A McGRAW-HILL PUBLICATION

THREE DOLLARS

# Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY

JANUARY 13, 1986

# OVERSEAS MARKETS: GOOD, BUT NOT GREAT

**GROWTH RATES WILL HOLD STEADY IN TOP 5 NATIONS**

PAGE 27

**HOW TECHNOLOGY IS CUTTING FAULT-TOLERANCE COSTS/55**

**GaAs STARTUPS THRIVE IN NEW JERSEY, OF ALL PLACES/62**


*"We did it!"*

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

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

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

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

*"You can't build a system out of data sheets and promises. National had it, they delivered it, and they got us here first."*

# While you're still dreaming about success, Sequent is delivering it. With National's Series 32000 family.

On January 17, 1983, eighteen people started a new company called Sequent Computer Systems. They had no product, no plan, no backing. Only a dream.

Two years later, that dream came true. They delivered their first system—a sophisticated parallel processing computer. A full year ahead of their competitors.

How'd they do it? Hard work. Calculated risks. Belief. And a critical decision. They chose the Series 32000™ microprocessor family.

It offered them a *complete* 32-bit microprocessor family, including demand paged virtual Memory Management, Floating Point, and other peripherals with full UNIX™ support.

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Sequent hit their window of opportunity. And that window is still open—for now. So find out how the Series 32000 can help you build your own success story. Contact National Semiconductor today.

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P.O. Box 58090
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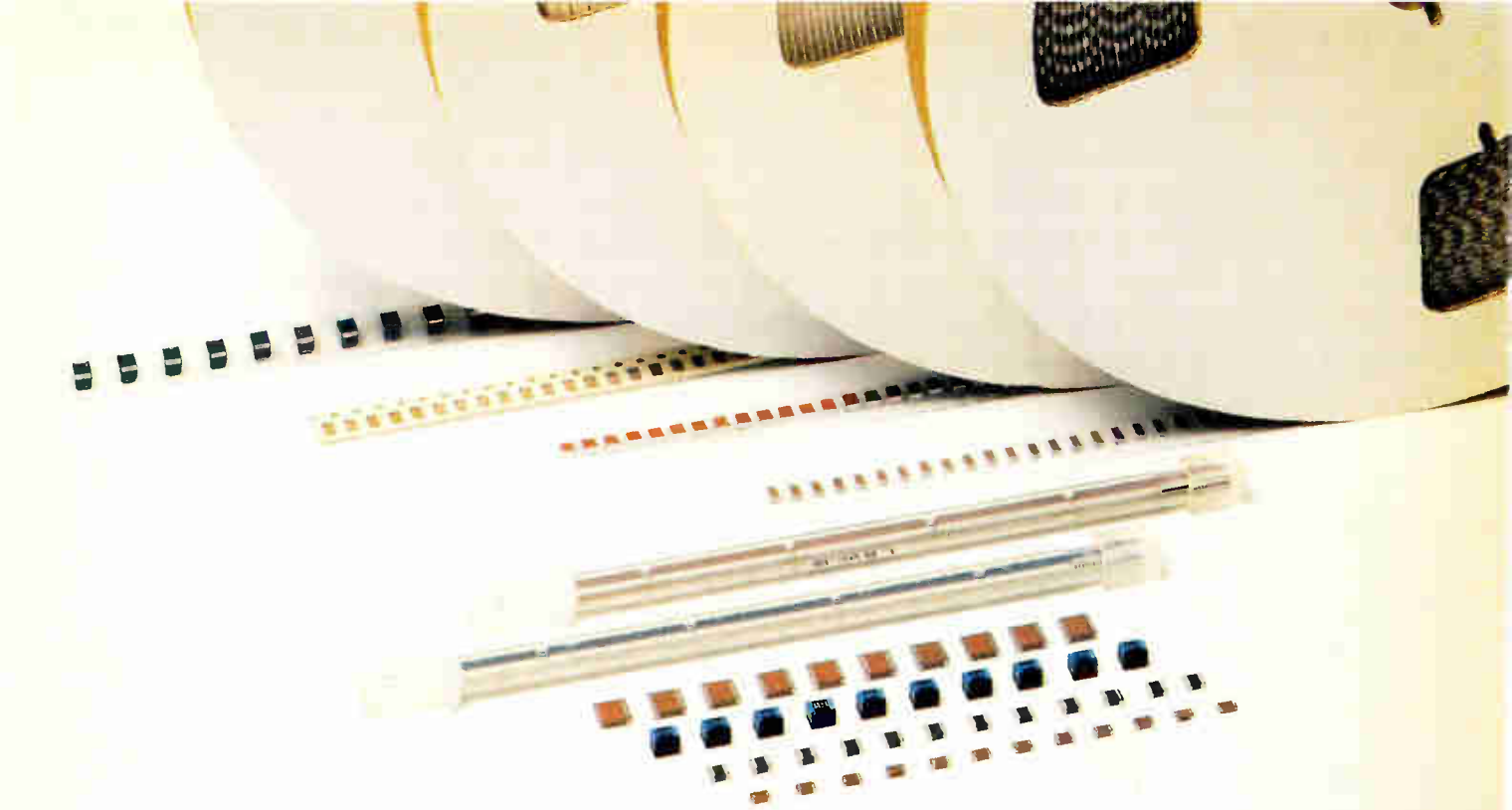
National Semiconductor
We're doing it.

Circle 1 on reader service card



# Be Sure Your Chips Come Off The Right Block.

## TDK Chip Components.

With any automated production process only as good as the parts it works with, be sure to make reliability your top priority when choosing chip components for automatic PCB production. Chip Components from TDK.

Placed at strategic locations on your PCB's TDK Microbeads provide efficient noise suppression in sensitive circuits. Decades of experience in ferrite materials have been combined with advanced design technology to bring you, for the first time, auto-mountable chip type microbeads.

In Leadless Inductors, TDK has been occupying a position of technological and market leadership for a number of years.

Famous for their extremely compact dimensions, constant quality levels and accurate adherence to spec's, TDK Leadless Inductors with their wide range of available inductances and ratings have been instrumental in permitting extremely high circuit board densities and flexible automation.

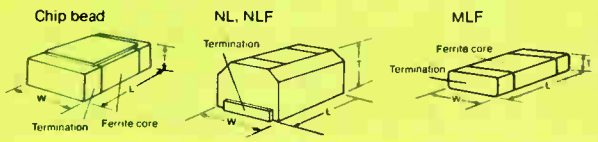
TDK Ceramic Chip Capacitors utilize multilayer techniques in extremely compact dimensions, enabling space saving board design while maintaining narrow tolerances.

Tape or magazine packaging is available for all TDK chip components for an optimum match to your production facilities. But whatever the package, three reassuring letters will be printed on it at no extra charge.

**Ferrite Chip Inductors**

| Type | Chip beads | Leadless inductors NL | NLF (shielded) | MLF (shielded) |
|---|---|---|---|---|
| 2.0×1.2×0.9 | Zo: 5–9Ω at 100MHz | | | |
| 3.2×1.6×0.6 | | | | L: 0.1–1.2μH |
| 3.2×1.6×1.1 | Zo: 14–26Ω at 100MHz | | | L: 0.39–27μH |
| 3.2×2.5×1.1 | | | | L: 12–56μH |
| 3.2×2.5×1.3 | Zo: 37–77Ω at 100MHz | | | |
| 3.2×2.5×2.2 | | L: 0.12–100μH | | |
| 3.2×2.5×2.5 | | | | L: 68–220μH |
| 4.5×3.2×1.5 | Zo: 55–130Ω at 100MHz | | | |
| 4.5×3.2×3.2 | | L: 1–1,000μH | L: 1–1,000μH | |
| 4.5×3.5×3.2 | | | L: 1–1,000μH | |

Dimensions, L×W×T (mm)




**Ceramic Chip Capacitors (Typical)**

| Type | Class I CH | PH | RH | SH | TH | UJ | SL | Class II 50V, 25V |
|---|---|---|---|---|---|---|---|---|
| 3.2×1.6 | 0.5–680pF | 0.5–820pF | 0.5–1,000pF | 0.5–1,200pF | 0.5–1,200pF | 0.5–1,000pF | 0.5–1,800pF | 1,000–12,000pF / 12,000–220,000pF |
| 2.0×1.25 | 0.5–430pF | 0.5–560pF | 0.5–680pF | 0.5–750pF | 0.5–820pF | 0.5–1,000pF | 0.5–1,800pF | 470–6,800pF / 47,000–100,000pF |

Dimensions, L×W (mm)

**Ferrite Micro Inductors (Typical inductance value)**

| Type | OL |
|---|---|
| 3.3×1.6(mm) | L: 8mH at 1kHz |
| 3.3×2.1 | L: 18mH, 25mH, 35mH at 1kHz |
| 4.0×2.0 | L: 25mH (Rdc: 60Ω) at 1kHz |

Dimensions, A×B (mm)

TDK®

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Circle 2 on reader service card

JANUARY 13, 1986 VOLUME 59, NO. 2

# Electronics

## NEWS



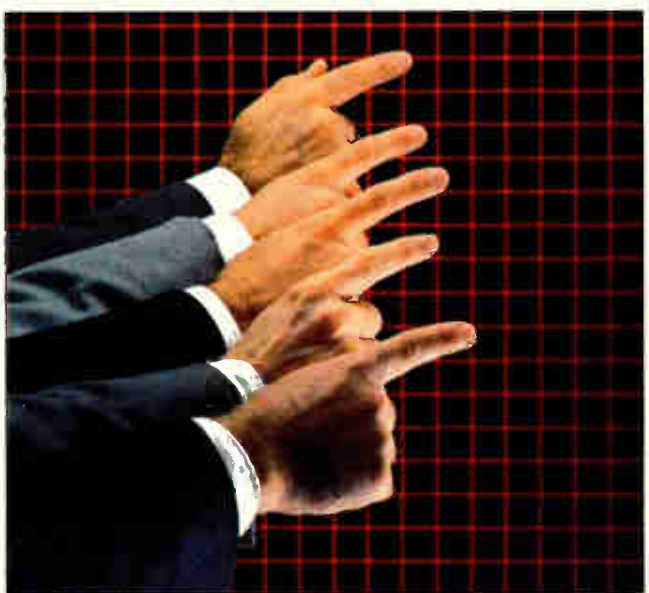
## INSIDE TECHNOLOGY



## PROBING THE NEWS



## COVER




*Cover photograph by Nava Benjamini*

## NEW PRODUCTS

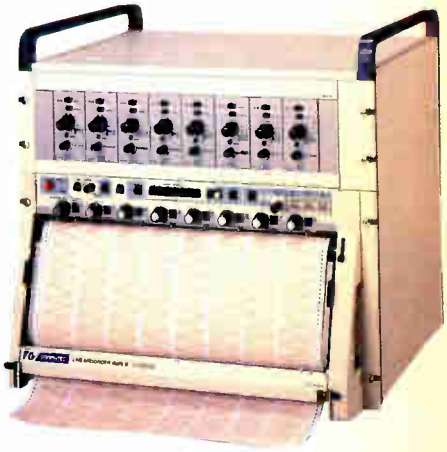


## DEPARTMENTS

# Express Yourself Graphically.

## Recorders

Linearcorders, miniwriters, multicorders, servocorders, X-Y recorders – and now multi-function hybrid recorders.

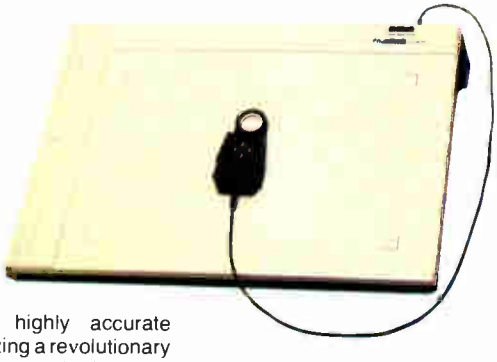


**MH9010**
18 channel intelligent recorder combining analog and digital techniques.
Simple interactive setting of measurement conditions.

**WR3500**
Vertical-type 19 inch rackmount thermal writing pen oscillograph (0~150 Hz). GPIB (IEEE-488) or RS232-C control functions, automatic annotation of data, 9 print heads.

## Input devices

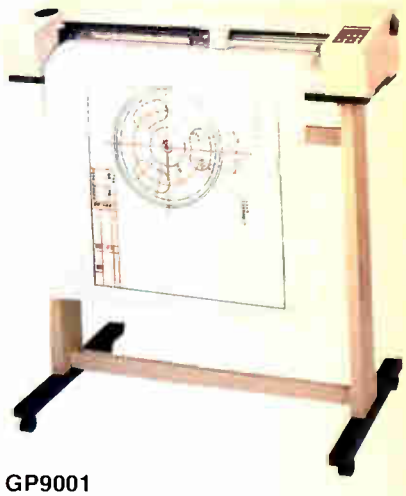
CAD/CAM, architecture, medical, marketing – our KD series of digitizers will meet all your application needs.



**KD4030A**
Compact, lightweight, highly accurate (±0.5 mm) digitizer utilizing a revolutionary electromagnetic digitizing method. It converts graphic information of up to A3 size into digital information suitable for input to a computer.

## Output devices

Flat-bed, drum and hybrid pinch roller types – a lineup ranging from large-format plotters with intelligent functions to compact desktop models.



**MP2000**
A3 size, high-speed intelligent X-Y plotter. 2-port interface, 3 switch-selectable command sets.

**GP9001**
A0~A3 size, high-speed pinch roller plotter utilizing simple plotting commands. Choice of water based fiber-tip, ball-point or ceramic-tip pens.

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**VET.** Erikson has spent 18 years abroad.

One of *Electronics'* strengths is our worldwide system of news bureaus, and nowhere is that more evident than in this week's overseas market report, the 24-page survey that begins on p. 27.

As with last week's domestic report, the compilation of figures and overviews began months ago with questionnaires. The overseas survey was handled by our four foreign bureaus in London, Paris, Frankfurt, and Tokyo. Then the bureau managers followed up with interviews of key company personnel.

Yeoman work on those surveys and interviews was done by Kevin Smith in London, Robert Gallagher in Paris, John Gosch in Frankfurt, and our three men in Tokyo: bureau chief Charlie Cohen, Mike Berger, and Jon Joseph.

Like all such journalistic projects, this effort required a support team of skilled and knowledgeable editors. One of the strong guiding hands of that team was executive news editor Arthur Erikson, who is an old European hand. Before returning to New York four years ago to assume his present post, Art served in Paris as our bureau chief and ran our international news operations. Before that, he worked three years in New York as international editor. All in all, Art spent 12 years in Paris for *Electronics* plus another 6 in Paris and Brussels for McGraw-Hill World News after working on a variety of newspapers and magazines and serving in the Navy.

Art's intimate knowledge of the European picture and his years of experience in handling market report data were invaluable as he spotted inconsistencies and served as the final authority in many cases. He proved, for the umpteenth time, that there is no substitute for experience.

**Also on the job** in New York as mainstays of the backup team were associate managing editor Ben Mason, who put in long hours in the office over the Christmas-New Year's holiday and made sure that the whole project stayed on schedule, and copy chief Susan Levi Wallach, who with her four copy editors kept the words flowing and the figures straight. And, as with the domestic report, Howard Bierman served as an editorial consultant.

We're proud of these people and all the others who helped, and equally proud of the results of their labor.


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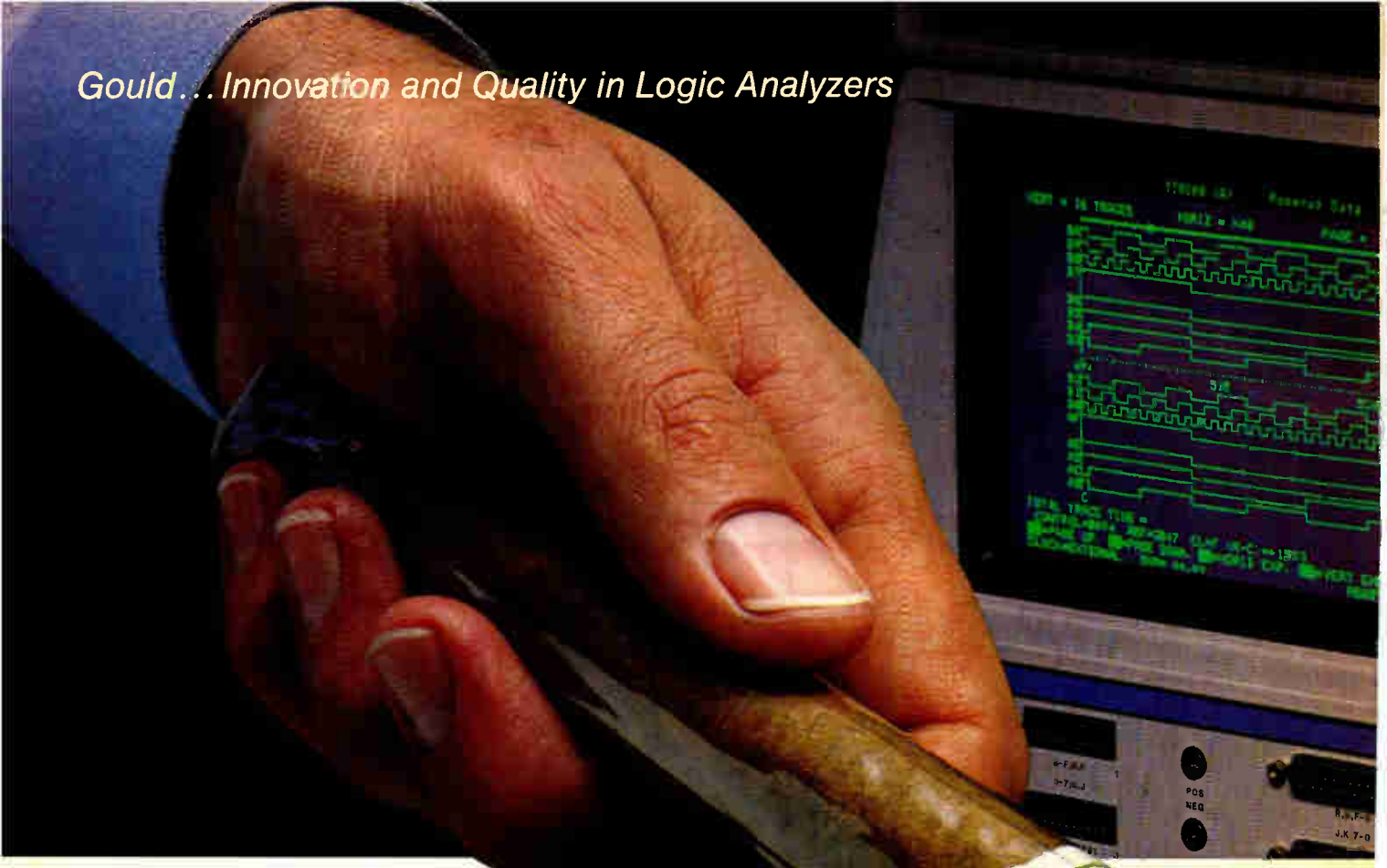


# Gould proudly announces six new additions to its family.

A proud lineage continues.

Gould knew a good thing when they saw Biomation and its precedent-setting K100 logic analyzer. We've built on that heritage to bring you the industry's most comprehensive line of logic analyzers.

One Gould Logic Analyzer is exactly the right tool for the job you're doing. Why pay for more analyzer than you need? Or settle for too little? Also, you can trade up for more sophistication without trading away ease of use.

And now, six new models extend and enhance our line.

The new K20 and K40 make Gould performance affordable for service and repair applications, as well as jobs where portability is important.

The new K115 and K450 models set new performance standards. The K115 may well be the best $\mu$P logic analyzer around. And the K450 has all high-speed channels for complex multi-$\mu$P and VLSI problems.

The new K125 may look plain, but it's a beauty below the surface. Handles up to 80 channels per mainframe. It makes CAE/CAD faster, more productive and leverages your engineering investment into ATE production.

And yes, there is a doctor in the house - the PG110. It checks up on our logic analyzer family - including the well-known K100/T12, K105, K205 and K500 units - to keep them up and running.

For details on Gould's New Generation in Logic Analyzers, call *TOLL-FREE (800) 538-9320, in Calif. (800) 662-9231.* Or simply write: Gould Inc., Design & Test Systems, 19050 Pruneridge Ave., Cupertino, CA 95014. Because a family that stays together pays.

***The New Generation in Logic Analyzers***

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**NEW K450.** All high-speed channels: f0ns resolution across 48 channels at 100 MHz or 5ns across 24 channels at 200 MHz. 5ns glitch capture on all channels with no loss of memory. 4K memory depth. Unique Auto Save for saving failures in unattended mode.


**NEW K115.** "The μP analyzer." Up to 72 channels for state/timing, 200 MHz on up to 8 channels. All key software/hardware integration tools, noise margin analysis, tolerance compare. Trace Control. Multi-level "Help." Disassemblers for all popular μPs, incl. 68020.


**NEW PG110.** Pattern generator has 96 data channels with 1.5ns data skew. Built-in patterns for ease of use.


**NEW K20.** Low cost. Weighs only 9 lbs. 8-ch. timing analysis. 24-ch. software debug. 3-level triggering. "Help" key. Easy to use.


**NEW K40.** 32-ch. software or timing analysis. 4-level triggering. Setup/compare memories. Plus μP option.


**NEW K125.** Use with CAE/CAD/ATE. 80-ch. capacity up to 200 MHz. ATE software packages, IBM PC controlled. Expand with multiple mainframes.

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*MEETINGS*

## UNIX USERS BEEF UP THEIR MEETING

UniForum, the international conference for users of AT&T Bell Laboratories' Unix operating system, is beefing up its technical sessions this year. A recurring theme will be Unix's role in connecting applications and hardware, with papers on compiler portability for minicomputers and microcomputers, adaptation of Unix to parallel multicomputing, and document-interchange architecture on a Unix system.

"People last year told us technical sessions were too lightweight, that there was too much commercialism," says Lizabeth Reilly, UniForum program chairman and executive director of /usr/group, the Unix users' group that sponsors the show.

New this year is a technical review team of eight engineers, which chose 18 papers from 51 technical abstracts; team members will moderate the six technical sessions. "Most of the papers are research-oriented," Reilly says.

A presentation on reduced-instruction-set computers and Unix should be a major draw. "Almost all RISC computers use Unix," declares Bruce Weiner, founder and president of /usr/group and president of MindCraft Inc., a Unix software company. John Mashey, an expert on RISC research and manager of operating systems for Mips Computer Systems Inc., will deliver the paper.

Whether RISC architecture is here to stay will be discussed in one of UniForum's 19 panel sessions, which focus on marketing. The show also has 15 tutorials and 9 workshops. About 200 vendors will exhibit Unix-related products. Attendance has ballooned from 300 at the first exhibit in 1981 to 15,000 last year.

**Aerospace Applications Conference,** IEEE (Warren Schwarzmann, TRW Inc., 4 Aurora Dr., Rolling Hills Estates, Calif. 90274), Four Seasons Lodge, Steamboat Springs, Colo., Feb. 1-8.

**Power Engineering Society Winter Meeting,** IEEE (J. G. Derse, 1030 Country Club Rd., Bedminster, N. J. 07921), New York Penta Hotel, New York, Feb. 2-7.

**3rd Automated Manufacturing Conference,** Frost & Sullivan Inc. (106 Fulton St., New York, N. Y. 10038-2786), Don CeSar Hotel, St. Petersburg Beach, Fla., Feb. 3-4.

**WTS 86:** World Telecommunications Showcase, U. S. Telephone Association (1801 K St. N. W., Washington, D. C. 20006), Dallas Convention Center, Dallas, Feb. 3-5.

**ATI '86:** 7th Annual Symposium on Automation Technology, CAD/CAM, and Engineering Data Handling, Automation Technology Institute Inc. (Jeff Smith, ATI, P. O. Box 242, Pebble Beach, Calif. 93953), Monterey Conference Center, Monterey, Calif., Feb. 3-7.

**UniForum,** /usr/group (4655 Old Ironsides Dr., Suite 200, Santa Clara, Calif. 95054), Anaheim Convention Center, Anaheim, Calif., Feb. 4-7.

**ICCA-7:** 7th International Conference on Assembly Automation, IFS (Conferences) Ltd. (35-39 High St., Kempston, Bedford MK42 7BT, UK), Zurich Fairgrounds, Zurich, Switzerland, Feb. 4-6.

**Backplane Bus Standards,** Buttersworth Scientific Ltd. (P. O. Box 63, Westbury House, Bury St., Guildford, Surrey GU2 5BH, UK), Forum Hotel, London, Feb. 5-6.

**International Conference on Data Engineering,** IEEE Computer Society (1730 Massachusetts Ave. N. W., Washington, D. C. 20036-1903), Bonaventure Hotel, Los Angeles, Feb. 5-7.

**Regicon:** Regional Conference on Electromagnetic Compatibility, IEEE (Larry Caney, 5340 Alla Rd., Los Angeles, Calif. 90066), Grand Hotel, Anaheim, Calif., Feb. 6.

**Electronic Printing Systems,** Dunn Technology Inc. (1855 E. Vista Way, Vista, Calif. 92083), Hilton Riviera, Palm Springs, Calif., Feb. 9-13.

**Orlando Manufacturing Productivity Conference & Exposition,** Society of Manufacturing Engineers (SME, 1 SME Dr., Dearborn, Mich. 48121), Orlando Expo Centre, Orlando, Fla., Feb. 11-13.

**BOCA IV,** Information Industry Association (316 Pennsylvania Ave. S. E., Suite 400, Washington, D. C. 20003), Boca Raton Hotel and Club, Boca Raton, Fla., Feb. 12-15.

**IEEE Annual Meeting,** IEEE (IEEE Annual Meeting Dept., 10th floor, 345 E. 47th St., New York, N. Y. 10017-2394), Red Lion Inn, San Jose, Calif., Feb. 18-19.

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

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

# When can a major upturn be expected?

# How much is Japan increasing capacity?

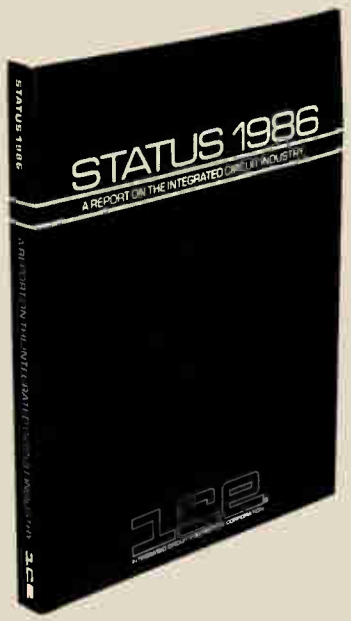
# Will U.S. manufacturers lose more marketshare to Japan?

# Where do we go from here?

## STATUS 1986

**A Report on the Integrated Circuit Industry**

**These critical issues are addressed in the 20th annual STATUS 1986 publication presented by the leading consultancy in the electronics industry.**

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# WEEK 12

No, it's not a foot-long DIP. It's really a convenient package for building 80286 designs. Our new 80286 kit.

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**80286/82C288/82284**

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Circle 151 on reader service card

# WEEK 13

Here are just the prescriptions for diagnosing problems in complex pipeline systems: our new 4K x 4 Am27S85A, 2K x 4 Am27S75A, and 1K x 4 Am27S65A Registered Bipolar PROMs.

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**Am27S85A/75A/65A**

## Quick cure.

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It's one reason why these PROMs are a quick cure. Here's another.

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Diagnostic simplicity, speed or both.

Any way you look at it, this is one cure that's easy to swallow.

Circle 152 on reader service card

# WEEK 14

Now there's no reason for military systems to burn one more milliwatt than they have to. Not when you can design them using the military versions of our high-speed, power-saving CMOS SRAMs, the Am99C68 and Am99C88.

Our 4K x 4 Am99C68, for example, is perfect for eliminating waste in high-performance applications like sonar, radar and ECM systems.

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

**Am99C68/Am99C88**

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

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

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

Circle 153 on reader service card

# WEEK 15

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

**Am3500 Family**

**Wrong number.**

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

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

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

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# TECHNOLOGY NEWSLETTER

## AIR FORCE HAS 40,000-PORT NETWORK IN THE WORKS

One of the largest networks ever will be built over the next five years for the Air Force by TRW Inc.'s new Information Networks Division in Torrance, Calif. Eventually it will connect up to 40,000 ports. The network will link five nationwide USAF Logistics Command sites with data, video, and voice service. An initial contract for $6 million, whose total value could reach $16 million as growth options are exercised, covers immediate requirements for about 10,000 ports of asynchronous network interface units as well as a number of IBM Corp. bisynchronous and synchronous interfaces, says the company. Commercial-grade network products will be used. □

## SUN ADDS TWO LARGE-COMPUTER MAKERS TO GROWING INTERFACE TEAM

Work-station manufacturer Sun Microsystems Inc. aims to add 64-bit interfaces to its rapidly growing hierarchical Network File System. Sun has teamed up in separate deals with Alliant Computer Systems Corp. and Convex Computer Corp.—two competing minisupercomputer makers—to develop computational servers and interactive graphics interfaces that will become a standard part of NFS. Sun, of Mountain View, Calif., introduced NFS a year ago as an open system for transparent distributed files on local-area networks. At the UniForum meeting next month in Anaheim, Calif., Sun plans to demonstrate an NFS network with equipment from a dozen hardware suppliers and programs from several software companies. It says nearly 20 hardware vendors now support NFS. □

## A BAG OF TECHNICAL TRICKS RESULTS IN SMALLEST CAMCORDER

Victor Co. of Japan has used a bag of technical tricks to come up with a VHS camcorder that it bills as the world's smallest and lightest of any format with playback capability. The aim is to blunt the market penetration of new-generation 8-mm camcorders and extend the life of the industry-standard ½-in. VHS format. JVC's VHS VideoMovie weighs 3½ lb and measures 4.8 by 6.5 by 8.8 in. It features the company's compact tape cassette and operates in 20- and 60-min modes. JVC eliminated the pickup tube used in its earlier products in favor of an NEC Corp. ½-in. charge-coupled-device pickup with complementary color filters. This CCD is even smaller than the 2/3-in. part used in Sony Corp.'s two 8-mm camcorders—one a record-only unit that is smaller than the JVC unit and one with playback that is larger. The CCD's size and sensitivity allowed JVC to reduce the size and weight of the lens. Further slimming down came from thinner printed-circuit boards and die-cast parts and the use of flatpack integrated circuits, hybrid ICs, and chip passive components. The system still includes such features as power zoom and image-sensing auto focus. □

## DELCO GOES ALL OUT TO CUT ELECTROSTATIC AND STRESS DAMAGE TO ICs

General Motors Corp.'s Delco Electronics Division is stepping up efforts to combat damage to integrated circuits from electrostatic discharge and electrical overstress during manufacturing and assembly. It has found that ESD and overstress account for 40% of all failures in Delco on-board computers and 44% of the failures in its radios. The number of ICs in products made at Delco's Kokomo, Ind., plant has jumped 500% since 1980, and as feature geometries shrink, the devices become increasingly susceptible to damage from ESD. In stepping up its efforts to fight the problems, which Delco says can cost it up to $22 million for a given model year, the company is adopting techniques for ESD-resistant product design and is training employees in proper handling techniques. □

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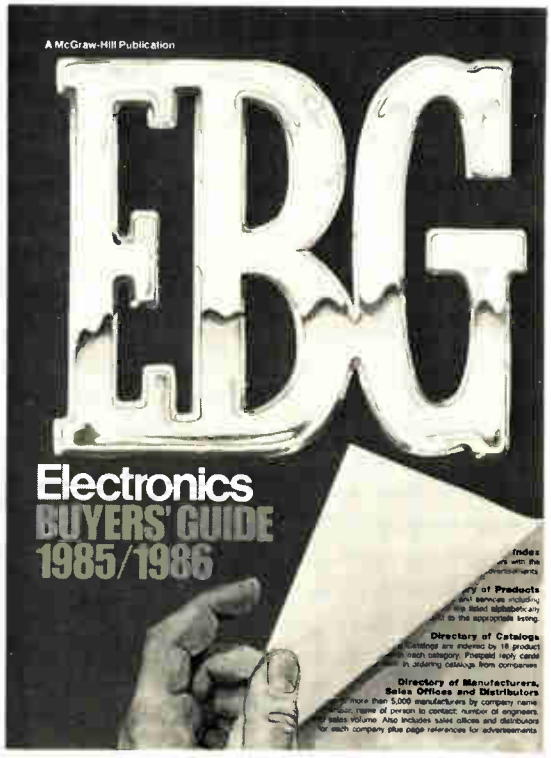


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# ELECTRONICS NEWSLETTER

## TWO MORE JAPANESE GIANTS WILL MAKE HARD-DISK DRIVES IN THE U. S.

NEC Corp. and Fujitsu Ltd. expect to start producing hard-disk drives in the U. S. as part of Japan's efforts to reduce exports to the U. S. and ease trade friction between the two countries. These moves parallel the plans of Hitachi Ltd., which will build hard-disk drives in Norman, Okla. [*Electronics*, Dec. 16, 1985, p. 88]. NEC Information Systems plans to expand its Boxborough, Mass., plant beginning in April and to start drive production the following year. Last year NEC exported 350,000 hard-disk drives from Japan, 50% to 60% of them to the U. S. Fujitsu's plans may even include the export of drives from the U. S. to Japan. The drives will be manufactured at a $40 million plant scheduled to start operating in Portland, Ore., in April. □

## EAST GERMANY TO MORE THAN DOUBLE ITS COMPUTER PRODUCTION

Data-processing equipment will play a major role in East Germany's drive to attain the highest 1986 growth rate of any Eastern European socialist country—a 4.4% rise in gross national product is the target. According to West German sources, output of office and personal computers for both export and domestic consumption is scheduled to jump 133%, from 7,500 units in 1985 to 17,500 this year. Further, roughly 125 large computers, 330 medium-sized systems, and 500 computer-based work stations are targeted for 1986, also substantially more than the 1985 output. East Germany also wants to raise productivity by 8.1% in 1986 by making greater use of data processing. Last year's plan called for a productivity increase of 7.1%. □

## EVER-GAME XEROX MAKES ANOTHER PLAY IN OFFICE AUTOMATION

Xerox Corp. is seeking once again to make it big in office computing, this time by capitalizing on its strengths in printers and publishing systems. Included in the new offerings is a 1-Mb/s network that links MS-DOS-based personal computers over standard twisted-pair telephone wire. In the past, Xerox has championed the much faster—and much more expensive—Ethernet for office communications, a system it still supports. Xerox has made several largely unsuccessful forays into the office hardware business. Now it is capitalizing on one office area in which it has won its spurs: electronic publishing. Among the products it is introducing are a series of work stations and printer systems and an electronic-publishing terminal setup. □

## CDROM SOFTWARE/PLAYER COMBO TO GET MAJOR MARKET TEST

Two companies will soon launch the first major market test of a compact-disk read-only-memory (CDROM) player and associated software. Grolier Inc. says its product, including its 9-million-word Electronic Encyclopedia [*Electronics*, Sept. 16, 1985, p. 26], will be marketed through computer dealers for a suggested retail price of $1,495. And Activenture Corp., Pacific Grove, Calif., pioneer of the retrieval software used on both products, will sell a similar package direct for $995. The two new products each consist of an IBM PC-compatible player and disk containing the encyclopedia. Grolier uses a Philips drive, while Activenture reportedly includes a Sony-built player. □

## WHAT'S THE NEXT KOREAN PRODUCT TO HIT THE U. S.? THE PHONE

The latest Korean-made consumer-electronics product to turn up on U. S. dealers' shelves is the telephone. The Korean market entry comes as the result of a joint venture between PacTel Communications Co., San Francisco, and Vodavi Technology Corp., Scottsdale, Ariz. The phones—a standard set and a slimline model—will be made by Gold Star Tele-Electric Co. □

# Faster than a speeding bullet. New Q-Bus™ analog I/O with 22-bit memory addressing.

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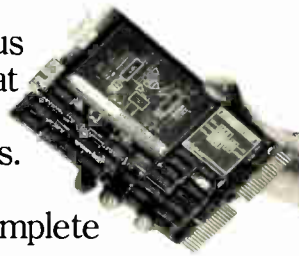

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# PRODUCTS NEWSLETTER

## $129 ADD-ON BOOSTS IBM PC'S SPEED BY AS MUCH AS 60%

Owners of IBM Corp. Personal Computers and PC/XTs can boost the performance of their systems by as much as 60% with a low-cost add-on product from Microspeed Inc. At $129, the Fremont, Calif., company's Fast88 module costs considerably less than other accelerator products, which range in price from $600 to $2,000. These products also take up an expansion slot and often create software-compatibility problems. Fast88 does not take up an expansion slot, but mounts inside the PC's back panel. It replaces the standard 4.7-MHz 8088 processor with a higher-speed 8-MHz 8088-2. Fast88 runs all existing IBM PC software. To run software that uses timing loops, users can flip a switch to return to the 4.7-MHz processor speed. □

## UNIX-BASED COMPUTER FROM PLEXUS HANDLES UP TO 80 USERS

Plexus Computers Inc. can now handle up to 80 users on its new P/75 supermicrocomputer—twice the capacity of the San Jose, Calif., company's previous top-of-the-line model. Built around the 68020 microprocessor and based on AT&T Co.'s Unix, the system handles communications traffic with a 68000 processor, which relieves the CPU of I/O functions. The system also supports a variety of communications protocols, including Systems Network Architecture and X.25. A minimum configuration with a 60-megabyte tape drive and a 145-megabyte disk drive sells for $36,000. □

## AMD'S VIDEO TIMING CHIP CONTROLS 1,024-BY-1,024-PIXEL DISPLAYS

A programmable video-timing controller from Advanced Micro Devices Inc. generates the synchronization signals for a high-resolution graphics display system and a CRT monitor. With a clock rate of 125 MHz, the Sunnyvale, Calif., company's Am8158 is suitable for bit-mapped graphics systems supporting resolutions of 1,024 by 1,024 pixels or more. Thanks to nine programmable registers on chip, users can program the number of pixels per memory access, the number of memory accesses per scan line, the number of scan lines per frame, and the pulse widths of the synchronization signals for the CRT monitor and the system. The controller is available now in 28-pin ceramic DIPs for $38.60 in lots of 100 pieces. □

## DEST BREAKS PRICE BARRIER WITH $1,995 PAGE SCANNER

Until now, price has been a major barrier to the widespread use of optical character readers, with some products costing as much as $6,000. Dest Corp. is breaking this barrier with a new $1,995 page scanner that works as a peripheral to IBM Corp. Personal Computers. The Milpitas, Calif., company's PC Scan hardware scans at a resolution of 300 dots/in. It can automatically enter text at a rate of 25 seconds per page. An interface board costs an additional $195. A character-recognition software package, Text Pac, which costs $595, automatically formats the transferred data for use by a variety of popular word-processing packages, such as WordStar and MultiMate, making the scanner far easier to use than earlier models. Delivery takes 30 days. □

## PROGRAM FROM RAPITECH QUICKLY CONVERTS COBOL PROGRAMS INTO C

Look for Rapitech Systems Inc. to introduce a Cobol-to-C conversion package similar to the company's Fortrix-C program, which converts Fortran programs into the C language at a rate of about 600 lines/min. The New York company should announce the Coblix-C package in the second half of the year. Coblix-C should cost about $4,500—the same as the current price for Fortrix-C, which is due to rise to $6,000 later this month. □

Electronics

# LITHIUM NIOBATE DEVICES FINALLY MAKE IT TO MARKET

## DUE SHORTLY: LIGHT-BEAM MODULATORS FROM TWO COMPANIES

**LISLE, ILL.**

Ultrafast guided-wave optoelectronic components based on lithium niobate crystals are finally about to become a commercial reality. For more than a decade the stuff of research only, $LiNbO_3$-based optical devices will be offered for sale by at least two companies this year.

The 1986 market will amount to little more than engineering samples, and the merchant business in 1987 will total only \$3 million to \$7 million, by one estimate. But most observers see important niches for the technology that could lead to annual markets approaching \$1 billion in the 1990s. And a number of large system houses in Japan, Europe, and the U.S. are waiting in the wings with the technology in-house, for eventual application in their own equipment or for sale.

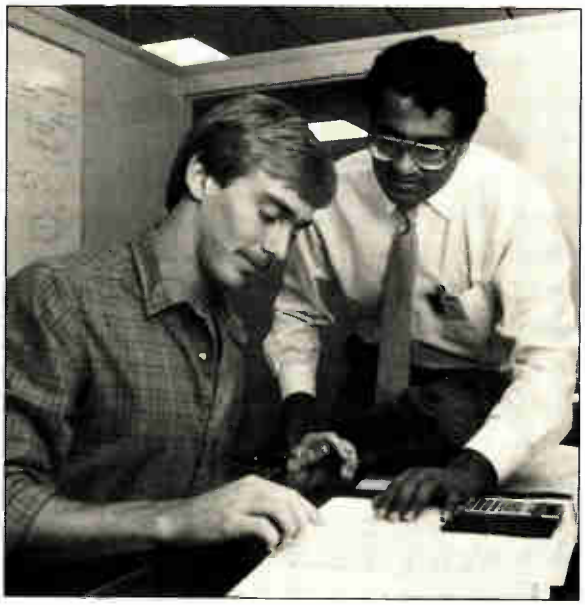
First on the market apparenty will be Crystal Technology Inc. The Palo Alto subsidiary of West Germany's Siemens AG is already the world's leading producer of $LiNbO_3$ crystals, and has now decided to go a step farther by selling optical waveguide devices built on its own materials.

This month the company plans to ship what it claims are the world's first commercially available $LiNbO_3$ optical guided-wave devices. Designed for experimental use in university and industrial laboratories, Crystal Technology's family of Mach-Zehnder optical guided-wave modulators features modulation bandwidths up to 3 GHz, 10-V maximum drive, and a 20-dB minimum extinction ratio. Channels vary in width from 4 to 8 μm, depending on wavelength specifications. As with any new technology, the parts won't come cheap. They initially will sell for \$4,000 each.

Not far behind is Amphenol Products, a Lisle, Ill., operating unit of Allied-Signal Inc. The company is currently spending \$1 million a year to develop $LiNbO_3$ guided-wave device technology, and plans to ship its first engineering prototypes by late February or March, says Sri Sriram, optoelectronics manager of Amphenol's fiber-optics product group.

Like Crystal Technology's device, Amphenol's first product will be an optical modulator based on titanium in diffused channels fabricated on a $LiNbO_3$ substrate. It will sell for \$1,000 to \$3,000. But Sriram hopes for a rapid price decline as the company starts down the manufacturing learning curve beginning late this year.

Manufacturing ramp-up will depend upon demand. But Amphenol plans to convert from building devices on $LiNbO_3$ slices to fabrication on undiced 3-in. wafers by summer and move into true production mode by late 1986 or early 1987, Sriram says.



**PROTOTYPES PROMISED.** Sriram, right, with coworker, says Amphenol plans to ship engineering samples by March.

In telecommunications, $LiNbO_3$ components such as optical modulators, switches, and filters will offer significant performance improvements over existing technology, proponents say. A $LiNbO_3$-based optical switch could easily handle bandwidths in the multiple-gigahertz range, for example, compared with maximum data rates in the low hundreds of megahertz for today's fastest electrical switches, says Rod C. Alferness, head of photonics circuit research for AT&T Bell Laboratories in Holmdel, N.J.

Other potential markets exist in fiber-optic sensing and signal processing. Because $LiNbO_3$ is well suited as a single-mode device, the continuing emergence of single-mode fiber is expected to provide added impetus for the devices. Though manufacturing hurdles remain, $LiNbO_3$ is ready to begin moving out of the lab now, backers say. By contrast, more glamorous monolithic optical circuits built from III-V materials such as gallium aluminum arsenide and indium phosphide [*Electronics*, Nov. 18, 1985, p. 39] are still 5 to 10 years away from commercial reality, they contend.

In fact, $LiNbO_3$ looks like the technology of choice for some niche applications thanks to its superior electro-optic characteristics, says Richard Becker, Crystal Technology's manager of integrated optoelectronic components. "A lithium niobate modulator will always be able to outperform the III-Vs," he contends.

And for some switching jobs, the ability to integrate lasers and detectors on the same chip—one attraction of III-V materials—won't be important, says AT&T's Alferness. AT&T is working with III-V as well as other materials, he says, "but this technology offers for now and the foreseeable future the only way to do reasonably fast optical switching." Another AT&T official says $LiNbO_3$ components could start showing up in small quantities for special applications in AT&T equipment within two years, though volume applications are farther away.

Still, some view optical $LiNbO_3$ devices as a gamble, especially this early in the game. "We have gone and stuck our neck out and said we can make these devices," notes Sriram.

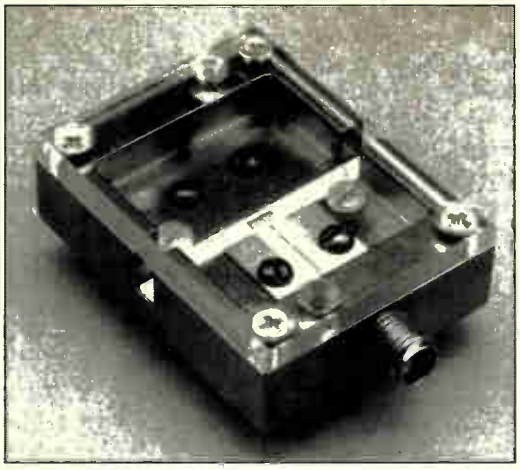
Unlike Crystal Technology, Amphenol plans to offer its devices initially with fiber pigtails attached. "The biggest challenge everybody is going to face in this technology is how you attach the

fiber to the $LiNbO_3$ crystal and keep it there for a long period of time," Sriram says. Ultraviolet light-curing epoxies used in today's research devices will not do for the real world, he says. Mechanical vibration and the differing thermal expansion coefficients of the silicon fiber and the $LiNbO_3$ could cause movement of the precisely aligned fiber.

Amphenol expects help on that front soon, however, from its participation in a multiclient research effort sponsored by Battelle Memorial Institute, Columbus, Ohio. The three-month-old effort has attracted funding pledged at $600,000 over three years from each of six participating companies and aims at developing optoelectronic device manufacturing and packaging technologies. The project already has made good progress toward a suitable nonepoxy fiber-to-crystal bonding method, says Sriram. "We expect that in a matter of about three more months, they will have achieved the basic solution in the sense that we'll at least have direction to go."

By jumping out early with $LiNbO_3$ components, both Crystal Technology and Amphenol hope to develop a market presence that will translate into market share later. Besides AT&T, the companies working in the technology include Fujitsu, NEC, NTT, and Toshiba in Japan; British Telecom, Ericsson, Philips, Plessey, Siemens, and Thomson-CSF in Europe; and defense contractors such as Hughes, McDonnell Douglas, TRW, and Westinghouse in the U.S.

"This is a very difficult game right now," says Amphenol's Sriram. "Currently, there are two of us playing. But once we show some stuff and start shipping products, I'm sure that a lot of other people will start looking into this technology." *–Wesley R. Iversen*



**MODULATOR.** Crystal Technology's modulators will be the first commercially available $LiNbO_3$ products.

*DATA COMMUNICATIONS*

# 18 VENDORS FORM GROUP TO SPEED OPEN NETWORK

**WASHINGTON**

Tired of waiting for open network standards, 18 U.S. computer manufacturers have got together and formed a nonprofit organization to come up as soon as possible with protocols they can start using. As its first priority, the newly formed Corporation for Open Systems network-standards organization will develop specifications and compliance tests for two upper-level applications in the International Organization for Standardization's seven-layered protocol—FTAM and X.400.

Equipment from different manufacturers supporting ISO file-transfer access methods (FTAM) could be on the market this year, and X.400 message-handling features would be available by the second quarter of 1987, according to an industry task force that studied ways to speed up the process of bringing ISO protocols to market.

The nascent COS has already redefined the network standards issue, previously a choice among various proprietary networks, including IBM Corp.'s Systems Network Architecture, and a few partial ISO systems that were proprietary at the higher levels [*ElectronicsWeek*, May 13, 1985, p. 34].

The arrival of COS brings a major new player to the arena. Currently signed up for COS participation are Amdahl, AT&T, Bell Communications Research, Burroughs, Concurrent Computer (formerly Perkin-Elmer's Data Systems Group), Control Data, Digital Equipment, Harris, Hewlett-Packard, Honeywell, National Advanced Systems, NCR, Northern Telecom, Sperry, Tandem, Telex, Wang Labs, and Xerox.

*Gear using new protocols could appear in 1986*

Through COS, the vendors plan to flex their marketing muscles and set priorities for the implementation of ISO protocols. COS will choose which protocols will be defined first, write their specifications, and provide a means of compliance testing by members and outside manufacturers. In that way, it hopes to get the process moving.

FTAM and X.400 are in line with priorities already set in the user-dominated Manufacturing Automation Protocol group and the National Bureau of Standards, both of which are working on ISO protocols.

So slow has been the pace of implementing the ISO protocols that the announcement of COS was met with some cautious words of welcome. "I believe that we are complementary, and at this point in time we support COS," said Michael A. Kaminsky, manager of the MAP program at General Motors Corp. "We are working in parallel," said Robert Blanc, director of the NBS's computer systems and engineering center.

COS also claims support from many European vendors. Seven of the 12 European companies that have announced support for ISO attended a COS "summit" meeting last month in Chicago.

The European Computer Manufacturers Association, however, was not invited to Chicago, nor were representatives of the International Telegraph and Telephone Consultative Committee or other European standards organizations.

**TOO RICH.** "At the moment, there is no provision to have trade associations as members of COS," says A. G. W. Biddle, president of the Computer and Communications Industry Association and godfather of COS. Standards committees tend to write compromise standards that are overly rich, Biddle says. The forum for decision making in COS will be senior-level product planners "who see the technology as a means to satisfy market needs," he continues.

COS was formed by the presidents and chief executive officers of the 18 sponsors, who met twice last year at Biddle's instigation. Out of these meetings came the decisions to form COS and start work on FTAM and X.400.

To sponsor COS will cost each company $125,000 the first year and $200,000 the second. For their money, sponsors will get a say in which protocols are defined first and will have first crack at the test beds developed for them. COS will locate near Washington and hire a staff of 25 to 40 people. A search is now on for a president—Biddle excludes himself—and operation is expected to be under way by March. Meanwhile, COS has had meetings with NBS, the MAP group, and the Technical and Office Protocols user group, all of which have done significant work on developing ISO protocols.

NBS has about 30 people working on OSI standards and spends about $2.5 million on the project annually. However, it has recommended transferring much of its work to the private sector, and several industry sources say that

the initial impetus for COS came from an effort to take NBS private. Blanc says that his only talks with Biddle and the 18 vendors concerned requests for information on what NBS was doing and what needed to be done.

**UNRUFFLED.** Biddle and the COS steering committee have also met with Kaminski and Charles Gardner of Eastman Kodak Co., chairman of the MAP/TOP steering committee. So far, no one's feathers have been ruffled. Kaminski's suggestion that users be admitted into COS apparently has been accepted.

COS still has some hurdles ahead, however. "The definition of test methodology and the determination of compliance goes right to the heart of the protocol process," says Charlie C. Bass, a founder of network vendor Ungermann-Bass Inc., of Mountain View, Calif. "MAP/TOP, COS, and NBS clearly are all attempting to achieve the same goals. However, the fact that they are different organizations complicates the process of setting a single set of standards, a single certification process, and so forth. There is turf being fought for. Until the individuals involved have sorted out their roles, we're in a period of some instability."

Robert Metcalfe, founder of 3Com Corp., Mountain View, applauds the goals of COS but warns that "compliance testing has often been used as a competitive weapon."

COS will meet Jan. 23 in Washington to try to expand its membership to about 50. It will invite users, smaller vendors, and even IBM to join. The rolls will close March 1 and remain closed for one year. *–Clifford Barney*

*SEMICONDUCTORS*

# ITALY'S SGS CLAIMS LEAD IN VERTICAL PNP DEVICES

**AGRATE, ITALY**

Engineers at Italy's principal semiconductor-component manufacturer are designing low-cost volume products in what they call $S^2P^2$—super signal power process—by exploiting a proprietary method for fabricating vertical pnp transistors isolated with a deep n-well. They claim that SGS Microelettronica SpA will be first to market with a true vertical complementary bipolar power technology that combines high gain and high power-handling capabilities.

The process, aimed primarily at intelligent-power applications that require pnp transistors, is the newest member of a family of bipolar linear technologies based on the Italian company's top-bottom isolation technique. The two-step method minimizes the spread of isolation diffusion in the $n^+$ epitaxial layer, thereby improving the structure's ability to handle voltage. Devices made with $S^2P^2$ can withstand transients of up to 120 V, high enough for use without external protection in automotive applications, for example.

The breakthrough that $S^2P^2$ adds to the family is a deep $n^+$ diffusion technique to form the bottom n-well, which enables the fabrication of isolated-collector vertical pnp transistors. SGS has also developed a high-density version of the technology for lower-voltage applications.

The true complementary nature of the vertical npn and pnp transistors made with the $S^2P^2$ process makes it suitable for use in nearly any configuration, including circuits such as high-side drivers and full bridges, which normally fall into the domain of hybrid technologies.

$S^2P^2$ can build four basic devices on the same chip. In addition to the pnp and npn transistors, it offers integrated-injection-logic linear and logic circuits and low-leakage diodes (LLDs). LLDs are normally added as discrete external components to bipolar power technologies when necessary. $S^2P^2$'s LLD, however, boasts losses four orders of magnitude lower than those of diodes made with standard processes. LLDs are particularly useful for inductive-load driving, where they increase efficiency.

Commercial bipolar power technologies have been limited to only npn vertical transistors; pnp devices are built with lateral structures. In a lateral pnp device, it is difficult to control the distance between the p-type emitter and collector regions, and small differences in this distance can cause large changes in the transistor's transfer ratio.

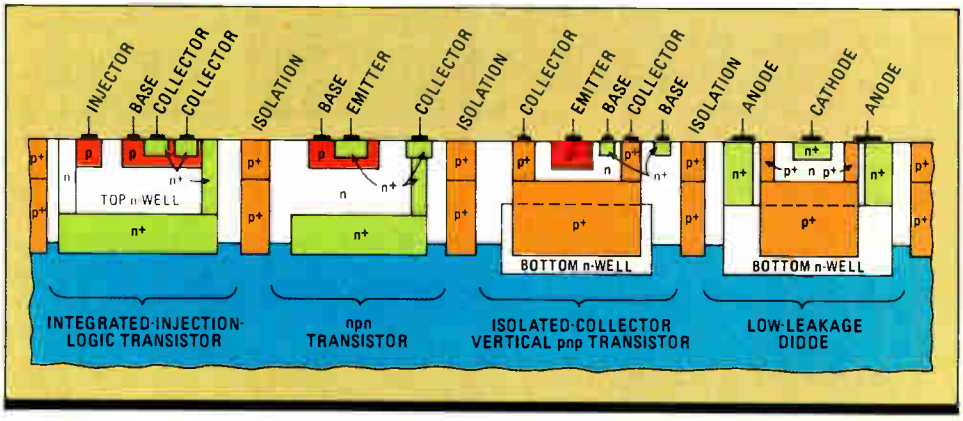
Another problem with lateral pnp structures is their relatively low base-collector breakdown voltage. This results from the fact that the base-collector junction is not located deep in the silicon, in contrast to a vertical transistor. Furthermore, lateral pnp devices take up far more space on the die than do vertical ones.

**OTHER ROUTES.** Hitachi Ltd., Texas Instruments Inc., and other semiconductor manufacturers have developed techniques for overcoming some of the shortcomings of lateral pnp transistors. TI's junction-isolated complementary bipolar approach, for example, produces lateral pnp devices with performance and reliability equal to npn transistors, but does not make it easy to achieve high densities.

SGS, however, has achieved high density with its second version of the process. For lower-voltage applications that require complex signal-processing circuits, the $HDS^2P^2$ (for high-density $S^2P^2$) version integrates dense linear and $I^2L$ control circuits with emitter-coupled logic, LLDs, and vertical transistors.

$HDS^2P^2$ combines dense logic and good analog performance—in terms of speed and power-handling—for data converters and other applications. Able to deal with transient voltages up to 60 V, the process is ideal for applications running at up to 100 MHz, and it can squeeze 270 $I^2L$ gates into 1 $mm^2$.

SGS is nearly ready to offer samples of the first product to be based on $S^2P^2$, the L9350, a high-side driver chip for inductive loads. The circuit is aimed primarily at the automotive market for fuel-pump driving, engine control, and safety functions. $HDS^2P^2$ will be used in the development of a high-performance low-drop voltage regulator, a stepper-motor driver, and a read/write amplifier for hard-disk drives, as well as a variety of other fast linear and low-drop power circuits. *–Robert T. Gallagher*




**WITH COMPLEMENTS.** Vertical pnp transistors fabricated over a deep n-well make SGS's $S^2P^2$ the first true vertical complementary bipolar power process technology used for commercial devices.

# A SHARPER WAY TO PROBE VLSI CHIPS?

**RICHARDSON, TEXAS**

Transmission electron microscopy, long considered strictly a research tool, now seems set to make its mark in the semiconductor business. The technique, which detects microstructures through thin layers of material, can uncover anomalies with resolutions as low as 2 Å. This makes it possible to give new insights into what goes on under the surface of integrated circuits, where features smaller than 1 μm are becoming common. Convinced that TEM will become a mainstream technique for IC quality- and reliability-assurance programs, a Richardson, Texas, startup called Ultrastructure Inc. has set itself up to do such analyses for chip makers and system houses.

In existence longer than scanning electron microscopes, TEM continues to get more powerful with each new generation. Today's systems can magnify 300,000 times and have about 50 times the resolution of more widely used scanning electron microscopes. "Production people [at both chip and system houses] are getting to the point where "Some device features are so small that they are reaching the limits of scanning equipment," says Russell F. Pinizzotto, president and cofounder of Ultrastructure, a two-year-old spinoff from the research labs of Texas Instruments Inc.

**SIX LENSES.** Ultrastructure images material with a six-lens transmission electron microscope from Japan Electron Optical Laboratories operating at 100,000 V. The system will image through silicon up to 0.5 μm thick.

This equipment performs crystallography probes, profiling the grain sizes of microstructures in a chip's metalization layers. Large variations in grain sizes can result in electromigration problems through metal lines. This condition can lead to high current densities and, over time, physically move alloy particles around, building up metal "whiskers" or open spaces in the interconnect lines.

Scanning electron microscopy, however, cannot detect microstructures in metal alloys, says Pinizzotto. Scanners are restricted mostly to the imaging of surface topology. Such microscopes scan a beam across the material and collect generated electrons from the die to produce images. "With TEM, we send electrons right through the prepared sample. They interact with the material and then we image the electrons when they come out the other side."

The trick, however, is in preparing the sample, which generally requires up to a half dozen steps. After decapsulating a device, Ultrastructure removes the protective die overcoating and silicon substrate from the back of the chip using acid solutions or plasma etching. A typical IC die measures 10 to 20 mils thick, and the process takes apart the die layer by layer for a top-down plane view.


**REVEALING.** Transmission electron microphotographs of an aluminum metalization line show the large discrepancy in grain size.

For an edge-on cross section of a chip, Ultrastructure epoxies two similar dice face to face. The dice are sandwiched between layers of unprocessed silicon. The sandwich is sliced with a diamond saw into 20-mil sections, and slices are polished to 3-mil thicknesses. An inspection site is etched, and ion milling is used to create a tiny hole in the center of the dished-out area. The transmission electron microscope focuses around the edges of the hole where the material is 0.5 to 0.25 μm thick.

The chip industry's push to under-1-μm geometries and its greater emphasis on product reliability are opening up the potential for greater use of these techniques in product-failure analysis, Pinizzotto believes. In addition, chip makers face the inspection of emerging three-dimensional circuits, analysis of ultrathin films and oxides, as well as collection of new types of data on process reliability. The accumulation of IC technology trends has made it worth the effort to perfect material-preparation methods for the high-resolution imaging and diffraction technique, he adds.

**LATE BLOOMER.** Though transmission electron microscopy has been around since the late 1930s, "it was not until the 1950s that people were able to make metallurgical samples thin enough for TEM imaging," Pinizzotto says. "Cross-sectional techniques [for profiles of IC structures] have been developed for TEM in just the last five years."

Ultrastructure charges from $800 to $2,500 per sample analyzed by its transmission electron microscope equipment. Its clients include large chip makers wanting to pinpoint fabrication problems, system houses scrutinizing suppliers' products, and IC-design teams attempting to reverse-engineer competitors' components and silicon processes.

Transmission electron microscopy has also been applied to gallium arsenide and mercury-cadmium telluride semiconductor compounds. Ultrastructure last year received a Small Business Innovation Research award from the National Institutes of Health to analyze solder and dental-alloy interfaces. Currently, it is awaiting word on a Department of Defense grant to fabricate 3-d ICs and a transmission electron method to analyze defects. *–J. Robert Lineback*



# ITT LEADS WAY WITH CHIP FOR DIRECT-BROADCAST TV

**FREIBURG, WEST GERMANY**

ITT Semiconductors will likely be the first chip maker to get into volume production on a single-chip decoder that will enable European TV viewers to tune in on the better sound and picture that will be transmitted by direct-broadcast satellites to be launched later this year. The low-cost one-chip decoder circuit will operate on the French standard for direct-broadcast satellites—the D2-MAC 12-GHz transmission scheme.

"We will be ahead of other European semiconductor makers by at least a year in getting a D2-MAC decoder to market," claims Rolf Deubert, director of electronic development at Intermetall GmbH, the ITT group's lead house in Freiburg. Deubert, along with other German engineers, worked with engi-

neers at French electronics giant Thomson SA in drawing up the D2-MAC specifications. This standard provides better pictures and sound than conventional terrestrial standards, such as PAL and NTSC, through its time-division-multiplexing system and digital coding techniques. It also improves the picture by eliminating the effects of cross-color and cross-luminance [*Electronics Week*, March 11, 1985, p. 38].

Now nearing completion, the ITT decoder is a very large-scale integrated circuit that uses 1.5-μm geometries to put more than 140,000 transistor functions on a 45-mm² chip. The decoder automatically adjusts the circuitry for optimum signal reception and can even select the language a viewer wants to hear on a broadcast. Samples will be offered during the second quarter and the chip will go into volume production a few months later—in time for the scheduled start of D2-MAC broadcasts this fall.

D2-MAC will be used with Europe's first DBS systems—West Germany's TV-Sat and France's TDF-1. France, West Germany, and the Benelux countries adopted D2-MAC last summer, and Switzerland, Austria, and some other countries are expected to follow suit this year.

**FOUR LANGUAGES.** The standard provides for four high-fidelity sound channels and up to eight channels with somewhat lower quality. The new system can broadcast the same movie in four languages, for example. Improved chrominance-noise performance comes from D2-MAC's large bandwidth—about 8 MHz. Digital encoding results in high sound quality and noise immunity.

**HEAD START.** Deubert claims ITT is a year ahead in the race for a D2-MAC decoder.

To handle the complex D2-MAC analog and digital data stream, the ITT designers had to come up with a decoder that can process digital signals at a clock rate as high as 27 MHz. In circuits for professional applications where costs might not be crucial, handling such high-frequency signals is not difficult, Deubert says. "But for a circuit that must be priced for consumer applications, the task isn't all that easy."

To cope with the high-speed signals, ITT designers drew on the company's expertise in small-geometry technology and pushed the geometries to well below 2 μm—uncommon dimensions for a low-cost consumer-market circuit. The use of CMOS technology kept power dissipation to tolerable levels at the high signal speed. Housed in a 68-pin package, the 1.5-μm single-chip solution to the D2-MAC signal-decoding problem contrasts with the multichip designs being pursued by other companies.

Also, the one-chip approach helps to keep the decoder's cost low. Deubert believes a circuit kit containing the decoder plus peripheral circuits—among them digital-to-analog and analog-to-digital converters and a microprocessor-based circuit—can be kept to about $40. If the decoder is designed by itself into a TV receiver that already uses digital circuitry—including the converters—its cost can be held to around $20.

**ADAPTS TO SIGNAL.** That price buys a versatile part. Controlled by software in the peripheral microprocessor-based circuit, the decoder analyzes the error rate of the received signal and determines the best filter characteristics for certain conditions. It produces data that adapts the filter characteristics to the quality of the received signals to improve such aspects as the signal-to-noise ratio. Such adaptive control may be necessary when the S/N ratio suffers as a result of an iced-up antenna, for example.

The software also lets the decoder act as a language selector. The D2-MAC data stream can define up to 100 languages in code, and from this stream the decoder can pick out any language or combination of languages to suit the TV viewer. Designed for use both in TV sets and at cable network facilities, the decoder also has the circuitry to descramble signals from future pay-TV services. *–John Gosch*

*AUTOMATIC TEST EQUIPMENT*

# HP MAKES ITS MOVE IN OPEN TEST NETS

**ANAHEIM, CALIF.**

Hewlett-Packard Co. is positioning itself to go after a larger chunk of the automated test-equipment business, building on the base it has established with the HP 3065 board-tester family. At the ATE West conference in Anaheim last week, the Palo Alto company unveiled a family of networking software products intended to increase the productivity of its testers by more fully automating their operation.

The family, called Q-Star, for quality test systems for test, analysis and repair, aims at linking existing test equipment and computers from HP and other vendors in an open and transparent distributed-processing network. All test resources—programs, revisions, and data storage—can be shared by individual operators at the lowest level. Moreover, Q-Star ties testing into larger computer-integrated manufacturing systems, allowing tighter management controls.

The HP announcement has a double-barreled significance for the ATE field. For openers, it addresses the issue of equipment connection, raised by users who have been asking for unified software solutions to integrate test gear. Too much attention has been paid to improving test hardware and not enough to making it work efficiently in a data network, many ATE users say. The Q-Star introduction should signal other suppliers to move in this direction, industry sources say.

**MOVING AGGRESSIVELY.** The new family is also a signal that HP finally is moving aggressively into system testing that relies heavily on software networking solutions. "HP never really understood it [system testing] or did it well," says Jerry D. Hutcheson, president of VLSI Research Inc., a San Jose, Calif., test-equipment and marketing consultant. He sees a possibility, however, that HP is starting to bear down now. A tipoff is Q-Star's open architecture that allows non-HP gear to work in it. In component testing, he notes, HP is quietly cutting back.

Competitors, too, are taking notice of the Q-Star announcement. "Even though we expected it, I must say I am very impressed," says Pauline Veilleux, marketing engineer at ATE heavyweight GenRad Inc. GenRad is credited with being the first major ATE company to offer a unified system—its Tracs (for test, repair, analysis, and control system), in 1983. The Waltham, Mass., company has steadily improved the system, which requires a large minicomputer for central control.

Not surprisingly, HP stresses the ad-

vantages of its distributed architecture that can accommodate modular software packages. "The combination [of distributed architecture and modular products] means test managers can start small and keep adding one step at a time," says Casey Cornett, marketing manager of HP's Manufacturing Test Division, Loveland, Colo.

The three new packages announced at ATE West join with the HP Network Services/3065 test-software program announced in November to make up Q-Star. Network Services provides network-wide transparent access to each tester, with the three new packages adding key functions. BTL Plus, for example, incorporates board testers into the network, and Paperless Repair programs add repair management.

The third new package, Q-Stats II, handles quality-control statistics collected automatically from all testers and terminals. It runs on an HP 9000 work station. All packages, each of which has a basic $4,500 price, will be available by midyear.

*Q-Star users can manage repairs and do QC work*

HP's ATE game plan based on the new software developments evidently seeks to spur sales of its own tester hardware—a fully equipped HP 3065 sells for upward of $237,000. But the fact that most ATE users do not use just one company's equipment requires that Q-Star—in fact, any unified ATE system—handle a wide variety of test equipment and interface with most computer families.

HP leaves little doubt that Q-Star is just the first of more ATE ventures that will push further onto the factory floor. The company is working on integrating the Manufacturing Automation Protocol into its system, but will not say when it expects to be done. *–Larry Waller*

***PACKAGING***

# CHIPS INSIDE CONNECTOR CUT COSTS, SAVE SPACE

**NEW YORK**

Saving a card slot in a small computer can add up. That's why Rapitech Systems Inc. thinks it's onto something: putting the electronics into the connector and plugging it into the memory bus, the company says, saves a slot inside the computer and cuts costs.

The small New York company is now embarking on an ambitious campaign to license its Acticon (for active connector) technology, a standard DB-25 connector that houses the serial-to-parallel conversion and other interface circuitry for an RS-232-C port. Now in the final stages of approval, Rapitech's patent would cover any electrical connector that houses the conversion circuitry needed for a logic interface between two data-handling systems that carry data in different formats.

Such a broad claim could be hard to defend against legal challenges, admits Rapitech's patent attorney Israel Nissenbaum. The patent also specifies the use of a printed-circuit substrate and integrated circuits within the connector housing.

In its present form, Acticon is a communications subsystem in a connector, capable of executing instructions it receives from the microprocessor and converting parallel data to serial form for transmission. Compatible with 8- and 16-bit processors, it offers full modem control and rates from 50 to 19,200 b/s.

Rapitech has built a prototype that consists of a standard DB-25 connector housing with an inlaid thick-film hybrid circuit on a ceramic substrate. On the substrate are ICs (including a communications controller), chip capacitors, a quartz crystal, a toroid core transformer, and a Graetz diode bridge. A dc-to-dc converter is also inside the 2.1-by-1.2-by-0.5 in. package.

The company is investigating the use of standard pc-board technology for production models, which would require the use of either small-outline ICs or bare chips wire-bonded to copper conductors on the pc board. Acticon units should sell for under $10 in production volumes, predicts Alexander Poltorak, Rapitech's president and a Russian emigre who says he came to the U. S. after he was stripped of his PhD in physics "because of my human rights activity."

**FROM HUNGARY.** The module was developed by Steven Farago, a Hungarian-born engineer who unsuccessfully tried to patent the connector interface in 1983. The patent application languished in the Commerce Department's patent and trademark office before Farago sold the idea last spring to Rapitech.

Rapitech has retained Adrian Horne, the British-born marketeer who set up the licensing program for Dolby Laboratories' noise-reduction system, to structure a licensing program. Horne thinks there is a potential market in the area of 50 million to 100 million units per year. He says the market is likely to grow steadily because of the increased emphasis on data communications.

Sure that the potential market is too large for a small company to handle alone, Horne convinced Rapitech to license the idea. "We should do our little part, and encourage everyone else to do theirs," he says.

**ACTIVE LINK.** Rapitech's Poltorak says his Acticon is a communications subsystem in a connector.

Connector companies are probably the best targets, Horne thinks. "We're adding a lot of value to the connector, which the connector guys like." But he warns that "while they're getting added value, they're also increasing their inventory expenses."

By April, Horne says, the first agreement should be signed, and he expects to have three licensees by July. Though Poltorak is aware of the potential difficulty involved in defending his company's patent in court, he professes confidence that by offering a reasonable licensing program, no one will try to slip around the protection of the law to produce a similar connector.

An Israeli company called Rad Computers Inc., with offices in Englewood, N. J., sells small modems and multiplexers that, like the Acticon, reside in small housings instead of plug-in boards. But Rad's offerings reside not in a plug but on the cable connecting the two pieces of equipment they serve. *–Tobias Naegele*

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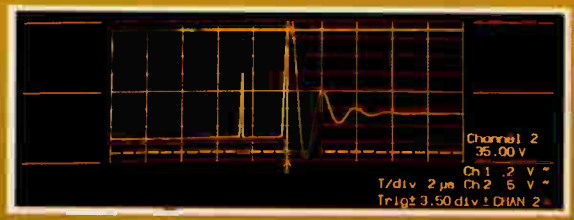


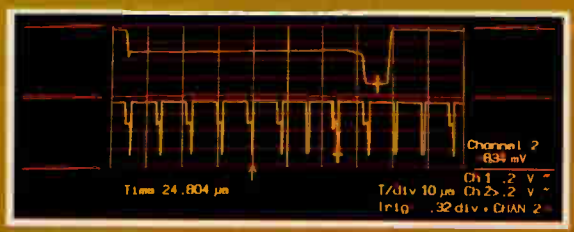


*Top: Acquisition Parameters listing enables the 9400 user to precisely set and check front panel settings, all of which can be remotely controlled.*

*Middle: Window mode trigger, set at ± 3.5 divs from center grid captures switching transient. 50% pre-trigger shows contact bounce prior to trigger moment.*

*Below: Crosshair marker, acting as a precise timer and DVM, gives time from trigger (arrow) and absolute voltage.*

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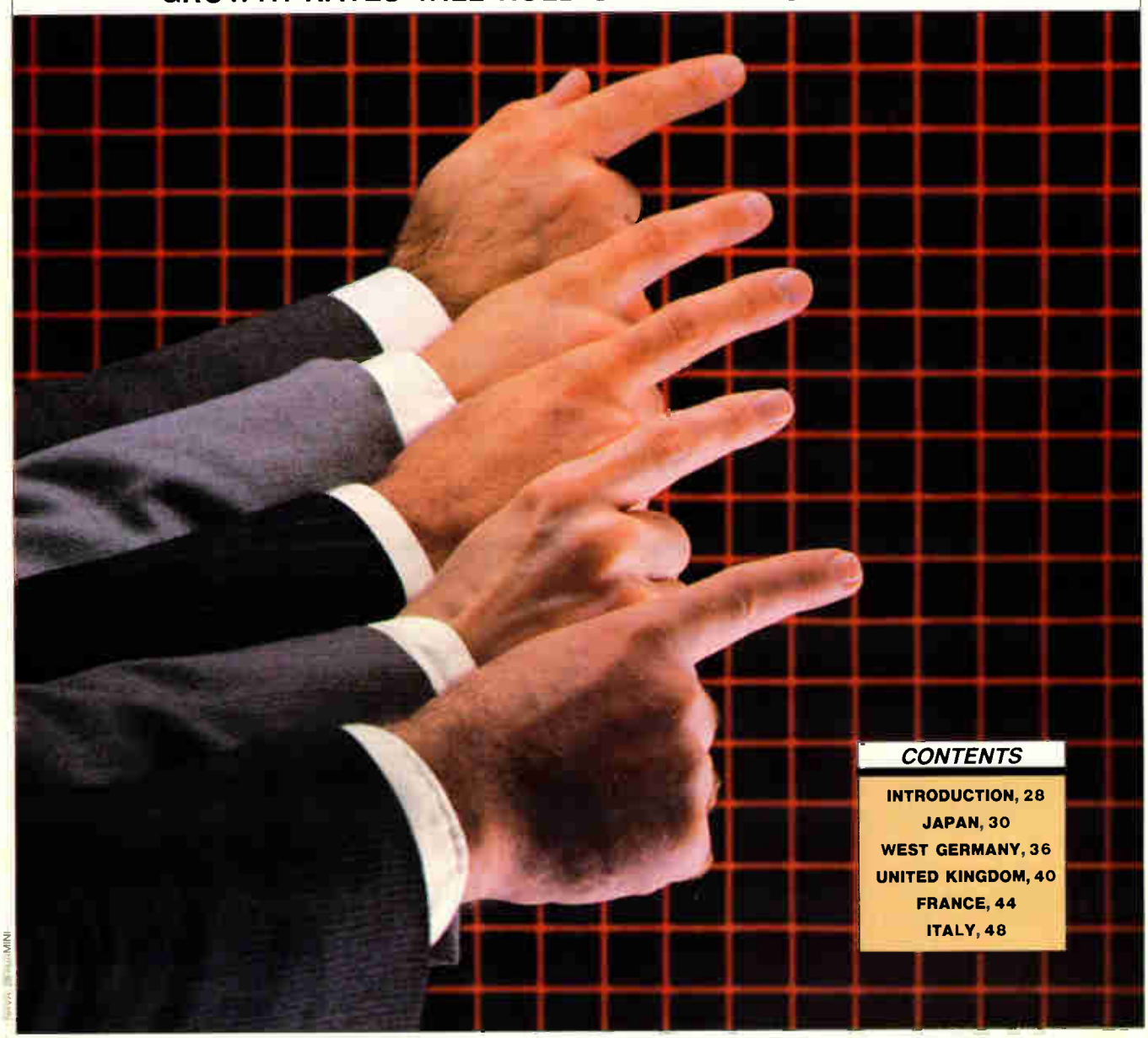
# 1986 OVERSEAS MARKET REPORT

## GROWTH RATES WILL HOLD STEADY IN TOP 5 NATIONS



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# INTRODUCTION

## CONSUMPTION IN TOP 5 MARKETS WILL RISE 8% TO $98.3 BILLION

The projections are in from electronics industry executives around the world, and all fingers point to steady growth—with moderate levels of increases—for the new year. But as with the U.S. market, growth in demand for electronic equipment in the top 5 overseas markets—Japan, West Germany, the United Kingdom, France, and Italy—will be at the low end of their historical growth ranges.

Although domestic demand for electronics goods in Japan will continue to grow, a slowdown in export markets will prevent the home market from expanding at more traditional growth rates, according to *Electronics*' market report. And continued strong capital spending in Europe will lead to continued growth in consumption in the continent's top four markets.

Lumping these top 5 overseas markets together shows that consumption of electronics equipment will total $98.3 billion this year, up 8% from 1985's $90.8 billion, which itself amounts to a gain of 8% over 1984. This 1986 demand for these five markets represents about 74% of demand in the world's largest market, the U.S., where consumption this year should hit about $132 billion.

Of these overseas markets, consumption in Japan is far and away the largest, accounting for some 41% of the $98.3 billion total, and the island nation should experience the largest expected growth rate in demand—10%. That would be rather paltry compared with growth rates earlier this decade. This rate of increase will bring Japan's total equipment consumption to $39.9 billion this year, the market report predicts. Slow as that rate of growth may seem in the industry's historical context, it's slightly better than the 9% growth that Japanese equipment consumption registered last year, when demand topped $36.3 billion, according to the market report.

Leading the way in Japan will be demand for data-processing equipment, which should increase 13% in 1986, to about $18.7 billion. Last year, consumption of data-processing gear grew 12%, to $16.6 billion. Growth in demand for communications equipment is expected to slow a bit this year from last year's growth of 10%, according to the market report. Overall consumption should reach almost $4.7 billion, an increase of 9% over last year's $4.3 billion.

Though still the second-largest segment of the Japanese market, the consumer electronics industry will see demand slow to 3% this year, to $11 billion, following last year's 6% rise, which brought consumption to $10.7 billion. The consumer electronics sector was long the growth leader in the Japanese equipment market, and manufacturers hope a stream of new products—including video disk systems, 8-mm video recorders with integrated cameras, and compact-disk audio players—will spur demand in the future.

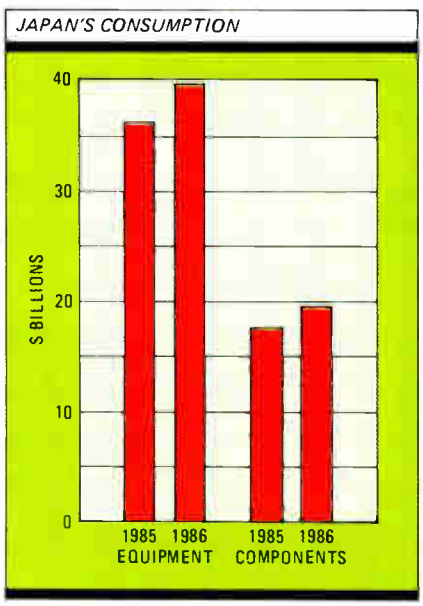
Japanese demand for test and measurement equipment should rebound in 1986 from last year's rather slow growth of 4%. This year, consumption should gain 9%, hitting $956 million, as equipment markets increase their strength and consumption of components climbs.

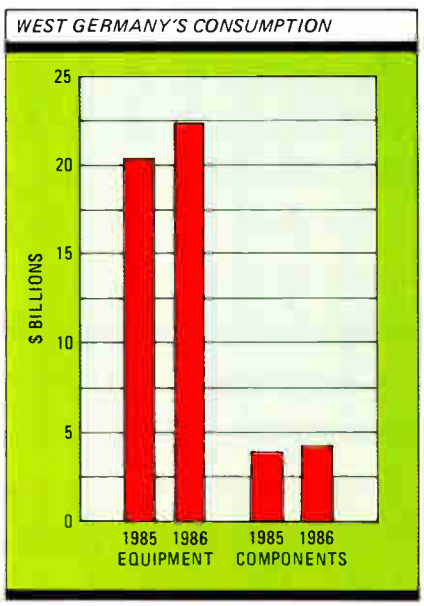
In the market for industrial electronics equipment, demand will grow 12% this year, to a total of $3.6 billion. The impetus comes from continuing plant automation, with customers adding such gear as process controllers and machine-tool controls, and from the rebounding semiconductor industry, which is boosting purchases of chip-making equipment.

Consumption of semiconductors and components in general will bounce back this year in Japan from last year's declines. Total component demand is expected to grow 9%, to almost $19.3 billion, a good sign in the wake of last year's 4% drop in growth, to $17.7 billion. Growth in demand will be strongest for semiconductors, the market report finds, where consumption should advance 13% in 1986, to $7.9 billion; last year, the sector dropped 6%, to just under $7 billion.

West Germany, the second-largest market for electronics equipment outside the U.S. and the largest in Europe with 23% of the $98.3 billion total overseas equipment market, will see total equipment consumption increase 8% this year, to almost $22.2 billion. This comes on the heels of a 6% advance in demand last year, to about $20.5 billion, the report finds. Demand in the largest part of the West German equipment market—data-processing equipment—will grow faster this year. The 1986 market will grow 9%, to $13.2 billion, following 1985's 7% rise, to $12.1 billion.

Following a flat 1985, demand for consumer electronics equipment in West Germany should manage a 5% gain, to $4.2 billion. Consumption of communications equipment should



move ahead at a sprightly pace this year. The market report sees demand growing 15% in 1986, to $3.1 billion. This follows 1985's 8% increase, to $2.7 billion. Growth in the market for test and measurement equipment will slow a bit this year, with an expected 9% gain, to $455 million, after 1985's 10% rise, to $418 million.

In the West German components arena, growth this year should more than double—to 8% from last year's 3%, the survey finds. That means total component consumption will hit $4.2 billion this year, versus $3.9 billion last year.

**EXCHANGE RATES**

**JAPAN**
235 YEN TO $1
**WEST GERMANY**
2.75 MARKS TO $1
**UNITED KINGDOM**
$1.40 TO POUND
**FRANCE**
8.4 FRANCS TO $1
**ITALY**
1,732 LIRE TO $1

The UK will see growth of its total equipment consumption in 1986 stay level with last year, at 7%, pushing demand for electronics products to $14.7 billion, compared with $13.8 billion last year. Increases in consumption will be led by communications equipment, which will advance 8%, to $3.1 billion, following 1985's 8% gain, to $2.8 billion. Makers of data-processing equipment will see demand slow to 7% and the market rise to $7.9 billion this year, following 1985's 9% rise, to $7.4 billion. The consumer electronics sector, which grew a flat 2% last year, to $2.9 billion, will grow 3% this year, bringing consumption to just over $3 billion.

Following a 2% gain in 1985, consumption of components in the UK will grow 8% this year, to $2.7 billion from $2.5 billion last year, the report finds.

Across the channel, equipment consumption in France will be up about 7%, to $13.1 billion, after a similar gain in 1985, to $12.2 billion. Demand for consumer electronics gear should increase at 1985's rate—4%—to $2.6 billion from last year's $2.5 billion. Meanwhile, consumption of data-processing equipment will slip to 6% from last year's 8%, bringing this year's market to $5.6 billion after 1985's $5.3 billion. Similarly, the growth in communications equipment will dip to 6% in 1986, to $3.7 billion, from 9% in 1985.

*Growth rates will be at the low end of the historical ranges*

Offsetting these figures will be higher growth in two other sectors. Test and measurement equipment will grow 15% this year, to $293 million, compared with 1985's 12% rise, to $255 million; industrial equipment will advance 19%, to $784 million, in 1986, compared with 1985's 13% gain, to $660 million.

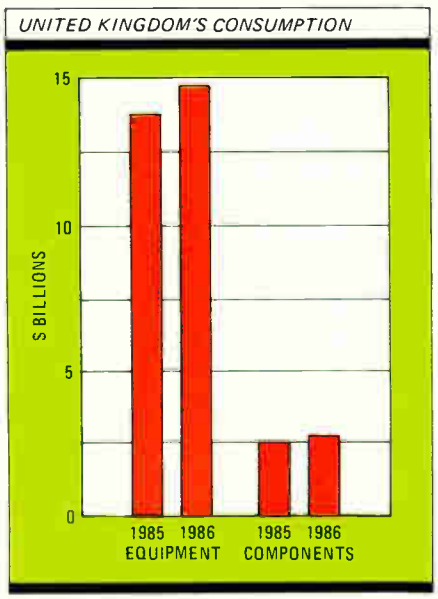
As for the components market, demand should grow 9% this year. This will bring it to $2.4 billion after a flat 1985, which saw demand top $2.2 billion.

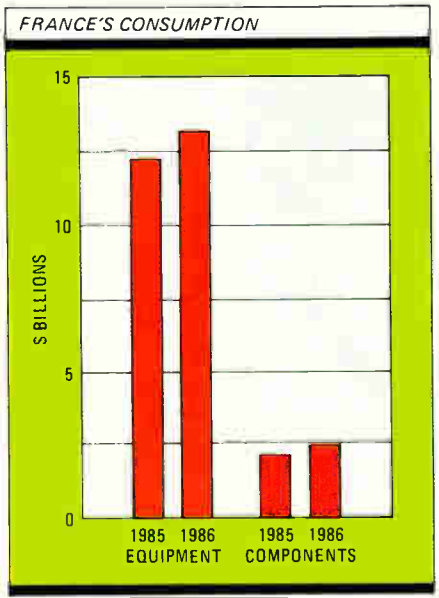
In Italy, growth in overall equipment consumption will slip to 9%, from 1985's 10% rate, to hit $8.5 billion. Individual markets will have an up and down year, with decreases in growth for data-processing and communications equipment, a flat year for consumer electronics gear, and higher growth rates for test and measuring and industrial electronics gear.

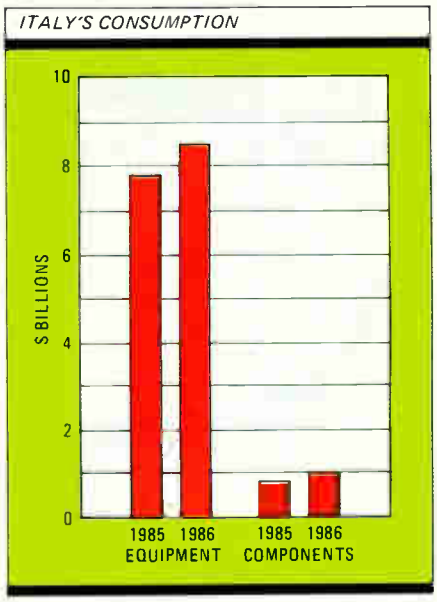
The *Electronics* overseas market report is based on estimates of industry-wide consumption at the factory level of various kinds of equipment and components from electronics executives in Japan, France, Italy, the UK, and West Germany. Consumption equals sales in the home market by domestic vendors, plus imports; it does not include exports by domestic producers. The survey was conducted through questionnaires mailed to industry sources in early fall 1985, so actual figures for 1985 may be higher once the fourth quarter's results are in.

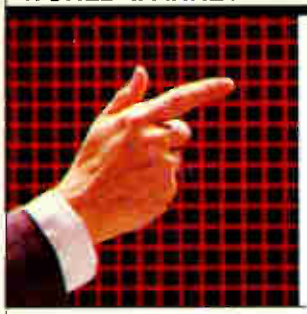
Estimates from industry sources were then reviewed and tabulated by the *Electronics* staff. In some cases, follow-up calls were made to sources to get a better understanding of their responses. In addition, secondary sources—such as trade associations and market-research companies such as Benn Electronics Publications, Luton, England, publisher of the Mackintosh Yearbook of West European Electronics Data 1986—were contacted in the five markets to corroborate projections and estimates. Some product categories have been added in this year's survey, while other categories have been deleted, so that totals may not be directly comparable to those of previous market reports conducted by *Electronics*. Estimates were provided in local currencies, which were translated into current U.S. dollars. No adjustments for the effects of inflation have been made in this report by *Electronics*, although questionnaire respondents may have factored their inflation estimates into their figures.

Executives in the five overseas markets note that there are many uncertainties facing their markets, not the least of which is the health of the U.S. economy. If it falters, the U.S. economy can have a chilling effect on their own economies. On the other hand, if growth in the U.S. quickens, business could pick up even further than overseas executives forecast. Either way, it should be clear by midyear if those fingers are all pointed in the right directions.





# JAPAN

## COMPUTERS WILL STAR IN $40 BILLION EQUIPMENT MARKET

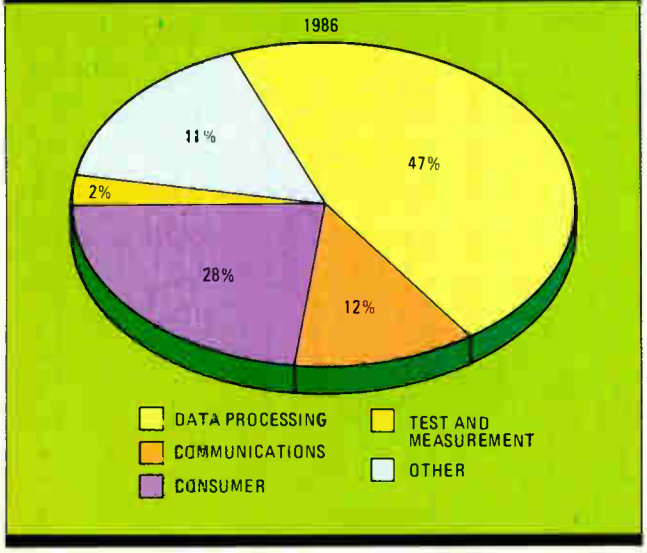
Computer and test and measurement equipment will once more outpace consumer products this year in the Japanese electronics market. The *Electronics* market forecast calls for an almost 13% increase in consumption of data-processing equipment, a 9% gain in test and measurement equipment, and 3% growth in consumer products. Total consumption for all Japanese equipment sectors will hit close to $40 billion this year, up from $36.3 billion in 1985. The 1986 forecast from the Electronic Industries Association of Japan is in the same neighborhood: data-processing equipment and testing gear will achieve a 13% gain, while the consumer market's growth should slow to 2%.

A wild card in the market is communications equipment, which shows an overall growth of 10.3%, to $4.7 billion, in the *Electronics* study. Last year's growth was 10%, according to survey respondents. The big news in communications gear is the facsimile machine; the industry is gearing up to raise production by 42%, much of it for export.

The slowdown in the consumer electronics market is due mainly to heavy competition and saturation in the market for video cassette recorders. Difficulties in export markets also condition the market outlook, but are not directly reflected in the *Electronics* consumption figures, which subtract exports and add imports to domestic production figures.

The 13% upswing in data-processing consumption this year, to $18.7 billion, comes from the burgeoning domestic market for business machines. Also playing a major role is the development of value-added and local-area networks, which are being installed at a fast clip. "The lines are going in, the cables are appearing in offices, and now the question for many companies is what to put on the end of that cable," says analyst Michael Connors at Jardine Fleming Securities, Tokyo.

HOW JAPAN'S EQUIPMENT DEMAND IS SEGMENTED




"I think the big payoff here will be for peripheral equipment makers, but it's a bit of guesswork right now because network businesses are just getting organized and installed." Manufacturers look toward the second half of 1986 for spiraling sales figures as customer needs become clearer.

The Japanese mainframe market rose 15% last year, to $956 million, according to the *Electronics* market report, and should tack on another 15% gain, to $1.1 billion. The growth rate for the midrange of the office-computer market (machines selling for $5,000 to $20,000) is much more robust: 20% last year, to $1 billion, with a jump of almost 29%, to $1.3 billion, expected this year, according to the *Electronics* survey. Fujitsu and IBM-Japan are running first and second in unit sales; Hitachi and NEC are also major forces in this market. NEC claims it enjoyed a great year in 1985 selling its systems to local government offices.

Strongest growth in the industry in 1985 was in small-business personal computers costing under $5,000, which racked up a 26% growth rate, to $1.2 billion; the prognosis for this year is equally lively, with 23% growth expected, to $1.5 billion. "The personal computer market in Japan is still very immature," says Peter Rawle, an analyst with the brokerage firm W. I. Carr & Sons Overseas Ltd., in Tokyo. "Immature, in the sense that in Europe and America, financial analysts, marketing people, and many executives commonly use personal computers as tools. In Japan, however, they're still mainly used as advanced clerical tools." As more upper-echelon business people begin using personal computers in the workplace, equipment sales will inevitably accelerate.

NEC claims the leading share of the business personal-computer market in Japan with its 9800 series, and Fujitsu is a feisty No. 2. The split between the two rivals is about 45% to 35%, according to Rawle's latest estimate. Another big seller is IBM-Japan's Multistation 5550, which combines personal computer, work station, and Japanese-language word processor.

The Japanese home-computer market is changing radically, with consumers opting for dedicated machines, rather than for general-purpose personal computers. There are a rash of new products pouring from all the major makers, priced at about $500, with word-processing and some calculating capabilities. Sales are aimed at students, homemakers, and businessmen who can afford to take a chance at that price.

For Japanese makers of consumer electronics equipment, foreign markets are all-important, so last year's dip in exports meant diminishing sales. Domestic consumption, which is the subject of this *Electronics* survey, also is weakening. Overall, the growth rate for consumer-electronics gear should be a meager 3% dropping from 1985's 5% gain, with consumption peaking at just over $11 billion.

The VCR market is especially vulnerable, trapped, in effect, by its past success. In Europe, for example, 30% of homes with TVs were equipped with VCRs by 1983, and this has meant lagging sales. In 1984, says the EIA-J, local manufacturers exported 3.76 million units to Europe, for a per-month

## JAPAN EQUIPMENT

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **EQUIPMENT, total** | **33,440** | **36,398** | **39,905** |
| **Data-processing and office equipment, total** | **14,756** | **16,593** | **18,738** |
| Data-processing systems, total | 5,547 | 6,536 | 7,586 |
| Personal computers (less than $5,000) | 973 | 1,226 | 1,507 |
| Microcomputers ($5,000 to $20,000) | 845 | 1,018 | 1,311 |
| Minicomputers ($20,000 to $100,000) | 583 | 694 | 798 |
| Superminicomputers ($100,000 to $400,000) | 634 | 691 | 753 |
| Mainframe computers ($400,000 to $1 million) | 832 | 956 | 1,099 |
| Supercomputers (greater than $1 million) | 1,680 | 1,951 | 2,118 |
| Data-input peripherals (including card read/punch, optical, and magnetic character readers | 337 | 361 | 380 |
| Data-output peripherals (including printers and displays) | 1,992 | 2,184 | 2,397 |
| Data-storage subsystems (including disk, tape) | 2,465 | 2,792 | 3,145 |
| Data terminals | 2,215 | 2,527 | 2,934 |
| Electronic office equipment, total | 2,200 | 2,193 | 2,296 |
| Copying equipment | 1,005 | 967 | 995 |
| Facsimile-transmission systems | 807 | 763 | 801 |
| Electronic typewriters | 113 | 137 | 145 |
| Billing and accounting equipment | 275 | 326 | 355 |
| **Consumer products, total** | **10,138** | **10,671** | **11,016** |
| Audio equipment, total | 3,044 | 2,908 | 2,905 |
| Car audio | 645 | 673 | 687 |
| Stereo equipment, total | 842 | 785 | 798 |
| Components (including tuners, turntables) | 693 | 628 | 631 |
| Consoles and compact systems (including TV-audio combinations) | 149 | 157 | 167 |
| Phonographs and radio-phono combinations | 53 | 47 | 42 |
| Radios (including table, clock, and portable) | 82 | 75 | 70 |
| Radio-recorder combinations, portable | 647 | 613 | 597 |
| Tape recorders and players | 691 | 554 | 504 |
| Compact-disk players | 84 | 161 | 207 |
| Television receivers, total | 2,211 | 2,365 | 2,397 |
| Color | 2,185 | 2,340 | 2,376 |
| Monochrome | 26 | 25 | 21 |
| Other consumer electronic products, total | 4,883 | 5,398 | 5,714 |
| Home video equipment, total | 2,754 | 3,286 | 3,559 |
| Cassette players and recorders | 2,361 | 2,809 | 3,014 |
| Cameras | 241 | 305 | 358 |
| Video disk players | 134 | 152 | 163 |
| Projection TV | 18 | 20 | 24 |
| Electronic musical instruments | 223 | 187 | 146 |
| Microwave ovens | 386 | 374 | 391 |
| Telephone-answering machines | 18 | 17 | 16 |
| Electronic games (video and nonvideo) and toys | 327 | 336 | 342 |
| Calculators (personal and professional) | 197 | 217 | 236 |
| Electronic watches and clocks | 978 | 981 | 1,024 |
| **Communications equipment, total** | **3,868** | **4,251** | **4,689** |
| Data-communications equipment | 203 | 241 | 266 |
| Facsimile-terminal equipment | 737 | 914 | 1,081 |
| Fiber-optic communications systems | 81 | 97 | 119 |
| Intercom systems | 75 | 82 | 83 |
| Paging systems, public and private | 97 | 103 | 111 |
| Radio, total | 923 | 980 | 1,060 |
| Broadcast equipment (AM and FM radio and TV systems, including antennas) | 209 | 217 | 231 |
| Microwave systems (including telecom and broadcast) | 446 | 475 | 519 |
| Mobile, land (for public safety, transportation, and industrial) | 201 | 217 | 237 |
| Mobile, marine (ship to shore stations, including recreational) | 67 | 71 | 73 |
| Telecommunications systems | 735 | 761 | 806 |
| Telephone and data switching, private (PABX) | 217 | 238 | 283 |
| Telephone and data switching, public | 434 | 457 | 465 |
| Television equipment, total | 366 | 378 | 415 |
| Broadcast equipment (including cameras, recorders, monitors) | 157 | 161 | 179 |
| CCTV (including educational, industrial, and medical) | 209 | 217 | 236 |

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **Test and measuring instruments, total** | **838** | **875** | **956** |
| Amplifiers, lab | 47 | 50 | 57 |
| Analog voltmeters, ammeters, and multimeters | 16 | 16 | 17 |
| Automatic test equipment, total | 303 | 310 | 347 |
| Component testers | 49 | 53 | 57 |
| IC testers | 197 | 195 | 217 |
| Pc-board testers | 57 | 62 | 73 |
| Calibrators and standards, active and passive | 14 | 14 | 15 |
| Counters, time and frequency | 32 | 34 | 37 |
| Digital multimeters (including probes and accessories) | 27 | 30 | 33 |
| Digital signal analyzers (Fourier analyzers and modal analyzers) | 24 | 25 | 27 |
| Logic analyzers | 16 | 19 | 23 |
| Microprocessor development systems | 72 | 76 | 82 |
| Microwave test and measuring instruments | 30 | 32 | 35 |
| Network analyzers | 11 | 12 | 13 |
| Oscillators | 21 | 22 | 24 |
| Oscilloscopes (including accessories) | 79 | 83 | 87 |
| Power meters (below microwave frequencies) | 15 | 15 | 16 |
| Recorders (including chart and X-Y types) | 43 | 43 | 45 |
| Signal generators (pulse, sweep, and function) | 59 | 61 | 63 |
| Spectrum analyzers | 29 | 33 | 35 |
| **Industrial electronic equipment, total** | **3,042** | **3,154** | **3,630** |
| Inspection systems | 94 | 118 | 176 |
| Machine-tool controls (including all numerical-control systems) | 347 | 415 | 495 |
| Motor controls | 179 | 206 | 243 |
| Process-control equipment (including computers, loggers, and consoles) | 1,214 | 1,391 | 1,584 |
| Semiconductor production equipment, total | 1,208 | 1,024 | 1,132 |
| Assembly (wire bonders, etc.) | 273 | 218 | 275 |
| Lithography (aligners, scribers, coaters, etc.) | 384 | 351 | 362 |
| Mask generation (digitizers, mask makers, etc.) | 71 | 58 | 74 |
| Wafer processing (furnaces, implanters, etchers, etc.) | 480 | 397 | 421 |
| **Power supplies (noncaptive), total** | **798** | **854** | **876** |
| Bench and lab | 41 | 45 | 50 |
| Industrial (heavy duty) | 85 | 94 | 95 |
| OEM and modular, total | 672 | 715 | 731 |
| Linear | 25 | 28 | 30 |
| Switching | 647 | 687 | 701 |

**All figures in current dollars.**
**Exchange rate: 235 yen to $1.**
The figures in this chart, based on a survey made by *Electronics* in October and November 1985, estimate the noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.

rate of about 314,000 units; in the first nine months of 1985, the total was just 2.29 million, an average of about 250,000 units a month.

In Japan, the 30% saturation level was reached in 1985, causing a 4% drop in domestic demand last year, according to Darrel E. Whitten, associate director of research for Prudential Bache Securities Far East (Tokyo). The *Electronics'* forecast predicts VCR sales in Japan will continue to increase, but at a modest 7% rate this year, to $3 billion.

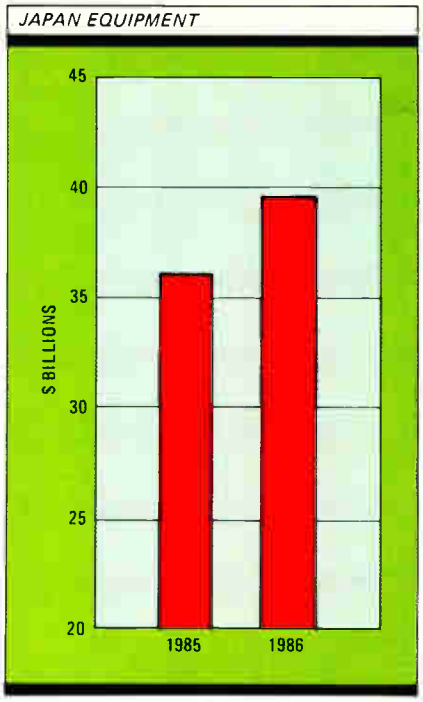
The huge U.S. market is not far behind. By the end of 1986, it will probably reach a 43% saturation level, meaning about 36 million homes will then have VCRs. Because the European and Japanese VCR markets combined are just two thirds the size of the U.S. market, the American slump is bound to have a broad impact on manufacturers. The drying up of exports means that Japanese VCR production will be down nearly 10% for 1986, Whitten says, following a like decrease in 1985. Industrywide, VCR production is now 80% of capacity and is on the decline.

The growing presence of Korean products in the U.S. mar-

ket is also hurting the Japanese sales. Buoyed by the strengthened yen and the resulting price rises for Japanese products, Korean VCRs are edging toward 12% of total U. S. sales.

Japan's consumer electronics manufacturers are hoping that video-disk players and 8-mm VCRs will be the next wave of hot products following the rising success of compact-disk audio players. Matushita, Sharp, and Victor are aggressively marketing their VHD video-disk players; Pioneer and Sony are pushing their laser-based players.

The CD player has considerably brightened Sony Corp.'s audio business, but the emergence of so many competitors could result in a profitless prosperity for all. Sony claims it sold 800,000 CD players worldwide in the fiscal year ending October 1985, as compared with 150,000 for fiscal 1984. Sony estimates it has about a 30% share of the world market, based on Japan's industrywide production of 3 million units. Demand by Japanese consumers for CD players will jump 29% this year, to $207 million, according to the *Electronics* survey. Industry sources say that the drop in demand for conventional record players just matches the increased demand for CD players.




Industry opinion about the future of 8-mm VCR technology is divided: some see an 8-mm boom; others predict consumer indifference. Sony, trying to recover from the battle its Beta VCR format lost to VHS, is promoting its 8-mm camcorder models. Though worldwide sales for 8-mm VCRs were only 500,000 in 1985, a Sony representative predicts that this figure will triple this year. "The 1985 figures were just 2% of the [conventional] VCR market sales," he says, "but we think that 8-mm sales will be 10% of VCR sales in 1986." Meanwhile, Canon Inc. announced that it is doubling its 8-mm production to 20,000 units per month, based on its recent marketing startup in Europe.

*Will 8-mm VCRs and video disk players be as hot as CD players?*

Sony is working on a variety of 8-mm products, searching for the one that will strike consumers' fancy. "Analysts are too concerned with price," says Haruyuki Machida, manager of press and public relations. "If the product is right, people will buy it. Our goal is to find products that will tap that disposable income we know is out there." Until someone comes up with such products, however, strong growth prospects in the Japanese consumer market, or in the U. S., are unlikely. Meanwhile, consumption of conventional VCR gear will receive some impetus from the millions of Japanese consumers who already own recorders and will purchase video cameras at a brisk pace this year, boosting consumption as much as 17%.

Whitten of Prudential Bache predicts that the slowdown in consumer electronics in Japan will force companies to diversify into industrial components, "for survival rather than growth." That's already happening at Sony, where component sales this year will be about $225 million, or roughly 4% of total company sales.

In the communications industry, the rising stars of the marketplace are facsimile machines. Consumption in 1985 advanced 24%, to $914 million, but growth this year should slow to about 18%, bringing the domestic market to almost $1.1 billion. However, total production, which includes machines for export, was up an impressive 24% last year. In 1986, Japanese manufacturers will increase production of fax equipment a whopping 42%, as suppliers exploit their near-monopoly in the world market. "Either the fax market will explode in 1986, or there's going to be blood on the walls in the wake of overproduction," says Connors of Jardine Fleming.

By the end of this year, he estimates that the world market for these machines will be worth $800 million; by the end of 1987, that figure will double. Japanese companies have an estimated 98% of the world market, he says.

At present, the penetration rate of fax machines in the U. S. is about 5% of all offices, compared with 15% in Japan. That Japanese manufacturers are bullish on the expansion of the U. S. market is seen in figures from Matsushita Graphic Communications Systems Inc., Tokyo. The company had planned a 42% increase for its total exports in 1985; the actual figure will be closer to 50%, or some 350,000 units, about half of them to the U. S. This figure is expected to double in 1986.

Other segments of the communications market—especially telephone receivers and digital private branch exchanges—are showing strong gains. Digital exchange sales, for example, were up almost 10% in 1985 and should achieve gains of 19% in 1986.

However, the Communications Industries Association of Japan believes the boom won't last forever. The Tokyo organization predicts an annual 8.2% worldwide growth rate overall in communications equipment in each of the next five years, down from the 14.5% rate of the past five.

The outlook for the Japanese market in test and measurement equipment is brightening. The growth in consumption last year dropped to a slim 4%, to $875 million, but it should more than double, to a 9% increase this year, to $956 million.

Nor will exports do much to brighten the outlook for Japanese test and measurement makers. Although Japanese companies now supply about 66% of domestic consumption, their penetration of the U. S. and European markets is low, well under 10%, according to W. I. Carr. The world market, valued at $6 billion in 1984, dropped to about $5.1 billion in 1985, but should resume modest single-digit growth this year and thereafter should pick up again, with growth rates rising 15% or even 20%, says W. I. Carr analyst Robert E. Johnson.

The semiconductor market slump has finally hit production-equipment makers full force, says Nippon Kogaku (Nikon), a leading maker of wafer steppers. It is reporting 1985 profits 30% below its forecast. The Japanese demand for semiconductor processing equipment slipped a significant 18% in 1985. With the expected upturn this year, consumption should improve 10.5% over last year's sales of slightly over $1 billion.

The factory-automation buildup in Japan continues, with robots sales strong. Although 1985 figures will not be published until this August, Paul Aron, vice chairman of Daiwa Securities in New York, predicts an increase in the total value of Japanese robots on the order of 45%—comparable to the increase reported in 1984. But the cost of developing new products and fierce competition among manufacturers has cut profit margins to the point where sales figures are no longer a firm barometer of how well equipment makers are doing.

"When a shakeout comes in a year or two, only the big companies—like Matsushita, Hitachi, and Mitsubishi—will be left," says Aron. "If smaller robots-only manufacturers survive, it will be because they have found a very specific niche—such as tape automated bonding for the electronics industry."

# A 9% RISE IN COMPONENT SALES WILL REVERSE 1985 DIP

As in the U.S., component demand in Japan will turn up again in 1986. Accelerating sales of integrated circuits for data-processing equipment, office-automation gear, and the smaller communications-equipment segment will pace the growth of semiconductors and other components in Japan this year. That's the consensus of Japanese executives responding to *Electronics'* market survey. Managers believe overall demand for components overall will rise almost 9% in 1986, to $19.3 billion, reversing a decline of just under 4% in 1985.

Hardest hit last year was the semiconductor segment, which recorded an overall drop in consumption of over 6%. But everyone participating in the *Electronics* survey sees a turnaround in semiconductor demand, with an expected 1986 growth of almost 13%. The Electronic Industries Association of Japan is even more optimistic, predicting that semiconductor sales will bounce back with a strong 25% jump. Memory consumption should rebound by close to 14%, to $1.3 billion, after a 15% decline last year, while total semiconductor consumption will likely exceed $7.88 billion, a bit higher than 1984's $7.5 billion.

The Japanese economy as a whole is experiencing declining growth rates, with the real gross national product slipping from almost 6% growth in 1984 to 5% in 1985, reports Gnostic Concepts Inc. The San Mateo, Calif., market researcher predicts that Japanese GNP growth will drop to 4% this year. Much of this is attributable to the Nakasone government's aggressive efforts to strengthen the yen against the dollar. The result will be a reduction in export profit margins. Were the GNP growth rate increasing rather than declining, recovery in the components industry would be even stronger.

That Japan is bullish on its semiconductor industry is seen by the big investment in production facilities last year. The Japanese increased MOS production capacity by 47% in 1985, even though their utilization of existing facilities was only 65%, according to Integrated Circuit Engineering Corp. The country now has the capacity to supply 65% of the world MOS market, estimates the Scottsdale, Ariz., consulting company.

Of course, sheer physical capacity is only part of the picture. Because of sharp price declines, the revenue per wafer has dropped from $445 to $380, ICE says. In addition, many new plants haven't yet begun operations, and underutilization means that production at some existing plants has diminished, especially in memory products. As a result, most suppliers are operating at far below their capabilities.

Another complicating factor is the effort by U.S. semiconductor makers, aided by strong U.S. government pressure, to win increased access to Japanese markets. Several major U.S. semiconductor producers, among them Texas Instruments, Motorola, and Fairchild, have established or are expanding semiconductor manufacturing capabilities in Japan. Moreover, the EIA-J, responding to allegations that the Japanese domestic market is closed to outsiders, maintains that total imports of ICs from the U.S. rose from $324 million in 1980 to $761 million in 1984, which works out to an increase of 135%.

Overall semiconductor consumption, including discretes, ICs, and optoelectronic devices, dropped by more than 6% last year, to $7 billion, according to the *Electronics* survey. Passive components dipped only 4% in 1985, to $8.8 billion, with capacitor sales down 16%, to $1.4 billion, and resistor demand down 6%, to $776 million. In 1986, semiconductors are expected to bounce back with a gain of almost 13%, to $7.9 billion, while passive components enjoy a 6% pickup, to $9.4 billion.

The main markets fed by these manufacturers are the consumer-electronics and data-processing industries. Demand in the consumer equipment market grew only 5%, to $10.7 billion, last year and is slated to drop to a 3% rate in 1986. Consumption of ICs for entertainment products will follow the same trend: after increasing 8% in 1985, to $897 million, demand will tail off to 3% in 1986.

Though the worldwide slowdown in industry growth the electronics industry rocked U.S. semiconductor manufacturers last year, Japanese makers were not as troubled, largely because of the health of the domestic consumer segment. Sales to consumer equipment makers may well falter, however, as their market weakens this year.

One piece of bad news for Japanese makers of TV sets, however, should not affect components makers. China has sharply cut back orders for Japanese TV sets and is importing receiver parts in kits rather than as finished products, a move dictated by the country's foreign-exchange crisis. In October 1985, the latest month for which export figures are available, Japanese makers shipped a total of 758,000 sets, a gain of 37% over the same month a year ago. About 255,000 of these units were marketed to China.

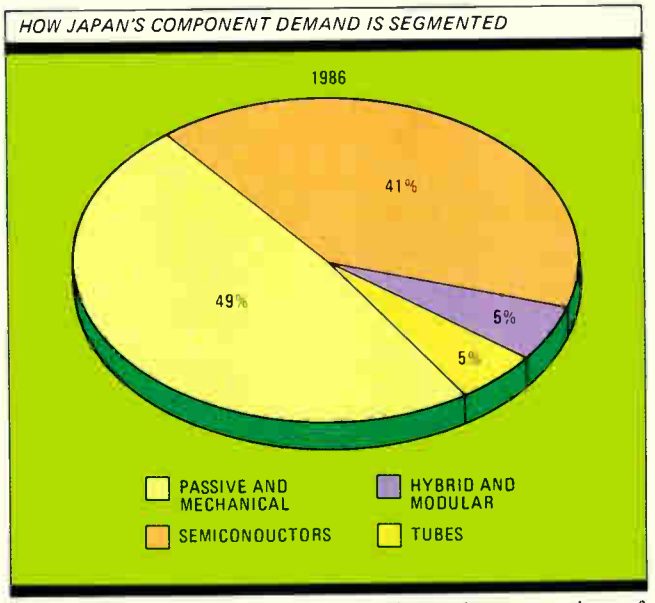
Adding to the woes of components makers is the slowing foreign market for video cassette recorders. Reduced VCR orders from the U.S. and from Europe—where exports have been below quotas—spell trouble for Japanese chipmakers, who will see their sales to domestic equipment makers fall. Moreover, the Koreans are entering the VCR market and are putting further pressure on Japanese export sales.

The sharply declining growth rate in the U.S. personal computer market has meant lower exports from Japan in peripherals equipment. Sales of printers and disk drives were especially hard hit last year, says Hitoshi Hoshi, a deputy manager in the marketing and sales-management staff at Toshiba's semiconductor group. At the same time, domestic personal-computer sales, which were mediocre last year, will turn around in the coming months, with sales to business especially good, he believes.

Strong growth in digital ICs will resume in 1986, as Japan continues its thrust to win market share in the world computer market. Bipolar logic families will show 15% growth, to more than $800 million, after a drop of 13% last year. CMOS parts will show an even bigger increase, of 19%, to $149 million.

Japanese consumption of memory devices slipped more than 15% last year, to $1.1 billion, but survey estimates indicate a strong turnaround of almost 14% this year. In the all-impor-

HOW JAPAN'S COMPONENT DEMAND IS SEGMENTED



tant market for dynamic random-access memories, overall dollar volume has fallen to less than half that of last year, says Masayuki Takegawa, manager of marketing and planning at Hitachi Ltd.'s electronic devices sales office in Tokyo. The drop is due to price erosion; demand was flat, he notes.

According to the *Electronics* survey, consumption of RAMs dropped about 12%, to $791 million, last year. This year, Takegawa continues, consumption of memories is expected to exceed last year's level, with the 256-K DRAM parts continuing to be the major industry product line.

Manufacturers turned out so many 256-K DRAMs in 1985 that original-equipment-manufacturer prices fell from $15 at the beginning of the year to $1.50 at the end. Prices of 64-K DRAMs fell through the floor, and supply was cut back to hike them up.

Toshiba's Hoshi claims that his company, which initially lagged in the 64-K DRAM race, has become a major contender in 256-K sales, but others dispute him. They say that Toshiba's lack of success with 256-K DRAMs is the reason that it jumped the gun in announcing 1-Mb parts, and its lead could be ephemeral. Other semiconductor makers are withholding introduction of these products for fear of competing with their own 256-K chips. Hitachi expects to announce its 1-Mb DRAM this spring, and Tomihiro Matsumura, senior vice president at NEC, says his company will introduce its chip in the first half of the year. Hitachi's Takegawa predicts that price crossover between 1-Mb and 256-K DRAMs could occur in late 1987; Hoshi says that it will not take place until 1988 or later.

Another segment of the business—the market for CMOS static RAMs—is surprisingly flat, according to Takegawa. These parts are not selling as well as had been predicted when it appeared likely that a flurry of portable computer products would be announced. The business is centered on 8-K by 8-bit CMOS SRAMs for portable Japanese-language word processors, as well as for portable computers. The Japanese word processors, unfortunately for chip makers, don't contain much memory. One new twist in the word-processor market is the Hitachi 4-Mb read-only memory. Besides ample capacity for the Japanese language's complex Kanji characters, the chip has enough room left over for program storage. Another application is storage of synthesized voice.

Introduction of a long-rumored battery-powered portable personal computer by IBM Corp. would add impetus to SRAM sales, says Takegawa. He adds that this would be a particularly attractive market for Japanese makers because, at present, there are no complaints about trade friction between Japan and the U.S. in SRAMs. Major manufacturers of SRAMs include Hitachi, NEC, Sony, and Toshiba.

## JAPAN COMPONENTS

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **COMPONENTS, total** | **18,388** | **17,743** | **19,284** |
| **Passive and mechanical, total** | **9,120** | **8,800** | **9,368** |
| Capacitors, total | 1,585 | 1,367 | 1,490 |
| Fixed | 1,537 | 1,326 | 1,452 |
| Variable | 48 | 41 | 38 |
| Connectors, plugs, and sockets | 1,180 | 1,217 | 1,305 |
| Filters, networks, and delay lines | 121 | 120 | 124 |
| Loudspeakers (OEM-type) | 292 | 304 | 312 |
| Microwave components | 213 | 227 | 232 |
| Printed circuits and interconnections | 813 | 893 | 921 |
| Quartz crystals (including mounts and ovens) | 216 | 217 | 221 |
| Readouts | 378 | 361 | 395 |
| Relays (for communications and electronics) | 343 | 310 | 317 |
| Resistors, total | 822 | 776 | 824 |
| Fixed | 357 | 342 | 367 |
| Potentiometers and trimmers, total | 465 | 434 | 457 |
| Composition | 450 | 421 | 443 |
| Wirewound | 15 | 13 | 14 |
| Servos, synchros, and resolvers | 115 | 121 | 125 |
| Switches and keyboards (for electronics), total | 623 | 587 | 641 |
| Transducers (pressure, temperature, motion, etc.) | 93 | 89 | 92 |
| Transformers, chokes, and coils (including TV yokes and flybacks) | 1,337 | 1,194 | 1,285 |
| Wire and cable, total | 989 | 1,017 | 1,084 |
| **Hybrid and modular, total** | **827** | **858** | **945** |
| Standard (ADCs, op amps, etc.) | 219 | 227 | 248 |
| Custom | 608 | 631 | 697 |
| **Tubes, total** | **974** | **1,093** | **1,087** |
| Cathode ray (except TV) | 63 | 63 | 67 |
| Image sensing (including camera tubes and intensifiers) | 21 | 27 | 31 |
| Light sensing (including photomultipliers) | 82 | 97 | 113 |
| Power tubes (below 1 GHz) | 27 | 27 | 29 |
| Microwave (including cooking) | 71 | 74 | 78 |
| Receiving | 9 | 8 | 9 |
| TV picture, total | 701 | 797 | 760 |
| Color | 678 | 769 | 728 |
| Monochrome | 23 | 28 | 32 |

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **Semiconductors, total** | **7,467** | **6,992** | **7,884** |
| Discrete, total | 1,789 | 1,669 | 1,814 |
| Diodes, total | 548 | 507 | 554 |
| Microwave (above 1 GHz), all types | 14 | 17 | 18 |
| Rectifiers and rectifier assemblies, total | 248 | 231 | 245 |
| Signal (less than 100 mA, including arrays) | 187 | 162 | 185 |
| Varactor (tuning) | 47 | 50 | 55 |
| Zener and reference | 52 | 47 | 51 |
| Thyristors (SCRs, Triacs, etc.) | 117 | 93 | 115 |
| Transistors, total | 1,124 | 1,069 | 1,145 |
| Bipolar, total | 953 | 914 | 982 |
| Power (more than 1-W dissipation) | 370 | 351 | 376 |
| Small-signal (including duals and arrays) | 583 | 563 | 606 |
| Field-effect, total | 89 | 81 | 83 |
| Rf and microwave (bipolar and FET, including GaAs) | 82 | 74 | 80 |
| ICs, total | 5,284 | 4,929 | 5,644 |
| Analog ICs, total | 1,355 | 1,441 | 1,517 |
| Communications (including telecom—codecs, etc.) | 94 | 97 | 101 |
| Entertainment | 832 | 897 | 924 |
| Interface (drivers, buffers, etc.) | 305 | 316 | 358 |
| Op amps (monolithic only) | 124 | 131 | 134 |
| Digital ICs, total | 3,929 | 3,488 | 4,127 |
| Standard logic families, total | 967 | 827 | 956 |
| Bipolar (TTL, Schottky, ECL, etc.) | 805 | 702 | 807 |
| CMOS | 162 | 125 | 149 |
| Memories, total | 1,319 | 1,146 | 1,302 |
| RAMs, total | 903 | 791 | 875 |
| ROMs total | 416 | 355 | 427 |
| Microprocessor and microcomputer chips | 887 | 807 | 996 |
| Special-purpose circuits | 632 | 571 | 705 |
| Semicustom logic (gate arrays) | 124 | 137 | 168 |
| Optoelectronic devices, total | 394 | 394 | 426 |
| Discrete light-emitting diodes | 259 | 243 | 245 |
| Image-sensing arrays | 26 | 39 | 56 |
| Laser diodes | 10 | 12 | 14 |
| Optically coupled isolators | 31 | 33 | 36 |
| Photodiodes and phototransistors (including arrays) | 35 | 33 | 35 |
| Solar (photovoltaic) cells | 33 | 34 | 40 |

**All figures in current U.S. dollars.**
**Exchange rate: 235 yen to $1.**
The figures in this chart, based on a survey made by *Electronics* in October and November 1985, estimate the consumption of components, valued at factory prices for domestic products and landed cost for imported products.

Sales of the smaller 2-K by 8-bit SRAMs have also fallen off, and 32-K by 8-bit SRAMs are still too expensive for volume applications. A small market exists for even more expensive high-speed SRAMs in cache memories and supercomputer main memories. For example, Fujitsu Ltd. will use 256-K CMOS SRAMs with access times of 55 ns in its new mainframe series, due in 1987.

Another group of products for which semiconductor manufacturers have had high hopes is semicustom logic products. Semicustom products were up over 10% last year, to $137 million, and are expected to pick up another 23% gain this year, to $168 million. Yet these growth rates mask a big disappointment for chip makers. The problem isn't lack of demand, which actually far exceeds the capability of manufacturers to supply customers' ever-burgeoning needs for new designs. Instead, the difficulty lies in too much competition and too many products, especially in gate arrays, resulting in deep cuts in price.

A Toshiba representative says that the number of product types introduced to the market has doubled since last year. At least one observer—Shunsuke Takada, liaison manager in Matsushita Electric Industrial Corp.'s corporate planning department—predicts that in the long run standard cells could be a more attractive product than gate arrays simply because there are fewer competitors.

Also, their very nature as semicustom products means these chips are manufactured at lower volumes than their mass-produced counterparts, so unit costs are higher. Yet customers have pressured the semiconductor industry to halve the price per gate from last year's cost, claiming that they're still paying too much on a per-area basis. For manufacturers, of course, sales volume doesn't justify the precipitous drop in price.

Demand is also increasing for erasable programmable ROMs, especially in the 256-K size, says Hitachi's Takegawa. The main activity is still in n-MOS devices, though CMOS products are gaining ground and many CMOS sizes are now available. EPROM exports are a good business for Japanese chip makers, although they are running into a flurry of dumping charges in the U. S.

Consumption of microcomputers and microprocessors is on the increase in Japan, with sales expected to reach close to the $1 billion level in Japan this year, a whopping 23% increase over last year. Especially popular are the low-power CMOS versions. Most 4-bit one-chippers are now CMOS, as are about half of the 8-bit one chippers and a smaller number of 8-bit multichip processors and some 16-bit products. More CMOS models are promised, including the complex 32-bit members of NEC Corp.'s upcoming V-series. Of special interest to customers are CMOS versions of the Z80, among them Hitachi Ltd.'s 64180, which includes direct-memory access and bank switching.

Two products that are growing at a comfortable pace are liquid-crystal displays and LCD driver chips. The growth of optoelectronic devices as a group should increase by 8%, to $426 million, this year. Growth would be much more rapid if IBM would introduce its portable PC and other companies jump on the laptop bandwagon, LCD vendors believe.

The development of more legible displays would also help expand the LCD market. A promising step was taken in this direction when Seiko Epson Corp. (then Suwa Seikosha) showed a prototype of a metal-insulator-metal-active matrix display in 1983. Seiko says it might put the line into production this year. For line-powered equipment, active competition will come from plasma-display panels offered by Fujitsu, Matsushita, NEC, and Dixy, a new company that will start volume production in late 1986.

The consumer industry is a major customer for semiconductor suppliers—and as it goes, so goes a hefty share of the discrete and IC market. And here the outlook is mixed, with but a 3% gain to $924 million expected in 1986.

Sales of Japanese word processors, for example, were brisk in 1985—750,000 units were shipped, fully 250,000 more than forecast originally. But because the majority of units were low-priced consumer products, it didn't much affect consumption of semiconductors.

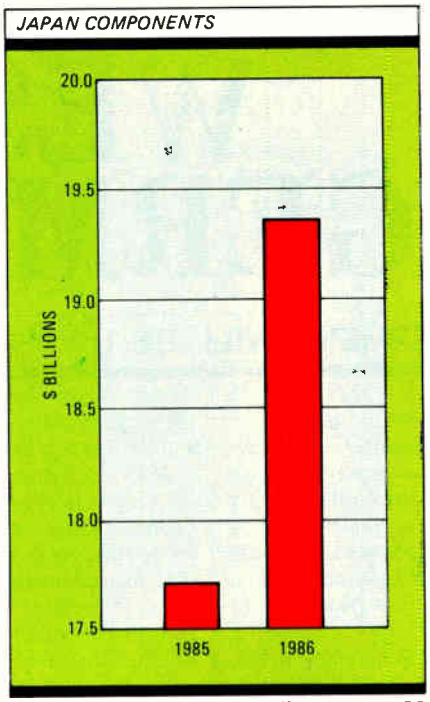
In the audio market, component suppliers are pinning their hopes on compact-disk players to drive up sales of expensive, higher-performance amplifiers. But, notes Matsushita's Takada, the rapid upswing in CD sales is coupled with a gradual reduction in demand for conventional record players, meaning that the overall stereo equipment market will consume more semiconductors only if amplifier sales rise. At the low end of the audio field, the sales of radio-cassette players are heading down and thus are not a source of growth for their manufacturers or for semiconductor suppliers.

Video-disk players are potentially a new volume market for semiconductors, but as yet production is low. The increasing popularity of the camcorder (a combination VCR and camera) could spur consumption of charge-coupled-device imagers. In fact, consumption of imaging arrays should grow a strong 15% this year, to $31 million, largely because of such new applications as camcorders for both 8-mm and ½-in. formats.

An encouraging development is the use of DRAMs for video memories. The demand for this technology was expected to emerge only with the advent of digital TV. But Toshiba's recently unveiled VCR, which uses semiconductor memories to provide slow-motion and freeze-frame options, brings with it the promise of other uses, including video-disk players and analog TV receivers. Memories for this application should have a different architecture than those used in computers; the technology is identical, however, and is not expected to create any problem when the market grows large enough to support the product.

The expected slowdown in sales of TV sets will have a big impact on the consumption of cathode-ray tubes. This year should see a decline of 5%, to $760 million, with color tubes affected more heavily than monochrome units. CRTs used for computer displays and the like should grow by 6%, to $67 million, however.

The consumption of communications ICs is expected to increase by only 4%, to $101 million this year, as quantities rise but prices begin to erode. However, the makers of fiber-optic cable can look to the telecommunications sector for strong growth—consumption of fiber-optic cable almost doubled in 1985 and will almost double again this year. The Japanese are engaged in a major modernization of their telecommunications network, and light-wave transmission is a key part of the plans.




*Semicustom product consumption is up, but prices are way down*

# WEST GERMANY

## DEMAND FOR EQUIPMENT WILL BE UP 8%, TO $22.2 BILLION

With the West German economy continuing to recover from the 1981-83 recession, the growth in demand for electronic equipment is accelerating, according to the *Electronics* market survey. Overall, equipment sales in West Germany should pick up about 8%, to $22.2 billion, an increase over last year's 6% growth. The fastest growth is expected from the communications sector, which should rise 14%, to $3.1 billion, up from the 9% increase in 1985. The data-processing sector will also improve over last year's growth rate, increasing from 7.5% to 8.6% this year, for a total of $13.2 billion. Industrial electronics, on the other hand, will show the same growth this year as it did in 1985, or a 7% rise to $1.1 billion. The industrial category should hit $1.1 billion in 1986.

This healthy market for all types of electronic products—business, industrial, and consumer—is fueled by an economy that will be growing 2.5% to 3% in 1986, predicts Richard Babic, an economist at Siemens AG, the country's largest producer of electronic equipment. This rate of improvement would represent a gain of at least half a percentage point over 1985.

*Communications sector will grow fastest, with 14% jump in 1986*

Agreeing is Manfred Beinder, chief economist at Standard Elektrik Lorenz AG, an ITT Corp. affiliate in Stuttgart. After six years of near-stasis, consumer consumption should be up from a minuscule 1% in 1985 to around 3% in 1986, Beinder says. Capital investment is expected to rise around 10%, roughly the same as during the year just ended. During the year ahead, price increases should be held to a moderate 1.5%. One nagging problem in 1986, though, is unemployment; 9% of the work force is without jobs.

The strong investment climate bodes particularly well for makers of data-processing systems. Networking is on the rise among West German businesses, as is the automation of offices and factories to offset rising labor costs. Both trends should mean a brisk year in computers.

A strong contender for a good share of that growth is the Unix operating system, predicts Jochen Rössner, senior marketing specialist at Sperry GmbH in Sulzbach, near Frankfurt. Its multitasking abilities make the AT&T Bell Laboratories system extremely popular with German corporations. Manufacturers who can offer a wide range of equipment based on Unix have excellent sales opportunities ahead of them, Rössner declares.

The personal computer subsector should also take off this year, the Sperry marketer says, scoring even greater gains than the data-processing market as a whole. And large-volume sales will take the sting out of declining prices. The *Electronics* survey projects a vigorous 29% jump this year in personal computers, to $1.2 billion. Systems selling for $5,000 to $20,000 should also be winners this year, with demand hitting $515 million, up over 10% of last year's needs. Mainframe computers, priced up to $1 million each, should also gain 10%, hitting $2 billion in 1986. That is a 30% increase over last year's almost 8% rise. For supercomputers, consumption will increase slightly to about $1.8 billion.

Makers of communications equipment have special reason to cheer capital-investment plans by the Bundespost, West Germany's postal authority. The Bundespost, which administers the country's public communications services, has earmarked a record $7.2 billion for capital investment in 1986, about 6% more than in 1985. And by far the biggest chunk—$6.7 billion—will be spent for communications equipment.

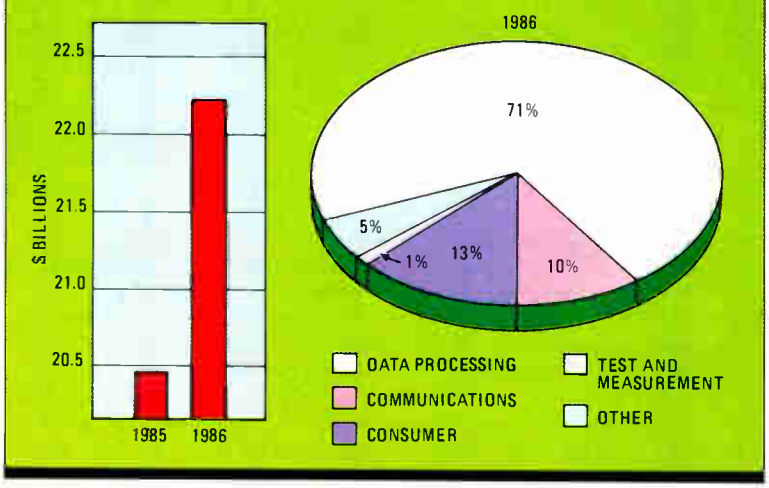
Among the items on the Bundespost's most-wanted list is equipment for digitizing the telephone network, for which it has allocated more than $1.1 billion, and hardware for extending cable-TV networks, for which $615 million has been set aside. In 1985, the Bundespost allotted $400 million for cable-TV expansion.

For public-telephone and data-switching systems, the *Electronics* survey predicts 19% growth, to $835 million. Telephone and telegraph carrier equipment will do even better, with a 21% increase to $841 million. Fiber-optic communications systems should rise 13% in 1986, to $35 million.

The market for microwave equipment, however, should see its growth decline somewhat because unusually high demand in 1985 satisfied market needs. The *Electronics* survey sees the microwave market still faring well, even though its 1986 growth is expected to hit 22%, down from last year's 28% rate, bringing it to $135 million.

"For the private communications sector, we expect a positive picture, too," says Hans Otto Matt, of Siemens's market research staff. Consumption of facsimile equipment, for example, should rise

WEST GERMAN EQUIPMENT



## WEST GERMANY EQUIPMENT

(millions of dollars)

| | 1984 | 1985 | 1986 |
|---|---|---|---|
| **EQUIPMENT, total** | **19,274** | **20,483** | **22,175** |
| **Data-processing and office equipment, total** | **11,271** | **12,113** | **13,154** |
| Data-processing systems, total | 8,053 | 8,644 | 9,356 |
| Personal computers (less than $5,000) | 717 | 954 | 1,231 |
| Microcomputers ($5,000 to $20,000) | 435 | 468 | 515 |
| Minicomputers ($20,000 to $100,000) | 1,864 | 1,908 | 1,937 |
| Superminicomputers ($100,000 to $400,000) | 1,593 | 1,710 | 1,875 |
| Mainframe computers ($400,000 to $1 million) | 1,724 | 1,855 | 2,038 |
| Supercomputers (greater than $1 million) | 1,720 | 1,749 | 1,760 |
| Data-input peripherals | 122 | 137 | 152 |
| Data-output peripherals | 491 | 544 | 603 |
| Data-storage subsystems | 1,223 | 1,315 | 1,442 |
| Data terminals | 744 | 823 | 934 |
| Electronic office equipment, total | 638 | 650 | 667 |
| Copying equipment | 370 | 374 | 381 |
| Electronic typewriters | 145 | 149 | 153 |
| Billing and accounting equipment | 123 | 127 | 133 |
| **Consumer products, total** | **4,000** | **4,028** | **4,179** |
| Audio equipment, total | 1,619 | 1,603 | 1,606 |
| Car audio | 246 | 251 | 257 |
| Stereo equipment, total | 646 | 636 | 633 |
| Components (including tuners, turntables) | 453 | 438 | 441 |
| Consoles and compact systems (including TV-audio combinations) | 193 | 198 | 192 |
| Phonographs and radio-phono combinations | 181 | 167 | 155 |
| Radios (including table, clock, and portable) | 105 | 101 | 97 |
| Radio-recorder combinations, portable | 184 | 181 | 184 |
| Tape recorders and players | 218 | 205 | 195 |
| Compact-disk players | 39 | 62 | 85 |
| Television receivers, total | 1,099 | 1,122 | 1,168 |
| Color | 1,064 | 1,091 | 1,142 |
| Monochrome | 35 | 31 | 26 |
| Other consumer electronic products, total | 1,282 | 1,303 | 1,405 |
| Home video equipment, total | 788 | 779 | 829 |
| Cassette players and recorders | 687 | 646 | 675 |
| Cameras | 73 | 108 | 131 |
| Video disk players | 28 | 25 | 23 |
| Electronic musical instruments | 84 | 87 | 90 |
| Microwave ovens | 57 | 83 | 127 |
| Electronic games (video and nonvideo) and toys | 90 | 80 | 75 |
| Calculators (personal and professional) | 47 | 37 | 31 |
| Electronic watches and clocks | 216 | 237 | 253 |
| **Power supplies (noncaptive), total** | **139** | **155** | **174** |
| Bench and lab | 11 | 12 | 13 |
| Industrial (heavy duty) | 32 | 33 | 34 |
| OEM and modular, total | 96 | 110 | 127 |
| Linear | 48 | 50 | 52 |
| Switching | 48 | 60 | 75 |

(millions of dollars)

| | 1984 | 1985 | 1986 |
|---|---|---|---|
| **Communications equipment, total** | **2,517** | **2,737** | **3,112** |
| Data-communications equipment | 92 | 104 | 122 |
| Facsimile-terminal equipment | 34 | 37 | 42 |
| Fiber-optic communications systems | 26 | 31 | 35 |
| Intercom systems | 97 | 101 | 107 |
| Paging systems, public and private | 26 | 27 | 29 |
| Radar-air, land and marine | 141 | 156 | 161 |
| Radio, total | 284 | 326 | 363 |
| Broadcast equipment | 48 | 50 | 52 |
| Microwave systems | 87 | 111 | 135 |
| Mobile, land | 114 | 127 | 138 |
| Satellite earth stations | 35 | 38 | 38 |
| Telecommunications systems, total | 1,742 | 1,873 | 2,165 |
| Telephone and data switching, private (PABX) | 478 | 475 | 489 |
| Telephone and data switching, public | 623 | 702 | 835 |
| Telephone and telegraph carrier | 641 | 696 | 841 |
| Television equipment, total | 75 | 82 | 88 |
| Broadcast (studio) equipment (including cameras, recorders, and monitors) | 50 | 53 | 57 |
| CCTV (including educational, industrial, and medical) | 25 | 29 | 31 |
| **Test and measuring instruments, total** | **379** | **418** | **455** |
| Amplifiers, lab | 4 | 5 | 5 |
| Analog voltmeters, ammeters, and multimeters | 9 | 9 | 10 |
| Automatic test equipment, total | 99 | 113 | 110 |
| IC testers | 56 | 66 | 59 |
| Pc-board testers | 43 | 47 | 51 |
| Calibrators and standards, active and passive | 4 | 4 | 4 |
| Counters, time and frequency | 14 | 15 | 17 |
| Digital multimeters (including probes and accessories) | 17 | 21 | 30 |
| Logic analyzers | 16 | 16 | 20 |
| Microprocessor-development systems | 51 | 54 | 56 |
| Microwave test and measuring instruments | 32 | 36 | 42 |
| Oscillators | 11 | 11 | 12 |
| Oscilloscopes (including accessories) | 60 | 68 | 74 |
| Power meters (below microwave frequencies) | 5 | 5 | 6 |
| Recorders (including chart and X-Y types) | 28 | 30 | 32 |
| Signal generators (pulse, sweep, and function), total | 13 | 13 | 14 |
| Analog | 8 | 7 | 7 |
| Digital | 5 | 6 | 7 |
| Spectrum analyzers | 16 | 18 | 23 |
| **Industrial electronic equipment, total** | **968** | **1,032** | **1,101** |
| Inspection systems | 17 | 18 | 19 |
| Machine-tool controls (including all numerical-control systems) | 78 | 85 | 91 |
| Motor controls | 126 | 134 | 143 |
| Photoelectric controls | 56 | 60 | 64 |
| Process-control equipment (including computers, loggers, consoles) | 608 | 647 | 690 |
| Semiconductor production equipment | 83 | 88 | 94 |

**All figures in current U.S. dollars. Exchange rate: 2.75 marks to $1.**

13.5%, to $42 million, according to the *Electronics* survey, and so should consumption of display terminals, text-processing systems, and electronic typewriters used in the telecommunications sector. As for private-branch exchanges, market saturation means sales will be flat, with most activity in replacement of analog systems by digital.

West Germany's telecommunications infrastructure is one of the most up-to-date in Europe, with its long-distance trunk networks almost entirely digital at the end of last year. By 1990, all new exchanges will be digital, with 3 million subscribers served by 200 digital local exchanges. Close to $2 billion was spent last year for this effort; an additional $2.1 billion is set this year, which accounts for the 16% growth estimated by *Electronics* for telecommunications as a whole.

In March of this year, pilot trials for the long-awaited integrated services digital network will begin and continue through 1988. The successful completion of this program will have an enormous impact on the telecommunications industry worldwide. Two experimental ISDN exchanges will be evaluated, one from SEL and the other from Siemens. The SEL switch, based on the ITT System 12, will serve 400 subscribers in Stuttgart, while service for another 400 in the Mannheim area will be controlled by a system designed around Siemens's EWSD digital switch.

By 1990, a broadband ISDN service labeled ISDN-B will be put into service using extensive fiber-optic links to support broadcast distribution, video telephones, and video conferencing. Also in the trial stage is a public videoconferencing service, with 12 centers around the country connected by a fiber-optic trunk network; Berlin uses a satellite connection, which will eventually be replaced with a fiber-optic link. Present fees run about $300 an hour for videoconferences within West

Germany, $400 per hour to link with other European cities, and to $800 per hour to hook up with U.S. video centers.

Siemens is aggressively pursuing the U.S. market for sales of its telecommunications products. Of the 1.5 million telex terminals installed around the world, close to one third are the Munich company's products, with the majority purchased by U.S. companies. Its EWSD digital exchanges are well accepted by communications equipment buyers around the world, as evidenced by over $1 billion in purchase orders. In addition, its joint alliance with Corning Glass Works in the optical-fiber market has earned Siemens recognition as a leading producer of this product.

With the distinction between computing and communications blurring, Nixdorf Computer AG has set its plans to derive half its future sales income from each category; last year, the company's sales exceeded $1 billion, with telecommunications products accounting for only 10% of the total. The date to achieve the 50 : 50 product mix is not clear as yet, says Horst Nasko, head of the telecommunications division, but could be within a decade or so. Convinced that data and voice would eventually be integrated in factory and office-automation systems, the company has made it a practice to use the same engineering staff to design its computers and its telecommunications products.

Makers of test and measurement equipment will also benefit from German industry's capital-spending plans. This market is gaining impetus from the growing use of microprocessors in all types of products, a phenomenon that's creating heavy demand for such advanced gear as microprocessor-development systems and logic analyzers. Development systems will be up only 4%, to $56 million, but logic analyzers will be up 25%, to $20 million. Surprisingly, automatic test equipment should drop 3% this year, to $110 million, largely because of an almost 11% drop in consumption of IC test equipment. However, board testers should rise 8.5%, to $51 million. In the oscilloscope market, which will be up around 9% in 1986, hitting $74 million, analog types are fast being replaced by digital versions.

West Germany's consumer sector is finally due for an upturn, moderate though it will be. Besides the improved economy and an upcoming tax cut, both of which will put more money in consumers' pockets, there's a pent-up demand for sophisticated gear for the home. These factors point to a 2% rise in the demand for consumer electronics products in 1986, according to Johanna von Ronai-Horvath, market researcher at ITT's Consumer Products Group in Pforzheim. "That increase won't knock you over, but given the high level of saturation for many items, it's not all that bad," she says. It beats 1985's under-1% growth, and a number of new products such as compact-disk players should perform particularly well.

*Electronics'* consensus figures are a bit more optimistic, predicting a 4% growth, with consumption rising to $4.2 billion. Video cassette recorders, CD players, and particularly microwave ovens will head the public's wish list. Microwave ovens are headed for sales exceeding $125 million, a booming gain of 53% over last year's $83 million.

## COMPONENTS MARKET SHOULD HIT NEW HIGH OF $4 BILLION

West Germany's components markets are picking up speed and should improve considerably this year; demand should rise a healthy 7%, according to the *Electronics* market survey. That would carry them beyond the $4 billion mark for the first time. They also stood up reasonably well last year—at least, compared to what was going on in such volatile markets as the U.S. The nation's suppliers of passive and active components scored a slim 1.4% gain overall in 1985.

Although semiconductors get the most attention, passive and mechanical components account for half the total parts business in West Germany. The survey consensus puts the 1986 rise in this sector at 4%, which would push the total to $2.1 billion.

The bright spot in last year's market was electromechanical devices, with a 14% gain, according to the Central Association for the Electrotechnical Industry. The Frankfurt association estimates that passive and active devices went up 5% and 4%, respectively. For 1986, the association is counting on an increase of at least 5% for the overall components sector, slightly more optimistic than the *Electronics* estimate. For tubes, the *Electronics* survey respondents put this year's growth in consumption at 4%. The market should hit $458 million in 1986, according to the survey.

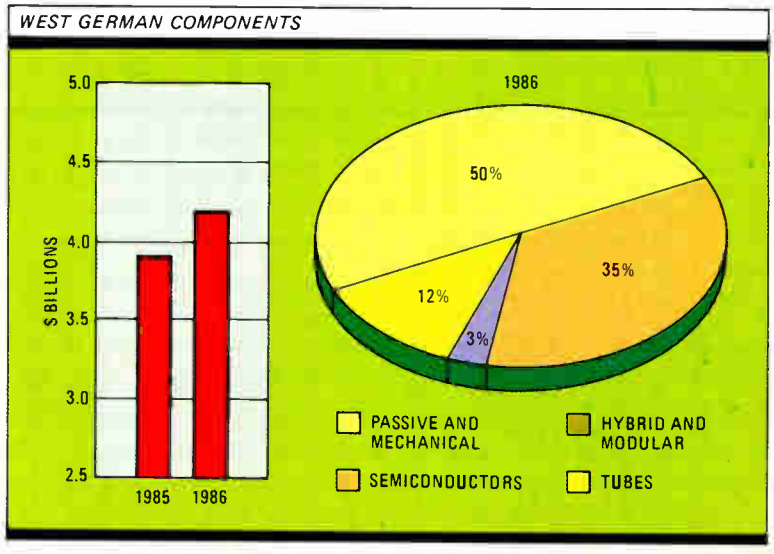
As for semiconductor sales, they slipped about 3% last year, even though markets were sagging elsewhere in Western Europe. In the view of Hans Hein, head of market research for Siemens AG's components group in Munich, "the worldwide slump is finally catching up with us and is holding growth this year to 5%." This estimate is considerably more pessimistic than the *Electronics'* survey consensus, which forecasts a resounding rebound of 13%, to $1.48 billion, as industry demand for new automated factory equipment hits the desks of purchasing agents.

The strongest gain, according to the *Electronics* survey, will be integrated circuits, which are pegged for a spurt of 26%, to $1.17 billion. Some market watchers will find that figure very optimistic. Hein, for example, spots the gain at a more conservative 5% to 10%.

Discrete parts will increase 4%, to $309 million, according to the *Electronics* survey. That rise matches reasonably well with Hein's increase of between 3% and 4%.

For European makers of ICs, a major problem is how to keep up with the Japanese and Americans in this fast-growing, but not always profitable, business. Siemens, for one, is determined to keep a strong presence. The Munich company was the first European company to produce 64-K dynamic random-access memories and is manufacturing 256-K memories. Semiconductors accounted for more than half the component group's sales last year.

In a bold attempt to muscle its way into the market for next-generation random-access memories, Siemens joined forces last year with Dutch giant Philips to develop leading-edge RAMs. Over a five-year period, Philips and Siemens,



Europe's No. 1 and No. 2 electronics companies, respectively, will invest some $560 million of research and development money in the venture, known as the Mega project. The German government will contribute some $130 million, and the Dutch government has indicated it will come up with about half that amount. The project calls for Siemens to concentrate on 1- and 4-Mb dynamic RAMs, while Philips tackles 1-Mb static RAMs.

Besides its collaboration with Philips, Siemens also has a long-standing relationship with Intel Corp. that includes second-sourcing the popular 8086 microprocessor and similar rights to 32-bit designs. The Munich company is also looking to open production, design, and marketing facilities in the U.S. and—despite its unsuccessful bid to buy Allen-Bradley Co.—to acquire U.S. passive-components plants.

At the same time that Siemens and Philips join forces in the Mega Project, they are squaring off as competitors in the market for surface-mounted devices. Siemens says the devices account for only 5% of its electronic components sales; the company hopes to increase that to 50% by 1990. European manufacturers, like their U.S. counterparts, are steadily increasing the use of SMDs in their equipment; Philips estimates the proportion will rise from 14% last year to 35% by the end of the decade. (In the U.S., SMD usage should jump from 30% to 50% in the same time span.)

For example, European makers are expected to buy twice as many surface-mountable capacitors in 1990 than they did in 1985. In sales figures, that's a rise from $80 million to $160 million. Likewise, the fixed-resistor market will catapult from last year's $11 million in sales to $55 million by the end of the decade; a similar upswing will take place among IC specifiers, where European consumption will jump from 500 million units in 1985 to 2.5 billion by 1990, according to Philips.

To take advantage of SMD benefits—such as reduced board size, a more fully automated assembly process, and improved reliability—equipment makers must invest in sophisticated assembly and testing gear. SMD equipment costs range from $250,000 to several million dollars, depending on the size of the machinery and the volume of the production run. Siemens and Philips, early suppliers of such equipment, are facing competition from U.S. and Japanese vendors eager to fulfill orders placed by European manufacturers.

Meanwhile, the telecommunications sector should buoy the demand for components, thanks in part to an experiment by the Bundespost, the government communications authority. The Bundespost last year gave a trial run to Siemens's C450 cellular-radio system, and regular service is slated to begin by the middle of this year. Within a few years, the Bundespost expects to have 100,000 subscribers, each paying a nominal $40 per month fee plus equipment costs.

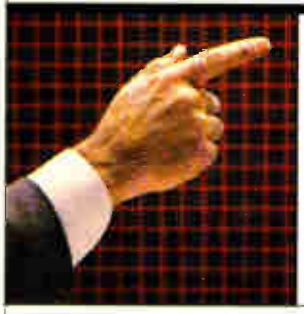
Initially, these costs are running $3,000 for transceiver and headset. But as demand picks up, such mobile-phone suppliers as AEG, Motorola, and ITT's Standard Electrik Lorenz, along with Philips and Siemens, will step up production and cut prices to around $2,000. With the cellular phone system able to handle 200,000 customers, that means a $400 million market for equipment on the horizon, with lots of active and passive components needed to make it happen. The *Electronics* study estimates a 16% increase this year in consumption of telecommunication ICs to $71 million. As soon as the demand for mobile phones reaches the production line, the demand for these chips will soar.

## WEST GERMANY COMPONENTS

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **COMPONENTS, total** | **3,843** | **3,897** | **4,184** |
| **Passive and mechanical, total** | **1,906** | **2,027** | **2,112** |
| Capacitors, total | 323 | 339 | 343 |
| Fixed | 313 | 328 | 333 |
| Variable | 10 | 11 | 10 |
| Connectors, plugs, and sockets | 383 | 443 | 491 |
| Filters, networks, and delay lines | 41 | 43 | 44 |
| Loudspeakers (OEM-type) | 75 | 78 | 80 |
| Printed circuits and interconnections | 527 | 545 | 557 |
| Quartz crystals | 37 | 38 | 39 |
| Readouts (optoelectronic and LCD) | 22 | 22 | 23 |
| Relays (for communications and electronics) | 103 | 107 | 113 |
| Resistors, total | 148 | 151 | 151 |
| Fixed | 86 | 87 | 87 |
| Potentiometers and trimmers | 62 | 64 | 64 |
| Switches and keyboards (for electronics) | 121 | 126 | 134 |
| Transformers, chokes, and coils | 126 | 135 | 137 |
| **Hybrid and modular components, total** | **113** | **119** | **131** |
| **Tubes, total** | **478** | **440** | **458** |
| Cathode ray (except for TV) | 13 | 16 | 17 |
| Image sensing (including camera tubes and intensifiers) | 16 | 17 | 18 |
| Light sensing (including photomultipliers) | 9 | 9 | 9 |
| Power tubes (less than 1 GHz) | 29 | 29 | 30 |
| Microwave (including cooking) | 39 | 40 | 41 |
| Receiving | 3 | 2 | 2 |
| TV picture, total | 369 | 327 | 341 |
| Color | 364 | 322 | 336 |
| Monochrome | 5 | 5 | 5 |

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **Semiconductors, total** | **1,346** | **1,311** | **1,483** |
| Discrete, total | 288 | 297 | 309 |
| Diodes, total | 118 | 121 | 123 |
| Microwave (less than 1 GHz) | 4 | 4 | 4 |
| Rectifiers and rectifier assemblies | 65 | 66 | 68 |
| Signal (less than 100 mA, including arrays) | 26 | 26 | 26 |
| Varactor (tuning) | 6 | 6 | 6 |
| Zener and reference | 17 | 19 | 19 |
| Thyristors (including SCRs and triacs) | 41 | 43 | 47 |
| Transistors, total | 129 | 133 | 139 |
| Bipolar, total | 115 | 119 | 125 |
| Power (more than 1 W dissipation) | 64 | 66 | 71 |
| Small-signal (including duals and arrays) | 51 | 53 | 54 |
| Field-effect | 9 | 9 | 9 |
| RF and microwave (bipolar and FET, including GaAs) | 5 | 5 | 5 |
| Integrated circuits, total | 985 | 932 | 1,174 |
| Analog ICs, total | 228 | 237 | 256 |
| Communications (including telecom—codecs, etc.) | 58 | 61 | 71 |
| Entertainment | 112 | 115 | 124 |
| Interface (drivers, buffers, translators, etc.) | 27 | 28 | 28 |
| Op amps (monolithic only) | 31 | 33 | 33 |
| Digital ICs, total | 757 | 695 | 826 |
| Standard logic families, total | 284 | 245 | 306 |
| Bipolar | 191 | 163 | 207 |
| CMOS | 93 | 82 | 99 |
| Memories, total | 208 | 194 | 187 |
| RAM | 145 | 138 | 134 |
| ROM | 63 | 56 | 53 |
| Microprocessor and microcomputer chips | 171 | 157 | 197 |
| Special-purpose circuits | 72 | 66 | 86 |
| Semicustom logic (gate arrays) | 22 | 33 | 50 |
| Optoelectronic devices | 73 | 82 | 92 |

**All figures in current dollars.**
The figures in this chart, based on a survey made by *Electronics* in October and November 1985, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
**Exchange rate: 2.75 marks to $1.**



# UNITED KINGDOM

## DEMAND WILL RISE JUST 6%, CONTINUING THE SLOWDOWN IN GROWTH

During the early 1980s, the electronics industry in the United Kingdom set the pace for the rest of Western Europe, fueled principally by a booming market for home and small computers. So inevitably, last year's collapse of these computer markets has put a damper on the rest of the industry. From double-digit growth in 1984, equipment markets slid back to a gain of less than 7% in 1985, according to *Electronics*' survey, and an even-lower 6% rise is predicted for 1986. If the UK equipment business hits this mark, it will total $14.7 billion this year, according to respondents to the survey.

In the crucial data-processing equipment sector, last year's gain was about 9%, a reasonable hike for most segments but disappointing for the high-growth computer industry. In 1986, the growth rate should tail off to 7%, putting the market, including office equipment, at close to $8 billion.

*Communications gear sets 1986 pace with gain of 7%*

Instead of topping the growth list, as they did last year, computers will trail communications equipment, which will run at about the same rate as last year—a gain of close to 8%, for total consumption in 1986 of $3.1 billion. Sales of industrial equipment are expected to move up by some 7%, to $373 million, as British industrialists update their factories, adding capacity and automation through improved process-control equipment and robotic systems. Instrumentation should grow at the same pace, bringing the sector to $268 million. That leaves consumer electronics as the only major sector to lag data-processing hardware in growth. The consensus in consumer electronics is a rise of almost 4% this year, to $3 billion.

The woes of Britain's home computer makers have been acute for a year now. After a disastrous Christmas selling period in 1984, two of the major players, Sinclair Research Ltd. and Acorn Computers, found themselves awash in inventory. And Micro-Focus Ltd., a supplier of business microcomputer software, had to lay off staff in order to survive.

During the second quarter of 1985, shipments of home computers ran 41% lower than the first quarter, which was already depressed by retailers failing to replenish inventories. But by the end of 1985, the picture was improving. The British Radio and Electronic Equipment Manufacturers Association (Brema) claims the gap between deliveries and stock was narrowing and heading toward equilibrium. Sales of home computers are forecast to net $313 million in 1985, according to IDC Europa Ltd., well below 1984's figure of $402 million. Several UK retail dealers estimate that 1985 sales will be less than 900,000 units, down significantly from 1.5 million in 1984.

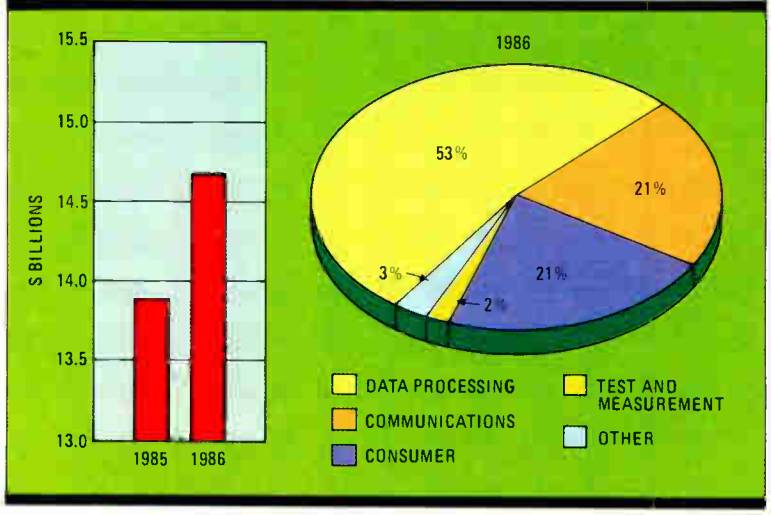
The year of the slump in the personal computer market brought financial crises to former high-flyers Acorn Computers and Sinclair Research. And by late last year, yet another maker of business personal computers, Apricot Ltd., was in trouble. Italy's Ing. C. Olivetti & C. bailed out Acorn, and founder Sir Clive Sinclair was saddled with a rescue package that cut his holdings and stripped his day-to-day management of the firm. At the moment, Sinclair reports strong sales of its ZX Spectrum Plus.

Along with tough times for home computers, 1985 saw the structural changes in Britain's consumer electronics industry beginning to surface, as production of locally assembled video cassette recorders and TV sets got into full stride.

For example, according to Brema, the industry expects that 1985 figures will show record exports of color TV sets, with sales in the first half of the year 18% higher than in the same period in 1984. Without these exports, UK TV makers would have registered a slide: the domestic market for color TV sets edged off to $811 million last year from 1984's $827 million, according to the survey. The outlook for the year ahead is a 5% rise, to $853 million. Also, says Brema, UK production of VCRs is rising, with new Japanese facilities coming on stream. These plants can meet 20% of local demand, and exports from these plants were at a record high, with 1985 up 40% over 1984.

Hard times were not confined to the home computer people. The telecommunications sector saw its ever-upward trend checked in 1985 as British Telecom cut back on orders from suppliers to reduce its heavy inventory levels. STC, one of several troubled British companies in 1985, suffered particularly and closed several production lines. Furthermore, software problems with System X, the mainstay public-switching exchange, slowed up the deliveries of digital exchanges and cut the profits of Plessey Co. plc. All the same, growth in the digital-exchange market last year was almost 9% and should

UNITED KINGDOM EQUIPMENT



## UNITED KINGDOM EQUIPMENT

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **EQUIPMENT, total** | **12,942** | **13,839** | **14,691** |
| **Data-processing and office equipment, total** | **6,797** | **7,377** | **7,851** |
| Data-processing systems, total | 4,266 | 4,651 | 4,966 |
| Personal computers (less than $5,000) | 576 | 659 | 632 |
| Microcomputers ($5,000 to $20,000) | 584 | 621 | 663 |
| Minicomputers ($20,000 to $100,000) | 350 | 413 | 466 |
| Superminicomputers ($100,000 to $400,000) | 765 | 819 | 885 |
| Mainframe computers ($400,000 to $1 million) | 1,050 | 1,119 | 1,215 |
| Supercomputers (greater than $1 million) | 941 | 1,020 | 1,105 |
| Data-input peripherals | 87 | 95 | 104 |
| Data-output peripherals | 345 | 368 | 383 |
| Data-storage subsystems | 824 | 905 | 1,015 |
| Data terminals | 561 | 624 | 632 |
| Electronic office equipment, total | 714 | 734 | 751 |
| Copying equipment | 390 | 391 | 388 |
| Electronic typewriters | 181 | 198 | 212 |
| Billing and accounting equipment | 143 | 145 | 151 |
| **Consumer products, total** | **2,859** | **2,923** | **3,030** |
| Audio equipment, total | 839 | 836 | 843 |
| Car audio | 85 | 88 | 92 |
| Stereo equipment, total | 216 | 234 | 239 |
| Components (including tuners, turntables) | 152 | 145 | 150 |
| Consoles and compact systems (including TV-audio combinations) | 64 | 89 | 89 |
| Phonographs and radio-phono combinations | 171 | 153 | 155 |
| Radios (including table, clock, and portable) | 63 | 59 | 56 |
| Radio-recorder combinations, portable | 158 | 154 | 151 |
| Tape recorders and players | 140 | 135 | 131 |
| Compact-disk players | 6 | 13 | 19 |
| Television receivers, total | 864 | 843 | 883 |
| Color | 827 | 811 | 853 |
| Monochrome | 37 | 32 | 30 |
| Other consumer electronic products, total | 1,156 | 1,244 | 1,304 |
| Home video equipment, total | 592 | 634 | 663 |
| Cassette players and recorders | 561 | 599 | 615 |
| Cameras | 27 | 32 | 45 |
| Video disk players | 4 | 3 | 3 |
| Electronic musical instruments | 54 | 57 | 61 |
| Microwave ovens | 214 | 250 | 268 |
| Electronic games (video and nonvideo) and toys | 18 | 16 | 15 |
| Calculators (personal and professional) | 132 | 135 | 138 |
| Electronic watches and clocks | 146 | 152 | 159 |
| **Power supplies (noncaptive), total** | **97** | **100** | **105** |
| Bench and lab | 11 | 12 | 12 |
| Industrial (heavy duty) | 22 | 24 | 26 |
| OEM and modular, total | 64 | 64 | 67 |
| Linear | 27 | 27 | 27 |
| Switching | 37 | 37 | 40 |

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **Communications equipment, total** | **2,626** | **2,841** | **3,064** |
| Data-communications equipment | 80 | 95 | 115 |
| Facsimile-terminal equipment | 25 | 28 | 32 |
| Fiber-optic communications systems | 15 | 18 | 22 |
| Intercom systems | 15 | 16 | 17 |
| Paging systems, public and private | 33 | 35 | 37 |
| Radar-air, land and marine | 645 | 691 | 728 |
| Radio, total | 255 | 272 | 294 |
| Broadcast equipment | 71 | 76 | 81 |
| Microwave systems | 23 | 25 | 27 |
| Mobile, land | 146 | 155 | 167 |
| Satellite earth stations | 15 | 16 | 19 |
| Telecommunications systems, total | 1,461 | 1,584 | 1,711 |
| Telephone and data switching, private (PABX) | 257 | 279 | 303 |
| Telephone and data switching, public | 811 | 882 | 959 |
| Telephone and telegraph carrier | 393 | 423 | 449 |
| Television equipment, total | 97 | 102 | 108 |
| Broadcast (studio) equipment (including cameras, recorders, and monitors) | 73 | 77 | 81 |
| CCTV (including educational, industrial, and medical) | 24 | 25 | 27 |
| **Test and measuring instruments, total** | **239** | **250** | **268** |
| Amplifiers, lab | 2 | 2 | 2 |
| Analog voltmeters, ammeters, and multimeters | 9 | 10 | 10 |
| Automatic test equipment, total | 45 | 44 | 50 |
| IC testers | 22 | 21 | 24 |
| Pc-board testers | 23 | 23 | 26 |
| Calibrators and standards, active and passive | 3 | 3 | 3 |
| Counters, time and frequency | 16 | 17 | 19 |
| Digital multimeters (including probes and accessories) | 17 | 18 | 20 |
| Logic analyzers | 8 | 8 | 9 |
| Microprocessor-development systems | 26 | 30 | 27 |
| Microwave test and measuring instruments | 12 | 14 | 16 |
| Oscillators | 3 | 3 | 3 |
| Oscilloscopes (including accessories) | 36 | 37 | 39 |
| Power meters (below microwave frequencies) | 1 | 1 | 1 |
| Recorders (including chart and X-Y types) | 21 | 21 | 21 |
| Signal generators (pulse, sweep, and function), total | 29 | 31 | 34 |
| Analog | 14 | 15 | 16 |
| Digital | 15 | 16 | 18 |
| Spectrum analyzers | 11 | 11 | 14 |
| **Industrial electronic equipment, total** | **324** | **348** | **373** |
| Inspection systems | 4 | 5 | 5 |
| Machine-tool controls (including all numerical-control systems) | 22 | 24 | 25 |
| Motor controls | 38 | 40 | 44 |
| Photoelectric controls | 16 | 18 | 19 |
| Process-control equipment (including computers, loggers, and consoles) | 205 | 223 | 242 |
| Semiconductor production equipment | 39 | 38 | 38 |

**All figures in current U. S. dollars. Exchange rate: $1.40 to 1 pound sterling.**

be about the same in 1986, putting it at $960 million.

Like other European telecommunications equipment makers, UK suppliers are struggling with the dilemma of finding new markets while jealously guarding their own telephone and telegraph monopolies. So even though consumption in their home market hasn't undergone much change, they are eager to sell their wares to the U. S., Japan, and neighboring European nations. And that's also the attitude of other European countries.

By cooperating on standardization efforts and eliminating nationalistic buying practices, European companies can participate in international marketing competition and thereby ward off telecommunications obsolescence, most industry observers suggest. So far, only the UK has opted to open its telecommunications market; in late 1981, it ended British Telecom's monopoly on customer equipment and service. British Telecom's purchase last year of exchange equipment from a joint venture between L. M. Ericsson and Thorn-EMI caused a major drop in the stock market value of its former sources—General Electric Co. plc, Plessey, and STC—accompanied by layoffs at their telecommunications-equipment plants.

The trauma of the UK move and its negative consequences may have slowed what, at best, was a cautious step toward decentralization by other European countries. Although Britain's 1981 decentralization was condemned loudly by its neighbors at the time, there is a definite move today among many European nations to shed their old ways.

Deregulation and liberalization are new words to many old-time officials in Europe's state-run PTTs. But private business and financial leaders in these same countries see the rapid blending of computing with telecommunications, forcing a shift in technological and manufacturing capability that can-

not be handled effectively by dedicated, fragmented efforts of individual European countries. As an example, telecom-industry experts estimate the cost to develop a sophisticated digital central-office system would be $3 billion in the U. S., $2 billion in Japan, and as high as $7 billion once the bill for all the duplicated European efforts was totaled.

Though the U. S. and Japan can amortize their large investment expenses with the sheer volume of their equipment installations, local European manufacturers will find it impossible to recoup their development costs and, even worse, will be forced to price their equipment out of the worldwide competitive market. Presented another way, the U. S. represents 35% of the world's telecommunications market and Japan another 11%, whereas the largest European segment is only 6%.

Europeans are learning from their experiences with fragmented development programs; they are joining in such European-sponsored programs as Esprit (European Strategic Program for Research in Information Technology), RACE (Research and Development in Advanced Communications Technology in Europe), and the French-led Eureka that will cover a variety of technologies.

Although skeptics watch and smile, there already are indications that significant changes are taking place in the European telecommunications community. Equipment certification, which once took as long as two years, has been streamlined to only two months. A major stumbling block for equipment standardization by the European PTT association, the Conférence Européenne de Postes et Télécommunications (CEPT), was the need for unanimous approval for changes or revisions; this rule has been replaced by a majority vote. The European Communities commission is also taking steps to provide more legal power for CEPT to enforce its standards.

As for the instrumentation and test sector, the *Electronics* survey predicts a 7% increase for 1986, which will carry the market to $268 million. The native heavyweight in the field, Marconi Instruments Ltd., has remained remarkably bullish. Still reaping the benefits of an ambitious new-products program, Marconi expects to show a 20% growth in its instrument sales when 1985 figures are totalled. "We have been very successful in increasing our market share," says marketing manager Roy Lester. Even so, the company is budgeting for a more modest growth of 10% to 15% this year.

Sales of automatic test equipment have held up better in Europe than in the U. S., notes Lester, but the market is in a period of technological change with the emphasis switching to smaller, low-cost systems. Marconi, for example, claims to be one of the first of the major European ATE manufacturers to bring out a bench-top tester.

## COMPONENT SALES WILL PICK UP SPEED, CLIMBING 6% TO $2.7 BILLION

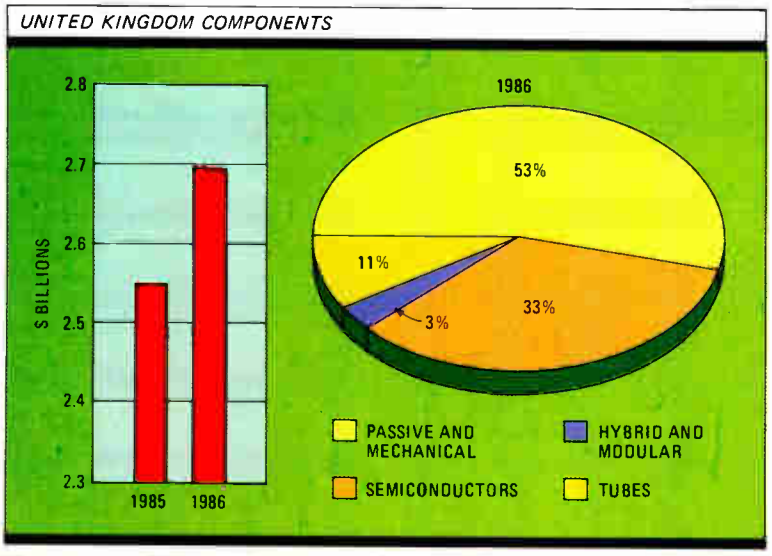
Last year was a downer for UK component vendors, due to the nosedive in computer sales—in particular, the personal computer. Tougher competition resulting from the liberalization of the captive telecommunications market and the slowdown in the consumption of parts destined for consumer equipment struck at the same time, helping to keep equipment makers' stockrooms overflowing with components.

The net result was a disappointing 1.6% growth in the components sector this past year, which carried the market to $2.5 billion, according to the *Electronics* survey. The main cause of the poor performance is the semiconductor sector, which slid 5%, to $830 million. Passive components, in contrast, managed to increase more than 4%, to $1.3 billion, led by relays and switches.

Coming off that nearly flat year, overall component sales in the UK should show a little more life in 1986. The survey predicts a 6% hike, to $2.7 billion. Here the improvement comes mainly from a rebound in semiconductors, which should rise 5.5%, to $876 million, bringing the market a little above its 1984 level. As they did last year, passive and mechanical components will outperform semiconductors, logging a 6% rise to $1.4 billion.

The problems that translate into lackluster market numbers for the components sector in the UK turn up at several levels. Graham Keddie, chairman of the Printed Circuit Manufacturers Association and of the GSPK group of companies, says 1985 was a terrible year for his sector, which has outlets in all kinds of equipment. Demand for nonconsumer pc boards, he says, fell as much as 30% to 35% below 1984's figures. The most heavily hit sectors were through-hole-plated and multilayer boards, precisely those products used in data-processing and telecom products. The *Electronics* survey shows that domestic consumption for all types of printed-circuit boards will gain less than 5% over 1985. Keddie, less optimistic, believes that consumption this year could just about get back to 1984's levels.

Although demand for semiconductors held up better last year in Europe than it did in the U. S. and Japan, some market watchers still describe the sector's drop as "disastrous." But there are one or two encouraging straws in the wind. Malcom Penn, vice president and director of the European Semiconductor Industry Service, Dataquest UK Ltd., London, is bullish about the prospects for 1986. "It looks like the market is improving," he says. "The book-to-bill ratio in the U. S. has been on the mend for two months in a row, and here in the United Kingdom there has been a lot of distributor activity. The original-equipment manufacturers are still sluggish, and there are some fears that the renewed activity may be a false start, but we do not think so."




Semiconductor consumption in the UK slipped to $830 million last year, with logic devices and memories each experiencing losses of more than 15%. Semicustom chips, finding high acceptance among British designers, shot from $54 million in 1984 to $70 million in 1985, according to the survey. A similar 30% gain is expected this year. In fact, Penn even visualizes some spot shortages.

Though there is general overcapacity, it may not be turned on fast enough to meet a market upswing. If business in the U. S. picks up, there will

## UNITED KINGDOM COMPONENTS

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **COMPONENTS, total** | **2,493** | **2,532** | **2,683** |
| **Passive and mechanical, total** | **1,280** | **1,337** | **1,420** |
| Capacitors, total | 199 | 203 | 218 |
| Fixed | 191 | 195 | 209 |
| Variable | 8 | 8 | 9 |
| Connectors, plugs, and sockets | 278 | 292 | 309 |
| Filters, networks, and delay lines | 19 | 20 | 21 |
| Loudspeakers (OEM-type) | 38 | 40 | 43 |
| Printed circuits and interconnections | 353 | 371 | 389 |
| Quartz crystals | 19 | 20 | 21 |
| Readouts (optoelectronic and LCD) | 22 | 23 | 24 |
| Relays (for communications and electronics) | 85 | 89 | 95 |
| Resistors, total | 85 | 88 | 93 |
| Fixed | 33 | 34 | 36 |
| Potentiometers and trimmers | 52 | 54 | 57 |
| Switches and keyboards (for electronics) | 93 | 98 | 107 |
| Transformers, chokes, and coils | 89 | 93 | 100 |
| **Hybrid and modular components, total** | **71** | **78** | **84** |
| **Tubes, total** | **267** | **287** | **303** |
| Cathode ray (except for TV) | 35 | 36 | 40 |
| Image sensing (including camera tubes and intensifiers) | 12 | 16 | 16 |
| Light sensing (including photomultipliers) | 3 | 2 | 2 |
| Power tubes (less than 1 GHz) | 8 | 8 | 9 |
| Microwave (including cooking) | 51 | 57 | 59 |
| Receiving | 3 | 2 | 2 |
| TV picture, total | 155 | 166 | 175 |
| Color | 151 | 163 | 172 |
| Monochrome | 4 | 3 | 3 |

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **Semiconductors, total** | **875** | **830** | **876** |
| Discrete, total | 160 | 151 | 159 |
| Diodes, total | 62 | 59 | 61 |
| Microwave (less than 1 GHz) | 13 | 11 | 10 |
| Rectifiers and rectifier assemblies | 36 | 35 | 38 |
| Signal (less than 100 mA, including arrays) | 6 | 6 | 6 |
| Varactor (tuning) | 1 | 1 | 1 |
| Zener and reference | 6 | 6 | 6 |
| Thyristors (including SCRs and triacs) | 20 | 19 | 20 |
| Transistors, total | 78 | 73 | 78 |
| Bipolar, total | 70 | 65 | 70 |
| Power (more than 1 W dissipation) | 34 | 32 | 34 |
| Small signal (including duals and arrays) | 36 | 33 | 36 |
| Field effect | 3 | 3 | 3 |
| RF and microwave (bipolar and FET, including GaAs) | 5 | 5 | 5 |
| Integrated circuits, total | 688 | 651 | 687 |
| Analog ICs, total | 121 | 129 | 134 |
| Communications (including telecom—codecs, etc.) | 14 | 25 | 26 |
| Entertainment | 37 | 35 | 36 |
| Interface (drivers, buffers, translators, etc.) | 30 | 30 | 31 |
| Op amps (monolithic only) | 40 | 39 | 41 |
| Digital ICs, total | 567 | 522 | 553 |
| Standard logic families, total | 223 | 190 | 199 |
| Bipolar | 127 | 107 | 109 |
| CMOS | 96 | 83 | 90 |
| Memories, total | 185 | 154 | 156 |
| RAM | 97 | 82 | 83 |
| ROM | 88 | 72 | 73 |
| Microprocessor and microcomputer chips | 86 | 89 | 90 |
| Special-purpose circuits | 24 | 19 | 17 |
| Semicustom logic (gate arrays) | 54 | 70 | 91 |
| Optoelectronic devices, total | 27 | 28 | 30 |

**All figures in current U.S. dollars.**
The figures in this chart, based on a survey made by *Electronics* in October and November 1985, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
**Exchange rate: $1.40 to 1 pound sterling.**

also be some firming of prices. All told, Penn expects the component sector to start moving upward in 1986.

But a market watcher for a major U.S. semiconductor company, who prefers to remain anonymous, was more pessimistic. He believes that the industry as a whole will grow by only 3% to 4% in 1986, far below 11% last year and 1984's 14%. Strong points are the defense sector and consumer electronics, where the demand has remained strong and has been boosted by local manufacture of VCRs, microwave ovens, and the like, he says. The industrial sector, too, showed a lot of energy. But the telecommunications sector, dominated as it is by British Telecom, started well and then fizzed out, and the business computer sector has been a disaster. As early as the first quarter of 1985, IBM started to cut back production of its Personal Computer at its facility in Greenock, Scotland. So before 1986 can get better for the components sector, a lot of inventory remains to be worked off.

As they wait for the market to turn around, British semiconductor makers hope they can work their way into contention as heavyweight players in the world market through technology advances expected to come out of the UK's fifth-generation computer project. A team of British equipment makers, for example, is pursuing wafer-scale integration to economically produce large system-level chips. Although it's too early to predict what sales will be for such products, just getting them developed would significantly boost the morale of the semiconductor industry.

New high-performance microprocessors should give a boost to 1986 sales. At the end of last year, amid considerable fanfare, Thorn-EMI's Inmos International plc finally introduced its 32-bit transputer, which it claims is the first microprocessor built for parallel-processing architectures. The 32-bit T414 device, with considerable potential for sales once the range of its applications is tapped, executes 10 million instructions per second and has a 50-ns cycle time.

Next to be delivered from Inmos is a transputer with 4-K bytes of on-chip memory, development software, and an evaluation board for use with the IBM PC and PC AT. Early this year, a 16-bit transputer and a disk controller will be introduced. Inmos has scheduled for 1987 unveiling a completely redesigned version of the T414, which will shrink the present circuitry by 30% and hike speed by 30%. Among the more immediate applications for the sophisticated microprocessor are military and defense projects being developed by Plessey Co. and the Royal Radar Research Establishment.

A three-year program, part of the UK's $450 million fifth-generation computer project, is under way to develop fault-tolerant techniques to overcome the inevitable wafer defects that occur during IC fabrication. Although fault-tolerant arrangements are being used with large memory chips, the UK's General Electric Co., Plessey, and International Computers Ltd., along with researchers at Britain's Brunel University are eager to add fault tolerance to other types of circuits.

Some bright spots are in the offing for more conventional parts as well, as advances in technology create new markets. Hybrid circuits are one example. At one time, most production went to the telecommunications sector, but one UK hybrid manufacturer reports that the technology is being taken up in a major way by other sectors, including instrumentation and small-volume manufacturers of special-purpose equipment. The *Electronics* forecast registers the rise for the hybrid market at 10% last year, but predicts a slowing to almost 8% this year.

# FRANCE

## EQUIPMENT CONSUMPTION WILL CLIMB 7%, THE SAME RATE AS LAST YEAR

In the wake of a listless 1985, the French electronics industry looks toward much the same thing in 1986. The *Electronics* market survey forecasts about a 7% growth rate for French equipment makers, to $13.1 billion. This will be a repeat of the growth rate recorded last year. The nearly static consumer market is expected to grow only 3%, while increased business spending will boost consumption of data-processing by 7% and industrial products by 19%.

This cautious optimism arises partially from the prospect of a change in government, as France readies for elections in the spring. A defeat for the Socialist government, which many French business leaders predict, would mean a loosening of governmental controls on wages and prices as well as a drop in the personal income tax. Because they expect a resulting upsurge in consumer spending, French companies are already planning increases in business investments for 1986.

*Telecom-equipment makers will fall victims to their own success*

The military market, where France has always been a strong performer, will get a big boost from a massive U.S. order. The nationalized conglomerate Thomson SA, along with a U.S. partner, GTE Corp., late last year nabbed a $4.3 billion contract to supply the U.S. Army with a battlefield communications system. Although the companies will be gearing up their first production lines this year, the order will not show in either of their balance sheets before 1987. Thomson does expect significant billings from a multi-billion-dollar Saudi Arabian contract it won two years ago to beef up 1986 profits.

Another promising segment is the industrial market, where increased investments are expected in automation and robotics systems. This market should grow 19%—from $660 million to $784 million—on the heels of a 1985 rise of 13%.

By far the strongest sector in the industrial market is computerized automation systems, which are rising at an annual rate of some 30%, predicts Philippe Gueinchard, industrial electronics analyst for the Bureau d'Informations et de Prévisions Economiques (BIPE) in the Paris suburb of Neuilly. Automation-systems manufacturers are taking advantage of a general trend toward the modernization of French industry as well as toward significantly improved profitability in French companies. The product portfolios of French companies in this field tend to be innovative and competitive, stresses Gueinchard, and this gives them an edge in satisfying domestic demand.

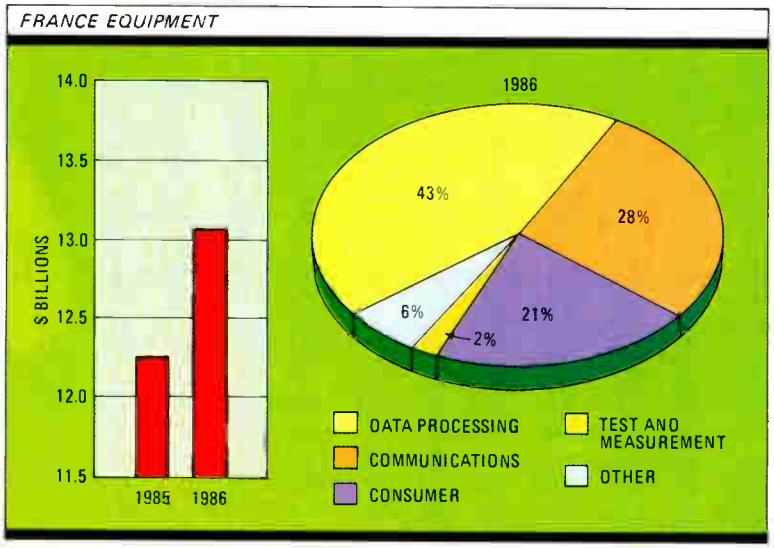
Another strong product group, which the BIPE includes in its industrial analysis, is that of banknote distributors and automatic tellers for the banking industry. Gueinchard looks for the acceleration in this field to slow a bit in 1986 as it nears the saturation point after several years of very heavy orders, particularly of banknote distributors.

The news is also good for French computer makers, because data-processing and office-automation systems are high on the shopping lists of French businesses. Mainframe systems should sell at a brisk 7% over last year, reaching $984 million; the personal computer market should do even better with a sharp 33% jump, to $252 million.

Berangère de Lestapis, the BIPE's data-processing and office-automation analyst, is looking for 1986 to be a strong year for professional microcomputer systems, which the *Electronics* survey puts at 6% growth, to $460 million. Also putting in a strong performance will be superminicomputers, growing 6%, to $665 million, while the home computer market will remain slow to take off. Next year, according to the *Electronics* survey, mainframes will make up 25.5% of the market, and supercomputers (those costing over $1 million) will take 20.5%. Superminicomputers will account for 17.3%, just behind minicomputers, which account for 18.2%. Microcomputers—machines costing between $5,000 and $20,000 will take 11.9%, and personal computers will make up 6.5% of the total data-processing equipment market.

French telecommunications-equipment makers will run into heavy weather this year. Because it now runs the most up-to-date digital network in Europe, the Direction Générale des Télécommunications is tapering off orders for digital switching equipment in 1986, so the growth rate should fall from 19% to 10%, for consumption totalling $941 million. And demand for private branch exchanges will rise only 2%, down from 5%, for total consumption this year of $1.3 billion. The growth rate for all communications equipment will fall from 9% to 6%, for total consumption of $3.7 billion.

The French consumer sector is counting heavily on new products in the face of a weak market that likely will register a mere 3% growth in consump-



## FRANCE EQUIPMENT

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **EQUIPMENT, total** | **11,444** | **12,242** | **13,065** |
| **Data-processing and office equipment, total** | **4,940** | **5,275** | **5,642** |
| Data-processing systems, total | 3,345 | 3,575 | 3,855 |
| Personal computers (less than $5,000) | 120 | 190 | 252 |
| Microcomputers ($5,000 to $20,000) | 412 | 433 | 460 |
| Minicomputers ($20,000 to $100,000) | 629 | 661 | 703 |
| Superminicomputers ($100,000 to $400,000) | 594 | 622 | 665 |
| Mainframe computers ($400,000 to $1 million) | 881 | 925 | 984 |
| Supercomputers (greater than $1 million) | 709 | 744 | 791 |
| Data-input peripherals | 32 | 35 | 38 |
| Data-output peripherals | 203 | 215 | 233 |
| Data-storage subsystems | 46 | 48 | 55 |
| Data terminals | 519 | 567 | 630 |
| Electronic office equipment, total | 795 | 835 | 831 |
| Copying equipment | 419 | 424 | 392 |
| Electronic typewriters | 179 | 199 | 208 |
| Billing and accounting equipment | 197 | 212 | 231 |
| **Consumer products, total** | **2,450** | **2,540** | **2,617** |
| Audio equipment, total | 987 | 1,040 | 1,083 |
| Car audio | 98 | 99 | 99 |
| Stereo equipment, total | 377 | 388 | 394 |
| Components (including tuners, turntables) | 271 | 283 | 294 |
| Consoles and compact systems (including TV-audio combinations) | 106 | 105 | 100 |
| Phonographs and radio-phono combinations | 24 | 24 | 25 |
| Radios (including table, clock, and portable) | 142 | 153 | 165 |
| Radio-recorder combinations, portable | 129 | 135 | 141 |
| Tape recorders and players | 176 | 188 | 194 |
| Compact-disk players | 41 | 53 | 65 |
| Television receivers, total | 977 | 982 | 988 |
| Color | 924 | 929 | 941 |
| Monochrome | 53 | 53 | 47 |
| Other consumer electronic products, total | 486 | 518 | 546 |
| Home video equipment, total | 178 | 188 | 198 |
| Cassette players and recorders | 153 | 159 | 165 |
| Cameras | 25 | 29 | 33 |
| Video disk players | n/a | n/a | n/a |
| Electronic musical instruments | 28 | 31 | 28 |
| Microwave ovens | 126 | 138 | 149 |
| Electronic games (video and nonvideo) and toys | 28 | 29 | 31 |
| Calculators (personal and professional) | 38 | 38 | 41 |
| Electronic watches and clocks | 88 | 94 | 99 |
| **Power supplies (noncaptive), total** | **69** | **69** | **73** |
| Bench and lab | 13 | 13 | 14 |
| Industrial (heavy duty) | 17 | 17 | 18 |
| OEM and modular, total | 39 | 39 | 41 |
| Linear | 20 | 20 | 21 |
| Switching | 19 | 19 | 20 |

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **Communications equipment, total** | **3,174** | **3,453** | **3,656** |
| Data-communications equipment | 129 | 145 | 166 |
| Facsimile-terminal equipment | 31 | 35 | 39 |
| Fiber-optic communications systems | 47 | 60 | 73 |
| Intercom systems | 29 | 31 | 34 |
| Paging systems, public and private | 21 | 24 | 25 |
| Radar-air, land and marine | 481 | 503 | 528 |
| Radio, total | 242 | 261 | 290 |
| Broadcast equipment | 110 | 122 | 135 |
| Microwave systems | 43 | 44 | 48 |
| Mobile, land | 70 | 75 | 83 |
| Satellite earth stations | 19 | 20 | 24 |
| Telecommunications systems, total | 2,146 | 2,343 | 2,447 |
| Telephone and data switching, private (PABX) | 1,242 | 1,310 | 1,337 |
| Telephone and data switching, public | 713 | 852 | 941 |
| Telephone and telegraph carrier | 191 | 181 | 169 |
| Television equipment, total | 48 | 51 | 54 |
| Broadcast (studio) equipment (including cameras, recorders, and monitors) | 28 | 30 | 32 |
| CCTV (including educational, industrial, and medical) | 20 | 21 | 22 |
| **Test and measuring instruments, total** | **227** | **245** | **293** |
| Amplifiers, lab | 3 | 3 | 4 |
| Analog voltmeters, ammeters, and multimeters | 11 | 11 | 12 |
| Automatic test equipment, total | 19 | 21 | 23 |
| IC testers | 11 | 12 | 13 |
| Pc-board testers | 8 | 9 | 10 |
| Calibrators and standards, active and passive | 1 | 2 | 2 |
| Counters, time and frequency | 6 | 7 | 7 |
| Digital multimeters (including probes and accessories) | 11 | 12 | 12 |
| Logic analyzers | 8 | 8 | 10 |
| Microprocessor-development systems | 51 | 62 | 76 |
| Microwave test and measuring instruments | 20 | 25 | 34 |
| Oscillators | 18 | 20 | 23 |
| Oscilloscopes (including accessories) | 24 | 25 | 27 |
| Power meters (below microwave frequencies) | 2 | 2 | 2 |
| Recorders (including chart and X-Y types) | 35 | 37 | 39 |
| Signal generators (pulse, sweep, and function), total | 14 | 15 | 17 |
| Analog | 9 | 10 | 11 |
| Digital | 5 | 5 | 6 |
| Spectrum analyzers | 4 | 5 | 5 |
| **Industrial electronic equipment, total** | **584** | **660** | **784** |
| Inspection systems | 11 | 12 | 12 |
| Machine-tool controls (including all numerical-control systems) | 12 | 15 | 17 |
| Motor controls | 13 | 12 | 15 |
| Photoelectric controls | 3 | 3 | 4 |
| Process-control equipment (including computers, loggers, and consoles) | 494 | 562 | 674 |
| Semiconductor production equipment | 51 | 56 | 62 |

**All figures in current U.S. dollars. Exchange rate: 8.4 francs to $1.**

tion this year. To offset a contracting market for stereo components, audio manufacturers are pinning their hopes on compact-disk players, and consumption there should grow 23%.

In fact, the brightest areas in the audio market are at the extreme ends of the price spectrum. At the low end are the briskly selling lo-fi systems—highly integrated, compact combinations of turntables, cassette players, amplifiers, and tuners; at the other is the growing market for the most expensive array of stereo components.

Video cassette recorders are not exactly new products, but market penetration in France is significantly behind that of other European countries because of the strict limitations on Japanese imports enacted in 1982. Those limits have since been lifted, but the market has been slow to overcome the inertia they created. Only a slight increase in VCR demand, less than 4%, is anticipated this year.

Although the *Electronics* survey projects a tiny 1% gain in demand for color TV sets, a 5% rise in demand is predicted by Jean-Philippe Dauvin, chief economist at Thomson Semiconducteurs. French consumers will be receiving a payback from the government for an obligatory loan it extracted at the beginning of its term, he notes. The sum, an average $400 to $500 per family, corresponds almost exactly to the cost of a color TV in France.

"There are basically three reasons why the market for color TV sets should improve in 1986," says Dauvin. "The simplest is that it has been flat, and it can't stay that way forever. Another is that TV is undergoing an explosion in France at the moment. We've just seen the opening of channel 4 [France's first pay-TV station] and a fifth channel will begin transmission early in the year." Finally, he says, the World Cup, a soccer extravaganza held every four years, will take

place this summer, and this event is popular enough so that additional consumers will want to buy TV sets.

Renée-Claire Bloch-Gani, the BIPE's consumer analyst, agrees with Dauvin that the reimbursement of the obligatory loan will have a positive effect on the consumer market, but she thinks it will help new, innovative products. She cites as proof BIPE's estimates for compact-disk audio systems. Last June, BIPE put French consumption of these systems at some 60,000 units for the year; by the end of the year, it revised that figure upward some two thirds to 100,000 units, as a result of an improved French economy and more disposable income in the hands of receivers. Another such product is the camcorder—a VCR with integrated camera—which is doing severe damage to the market for home movie cameras.

The electronics industry was among those nationalized by the French government three years ago, in hopes of creating new jobs and establishing a trade surplus. But the resulting wage freezes and continuing high unemployment rates led instead to a weak domestic market for consumer goods.

To compensate, electronics makers have explored foreign markets and have also sought collaboration with both European and U. S. companies in sharing technology, notably in the ambitious Eureka program. This year, exports will be influenced by such wild-card factors as decentralization of industries in other European countries, the success of partnerships with high-tech leaders, and the health of Eureka.

One aim of Eureka, the European Research Coordination Agency, is to create an internationally competitive European electronics industry with technology leadership in five sectors. The project is still in its early stage, with only France and West Germany of the 18 participating countries having pledged financial support. Among the questions to be thrashed out is whether intra-European partnerships will mean the end of ventures with U. S. and Japanese organizations, as well as whether it's realistic to bar those two nations from the project if high-tech research is the goal.

Among the plans proposed by Eureka is a $65 million project for a robot-based flexible manufacturing system involving France's Compagnie Générale d'Electricité, Italy's Comau/Fiat, and Switzerland's Lasag. Another joint effort involves the setup of a microlithography production line to be pursued by France's Matra, Sormel, and CNET, Italy's SGS, and the UK's Cambridge Instruments. This project carries a $100 million price tag. A $90 million allocation has been set aside for an integrated broadband communications switching system, to be developed by France's CIT-Alcatel, UK's Plessey, and Italy's Italtel. Still another $60 million has been budgeted for a gallium arsenide chip-making facility sponsored jointly by France's Thomson Semiconducteurs and the UK's General Electric Co.

## PASSIVE AND MECHANICAL COMPONENTS TO PACE 8% GROWTH

The French components market ended up last year with a meager 1% gain in consumption over 1984, according to the *Electronics* survey—but there are high hopes for a very respectable 8% increase overall this year, to almost $2.4 billion. Much of the increased component demand will be earmarked for the industrial sector, which is headed for an impressive 19% gain this year; another lift will come from data-processing systems, predicted to grow 7% over last year.

Pacing the growth will be passive and mechanical components; they are the sole billion-dollar-plus sector and should pick up 8.5%, to $1.1 billion. Nearly the same gain—8.3%, to $339 million—is in sight for tubes, the third-ranking sector in market size, largely because of a strong showing by TV picture tubes.

Semiconductors, second in market weight, should recover from their 4% dip in 1985 to register a 7% upswing, hitting $726 million. In the closely watched semiconductor sector, discretes will outstrip integrated circuits, according to the survey. Diodes, thyristors, and transistors are pegged for a 7% rise, to $217 million. ICs, by contrast, will move up only 5.5%, to $479 million.

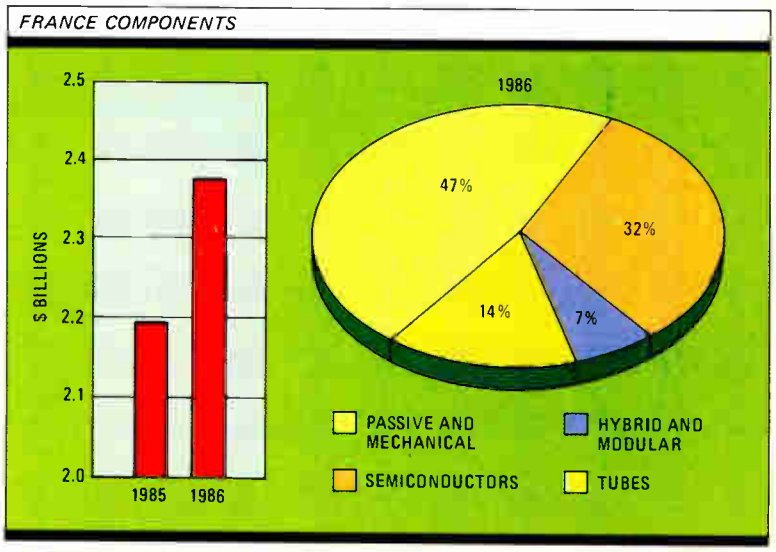
Although the consensus figures show only a 3% gain for analog ICs, to $106 million, Jean-Philippe Dauvin, chief economist at Thomson Semiconducteurs, the principal components manufacturer of the nationalized conglomerate Thomson SA, expects the category will do much better than that—something like 6%. The upswing is a result of the growing use of analog chips in consumer equipment, he says.

Another factor helping the analog market is the improved profitability of French companies, which means greater investments in automated production systems. Analog devices will get little help from the telecommunications market, however, where French government orders for electronic switches are on the decline.

The bipolar digital market will continue to suffer from softening prices, the result of overstocked inventories for both consumers and distributors, especially in parts for data-processing machines. Consumption this year should increase only about 2%, to $83 million, according to the *Electronics* survey, and MOS parts should rise no more than 3.5%, to $59 million.

Memories will make a modest comeback from the disastrous fall recorded in 1985, rising by almost 9%, to $138 million—but still less than 1984's consumption of $155 million. Random-access memories ought to do much better than read-only memories, but even so the market will wind up below its 1984 level. The big winner in the French semiconductor market is the gate-array sector, which is expected to grow by 20% this year, to $12 million. Even higher growth is in sight for the years ahead as engineers become more accustomed to the design techniques.

Dauvin is very optimistic about the French components market in general for 1986. After increases of only 2% in the first two quarters and a flat third quarter, he expects the market to soar, with an increase of 30% in the final quarter. He points out that the typical cycle for the components business starts with almost dizzying growth, driven by equipment manufacturers that overorder in fear of being unable to find the key components necessary for their products. This rise



ends abruptly when they realize that they have big enough stocks of components to last them for many months. The market then nosedives and stays low until supplies again begin to get short. Dauvin's best estimate puts the timing for this turnaround at the middle of the year.

Somewhat similar expressions of optimism for a 1986 upturn in components were heard at many booths at last November's International Components Show in Paris. Although bookings are expected to be poor for the first quarter of 1986, activity will pick up after the second quarter, predicts Michel Thouvenin, marketing director of Matra-Harris Semiconducteurs. Other marketing executives of European components companies believe that inventory levels at equipment makers have dropped to a point where purchase orders for new supplies will occur before mid-1986.

Like many of its European counterparts, France's semiconductor community is hoping to edge its way more forcefully into the world market. Although a dozen European companies have heavy investments in semiconductor production, their total sales account for only 10% of worldwide sales. Only the Netherlands' Philips ranks among the top 10 semiconductor vendors, thanks to its U.S. subsidiary, Signetics Corp.

But some European chip makers, Thomson among them, are committed to turning the situation around. Thomson made a move in this direction last fall, when it acquired the loss-ridden U.S. company Mostek Corp. from United Technologies Corp. Skeptics called the purchase a poor move, but Thomson executives say it advances their plans to reach $1 billion in sales by 1990.

Another opportunity for growth being examined by some European semiconductor houses lies with low-volume, high-profit application-specific ICs. In this area, highly automated production lines, such as the Japanese have in place for commodity memory chips, do not offer any particular edge. More important for the ASIC market is fast turnaround time in designing these chips. Production of these chips is quite feasible using established processes rather than state-of-the-art techniques. So, equipped with the latest work stations, companies such as Thomson are convinced that they can work more closely and more comfortably with European customers than can U.S. or Japanese suppliers.

Another fillip for the French components market will come from continued heavy orders for Minitel terminals by the French Direction Générale des Télécommunications. These terminals give access to an automated phone directory, as well as to other information services being supplied by private companies. Orders for this year are estimated at more than 3 million terminals, which means an equal number of 9-in. monochrome cathode-ray tubes, one-chip modems, and 8-bit microcontrollers, in addition to keyboards, cabinets, and connectors. All these components are made in France and easily amount to enough of a market to offset the drop in orders for public switching equipment.

In a move toward trimming operations and concentrating on special market niches, Thomson consolidated all its high-reliability silicon-products operations early last year. The result was a $20 million business that should grow some 40% this year, mainly from exports to other European and Middle East nations. Other French components companies closed last year with nominal growth and profits by trimming their operations or by concentrating on special market niches in an effort to compete with Japanese and U.S. manufacturers.

## FRANCE COMPONENTS

| | (millions of dollars) | | |
|---|---|---|---|
| | 1984 | 1985 | 1986 |
| **COMPONENTS, total** | **2,175** | **2,197** | **2,369** |
| **Passive and mechanical, total** | **1,014** | **1,037** | **1,126** |
| Capacitors, total | 157 | 174 | 186 |
| Fixed | 142 | 157 | 166 |
| Variable | 15 | 17 | 20 |
| Connectors, plugs, and sockets | 231 | 235 | 251 |
| Filters, networks, and delay lines | 18 | 18 | 19 |
| Loudspeakers (OEM-type) | 76 | 81 | 86 |
| Printed circuits and interconnections | 208 | 205 | 241 |
| Quartz crystals | 35 | 37 | 40 |
| Readouts (optoelectronic and LCD) | 13 | 13 | 14 |
| Relays (for communications and electronics) | 68 | 65 | 70 |
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| Fixed | 62 | 64 | 65 |
| Potentiometers and trimmers | 25 | 25 | 27 |
| Switches and keyboards (for electronics) | 42 | 44 | 48 |
| Transformers, chokes, and coils | 79 | 76 | 79 |
| **Hybrid and modular components, total** | **161** | **166** | **178** |
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| Cathode ray (except for TV) | 9 | 10 | 10 |
| Image sensing (including camera tubes and intensifiers) | 18 | 18 | 19 |
| Light sensing (including photomultipliers) | 6 | 7 | 7 |
| Power tubes (less than 1 GHz) | 20 | 20 | 21 |
| Microwave (including cooking) | 47 | 49 | 54 |
| Receiving | 6 | 6 | 7 |
| TV picture, total | 185 | 203 | 221 |
| Color | 168 | 187 | 205 |
| Monochrome | 17 | 16 | 16 |

| | (millions of dollars) | | |
|---|---|---|---|
| | 1984 | 1985 | 1986 |
| **Semiconductors, total** | **709** | **681** | **726** |
| Discrete, total | 194 | 202 | 217 |
| Diodes, total | 67 | 70 | 77 |
| Microwave (less than 1 GHz) | 6 | 7 | 7 |
| Rectifiers and rectifier assemblies | 33 | 34 | 36 |
| Signal (less than 100 mA, including arrays) | 14 | 15 | 17 |
| Varactor (tuning) | 9 | 9 | 10 |
| Zener and reference | 5 | 5 | 7 |
| Thyristors (including SCRs and triacs) | 74 | 77 | 82 |
| Transistors, total | 53 | 55 | 58 |
| Bipolar, total | 42 | 42 | 44 |
| Power (more than 1 W dissipation) | 30 | 30 | 32 |
| Small signal (including duals and arrays) | 12 | 12 | 12 |
| Field effect | 2 | 3 | 3 |
| RF and microwave (bipolar and FET, including GaAs) | 9 | 10 | 11 |
| Integrated circuits, total | 491 | 454 | 479 |
| Analog ICs, total | 96 | 103 | 106 |
| Communications (including telecom—codecs, etc.) | 18 | 22 | 23 |
| Entertainment | 48 | 48 | 50 |
| Interface (drivers, buffers, translators, etc.) | 8 | 10 | 10 |
| Op amps (monolithic only) | 22 | 23 | 23 |
| Digital ICs, total | 395 | 351 | 373 |
| Standard logic families, total | 147 | 138 | 142 |
| Bipolar | 87 | 81 | 83 |
| CMOS | 60 | 57 | 59 |
| Memories, total | 155 | 127 | 138 |
| RAM | 115 | 95 | 104 |
| ROM | 40 | 32 | 34 |
| Microprocessor and microcomputer chips | 71 | 64 | 68 |
| Special-purpose circuits | 14 | 12 | 13 |
| Semicustom logic (gate arrays) | 8 | 10 | 12 |
| Optoelectronic devices | 24 | 25 | 30 |

**All figures in current dollars.**
The figures in this chart, based on a survey made by *Electronics* in October and November 1985, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
**Exchange rate: 8.4 francs to $1.**

# ITALY

## GROWTH IN EQUIPMENT CONSUMPTION WILL DIP A BIT, TO 8.5%

A healthy economic climate and a pickup in demand by businesess for more efficient equipment will keep the Italian electronics market growing in 1986. However, the growth in consumption will dip a bit to 8.5%, or about $8.5 billion, according to the *Electronics* survey. While data processing will continue its 20% climb, communications equipment growth is expected to dip. In 1985, total equipment consumption grew at close to 10%, to $7.8 billion, with data-processing consumption rising 21% over 1984, to $3.7 billion.

The components sector looks even better. Consumption will jump 10% this year, more than double the 4% gain recorded last year, with the total rising from $838 million to $923 million. Semiconductor devices will register the biggest gain, a 15% increase from $407 million to $469 million, well above last year's 3% gain. Passive and mechanical components will continue steady with last year's growth—from 7% up to an 8% increase to $305 million.

"We are in the middle of a new phase in Italian industrial development," says Bruno Lamborghini, director of economic studies for Ing. C. Olivetti & C., Ivrea. "There is a great deal of innovation going on, new products are being created, and expectations for growth have been revised upward."

For electronics manufacturers, the most cheering aspect of this new exuberance is in Italian business investments. Corporations have been investing at a rate of nearly 20% of their profits for the past two years, and with similar capital spending expected this year, business systems and personal computers will benefit. What is more, native companies are showing better cash flow than in previous years and so are less in need of financing such purchases on credit, which in Italy is available only at prohibitive rates.

Lamborghini expects 1986 to be as good as last year in the Italian data-processing and office equipment market, with overall growth somewhere around 20%. *Electronics'* survey points to a similar 20% gain, to $4.2 billion. Leading that push will be the personal computer market.

The data-processing industry is also bolstered by a significant growth in exports, a figure that Lamborghini puts as high as 70% for 1986. Much of this upswing is a result of Olivetti's recently won contracts to supply IBM-compatible personal computers to both AT&T Co. and Xerox Corp.

*Electronics* has pegged the brisk domestic personal computer market to grow this year by more than 25%, to $460 million. This market, of which Olivetti and IBM have a combined 65% share, owes its success to the fact that the personal computer is the machine of choice for many small businesses in Italy. Larger businesses, meanwhile, are buying increasingly sophisticated equipment with extended functionality and multistation systems and are showing interest in local networks as well. In this sense, Lamborghini thinks, the Italian market is catching up to its European counterparts.

Although sales of electronic typewriters are expected to be flat, computer peripherals will be strong, with a 40% rise in the consumption of printers as well as significant increases in the number of hard disks produced—both of which mean more demand for components. Most European companies have given up production of floppy-disk drives in the face of withering competition from suppliers in the Far East.

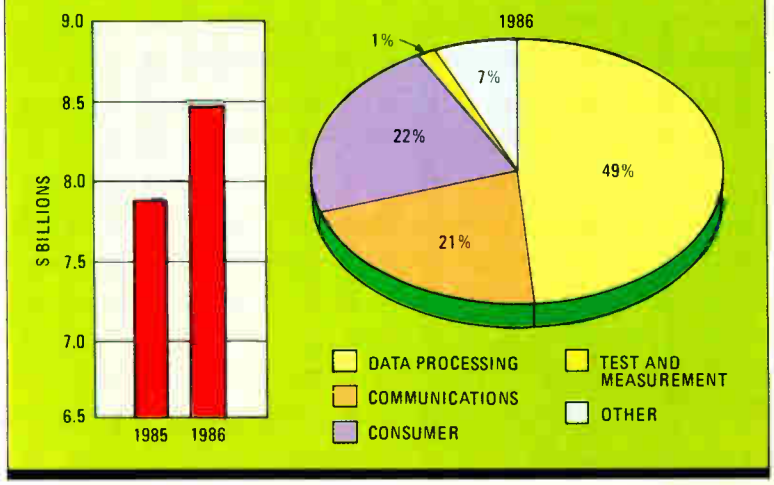
Overall growth in Italian electronics will be an estimated 31% in the five years from 1984 to 1989, according to the recently released Mackintosh Yearbook of West European Electronics Data, published by Benn Electronics Publications Ltd., Luton, England. Contributing to that growth, says the yearbook, will be several Italian companies that pulled themselves out of the red in 1985.

Among them was SGS Microelettronica SpA, the state-owned semiconductor producer, which finally returned to financial health after several years of losses. Looking to the future, SGS has invested in a 5-in.-wafer front-end fabrication facility for analog integrated circuits and a 6-in.-wafer fab for MOS ICs.

In the telecommunications sector, the state-owned Italtel, the nation's biggest producer of telecommunications products, also recovered from heavy losses in the early 1980s. Italtel last year joined forces with Telettra, a communications subsidiary of Fiat SpA, and GTE Corp. to develop and produce digital telephone exchanges intended to be used in the modernization of Italy's switching systems.

The Mackintosh study sees a boost for the telecommunications industry in a new law that would transfer much of the decision making in this area away from the government utilities SIP and Italcable. A new simplified structure means the market for telecommunications equipment would pick up. However, although the present monopolistic telecommunica-

ITALY EQUIPMENT



## ITALY EQUIPMENT

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **EQUIPMENT, total** | **7,106** | **7,802** | **8,468** |
| **Data-processing and office equipment, total** | **3,221** | **3,702** | **4,188** |
| Data-processing systems, total | 1,692 | 2,045 | 2,445 |
| Personal computers (less than $5,000) | 266 | 366 | 460 |
| Microcomputers ($5,000 to $20,000) | 59 | 88 | 148 |
| Minicomputers ($20,000 to $100,000) | 355 | 394 | 434 |
| Superminicomputers ($100,000 to $400,000) | 540 | 623 | 718 |
| Mainframe computers ($400,000 to $1 million) | 261 | 301 | 365 |
| Supercomputers (greater than $1 million) | 211 | 273 | 320 |
| Data-input peripherals | 37 | 39 | 42 |
| Data-output peripherals | 215 | 237 | 252 |
| Data-storage subsystems | 397 | 428 | 456 |
| Data terminals | 277 | 313 | 352 |
| Electronic office equipment, total | 603 | 640 | 641 |
| Copying equipment | 363 | 364 | 366 |
| Electronic typewriters | 185 | 219 | 216 |
| Billing and accounting equipment | 55 | 57 | 59 |
| **Consumer products, total** | **1,715** | **1,792** | **1,899** |
| Audio equipment, total | 572 | 596 | 623 |
| Car audio | 51 | 55 | 61 |
| Stereo equipment, total | 314 | 323 | 327 |
| Components (including tuners, turntables) | 265 | 280 | 289 |
| Consoles and compact systems (including TV-audio combinations) | 49 | 43 | 38 |
| Phonographs and radio-phono combinations | 6 | 6 | 7 |
| Radios (including table, clock, and portable) | 57 | 59 | 60 |
| Radio-recorder combinations, portable | 71 | 75 | 81 |
| Tape recorders and players | 73 | 78 | 87 |
| Compact-disk players | n/a | n/a | n/a |
| Television receivers, total | 771 | 801 | 837 |
| Color | 700 | 745 | 785 |
| Monochrome | 71 | 56 | 52 |
| Other consumer electronics products, total | 372 | 395 | 439 |
| Home video equipment, total | 123 | 129 | 142 |
| Cassette players and recorders | 95 | 100 | 110 |
| Cameras | 23 | 24 | 26 |
| Video disk players | 5 | 5 | 6 |
| Electronic musical instruments | 25 | 28 | 30 |
| Microwave ovens | 12 | 14 | 30 |
| Electronic games (video and nonvideo) and toys | 13 | 16 | 19 |
| Calculators (personal and professional) | 55 | 61 | 66 |
| Electronic watches and clocks | 144 | 147 | 152 |
| **Power supplies (noncaptive), total** | **33** | **38** | **40** |
| Bench and lab | 1 | 2 | 2 |
| Industrial (heavy duty) | 10 | 11 | 11 |
| OEM and modular, total | 22 | 25 | 27 |
| Linear | 8 | 9 | 10 |
| Switching | 14 | 16 | 17 |

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **Communications equipment, total** | **1,551** | **1,658** | **1,697** |
| Data-communications equipment | 81 | 87 | 97 |
| Facsimile-terminal equipment | 10 | 20 | 23 |
| Fiber-optic communications systems | n/a | n/a | n/a |
| Intercom systems | 11 | 11 | 12 |
| Paging systems, public and private | 4 | 4 | 5 |
| Radar-air, land and marine | 94 | 99 | 102 |
| Radio, total | 133 | 142 | 159 |
| Broadcast equipment | 55 | 59 | 63 |
| Microwave systems | 40 | 43 | 46 |
| Mobile, land | 38 | 40 | 50 |
| Satellite earth stations | n/a | n/a | n/a |
| Telecommunications systems, total | 1,177 | 1,253 | 1,254 |
| Telephone and data switching, private (PABX) | 162 | 176 | 189 |
| Telephone and data switching, public | 827 | 883 | 883 |
| Telephone and telegraph carrier | 188 | 194 | 182 |
| Television equipment, total | 41 | 42 | 45 |
| Broadcast (studio) equipment (including cameras, recorders, and monitors) | 16 | 16 | 17 |
| CCTV (including educational, industrial, medical) | 25 | 26 | 28 |
| **Test and measuring instruments, total** | **81** | **90** | **101** |
| Amplifiers, lab | 1 | 1 | 1 |
| Analog voltmeters, ammeters, and multimeters | 3 | 4 | 4 |
| Automatic test equipment, total | 17 | 20 | 24 |
| IC testers | 5 | 6 | 7 |
| Pc-board testers | 12 | 14 | 17 |
| Calibrators and standards, active and passive | n/a | n/a | n/a |
| Counters, time and frequency | 3 | 3 | 3 |
| Digital multimeters (including probes and accessories) | 3 | 3 | 3 |
| Logic analyzers | 6 | 7 | 8 |
| Microprocessor-development systems | 8 | 10 | 12 |
| Microwave test and measuring instruments | 13 | 14 | 16 |
| Oscillators | 1 | 1 | 1 |
| Oscilloscopes (including accessories) | 12 | 12 | 13 |
| Power meters (below microwave frequencies) | 1 | 1 | 1 |
| Recorders (including chart and X-Y types) | 6 | 6 | 6 |
| Signal generators (pulse, sweep, and function), total | 4 | 4 | 5 |
| Analog | 3 | 3 | 3 |
| Digital | 1 | 1 | 2 |
| Spectrum analyzers | 3 | 4 | 4 |
| **Industrial electronic equipment, total** | **505** | **522** | **543** |
| Inspection systems | 6 | 8 | 10 |
| Machine-tool controls (including all numerical-control systems) | 48 | 50 | 53 |
| Motor controls | 44 | 46 | 49 |
| Photoelectric controls | n/a | n/a | n/a |
| Process-control equipment (including computers, loggers, and consoles) | 393 | 404 | 416 |
| Semiconductor production equipment | 14 | 14 | 15 |

**All figures in current U. S. dollars. Exchange rate: 1,732 lire to $1.** n/a: no estimate available

tions setup in Italy (as in most European countries) discourages outside competition, it also throttles growth, evidenced by the downturn in the growth rate in the *Electronics* forecast for this year: from almost 7% to just over 2% for $1.7 billion total consumption.

### UPTURN IN COMPONENTS

The Italian components market took a roller coaster ride in 1985. There was strong demand during the first quarter, then steady deterioration into the third quarter, when consumption dipped to 15% below the early 1984 level. Still, last year's skimpy 4% growth rate looks to strengthen to this year's 10%.

Enrico Villa, director of Economic Studies for SGS, Italy's largest components producer, compares the ups and downs to those suffered by U. S. components makers last year. Still, most makers attribute the wild swing to overordering—resulting in overstocked inventories—by Olivetti, Italy's largest components consumer. Olivetti strenuously denies this charge, claiming that the falling dollar made it expedient to place its orders overseas after the first quarter of 1985. According to the components houses, however, Olivetti had already placed significant orders for delivery during the first couple of months of 1986.

Another boost for manufacturers comes from the telecommunications market, with last year's roaring 23% gain in consumption of telecom ICs moderating to a still-healthy 15%, for total consumption of $105 million. An important factor is the continuing shift by Italtel from electromechanical to electronic exchanges. Currently, Italtel's production is evenly divided between the two, but it will have shifted to 100% electronic switches by the end of the decade. Also helping telecommunications consumption is the gradual integration of additional

## ITALY COMPONENTS

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **COMPONENTS, total** | **804** | **838** | **923** |
| **Passive and mechanical, total** | **266** | **284** | **305** |
| Capacitors, total | 50 | 53 | 55 |
| Fixed | 48 | 51 | 53 |
| Variable | 2 | 2 | 2 |
| Connectors, plugs, and sockets | 58 | 66 | 72 |
| Filters, networks, and delay lines | 3 | 3 | 3 |
| Loudspeakers (OEM-type) | 5 | 5 | 5 |
| Printed circuits and interconnections | 62 | 66 | 73 |
| Quartz crystals | 3 | 3 | 3 |
| Readouts (optoelectronic and LCD) | 7 | 8 | 8 |
| Relays (for communications and electronics) | 10 | 10 | 11 |
| Resistors, total | 25 | 26 | 28 |
| Fixed | 12 | 13 | 14 |
| Potentiometers and trimmers | 13 | 13 | 14 |
| Switches and keyboards (for electronics) | 15 | 16 | 17 |
| Transformers, chokes, and coils | 28 | 28 | 30 |
| **Hybrid and modular components, total** | **6** | **6** | **6** |
| **Tubes, total** | **137** | **141** | **143** |
| Cathode ray (except for TV) | 2 | 2 | 2 |
| Image sensing (including camera tubes and intensifiers) | 2 | 2 | 2 |
| Light sensing (including photomultipliers) | 1 | 1 | 1 |
| Power tubes (less than 1 GHz) | 8 | 8 | 9 |
| Microwave (including cooking) | 7 | 8 | 9 |
| Receiving | 2 | 2 | 2 |
| TV picture, total | 115 | 118 | 118 |
| Color | 102 | 103 | 104 |
| Monochrome | 13 | 15 | 14 |

| | (millions of dollars) 1984 | 1985 | 1986 |
|---|---|---|---|
| **Semiconductors, total** | **395** | **407** | **469** |
| Discrete, total | 96 | 95 | 105 |
| Diodes, total | 42 | 38 | 44 |
| Microwave (less than 1 GHz) | 4 | 4 | 4 |
| Rectifiers and rectifier assemblies | 25 | 22 | 27 |
| Signal (less than 100 mA, including arrays) | 6 | 5 | 6 |
| Varactor (tuning) | 2 | 2 | 2 |
| Zener and reference | 5 | 5 | 5 |
| Thyristors (including SCRs and triacs) | 9 | 9 | 9 |
| Transistors, total | 45 | 48 | 52 |
| Bipolar, total | 41 | 43 | 45 |
| Power (more than 1 W dissipation) | 22 | 26 | 27 |
| Small signal (including duals and arrays) | 19 | 17 | 18 |
| Field effect | 1 | 1 | 2 |
| RF and microwave (bipolar and FET, including GaAs) | 3 | 4 | 5 |
| Integrated circuits, total | 279 | 291 | 341 |
| Analog ICs, total | 130 | 153 | 178 |
| Communications (including telecom—codecs, etc.) | 74 | 91 | 105 |
| Entertainment | 25 | 27 | 32 |
| Interface (drivers, buffers, translators, etc.) | 16 | 17 | 21 |
| Op amps (monolithic only) | 15 | 18 | 20 |
| Digital ICs, total | 149 | 138 | 163 |
| Standard logic families, total | 54 | 49 | 60 |
| Bipolar | 31 | 29 | 38 |
| CMOS | 23 | 20 | 22 |
| Memories, total | 43 | 36 | 39 |
| RAM | 31 | 26 | 28 |
| ROM | 12 | 10 | 11 |
| Microprocessor and microcomputer chips | 19 | 18 | 20 |
| Special-purpose circuits | 24 | 22 | 24 |
| Semicustom logic (gate arrays) | 9 | 13 | 20 |
| Optoelectronic devices, total | 20 | 21 | 23 |

**All figures in current dollars.**
The figures in this chart, based on a survey made by *Electronics* in October and November 1985, estimate noncaptive consumption of equipment, valued at factory prices for domestic products and landed cost for imported products.
**Exchange rate: 1,732 lire to $1.**

electronic facilities into telephone sets. A positive influence from the Italian military and aerospace market will come from Italsat, Italy's first national telecommunications satellite, which will be produced in Rome this year by Selenia SpA.

The automotive market will hike its consumption of components, as Fiat and Alfa Romeo expand their use of electronic ignition, fuel-injection systems, and various other microprocessor-controlled subsystems, such as an optional antiskid system, in their new models. Other areas providing new markets for liquid-crystal components will be dashboard displays.

The Italian consumer market continues to hold its own in terms of consumption of equipment, but components manufacturers have been unable to cash in very much. The obvious reason is that all newer products—such as VCRs and compact-disk players—are imported. Nonetheless, some improvement is in sight here. Domestic production of VCRs will begin early this year as a result of a joint venture between West Germany's Standard Elektrik Lorenz AG and Italy's state-owned consumer producer REL. Production, based in Rome, is initially targeted for an annual capacity of 100,000 units, no doubt aiming at the 10% growth that is expected in the home market.

In terms of semiconductor technologies, says Villa, the star performers this year should be MOS processes, with CMOS and n-MOS chips turning in 30% and 20% gains, respectively. The *Electronics* survey uncovered a 6% drop in digital bipolar devices in 1985, but they will come roaring back in 1986 with 31% growth, to $38 million. Analog ICs and discrete parts will grow 16% and 11%, respectively, to $178 million and $105 million. Small-signal and power transistors and rectifiers will form the biggest markets in the discrete area. □

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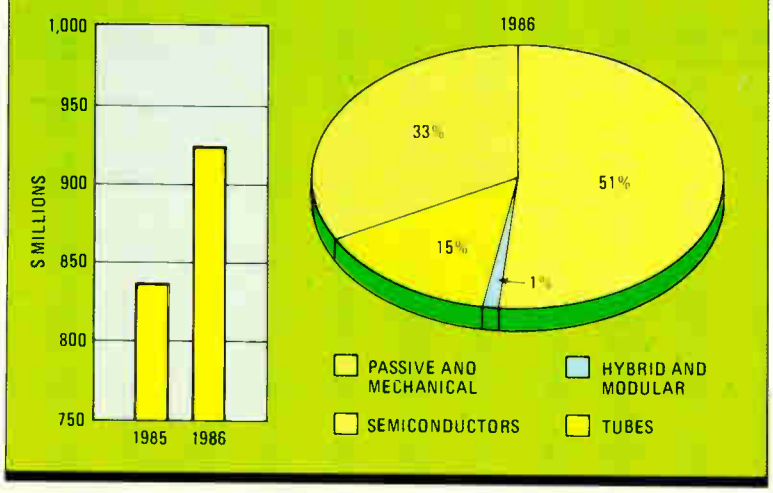
ITALY COMPONENTS



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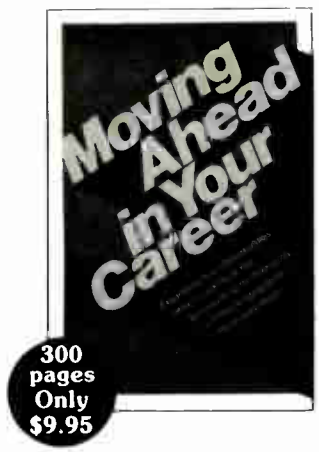


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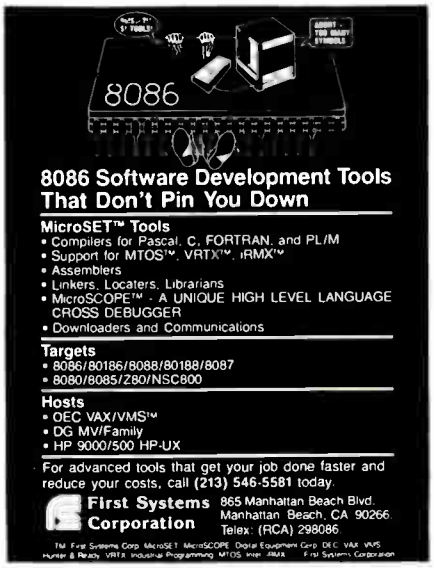


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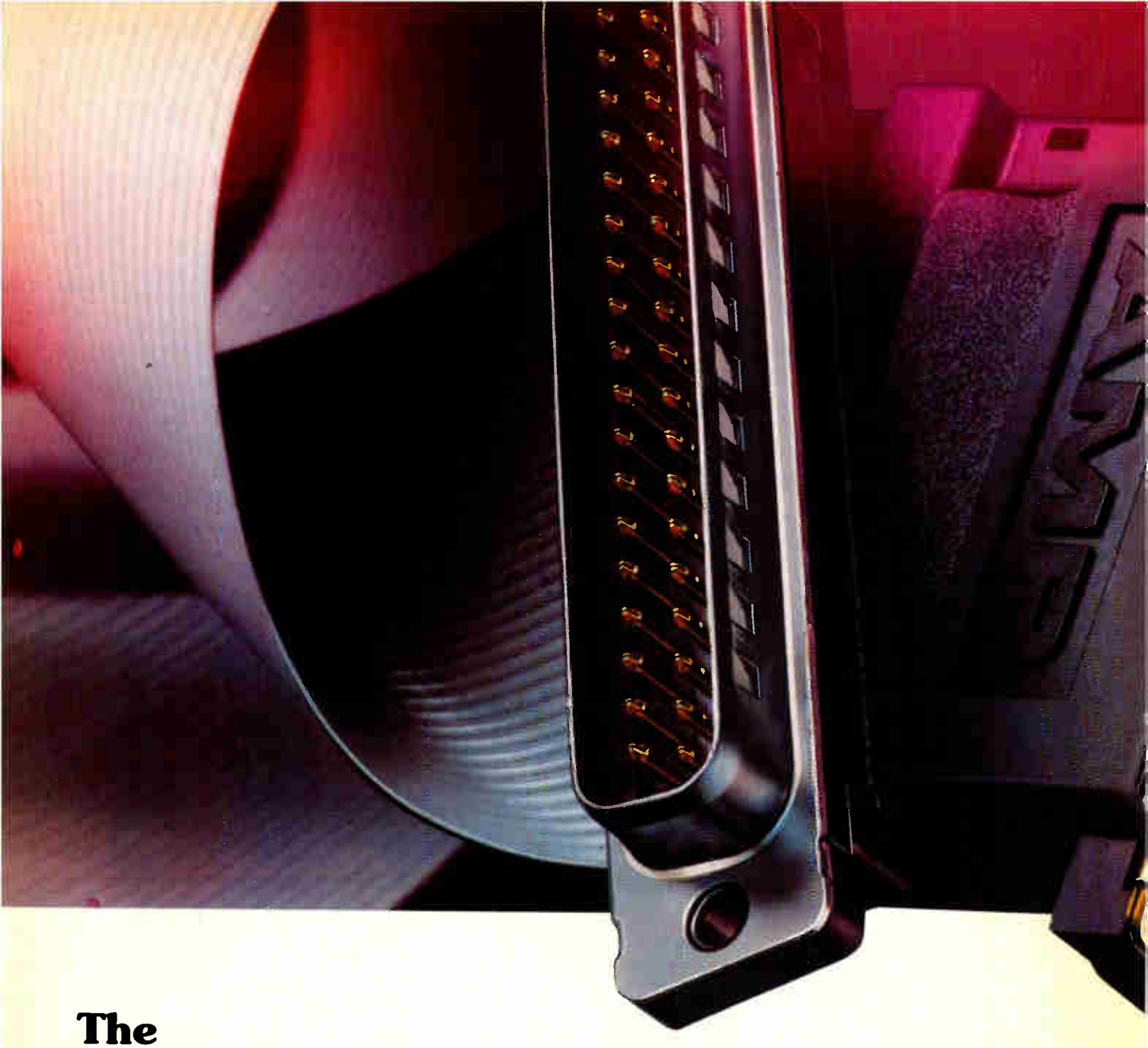

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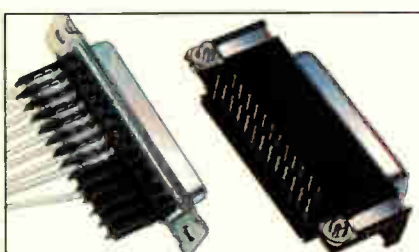

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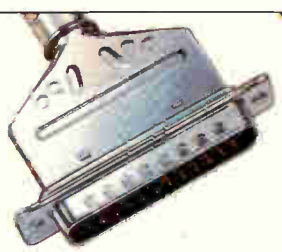

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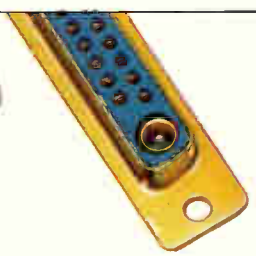

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# INSIDE TECHNOLOGY

# HOW TECHNOLOGY IS CUTTING FAULT-TOLERANCE COSTS

## 2:1 GAIN IN PRICE/PERFORMANCE CLAIMED FOR TRANSACTION SYSTEM

On-line transaction processing is one of the most stringent applications that a computer system tackles. Such processing demands high accuracy, reliability, and speed. So far, only users with big bucks have been able to grab a piece of the on-line action. Now Tolerant Systems Inc. has developed a new-generation computer system that it says will bring high-volume, fault-tolerant, on-line transaction within reach of a wide range of commercial users.

In Tolerant's Eternity series multicomputers, the operating system is independent of the hardware. The system is expanded by adding building blocks to support up to 2,500 users. A basic system, selling for $190,000, consists of two system building blocks, 4 megabytes of main memory, two 128-megabyte disk drives, one 1,600-bits-per-inch tape drive, 24 asynchronous communication lines, and two communications processors, each with half a megabyte of memory. It performs closed exchanges of information such as sales orders, hotel reservations, and transfers of funds. If a failure occurs during a transaction, the system restores itself to its original state before the transaction began executing and starts over, says Dale Shipley, founder and vice president of engineering for the San Jose, Calif., company.

The Eternity multicomputer system (Fig. 1) executes four transactions a second per system building block, offering a 2:1 price/performance improvement over its nearest competitor, Tandem Computers Inc.'s Nonstop II, according to Tolerant Systems. Because mainframe and minicomputer manufacturers added on-line transaction processing to general-purpose computers, first-generation machines were typically force-fit into fault-tolerant operation, Shipley says. The second generation, implemented by Tandem Computers in 1976, based fault-tolerant operations on a concept called software checkpointing. The third generation arrived in 1982 with Stratus Computer Inc.'s redundant-hardware system.

The hallmark of what Tolerant calls its fourth-generation system is that it was designed from the outset to be a fault-tolerant machine. The company's design "significantly reduces the overhead associated with fault tolerance," Shipley says.

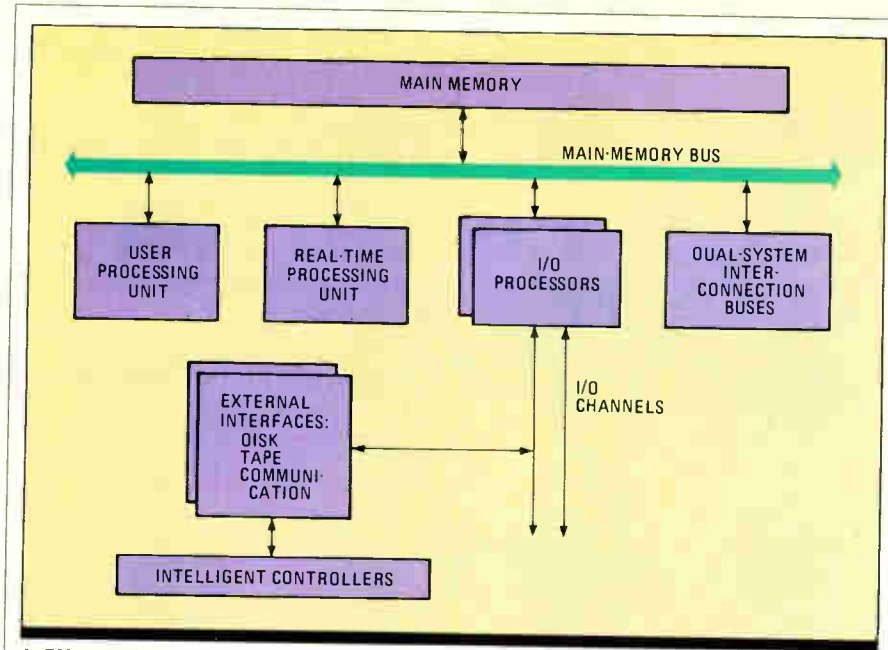
The Eternity series is a distributed system based on a symmetrical, loosely coupled, transparent network model in which all computers are functionally equivalent. Any functional differences during operation come from configuration and application design rather than from system architecture, design, or performance. The aim is to push processing as close as possible to the physical device being managed, slashing through layers of operating systems and software.

The advantage of Tolerant's linear architectural model is the ability to start small and build up to a large system as needed, Shipley says. The loose coupling in Tolerant's architecture greatly reduces the likelihood of an error propagating throughout the system and causing a total system failure.

The standard system building block contains four kinds of processors: a user processing unit, a real-time processing unit, one or two input-output processors, and a communications interface processor (Fig. 2). The user and real-time processing units are available using either National Semiconductor Corp. 32032 or 32016 microprocessors. The I/O processor and communications interface processor are 32016s. Tolerant expects to upgrade the machine as microprocessors advance. The com-

**1. ON LINE.** Tolerant's Eternity system does fault-tolerant transaction processing at low cost. It executes four transactions a second per building block.

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




**2. BUILDING BLOCKS.** System building-block hardware provides an environment for functionally distributing the system software across multiple processors.

pany is testing the 32332 chip and says it appears to be three times faster than the 32032. The system's architecture also allows other microprocessors to be used. Because of the system's completely asynchronous design, it can even incorporate microprocessors of different speeds.

Of the four processors, the communications-interface processor handles data communications and the user-processor unit is dedicated to application processing. The I/O processor functions as a software I/O bus controller. It is a very high-level I/O interface that abstracts the software from the details of the hardware. That is, any hardware base can be used as a data-transfer vehicle without radically affecting the system software as long as the high-level interface is unaffected.

The real-time processor unit responds to most of the hardware-interrupt signals. It hides the CPU-cycle cost of implementing a loosely coupled, distributed system. This split between I/O and real-time processors enables the user-application processor to be time- and queue-driven, resulting in an efficient environment for executing applications. With this architecture, the system becomes more efficient as the processing load increases, rather than becoming less efficient as is the case with other computers.

## SYSTEM EXPANSION

This self-contained superminicomputer configuration—one system building block—can be expanded to include multiple computers, forming a locally distributed system. Further expansion, by connecting the computers over long-distance networks, can turn it into a globally distributed system. The configuration choice, rather than being imposed by the architecture, comes from the requirements of the application.

The Tolerant transaction-executive operating system enables the multiple independent system building blocks to operate as a single computer system from the point of view of users and applications programs. Adding building blocks to the system increases both terminal capacity and transaction throughput. For example, four building blocks process twice as many transactions per second as two. The operating system automatically distributes and balances the work load among all resources, helping keep response time constant as the system grows.

The system architecture gives the user a single-computer view of the configuration without regard to the number of real computers in the system. Making up the view are all the on-line storage and other devices physically connected to the system as well as interprocess communication channels. For administrative and security reasons, the architecture supports the concept of reference, or individualized, domains. This means that any individual computer's view can be limited to a subset of the total system view.

Central to Tolerant's architecture is the concept of data correctness. The system has as much failure-detection hardware as possible, yet remains cost competitive with other systems. In addition to supporting error detection, the hardware in some cases does error correction. The system software keeps a log of all errors and system failures.

Most important, the architecture supports the concept of a transaction. Critical to data correctness and consistency is viewing a transaction as a completely self-contained action. Transactions usually are completed successfully. But if a failure occurs, the system ensures that the transaction leaves no side effects, or errors, that will prevent a quick recovery of the on-line transaction-processing functions. For example, a transfer between two bank accounts will always result in a proper balance. If an imbalance occurs as a result of a system failure, the accounts will appear as though the transaction was never attempted, and both accounts will return to their pretransaction state. In many cases, failures result from errors in software rather than in hardware. Both hardware and software errors are logged for auditing purposes.

At the top level, the system's software is based on a full peer-level transparent network, which means that all computers in the network are functionally equivalent. At the next level, the functional components of the system software are most often client-servers, in which one computer controls or calls another to perform different functions.

## CLIENT-SERVER MODEL

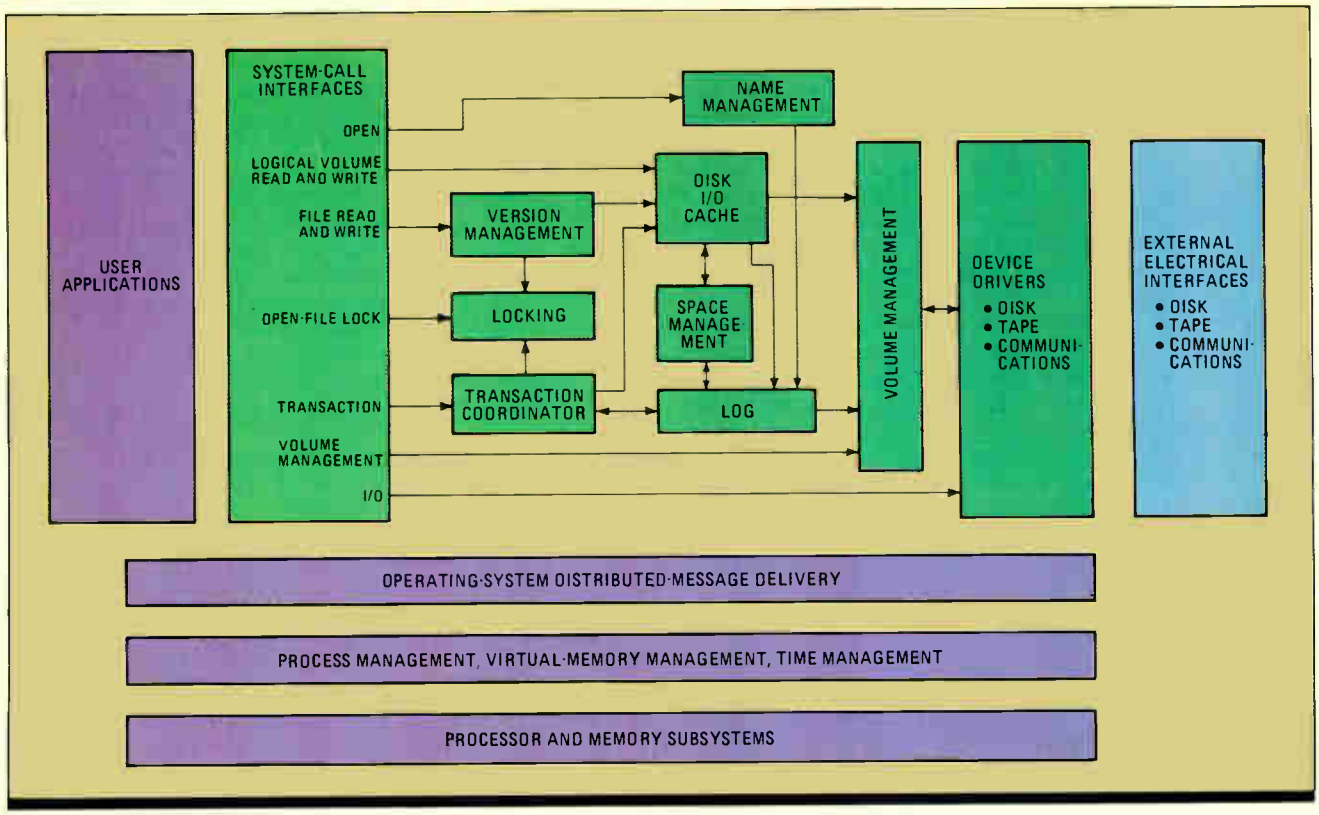
Client programs are the active elements of the architecture. Server programs perform defined services, such as file and data-base management, for the clients. All user-level programs are clients.

With a client-server model, processing can be assigned to a processor as close as possible to the resource. For example, client programs should usually be processed by the computer to which the user is physically and logically connected. Server programs, on the other hand, should be processed by the computer that is managing the file or data-base resources being used by the application.

Tolerant supplies a toolkit to aid the designer in putting to work applications that are based on the client-server model. When the toolkit is used, the application logic is split naturally into terminal-oriented clients and data-base-oriented servers.

The components of the transaction-executive operating system include an integrated transaction-oriented file system, integrated data communications, and networking (Fig. 3). The user references system resources by opening an object stored in the file system. Objects include file systems, directories, physical devices, and interprocess communication channels. Transaction-executive software automatically links the program with the requested object. This enables the configuration to expand or contract without changing the application or the user's view of the configuration.

Data communications and networking are integral parts of




**3. FILES.** To obtain low processing overhead for fault tolerance, the operating system relies on a transaction-oriented file-system architecture.

the Tolerant linear architecture. Besides supporting conventional character-oriented Unix-compatible TTY terminal code, the transaction-executive operating system provides a message-oriented facility (TX-Comm) optimized for block transfers. TX-Comm is equally applicable to forms-oriented or message-oriented transaction-processing networking. TX-Comm is distributed across the user processing unit and the communications interface processor. Using this distribution approach, all the high-overhead, real-time, interrupt-driven communications processing is removed from the user processor.

## VIRTUAL-TERMINAL ACCESS

As part of the communication facilities, the transaction executive provides a virtual-terminal access method, which provides a view of a terminal compatible with the Advanced Data Communication Control Procedure (ANSI) standard for application programs. In addition, the access method synthesizes ANSI character-oriented terminals into a block-oriented device for the application. This allows low-function low-cost terminals to work as expensive block-oriented intelligent terminals, and a single application can connect with different types of terminals.

As with Unix TTY terminal code, the virtual terminal is distributed across the user processor and the communications interface processor with the majority of the processing handled in the real-time communications-interface-processor environment. This distribution combined with the block-oriented virtual-terminal interface results in a highly efficient, transaction-oriented, run-time environment without borrowing user-processor instruction cycles.

The communications interface processor is an important part of the linear architecture. In addition to offloading high-overhead terminal and network-protocol processing, the communications-interface-processor approach provides for straightforward incorporation of other interfaces. By changing the communications interface processor's physical and electrical interface, additional interfaces can be added by developing custom gateways to the outside world.

Another key element of the architecture is the connection system, which provides a general mechanism for linking functions over a distributed system. The linkage is based on queues that are used to synchronize execution of a process pair. The connection system is optimized so that if the local functional component can handle the service requested, a direct subroutine call is executed rather than sending a message to a queue.

Each system process has an associated request-response queue. Each user-level process also has an associated response queue. When a process requests a service—reading a record, for example—the connection system routes the request to the appropriate queue. The request includes the queue address of the requesting process. The responding process retrieves a request from the queue, processes it, and returns a response. Entering a message in a queue causes a waiting process to continue execution at the instruction following the requested operation queue. The connection system resolves the logical queue addresses to physical queue addresses and sends a message to the appropriate queue. Function-specific logic at each end formulates and decodes the messages. The queues and the function-specific logic are provided as part of the system to maintain a single computer view when the system configuration is expanded to include multiple computers.

## INVISIBLE CONFIGURATION

Central to Tolerant's linear architecture is the invisibility of its configuration to the user. The software architecture hinges on a single global name space provided by the operating system. This concept enables all programs outside the operating-system kernel to address or reference objects or devices, without regard to the physical position of those objects.

The naming mechanism is based on the concept of an endpoint, an address that will provide a particular service or understood response. The user has to know only the path

name. The machine takes care of where the resource is and how to deliver the resource to the user. The name-resolution convention follows standard Unix file-system name resolution.

Tying end-point location resolution to the file-system naming convention is an innovative way to provide well-understood uniform addressing. This enables the physical topology of the system to change without changing the name used to access the object; that is, the system topology is invisible to the user. This invisibility enables the system configuration to expand or contract without requiring a change to the programs running on the system and without changing the users' view of the system.

Also inherent in the system is the concept of a transaction as a self-contained action. A transaction must be completed successfully. The scope of a transaction encompasses all recoverable resources used during the transaction and all processes involved in the transaction. An application may choose not to include recoverable resources—for example, a spooled file—within the scope of a transaction. When a transaction is opened, the user program specifies whether the resource is to be protected by transaction data-correctness and -consistency. Conventional transaction-integrity and -consistency techniques have been integrated into the operating system.

## TRANSACTION FACILITIES

To use the system's transaction facilities, the user embeds begin, commit, abort, and/or transaction-point statements at the appropriate points in the program source code. A user program enters transaction mode by executing a begin-transaction statement and exits transaction mode by executing a commit-transaction statement. While in transaction mode, program execution may be restarted at the begin-transaction statement by executing an abort-transaction. When an abort-transaction is executed, the program state and all recoverable resources used by the program are restored to their begin-transaction state. Recoverable resources include files and interprocess communications channels opened by requesting transaction protection. If the channels are connected to other processes when an abort-transaction is executed, those processes are aborted. Resources that have not been opened by requesting transaction protection are not affected by the abort-transaction function.

To achieve continuous operation should multiple hardware or software failures occur, the system design provides a file- and data-base-recovery mechanism, terminal-activity logging, and virtual-process imaging. With imaging, the user declares at run time that a particular program or process is to be imaged. When the user makes this declaration, the system automatically creates two additional virtual images of the process on another system building block in the network. This results in three images of the process—the active user process, the primary image, and the secondary image.

The active process executes the user's program under normal conditions. If the computer executing the active process fails, the current primary image becomes the active process in a transparent on-line reconfiguration. The two backup images—primary and secondary—are needed to provide a fail-safe condition while the backup images are being updated. When the active process executes a begin-transaction command, the system first updates the status of the secondary image, then reverses the roles of the backup images—the updated secondary image becomes the primary image—and finally, the new secondary image is updated. For full protection however, the disk-backing storage for all three images must be kept in a file system that has been replicated on three or more disk drives, each with its own controller.

After the system has made the primary process the new active process and the affected files have been rolled back to the state they were in at the time of the last begin-transaction statement, execution of this new active process starts from the beginning. The system rolls forward to the point of failure, then continues. If the program is driven by terminal input, the input for the roll-forward portion is retrieved from the terminal log and not from the active terminal. The terminal log contains all terminal input since the begin-transaction statement. Terminal output is suppressed until the program has been rolled forward to the point of failure.

All the features that provide continuous operation, system-level transaction control, n-plexing of the disk-drive subsystems, terminal logging, and the virtual-process imaging, can be selected program by program. This allows application needs to dictate the level of protection rather than having the system impose this choice on all applications, whether they need it or not. □

# SHIPLEY'S INTEL EXPERIENCE LED TO FOUNDING OF TOLERANT

**Dale Shipley** is a one-time hacker who went on to found Tolerant Systems Inc. and lead the development of the Eternity series fault-tolerant multicomputer as the San Jose, Calif., company's vice president of engineering.

Shipley got his start in software engineering in 1967 when he was a computer operator at General Electric Co.'s Information Systems Division, Phoenix, Ariz. "I worked night shifts. When the other guys were off playing cards or reading books, I was playing around with the computer."

When an entry-level programming position opened up, Shipley grabbed it. The project involved the development of the GCOS operating system. Here, Shipley advanced rapidly. "I became the chief architect of what is now GCOS-8," he says. "I hold a patent for the architecture or design of their current mainframe processors."

**DEDICATED.** Tolerant's Shipley leads the technical team that developed the fault-tolerant Eternity.

In 1971, Honeywell Inc. bought GE's computer business. (GCOS is today Honeywell's standard minicomputer and mainframe operating system.) During the next nine years at Honeywell, Shipley gained the extensive experience in on-line transaction processing that would lead to his founding Tolerant.

His career path took an important detour in 1980, when he signed on with Intel Corp., where he worked with microprocessors instead of mainframes. After six months as head of original-equipment-manufacturer software, Shipley was charged with developing a technical strategy for Intel's new commercial microsystems operations.

At Intel, "I got an exposure to microprocessor technology and where VLSI technology was going. That's really what led to founding Tolerant," Shipley says. Just as important, he hooked up with Eli Alon, director of engineering in Intel's development systems operation. The two put together a business plan, quit Intel, and set about raising money to start Tolerant. Alon, initially the president of the company, now serves as an adviser and a member of the board of directors. David Caplan took over as president and chief executive officer a year ago.

The company, armed with a strategy to design and sell on-line transaction processing systems with modular expand-ability and fault tolerance, went on line itself in 1982. □

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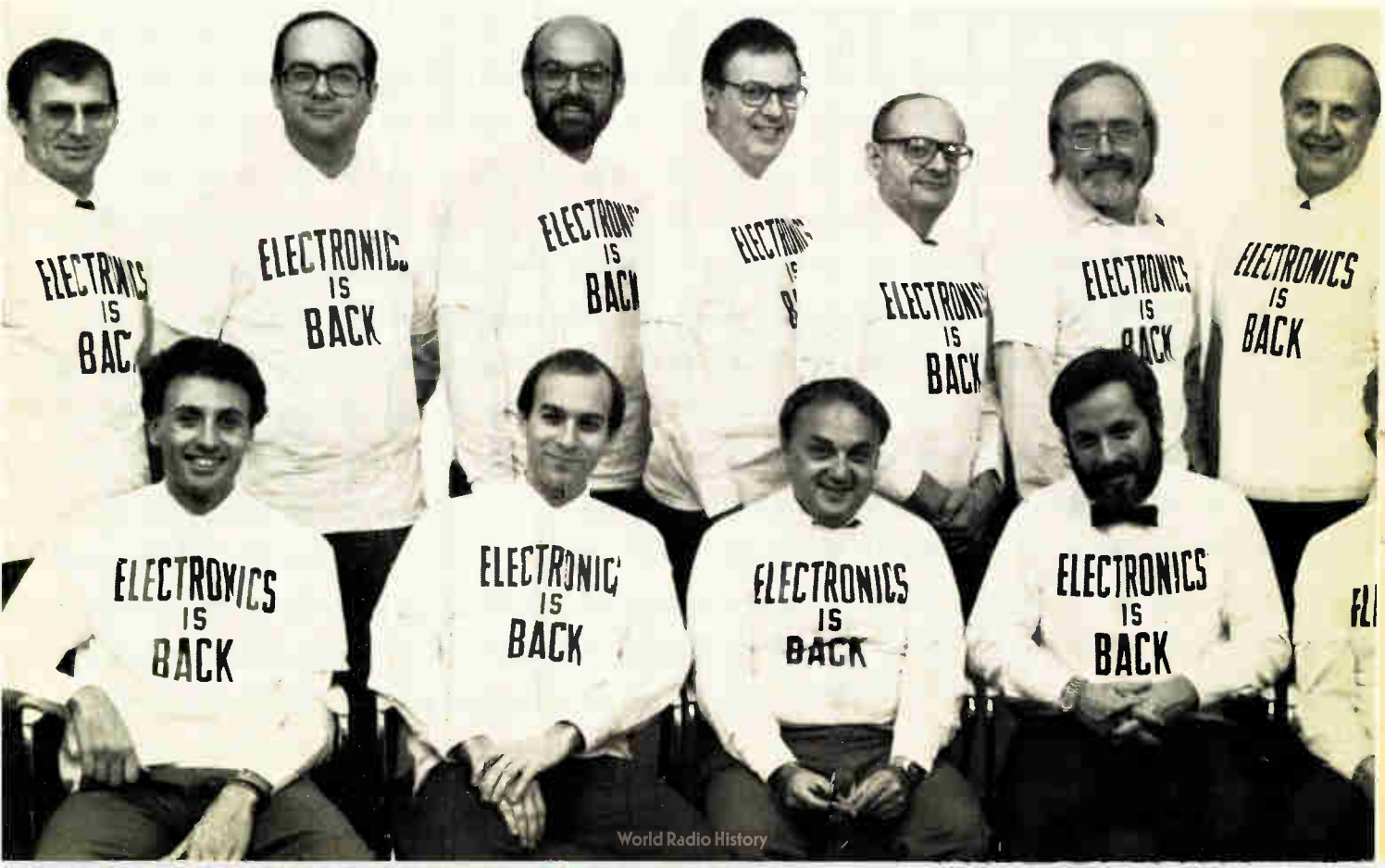

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# PROBING THE NEWS

# SURPRISE! GaAs STARTUPS THRIVE IN NEW JERSEY

## A DOZEN VENTURES EMERGE; BELL LABS IS BIG SOURCE OF TALENT

*by Tobias Naegele*

**SOMERVILLE, N. J.**

Word is spreading: a new garden is blooming here in the central part of the Garden State. It is a technological oasis of gallium arsenide companies that together make up what is coming to be known as Gallium Gardens. Surrounded by AT&T Bell Laboratories, RCA Corp.'s Solid State and Research divisions, and universities with strong research traditions, the garden is in full bloom.

"I'll tell you what we're doing here," says Saul Lederhandler, president and chief executive officer of Microwave Semiconductor Corp., perhaps the biggest spender in New Jersey's GaAs community. "We're going to turn the United States on its side and bring gallium arsenide to the East Coast."

**MADE IN N. J.** Lytel designed a liquid-phase epitaxy system to make GaAs LEDs and FETs.

New Jersey is joining Boston, Dallas, Los Angeles, and San Jose, Calif., as the centers of GaAs activity. Yet few outside the area have really taken notice. "A garden is growing up right beneath their noses," says Gene Gordon, president of Lytel Inc., "and they don't even smell the flowers."

Two factors figure prominently in the nearly one dozen GaAs ventures—half of them started this decade—now operating in New Jersey (see table, p. 63). First was the breakup of AT&T and the changing atmosphere at Bell Labs, and second, the built-in advantages the state has to offer high-technology companies: an established service sector, a well-educated and trained population, and an excellent geographic location.

"What's happening now in New Jersey is that the breakup has changed Bell Labs, making it a major source of talent," says Ronald Rosenzweig, president of Anadigics Inc. Rosenzweig cofounded Microwave Semiconductor Corp. in 1968 and sold it to Siemens AG of West Germany in 1983. He is now setting up Anadigics in Warren, N. J., to make small- and medium-scale integrated circuits for broadband microwave amplifiers, analog-to-digital converters, and digital signal processing.

Lytel's Gordon led the charge out the door from Bell Labs. The 26-year Bell veteran took early retirement in 1983 to start Lytel, which he says was the first startup in the device area to come out of Bell Labs since 1959.

**OTHERS FOLLOW.** Almost immediately after Gordon broke with AT&T, others began to follow. Researchers broke off to begin Em-Core and Gain Electronics Corp. Others left for new opportunities at Anadigics, Microwave Semiconductor, and others. "I don't want to take credit for starting a stampede," Gordon says, "but it's possible. If I had not left and done my thing, they might not have done it either."

Gordon acknowledges having hired at least 10 people from Bell Labs at Murray Hill, and says he is no longer a welcome visitor to his old stamping grounds. He says AT&T was "not tickled" by his hiring away Bell researchers, and it countered his actions with litigation seeking to prevent Lytel from doing business. The litigation ended with Gordon agreeing not to solicit Bell Labs employees for a year. Researchers at Bell Labs say their GaAs efforts have not been seriously affected by the startups, however. "People have always left Bell Labs," one says.

Other companies, especially Microwave Semiconductor, drew heavily from AT&T talent. Lederhandler says he has added more than 45 professionals since May, more than half of whom hold PhDs. He declines to specify how many of those came from AT&T, but he does admit that two of the top three people in his GaAs division were recruited from Bell Labs.

Under Lederhandler's leadership, Microwave Semiconductor is aiming to be the brightest flower in Gallium Gardens. The Somerset, N. J., company is pouring $44.5 million into a three-year effort in GaAs power FETs, GaAs digital and analog ICs, and microwave monolithic ICs, or MMICs. The Department of Defense has promised to award a total of $120 million for research into MMICs in a program experts say will be for GaAs what the Pentagon's Very High-Speed Integrated Circuits program, or VHSIC, has been for silicon.

Microwave Semiconductor's three-year program began a year ago with the construction of a small Class 100 clean room that will eventually be

turned over for use as a research and development facility only. The rest of the money is being used to build and furnish a 90,000-ft² facility that will house a 6,000-ft² Class 10 clean room with 3-in.-wafer capability and automated wafer handling.

Moreover, the company will continue to hire technical and professional staff at an almost frantic rate: Lederhandler says his plans call for an additional 20 to join the ranks by 1988. He estimates that by then, his company will have invested some $150 million to $200 million in its GaAs project.

That, he says, is the minimum ante for a serious gamble in GaAs. "This is not a simple-minded game," Lederhandler says. "The stakes are very high and there's no room for mistakes. To be a player in this game, I say the critical mass is $40 million to $50 million."

**BIG NEIGHBORS.** Gallium Gardens is relatively compact, with Morristown as its northern tip and Princeton, some 30 miles away, as its southern end. Most of the growth has been in and around Somerville and the Plainfields, near RCA Solid State and Bell Labs' Murray Hill research center.

To the uninitiated, New Jersey might seem to be an unlikely locale for a technology center. But the state boasts some impressive statistics. According to its Department of Commerce, New Jersey has a well-educated population, with a citizenry that included 135,550 engineers and scientists in 1982—a figure that, according to the department, is now "considerably larger." College-educated residents now account for 18.5% of its population.

"There's lots and lots of talent in this area," says Anadigics' Rosenzweig, who says that 16 of his year-old company's 21 employees were living or working in New Jersey before they joined him.

Although New Jersey's higher education system is small, the state is surrounded by good engineering schools from which such companies as Microwave Semiconductor glean 8 to 10 trainees each year. Carnegie-Mellon and Lehigh universities in Pennsylvania and Cornell and Columbia universities in New York state join New Jersey's state university, Rutgers, in New Brunswick and Stevens Institute of Technology in Hoboken to provide talent.

In addition, the state is ideally situated at the heart of the East Coast corridor, relatively close to Washington, New York, and Boston. Being close to the nation's capital is advantageous to companies hoping to win government and military contracts, an area for which GaAs is well-suited. Being near New York, says Anadigics' Rosenzweig, is important to venture-capital investors based there who like to keep close tabs on the companies they invest in. And being near Boston is important because of the GaAs research under way at such companies as Raytheon Co.

Executives at the new companies also cite other attributes, such as the area's proximity to several major international airports (Newark International is just 30 miles from Somerville), the Jersey shore (less than 50 miles away), and the cultural centers of New York and Philadelphia (40 and 60 miles away, respectively). The airports are important for business reasons, but the cultural and recreational attractions are essential, they say, to lure the kind of talent they need to a state that is often considered an overblown suburb of Philadelphia and New York. "Face it," says Rosenzweig. "The places where people want to be are Los Angeles, New York, Boston, and San Francisco."

Perhaps more important than these considerations, however, is that the state already has an infrastructure of service and support companies in place. Chemical companies, machinists, distributors, and other firms essential to new companies that cannot afford to maintain such operations internally are well established. The labor force includes people with experience in clean rooms and high-technology manufacturing, which keeps training—and associated costs—to a minimum.

"We can find virtually all of our supplies here," says Norman Shumaker, president of Em-Core, a small startup in South Plainfield that specializes in GaAs materials and processing equipment, run by a trio of scientists who left Bell Labs two years ago. "We found the people we need and the resources we need in terms of space. We did bring in a chemical engineer from out of state, but you can't find everybody in Jersey."

**A DISSENTER.** Yet there are those who don't think you can find anyone in New Jersey. Chuni Ghosh, president of Tachonics Inc., Grumman Corp.'s entry into GaAs semiconductors, says the only reason his firm is opening up near Princeton is that Grumman wants the outfit near its Long Island headquarters in Bethpage, N. Y. He scoffs at the notion of a GaAs center in New Jersey, saying that most of the serious work is on the West Coast where Hughes Aerospace is dominant and where he has done most of his hiring.

**SOURCE.** Rosenzweig sees change in Bell Labs as key to new GaAs ventures.

**REORIENTATION.** Lederhandler is helping bring GaAs to the East Coast.

The newest bud in Gallium Gardens, Tachonics will produce analog ICs aimed at the military market. It is Grumman's first venture into the semiconductor business [*Electronics*, Dec. 23, 1985, p. 68].

Ghosh, though, is alone among the exuberant new executives of Gallium Gardens, who predict an ever-growing center of activity will grow up on the little plot of land (there are only four states smaller than New Jersey, but only eight are more populous). "There's a genuine community of interest here," says Gordon. "That provides for relatively simple mobility. We'll compete with each other, steal people from each other. Local universities will begin to develop and fund compound semiconductor research." In short, he says, growth will breed more growth. □

*GaAs STARTUPS GROW IN NEW JERSEY*

| Company | Year started | Location | Founders | From | Products |
|---|---|---|---|---|---|
| Lytel | 1983 | Somerville | Gene Gordon | AT&T Bell Laboratories | High-speed LEDs, lasers, and p-i-n FETs |
| Anadigics | 1984 | Warren | Ron Rosenzweig<br>George Gilbert<br>Charles Huang | Microwave Semiconductor<br>Microwave Semiconductor<br>Avantek | Analog and digital ICs |
| Em-core | 1984 | South Plainfield | Norman Shumaker<br>Wilfrid Wagner<br>Richard Stall | AT&T Bell Labs | Epitaxy and chemical-vapor-deposition equipment and materials |
| Epitax | 1984 | Princeton | Greg Olsen<br>Vladimir Ban | RCA Labs<br>RCA Labs | Fiber-optic detectors and long-wave LEDs |
| Gain Electronics* | 1985 | Somerville | Raymond Dingle | AT&T Bell Labs | High-speed ICs |
| Tachonics* | 1985 | Princeton (tentative) | Chuni Ghosh | ITT | Military ICs |

*not yet in production

SOURCE: *ELECTRONICS*

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## IT HAS LARGEST SHARE OF THIS INTEGRATED VOICE AND DATA NETWORK MARKET, BUT FACES STIFFENING COMPETITION

**WOODCLIFF LAKE, N. J.**

Three years ago, when Timeplex Inc. introduced its Link/1 high-speed T-1 integrated voice and data network, Ed Botwinick, the company's president, cofounder, and chief executive officer, knew it was the start of something big. But he had no idea just how big. Since then, the product has catapulted Timeplex into a leading position in T-1 networks, with a 30% to 40% market share, and helped it grow from a tiny $8 million company to one that will declare revenue for all its products of about $120 million this year.

But even as the company grows at such a rapid rate, there is trouble on the horizon. As T-1 networking moves into its second generation, startups and competitors are beginning to gain strength (see table); Timeplex will have to test its mettle in a tougher market. The company's marketing department admits that it is too small to meet the huge market demand at present. Also, it may not be able to grow fast enough to keep pace with the market's growth. How well the company can capitalize on its early gamble in the market will probably determine its continued position as an industry leader.

T-1 lines are multiplexed groups of 24 standard telephone voice channels that transmit voice and data at 1.544 Mb/s. Timeplex was among the first in the business to devise an integrated digital network for voice and data communications that can take advantage of the high-speed T-1 lines, and its early-bird status has earned it the preeminent position in the worldwide T-1 market. Though the systems are expensive, often carrying price tags in the millions of dollars, the high-speed lines are considered essential to controlling communications costs and improving efficiency in large companies with widely separated offices.

The key to such rapid recognition for Timeplex was its timely development of Link/1—a T-1 network management system—coupled with an aggressive sales strategy and support organization. Together, they have generated almost unprecedented growth for the 16-year-old company. In fiscal 1985, Timeplex reported revenue of $96 million, a twelvefold increase since 1977, when the company earned $8 million. In the first quarter (ended Sept. 30) of fiscal 1986, revenue hit $29 million—a breakneck pace that should put the company's performance at close to $120 million for the year. Timeplex's swift growth has come while those making other data-communications products have suffered from increasing foreign competition.

Since its introduction in January 1983, Link/1 has not only come to command the T-1 network market, but in a catalog of multiplexers and other telecom equipment, it has quickly become the company's most important product. According to Chuck Kanupke, vice president for telecommunications for market researcher Dataquest Inc., San Jose, Calif., Link/1 will garner about $55 million—or roughly half its total revenue—for Timeplex this year.

**EMBATTLED.** Timeplex's Botwinick and Brown prepare to repel new competitors in the T-1 network market.

Andy Schopick, an analyst with The Gartner Group, a Stamford, Conn., market researcher, cites similar figures. He estimates that Timeplex could account for better than 42% of the $130 million 1985 worldwide market and expects the T-1 market to grow to $200 million or more this year. But though Timeplex's revenue should continue to climb, its market share will probably shrink, Schopick says.

**MAINTAINING MOMENTUM.** Not all agree, however. Botwinick admits it will be difficult, if not impossible, to maintain 30% or better annual growth, but he is not about to concede his company's market share or technological leadership. And Dataquest's Kanupke foresees no loss of momentum.

"I think they're going to continue to increase their market share," he says. "T-1 network systems will really become the interface into the ISDN [integrated services digital networks] in the future—that's why products like Link/1 will be so popular." And even though "competitors are starting to come out with products with features as good as or better than Timeplex," he adds, its established market presence will ensure its position.

All of which sounds like good news for a venture-capital-funded company that almost didn't come into being in the first place. Botwinick was a venture-capital investor with Merrill Lynch, Pierce, Fenner & Smith Inc. when he came upon a small group that was seeking funding to produce a line of multiplexers for data communications. Unable to sell his employers on the idea, he sold his friends on it instead. The company grew slowly, but enough to persuade Botwinick to leave Merrill Lynch and join Timeplex as its president full time in 1977. Today, its employees and their close friends own more than a third of the company,

*HOW TIMEPLEX STACKS UP*

| Company | Product | 1985 sales ($ millions) | 1984 sales ($ millions) |
|---|---|---|---|
| Timeplex | Link/1 | 30.0 | 8.8 |
| General Datacomm Industries | Megamux, Megamux Plus | 27.0 | 25.0 |
| Coastcom | D/1 Multiplexer | 11.0 | 7.0 |
| Avanti Communications | Ultramux | 13.0 | 6.0 |
| Datatel | 9100, 9200 | 6.0 | 3.0 |
| Tellabs | T-Plexer | 12.0 | – |
| Network Equipment Technologies | IDNX | 10.0 | – |
| Others | | 40.0 | 13.0 |
| Total | | 149.0 | 62.8 |

SOURCES: DATAQUEST INC., COMPANY DATA

Botwinick says, a fact he believes protects it against unfriendly takeover attempts.

"This success didn't happen by accident," he says. "We were in the right place at the right time with the right product line."

But doing that is not easy. Timeplex gambled on developing expensive systems for an untested market—one that initially catered almost exclusively to Fortune 200 companies, to which tiny Timeplex was an unknown quantity.

Timeplex succeeded as much with an intensive sales strategy as with its product line. The company invests more than 20% of its revenue—roughly twice what it spends on research and development—in its sales program. Application engineers draw up detailed plans for installation proposals long before the company will see its first dime from an account; the typical sales cycle runs at least six months to a year.

In addition, the company trains its customers to use the system, tests each network in a simulated environment before delivery to iron out potential bugs, and sponsors seminars for the executives who pay anywhere from about $150,000 to $5 million or more for the systems. This commitment is necessary, says Victoria Brown, senior vice president of sales and marketing, because customers often come to Timeplex asking for guarantees that the new networks will offer mean time between failure of up to 10 years.

**THREE LEVELS.** Customer support for service and maintenance comes on three levels: locally based application engineers, regional network consultants, and national network analysts. In addition, the company provides training for information-system managers.

Sales pitches are so intensive that it takes six to nine months to train salespeople, Brown notes. That could be a major hindrance to a company trying to maintain growth in its sales force equal to or greater than that of its revenue. As fast as its revenue is climbing, business could actually be too good. "We suffer from a lack of market coverage," she admits. "There's more out there than we're able to cover."

The situation could get worse before it gets better. "It used to be that most of the T-1 users were in the major metropolitan areas, like New York, Chicago, and San Francisco," she says. "But we're now seeing smaller financial institutions in the Southern states putting in nets."

As AT&T Co. installs additional T-1 lines, more companies will make the switch to the high-speed systems. "People are beginning to understand the value of T-1," Botwinick says. "They are beginning to recognize that it is a huge volume discount." *–Tobias S. Naegele*

## BOTTOM LINES

### CULLINET BUYS INTO MICHIGAN CONSULTANT

Cullinet Software Inc., the Westwood, Mass., supplier of software for database-management systems, integrated applications, and information centers, has purchased 15% of Computer Strategies Inc. for an undisclosed amount. Cullinet also has an option to pick up the remaining 85%. Computer Strategies, a five-year-old privately held company in Grand Rapids, Mich., does manufacturing consulting and specializes in providing integrated manufacturing-control systems. Cullinet entered the applications market three years ago and now earns 17% of its revenue there. It garners another 11% from manufacturing-systems software.

### VARO SELLS OFF SEMICONDUCTOR UNIT

Varo Inc. has signed a letter of intent to sell the assets of its wholly owned subsidiary, Varo Semiconductor Inc., to V-QSI Acquisition Corp., a newly formed investment group. Varo, of Garland, Texas, expects to complete the deal next month. The price was not announced, but the operation's net book value at the end of Varo's second 1986 quarter (Oct. 31) was $15.2 million. "Varo will use the proceeds primarily for manufacturing requirements for a large Army contract obtained in September and for future acquisitions," says company president James F. Gero. He adds that the deal is in line with the company's new objectives: proprietary defense electronics and electro-optical products. Varo Semiconductor makes products primarily for the commercial market.

### CONNECTORS TAKE A MOMENTARY DIP

Inventory surplus, accumulated in 1984 and depleted throughout 1985, was largely responsible for an overall decrease in the production value of connectors and integrated-circuit sockets last year, according to a study by Gnostic Concepts Inc. In 1984, U.S. production totaled $3.9 billion, but the San Mateo, Calif., market researchers predict that year-end 1985 figures will show a 1.4% decrease in production value. However, it is expected that by 1990, production of connectors and IC sockets will total over $7.5 billion, or an annual growth of 11.4% between 1984 and 1990. The fiber-optic connector segment will have the biggest average annual growth in production, 32.5%, and most high-density connector types are expected to grow faster than the average.

# SCRICCO'S 'PROBLEM'—EVERYONE SHOULD HAVE IT

**NATICK, MASS.**

Francis Scricco has an enviable problem. "We can't do everything we're being asked to do," laments the president of Proteon Inc., a maker of token-ring local-area networks. So his most pressing task is to get his opportunities in order—saying yes to the best of them and holding off on others.

This was precisely the problem that Scricco, 36, expected when he left General Electric Co. last month to become president and chief executive officer of Proteon, which offers an IBM-compatible network and other high-speed networks. Business for the privately held company had been good even before IBM Corp. introduced the first token-ring hardware for its Personal Computer in October, Scricco reports. After that, Proteon's growth chart went nearly vertical. "We're looking at 25% to 30% increases per month in our sales."

Founded as a consulting company 13 years ago, Proteon has received an injection of more than $8 million in venture capital in the past two years. With the recent surge, the central issue for the company has become growth management. Much of this boils down to organizational basics—"blocking and tackling," in Scricco's words—but applying the basics with a light touch.

**NOT TOO MUCH.** "There are a lot of ex-GE guys who went into small companies, brought too much organization, and strangled the place," says Scricco, adding that the trick is not to eliminate creativity.

Scricco, a native of Worcester, Mass., graduated from Worcester Polytechnic Institute with a degree in mechanical engineering and spent one summer working as an engineer. "They put me in a bullpen with 25 or 30 other engineers and I really wanted more," says Scricco. "I wanted to be valued more and compensated more."

He left engineering to get a master's degree in business administration from Columbia University and then went to work for the Boston Consulting Group Inc. Moving over to GE, he was assigned first to its Fairfield, Conn., headquarters. Later, he managed an air-conditioner factory and for a time headed up a TV products development group.

**LAN MAN.** Proteon's Scricco has found the local-area-network business almost too good.

Scricco concedes he is still learning the technical side of the networking business, but he is confident in discussing market issues, particularly the impact of IBM's introduction of 4-Mb/s boards for networking. Though Proteon is riding the wave apparently generated by the IBM announcement, Scricco acknowledges, "IBM will get a big chunk of the market. Lots of people are true blue—there are people who will buy IBM lunchboxes."

On the other hand, he believes there are windows of opportunity for independent vendors. Scricco says Proteon will soon offer 4-Mb/s LANs that link equipment from a variety of vendors—which IBM does not yet do—and offer the ability to migrate to 10- and 80-Mb/s LANs. And Scricco predicts the demand will build quickly for these higher-speed products.

In his view, most customers are now interested in moving screens of information and in relatively light tasks such as electronic mail. "My frustration is that when everyone thinks about LANs, they think about hooking four personal computers together. But customers are getting very sophisticated, very fast. The market will move to include large complicated systems."

Less of a competitive challenge, in his view, is Ethernet. "Theoretically, it was terrific. The problem is that it doesn't work nearly as well as the calculations show. Token rings will connect smaller Ethernets, and a lot of people who haven't gone to LANs will go right by Ethernet to token ring," he predicts. *–Craig D. Rose*

## PEOPLE ON THE MOVE

**BERT BERSON**

☐ Acrian Inc., a supplier of application-specific power amplifiers, subsystems, and semiconductor devices, has hired Bert Berson as vice president of strategic planning. In the position, a new one for the San Jose, Calif., company, Berson will be responsible for market development as well as strategic planning. Prior to joining Acrian, Berson was president of Interdevices Inc., vice president of Avantek Inc.'s Semiconductor Division, and manager of research and development at Hewlett-Packard Co.'s Microwave Semiconductor Division.

**BERNARD HORN**

☐ Softstrip International Ltd., a joint venture formed by Eastman Kodak Co. and Cauzin Systems Inc., has appointed Bernard Horn as managing director and chief executive officer. Softstrip International was formed in November 1985 to market Cauzin's Softstrip technology—which enables data to be printed on paper in a highly condensed format and read into a personal computer—outside North America. Horn previously launched and managed the Systems Division for Rank Xerox Ltd.

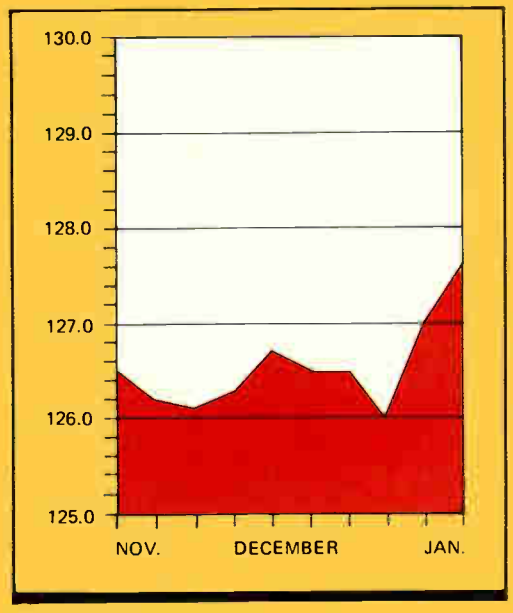
**DEREK BELL**

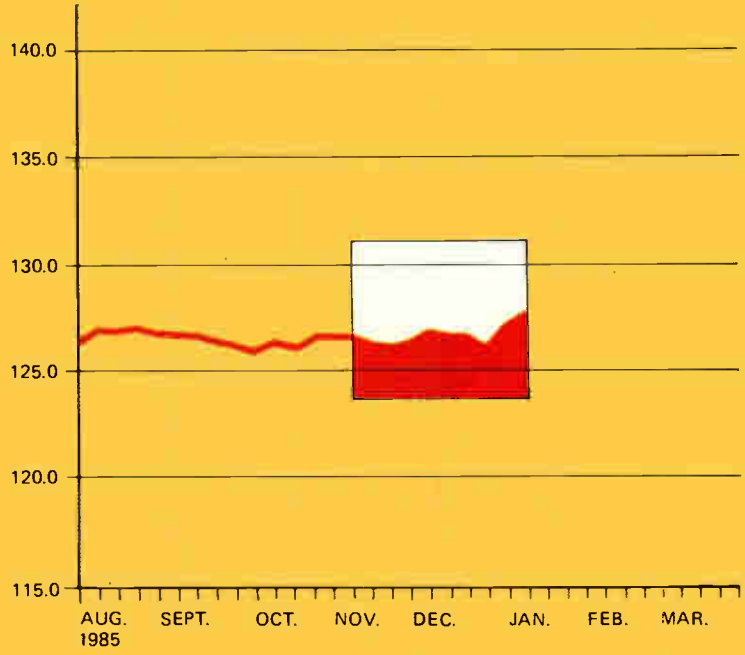
☐ Daisy Systems Corp. has named Derek Bell vice president and general manager of its Analog Design Automation Division. He joins the Mountain View, Calif., company after 13 years at Signetics Corp., where he held positions as vice president and general manager of the Automotive Division and design manager of the Analog Division. Bell's last position was vice president for development of erasable programmable read-only memories.

**JAMES MITCHELL**

☐ Quad Systems Corp., a privately held Horsham, Pa., maker of automated surface-mount assembly systems, has selected James Mitchell as president. Before coming to Quad Systems, he spent 17 years with AccuRay Corp., a Columbus, Ohio, manufacturer of computer-based measurement control and information systems, leaving as senior vice president.

## ELECTRONICS INDEX




| | |
|---|---|
| THIS WEEK | = 127.6 |
| LAST WEEK | = 127.0 |
| YEAR AGO | = 128.8 |
| 1982 | = 100.0 |

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

## U. S. ELECTRONICS SHIPMENTS

| Shipments ($ billions) | November 1985 | October 1985 | November 1984 |
|---|---|---|---|
| Communications equipment | 5.527 | 5.256 | 4.876 |
| Radio and TV receiving equipment | 0.971 | 0.960 | 0.894 |
| Electronic and electrical instruments | 4.793 | 4.572 | 4.523 |
| Components | 3.092 | 3.161 | 3.690 |

## U. S. GENERAL ECONOMIC INDICATORS

| | November 1985 | October 1985 | November 1984 |
|---|---|---|---|
| Index of leading economic indicators | 171.5 | 171.3 | 165.1 |
| Budgeted outlays of the federal government ($ billions) | 84.763 | 85.074 | 79.956 |
| Budgeted outlays of the Department of Defense ($ billions) | 21.971 | 21.942 | 22.017 |
| Operating rate of all industries (% capacity) | 78.0 | 77.9 | 79.2 |
| Industrial-production index | 125.1 | 124.6 | 123.4 |
| Total housing starts (annual rate in thousands) | 1,547 | 1,761 | 1,616 |

A 3.1% increase in U. S. shipments of electronics equipment helped the *Electronics* Index gain 0.5% in the latest week. Though November's rise gave a much-needed boost to a still-ailing industry, total shipments are up only 2.9% from their level of 12 months ago. And judging from the erratic pattern that consignments have set over the past year, this latest hike doesn't necessarily signal the start of an industrywide recovery.

The increase in shipments in November benefited every industry sector but components. Communications equipment was the most buoyant electronics market in November, with a 5.2% gain in shipments over October and a 13.4% improvement from November 1984. Next was the instruments market, where consignments advanced 4.8% for the month and showed a 6% year-over-year gain. Radio and TV manufacturers saw their shipments rise 1.1% in November, bringing them up nearly 9% from the year before. The components industry, however, saw its shipments drop 2.2% in November, pushing the total to 16% below that of 12 months ago.

When your business takes you away from the office, you'd like to think that everything's still under control. The sad truth is that your absence has probably led to confusion, disorder, and a fair amount of corporate mayhem.

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Circle 71 on reader service card

# NEW PRODUCTS

## DOUBLING THE PERFORMANCE OF A DATA-BASE COMPUTER

### TERADATA DOES IT BY UPGRADING TO INTEL'S 80286 MICROPROCESSOR

Once a faster processor becomes available in a microprocessor family, designers of end products using an earlier model rush back to the drawing boards to take advantage of the improved performance. This is exactly what Teradata Corp. has done with its DBC/1012 relational data-base computer. By replacing an Intel Corp. 8086 processor, which is rated at about 500,000 instructions/s, with the faster 8-MHz 80286—rated at 1 million instructions/s—the company has produced the DBC/1012 model 2, which has more than twice the performance of the the first model [*Electronics*, Jan. 6, 1986, p. 19].

**20/20** Teradata's 20-processor DBC/1012 model 2 data-base computer runs at 20 mips and stores 12.4 gigabytes.

The job of bringing the new processor into play was made easy because the Teradata architecture was designed with such a move in mind. For the data-base computer, the company developed its proprietary parallel-processing technology, called Ynet—a design that interconnects low-cost subsystems built with microprocessors into a high-performance parallel-processing system [*Electronics*, Jan. 26, 1984, p. 50]. The model 2 uses the same architecture.

Prices of the enhanced-performance model 2 are set to provide good price/performance characteristics. "The new model 2 pricing provides our customers with relational data-base capabilities at approximately one quarter the cost of a host-based, software solution," says Teradata president Ken Simonds.

**EXPANDABLE.** Also like the original model, the model 2 is both expandable in small increments and fault tolerant. It also provides fail-safe relational data-base service to one or more host computers. It offloads data-base operations from the hosts, assuming all data-base management, control, and retrieval functions as well as responsibility for data security and integrity.

In contrast to data-base-management systems that use host-resident software, the DBC/1012 lets users share the same data base among several computers even though they may be running different operating systems. For example, one DBC/1012 machine could simultaneously connect to one IBM Corp. computer running the VM operating system and to a second one running MVS.

The model 2's modular design provides a growth path from a minimum configuration of three processors up to a massively parallel 1,024-processor system. Performance improves linearly as processors are added. Because disk drives can be added at the same time as processors, the system's total storage capacity grows along with the system's performance.

For present users of the DBC/1012 who want to increase their systems' performance, Teradata is offering model 2 performance as an upgrade to existing systems in the form of new 286 processor modules, which can be installed in the field. The new models are completely compatible with the first model, so users installing the model 2 in addition to the model 1 or upgrading one of the 8086-based machines have no changes in operation to worry about.

Schering-Plough Corp.'s information center in Memphis, Tenn., is a beta-test-site customer for the model 1. "No operational changes were required to install the upgraded system, and we are seeing a 2.5 to 2.7 times increase in our relational processing," says Mike Motto, director of operations.

A typical 80286-based system might contain 12 processors—for about a 12-mips performance rating—and eight 500-megabyte disk drives. This configuration sells for $562,000. Processors and disks can be added at an incremental cost of $39,000 per processor and $10,500 for each 500-megabyte disk—about $21 per megabyte. *–Tom Manuel*

Teradata Corp., 12945 Jefferson Blvd., Los Angeles, Calif. 90066. Phone (213) 827-8777 [Circle reader service number 338]

## SIGNAL PROCESSORS WORK IN THREE DATA FORMATS

When Analog Devices entered the digital signal-processing market in 1982 by second-sourcing popular parts, it also promised to introduce designs of its own. Now the company's Digital Signal Processing Division is delivering samples of 64-bit CMOS chips that boast the highest throughput and the lowest power consumption in the industry.

The ADSP-3210 multiplier and -3220 arithmetic logic unit are the only floating-point chips that can perform operations in three data formats: 32-bit single-precision floating point, 64-bit double-precision floating point, and 32-bit fixed point. For binary floating-point arithmetic, both chips comply with the emerging IEEE-754 (Draft 10.0) standard.

The company also is unveiling two Word-Slice components that speed up

microcode and address generation in high-performance processors executing algorithms for digital filters, fast Fourier transforms, and matrix operations. Both the ADSP-1401 program sequencer and -1410 address generator can operate with the 3210 and 3220 or with any 8-, 12-, 16-, or 32-bit fixed-point mulitiplier on the market.

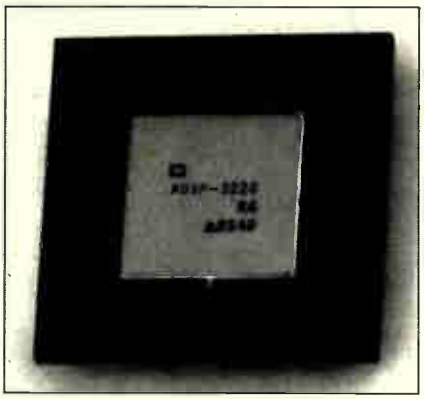
The 3210 and 3220 offer a throughput of 10 million floating-point operations per second and a 400-mW power consumption. The chips use a single internal pipeline to deliver 100-ns throughput for single-precision addition and multiplication and for double-precision addition. The 3220 ALU does double-precision multiplication in 100 ns and the 3210 does it in 400 ns.

**1½-MICRON CMOS.** The parts get their speed from Analog Devices' fabrication process. "We're using 1½-μm double-layer-metal CMOS, which is faster than TRW's original bipolar process, although TRW has pushed up the speeds on some of its bipolar parts," says David Fair, a marketing specialist.

At these speeds, the ALUs are faster than Advanced Micro Devices Inc.'s bipolar Am29325, which performs single-precision calculations in 125 ns but consumes about 7 W. The 3210 and 3220 also beat Weitek Corp.'s n-MOS multiplier and ALU pair, the 1264 and 1265. Weitek's pair performs single-precision operations in 120 ns, but because the pair uses a multiple-pipeline architecture, they beat Analog Devices' parts in double-precision multiplication—240 ns, compared with 400 ns. Weitek's pair consumes 3.6 W. Neither the AMD part nor the Weitek pair performs fixed-point operations. Fair says that when testing is completed, the final performance specs should be even better.

The combination of operating formats suits the Analog Devices parts to a wide variety of applications. For example, engineering work stations, minicomputers, and array processors can take advantage of the wide dynamic range available in the double-precision floating-point calculations for tasks such as circuit simulation and finite element analysis, while single-precision operations provide the high-speed pipelined execution required in sonar and radar. Graphics systems can use the 32-bit fixed-point arithmetic to calculate the memory pointers to their pixel arrays.

The 3210 and 3220 support the gradual underflow provisions of the proposed IEEE floating-point format. Each chip has a fast mode that sets results at a value less than the IEEE normalized format to zero. Fast mode simplifies underflow exception handling but retains all the benefits of high dynamic range and the IEEE standard's precision.



**VARIETY.** Analog Devices chips operate in three formats, including 32-bit fixed-point.

The 1401 16-bit sequencer generates microcode memory addresses for handling complex sequencing operations such as looping, jumping, branching, subroutines, condition testing, and interrupts in microprogrammed systems. Unlike other program sequencers, the 1401 provides programming flexibility thanks to 1-K of on-chip RAM.

A designer can partition the RAM between stack and jump-address storage. For example, he can free any of the sequencer's four decrementing 16-bit counters by storing the counters' contents temporarily in RAM. The 1401 has a 35-ns clock-to-address time and consumes just 200 mW.

The 1410 address generator has a 20-ns clock-to-address time and a minimum 80-ns cycle time. It consumes 175 mW during operation. The chip supplies the address of a location in data or coefficient memory. In one instruction cycle, the chip can send an address pointer to data memory, modify the pointer by an offset value to determine the next memory read or write address, compare the same output pointer to a preset value, and reinitialize that counter. Cascading two address generators or using two cycles to perform double-precision addressing extends the chip's address range to 30 bits.

The 3210 and 3220 come in plastic pin grid arrays. Fair says Analog Devices' proprietary passivation technique permits the plastic packaging. "The plastic packages lowers the prices and opens new applications," he says. Commercial-grade samples of all four parts are available now. In lots of 100 pieces, the 3210 and 3220 cost $350 each, the 1401 is $65, and the 1410 goes for $45. All parts will be available processed to MIL-STD 883-C in the next quarter. *–Steve Zollo*

Analog Devices Inc., Literature Center, 70 Shawmut Rd., Canton, Mass. 02021
[Circle 339]

# HITACHI MICROCOMPUTERS CAN BE PROGRAMMED IN C

Designers of systems built around Hitachi's 8-bit single-chip microcomputers can now write programs in the high-level C language, thanks to a cross-compiler the company has designed for use on its development system. Until now, both systems and applications software for its HD6301 and HD6303 chips had to be written in assembly language.

The two Hitachi chips are CMOS versions of Motorola's 6801 and 6803 microprocessors. They add instructions to the Motorola parts' instruction set. Where quick product development is essential, Hitachi has two models of the 6301 available with one-time user-programmable ROM. High-speed software development in C and the ability to burn code directly into ROM should result in extremely rapid product development.

Now that single-chip microcomputers can support large memories, the somewhat longer C programs are a reasonable tradeoff for the language's other advantages. These include many pluses common to most high-level languages, such as ease of programming, and some that pertain only to C, such as its ability to work with machine-specific code.

The Hitachi compilers conform to the Kernighan and Ritchie specification for C and AT&T Bell Laboratories' Unix operating system, making it simple to transfer existing C programs. Because C code is modular, it is suited to structured programming techniques for rapid, low-cost program development. C is more able than most high-level languages to work with machine-specific code when necessary, and it can separate the machine-specific and -independent modules. It also allows the designer to embed assembly code.

Because the optimized compiler makes full use of the microcomputer's instruction set, compiled code is kept small, with an average C program length 1.3 times longer than one written in assembly code. Like assembly code, the C programs can be burned into ROM, and a library of I/O functions is available.

The compiler for Hitachi's development system, which runs under the CP/M-86K operating system, is available

now. Cross-compilers for writing software for the Hitachi chips on the Digital Equipment Corp. VAX minicomputer and the IBM Corp. Personal Computer should be ready in March.

Hitachi's C-language cross-compiler sells for $1,275 in Japan. It will be available in the U. S. for the same price as soon as English-language manuals are completed. *–Charles L. Cohen*

Hitachi Ltd., Semiconductor and IC Division, 1-5-1 Marunouchi, Chiyoda-ku Tokyo 100 Japan [Circle 340]

## OPERATING SYSTEM IS PC-DOS-COMPATIBLE

STD DOS, an operating system for STD-8088 computers, offers an I/O-control system that is fully compatible with IBM Corp.'s PC DOS. It can run the thousands of applications programs written for use under PC DOS. A basic I/O system and device-driver package give the user access to the common system peripherals.

STD DOS enables designers to use the

STD bus-board approach for developing their products and control systems. It gives disk support for both target and development environments with four basic file types: Promfiles, Ramfiles, Diskfiles, and Remotefiles. Remotefiles enables the STD system to access data from systems other than IBM Personal Computers, linked through serial ports.

An STD DOS target system starts at $995, which includes the firmware. A stand-alone system, including a ZT 8806 CPU that provides 320-K bytes of Promfile, starts at $4,695. Harsh-environment options are also available. Systems will be available in the first quarter of 1986.

Ziatech Corp., 3433 Roberto Ct., San Luis Obispo, Calif. 93401.
Phone (805) 541-0488 [Circle 350]

## OCR WON'T BYPASS ODD CHARACTERS

Character Image Recognition, optical-character-recognition software for the IBM Corp. Personal Computer, comes in two versions. CIR I recognizes standard typewriter and printer fonts and is interactive—that is, the program displays unrecognized characters in context so an operator can enter the appropriate letter. The user also can review text files with a spelling-check program.

CIR II offers an interactive learning mode, in which the operator can train the software in character recognition. CIR II can be taught character by character or in batch mode, several pages at a time.

Both software packages work with the maker's series 700 Word Image Processing Systems, priced at $3,950 including a scanner. CIR I goes for $695, CIR II for $1,995. Both packages are available now.

Datacopy Corp., 1215 Terra Bella Ave., Mountain View, Calif. 94043.
Phone (415) 965-7900 [Circle 351]

## MONITOR TESTS FIELD CAMERAS

An 8-lb picture, audio, and waveform monitor checks video cameras and recorders in the field. The monitor sends a color TV picture to a 2.6-in. screen and simultaneously displays two-line and two-field waveforms on the graph lines of a companion screen. A standard IRE filter eases lens-opening checks, and the X4 vertical magnifier simplifies setup level and black-balance checks.

The LVM-5863A electronic-field-production monitor comes in a carrying case with a shoulder strap. It will operate from a 12-V car battery or from two clip-on rechargeable batteries. Available now, it sells for $1,900.

Leader Instruments Corp., 380 Oser Ave., Hauppauge, N. Y. 11788.
Phone (516) 231-6900 [Circle 356]

## CURRENT SOURCE WEIGHS 40 LB

A 100-A ac/dc current source weighs less than 40 lb and has a front panel only 5¼ in. high—less than half the weight and size of comparable current sources, the maker says. Multiple units can be connected in parallel for higher-current applications; for example, a 1,000-A controlled source would take up less than 7 ft of rack space.

The model 100 runs as a stand-alone unit or on the IEEE-488 bus. It has six

ranges—2-, 20-, and 200-mA and 2-, 20-, and 200-A—and each range has a current output that is proportional to a 0- to 20-V ac/dc input. Accuracy is to within 50 parts per million.

The basic model 100 sells for $4,150; an installed IEEE-488 interface adds $395. Shipping takes 60 days.

Shepherd Scientific Inc., 7100 Convoy Ct., San Diego, Calif. 92111.
Phone (619) 268-9696 [Circle 358]

## SYNTHESIZER ARRAY HOLDS FOUR MODULES

The FSRS4 frequency-synthesizer array can accommodate up to four synthesizer modules for rack mounting or bench-top operation. Each module covers the frequency range of 225 to 425 MHz or 80 to 160 MHz.

All synthesizer modules can be independently controlled, or they can be synchronized to one frequency reference of 5 MHz, thereby creating a coherent system. Other frequency bands are available as required, to 1.2 GHz. Radio-frequency output is +10 dBm across the band, and it can be frequency-modulated up to ±30 kHz.

Module prices range from $5,000 to $8,000 each, and customers can specify frequency ranges and step sizes without extra charge. Delivery takes 12 to 15 weeks.

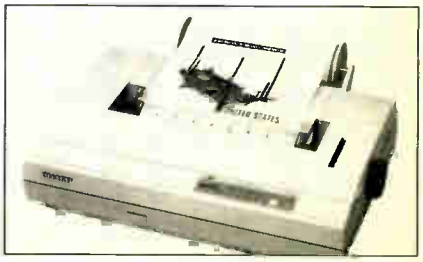
Systematix Electronics Corp., 218 Stuyvesant Ave., Lyndhurst, N. J. 07071.
Phone (201) 935-6249 [Circle 357]

## COLOR INKJET PRINTER COSTS UNDER $1,500

A new inkjet printer combines the four standard colors of cyan, magenta, yellow, and black to produce up to 256 hues. The model JX-720, which sells for $1,495, offers a resolution of 120 dots/in. and prints a full-page color image, 1,024 by 1,024 dots, in 2.2 minutes.

The JX-720 connects with a personal computer through a Centronics parallel interface. An automatic print-head cleaner minimizes nozzle clogging. The printer, which accepts cut sheets, roll paper, or transparencies, is available now.

Sharp Electronics Corp., 10 Sharp Plaza, Paramus, N. J. 07652.
Phone (201) 599-3856 [Circle 359]



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# ELECTRONICS WEEK®

## THREE GIANTS SET IC JOINT VENTURE

General Electric, Mitsubishi Electric America, and Westinghouse Electric have established a joint-venture corporation to manufacture and market a line of power semiconductors. The venture was announced last September but awaited government approval before implementation. The U.S. Justice Department has raised no objection. The new company, called Powerex Inc., takes over the power-semiconductor line of Westinghouse and GE. It will have headquarters in Youngwood, Pa., and manufacturing facilities at the present GE plant in Auburn, N.Y., as well as the Westinghouse facilities in Youngwood; Gurabo, Puerto Rico; and LeMans, France.

## PACIFIC BELL UNVEILS 'VICTORIA'

Pacific Bell has unveiled its closely guarded technology for converting a telephone line into seven simultaneous communications channels. Called Project Victoria, the scheme uses a multiplexer to combine signals from the voice and digital service inputs into a transceiver. These are transmitted over local telecommunications wires in rapid-fire sequence to a transceiver-multiplexer at the local central office and then routed to gateways, where they are reconverted to standard transmission signals. The subscriber can specify data-channel transmission speeds from 50 to 9,600 b/s. The system will be tested in Danville, Calif.

## POWER-SUPPLY FIRM BUYS BOSCHERT

Continuing the aggressive acquisition policy that has helped propel it from a $3 million company in 1978 to nearly $53 million in 1985, Computer Products Inc., Pompano Beach, Fla., has acquired the stock of Boschert Inc., Sunnyvale, Calif. [*Electronics*, Dec. 9, 1985, p. 55]. The purchase, which also included a Hong Kong manufacturing operation, was made from BICC plc, London. Boschert manufactures standard and custom switching power supplies. Computer Products will merge its Compower division, San Jose, Calif., with Boschert into a single company that will retain the Boschert name but operate as a unit of CPI's Power Conversion Group of Milpitas, Calif. The Hong Kong company will be renamed Computer Products-Asia Pacific Ltd. and become CPI's Far East manufacturing arm.

## INDICTED PARADYNE SUSPENDED BY U.S.

Paradyne Corp. has been notified by the U.S. Department of Health and Human Services that it is suspended from receiving further government contracts. On Dec. 12, a federal grand jury indicted the Largo, Fla., company, along with present and former top officials and one Social Security Administration employee. It alleged conspiracy, bribery, perjury, and obstruction of justice to win a $115 million contract to computerize Social Security field offices, the largest ever awarded by the administration. Paradyne denies it faked a computer demonstration during the bidding process by showing equipment that it either did not own or had not fully developed.

## CONCORD TO BUILD DEC MAP INTERFACE

Concord Data Systems Inc. has signed a multiyear deal to supply 10-Mb/s Manufacturing Automation Protocol interfaces for Digital Equipment Corp.'s MicroVAX computers. Concord, in Waltham, Mass., will base the board-level interfaces on a VLSI chip set that will implement the lower four layers of the MAP protocols. The software will be developed by DEC, which is based in Maynard, Mass.

The agreement strengthens Concord's claim that it is the leading supplier of MAP-compatible products. The company says it has more than 1,000 of its Token/Net Interface Module connections installed in more than 100 manufacturing sites around the world.

## NATIONAL SAYS BUSINESS IS BETTER

Although it reported a $34.8 million net loss for the second quarter of fiscal 1986, ended Dec. 15, National Semiconductor Corp. sees a slight improvement in its IC business. The Santa Clara, Calif., company's Semiconductor Division showed a "modest" improvement in order rates, says its president and chief executive officer Charles E. Sporck, which has resulted in backlog growth for the first time since fiscal 1984. In addition, Sporck claims the Digital Systems segment, which consists mostly of its National Advanced Systems mainframe computer company, showed "substantial" improvement compared with the first half of fiscal 1985.

## ZILOG AND STARTUP TEAM IN MEMORIES

Zilog Inc. of Campbell, Calif., has signed an 18-month contract with startup Catalyst Semiconductor of Santa Clara, Calif., to jointly develop and produce nonvolatile memories. Its first product, expected to reach production by the second half of 1986, will be a version of Zilog's Z8 microcontroller with on-chip electrically alterable capabilities, according to Dick Motta, director of technology for Zilog's Components Division. Catalyst specializes in nonvolatile memories, while Zilog has considerable microcomputer expertise as well as a production facility in Nampa, Idaho.

## ATT-PHILIPS WINS UK TELECOM ORDER

After losing an important bid to supply System Y, the UK's planned second public network, ATT-Philips, the joint venture of AT&T Co. and Philips Telecommunications BV, won a contract to supply a 5ESS-PRX exchange to British Telecom plc's International Switching Center. The contract, worth just under $25 million, calls for installation to begin in April.

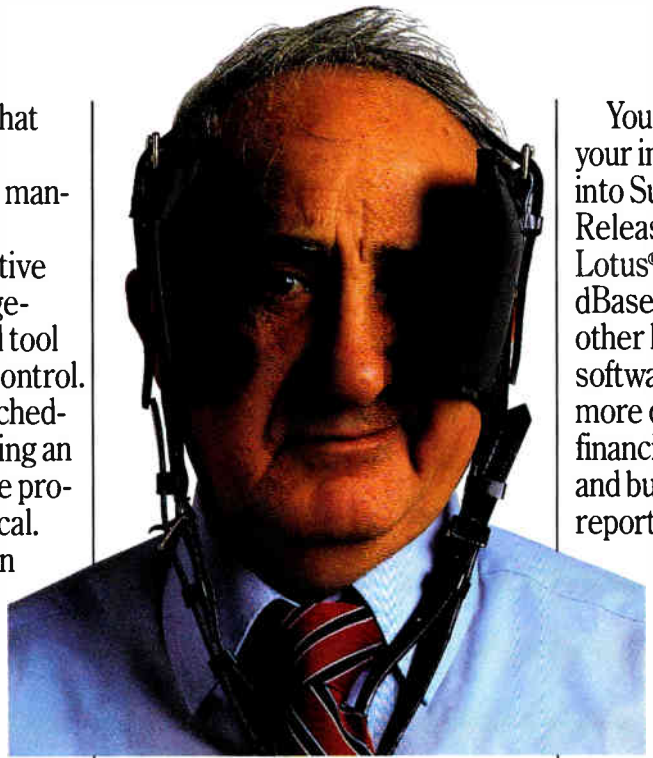
## JUSTICE OKAYS SOFTWARE LOCK

The Justice Department's Antitrust Division gave the green light last week to an effort to develop voluntary standards to prevent unauthorized copying of software. The Association of Data Processing Service Organizations had sought the division's approval. Douglas H. Ginsburg, who heads the antitrust division, said in a letter that Adapso had identified "a problem that may be an appropriate subject of cooperative action." Adapso's proposed software-protection standards include a software-embedded lock.

## RATIONAL LICENSES UNILOGIC SCRIBE

Rational, in Mountain View, Calif., has signed a $1.1 million agreement with Lexeme Corp., in Pittsburgh, for exclusive marketing rights to an Ada version of Scribe, a documentation-generation program. Lexeme will use its proprietary software-translation technology [*Electronics*, Sept. 23, 1985, p. 59] to convert Scribe from Bliss to Ada so it can run on Rational's R1000 Ada software-development systems. Scribe was developed at Lexeme's sister company Unilogic Ltd. The Ada version will be ready in June.

# Why look like the average manager?



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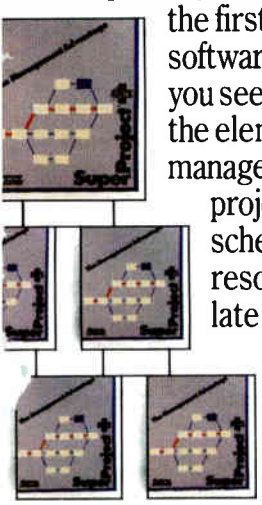

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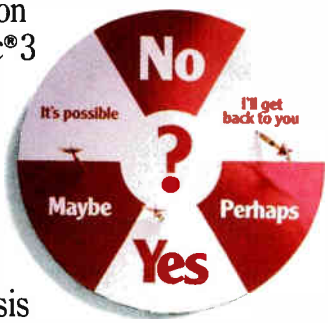


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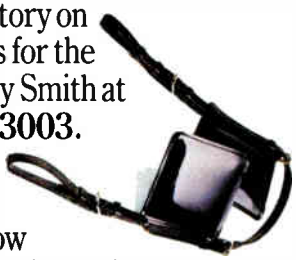

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# The way is CA.



Circle 901 on reader service card

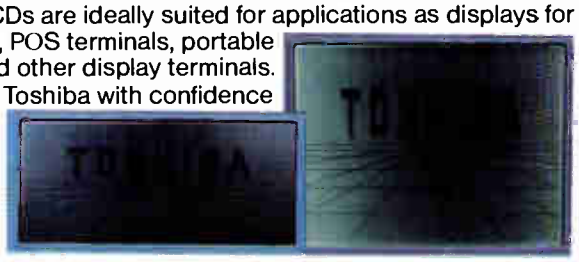

# 2,000 sharper-than-ever characters all on a portable LCD display.

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

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

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

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



*TLC-363* *TLC-402*

## Specifications

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

Design and specifications are subject to change without notice.

# TOSHIBA

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**Toshiba Europa (I.E.) GmbH:** Electronic Components Div.: Hammer Landstrasse 115, 4040 Neuss 1, F.R. Germany Tel. (02101) 1580
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