consumption only, including imports).

In the year ahead, equipment suppliers in Japan should mark much the same growth they did last year: slipping a percentage point to 13%. All the same, competition figures to stiffen as the native producers scramble to recoup lost exports at home while U. S. producers try to leverage favorable exchange rates to break into the Japanese market.

As throughout the industrialized world, data-processing hardware will drive Japan's equipment markets. Mainframes still account for more than half of computer-system sales in Japan and they'll fuel a 15% rise that will carry the sector to $58.7 billion. Consumer electronics, the No. 2 sector, won't come anywhere close: sales will ease up only 6% to $26.5 billion and that is mainly because home computers and new-wave video equipment like camcorders will run strong while color TV stays flat. As last year, communications equipment is in for a lift from the push toward integrated digital services networks, enough to match the 1987 rise of 8% and take the sector to $13.8 billion. In industrial electronics, robot installations are on the rise as manufacturers react to the strong yen by automating their factories, and semiconductor production equipment fig-





OVERSEAS MARKET REPORT

JAPAN

WITH COMPUTERS AND SOFTWARE LEADING THE WAY, EQUIPMENT MARKETS WILL RISE 13%

Japanese equipment and software markets are poised for a year of good growth, with sales rising 13% to $128.3 billion overall. The 1988 increase will virtually match last year's 14% growth rate to $113.4 billion—no mean feat as Japanese equipment makers are forced to turn inward to replace lost export markets, pursued by U. S. manufacturers attempting to take advantage of the more favorable exchange rate. (Last year, the *Electronics* survey used an exchange rate of 163 yen to $1; this year, the rate is 125 yen. So comparing dollar totals in this year's tables with those published last year can be misleading.)

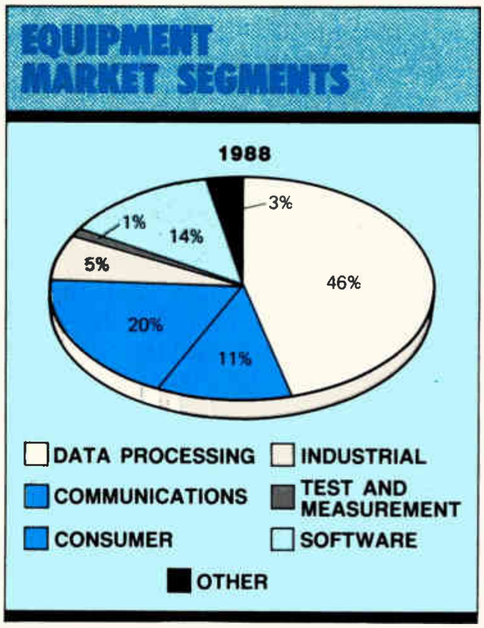
Growth is being driven by the data-processing and software sectors, which together account for about two-thirds of the total equipment markets. These are also the areas where U. S. manufacturers have the greatest hopes of market penetration. That's because Japan continues to use U. S. operating systems and software—a trend that means rapid growth in Unix-based work stations and widespread interest in IBM Corp.'s PC AT compatibles, for example. However, there's growing interest in the convenience of Japanese-language input and that, too, is fueling sales of work stations, personal computers, and kanji word processors.

A good year following a so-so year is the story for industrial equipment. Growth will be strong in semiconductor-production equipment, as companies tool up after emerging from a slump and increased production of 1-Mbit random-access memories spurs equipment sales. Also, robot sales will climb as manufacturers seek to deal with the higher priced yen by increasing efficiency.

For makers of test-and-measurement equipment, the spur is accelerated activity in 1-Mbit DRAMs and other advanced semiconductors, as well as the start of the phone systems' integrated services digital networks this year. The ISDN startup and government pressure for increased investment to fan domestic demand are also driving Nippon Telegraph & Telephone Corp.'s purchases of digital switches and transmission facilities, while users are expected to buy new communications equipment.

The market with the slowest growth is consumer electronics, which is now down to about 20% of the total equipment market and falling after holding steady at 28% for the preceding two years. Growth will be a languid 6% this year, to $26.5 billion, following a 4% hike in 1987.

In the fast-paced data-processing sector, computer makers should see a robust year: the *Electronics* survey estimates that overall consumption will rise 15% to $58.8 billion. In mainframes, *Electronics* forecasts a 16% increase to $14.9 billion—about the same growth rate as last year. But there is a bit of a slump at the top end of the range, says Takehiko Inoue, general manager of NEC Corp.'s EDP Product Planning Division, who adds that he expects lower growth than last year's 15%—perhaps 10% to 13%. One of the reasons for the slowdown is reduced purchases for manufacturing, especially by exporters. Most affected is IBM Japan, because about half of its business is in large computers, and about 40% of that is to manufacturing industries—the largest ratios for any Japanese computer firm.



For supercomputers—a small market in Japan compared with mainframes—*Electronics* sees an 18% increase to $373 million. U. S. makers should pick up 20% to 30% of that business.

The fastest-growing equipment sales are in a still small market segment—minsupercomputers, which should soar by 122% this year to $80 million. In 1986, the market was just $18 million, and last year it reached $36 million. Seven U. S. companies—Alliant, Convex, Elxsi, Floating Point Systems, Gould, Multiflow, and Scientific Computer Systems—sell minisupercomputers in Japan; no Japanese manufacturer does. In Japan, minicomputers and superminicomputers are mainly

	1986	(millions of dollars) 1987	1988
Data processing and office equipment, total	**42,977**	**51,172**	**58,748**
Data processing systems, total	19,832	22,870	26,723
Personal computers	2,794	3,104	3,534
Technical work stations	1,160	1,867	2,758
Office computers	2,960	3,091	3,287
Minicomputers	1,072	1,108	1,182
Superminicomputers	494	574	663
Mainframe computers	11,107	12,775	14,846
Minisupercomputers	18	36	80
Supercomputers	227	315	373
Data input peripherals	224	296	336
Optical character readers	136	176	208
Other data-input peripherals	88	120	128
Data output peripherals, total	4,284	5,854	6,613
Displays	935	1,317	1,464
Plotters	152	212	242
Printers, impact-type	2,017	2,449	2,583
Printers, nonimpact-type	823	1,500	1,906
Other data-output peripherals	357	376	418
Data storage subsystems, total	8,228	10,318	12,086
Flexible disks	1,478	1,754	2,074
Hard disks	4,541	6,262	7,614
Magnetic tapes	1,975	2,018	2,014
Optical disk systems	74	124	224
Other data-storage subsystems	160	160	160
Data terminals, total	4,899	5,634	6,480
CRT	1,993	2,293	2,637
Other (teleprinters, remote job entry, etc.)	2,906	3,341	3,843
Electronic office equipment, total	5,510	6,200	6,510
Calculators (nonconsumer)	533	510	502
Copying equipment	1,038	1,114	1,158
Facsimile transmission systems	1,711	1,916	2,136
Kanji word processors	1,424	1,572	1,869
Billing and accounting equipment	804	1,088	845
Power supplies (noncaptive), total	**2,011**	**2,309**	**2,506**
Bench and lab	73	83	89
Industrial (heavy duty)	172	176	184
OEM and modular, total	1,766	2,050	2,233
Linear	59	65	68
Switching	1,707	1,985	2,165

	1986	(millions of dollars) 1987	1988
Test and measuring instruments, total	**1,289**	**1,353**	**1,505**
Amplifiers, lab	9	9	9
Analog voltmeters, ammeters and multimeters	18	17	17
Automatic test equipment, total	457	493	551
Component testers	27	27	28
IC testers	377	409	462
PC-board testers	53	57	61
Calibrators and standards, active and passive	18	19	19
Counters, time and frequency	21	23	21
Digital multimeters	50	58	60
Logic analyzers	38	38	43
Microprocessor development systems	121	130	161
Microwave test and measuring instruments	25	26	27
Oscillators	15	15	16
Oscilloscopes (including accessories)	127	141	152
Power meters (below microwave frequencies)	168	168	172
Recorders (including chart and X-Y types)	99	91	126
Signal generators (pulse, sweep, and function)	62	63	64
Analog	19	20	20
Synthesized	43	43	44
Spectrum analyzers	61	62	67
Software, total	**11,240**	**14,200**	**17,712**
Microcomputer software, total	1,440	2,000	2,560
Systems software	320	400	480
Applications software	1,120	1,600	2,080
Minicomputer software, total	2,400	2,880	3,360
Systems software	800	880	960
Applications software	1,600	2,000	2,400
Mainframe software, total	7,400	9,320	11,792
Systems software	1,400	1,720	2,152
Applications software	6,000	7,600	9,640
EQUIPMENT, TOTAL	**99,515**	**113,441**	**128,272**

All figures in current U.S. dollars.
The figures in this table, based on a survey made by Electronics in October and November 1987, estimate the noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
Exchange rate: 125 yen to $1.

be robot systems, up 12% to $2.2 billion after a 9% boost in 1987.

In test and measurement, 1988 is a year of high hopes because of the anticipated increase in semiconductor sales, especially 1-Mbit dynamic random-access memories. After last year's forecast of a 9% increase went unrealized—sales rose only 5% to $1.4 billion—the *Electronics* survey indicates an 11% jump to $1.5 billion.

Communications equipment appears poised for an 8% rise to $13.8 billion, about the same growth rate as last year, as manufacturers prepare to announce ISDN terminals and facsimile equipment. ISDN also provided a boost last year, as NTT accelerated its purchases of digital exchanges, both for the start of ISDN in March and because the government wanted to stimulate demand.

In consumer electronics, the *Electronics* survey indicates that 1988 will see a rise of just 6% to $26.5 billion after a 4% rise in 1987 to $25.1 billion. Just as last year's figure was helped by an 18% jump in sales of home video equipment, such as video-cassette recorders and camcorders, this year's will be hurt by a cooling market. Home video equipment sales will be up only 3% to $5.9 billion. But with total TV sales rising just 4% to $5.5 billion, projection TV will be a big winner, albeit starting from a narrow base. Sales will rise 42% to $68 million. At the other end of the size spectrum, perhaps 1 million pocket TVs were sold in 1987 at an average price of $240, and both size and picture quality are creeping upward. Sales should climb to 1.3 million in 1988.

Sales of video disk players, especially the VHD capacitive-pickup types, were down almost 2% in 1987 but optical types should perk up this year and lead the way to an 11% increase, to $392 million. Out front will be CD-V—CD with video—a new category of video players that has hit the market. Last year something like 100,000 CD-V players were sold, and Kiyohara Sasaki, deputy manager of Toshiba Corp.'s Consumer Products Planning Office, forecasts that there will be 400,000 this year at an average retail of $950.

In audio, makers of digital audio tape find that most Japanese are apparently concentrating on the compact disk. Estimates are that perhaps 20,000 DAT units were sold last year at an average selling price of $1,600, and that 50,000 will be sold this year.

stations for computer-aided design and engineering: they should rise 15% to $288 million, atop a 14% increase last year. "When the economy sours, people more readily invest in computers to streamline operations," argues Rössner of Unisys.

The slowdown that characterized West Germany's communications equipment markets in 1986 continued into 1987, and in 1988 the situation may get worse. The *Electronics* survey pegs last year's market at $5.5 billion, up 7% over 1986, and projects only a 2% rise to $5.6 billion this year. Some forecasters come in at a higher growth figure for 1988, however, around 5%.

Several factors underlie the lull. One is that communications is still in the analog-to-digital transition period. Although there's much talk about integrated services digital networks, there's been little action so far in terms of installations. To be sure, some ISDN public switches are in place, but installations on a large scale won't get under way until the early 1990s.

Also, the slow growth in the computer market is pulling communications down, says Manfred Beinder, chief economist at Stuttgart-based Standard Elektrik Lorenz AG, a subsidiary of the French communications group Alcatel NV. "With data processing and communications coupled the way they are, one follows the other either up or down," he says.

WEST GERMANY EQUIPMENT

(millions of dollars)	1986	1987	1988
Data processing and office equipment, total	**15,272**	**16,660**	**17,883**
Computer systems	9,047	10,071	10,919
Personal computers (under $5,000)	938	1,063	1,188
Microcomputers ($5,000 to $20,000)	863	979	1,025
Minicomputers ($20,000 to $100,000)	1,751	1,863	2,022
Superminicomputers ($100,000 to $400,000)	1,004	1,119	1,225
Mainframe computers ($400,000 to $5 million)	4,471	4,999	5,419
Supercomputers (over $1 million, with integral vector processor)	20	48	40
Data-input peripherals	425	459	494
Data-output peripherals	1,238	1,338	1,444
Data-storage subsystems	1,938	2,125	2,313
Data terminals	1,400	1,514	1,628
Electronic office equipment, total	1,224	1,153	1,085
Copiers	693	711	708
Electronic typewriters	381	354	315
Word-processing systems	150	88	62
Test and measuring instruments, total	**573**	**594**	**623**
Amplifiers, lab	9	9	9
Analog voltmeters, ammeters, and multimeters	14	13	12
Automatic test equipment, total	159	181	208
Discrete-component testers	4	5	6
IC testers	55	63	72
Pc-board testers	100	113	130
Calibrators and standards, active and passive	4	4	4
Counters, time and frequency	13	13	13
Digital multimeters (including accessories)	41	41	42
Logic analyzers	28	28	29
Microprocessor development systems	63	59	56
Microwave test and measuring instruments	41	43	45
Oscillators	8	8	8
Oscilloscopes	100	100	100
Recorders and plotters	41	41	42
Signal generators, total	21	21	21
Analog	11	10	9
Synthesized	10	11	12
Spectrum analyzers	31	33	34
Industrial electronic equipment, total	**2,649**	**2,598**	**2,649**
Inspection systems	48	47	46
Machine-tool controls (including numerical)	248	228	203
Motor controls	275	291	266
Process-control equipment (including computers, loggers, consoles)	1,563	1,494	1,531
Programmable controllers	406	400	453
Semiconductor production equipment	109	138	150
Power supplies (noncaptive), total	**254**	**272**	**296**
Bench and lab	22	23	23
Industrial (heavy duty)	25	18	13
OEM and modular, total	207	231	260
Linear	63	50	47
Switching	144	181	213
CAD/CAE equipment, total	**219**	**250**	**288**
Consumer electronics, total	**6,272**	**6,561**	**6,761**
Audio equipment, total	1,948	2,107	2,188
Car audio	450	481	494
Compact disk players	273	389	487
Phonographs and radio-phonographs	68	61	51
Radios (including table, clock, and portable)	49	48	46
Radio/recorder combinations	268	269	263
Stereo equipment, total	444	451	454
Components (including tuners and turntables)	319	313	306
Consoles and compact systems	125	138	148
Tape recorders and players	396	408	393
Home video equipment, total	1,163	1,253	1,335
Camcorders and cameras	128	206	269
Cassette players and recorders	1,035	1,047	1,066
Television receivers, total	1,773	1,831	1,860
Color	1,723	1,784	1,813
Monochrome	50	47	47
Other consumer electronic products, total	1,388	1,370	1,378
Calculators (personal and professional)	90	78	77
Electronic musical instruments	86	88	88
Electronic watches and clocks	376	388	403
Home computers (under $1,000)	611	497	441
Microwave ovens	225	319	369
Communications equipment, total	**5,123**	**5,484**	**5,586**
Data communications equipment	197	201	206
Facsimile terminals	120	188	231
Fiber-optic communications systems	63	141	250
Intercom systems	50	53	50
Navigation aids, except radar	38	47	52
Paging systems, public and private	47	50	53
Radar (air, land, and marine)	256	272	292
Radio, total	582	677	786
Broadcast equipment	102	120	131
Land mobile	208	245	386
Microwave	209	218	206
Satellite earth stations	63	94	63
Telecommunications equipment, total	3,570	3,635	3,427
Customer premise equipment	338	325	294
Telephone and data-switching, private (PABX)	904	935	984
Telephone and data-switching, public	844	969	938
Transmission and carrier equipment	1,484	1,406	1,211
Television equipment, total	200	220	239
Broadcast (studio) equipment	75	70	74
CCTV (educational, industrial, and medical)	125	150	165
EQUIPMENT, TOTAL	**30,362**	**32,419**	**34,086**

All figures in U.S. dollars.
The figures in this table, based on a survey made by Electronics in October and November 1987, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
Exchange rate: 1.60 marks to $1.

WEST GERMANY COMPONENTS

	1986	1987 (millions of dollars)	1988
Semiconductors, total	**2,161**	**2,005**	**2,094**
Discrete, total	528	483	493
Diodes, total	198	184	183
Microwave (above 1GHz)	10	9	10
Rectifiers and rectifier assemblies	108	100	104
Signal (less than 100 mA)	32	29	27
Varactor	11	10	11
Zener	37	36	31
Thyristors	98	93	96
Transistors, total	232	206	214
Bipolar, total	207	182	185
Power (1W or more)	107	94	96
Small-signal	100	88	89
Field effect	19	19	23
RF and microwave power (including GaAs)	6	5	6
Integrated circuits, total	1,633	1,522	1,601
Custom and semicustom, total	250	231	263
Custom (compiled, standard cell, hand-crafted)	125	109	129
Gate arrays	75	78	81
Programmable logic devices	50	44	53
Linear ICs, total	432	394	419
Communications (codecs, SLICs, etc.)	106	97	101
Consumer-product ICs	181	165	178
Interface (buffers, decoders, drivers, etc.)	54	51	55
Op amps (monolithic only)	56	50	52
Voltage references and regulators	33	29	31
Timers	2	2	2
Memories, total	262	288	307
Application-specific	6	6	7
Random access memory, total	162	185	194
Dynamic RAM	116	132	139
Static RAM	46	53	55
Read-only memory	94	97	106
Microprocessors and microcomputers	289	283	306
Standard logic families, total	400	326	306
Bipolar	256	213	200
CMOS	144	113	106
Hybrid and modular components, total	**159**	**163**	**166**

	1986	1987 (millions of dollars)	1988
Passive and mechanical, total	**3,529**	**3,513**	**3,577**
Capacitors, total	572	560	600
Fixed	555	544	584
Variable	17	16	16
Connectors, plugs, and sockets	906	875	875
Filters, networks, and delay lines	74	73	73
Loudspeakers (OEM)	138	141	142
Printed circuits and interconnection systems	813	837	845
Quartz crystals	69	71	72
Relays (for communications and electronics)	230	231	233
Resistors, total	236	237	234
Fixed	131	131	128
Potentiometers and trimmers	105	106	106
Switches and keyboards	225	219	222
Transformers, chokes, and coils	266	269	281
Tubes, total	**752**	**773**	**801**
Cathode-ray (except TV)	41	44	47
Image-sensing (including vidicon and orthicon)	49	51	52
Light-sensing (including photomultipliers)	11	12	13
Power tubes (including klystrons, magnetrons and traveling wave)	91	94	96
TV picture tubes, total	560	572	593
Color	550	563	585
Monochrome	10	9	8
Optoelectronic devices, total	**136**	**132**	**139**
Discrete light-emitting diodes	30	28	29
Imaging arrays (CCD, diode, transistor)	n/a	n/a	n/a
Laser diodes	2	3	3
Optically coupled isolators	27	25	27
Photoconductive cells (light-dependent resistors)	21	22	23
Photodiodes and phototransistors	23	21	23
Photovoltaic (solar) cells	5	5	5
Readouts (LCD, LED, fluorescent character displays)	28	28	29
COMPONENTS, TOTAL	**6,737**	**6,586**	**6,777**

All figures in current U.S. dollars. The figures in this table, based on a survey made by Electronics in October and November 1987, estimate noncaptive consumption of components, valued at factory prices for domestic products and landed cost for imported products. **Exchange rate: 1.60 marks to $1.**

including memories, will firm up a bit. ICs will keep replacing discretes, except for optoelectronic devices. As a result, the *Electronics* forecast for discretes is growth of only 2% to $493 million. Optoelectronic devices will move up 5% to $139 million.

In chips, the lustiest growth will come in application-specific integrated circuits. Peter Olfs, spokesman for technical activities at Siemens, sees worldwide sales of nonstandard ICs, including ASICs, rising by as much as 17% annually during the next few years; that compares with his forecast of 11% for standard ICs. ASIC growth in West Germany, he feels, will keep pace with that elsewhere in the world. Olfs' estimates are essentially in line with the *Electronics* forecast, which spots the market for custom and semicustom circuits, including ASICs, at $263 million. That's a rise of 14% over the $231 million market for 1987, a year that saw custom circuits decline by 8%.

ASICs, of course, replace standard logic packages in most instances, an impact that is reflected in the market. Despite the general turnaround for ICs, sales of standard logic will drop to $306 million, according to the survey. They were $400 million two years ago. The rise of ASICs, though, has not checked sales of microprocessors and microcomputers: they are forecast to bounce back 8% to $306 million after last year's 2% decline.

Though near-term growth prospects aren't that bright, Hein and other market analysts are optimistic about the future simply because, they say, equipment markets are destined to expand. "Long-term, the overall trend in IC sales is a 12% to 13% annual rise," says Hein.

As for passive components, they continue to plod along, hovering at a level around $3.5 billion and growing less than 2% a year. Despite the lackluster prospects, "We are not pushing the alarm button," says Klaus Wolf, managing director of the Electrical and Electronics Industry Association. Wolf notes that sagging prices caused the market drop last year; unit sales of parts increased. He expects prices will firm up a bit this year and put passives back on an upward trend.

Tubes will mark a modest advance: a gain of 4% to $801 million. Credit most of that rise to the demand for flat, square-corner picture tubes—more expensive than conventional picture tubes—by TV makers.

own with a 6.5% rise to $3.1 billion.

"Three years ago, people were saying mainframes were dead," says Mike O'Riordan, director of UK marketing for Unisys Ltd. "But they grew about 50% last year [for Unisys], and we should see growth of around 19% in 1988." Deregulation of financial houses, he explains, is forcing both small savings banks and large commercial banks to become more competitive by putting terminals into all their branches. That, and heavy activity in airline reservation systems, has been a salient factor in the strength of mainframes, he explains.

O'Riordan's optimism is echoed in a recent survey conducted by the Confederation of British Industries. The CBI says that 48% of the companies it polled in the computer sector reported that order levels were higher than the average for 1987. Moreover, 83% reported fuller export order books, and 62% said that the value of orders in hand was higher. Nevertheless, trade statistics released in mid-December indicate that for the first half of 1987, the balance of trade for the sector was in deficit by $613 million. Mark that up to the success of foreign brands by companies that don't produce hardware in the UK.

Communications has always represented a steady market in Britain, and it will continue its measured advance this year. The survey shows shows a 6.5%

UNITED KINGDOM EQUIPMENT

	(millions of dollars)		
	1986	1987	1988
Data processing and office equipment, total	**9,421**	**9,907**	**10,460**
Computer systems, total	5,799	6,217	6,680
Personal computers (under $5,000)	1,018	1,079	1,138
Microcomputers ($5,000 to $20,000)	648	759	820
Minicomputers ($20,000 to $100,000)	797	851	944
Superminicomputers ($100,000 to $400,000)	574	592	657
Mainframe computers ($400,000 to $5 million)	2,738	2,901	3,090
Supercomputers (over $1 million, with integral vector processor)	24	35	31
Data-input peripherals	157	167	178
Data-output peripherals	648	666	703
Data-storage subsystems	1,203	1,258	1,314
Data terminals	740	777	786
Electronic office equipment, total	874	822	799
Copiers	535	535	546
Electronic typewriters	213	204	194
Word-processing systems	126	83	59
Test and measuring instruments, total	**382**	**373**	**384**
Amplifiers, lab	2	2	2
Analog voltmeters, ammeters, and multimeters	15	15	14
Automatic test equipment, total	78	78	81
Discrete-component testers	4	4	4
IC testers	28	30	31
Pc-board testers	46	44	46
Calibrators and standards, active and passive	4	4	4
Counters, time and frequency	28	26	26
Digital multimeters (including accessories)	24	22	24
Logic analyzers	13	13	15
Microprocessor development systems	35	35	37
Microwave test and measuring instruments	20	19	20
Oscillators	5	5	5
Oscilloscopes	52	54	56
Recorders and plotters	39	39	41
Signal generators, total	43	37	33
Analog	22	17	13
Synthesized	21	20	20
Spectrum analyzers	24	24	26
Industrial electronic equipment, total	**1,105**	**1,185**	**1,300**
Inspection systems	7	8	8
Machine-tool controls (including numerical)	44	46	50
Motor controls	194	205	215
Process-control equipment (including computers, loggers, consoles)	723	770	836
Programmable controllers	100	115	148
Semiconductor production equipment	37	41	43
Power supplies (noncaptive), total	**133**	**134**	**139**
Bench and lab	15	13	15
Industrial (heavy duty)	31	31	33
OEM and modular, total	87	90	91
Linear	35	31	28
Switching	52	59	63

	(millions of dollars)		
	1986	1987	1988
CAD/CAE equipment, total	**122**	**204**	**294**
Consumer electronics, total	**4,633**	**4,695**	**4,790**
Audio equipment, total	1,276	1,338	1,398
Car audio	189	200	211
Compact disk players	148	200	250
Phonographs and radio-phonographs	191	185	185
Radios (including table, clock, and portable)	65	67	63
Radio/recorder combinations	194	198	202
Stereo equipment, total	315	309	302
Components (including tuners and turntables)	191	189	185
Consoles and compact systems	124	120	117
Tape recorders and players	174	179	185
Home video equipment, total	844	910	968
Camcorders and cameras	67	87	104
Cassette players and recorders	777	823	864
Television receivers, total	1,138	1,117	1,135
Color	1,101	1,082	1,104
Monochrome	37	35	31
Other consumer electronic products, total	1,375	1,330	1,289
Calculators (personal and professional)	68	68	68
Electronic musical instruments	85	87	89
Electronic watches and clocks	241	259	263
Home computers (under $1,000)	500	431	379
Microwave ovens	481	485	490
Communications equipment, total	**5,512**	**5,885**	**6,269**
Data communications equipment	148	176	196
Facsimile terminals	176	192	211
Fiber-optic communications systems	33	46	60
Intercom systems	24	26	28
Navigation aids, except radar	507	520	535
Paging systems, public and private	56	57	59
Radar (air, land, and marine)	1,049	1,073	1,104
Radio, total	832	942	1,036
Broadcast equipment	102	109	109
Land mobile	648	744	833
Microwave systems	56	59	61
Satellite earth stations	26	30	33
Telecommunications equipment, total	2,553	2,710	2,894
Customer premise equipment	370	392	413
Telephone and data-switching, private (PABX)	389	389	379
Telephone and data-switching, public	1,230	1,326	1,443
Transmission and carrier equipment	564	603	659
Television equipment, total	134	143	146
Broadcast (studio) equipment	93	100	102
CCTV (educational, industrial, and medical)	41	43	44
EQUIPMENT, TOTAL	**21,308**	**22,383**	**23,636**

All figures in current U.S. dollars.
The figures in this table, based on a survey made by Electronics in October and November, 1987, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
Exchange rate: $1.85 to 1 pound.

automate Italy's voting booths. Another would computerize the national lottery with thousands of point-of-sale terminals, and a third would automate all Italian deed-registry offices.

In the communications sector, as well, government action will mean the difference between so-so markets and solid ones. The survey forecasts a gain of 7% to $3.7 billion, slightly off last year's 8% rise. But the market could take a strong upward bound after 1988. If a proposed 20% increase in the current 10-year telecommunications plan goes through, switching-equipment makers will see their orders rise from this year's 1.3 million lines to 2.3 million lines a year. "Thirty percent of Italian households now have phones; the goal is to reach the same level as the UK—38%," says Claudio Pilati, a vice president at Italtel SpA, Milan, the leading Italian telecommunications producer. "It's practically all digital," he adds.

Tuning in on the consumer electronics sector, the survey foresees a market of $3.1 billion, up 6% over 1987. Saturation has set into the market mainstay, medium-size color-TV sets, and overall no gain is in sight. But "portables and sets with big, square screens should do well," says Mario Zappini, an official of the electronics trade association ANIE in Milan. Video-cassette recorders are still running strong, and sales of camcorders and compact-disk players will burgeon.

ITALY EQUIPMENT

(millions of dollars)	1986	1987	1988
Data processing and office equipment, total	**4,740**	**5,374**	**5,741**
Computer systems, total	2,889	3,286	3,601
Personal computers (under $5,000)	672	806	921
Microcomputers ($5,000 to $20,000)	258	289	318
Minicomputers ($20,000 to $100,000)	542	633	704
Superminicomputers ($100,000 to $400,000)	284	325	358
Mainframe computers ($400,000 to $5 million)	1,125	1,215	1,292
Supercomputers (over $1 million, with integral vector processor)	8	18	8
Data-input peripherals	61	67	73
Data-output peripherals	300	336	379
Data-storage subsystems	635	719	796
Data terminals	259	290	304
Electronic office equipment, total	596	676	588
Copiers	413	495	421
Electronic typewriters	154	164	154
Word-processing systems	29	17	13
Test and measuring instruments, total	**210**	**232**	**248**
Amplifiers, lab	2	2	2
Analog voltmeters, ammeters, and multimeters	7	7	6
Automatic test equipment, total	46	52	58
Discrete-component testers	2	2	2
IC testers	18	20	23
Pc-board testers	26	30	33
Calibrators and standards, active and passive	n/a	n/a	n/a
Counters, time and frequency	5	5	5
Digital multimeters (including accessories)	11	12	12
Logic analyzers	7	8	8
Microprocessor development systems	21	23	27
Microwave test and measuring instruments	28	32	35
Oscillators	2	2	2
Oscilloscopes	27	27	26
Recorders and plotters	21	23	25
Signal generators, total	15	17	17
Analog	8	9	9
Synthesized	7	8	8
Spectrum analyzers	18	22	25
Industrial electronic equipment, total	**1,224**	**1,356**	**1,481**
Inspection systems	17	18	20
Machine-tool controls (including numerical)	104	116	128
Motor controls	113	132	144
Process-control equipment (including computers, loggers, consoles)	917	1,004	1,094
Programmable controllers	57	66	72
Semiconductor production equipment	16	20	23
Power supplies (noncaptive), total	**65**	**71**	**76**
Bench and lab	5	5	5
Industrial (heavy duty)	18	20	22
OEM and modular, total	42	46	49
Linear	15	16	16
Switching	27	30	33

(millions of dollars)	1986	1987	1988
CAD/CAE equipment, total	**221**	**288**	**373**
Consumer electronics, total	**2,718**	**2,877**	**3,053**
Audio equipment, total	655	701	755
Car audio	138	142	142
Compact disk players	29	39	51
Phonographs and radio-phonographs	31	29	28
Radios (including table, clock, and portable)	54	54	54
Radio/recorder combinations	104	108	114
Stereo equipment, total	188	211	241
Components (including tuners and turntables)	121	128	134
Consoles and compact systems	67	83	107
Tape recorders and players	111	118	125
Home video equipment, total	289	412	534
Camcorders and cameras	43	54	96
Cassette players and recorders	246	358	338
Television receivers, total	1,052	1,052	1,047
Color	1,000	1,004	1,004
Monochrome	52	48	43
Other consumer electronic products, total	722	712	717
Calculators (personal and professional)	92	83	82
Electronic musical instruments	46	44	44
Electronic watches and clocks	271	267	273
Home computers (under $1,000)	270	265	258
Microwave ovens	43	53	60
Communications equipment, total	**3,218**	**3,472**	**3,723**
Data communications equipment	86	98	115
Facsimile terminals	42	61	69
Fiber-optic communications systems	n/a	n/a	n/a
Intercom systems	35	36	33
Navigation aids, except radar	149	163	179
Paging systems, public and private	6	4	4
Radar (air, land, and marine)	248	263	289
Radio, total	201	225	246
Broadcast equipment	18	21	25
Land mobile (mobile and base stations)	104	116	128
Microwave	79	88	93
Satellite earth stations	n/a	n/a	n/a
Telecommunications equipment, total	2,395	2,563	2,727
Customer premise equipment'	550	595	643
Telephone and data-switching, private (PABX)	262	288	302
Telephone and data-switching, public	1,291	1,372	1,457
Transmission and carrier equipment	292	308	325
Television equipment, total	56	59	61
Broadcast (studio) equipment	27	28	29
CCTV (educational, industrial, and medical)	29	31	32
EQUIPMENT, TOTAL	**12,396**	**13,670**	**14,695**

All figures in current U.S. dollars.
The figures in this table, based on a survey made by Electronics in October and November 1987, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
Exchange rate: 1,200 lire to $1.

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MILITARY/AEROSPACE NEWSLETTER

GaAs WAFER SUPPLIES COULD BE TIGHT IF DEMAND FOR CHIPS TAKES OFF

Suppliers of gallium arsenide wafers are struggling as demand for GaAs chips lags—and that could cause problems for the Defense Department's plans to boost GaAs chip output. "Right now, the [wafer] industry's dead," says Karl Lifshitz, president of GFI Advanced Technologies, a New York supplier of purified gallium. "There are a couple of people going under." But Mimic, the $500 million Pentagon program to boost yields for microwave and millimeter-wave integrated circuits, could ignite the GaAs market; some insiders predict that individual defense programs could require up to 200,000 chips a month [*Electronics*, Nov. 26, 1987, p. 122]. That's just 33% less than the 300,000 GaAs chips the entire U. S. industry produced in 1987, says one wafer supplier. But there's a downside to a sudden boost in demand. "If the government wanted 1 million devices this year, no one could supply them," he says. "There wouldn't be enough material." □

THE ARMY LOOKS AT SILICON SOLUTIONS FOR HIGH-DENSITY RAD-HARD SRAMs

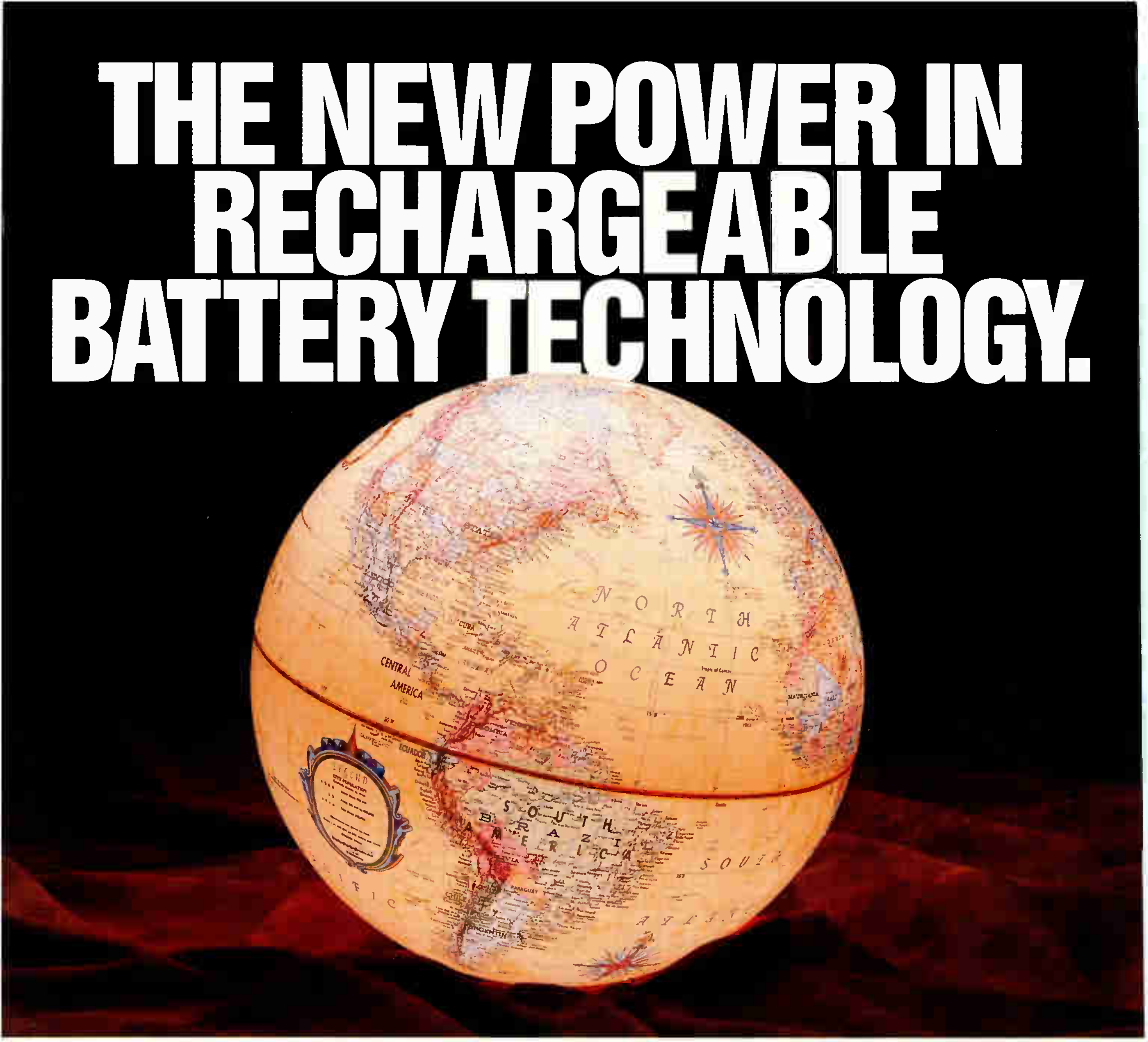
The Army Space Defense Command in Huntsville, Ala., wants high-density, radiation-hardened memory chips, and it's looking at three competing silicon technologies to get them. It's funding programs to develop 64- and 256-Kbit static random-access memories in bulk silicon, silicon-on-insulator, and silicon-on-sapphire technologies. The parts are needed for the satellites and missile interceptors that will be key to the Strategic Defense Initiative. A parallel effort in gallium arsenide is being handled by the Defense Advanced Research Projects Agency [*Electronics*, Jan. 7, 1987, p. 162]. Seven companies are battling it out in the silicon program. Honeywell and IBM are pursuing bulk silicon, Texas Instruments and Harris are studying silicon-on-insulator, and GM/Hughes Electronics, GE/RCA, and Westinghouse Electric are looking at silicon-on-sapphire. Each is pursuing either 64- or 256-Kbit densities, and TI is developing 64-Kbit "elements," using 1-μm lines, that it hopes eventually to combine on a single chip to create a 256-Kbit part. □

SDI RAILGUNS COULD ALSO LAUNCH SMALL SPACE PROBES

Scientists at the Jet Propulsion Laboratory in Pasadena, Calif., are proposing a novel scheme that would use railgun technology developed for the Strategic Defense Initiative to launch small scientific space probes. The plan is of interest because of a rising backlog of experiments caused by delays in NASA's Space Shuttle program. Advances in microelectronics have reduced the weight of the contents of conventional space probes from hundreds of pounds to less than 3 lbs. A 2.2-lb. spacecraft launched by an orbiting railgun would achieve an exit velocity of about 6 miles/s, scientists say, allowing it to travel the 750 million miles between Earth and Saturn in just two years. □

UNISYS MAKES THE TOKEN RING FAIL-SAFE FOR U. S. WARSHIPS

Unisys Corp. has developed an adapter for the Navy's shipboard token-ring local-area network that can reconfigure the network if vital links are broken. Called SafeNet I, for Survivable Adaptable Fiber Optic Network, it adds a second, counter-rotating ring to the primary token-passing ring. If the primary ring is broken, the secondary link takes over; if both are damaged, SafeNet I software will reconfigure the warship's net, pulling pieces of the rings together to maintain vital links. Unisys demonstrated the embedded redundant token ring, which uses special adapaters based on Texas Instruments Inc.'s TMS380 token-ring chips, last week in San Diego. A second-generation version, SafeNet II, will eventually add compatibility with the fiber distributed data interface standard. □



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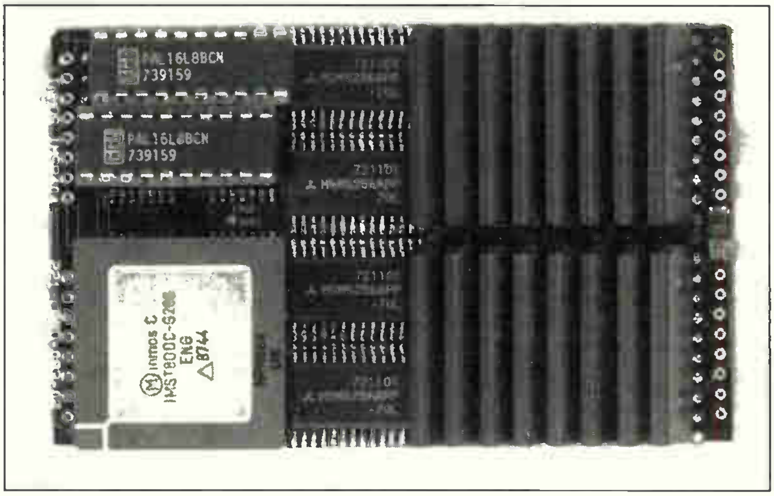
NEW PRODUCTS

CREDIT-CARD SIZE TRANSPUTER MODULES CAN TURN A PC INTO A SUPERMINI

INMOS LINE SNAPS TOGETHER INTO MORE THAN 100 CONFIGURATIONS

Building powerful multiprocessor computer systems that rival superminicomputer performance is becoming almost as easy as snapping together Lego building-block toys, with Inmos International plc's modular line of transputer-based boards.

The Bristol, UK, company's modules—as small as a credit card—boast microprocessors that deliver performance up to 4 million whetstones and memory capacities ranging up to 8 Mbytes. By stacking them together in mix-and-match fashion, designers can quickly fabricate a high-performance system that plugs into popular platforms such as Sun Microsystems Inc. work stations or IBM Corp. Personal Computers and compatibles.



MINI. Shown actual size, the B404 transputer module packs 128 Kbytes of fast SRAM, 2 Mbytes of DRAM, and an IMS T800 floating point transputer processor.

100 FLAVORS. "With this approach we can meet requests for up to 100 different board designs with only a few basic bare motherboards and a few module boards," says David Bye, field applications engineer for Inmos Corp.

The building blocks are well suited for imaging, graphics, industrial control, robotics, and military systems as turbo chargers for technical work stations, and other multiprocessor systems requiring tens to hundreds of processors.

Initially, Inmos is offering five modules and two motherboards. The two motherboards are the IMSB008, which is compatible with IBM's PC XT, and the IMSB012, which conforms to the double-extended Eurocard format.

The motherboards, which can be cascaded together to configure very powerful systems, have two roles. First, they provide an interface between the modular transputer array and the host computer. The other function is to create soft-wired transputer networks using the four communications links on each processor and the on-board link switches to dynamically wire the processors into a specific configuration—matrix, pipeline, or tree structures, for example.

The B008 contains 10 slots for the module boards. The B012 has 16 slots. An IMS T212A-G20S transputer is used as a control processor on both boards. One IMS C004 link switch is used on the B008 and two on the B0012.

The first five module boards are IMSB401, B402, B403, B404, and B405. The B401 is the smallest size available. It packs a T414B-G20S or T800C-G20S transputer and 32 Kbytes of static random-access memory and measures 3.66 in. by 1.05 in. The B402 has 8 Kbytes of SRAM and one T212A-G20S transputer and is the same size as the B401.

At 3.66 in. by 4.35 in., the B403 sports 1 Mbyte of dynamic RAM and either a T414B or T800C transputer. The B404 and B405 both come with T800C transputers and have 2 and 8 Mbytes of DRAM, respectively. The B404 is 3.66 in. by 2.15 in. The B405 measures 3.66 in. by 8.75 in.

All the modules have standard 16-pin dual-in-line edge plug and socket connectors with extra wide 3.5-in. pitch.

Available now, the modules range in price from $584 for the B402 module to $7,471 for the 8-Mbyte B405. The PC-compatible B008 motherboard costs $1,226 and the Eurocard-compatible B0012 costs $1,750. – *Tom Manuel*

Inmos Corp., 1110 Bayfield Dr., P. O. Box 16000, Colorado Springs, Colo. 80935. Phone (303) 630-4000 [Circle 340]

POWER SUPPLY REGULATES VOLTAGE 5 TIMES BETTER

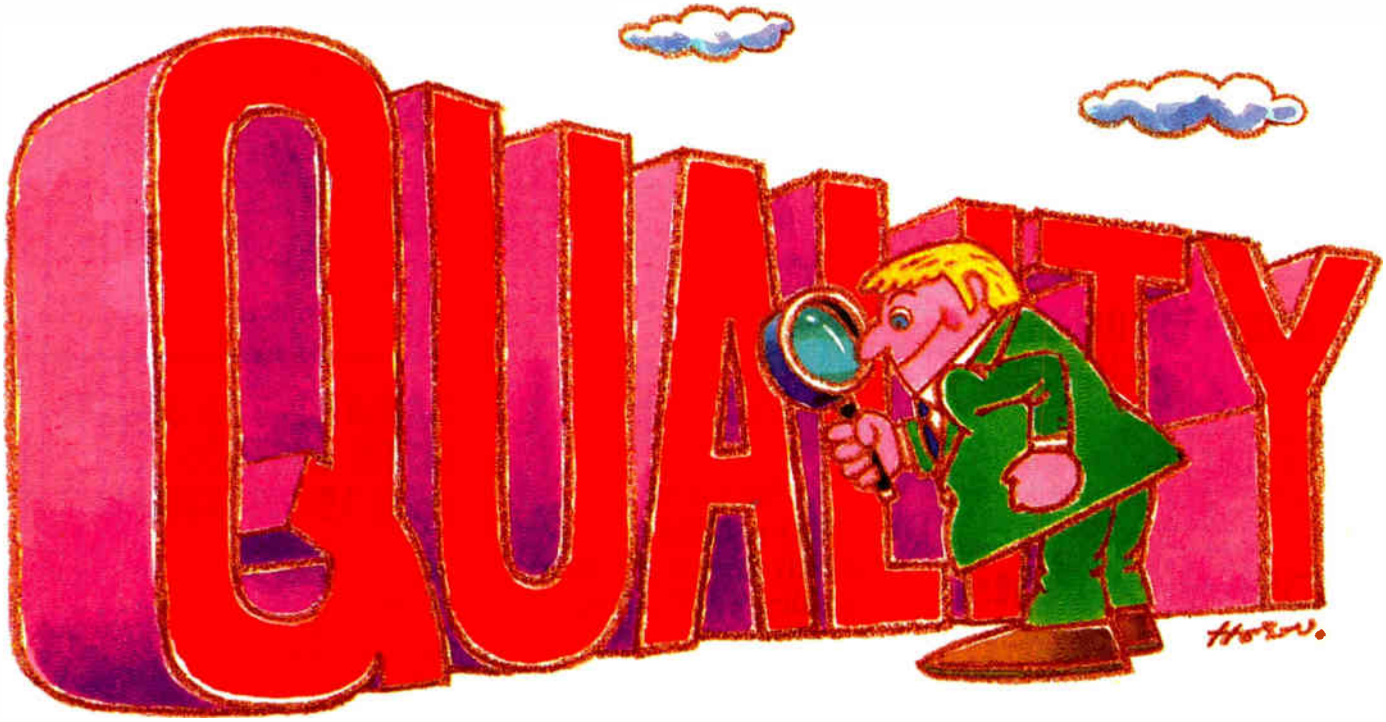
The current-sharing technique used by Computer Products Inc. in its new series of redundant power supplies guarantees 0.2% output voltage regulation during a single-point failure—compared to 1% regulation for major competitors.

The higher precision means designers get more reliability and enhanced data integrity for a wide variety of equipment that must be kept on line. Unlike techniques that depend on master/slave interactions to maintain current flow during failures, the Pompano Beach, Fla., company's method keeps each output power source independent. This forced current sharing is achieved in the 250- to 600- W Switching Power Supply Series by a closed-loop circuit controlled by a high-gain amplifier that disconnects the failed output.

Up to seven outputs, all with the same power rating and all tied to the same computer power bus, are available, says Rex Vacca, Computer Products product manager.

The series targets applications in which high reliability and minimum sys-

More than just a word...



If one word could describe the corporate philosophy of Graphtec, that word would be quality. From the preliminary design through to final delivery, we know that the key to success is in making equipment that works, perfectly. At every stage, components are rigorously tested, performance is carefully scrutinized and any parts less than perfect are rejected. Why do we go to the trouble? Quite simply, because our reputation is on the line with every product you buy.

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Of course, the real proof is in our products. Three superb new devices just released should convince you that investing in Graphtec is a wise decision. Call your dealer and see for yourself the sophisticated MS5100 Data Analyzer, the PD9111 Large Format Plotter and the KD3300 Digitizer.

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speed grades of 70, 80, 100, and 120 ns. Both versions are available in 16-pin plastic dual in-line packages and surface-mountable 18-pin plastic leaded chip carriers. Vitelic is also offering the chips in a 16-pin ZIP, which doubles the chips's packing density.

In 100-piece quantities, the 70-ns parts sells for $7.87 each. The 100-ns parts cost $5.66 each. The low-power versions cost $8.78 for 70-ns speeds and $6.24 each for 100-ns parts. Pricing is for 100-piece orders. – *J. Robert Lineback*

Vitelic Corp., 3910 N. First St., San Jose, Calif. 95134.
Phone (408) 433-6000 [Circle 360]

SARATOGA'S SRAM USES BICMOS FOR 15-NS SPEED

Saratoga Semiconductor Corp. has introduced biCMOS technology to the world of application-oriented static random-access memories with a 16-Kbit cache-tag RAM that boasts a top address-to-compare access speed of 15 ns.

Saratoga's SSL4180, a 22-pin, 4-K-by-4-bit tag RAM, and SSL4181, a similar part that has open-drain-match outputs in place of the 4180's totem pole outputs, are at least 5 ns faster than competing all-CMOS 4-K-by-4-bit parts, says Dan Scovel, product marketing engineer.

Saratoga's biCMOS, called Sabic-II for Self-Aligned Bipolar CMOS, is a 1.5-μm technology, which is used to integrate a 16-K array and 4-bit comparator. The tag RAM's die measures 145 by 158 mils. The Cupertino, Calif., firm will also use the same process to introduce a second 16-Kbit tag RAM, organized as 2-K-by-9-bit, by midyear.

Samples of the 4-K-by-4-bit cache-tag parts, with address-to-compare times of 15, 20, 25, and 35 ns, will be available this month. The biCMOS design also offers data-to-compare access times of 12.5, 15, or 20 ns.

The 4180 and 4181 are TTL-compatible with +5-V power supply. They feature a flash-clear function and can be used together to expand word widths. The maximum power dissipation for the memory parts is expected to be 560 mW.

In 1,000-piece orders, the 15-ns tag RAMs cost $31.50 each in 22-pin plastic dual in-line packages. In similar quantities, the 20-ns speed grade costs $27.50 each, 25-ns chips $24.50, and 35-ns tags $21.50. Deliveries of volume shipments start in April. – *J. Robert Lineback*

Saratoga Semiconductor Corp., 10500 Ridgeview Ct., Cupertino, Calif. 95014.
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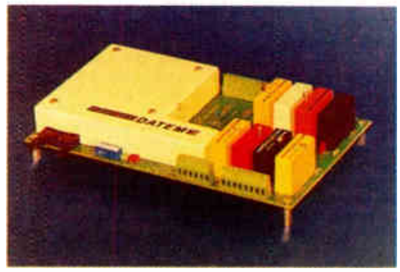

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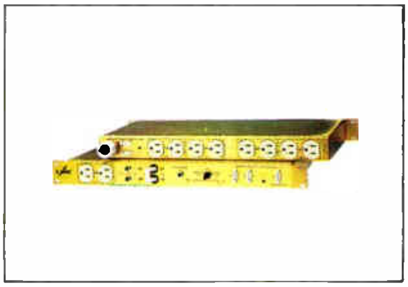

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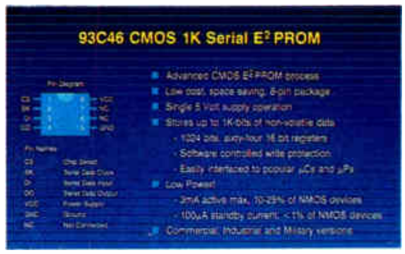

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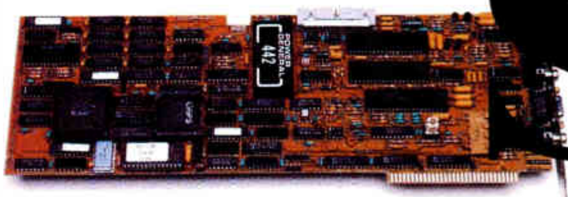

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