JANUARY 13, 1982

CELLULAR COMMUNICATIONS PLAYERS GIRD FOR MARKET BATTLE/97

Minicomputer matches mainframe throughput/155

Extending local networks with microwave links/164

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Electronics

Slow build-up to a stronger year

CIRCUIT BOARD TESTING: SHOULD IT BEGIN IN PRODUCTION OR IN THE LAB?

Some successful companies charge production with the responsibility for developing test procedures. Others give the job to the design lab. And with many it's a shared responsibility.

However, if these methods were decided by the standards of yesterday's technology, you may increase today's productivity with a different approach. Consider these points:

Testing options begin in the lab.
With today's product designs using microprocessors, memory and other LSI circuits, the question "How to test?" will arise long before a design is released to production. When asked in the hardware/software definition phase, electronic manufacturers can opt for one of three approaches: 1) Not to design for testability, thus leaving test development responsibility to production. 2) Design for go/no-go self test, covering a "critical" subset of board functions, and leaving fault isolation to skilled technicians in production as well as the field. 3) Design for thorough self test, including diagnostics, which facilitate fault isolation, thus providing a total test solution for R&D, production and field service.

Can you afford to design for testability?
Let's take a look at the trade-offs. Option 1 appears to offer the shortest design cycle. However, the designer will probably take longer than planned in design turn-on. And design follow-up with production often takes more effort than expected. Longer production test development time is also likely to delay shipments.

Designing in a go/no-go self test (option 2) solves some of the problems associated with option 1. However, a limited self test may still lead to failures at system turn-on. And without fault isolation, expensive technician time will be needed in production and field service.

At first glance, option 3 may seem to require too much of the designer's time. However, the payback can be significant in reduced debugging time and enhanced test effectiveness. After all, the designer best understands the product structure and critical aspects of its operation. And the designer has the tools and the opportunity to implement design features often required for high fault-coverage testing of complex LSI circuitry.

A decision that impacts production most.
Whatever the decision, production will feel its effect most. A balance must be found between design time and a viable board test solution. HP provides that balance with the 3060A Board Test System. Equipped with the High Speed Digital Functional Test Option (HSDFT), it delivers the flexibility to solve your μP and LSI board testing problems whether you design for testability or not.

For example, the 3060A can activate μP-based, designed-in stimulus firmware and measure the dynamic board response using Signature Analysis. If self-stimulus isn't available you can use the HSDFT programmable stimulus capability (Figure 1).

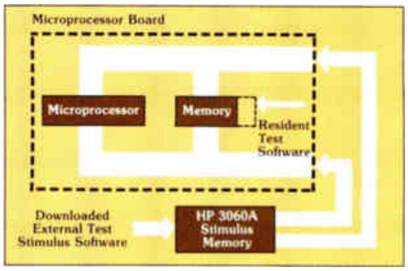

Figure 1 — The 3060A can activate resident test stimulus software or provide that stimulus from its own RAM.

Test stimulus software developed for design turn-on can even be leveraged for production test by downloading from your design system (such as the HP 64000) into 3060A stimulus RAM. Or, alternatively, HP's 3060A Digital Functional Test software provides easy-to-use stimulus and measurement programming procedures.

For fault isolation, the 3060A HSDFT software provides automatic backtracking via in-circuit visibility on the basis of a topological description of the board. And, these procedures can be used as the basis for effective field service repair using HP Signature Analysis instrumentation (HP's 5005A).

The bottom line? Rapid software development, thorough testing, high throughput and efficient field trouble-shooting — the complete solution. That's worth investigating.

For more information.
Let HP help you optimize your investment in design, test and service. Write Hewlett-Packard, 1820 Embarcadero Road, Palo Alto, CA 94303. Or call the HP regional office nearest you: East (201) 265-5000, West (213) 970-7500, Midwest (312) 255-9800, South (404) 955-1500, Canada (416) 678-9430.

**HP Circuit Testers—
The Right Decision**

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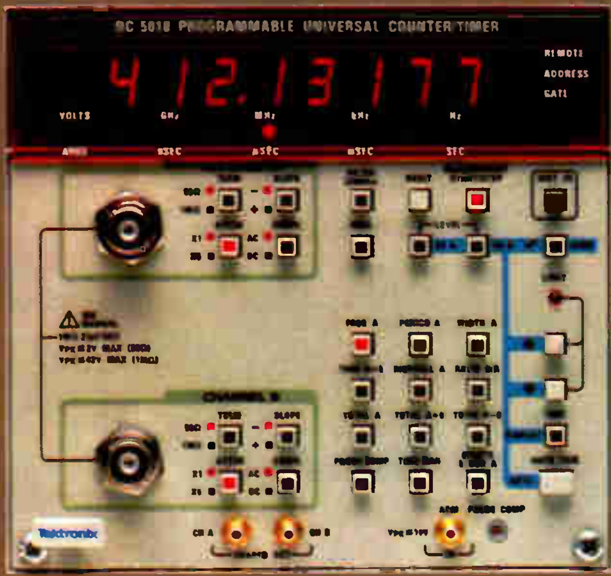

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New features include a single input Rise/Fall mode and probe compensation, a patented Tek exclusive.

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Electronics

The International Magazine of Electronic Technology **Vol. 55, No. 1 • January 13, 1982**

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Electronics

Highlights

Cover: World markets to push past starting weaknesses, 121

The bright spots in generally dismal national economies last year were the electronics industries, and 1982 looks as if it will be a reprise. *Electronics*' annual market survey, based on input from manufacturers around the world, does point to a stronger second half. Nowhere will this be more true than in the U. S. (p. 122), where the current recession is expected to dissipate around summertime. The outlook in Europe (p. 137) is less promising, although electronics firms are healthier than other industries. A steady, if unspectacular, 4% overall real growth rate in Japan (p. 145) will be outpaced comfortably by that country's electronics industries.

The cover photograph is by Don Carroll.

Cellular mobile radio is still in neutral, 97

A morass of administrative appeals and court challenges may bog down the Federal Communications Commission's decision to split the mobile telephone market equally between the traditional telephone companies and other companies. The market is expected to flourish once the new cellular radio systems are introduced. The FCC has approved them as part of its effort to expand the present car-telephone service.

Minicomputer runs at 4-MIPS clip, 155

Combining proven emitter-coupled-logic technology with a pride of mainframe techniques, a 32-bit superminicomputer can execute up to 4 million instructions a second. A highly parallel pipeline architecture features a cache memory, 64- and even some 128-bit-wide buses, and separate instruction-fetching and -execution units.

Local nets take to the air with microwave links, 164

A family of compact 23-gigahertz microwave links transmits signals in local networks and closed-circuit TV systems, serving in applications where cable laying would present problems. The links are free from interference because there are no other communications channels at this frequency.

Three-state logic simplifies display addressing, 169

Utilizing the three-state address lines of standard integrated circuits pares down the number of lines required to drive solid-state displays. Compared to matrix addressing, 50% fewer lines can drive a light-emitting-diode display; alternatively, the technique can yield a single-level interconnection scheme that avoids wiring crossovers.

. . . in the next issue

Looking at local networks: part of a continuing series . . . using leadless chip-carriers for memories . . . more on design automation: a user-friendly work station for the era of very large-scale integration

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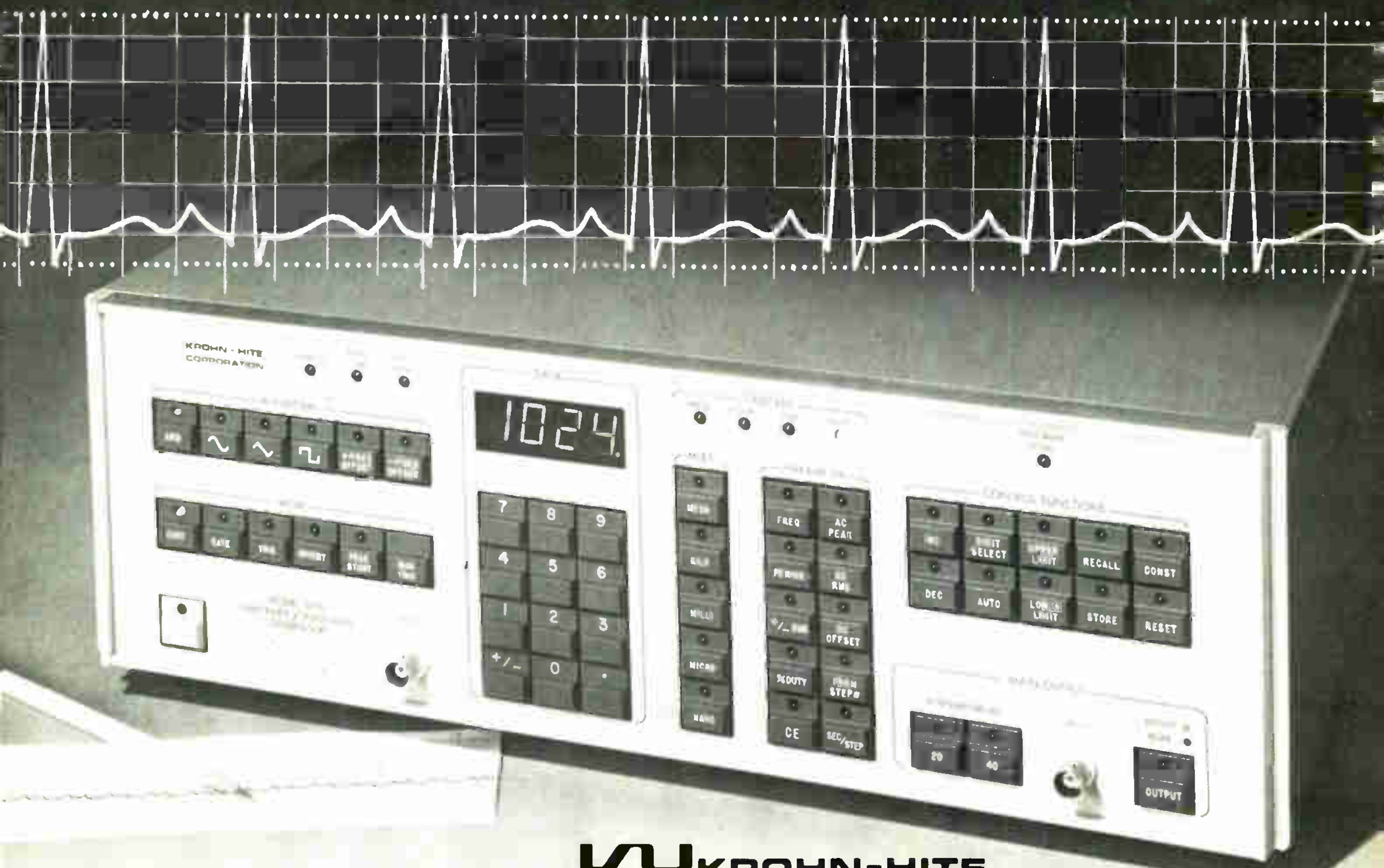

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Publisher's letter

As we see it, our mandate is to make sure our readers get the information they need to stay afloat in the ever-rising tide of high technology. Thus most of the package of news stories and feature articles that our reporters and editors put together every fortnight deals with advances in electronics technology.

Yet these advances actually mean little (except perhaps in ivory towers) unless they add substance to the marketplace that will nurture them. Our mandate, then, commits us to keeping watch on the marketplace as well as the sources of technology.

Coverage of the marketplace runs from January through December, but the most visible effort of the year is our annual World Markets Forecast (the 1982 edition starts on p. 121). This is truly an all-hands project for our technical department editors and our overseas field editors. They all get in at the beginning of the months-long effort, starting in late summer. Then, the product categories for the survey questionnaires through which we gather the raw data for our market charts are revised, and the questionnaire mailing list is updated.

During the fall, our editors intersperse market-report interviews and follow-up calls to market-data sources with their regular reporting and writing chores. In December, they write their market-outlook narratives. For our 1982 report, it was New Year's Eve when final corrections went to the printer.

Before the editors can write their market outlooks, they need the numbers that will appear in the charts. The raw inputs come from close to 1,000 sources in the U. S., Japan, and 11 countries in West Europe. There are over 500 product categories for U. S. markets and some 175 each for Japan and Europe—all told, then, there are 3,200 market estimates in the charts. Developing them kept managing editors Ray Capece and Art Erikson and business trends editor Howard Bierman working late nights through November and much of December.

McGraw-Hill Publications Co.'s Economic department, as it has for the past several years, took on the chore of plotting the inputs for the U. S. section and then checking market estimates with department editors. The painstaking task of copyreading the finished tables was done mostly by assistant managing editor Margaret Eastman.

Traditionally, we have run the U. S. market chart as a four-page centerpiece surrounded by the narrative that explains the trends underlying the market numbers. There is no such four-page chart this year—to make it easier to find and use information on the categories that interest our readers, we have split it up into sections and run these alongside the appropriate text.

For the same reasons, we have separated the market listings for Japan and Europe, which used to run side by side on the same page. The total number of figures in the charts is nonetheless larger than ever.

Besides the 32-page section that starts on page 121, this year we will again publish a separate World Markets Forecast Data Book. In addition to a reprint of the survey in this issue, it will carry a lot of the background material that went into the forecasts. For example, the 1982 book will describe the methodology of the forecasting and show the range of estimates for each product category in the U. S.

There will be an analysis of the 1982 forecast backed up with an overall outlook written by McGraw-Hill's economists. A major section consists of the country-by-country market tables from which the European charts were compiled.

The 1982 World Markets Forecast Data Book will be ready in late March and will sell for $150. Orders should include payment and be sent to Electronics Magazine Books, 1221 Ave. of the Americas, New York, N. Y. 10020.

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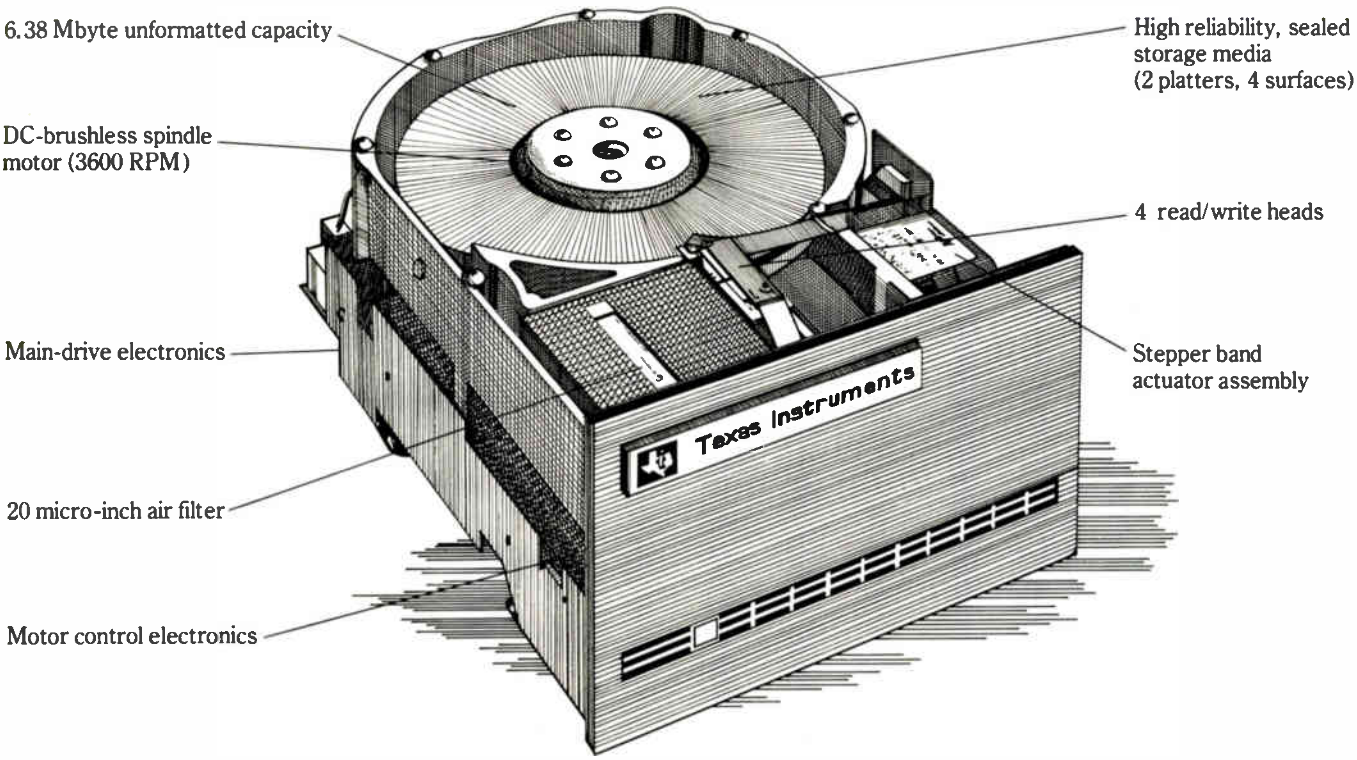

TI's 5¼-inch Winchester Disk's sealed storage media can offer information processing and data storage security with high reliability. With its compact, lightweight design and low power requirements, this low-cost, versatile storage disk can be easily integrated into applications, including microprocessor-based small business systems.

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Readers' comments

Supply-side job markets?

To the Editor: Ray Connolly's "EE shortage divides industry, IEEE" [*Electronics*, Nov. 30, 1981] is based on two simultaneous misunderstandings—that there is a shortage of electrical engineers, and that the Institute of Electrical and Electronics Engineers and the electronics industries disagree.

First, there is no shortage, but a surplus, and Connolly's own figures prove it: annual salaries increased by 15.7% between 1978 and 1980. That is much slower than the 23% increase in the Consumer Price Index for the same period. The price of a commodity in short supply goes up, not down. In addition, Electronic Engineering Times reported on Dec. 7, 1981, that the total employment of engineers in a sample has fallen by 8% since March.

Second, the IEEE agrees with the industries as represented by American Electronics Association, again contrary to Connolly. There is no division but a cynical conspiracy to conjure up a fake shortage. If this results in luring more students into engineering schools, the initial beneficiaries will be the academics, that is, the IEEE and Nuclear Regulatory Commission hierarchies, while the electronics industries will benefit a few years later from an ample supply of hot bodies to further depress salaries. The losers will of course be all engineers.

Jorgen P. Vinding
Monte Sereno, Calif.

Corrections

In "Chip resistors gain support" (Nov. 17, p. 90), Allen-Bradley Co. was characterized as the only domestic source of carbon-composition resistors. However, the Stackpole Carbon Co. of St. Marys, Pa., also produces these components. And in a story on Interlan Inc.'s NI2010 Ethernet interface on page 175 of the Nov. 30 issue, the price of the unit should be $2,625 in quantities of 25 and the maximum length of cable that can be used before repeaters are required should be 500 meters.

Interested in higher performance software?

The Mark Williams Company announces **COHERENT**,™ a state of the art, third generation operating system. **COHERENT** is a totally independent development of The Mark Williams Company. **COHERENT** contains a number of software innovations not available elsewhere, while maintaining compatibility with UNIX*. The primary goal of **COHERENT** is to provide a friendly environment for program development. The intent is to provide the user with a wide range of software building blocks from which he can select programs and utilities to solve his problems in the most straightforward manner.

COHERENT and all of its associated software are written totally in the high-level programming language **C**. Using **C** as the primary implementation language yields a high degree of reliability, portability, and ease of modification with no noticeable performance penalty.

Features

COHERENT provides **C** language source compatibility with programs written to run under Seventh Edition UNIX, enabling the large base of software written to run under UNIX (from numerous sources) to be available to the **COHERENT** user. The system design is based on a number of fundamental concepts. Central to this design is the unified structure of i/o with respect to ordinary files, external devices, and interprocess communication (pipes). At the same time, a great deal of attention has been paid to system performance so that the machine's resources are used in the most efficient way. The major features of **COHERENT** include:

- multiuser and multi-tasking facilities,
- running processes in foreground and background,
- compatible mechanisms for file, device, and interprocess i/o facilities,
- the shell command interpreter—modifiable for particular applications,
- distributed file system with tree-structured, hierarchical design,
- pipes and multiplexed channels for interprocess communication,
- asynchronous software interrupts,
- generalized segmentation (shared data, writeable instruction spaces),
- ability to lock processes in memory for real-time applications.
- fast swapping with swap storage cache,
- minimal interrupt lockout time for real-time applications,
- reliable power failure recovery facilities,
- fast disc accesses through disc buffer cache,
- loadable device drivers,
- process timing, profiling and debugging trace features.

*UNIX is a trademark of Bell Labs

Software Tools

In addition to the standard commands for manipulating processes, files, and the like, in its initial release **COHERENT** will include the following major software components: **SHELL**, the command interpreter; **STDIO**, a portable, standard i/o library plus run-time support routines; **AS**, an assembler for the host machine; **CROSS**, a number of cross-assemblers for other machines with compatible object format with **'AS'** above; **DB**, a symbolic debugger for **C**, Pascal, Fortran, and assembler; **ED**, a context-oriented text editor with regular expression patterns; **SED**, a stream editor (used in filters) fashioned after **'ED'**; **GREP**, a pattern matching filter; **AWK**, a pattern scanning and processing language; **LEX**, a lexical analyzer generator; **YACC**, an advanced parser generator language; **NROFF**, an Nroff-compatible text formatter; **LEARN**, computer-aided instruction about computers; **DC**, a desk calculator; **QUOTA**, a package of accounting programs to control filespace and processor use; and **MAIL**, an electronic personal message system.

Of course, **COHERENT** will have an ever-expanding number of programming and language tools and basic commands in future releases.

Language Support

The realm of language support is one of the major strengths of **COHERENT**. The following language processors will be supported initially:

- **C** — a portable compiler for the language **C**, including stricter type enforcement in the manner of **LINT**.
- **FORTRAN** — portable compiler supporting the full ANS Fortran 77 standard.
- **PASCAL** — portable implementation of the complete ISO standard Pascal.
- **XYBASIC**™ — a state of the art Basic compiler with the interactive features of an interpreter.

The unified design philosophy underlying the implementation of these languages has contributed significantly to the ease of their portability. In particular, the existence of a generalized code generator is such that with a minimal effort (about one man-month) all of the above language processors can be made to run on a new machine. The net result is that the compilers running under **COHERENT** produce extremely tight code very closely rivaling that produced by an *experienced* assembler programmer. Finally, the unified coder and conformable calling sequences permit the intermixture of these languages in a single program.

Operating System

In part because of the language portability discussed above, and in part because of a substantial effort in achieving a greater degree of machine-independence in the design and implementation of the **COHERENT** operating system, only a small effort need be invested to port the whole system to a new machine. Because of this, an investment in **COHERENT** software is not tied to a single processor. Applications can move with the entire system to a new processor with about two man months of effort.

The initial version of **COHERENT** is available for the Digital Equipment Corporation PDP-11 computers with memory-mapping, such as the PDP 11/34. Machines which will be supported in the coming months are the Intel 8086, Zilog Z8000, and Motorola 68000. Machines for which ports are being considered are the DEC VAX 11/780 and the IBM 370, among others.

Because **COHERENT** has been developed independently, the pricing is exceptionally attractive. Of course **COHERENT** is completely supported by its developer. To get more information about **COHERENT** contact us today.

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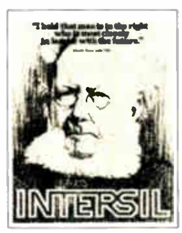

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The social responsibility of technologists

Industry pundits tell us that the future for electronic technology in the office and the plant is bright. In fact, some say that it will be the foundation of what is being called the reindustrialization of America, as well as the key to successful competition with countries like Japan.

But automation on such a broad front has social implications—some advance planning is needed. As at no other period in the modern industrial age, the effects of the coming changes will be felt by almost everyone directly—some new jobs will be created but many traditional ones will be erased. For example:

- Manufacturers, especially auto makers, are expected to retool with robotic systems. The auto industry alone expects that about 20% of jobs done by humans will be eliminated. This might be a conservative figure; the Japanese have found that two or three robots can do the work of 50 persons.
- Women and the young continue to enter the workforce, even as the job market barely keeps pace. An automated industrial base will create even fewer new jobs than there are now.
- In the office, word processing is said to increase productivity by 30% to 60%, spelling the end of the typing pool as it is now known. Word processors based on speech recognition will exacerbate the situation.

Thus, in a society already suffering from lack of opportunity for many, there will be fewer entry-level jobs on the one hand and an ever-expanding pool of unemployed experienced workers on the other.

The standard reply to such gloomy predictions—which have recurred every time technology threatens severe displacement (autos versus buggy whips, for example) is that new applications will bring entire new industries, and with it better, more interesting jobs. The problem with that this time around is that the new jobs will probably require higher skills and training than the average assembly-line worker now possesses. Even if the new opportunities do develop, what happens to the displaced in the meantime?

Obviously, a good deal of discussion and planning is required to reduce the problems that will inevitably develop as technology continues its inexorable march. More than any other, the electronics industries can contribute greatly to solving them.

First, technology itself can help. Computers, the video disk, and television have already proved to be powerful educational tools. Through appropriate hardware and software, we can start overhauling our primary and secondary schools to start preparing our youngsters for the automated and computer-oriented society they will face.

These same tools can be used to bring unions and management together by helping both to inform and enlighten their people on the need to refocus their priorities—the unions shifting from pay benefits to job retention, productivity, and retraining, while management obtains a greater understanding of the effects of these changes on workers and society. Furthermore, unions, management, and educators must cooperate to help school the undereducated for the increasingly technical sorts of jobs to come.

Government must play a part, too. This is a national problem, one that could lead to dangerous social unrest unless headed off by serious planning and goal setting.

We do not countenance for a moment the Luddite philosophy of halting progress in technology because it is harmful. The solution to many of the world's problems requires more technology, not less. But the benefits that a technological world offers can come at a very high price unless attention is paid to the issues raised along the road to progress.

People

Image conferencing turns on Hudson of Northern Telecom

If a picture is worth a thousand words, then image conferencing should be worth even more to tomorrow's top executives. A key development in its eventual evolution will take place early this year when Northern Telecom Inc. places its long-awaited Displayphone on the market, says Desmond F. Hudson, group vice president of business communications systems in Richardson, Texas.

After test-marketing the unit for almost a year, Northern Telecom is scheduled to formally introduce the Displayphone this quarter at a price of about $2,000 [*Electronics*, Dec. 29, 1981, p. 33]. The set marries the standard features of both telephone sets and data terminals into a single unit aimed at executives, says the 45-year-old Quebec native who joined the firm in 1977, after working 12 years for Bell Canada.

Custom jobs. Desmond Hudson says that desktop phone-data terminals will have to be modularized.

"We went with a small built-in screen (7 inches diagonally). If you put a big terminal in front of most people, it can be a little threatening," explains Hudson, who holds a bachelor of science degree in engineering physics from McGill University in Montreal and a B. S. degree in mathematics and physics from Loyola University, which has since become part of Concordia University, also in Montreal.

"However, in the test marketing, we have learned that there are other applications, when—let's say a finance man—might want 132 characters on a screen," he notes. "What some were saying was that there's room for general products, but you are going to have to modularize it so a big screen or a printer can be put on if it's needed." Displayphone options for larger screens and keyboards, as well as printers, are expected to appear on the market in the next several years.

Eventually, a new breed of display stations will also be needed for secretaries and other office professionals, suggests Hudson, who was named to his present post in August 1980. The Displayphone, he says, is seen as part of "a process that's adding a lot of horsepower and bandwidth to the desk."

With the set, voice and text information are linked and the next logical step is image capabilities—people seeing and talking over communication networks. Hudson calls it "image-conferencing on a desk-to-desk basis." It will begin showing up in the office around the end of the decade, he believes, but the high cost of wideband networks will keep its use to a minumum until the 1990s.

TI's Whitaker looks for technology mix in linears

Manufacturers of linear semiconductors will adopt a cookbook approach in the 1980s as they mix processing technologies to link a wide range of new devices for specific market applications. That is the forecast of Delbert A. Whitaker, recently named manager of Texas Instruments Inc.'s four-month-old Linear Functions division.

For instance, in the 1960s linear chip makers relied primarily on bipolar processing. Then, in the mid-1970s bipolar devices were combined with JFETS (junction field-effect transistors) for higher speed and input impedance. The result was bi-

FET. Last year, TI unveiled bid-FET, which mixed four technologies: double-diffused MOS FET, complementary-MOS, JFET, and bipolar. Also last year, TI received patents for its n-FET process, which combines bipolar with n-channel JFET for single–power-supply devices.

Technology recipes of the future will depend on what performance characteristics are desired: a pinch of C-MOS to cut power requirements, a dash of JFET for speed, and so forth. TI most recently used bid-FET, D-MOS, and bipolar devices to fabricate a three-terminal high-voltage regulator.

The combination of processes will continue to accelerate this decade as linear firms move into higher levels of integration and smaller die sizes, says the 38-year-old native Texan, who received a bachelor of science degree in electrical engineering at Texas A & M University in 1965. "Applications will drive the mixing," Whitaker says.

As the technique permits more functions to be placed on a chip, linear devices will quickly replace

Mix and match. Delbert Whitaker expects TI's linear mix to be application-driven.

many hybrid components. However, Whitaker cautions, "I think that hybrids will always be one step ahead of linear—they are going to always be in the next generation. But the thing that we'll bring to the game will be mixing technologies on a monolithic chip, which is more cost-effective."

Even linear arrays—semicustom devices that can be tailored to suit specific applications—will be challenged by mixed technology trends, says the 11-year TI veteran, who began his technical career at General Electric Co. □

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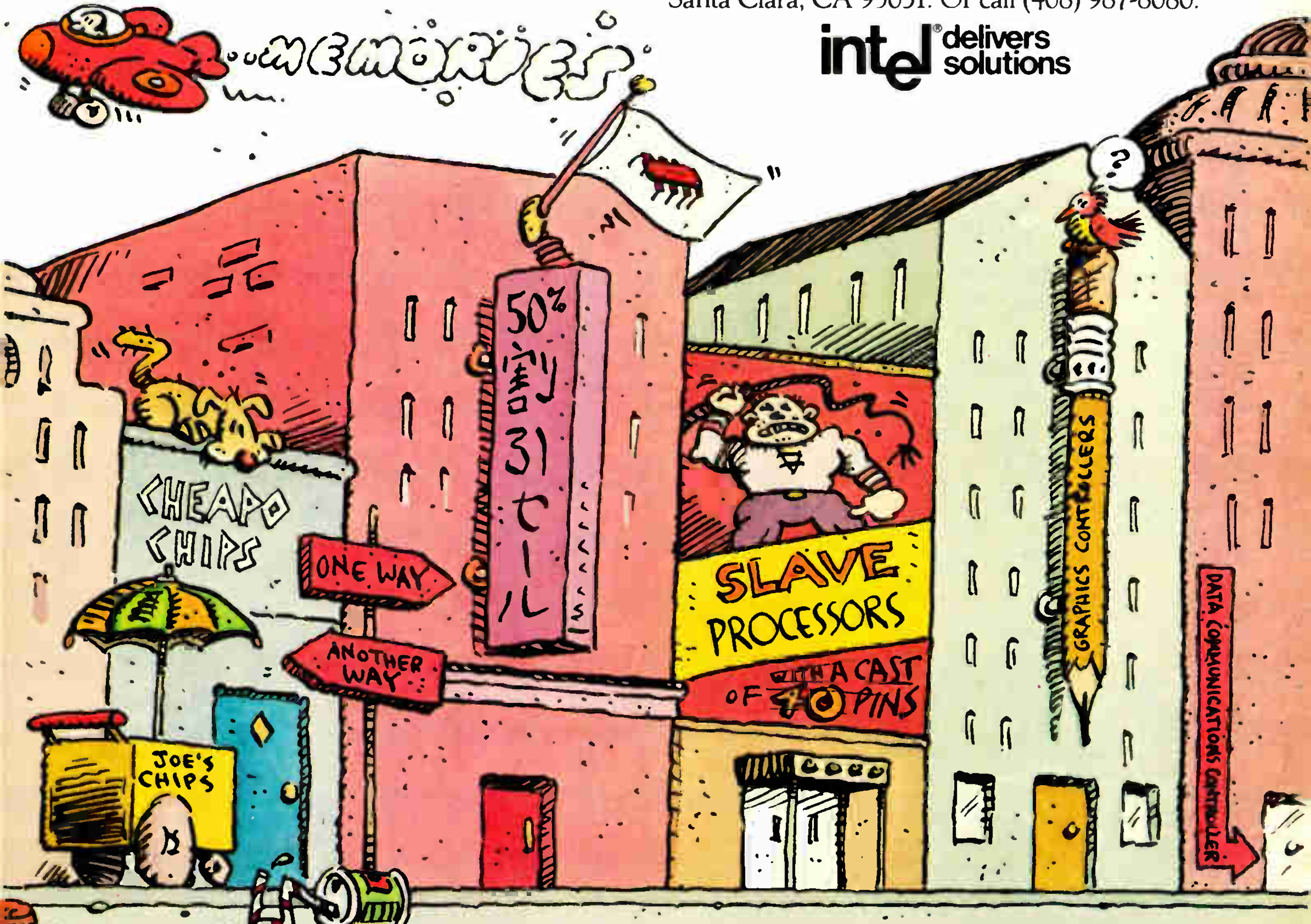

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Select your own width and speed combination, for data acquisition.

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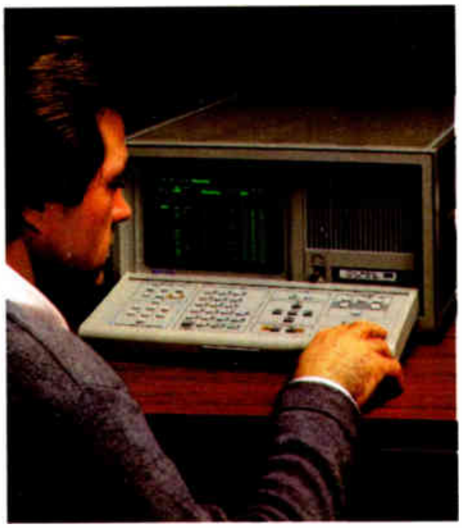
To back it all up, there's powerful triggering, programmable reference memory and multiple clocks. Plus glitch triggering, with a separate glitch memory for



unambiguous glitch detection and our unique, new "arms mode" allows timing correlation between synchronous and asynchronous data.

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Pattern generation capability is built around a 16 channel, 25 MHz module. Through additional expansion modules, you can raise the total to 80 channels while maintaining full system speed. The pattern generator allows interaction with the prototype through data strobe outputs and external control inputs, including an interrupt line. The generated pattern can even be changed based on the data acquired by the logic analyzer.

The DAS 9100 lets you start debugging hardware even before your software is available. Pattern generation makes it all possible.

With plenty of room for mainframe options to fit your application.

A powerful I/O option adds RS-232, GPIB and hard copy interace for full remote programmability. A built-in magnetic tape drive using DC-100 cartridges is also available, so you can save whole or partial instrument setups for recall. Pattern generation routines and reference memory data also can be stored.

DAS 9100 easy-to-use keyboard and menus tie it all together.

Operation of your DAS 9100 is simple and straightforward. Selectable menus help you set up trigger conditions, select data formats, and define voltage thresholds. You can even define your own mnemonics to fit the data under test.

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Circle 23 on reader service card

Personal computers need standards

by Fred M. Gibbons, *president, Software Publishing Corp., Mountain View, Calif.*

Today consumers can walk into a stereophonic equipment store knowing that, regardless of surface cosmetic differences or quality of reproduction, all systems can play any music selected. In most cases, too, the purchaser can also select any combination of turntable, amplifier, and speakers, all from different manufacturers, knowing they are compatible.

This ability to mix and match components does not exist in the personal computer industry. Almost every major personal computer manufacturer has its own operating systems, languages, data formats, and interface conventions. The competitive strategy for a hardware manufacturer is to develop a large inventory of software and peripherals that will run only on its machines. But it is the consumer who is the real loser, because hardware selection becomes limited by available software and peripherals.

When the consumer loses, the manufacturer does too. Explosive growth of the personal computer market really depends on buyers with little interest in computers and computerese. They want solutions to problems. The consumer would be better served by the personal computer industry if standards were established for instruction sets, operating systems, data formats, languages, and peripheral interfaces.

With standardization, the consumer could walk into a retail outlet and look at demonstrations of a wide range of personal computers performing word-processing, accounting, and entertainment functions. He could then select the model that fitted his particular needs, without the confusion and frustration that comes from having to learn about all the variations in software and peripherals that exist.

Some argue that standardization is a plea for consistency in which product innovation will degenerate to the lowest common denominator. I question this opinion. There is tremendous need for innovation in the field of personal computers that would be filled even if standards were in force. Where is the hand-held, under-$1,000 computer that can run VisiCalc? Technology might have already provided one if the research and development money that hardware manufacturers have been pouring into systems software development had been rechanneled into low-cost hardware design.

All the more damning is that, even with the freedom to invent their own interface hardware and operating software, manufacturers have developed little consumer-usable innovation. Proof of this lies in the common complaint when a new computer is introduced that there are no software or peripherals for it.

The consumer also loses when software manufacturers spend resources on developing the same programs for several different machines. This redesign can take as long as the original development and adds little. The software company ends up building several versions of the same product, all of which sell in lower volume. The result is higher prices for the consumer. Alternatively, this conversion investment could be reallocated for better documentation or the development of a friendlier user interface.

Opponents of standards contend they will inhibit the ability of hardware manufacturers to create product differentiation. The answer is to be innovative with hardware technology: build flat-panel displays or a 3-ounce portable computer or something as powerful as an 8-million-instruction-per-second system.

IBM Corp. has shown the way by adopting industry-standard microprocessors (the Intel 8088), operating systems (UCSD Pascal and CP/M-86), and outside software. Despite this use of off-the-shelf components, the company has still earned high marks for innovation and low price. IBM has set an example, possibly the standard example.

I believe the responsibility of standardization rests heavily on Apple, Radio Shack, Atari, Mattel, Commodore, and Sinclair. As industry leaders, they need to put aside their egos and fear of competition and take a leadership role in standardizing the industry for the benefit of the consumer and themselves.

Electronics *will periodically invite the expression of outside views on this page concerning issues of importance to the electronics industries.*

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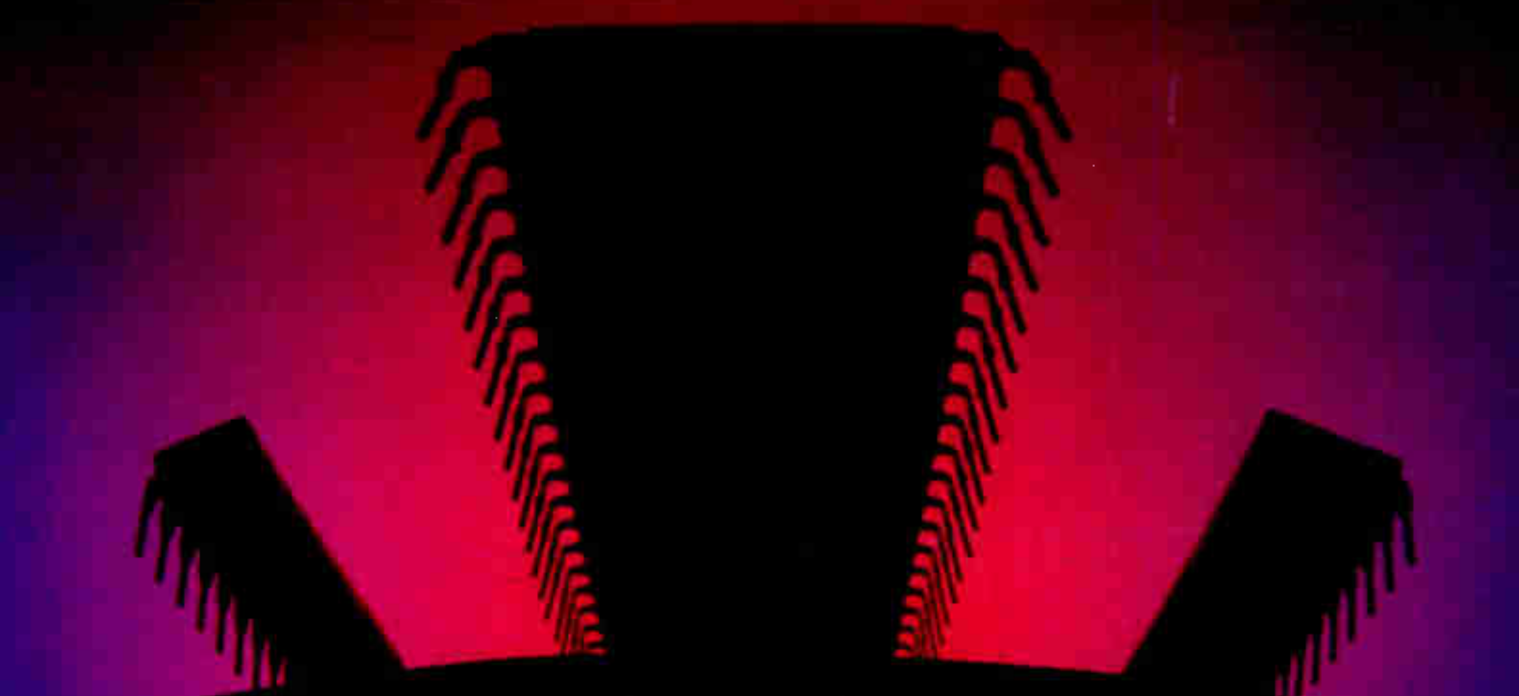

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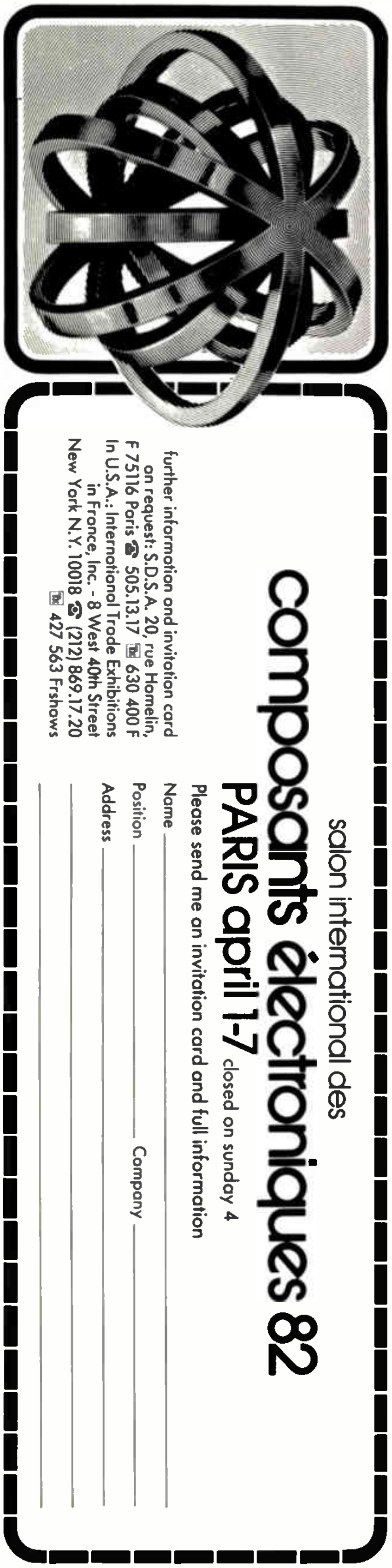

Meetings

International Solid State Circuits Conference, IEEE (L. Winner, 301 Almeria Ave., Coral Gables, Fla. 33134), Hilton Hotel, San Francisco, Feb. 10–12.

2nd Conference on High-Frequency Communications Systems and Techniques, The Institution of Electrical Engineers (Savoy Place, London, England WC2R 0BS), Savoy Place, London, Feb. 15–16.

9th Plating in the Electronics Industry Symposium, The American Electroplaters' Society (Jack Sheehan, 1201 Louisiana Ave., Winter Park, Fla. 32789), Sheraton-Atlanta Hotel, Atlanta, Feb. 16–17.

Aerospace Applications Conference, IEEE (Russel Gaspari, Hughes Aircraft Co., MS S12/V305, P. O. Box 92919, Los Angeles, Calif. 90009), Woodbridge Conference Center, Snowmass, Colo., Feb. 21–28.

Nepcon '82 West, Cahners Exposition Group (222 West Adams St., Suite 999, Chicago, Ill. 60606), Anaheim Convention Center, Anaheim, Calif., Feb. 23–25.

Compcon Spring, IEEE (Harry Hayman, P. O. Box 639, Silver Spring, Md. 20901), Jack Tar Hotel, San Francisco, Feb. 26–28.

Robots VI Conference and Exposition, Society of Manufacturing Engineers (1 SME Dr., P. O. Box 930, Dearborn, Mich. 48128), Cobo Hall, Detroit, March 1–4.

9th Communications Satellite Systems Conference, American Institute of Aeronautics and Astronautics (1290 Avenue of the Americas, New York, N. Y. 10104), Town and Country Hotel, San Diego, Calif., March 7–11.

Spring Engineering Conference, Society of Cable Television Engineers (1900 L Street, N. W., Suite 614, Washington, D. C. 20036), Copley Plaza Hotel, Boston, March 8–10.

Southeast Printed Circuits & Microelectronics Exposition, Cahners Exposition Group (222 West Adams St., Suite 999, Chicago, Ill. 60606), Sheraton Twin Towers Convention Center, Orlando, Fla., March 9–10.

15th Annual Simulation Symposium, IEEE (Harry Hayman, P. O. Box 639, Silver Spring, Md. 20901), Tampa, Fla., March 17–19.

4th Annual Microelectronics Measurement and Test Conference, Benwill Exposition Group (1050 Commonwealth Ave., Boston, Mass. 02215), Hyatt San Jose, San Jose, Calif., March 23–24.

Southcon/82, IEEE (Robert Myers, Electronic Conventions Inc., 999 North Sepulveda Blvd., El Segundo, Calif. 90245), Expo Center, Orlando, Fla., March 23–25.

Infocon 82, IEEE (Harry Hayman, P. O. Box 639, Silver Spring, Md. 20901), Sahara Hotel, Las Vegas, March 29–April 2.

Reliability Physics Symposium, IEEE (Frank B. Micheletti, Rockwell International, 3370 Miraloma Ave., Anaheim, Calif. 92803), Town and Country Hotel, San Diego, March 30–April 1.

Seminars

Microwave Stripline Design, Feb. 16–17, and Modern Microwave Solid State Devices and Sources, Feb. 18–19. Short courses sponsored by the Department of Continuing Education-R, Georgia Institute of Technology, Atlanta, Ga. 30332.

International Zurich Seminar on Digital Communications, IEEE (Ms. M. Frey, EAE Siemens-Albis AG P. O. B. Ch-8047, Zurich, Switzerland), Swiss Federal Institute of Technology, Zurich, March 9–11.

Quality Circle Conference, The University of the State of New York (Study Circle Consortium, Room 234M, Education Building, Albany, N. Y. 12234), Granit Hotel, Kerhonkson, N. Y. March 14–16.

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Marconi's AM/FM Signal Generator 2017 looks special – and it is. It is a stable, low noise generator offering high outputs, up to 4V e.m.f., over the frequency range 10kHz to 1024MHz. It has two manual control systems, digital via the keyboard or analog via rotary controls. It can be programmed via the GPIB to extend the 2017's range of applications to include automatic testing, either as part of a bench-top system or in a full ATE assembly.

Being microprocessor controlled, the 2017 is simple to operate and has a memory facility allowing up to 10 complete settings to be stored for later use. Digital displays and annunciators clearly indicate the instrument's settings at all times. The microprocessor also performs conversion of RF calibration units and provides an incrementing facility, allowing the carrier frequency to be stepped up or down in steps of any size. A key can be pressed to indicate total shift.

At the heart of the 2017 is a low noise, cavity-tuned oscillator that produces a sideband noise figure of better than –135dBc/Hz at 20kHz offset at 470 MHz, with complete freedom from spurious non-harmonic signals. A series of digital dividers and filters ensures that the noise level is even lower at frequencies below 256MHz. Additionally, a slow sweep mode, operating between any two frequencies on a carrier frequency range, facilitates measurements of spurious receiver responses, full spectral purity being retained throughout.

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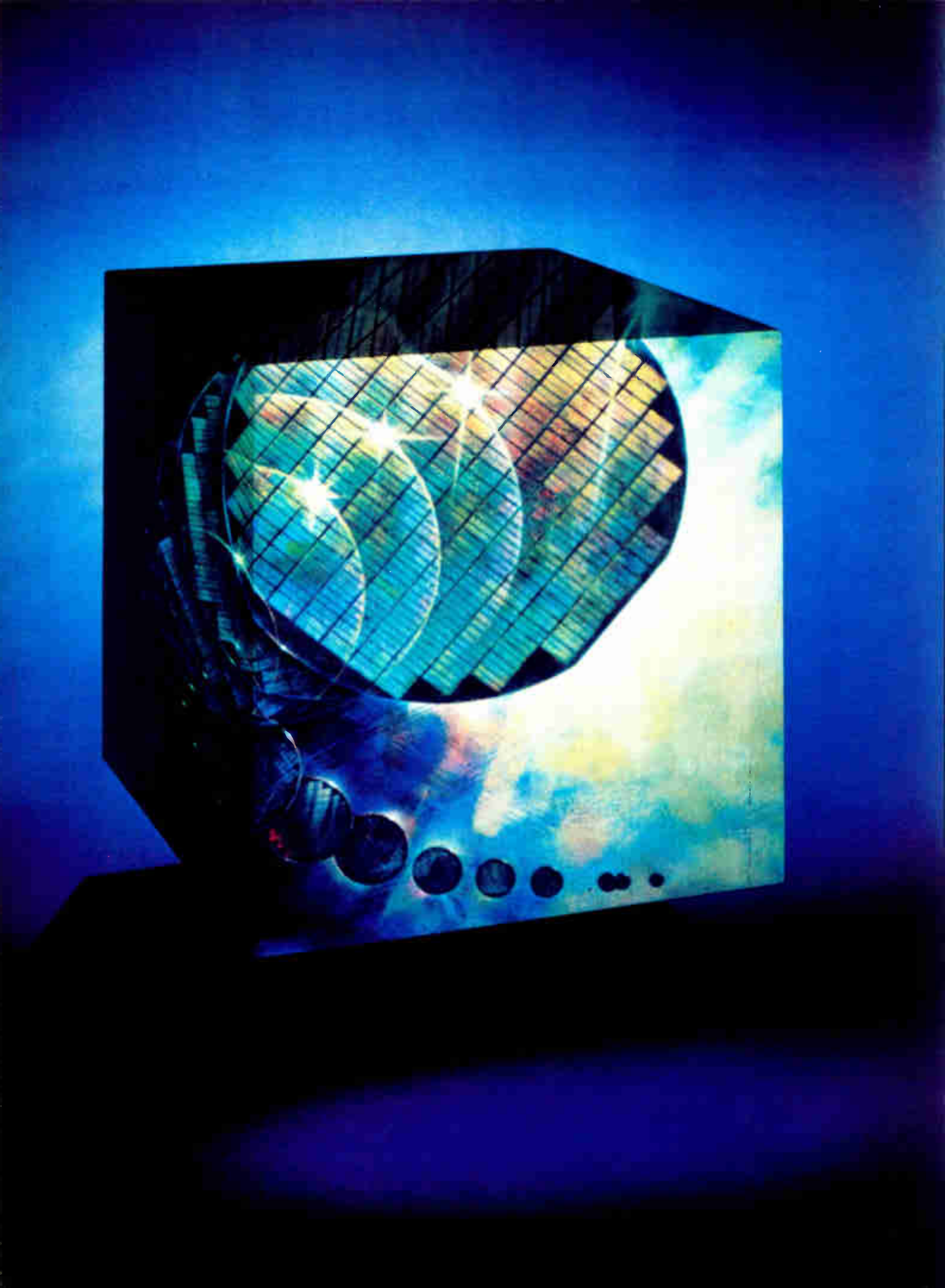
Circle 27 on reader service card



GOULD BIOMATION K100-D

NCR seeks chip combining processor, nonvolatile memory

After talking with several microprocessor makers, NCR Corp., Dayton, Ohio, is reported close to agreement with one on a joint deal aimed at development of a microprocessor with on-chip nonvolatile memory. **NCR's presumed contribution would be its n-channel silicon-nitride-oxide semiconductor (SNOS) technology** introduced last year in the form of the NCR 4485, a 4-K nonvolatile random-access memory [*Electronics*, Sept. 22, 1981, p. 178]. With three power supplies required, the process used on the 4485 would not be ideal for integration of 5-V-only microprocessors. But NCR is known to be developing a 5-V-only version of SNOS and plans to introduce single-supply 1- and 2-K nonvolatile RAMs.

Accessories market opens fast for IBM Personal Computer

Starting what is sure to be a trend, Tecmar Inc. has announced more than 20 hardware add-ons for IBM Corp.'s Personal Computer. The Cleveland, Ohio, firm can deliver **an expansion chassis, a Winchester disk drive and controller, 256-K-byte dynamic random-access-memory boards,** parallel and serial interfaces, an IEEE-488 interface, digital-to-analog and analog-to-digital converters with 8- to 16-bit resolution, a video-image digitizer, a music synthesizer, prototyping boards, and other products. Tecmar vice president David D. Wertman says that though IBM is not publicly endorsing the line, "they sure aren't unhappy about it."

Faults show up in Japanese RAMs

Given the much discussed Japanese reputation for quality, engineers at a consulting firm, Integrated Circuit Engineering Corp. in Scottsdale, Ariz., say they were surprised to find some shortcomings in a recent evaluation of Japanese-made 16-K random-access memories. **Problems observed included poor overlay passivation, marginal metal-step coverage, and indications of poor workmanship** in chip-dicing and wire-bonding techniques. A half dozen production samples from each of four Japanese vendors were evaluated. While none of the faults is uncommon, an ICE official notes that the quality of U. S.-made parts has, in the past few years, reached the same level as that of Japanese circuits. He adds, "I can't see a significant difference in the quality of production-level parts."

Spread spectrum attracts NASA

It has taken more than 30 years, but spread-spectrum technology may be ready to move from the exclusive domain of military radar and countermeasure systems. The National Aeronautics and Space Administration has passed the word to industry that it wants to look into a spread-spectrum system to distribute scientific data from spacecraft experiments. NASA **currently collects data by a single large antenna and distributes it by land lines, radio links, or even mail.** Delivery is characterized by inefficiencies, delay, and many overhead bits. In the proposed solution, a direct-broadcast code-division multiple-access system using a spread-spectrum transmitter will deliver data directly to the user.

Codec-filter chip going into production

After a half year of turning out samples, Motorola Inc. is accelerating production of its single-chip codec-filter, the MC14403. The part is the latest entry in a growing field of codec-filter chips for the telecommunications switching industry. **Motorola is banking on the 14403's 16-pin design to attract space-conscious systems manufacturers**—existing versions from other firms require packages with 20 or more pins. Getting the circuits into a smaller package was certainly no small task; it took Motorola circuit designers in Austin, Texas, 2½ years to develop the 36,000-mil² chip. Most of the part's nine patents pertain to pin-saving circuitry. The low-power silicon-gate complementary-MOS device—which has an on-board precision voltage reference—requires no external components like capacitors or resistors.

Chip swap turns 8-bit CPU board into a 16-bit unit

What is said to be the fastest S-100 central processing unit may also be one of the most flexible, according to its makers, Lomas Data Products Inc. of Westboro, Mass. Called the Lightning One, **the unit can be upgraded in the field from 8- to 16-bit operation** simply by replacing its Intel 8088 microprocessor with an 8086. Pinout differences between the two processors are resolved by on-board logic, making the unit an attractive entry in a market now shifting from 8- to 16-bit products. The board runs at 4, 5, 8, or 10 MHz, depending on the microprocessor used and the speed of other devices on the bus.

Digital equalization bows for hi fi

Calling it the first high-fidelity component to use true digital signal processing, Teledyne-Acoustic Research Inc., Norwood, Mass., has unveiled a prototype of its adaptive digital signal processor. The ADSP uses 16-bit converters and a Texas Instruments 16-bit TMS9995 microprocessor to evaluate and compensate for loudspeaker response and listening-room effects. **It is calibrated using a built-in white-noise source; error-detection and -correction signals are generated simultaneously.** The unit operates in the time, rather than the frequency, domain—the first consumer equalizer to do so—and thus is more accurate than multiband analog equalizers. It is also the first consumer device able to smooth both broad-band effects and peaks or notches only a few hertz wide. The firm hopes to begin its manufacture this year.

DEC organizes Small Systems Group with Knowles as head

To intensify its efforts in the small-systems sector of the computer business, Digital Equipment Corp. of Maynard, Mass., has formed a new market organization, the Small Systems Group. Andrew C. Knowles III has been named group manager and vice president. **His appointment is seen as evidence of DEC's desire to penetrate the small-systems sector more effectively**; for the past several years, Knowles has been moved through the company as a top-level trouble shooter. What's more, DEC is expected to make several major announcements in the small-systems area in 1982, among them, its first personal computer. DEC engineers now are working overtime, including weekends, to finish the design.

Modula-2 available for Apple II

Modula-2, the new language from Pascal author Niklaus Wirth [*Electronics*, March 24, 1981, p. 39], is moving into the realm of popular computers with the introduction of a complete Modula-2 package for the Apple II from Volition Systems of Del Mar, Calif. **The package includes a loader and lets users create a library of up to 50 modules** and compile and execute Modula-2 programs on the Apple. The software, which requires the UCSD P-system for operation, costs $550, with first deliveries set for next month, the company says.

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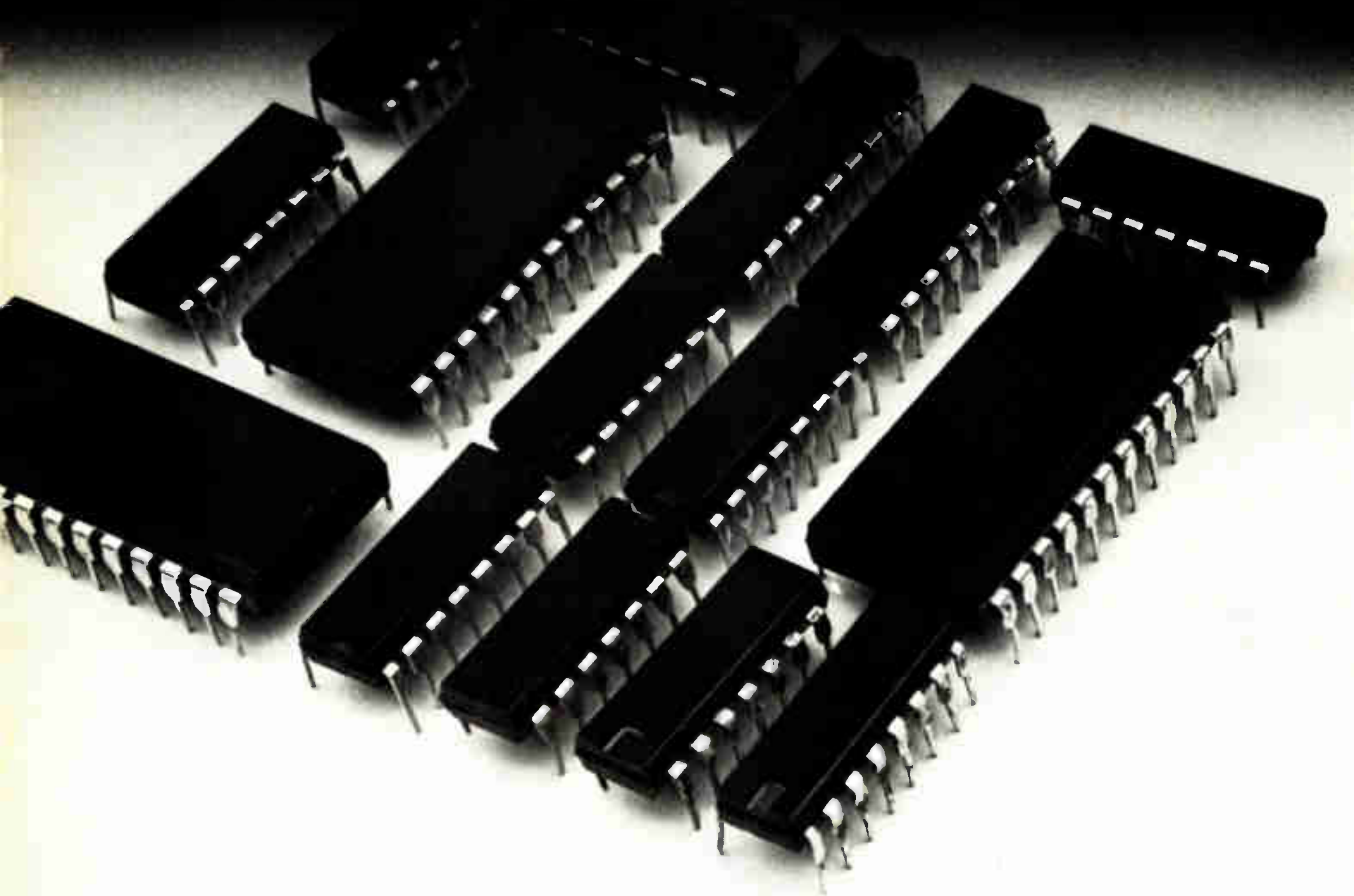

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Two-step technique reduces error rates by orders of magnitude

by Harvey J. Hindin, Communications and Microwave Editor

Bell Laboratories combines equalizer and canceler to undo both amplitude and phase distortion effects

A technique for reducing bit errors on digital communications channels has been developed that improves the error rate by two or three orders of magnitude. Eventually, rates for data sent over telephone lines, for example, could be as low as 1 bit in every 10 million, an exceptionally low number.

The method was developed at Bell Laboratories by staff members Tong Lim in Holmdel, N. J., and Allen Gersho, now at the University of California in Santa Barbara. It combines two well-known communications techniques—adaptive equalization and cancelation—that have seldom been used together (see diagram). It also improves on them.

Old problem. Amplitude and phase distortion in a high-speed data channel causes the smearing of digital pulses into each other so that a 1 can look like a 0 and vice versa. Known as intersymbol interference, this phenomenon occurs in band-limited channels, such as conventional twisted-pair wiring, conditioned lines, or coaxial cable.

If phase distortion is the dominant error-causing mechanism in the communication link, a fractionally spaced equalizer [*Electronics*, June 2, 1981, p. 44] eliminates virtually all of the intersymbol smearing without adding significantly to the channel's noise level. The equalizer does its job by continually adding or subtracting small phase shifts to the received signal so as to cancel the phase shifts introduced by the channel itself. These shifts vary with time and so must the equalizer's corrections.

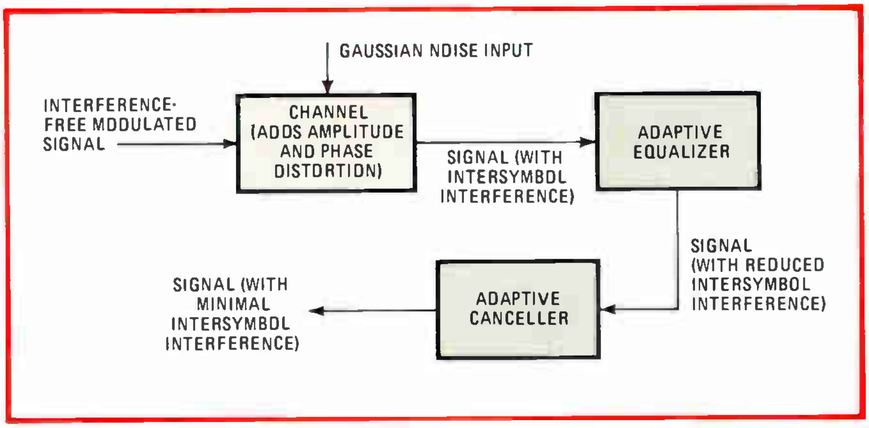
Unfortunately, straightforward amplitude equalization, though it removes amplitude distortion on the channel by adding and subtracting small voltages, generates more noise than can be tolerated. Designers cope by using a technique called decision-feedback equalization—which offers some, but not enough, improvement by means of feedback loops. To do a better job, Bell pairs the equalizer with a canceler.

In a canceler, an iteratively generated replica of what is believed to be the undistorted signal is continuously compared with the actual distorted signal. The difference between the two is constantly reduced until an undistorted signal emerges. To do its job, Bell's canceler has added an internal filter, which is in essence matched to the impedance characteristics of the communication channel and maximizes the equalizer-canceler signal-to-noise ratio.

The technique yields results very close to the ideal, in the sense it approaches the error rate of a matched filter receiving just one pulse at a time. Bell's equalizer, which provides the input signal to the canceler, has its taps, weighting functions, and architecture specifically designed for reducing both amplitude and phase distortion. Both it and the canceler, so far only simulated in a computer, were developed through a mathematical analysis of the behavior of adaptive equalizers and cancelers connected in cascade.

The analysis also showed a digital transversal filter set up as the matched filter would perform better than the simple delay line used in previous canceler designs. Both allow individual signal components to be delayed, weighted, and compared with other signal components.

Lin and Gersho simulated communications over three separate channels with a data stream of 9.6 kilobits a second. Amplitude distortion was varied from zero to very



Cascade. Technique for reducing intersymbol interference uses an adaptive equalizer to feed an adaptive canceler. This, in turn, could provide low-error data input to a modem.

severe, as was the phase distortion. To simulate the conditions of practical channels, Gaussian noise was added into the signal path.

Once the equalizer had been operational long enough for it to get a good estimate of what the data stream should look like without intersymbol interference, the canceler went into operation. For a case of moderate amplitude and phase distortion, the new approach was able to yield 2 decibels improvement in S/N ratio over the older linear equalizer and 1 dB over the decision-feedback equalizer. Every decibel corresponds to an order of magnitude reduction in error rate.

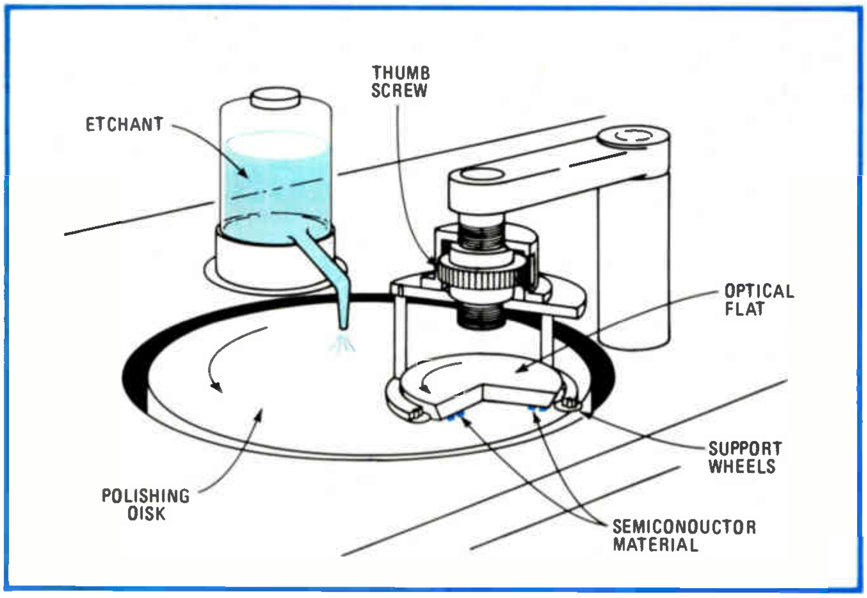
For the severely distorted channel, the results are even "more impressive," as its inventors put it. The new approach is respectively 3 dB and 1 dB better than linear equalization and decision feedback.

Gersho points out the new technique is clearly useful for improving the performance of modems and other data-communications receivers. Although Bell is keeping mum, it is likely that the equalizer-cancelers will be scattered about the forthcoming advanced communications service (ACS) network and could also be used in modems manufactured by Western Electric. Though ACS's competitors will be able to develop intersymbol interference reduction techniques of their own, Bell could have the jump on delivering data with lower error rates.

Production

Spinning etchant polishes flat, fast

Integrated circuit process engineers have a new method to consider for polishing the surfaces of semiconductor materials. Developed at the Massachusetts Institute of Technology's Lincoln Laboratory, Lexington, Mass., it is called hydroplane polishing, and by floating the semiconductors on the surface of a moving etchant, it achieves very flat and smooth surfaces quickly.



Hydroplaning. In the MIT apparatus, semiconductor wafers or dice are polished rapidly by an etchant solution as they rotate on an optical flat placed close to a spinning disk.

The new approach is important because device yields and geometries often are limited by the surface quality of semiconductor materials. Etch rates will differ over a surface that has been damaged mechanically, cutting production yields. If a wafer is not flat enough, optical masking systems run into focus problems, limiting both yield and line widths. When an epitaxial growth phase is involved, especially molecular beam epitaxy, wafer-surface defects are reflected in the epitaxial layer, again cutting yield.

With hydroplane polishing, these problems could be avoided, according to MIT. In tests with materials including gallium arsenide, indium phosphide, and mercury cadmium telluride, the system produced surfaces flat to within 0.3 micrometer—excellent by prevailing standards—and free of mechanical defects.

Today's way. Some form of mechanical polishing is almost always needed to obtain flat surfaces. Chemical etching, also used, does not cause defects but is very slow—making the process a tradeoff of throughput for yield. A hybrid technique, involving chemical and mechanical polishing, buffs wafers with a pad soaked in etchant. But such polishing still is slow, removing only about 0.5 μm of material per minute, and if the wafer should contact the pad, mechanical damage results.

With MIT's system, material is removed fast—at rates of more than 28 μm per minute, according to MIT. About 10 μm/min is said to yield the best surface quality, and slower rates can be used for more precise control of wafer thickness.

The technique was developed by Lincoln lab technicians Joseph V. Gormley and Michael J. Manfra with staff member Arthur R. Calawa. Their apparatus consists of a round optical flat about 10 centimeters in diameter mounted in an adjustable holder, as shown in the diagram. The holder can be raised or lowered to control its distance from a polyurethane-covered 9-inch-diameter polishing disk spinning at 1,200 rotations per minute. A continual stream of etchant solution is fed to the center of the polishing disk, and it flows outward because of the effect of centrifugal force.

Wafers are bonded to the flat using wax and then uniformly ground and cleaned. Placed in the holder, the flat is lowered to within about 125 μm of the polishing disk. The optical flat is free to rotate, and does so at about 1,800 rpm, driven by the coupling of the lower disk's motion via the etchant solution.

During polishing, the semiconductor material hydroplanes on a film of etchant. The solution is always chemically active and clean, since it is continually replenished. Moreover, the motion of the system boosts the polishing speed.

Nearly as important as the mechanical design of the system was the makeup of the etchant solution. It had to be viscous enough to keep the rotating surfaces apart, but have only limited surface tension so as not to pull the disks together.

The team finally settled on 0.1% to 1.0% bromine in a solution consisting of about 80% methanol and 20% ethylene glycol. Varying the bromine content varies material removal rate by from 8 to 14:1, depending on the material that is being polished.

Manfra believes there is commercial promise for the system, but notes that no firm has yet asked to license it. Meanwhile, work proceeds at a low level, with plans made for an automated version of the polisher with a larger 12-in.-diameter polishing wheel. **-James B. Brinton**

Operating systems shape up for 16 bits

Unix is only one of several operating-system possibilities for 16-bit microprocessors. First to be made available was CP/M-86 from Digital Research Inc., Monterey, Calif., a version of the 8-bit standard system, CP/M-80, but rewritten for the 8086. The multiuser-multitasking version, MP/M-86, also emulates many of the convenient program-development features of Unix. Digital Research offers a network version, CP/NET, that allows separate microsystems to share expensive peripherals as well as communicate with each other.

Destined to be one of the more popular systems is MS-DOS, a simpler system than those based on Unix, from Microsoft Inc., Bellevue, Wash. It is designed for the 8086 and incorporated into IBM Corp.'s Personal Computer, a machine whose sales and application programs are expected to climb in numbers rapidly. MS-DOS offers facilities similar to CP/M with the promise of more to be added in the future—including an integrated graphics output. Also from Microsoft are implementations of Unix, which it calls Xenix, designed for the LSI-11, 8086, Z8000, and 68000. The company says MS-DOS will be compatible with these Xenix systems in the future.

Another system that is already available with several implementations, like Unix, is the Pascal-based UCSD P system. Softech Microsystems Inc., San Diego, offers it for three 16-bit processors—LSI-11, 9900, and 8086—with a version for the 68000 running in house but not yet released. It is the only one to use an intermediate-code, or pseudo-code, P system that is then translated into the object code of the host. This intermediate-code feature guarantees that any program written on one system can be run on any other that uses the P system. **-R. Colin Johnson**

Software

Unix implemented for 68000 systems

While the CP/M operating system may have achieved the status of *de facto* standard for the noncaptive 8-bit microcomputer world, no comparable system has yet conquered in the 16-bit arena.

CP/M's 16-bit successors, CP/M-86 and the multitasking MP/M-86, designed for the 8086, must be considered major contenders. But the drastic reduction in the price of Unix that Western Electric Co. announced for its system 3 last month [*Electronics*, Dec. 15, p. 42] gives great impetus to applications of this software.

So does the appearance of Unix implementations for use on the Motorola 68000. Placed in production last year, the 68000 is now No. 3 in sales behind the 8086 and 9900 and growing rapidly in popularity. (See "Operating systems shape up for 16 bits.")

Two Unix implementations for the 68000 are already on the market, and more than a half dozen others are in development. The first implementation came from a source better known for a different kind of programming—Lucasfilm Co. of San Raphael, Calif., maker of the "Star Wars" film series. Developer of the computer graphics effects featured in the films, it was the first to buy the Stanford University network work station that is built around the 68000 [*Electronics*, Oct. 20, p. 46]. The firm came up with the program out of necessity.

"We have two DEC VAX systems running under Unix here, and we wanted to link them to the 25 personal work stations we bought," says Ed Catmull, director of Lucasfilm's Computer Research & Development division. He wanted a Unix-based Xenix program from Microsoft Inc., but the Bellevue, Wash., software house had the 68000 third on its list of priorities after the 8086 and Z8000.

Lucasfilm could not wait for what is now the Xenix-68K program, so it developed its own. "We then decided to license it at $10,000 for unlimited use and regardless of the number of CPUs," he says. For an original-equipment manufacturer, this could represent a savings over the charge per central processing unit of programs from other software vendors.

The first OEM vendor to use the Lucasfilm program is Codata Systems Corp., Sunnyvale, Calif., whose CTS-300 system [*Electronics*, April 21, 1981, p. 215] also uses the CPU board from the Stanford work station. Catmull cautions, however, that Lucasfilm is not a full-service vendor. "We are just interested in a one-time sale to help defray the cost of our R&D," he says.

Support. For full support, OEMs can count on Microsoft, which introduced its Xenix-68K program in late November, about four months after Lucasfilm. "We offer one-stop shopping. The price of the Bell Unix license is included in our fee," notes Mark Ursino, product marketing manager for Xenix. "For the first CPU, our Xenix-68K plus the Bell license would be $500, but for someone who commits to pay $1 million in royalties over a three-year period we would charge about $190 a copy for 2-to-16-user systems."

Since Unix is oriented toward Digital Equipment Corp.'s PDP-11 minicomputer, targeting it for microcomputers requires a different philosophy, Ursino continues. "In a minicomputer environment, CPU power is at a premium. And because you have large, fast peripherals, file swapping is not a problem. With microcomputers it's the other way around. You have CPU power to burn, but because you have cheaper, slower peripherals, disk access is at a premium."

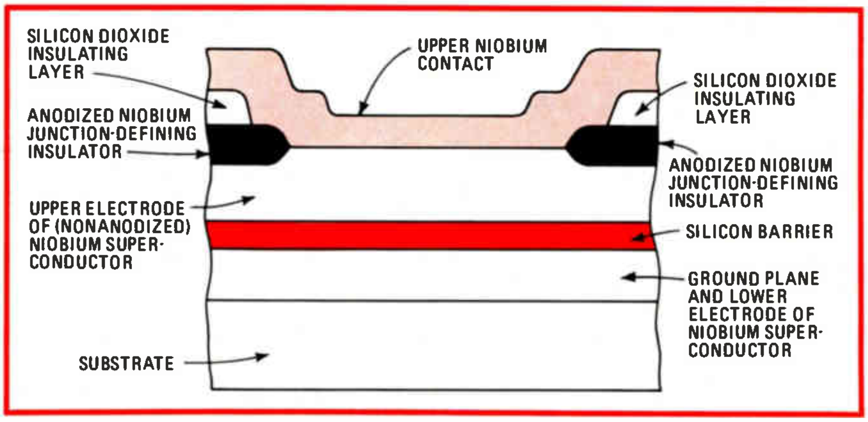
Ursino notes that Microsoft installed more intelligence into the disk-buffering and disk-cache system than exists in standard Unix. "The standard Unix flushes the entire buffer on a swap-out, for example, while the Microsoft version flags those things that should be the last to be flushed," he points out. This includes file directories, which are likely to be accessed frequently. Microsoft has also redone the Unix memory-management scheme so that the processor can load noncontiguous areas of physical memory.

Viewing Microsoft's implementations of Unix, Ursino points out that the 8086 and Z8000 segment their memory into 64-K partitions, while the 68000 can directly address 2 megabytes.

Unix look-alikes, originally developed to provide a cheaper alternative to standard Unix, which now is price-competitive, are still available from about a half dozen companies, including Whitesmiths Ltd., New York, and Mark Williams Co., Chicago. **-Martin Marshall**

Superconductors

Niobium toughens Josephson devices



Refractory. Sperry's fabrication process combines a superconductor ground plane and a lower electrode on one layer, and forms junction-defining insulators through a selective anodizing process rather than by etching. Niobium is sturdier than usual lead alloys.

New materials may be moving Josephson junction circuits nearer to the real world. Developed at the Sperry Research Center in Sudbury, Mass., the materials promise higher yields and more rugged, uniform parts than before and also allow simpler and faster processing.

"We're able to build logic parts in about two weeks; the same devices would take closer to six or eight weeks with current fabrication methods," asserts Harry Kroger, manager of high-speed logic technology at the center.

Refractory. Kroger and fellow researchers Don W. Jillie and Lawrence N. Smith report that their Josephson logic chips are the first built entirely from refractory metals. The superconducting metal is niobium, and niobium oxide (Nb_2O_5) is used as a junction-defining insulator.

Silicon dioxide forms additional insulating layers and silicon forms the tunneling barriers that produce the Josephson effect. Resistors are of molybdenum.

The composite package appears immune to thermal cycling, which degrades performance in conventional lead-alloy–based Josephson devices, says Kroger. Despite their advantages as superconductors, lead alloys are structurally weak and unable to tolerate cycling between their supercooled operating environments and room temperature.

"I haven't seen one of our chips fail, despite repeated cycling," Kroger adds. "They are so rugged physically that you can knock them around or scratch them with a knife and still do no damage."

Silicon analog. During fabrication, the Sperry team employs a so-called selective niobium anodization process (SNAP), a rough analog of the production of silicon-transistor isolation by thermal oxidation. Using SNAP to anodize junction-defining insulators on the upper semiconductor electrode, as shown in the diagram, eliminates several lithographic steps normally required to pattern the junction barrier.

Also borrowed from semiconductor processing is the technique of combining multiple functions on a single layer. "We discovered that we didn't need separate layers for the ground plane and the lower superconductor electrode," Kroger says.

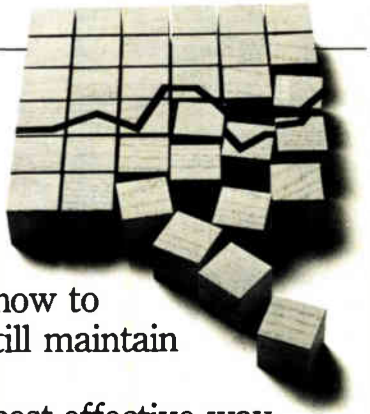
Combining functions reduces the number of lithography steps normally required in Josephson fabrication from between 11 and 14 to only about 5 steps, he adds. Having fewer steps lessens the chance of contamination, so that the resulting device should have higher yields and better device uniformity.

Kroger reports that a series array of 49 logic junctions demonstrated a standard deviation in their critical-current tolerance of only 2.5%. That, he adds, is good enough for the junctions to work together in an integrated circuit.

An issue. A researcher at IBM Corp. agrees that an attraction of the Sperry method is that it addresses the uniformity issue. "Many people are looking for ways to make fabrication a more stable process, and this approach does look promising," says Avi Mukherjee, a research staff member at IBM's Thomas J.

AN OPEN LETTER TO: **DATA GENERAL, PRIME COMPUTER AND ROLM**

Are digital board testing costs pulling the profit picture apart?



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Functional vs. In-circuit. In-circuit testers are not the total solution that other ATE suppliers would like you to believe. With man months required to software model new LSI and VLSI devices, your programming costs can skyrocket. And remember, production testing doesn't begin until the development is completed. Fluke's two testers will have you testing boards sooner and with higher confidence levels. And here's a bonus. You can buy both systems for the price of one In-circuit tester.

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Watson Research Center in Yorktown Heights, N. Y. But Mukherjee cautions that "much work must still be done before it's proved that this is the best alternative."

"This is our first attempt at proving just the feasibility of our methods, so we haven't yet tried for the smallest or fastest parts by any means," Kroger explains. "The logic circuits we've reported have 12-micrometer line widths, though we've done work down to about the 3-μm level. Now, we're concerned with characterizing device performance, pushing down into the 1-μm range, and fabricating Josephson memory parts as well as logic and discrete devices." A Josephson switch (called a Jaws circuit) built with five junctions will undergo performance testing in the next few months. -Linda Lowe

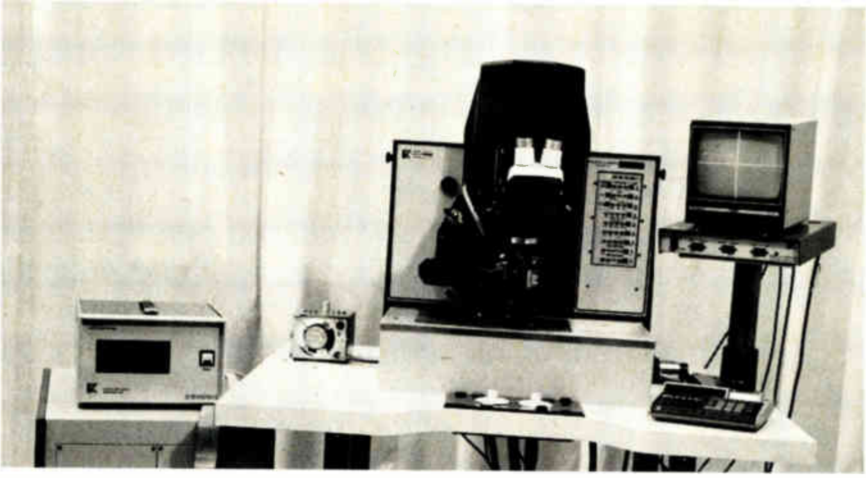
Production

Automation tugs at pull testers

Automated wire bonders are certainly a boon to hybrid-circuit makers, boosting their output enormously. But the bonders' very success is also the cause for concern when the wires must be subjected to 100% pull tests for military certification. Pull testers are not nearly as automated as the bonders, thereby leading to production bottlenecks.

Enter Kulicke & Soffa Industries Inc., the Horsham, Pa., maker of production equipment for the semiconductor industry. Working with funds from the Naval Ocean Systems Center, San Diego, Calif., the company took the core of one of its automated bonders and devised a pull tester automated to an extent never before achieved.

The hybrid automated lead tester, or Halt as it is more easily referred to, performs nondestructive pull tests on the wires of nearly any hybrid. Unveiled after some two years of development, it applies grams of force to wires ranging from 0.7 to 2 mils in diameter.



Similar. With its positioning joy sticks (foreground), viewing screen, and microscope, K&S's Halt pull tester resembles its microprocessor-controlled wire bonder.

K&S built it in the shell of its microprocessor-controlled 1470 automated bonder, with a substantial amount of memory added to handle the new chores. Like the bonder, the Halt can be programmed either by entering into memory the test positions and pull forces or by manually running through one of the hybrids in a learning mode.

It performs 1.3 tests per second, compared to one test in 2 to 5 s with semiautomated units on the market, according to Max Bycer, vice president. These require the pull head, or hook, to be positioned manually at each wire; the Halt does this automatically, although each hybrid must be put in place by hand.

With the pull hook exerting pressure upward, the microprocessor system makes a resolution-of-forces calculation to compute the force actually being exerted along each end of the wire. These forces vary depending on the angle between the wire and bonding pad. This angle varies, in turn, as the wire is pulled taut. The force is monitored via the movable core of a linear variable differential transformer, which converts the pull force to a voltage.

After checking a wire, the hook, which is mounted on a movable head, rotates to clear the wire and lifts. It moves, lowers, and pivots to slip under the next wire.

Kulicke & Soffa plans to introduce a commercial version of the system, which will be given to the Navy for further tests and ultimate use. The firm, however, is not yet certain whether it will manufacture the full Halt, to sell for about $55,000, or make a cheaper, less automated version. A product could be introduced in 6 to 12 months.

Need. Others feel it could sell. "We get calls for that type of product all the time," says John Batchelder, western sales manager for Unitek Corp.'s Equipment division in Monrovia, Calif., which makes a semiautomated pull tester with a base price of $5,900.

George Kelly, sales engineer at Orthodyne Electronics Corp., Costa Mesa, Calif., feels the product would succeed in commercial and military markets. "You put out so many parts with automatic bonders, you can't afford to put out bad parts," he notes. Orthodyne makes an automatic tester mounted with a wire bonder. Priced at $80,000, it checks out a limited number of wires on discrete components. -Terry Costlow

Medical

Eye communicator aids handicapped

Tracking eye movements electronically has been used by the military to control a soldier's gunfire by aiming and firing weapons as he or she stares at the target. Similar schemes

are also used by the advertising industry to assess, for example, what may draw attention in an ad layout.

A next step in the application has recently been taken at the Rehabilitation Institute of Pittsburgh, which serves children with severe speech impairments. There, Mark Friedman, the volunteer director of computer engineering, has cobbled together a system of donated parts that helps the patients generate synthesized speech. He calls it the Eye-Tracker Communications System.

Picking words. The children produce speech by staring at words presented in eight liquid-crystal-display regions set around the perimeter of a three-by-three-region matrix (the center area is not used). Initially, the displays contain subject headings. Then, as the gaze is directed at a specific region, the word in the area is stored in memory, and eight new words or phrases are presented that relate to what has just been selected.

Increasingly more specific choices are possible until a phrase or sentence is formed, such as "may I have an apple." An 18-element sentence can be put together in less than a minute, according to Friedman.

He points out that those who are severely spastic or paralyzed have no reliable body movements under voluntary control other than the eyes. Even when body movements can be controlled, using the eyes was found to be faster and less fatiguing.

Eye-movement-sensing systems are in the $10,000 range, which is prohibitively high for most hospitals. But because he did not need the precision previous applications required, Friedman put together a far simpler sensor that would have cost about $1,500 if he would have had to buy all the parts.

He uses an infrared-sensitive surveillance camera made by RCA Corp. to monitor stores and parking lots. Or, if it is likely that young patients will be handling the unit, he substitutes a low-voltage solid-state camera that General Electric Co. developed for robotics and industrial process control.

Either camera maintains a sharp image of the eye, focusing on the

News briefs

GenRad seeks new Futuredata buyers

Rather than sell its Microprocessor Development Systems division to a group of employees as expected [*Electronics*, Dec. 29, 1981, p. 33], GenRad Inc. is broadening its discussions to include other technology firms. A source close to the negotiations between the Concord, Mass., firm and employees of the one-time Futuredata says that the talks stalled when the financial community found so-called weaknesses in the management team nominated by the employee group. Talks with the insiders will continue, but GenRad sources say the firm is seeking companies both here and abroad that offer a good technology fit so as to assure continuing customer support.

Meanwhile, work at the up-for-sale division is continuing on in-circuit emulators for Zilog's Z8001 memory-management-equipped 16-bit microprocessor, the Z8003, and the Z8, as well as Intel's 8051 and its 8086/7 and 8088/7 processor pairs. Yet GenRad, having made a firm decision to divest, is carrying the division on its books as a discontinued operation.

Post Office starts service to make mail electronic

The U. S. Postal Service's E-COM system (for electronic computer-originated mail) went on line Jan. 4 to assist large-volume mailers in 25 cities across the country send their computer-generated messages at lower cost. RCA Corp.'s Government Communications Systems division, Camden, N. J., developed and installed E-COM under a $31.8 million contract.

E-COM transfers an electronic message to a tape or a data-storage disk and transmits it to computers at the 25 post offices now in the system by telephone line or telecommunications common carrier. There the message is printed, stuffed in an envelope, and delivered locally via first-class mail within two days, according to the Postal Service.

The Postal Service is preparing for 12 million E-COM messages this year and 70 million annually by 1985. The Justice Department had asked a Federal court to enjoin or delay the system, claiming the Postal Rate Commission had not approved it.

Health agency says CAT scanners are too few, not too many

With one computer-aided tomographic system, or CAT scanner, for every 60,000 people, the National Institutes of Health, Washington, D. C., says that there are too few of the systems, not too many, as charged by some government and citizen groups. In a just-issued report, the NIH says that fears of CAT scanner overuse causing an increase in medical costs were unwarranted. Instead costs have fallen as a result of CAT use, it says.

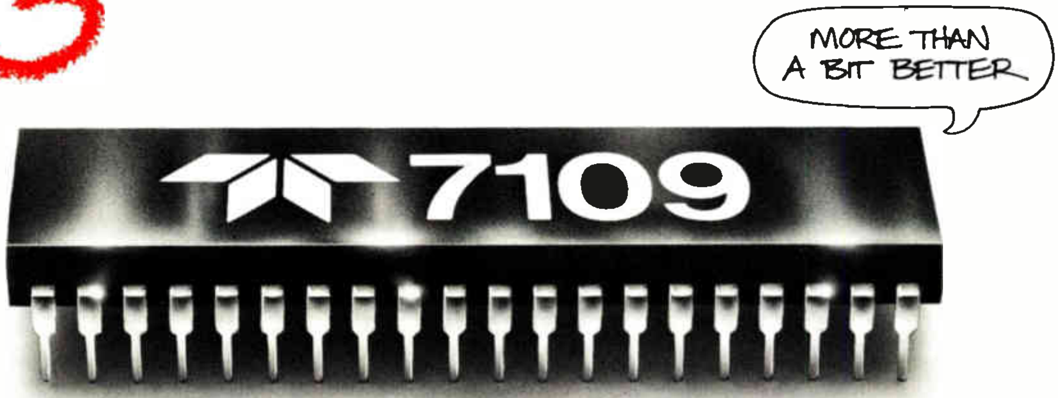
The study also notes that while the CAT scanner market has slowed in recent years largely as a result of restrictive "certificate of need" policies on the part of state governments, the scanners themselves have been refined so that a scan that eight years ago took five minutes now requires only 10 seconds. The NIH's strong stand on the usefulness of CAT systems in the diagnosis of structural diseases such as tumor, head injuries, and brain infections, could help liberalize state certificate-of-need requirements.

Milton Bradley loses heavily to video games

Milton Bradley Co.'s Christmas was bleak, and its New Year looks not much brighter. Its hand-held electronic games, selling for around $40 each, lost out last year to video games, whose greater flexibility evidently outweighed price tags three to four times as high. As a result, analysts think the Springfield, Mass., firm's sales could have sunk below $400 million, whereas in 1980 it grossed $420 million, almost 40% of which was earned by electronic games.

The company's immediate reaction, which was announced Dec. 29, was to sell its 266,000-square-foot Springfield assembly plant to Digital Equipment Corp. for $3 million. The toymaker in addition shut down its still unfinished 20,000-ft^2 facility in St. Lucia, West Indies, which was originally meant to handle the production overflow for what at the time seemed like an endless demand for hand-held games.

The Amazing ~~12~~ 13-Bit ADC



Compared to ADC's using successive approximation, Teledyne Semiconductor's integrating 7109 is truly amazing. Our 12-bit binary ADC not only interfaces directly with your microprocessor or data acquisition system but gives you a 13th sign bit free. So you'll get a lot better resolution when converting bipolar inputs.

Speaking of inputs, the 7109 features high impedance with low leakage current of 1 pA and high sensitivity of 100 μV/LSB. As a result, there's no problem of overloading by your source.

What's more, the 7109 has an auto-zero system that eliminates zero offset adjustments and compensates automatically for drift caused by external components. Also this dual-integrating ADC does away with sample-and-hold amplifiers, along with their inherent inaccuracies.

There's more to relish from the single-chip CMOS 7109. Like internal reference, no missing codes, excellent differential non-linearity, and lower power requirements – only 20 mW.

On the output side, the 7109 provides byte organized 3-state outputs for direct connection to an 8- or 16-bit bus. For simple serial data transmission, a handshake mode allows direct connection to industry-standard UART's.

For more amazing information about the 7109 or our other data conversion products, contact us today. You'll be amazed.

Teledyne Semiconductor, Dept. B 1, 1300 Terra Bella Avenue, Mountain View, CA 94043; phone (415) 968-9241, ext. 241.

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cornea's reflection of the filament of an ordinary incandescent lamp. Focus is maintained by an ultrasonic ranging and focusing arrangement as in Polaroid cameras.

Stares. Words, stored in a bubble memory in the form of compressed and digitized speech, are selected when the camera sees the patient staring at a region for 2 to 3 seconds. Pointers to these words are accumulated until the phrase is complete. The words are fed to the speech-generating subsystem built around a Motorola MC3418 continuously-variable-slope delta modulator-demodulator. Compressed, rather than synthesized, speech is used because Friedman finds his young patients prefer communication that conveys gender and age.

Two systems have been developed. A relatively large teaching unit is built around an Apple II personal computer; a smaller communicator is controlled by a 6502-based Rockwell AIM-65 single-board computer with a built-in printer. Vocabulary—some 5,000 words arranged in a hierarchical branching scheme—is contained in a 256-K magnetic-bubble memory, National Semiconductor's BLC-9250.

Friedman hopes the system could be made commercially to sell for $2,500 to $3,000 and eventually "be as available as motorized wheelchairs." -Jesse J. Leaf

Business

Rockwell tries for commercial markets

After years of supplying microprocessors to toy and home-computer manufacturers and to its internal divisions, Rockwell International Corp.'s Electronic Devices division is broadening its approach to include commercial marketplaces. Although its consumer sales place Rockwell among the leaders as an 8-bit chip supplier, its customer base outside that segment is minuscule.

Yet another. The move into new markets follows yet another of Rockwell's frequent reorganizations, but one that recruits outside personnel familiar with commercial needs, rather than merely reshuffling Rockwell employees. "We had to recruit people who had this background, since our people grew up in the internal market," says Kent W. Black, president of commercial electronics operations, the parent of the devices division.

From now on Device Products, the Anaheim, Calif., segment of the division that makes and markets microprocessors, "will handle internal sales at arms' length," Black says. "One of the mistakes of the past was concentrating on our internal divi-

Helper. By fixing her gaze at displayed words, this handicapped child can communicate using synthesized speech. The personal communicator unit shown is bulkier than necessary, fabricated as it was from off-the-shelf and mostly donated parts.

NATIONAL ANTHEM®

SEMICONDUCTOR NEWS FROM THE PRACTICAL WIZARDS OF SILICON VALLEY

Introducing high-performance memory support.

NATIONAL'S NEW DP8400 FAMILY PROVIDES VERSATILE SINGLE CHIP SOLUTIONS TO ERROR CORRECTION AND DYNAMIC RAM CONTROL.

New opto bargraphs save space and money

Fiber optic link keeps a low profile

The reliability of COPS microcontrollers

Free literature from the tional Archives

Bright new opto products

New general-purpose filter breakthrough

New low-power, high performance μPs

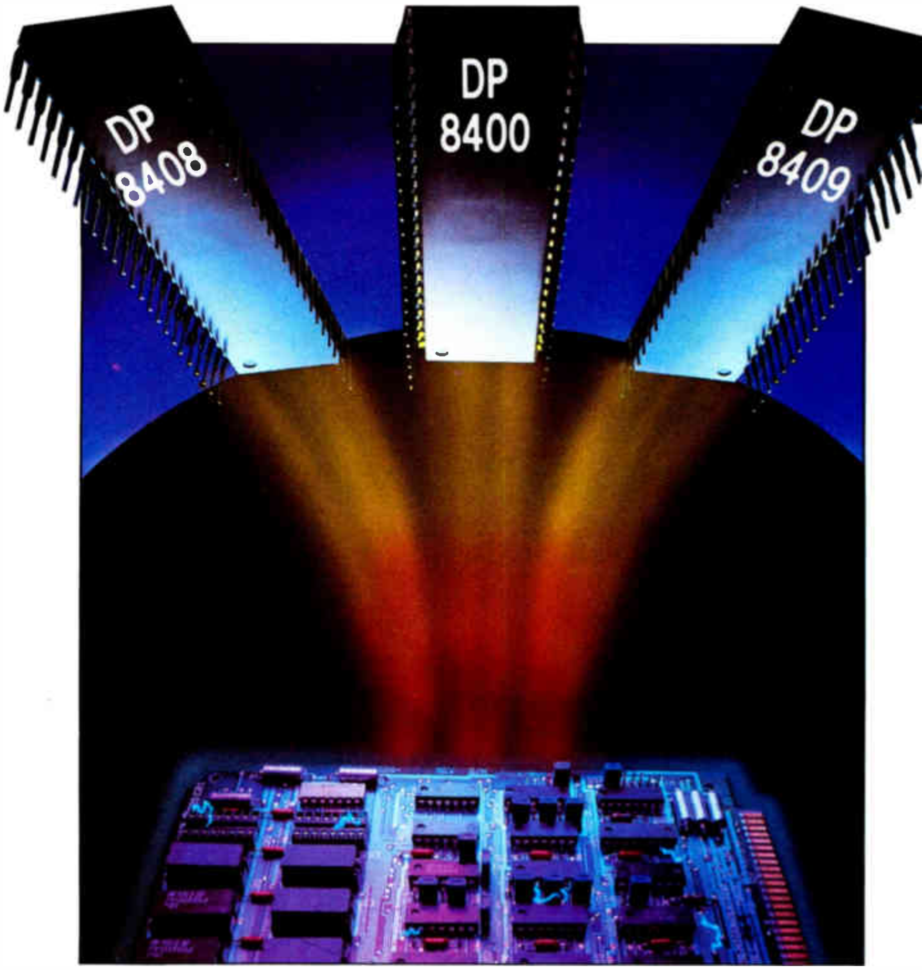
First two-chip approach to high-speed serial datacomm

Digitalker COPS Data Acquisition Logic Transistors Hybrids Linear Interface Fiber Optics RAMS/ROMs/PROMs Transducer Displays Custom Circuits Optoelectronics Memory Systems Microprocessors Microcomputer Systems Board Level Computers Modules Mil/Aero

NATIONAL ANTHEM

The DP8400 Family: a breakthrough in memory support.

A new family of upgradable single-chip memory system support circuits offer faster memory access and a safe way to plan for future growth.



National, the leader in advanced interface circuitry, has just added another industry first to their line.

The DP8400 Family of memory support circuits now offers single-chip solutions for controller/driver and error correction designs.

The growing family currently includes three 48-pin chips: the DP8400 Expandable Error Checker and Corrector (E^2C^2), the DP8408 DRAM controller/driver, and the DP8409 multimode DRAM controller/driver.

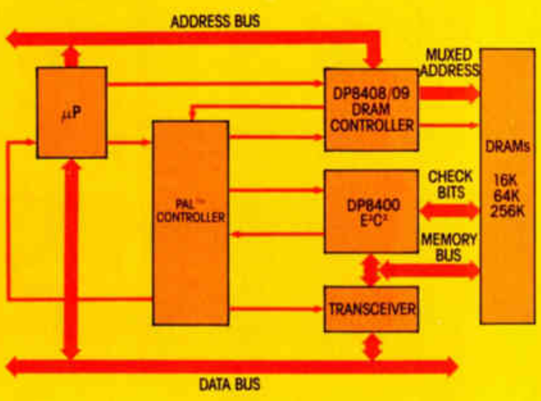
These single-chip circuits offer complete support for memory systems now and far into the future. Because they work with memory devices from 16K to 256K, designers are no longer restricted by the functional limitations of the control and support circuitry. And the flexibility of the E^2C^2 allows upgradeability when combined with future family members.

As memory systems are upgraded to higher and higher densities, one 48-pin memory control socket and one 48-pin error detection/correction socket is all that's ever required for 16-bit systems.

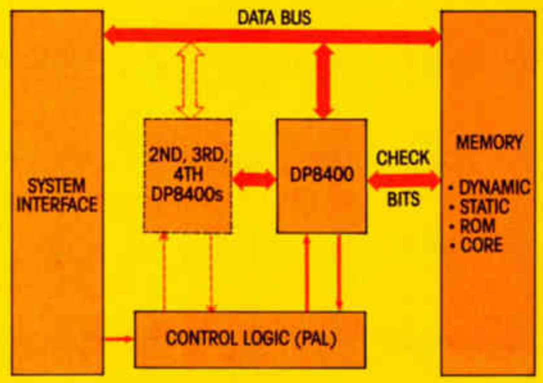
Correcting errors others can't even find. As memory chip densities increase, so do the probabilities of soft and hard errors. Most current error correction systems can catch and correct single bit errors, but will crash a system if confronted by multi-bit errors.

The DP8400 error checker/corrector is

DP8400 FAMILY'S SINGLE-CHIP CONFIGURATIONS GREATLY SIMPLIFY MEMORY SYSTEM DESIGN



THE EASY-TO-USE DP8400 INTERFACES BETWEEN THE SYSTEM PROCESSOR AND MEMORY



EASILY CONTROLLABLE WITH PALs OR DISCRETE LOGIC; EASILY EXPANDABLE FROM 16 TO 32, 48, OR 64 DATA BITS the only single-chip device for detecting and correcting double-bit errors. This provides far higher memory system integrity than any single-bit correction system ever could.

Using a double complement correction routine, the DP8400 can find and correct all single-bit errors and all double-bit errors if at least one of the errors is hard. In the unlikely event of two soft errors in a single memory word, the DP8400 will set a condition flag. Double soft error correction and triple error flagging can be accomplished with the use of two DP8400s and extra check bits.

In addition, the DP8400 includes system byte parity support to detect transmission errors between the system and the memory.

Expanding directly from 16 to 64 bits. The DP8400 can be directly expanded to handle any currently used word size without the use of external circuitry. Two DP8400s are required for 32-bit word lengths, three for 48, and four for 64 bits.

Unique diagnostic capabilities. The DP8400 also includes advanced self-diagnostic features to minimize memory system downtime and enhance system test capabilities.

Error logging applications are easily accommodated, making for faster and easier troubleshooting when problems occur. This also aids in preventive maintenance, since error-logging can be used to pinpoint marginal memory chips.

KEY FEATURES

DP8400

- Fast error detect and correct.
- Double-bit error correct.
- Easily expandable to 16, 32, 48, and 64 bit data words.
- Three error flags provide complete error reporting.
- System byte parity support.
- Full diagnostic capability.
- Alternate sourced.*

DP8408/09

- On-chip capacitive drivers.
- Controls all 16K, 64K, and 256K DRAMs.
- All DRAM control on one chip.
- Automatic access modes.
- Fast throughput times for address and control signals.
- Hidden refresh capability (DP8409).
- External control capability.
- Alternate sourced.*

DP8408/09 controller-drivers combine a 2-to-1 reduction in access time with a 20-to-1 reduction in chip count.

Advanced error detection/correction capabilities are only the beginning of the DP8400 Family story. The DP8408 and DP8409 DRAM controller/drivers offer single-chip memory control features no other circuits can match, including functions that previously required up to 20 ICs.

By using a single LSI controller, propogation delay skews—a major contributing factor in access control "overhead" time—are cut to the bone.

Automatic access mode. To trim the access control time even further, the DP8408/09 also provide an automatic access mode that eliminates the need for external timing and control circuits.

As a result, the memory's $\overline{RAS}$ to $\overline{CAS}$ access control time is an exceptionally fast 70ns. That's half the time required by the fastest multi-chip approach to the problem.

When used with any DRAM (including National's NMC4164), the DP8408 or DP8409—each with capacitive drivers on chip—make a board full of dynamic RAMs appear static to the rest of the system.

Flexible operating modes. Versatility of the DP8408/09 is enhanced by several selectable modes of operation.

The DP8408, which features eight multiplexed address bits to support all 16K and 64K DRAMs, has six modes:

- Externally-controlled refresh.
- Externally-controlled access.
- Auto access for DRAMs with $t_{RAH}<30$ns.
- Faster auto access for DRAMs with $t_{RAH}<20$ns.
- External control of all $\overline{RAS}$ access.
- Set end of count.

The DP8409 (pin-out compatible with the DP8408) features nine multiplexed address bits to support all known 256K dynamic RAMs as well as all 16K and 64K dynamic RAMs. This controller offers a total of nine selectable modes of operation. In addition to those listed above for the DP8408, the DP8409 provides:

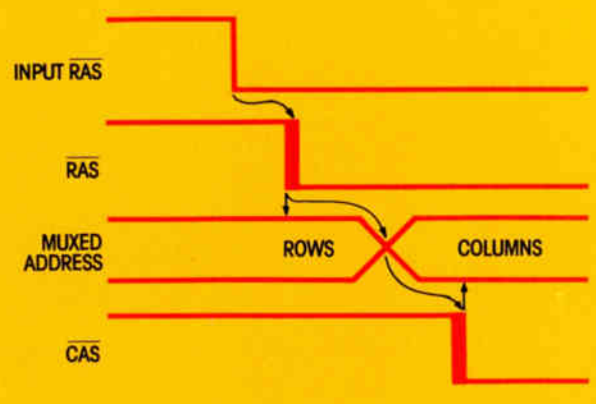
- Auto refresh (either hidden or forced).
- Fast auto burst refresh.
- Auto initialize of all memory locations.

Already alternate-sourced* for faster access. Besides just designing single-chip memory support circuits now and for the future, National has also made sure that the parts will be quickly and easily accessed from local distributors everywhere. Arrangements have already been made for the DP8400, DP8408, and DP8409 to be alternate-sourced.

For complete information on National's new memory support family, check box B8 on this issue's National Archives coupon.

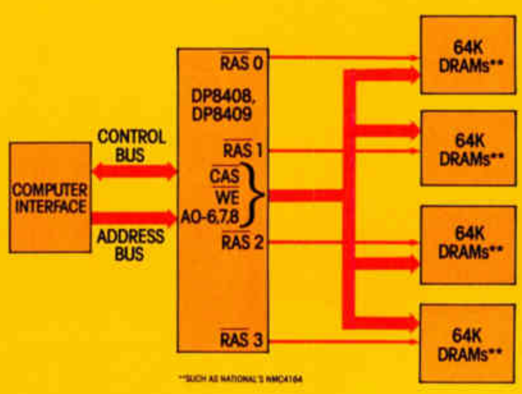
*Alternate-sourced by Monolithic Memories, Inc.
PAL is a trademark of Monolithic Memories, Inc.

DP8408/09 AUTO ACCESS MODES



ONE INPUT SIGNAL INITIATES ALL TIMING AND MAKES DYNAMIC RAMs APPEAR STATIC

MINIMUM CHIP SOLUTION FOR DRAM CONTROL AND DRIVE



CAPACITIVE DRIVE ON-CHIP (UP TO 1000pF)

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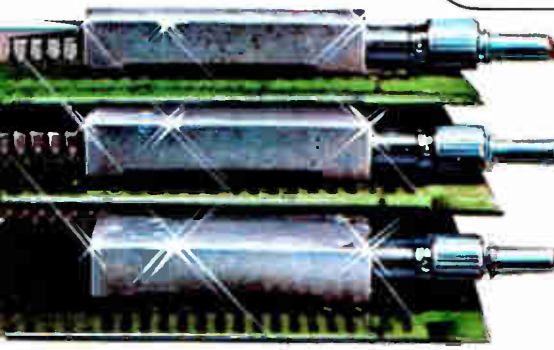


National introduces low profile fiber optic links.

Their new EZLINK™ system with bayonet connectors is slim enough to fit into standard .5″ card cages.

National's new fiber optic data link offers high performance in a very practical package. And features no one else can match.

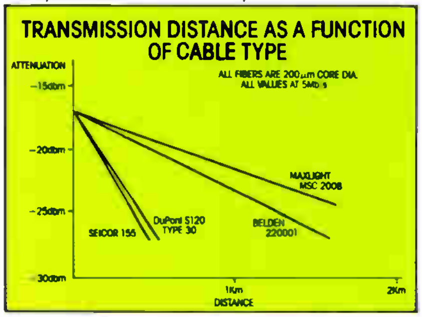
- Transmission speeds up to 10 Mb/s.
- Operates over distances of 2000 meters or more.
- A cast metal housing that ensures noise immunity.
- .3″ maximum package height (including connector) to fit in standard .5″ board spacing.
- Transmits more than 100μW into a 400μm core with a peak emission wavelength of 820nm.
- Receiver is pin-selectable for either speed or sensitivity. Choose 5 Mb/s at 2μW sensitivity or .5 Mb/s at 400nW.
- Quickly attached bayonet connector ensures repeatable low-loss fiber optic coupling.
- Rugged 14-pin DIP package with pin-programmable transmitter and receiver operation.
- Direct interface with TTL or CMOS logic levels.
- Innovative fiber-to-chip attachment makes high volume production possible.
- Joint connector development with Amphenol North America Division ensures a reliable supply of cable and connectors.

Flexible design for easy application. The new system consists of the FOT180B transmitter (housing driver circuitry, light source, and optical port), the FOR100B receiver (with optical port, photodiode, preamp, and comparator), and the optical fiber connecting them.

As the first of National's new family of fiber optic products, the transmitter and receiver feature a new bayonet-type connector jointly developed by National and Amphenol North America to complement the link's low profile metal package.

Connections are simple and secure. The connector is pressed in and twisted to lock in place and will withstand severe vibration.

The system is designed for application in computer mainframes and peripherals, distributed processing, industrial control, as well as any data transmission system that requires exceptional noise immunity.



Glowing Performance. The FOT180B transmits over 100μW into a 400μm core and over 20μW into a 200μm core (or −10dBm and −17dBm, respectively) with a rise time of under 16ns. That provides a data transmission speed of 20Mb per second. Peak emission wavelength is 820nm, optimum for both plastic and glass fibers.

In high-speed mode, the receiver runs at 5Mb/s with only 2μW of power. In high-sensitivity mode, it can run at .5Mb/s with 400nW input. For ultra-low power applications, it's possible to run at 100Kb/s with a mere 30nW, which translates to only −45dBm. And all at a less than 10^{-9} bit error rate.

The link's performance means data can be transmitted over 2Km with a low cost 10dBm fiber cable with just a single 5V power supply.

See the graph for other application options.

High reliability, low noise. The weakest link in optical communication has always been the LED. The FOT180B uses a Gallium Aluminium Arsenide chip doped with Germanium for proven outstanding reliability.

The link's double-walled metal housing shields the transmitter and receiver from EMI, while helping to maintain a noise-free environment around the link itself. As a result, much of the external circuitry normally used to filter EMI can be eliminated.

One-stop shopping. The new link is now available from National and their distributors for only $149.* The entire system includes the transmitter, the receiver, 10 meters of PIFAX™ S120 cable and both connectors required for a complete digital data link. The FOT180B transmitter is priced separately at $42.90* and the FOR100B at $53.90* in 100 piece quantities.

A wide variety of Amphenol™ connectors is also available.

Amphenol Connector Part Numbers

905-143-5001	for 125-micron fiber
905-143-5002	for 140-micron fiber
905-143-5003	for 200-micron fiber
905-143-5004	for 230-micron fiber
905-143-5005	for 400-micron fiber
905-143-5006	for 600-micron fiber
905-143-5007	for 1 mm fiber
905-144-5000	feed-through connector
227-909-2042	polishing tool

For further information, check box C1 on this issue's coupon.

*U.S. prices only

EZLINK is a trademark of National Semiconductor Corporation
Amphenol is a trademark of Amphenol North America Division
PIFAX is a trademark of DuPont Corporation

Conserving power is a National accomplishment.

Here are four new power-saving 8048 μPs, the lowest power, high speed 8048s yet.

In addition to their INS8048 Series of microcomputers, which draw half of the power of standard 8048s, National is now producing four new ultra-low power, high speed microcomputers, expanding their broad line of μPs.

National has always been strongly committed to low power designs—as in their P²CMOS™ and NSC800 family, rapidly becoming the low power family. But now they've gone still another step further and produced four new 8048 series μPs that offer the speed of the standard 8048 at ⅓ the power.

Meet the new family. National's new introductions include:

- INS8048L Series—the 8048L, 8049L and the 8050L offering the speed of the standard 8048 Series at ⅓ the power.
- NS80C48—still at the same speed, this P²CMOS part consumes only ¼ the power of the INS8048L (less than 1/13 the power of the industry standard 8048).
- NS80CX48—features the same specs and P²CMOS process as the NS80C48, but includes special power-down and timer/counter operations.

  It incorporates an "Extra Features" mode that allows software control of its power consumption. It's highest power consumption is equivalent to that of the NS80C48 and goes down from there, made possible by a special "Features Control Register."

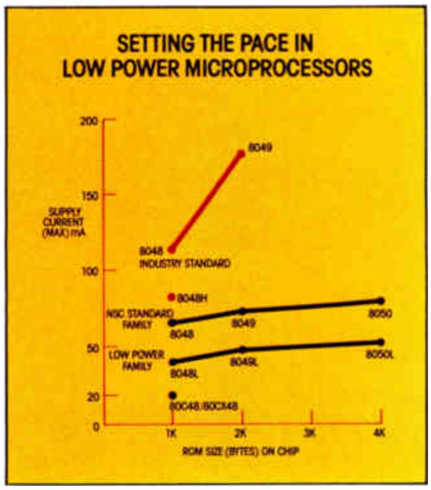
  Any NSC800 peripheral will interface easily with the NS80CX48 for more ROM, I/O and timer capability.
- NS87P50—"piggy-back" prototype XMOS™ μP for the INS8048L Series, NS80C48 and other 48 Series members, at both 6 and 11 MHz clock speeds, and memory sizes from 1K to 4K bytes.

In addition to being pin-compatible with the popular NMOS 8048s, these new devices all incorporate the same architecture.

Low power pays off. With National's new line of μPs, it's possible to get the pay-off while increasing performance.

For example, systems designed with low power circuits can be physically smaller. Power supplies, fans and cooling systems can be reduced or eliminated. PC boards can be designed for more dense configurations. And of course, low power systems are more reliable.

STARPLEX II™ with ISE™ for the 8048s. STARPLEX II, National's highly interactive development system, supports and speeds the overall 8048 development effort.



With ISE (In-System-Emulator), engineers can develop, test, analyze and debug prototype software and hardware for any 8048 μP.

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For more information on these new power-saving μPs, check box C2 on this Anthem's coupon.

It could put you in a high powered position for low powered applications.

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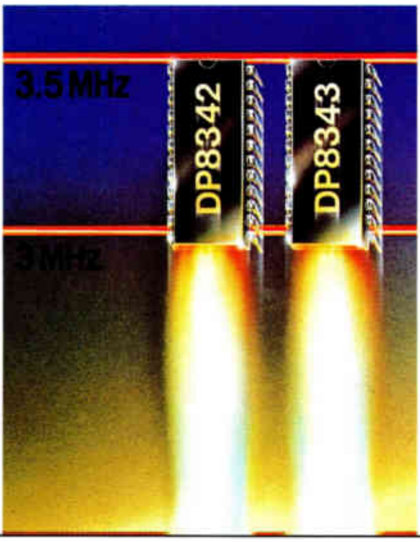
NATIONAL ANTHEM

The best rates in the industry for high speed serial data communications.

Give system throughput a boost with the industry's first two-chip approach to 3.5MHz data rates.

One of the largest single limiting factors to system throughput is the data wait: the time spent on data transmission between various portions of the system.

The Practical Wizards have solved this and several other problems with only two 24-pin chips—the DP8342 transmitter/encoder and the DP8343 receiver/decoder.



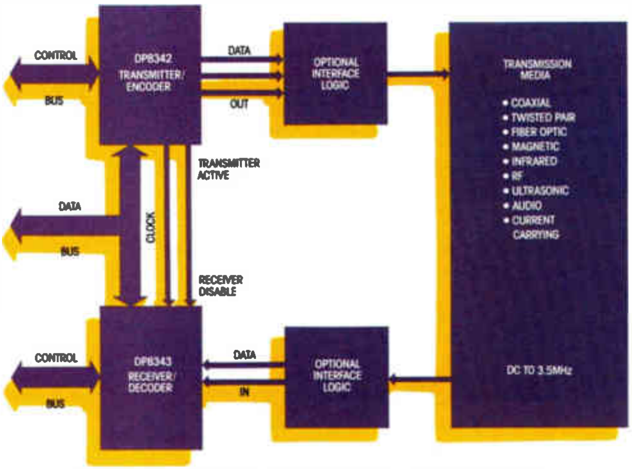
These two digital interface devices allow data bit rates (8-bit data words) up to a wait-reducing 3.5MHz using bi-phase Manchester encoding.

Lower hardware costs. Until now, this kind of performance has only been achieved with 40 or so SSI/MSI components. This fact alone results in significant savings in terms of board space and component costs.

But there's more to the cost story than just chip count. The DP8342/43 combination allows high speed serial data buses to be used rather than the more expensive parallel buses.

So, by adding the appropriate optional line interface circuitry, the DP8342/43 can be used with a wide variety of media, including coaxial, twisted pair, fiber optic, magnetic, infrared, RF, ultrasonic, audio, and current carrying.

Greater data integrity over longer distances. These new devices not only enhance data rates, they also enhance data integrity and permit longer transmission lines.



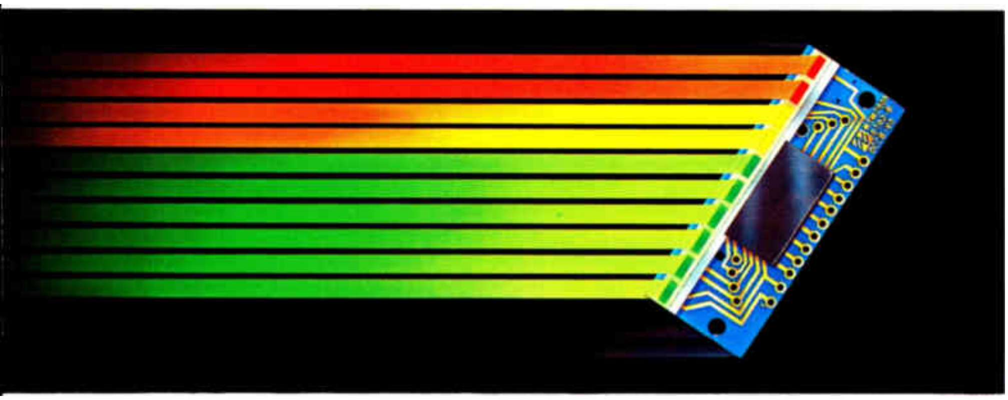
DP8342/DP8343 APPLICATION VERSATILITY

One reason for this is a digital phase-locked loop in the DP8343 receiver/decoder that automatically adjusts the receive window. As a result, it provides excellent data recovery over wide frequency variations.

For complete details on these remarkable new interface components, simply check box B7 on this issue's coupon.

It's the easy way to start losing wait in all the right places.

National is first to put chips on display.



Analog displays are receiving a 25% reduction in design-in cost with the first LED displays to incorporate an on-board driver IC.

Now engineers designing analog instruments such as panel meters, temperature control systems, thermometers and speedometers can save space and increase instrument reliability with National's integrated bargraph displays.

Rugged reliability, curtailed costs. Due to their single-unit construction, the NSM3900 LEDs are considerably more reliable and resistant to shock than the traditional separate driver/display models.

Their NSM3900 Series of bargraph displays combines a 10-element linear array with a monolithic driver circuit on-board. As a single, self-contained driver/display unit it measures only 2" x .85."

The advantage of single-unit construction also provides significant reductions—up to 25%—in stocking and development costs.

Further, mounting costs are reduced to a minimum by eliminating the task of separate driver/display PC board assembly.

Practical versatility for unlimited applications. The NSM3900 Series bargraphs are end-stackable and can be cascaded to 10 arrays (100 bargraph elements).

What's more, they're available in all combinations of red, yellow and green.

Versions of each color are available for linear, logarithmic or VU meter functions. The choice of bar or dot mode is externally selectable by the user.

More from the Linear Leaders. In addition, National also offers 7-segment LED displays with serial data input—the NSM4000 Series—also in red, yellow and green.

All with the Linear Leaders' drive chip on display.

For more information on the NSM3900 Series bargraph displays, check box B4 on this Anthem's coupon.

Yet another first in reliability and savings from the Practical Wizards.

MF10: A filter for everything for next to nothing.

The first monolithic, general-purpose dual active filter using switch-capacitor technology will revolutionize the way engineers use filters.

A low-cost, monolithic, CMOS active filter that can perform a wide variety of functions and requires no external capacitors to operate may sound like an impossible dream, but thanks to National's linear leadership, the new MF10 has all those attributes and more.

It's a revolution in filters that greatly simplifies the design of all filter applications. At a cost that most conventional filters will find hard to match.

Clock-tuning simplifies frequency adjustments. All other active filters must have their center frequencies tuned with external resistors and capacitors, a lengthy and delicate procedure which must be performed in assembly and during replacement or repair.

The MF10 eliminates this headache with a unique design concept that sets the center frequencies of various second-order functions directly proportional to an external clock frequency within an accuracy of 0.6%.

This design minimizes frequency tuning, since the complicated resistor/capacitor interrelationship is eliminated. Once the clock frequency is set, no further tuning is needed. Gain and filter selectivity (Q) are determined with external resistors.

Improved frequency stability. The MF10 has unprecedented frequency stability. Since the only necessary external components are the clock and three to four resistors (depending on the application), the MF10 is far less sensitive to external component variation than conventional filters. So the need for costly retuning is all but eliminated.

The stability and repeatability of the center filter frequency in the MF10 is directly dependent on the quality of the clock. In addition, the design allows one clock to drive an unlimited number of cascaded MF10s.

A filter for all applications. Most monolithic filters are single purpose. The MF10 is general purpose, capable of performing a wide variety of functions: allpass, lowpass, highpass, bandpass, and notch up to 20kHz with a Q as high as 500.

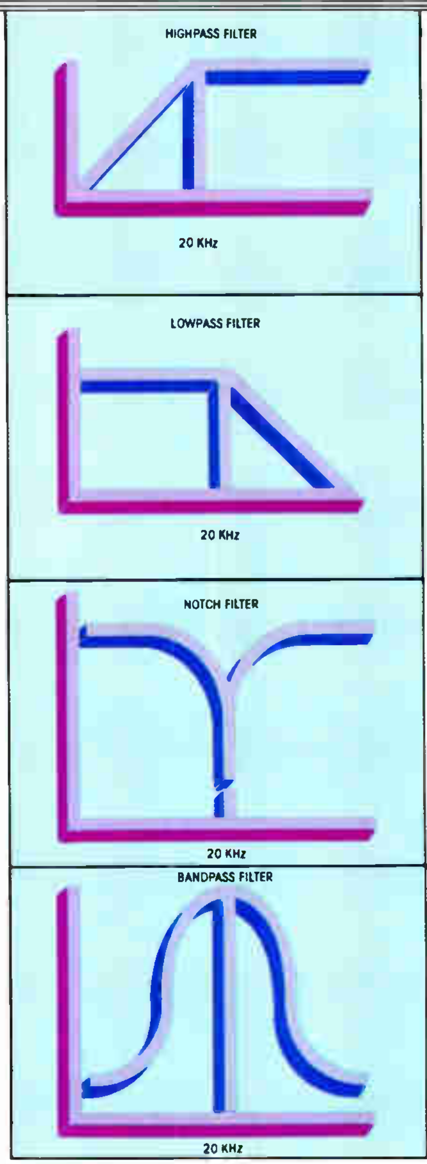
Typically, the lowpass and bandpass outputs can sink .75mA and source 3mA. Other functions can sink 1.5mA and source 3mA.

Built into the MF10 are two independent filters. Both are second-order building blocks which can perform all classical filter functions. Functions up to fourth-order and filter configurations such as Butterworth, Bessel, Cauer, and Chebyshev can be performed easily by cascading the two second-order building blocks.

Low cost, immediate availability. The MF10 is not only a breakthrough in circuit design, but also a breakthrough in cost. There is simply nothing on the market today that can match it for price and performance. The filter is available in a 20-pin (.3" wide) plastic package at a cost of $3.70* in quantities of 100 and up. Delivery is from stock, so waiting time is next to nothing.

For more information on National's filter breakthrough, check box B9 on this issue's coupon.

*U.S. prices only



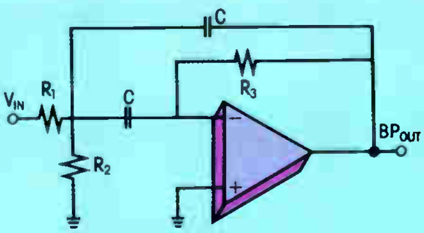
With the MF10, only 3 or 4 resistors and a clock are required to build filters with a frequency response of up to 20kHz. The characteristic frequencies shown above can be programmed by varying the clock frequency and/or by varying an external resistor.

Active filter design made easy.

Designing a simple bandpass filter with the new, monolithic MF10 is far easier than the conventional discrete R, C design.

Compare the complicated interrelation of R and C values in the discrete design with the simplicity of the calculations for Q, bandpass gain, and center frequency using one-half of the MF10.

DISCRETE R, C, ACTIVE BP FILTER

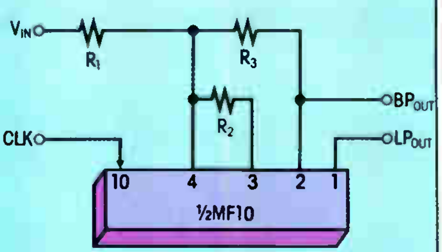


$$R_1 = \frac{Q}{H_{0BP}\,\omega_0 C}$$

$$R_2 = \frac{Q}{\omega_0 C(2Q^2 - H_{0BP})}$$

$$R_3 = \frac{2Q}{\omega_0 C}$$

MONOLITHIC MF10 ACTIVE BP FILTER



$$\frac{R_3}{R_2} = Q$$

$$f_0 = \frac{\omega_0}{2\pi} \approx \frac{f_{CLK}}{100} \text{ or } \frac{f_{CLK}}{50}$$

$$\frac{R_3}{R_1} = H_{0BP} \text{ (bandpass gain)}$$

An illuminating display of quality and reliability.

Three bright new products demonstrate National's commitment to the optoelectronics market.

National has announced three new additions to its already broad line of opto products: their 5082-76XX Series and 5082-77XX Series of standard .43" seven-segment numeric displays, their 5082-4X5X Series of T-1¾ standard profile lamps, and their 5082-4X9X Series of T-1¾ low profile lamps.

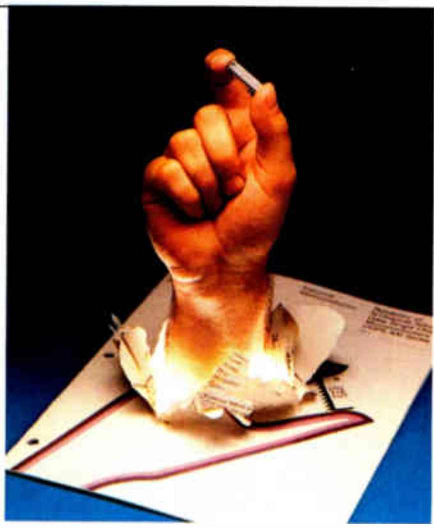
The kind of manufacturing efficiencies suppliers have come to expect from National have made it possible to price the new products substantially lower than the competitive components they replace, while improving their quality.

The units feature higher efficiency dice for brighter output in green, yellow, standard red, and high-efficiency red. Rigid terminal pins on the .43" digits practically eliminate lead bending or breakage during insertion. The numeric display has significantly better output, due to reduced segment-to-segment crosstalk.

All three new products, as well as the rest of National's opto product line, are available for immediate delivery. Customers seeking enlightenment can get free samples from their regular opto rep or distributor.

For details, check box C0 on this issue's coupon.

Test results show COPS reliability can't be beat.



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National's brochure on the NMOS COPS Family members tells the whole reliability story, starting with the fabrication process, giving complete test descriptions and results.

It details, for instance, operating life test results and temperature and humidity biased tests. It also covers COPS temperature cycling and "pressure cooker," or autoclave, results. It also includes a summary table that displays all of the results for easy referencing.

To receive a copy, just check box B6 on the Anthem coupon below.

It's free for the asking from the Practical Wizards of Silicon Valley. They're making higher reliability an industry standard.

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What's new from the National Archives?

- 52 ☐ Data Update—Latest New Product Information
- 84 ☐ NSM3900 Series Bargraph Data Sheets
- B6 ☐ COPS Family Reliability Brochure
- B7 ☐ DP8342/43 Data Sheets
- B8 ☐ DP8400 and DP8408/09 Data Sheets
- B9 ☐ MF10 Data Sheet
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NA 37

sions' needs. We have missed the boat in some respects."

Skeptics point out that Rockwell has often before changed its thrust, only to take yet another tack shortly thereafter. Even internal sources acknowledge that reputation. "Rockwell's been quite schizophrenic in the past," says an employee involved in the latest moves.

Focus. Shipments to firms such as Apple Computer and Atari of one million units per quarter put Rockwell in a four-way fight for leadership in microprocessor sales with Zilog, Commodore, and Synertek, according to Dataquest Inc. of Cupertino, Calif. The firm now plans to build on that base by focusing on equipment for communications and the office of the future.

Rockwell will aim at the high end of the 8-bit market and emphasize the ease of moving from the 8-bit 6500 to the 16-bit 68000, due to the software and hardware compatibility of the products, says Howard Cotterman, who was recruited from Intel last year to become general manager of Device Products.

Rockwell is gearing up with a 40% increase in its product marketing staff. Device Products is also doubling its applications engineering staff to help devise new markets for the products and assist customers. In Europe, also, the new emphasis will rely heavily on Rockwell's existing 6500 line and the second sourcing of Motorola's 16-bit 68000.

Production. "Our image is not to be at the leading edge in architecture or instruction sets. What we're looking at here is leadership in production of the 6500 and 68000," Cotterman notes.

To improve its chances in the new markets, Rockwell will add 22 new microcomputer products this year. These will feature different capabilities and memory capacities and will target the graphics, data communications, and discrete digital display needs of communications and office automation markets. The firm will also formally open a new design center in San Diego later this month. "They seem committed," says Ken McKenzie, senior analyst at Dataquest. "Rockwell knows the steps to take, but it's very expensive and takes a lot of training. If they take the approach they used in high-volume sales of the 6500, it could be very interesting." **-Terry Costlow**

Communications

AT&T awaits out-of-court deal

An out-of-court settlement before the conclusion of its Federal antitrust trial at the end of January is clearly the course favored now by American Telephone & Telegraph Co. Such a settlement is seen as far less risky to the company than the expected court judgment that AT&T violated antitrust laws by using both its technological expertise and economic clout to unfairly prevent competition and monopolize U. S. telecommunications.

Attention. With a settlement, however harsh, in hand, AT&T could then turn its full attention to cajoling the lower house of Congress to deregulate U. S. telecommunications in ways that would favor the company's position. "I think AT&T would prefer the congressional frying pan to the court's fire," says one top member of the Washington telecommunications legal community.

Lobbyists and lawyers for AT&T's competitors agree with the view, but want to see the settlement terms before going further. "If it requires AT&T to spin off part or all of Western Electric, for example, and requires AT&T's local phone companies to buy via competitive bidding, that would suit our members fine," says one trade-association counsel. "If it is weaker than that—and it may well be—or if AT&T tries to change that legislatively, we'll have to fight like hell on the Hill." Any settlement with the Department of Justice still must be accepted by Judge Harold H. Greene of the U. S. District Court in Washington.

"AT&T is fighting hard, but also running a bit scared," says another source, commenting on the settle-

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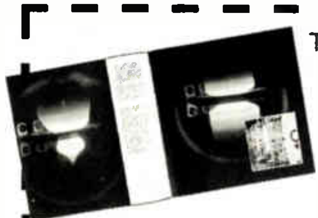

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ment negotiations disclosed on Dec. 31 by William F. Baxter, assistant attorney general for antitrust on the AT&T suit. He is seen as taking a hard line in the negotiations. Divestiture of some AT&T segments or, at the least, a requirement that any new subsidiaries hold some stock outside AT&T so that separate financial reports would be indicated, are reportedly among Baxter's demands. Separate financial reports are regarded as one means of preventing AT&T's subsidization of its subsidiary ventures.

The antitrust suit embraces a wide range of charges, beyond AT&T's having monopolized U. S. telecommunications unfairly. The company clearly is now under pressure, in the form of:

■ Judge Greene's hard line during the ongoing trial and his determination to complete the court proceedings by the end of this month. Last September, for example, Greene wrote that the prosecution had demonstrated "that the Bell System has violated the antitrust laws in a number of ways over a lengthy period" [*Electronics*, Sept. 22, 1981, p. 46].

■ The threat of new private antitrust suits by AT&T competitors if the company is judged guilty by Greene, plus the need for AT&T to husband its resources and set a policy to meet competition in new markets from such corporate giants as Exxon, IBM, and Xerox.

■ Hearings now set for February in the House on new telecommunications deregulation legislation before Rep. Timothy E. Wirth (D., Colo.), chairman of the energy and commerce subcommittee on telecommunications, consumer protection, and finance. The so-called Wirth Bill asks far more stringent controls on AT&T than the Senate-passed S. 898 [*Electronics*, Oct. 20, 1981, p. 59].

Any significant breakup of AT&T has been strongly opposed by the departments of Commerce and Defense on the respective grounds of weakening the U. S. in expanding overseas telecommunications trade and damaging the nation's security in its dependence on Bell System facilities. **-Ray Connolly**

Standard Microsystems announces the first 25 MHz Video Display Controller.

Standard Microsystems made headlines when we put all the complex circuitry for a CRT video display on just two chips.

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The CRT 8002H operates at 25 megahertz over the entire temperature range from 0° C to 70° C. The 25 MHz operating speed makes possible the low-cost display of a full 132 characters, rather than 80 characters, *an outstanding 65% improvement.*

The CRT 8002H is the *first* commercially-available MOS/VLSI circuit which employs a metal silicide to replace doped polycrystalline silicon in silicon-gate MOS integrated circuits.

Standard Microsystems' use of its proprietary new COPLAMOS® Titanium Disilicide — Gate technology has resulted in a reduction in the sheet resistivity of the polycrystalline silicon layer *by a factor of 20 to 50 times* with a corresponding reduction in internal RC time constants.

Thus, the CRT 8002H provides a high-density character generator, field and character attributes generator, and video shift register with far greater information capacity than any other MOS/VLSI device on the market.

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SCIENCE/SCOPE

A new adaptive radar, using technology that could be applied in the future to many different weapon control systems, has completed feasibility tests. The radar, called FLEXAR (Flexible Adaptive Radar), uses a multimode transmitter and a programmable signal processor that are now in production, plus a new lightweight, low-cost electronically-scanned antenna. The antenna rotates once each second while the beam electronically scans up and down and back and forth. Waveforms are selected automatically to match the environment. Such flexibility enables the radar to adapt its waveform beamwidth and scan rate as needed to acquire and track targets. Hughes developed FLEXAR for the U.S. Navy.

A series of lightweight millimeter-wave parabolic dish antennas has been introduced by Hughes. The antennas, designated the 4581xH series, are made with a special aluminum and glass laminate. They are available in eight waveguide bands between 26.5 and 170 GHz and in six different sizes. The smallest, a 4-inch diameter dish, incorporates a prime focus feed. The others, in sizes of 10, 12, 18, 24, and 36 inches, use a Cassegrain feed. All are designed for low sidelobe performance. A typical weight is 7.5 pounds for the 12-inch model.

Satellite pictures are helping geologists understand major features around the world, including continental plates. Images from NASA's Landsat spacecraft, along with earthquake data, have given tectonics specialists insight into the relative motions of the Indian subcontinent and Eurasia. Scientists previously thought that one earthquake-prone crustal deformation was confined to a long, narrow zone -- the result of the Indian plate thrusting under Eurasia. Landsat images, however, revealed landforms that indicate the deformation extends over a large area quite similar to California's San Andreas fault. This interpretation also helps explain why earthquakes occur throughout Asia. The "cameras" on the Landsat spacecraft, called multispectral scanners, were built by Hughes.

Hughes Industrial Electronics Group offers the advantages and opportunities of a small company backed by the resources of a $2-billion company. Our facilities are in the Southern California communities of Carlsbad, Irvine, Newport Beach, Torrance, and Sylmar. Our programs incorporate 34 different technologies. They include silicon and GaAs semiconductor technologies, fiber optics, microwave and millimeter-wave communications, microprocessors, lasers, and solar cells. Send resume to B.E. Price, Hughes Industrial Electronics Group, Professional Employment, Dept. SE, P.O. Box 2999, Torrance, CA 90509. Equal opportunity employer.

A new solid-state millimeter-wave sweep generator covers the entire W-band from 75 GHz to 110 GHz. The unit, designated Model 47726H, plugs into the Hewlett-Packard 8620C main frame or the new H-P 8350A main frame with high-resolution digital displays. Like other Hughes sweepers, it consists of a full-band sweep source, leveling loop, and a full-band sweep plug-in. An automatic feature allows the user to select the frequency spans of interest directly on the 8350A.

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Military-spending record totaling $215.8 billion sought by Reagan . . .

Proposed U. S. military outlays will climb to a record $215.8 billion in the fiscal 1983 budget to be delivered to Congress on Feb. 8, with electronics accounting for over 12%. Total outlays, or funds actually spent in the fiscal year beginning next October, are proposed to climb about 18% from this year's level, say knowledgeable officials. **Much of that will be eaten up by pay increases and facilities construction.** The total obligations in the first Defense Department budget prepared from scratch by the Reagan Administration will be $245 billion, up 15% from this year's record. New ship starts, including two nuclear carriers and two attack-class and one missile-launching nuclear submarines, will take a large share of the new weapons spending. But no big program cancellations are proposed, except for the Lockheed P-3C antisubmarine warfare plane.

. . . NASA outlays flat; Venus mission killed and Galileo slowed

National Aeronautics and Space Administration outlays proposed for fiscal 1983 will rise by a small margin above the $4.89 billion scheduled for this fiscal year, say Government sources. After inflation, outlays will remain flat. One program killed in the new Reagan budget is the $150 million Venus-orbiting imaging-radar (VOIR) spacecraft set for a 1988 launch and now in development competition by Hughes Aircraft Co., Los Angeles, and Martin Marietta Aerospace, Denver [*Electronics*, Aug. 11, 1981, p. 49]. **However, pressure from space-exploration advocates has reportedly saved the Galileo program, which will fly by Jupiter.** The Galileo compromise, say insiders, calls for the 1985 launch to use a conventional upper-stage engine, rather than the high-energy Centaur, whose development will be canceled. That action means it will take Galileo four years to reach Jupiter instead of the proposed two. Citing the resultant increase's effects on in-flight reliability, one agency official called the slowdown "a false economy." Also killed is the 1986 U. S. mission to examine Halley's Comet as it flies around the sun. Aeronautics research and development will also decline.

Industry questions FAA's plans for collision avoidance

Avionics and aircraft suppliers and users still have reservations about TCAS I and TCAS II—the new traffic-alert and collision-avoidance systems under consideration by the Federal Aviation Administration. Prior to a Washington briefing on TCAS, **developers and users expressed concern that system and hardware developments are still not sufficiently mature.** Further reservations by members of the Airlines Electronic Engineering Committee, which drafts commercial avionics specifications, are whether the TCAS II hardware that may be approved for new-generation airplanes—the Airbus Industrie A-310 and the Boeing B757 and 767—can be retrofitted into the smaller avionics spaces of existing fleets.

SBS international plan open to challenge

Watch for a challenge before the Federal Communications Commission that will slow the Satellite Business Systems Inc. proposal that it become an international carrier. **The McLean, Va., company will need that approval to implement its January deal with British Telecom** (see p. 71) for joint provision of transatlantic services, including digital high-speed data, facsimile, and video teleconferencing. Competing international carriers, including American Telephone & Telegraph Co., are certain to object to the plan, say FCC officials.

Washington commentary

NASA and NSF: luxuries or necessities?

The New Year began on a sour note for members of the American Association for the Advancement of Science when President Reagan's science adviser delivered the keynote address of their annual meeting. "The idea that we [the U. S.] can't be first across the spectrum of science and technology is not simply a function of our current economic situation," George Keyworth asserted in Washington, D. C., on Jan. 3. The U. S. can no longer afford the luxury of continuing to fund "less productive research areas," he said.

Keyworth's views rattled many at the meeting who were hearing them from him for the first time. Yet they represented nothing new from the nuclear-weapons physicist, who was named head of the White House Office of Science and Technology Policy in mid-1981.

Priorities and biases

What was sobering to some of Washington's congressional leaders, however, were two aspects of Keyworth's remarks. As one senior Senate staff member put it after the speech, "he's warning the [research and development] community to be ready for some big budget cuts" when the Reagan program for fiscal 1983 goes to Capitol Hill late this month. The second concern, raised simultaneously by many AAAS members, was Keyworth's failure to define "less productive research." In the past he has faulted National Aeronautics and Space Administration planetary programs and a variety of efforts by the National Science Foundation. On the other hand, he is a strong advocate of increased military R&D. What is productive or unproductive research is often a matter of judgment that is affected by an official's professional bias—which the science adviser to the President continues to demonstrate.

Keyworth's biases—coupled with widespread reports that the Office of Management and Budget has NASA planetary programs and new R&D starts near the top of its fiscal 1983 hit list—is prompting a number of pro-science and education legislators to try to go around Keyworth directly to the President.

Among them is Sen. Harrison Schmitt (R., N. M.). In mid-December, the former astronaut, who is now chairman of the science, technology, and space subcommittee, wrote Edwin Meese, counselor to the President, expressing concern about "apparent misunderstandings or misconceptions in the Administration about science and technology." After lauding reports that Keyworth's office would get a Science Advisory Board made up of top U. S. academic and industrial leaders, the senator went on to make his case for salvaging NASA and its technological efforts in a most politic manner.

America's "critical advantages in economic competitiveness and national security have been our superior capabilities for discovery and innovation along with corresponding abilities for realizing new and competitive goods and services," Schmitt wrote. "These advantages, which are now being aggressively challenged by competitors, can no longer be taken for granted" by the White House. Failure to make a long-term Federal investment in the nation's research and technology base "threatens the future of our economic stability and national security and specifically threatens the President's economic recovery program."

In an obvious allusion to the disdain of Keyworth and OMB for planetary exploration, Schmitt told Meese that "this extraordinary effort cannot be simply regarded as an extraneous program to be tossed aside in times of economic strife." Space exploration's technology base "has both direct and indirect impact on our national security," the senator observed, citing the defense contributions of NASA spacecraft guidance and control systems, self-contained automatic control capabilities, and system radiation hardening.

More than motherhood

The long letter by Schmitt—whose pre-lunar landing accomplishments include a Harvard doctorate in geology, teaching fellowships from Harvard and the NSF, and a Fulbright scholarship—also addresses the alarming national "shortfall or maldistribution of skilled scientific and technical manpower," as well as the U. S. decline in science and mathematics education at the primary and secondary levels. "These related problems certainly will not be positively addressed by the cancellation of educational opportunities that are created by basic research and other NSF science education activities."

Any response to Schmitt by White House counselor Meese is not yet on the record. It is to be hoped that Meese's view was not reflected in science adviser Keyworth's subsequent shrug to the AAAS that the U. S. must recognize and live with "the fact" that "the rest of the world is catching up." If that is the view of President Reagan's principal science adviser, then the country, as well as the Administration, is in trouble.

-Ray Connolly

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Japan advances on supercomputer . . .

Japan is moving a step closer to building the world's fastest scientific computer [*Electronics*, Aug. 14, 1980, p. 65]. Research on the supercomputer has been funded by the Ministry of Finance for almost $3.8 million in the budget for the fiscal year starting April 1. **Approval by the Japanese parliament is considered certain.** Of the sum, $3.2 million will be divided among six computer manufacturers for contract research, while the government's electrotechnical laboratory will get the remainder. A new industry association will administer the project and give initial contracts to the individual companies sometime this month.

. . . six firms to share work

For the supercomputer, it is expected that all six firms—Fujitsu Ltd., Nippon Electric Co., Hitachi Ltd., Toshiba Corp., Mitsubishi Electric Corp., and Oki Electric Industry Co.—will do research on parallel processing. Concurrently, research will be carried out on three types of devices: Fujitsu, NEC, and Hitachi will work on Josephson-junction devices; **Fujitsu and Oki will work on high-electron-mobility transistors;** and NEC, Hitachi, Toshiba, and Mitsubishi will work on high-speed gallium arsenide field-effect-transistor devices. Total budget for the project is expected to be about $92 million to $138 million over a nine-year period.

Western Union adding Teletex service

Adopting a European-pioneered communications service, Western Union Telegraph Co. is expanding beyond Telex traffic to add Teletex, a Telex-compatible service that links directly to electronic typewriters and word processors and permits text communications at 2.4 kb/s [*Electronics*, April 7, 1981, p. 101]. To handle Teletex, Western Union is buying another EDS (electronic data switching) system from Siemens AG, to be installed at a Western Union facility in New York this year. **The system is part of a $6 million order that also includes the expansion of three existing EDS switches in the U.S.**—two in New York and one in Los Angeles. In total, the order calls for about 5,800 lines for the four switches, of which 640 lines will initially be set aside for Teletex. Trial runs between Western Union and the German post office will start some time during the first six months of this year.

SBS extending services to Britain

Satellite Business Systems and British Telecom have announced plans for an advanced transatlantic communications service providing teleconferencing, high-speed data transmission, electronic mail, facsimile, and other services. The transatlantic hop between British Telecom's fast-expanding digital network and SBS's half-billion dollar domestic satellite network **will be via existing Intelsat facilities, initially at 56 kb/s and subsequently at 1.5 Mb/s per channel.** SBS, jointly owned by IBM, Aetna Life & Casualty, and Comsat General Corp., will apply to the Federal Communications Commission for permission to operate as a licensed international carrier (see p. 63) and for a trans-Pacific link. British Telecom is well-placed to extend SBS's wideband digital service through its comparable terrestrial X Stream service [*Electronics*, Dec. 29, p. 54], which provides leased lines capable of sending up to 2 Mb/s as well as a packet-switched service. Beginning in late 1983, it will offer a European business service beaming traffic to small rooftop antennas via the European communications satellite and France's Telecom 1.

International newsletter

Europe to get digital audio disks by year's end

Watch for Philips to introduce its compact digital audio disk on the European market towards the end of 1982 at a price of around $600 to $800. To date, about 29 audio equipment manufacturers in Europe and the Far East—among them Bang & Olufsen, Grundig, Akai, Hitachi, and Matsushita—have taken out licenses to build the system **in which digitally encoded and laser-read audio signals are stored on a compact 11.5-cm disk.** Philips, which collaborated with Sony on the development, expects to have some 200 record titles available at launch and to add a further 300 during 1983. The Dutch group has also had success in promoting a standard on miniature video cassettes used in portable video cameras, reaching agreement with Sony and Matsushita. It hopes this could also lead to standardization of larger video cassettes.

Telefunken enhances presence in China

In a move to strengthen its position in the Chinese market, West Germany's AEG-Telefunken plans to set up a joint venture with Hong Kong–based Sun Hung Kai Ltd. that will serve as a basis for doing business with the Peoples' Republic of China. Operating out of Hong Kong with branch offices in Peking, Canton, and Shanghai, the new company will supply conventional electromechanical components and control systems to industrial plants in China. **Beyond that, the two companies are eyeing a second joint venture, this one with China as a one-third partner.** That firm would manufacture electronic typewriters and word processors for the Chinese market, using know-how supplied by AEG-Telefunken's office equipment subsidiary, Olympia Werke AG. Frankfurt-based Telefunken is an old hand at trading with China—recent deals involved the delivery of color television parts and electronic typewriters.

Fujitsu developing TV conference system

Fujitsu Ltd. is using itself as a guinea pig to develop a television conference system that it hopes eventually to put on the market. Its first installation, next autumn, will keep workers at its system laboratory in Tokyo in touch with 1,000 software engineers scheduled to be transferred from there to a computer plant in Numazu. **Three more facilities will be added to the network by the end of 1983.** The installations will include TV, a conference audio system for communication, an electronic blackboard, and a facsimile machine for transfer of hard copy.

Addenda

As expected, Victor Company of Japan Ltd. has signed with Thorn-EMI and AEG-Telefunken to **form a joint company to manufacture consumer video products in Europe** [*Electronics*, Nov. 30, p. 55]. The as-yet unnamed company will be incorporated in the Netherlands with manufacturing subsidiaries in England and West Berlin. . . . Fairchild Camera & Instrument Corp. of Mountain View, Calif., is putting up **a $9 million semiconductor production facility in West Germany.** Located at Wasserburg in eastern Bavaria, the facility will concentrate on producing bipolar integrated circuits mainly for computer and communications applications. . . . An etching system for integrated-circuit production will soon be marketed in Europe by CIT-Alcatel of Paris. Like advanced U. S. and Japanese systems, the GIR 200 **operates in both planar-plasma and reactive-ion etching modes,** with a capacity of from 30 to 60 chips per hour at a resolution of up to 0.6 μm. Processing is automatically controlled by French-manufactured 6809 microprocessors.

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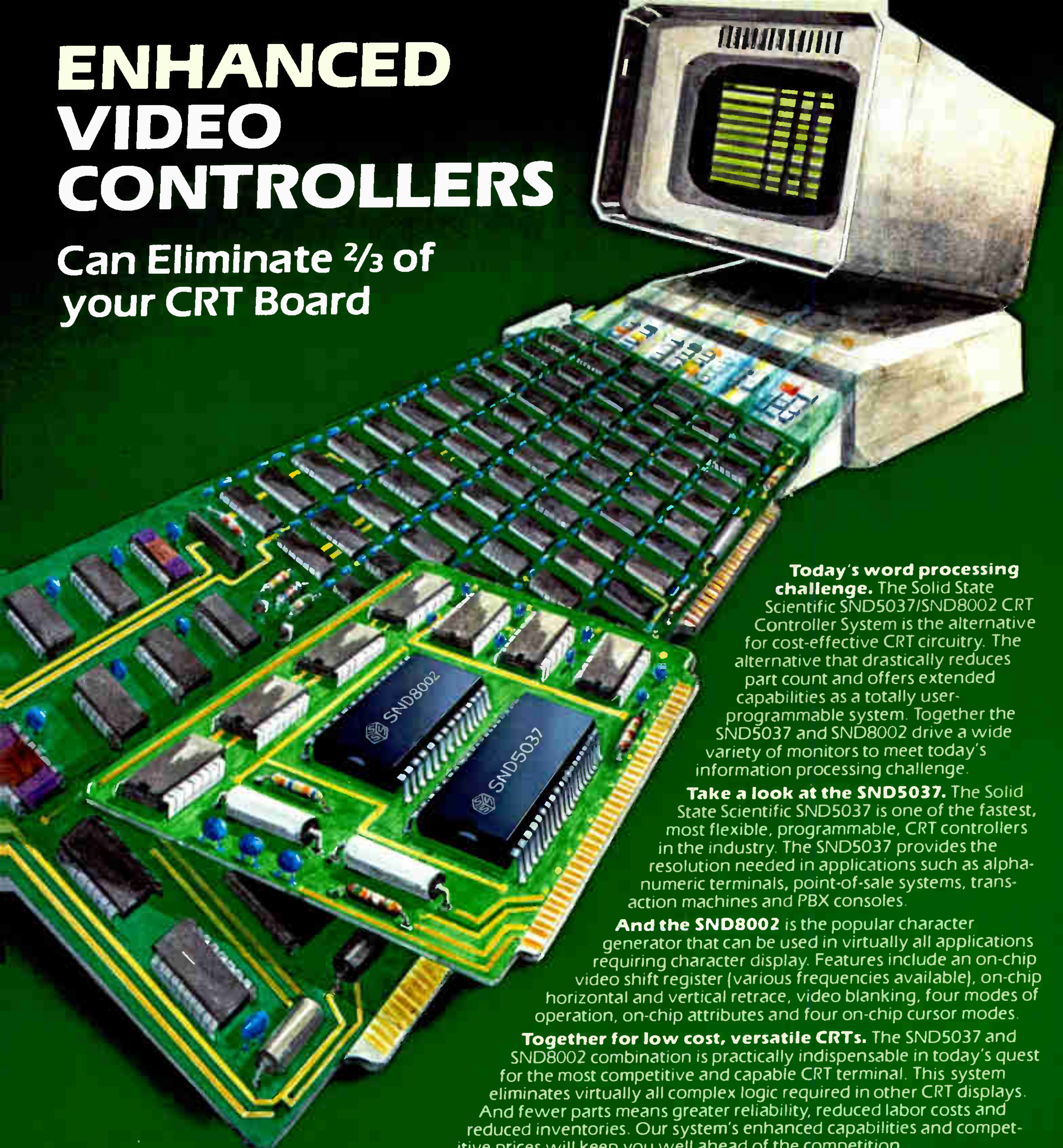

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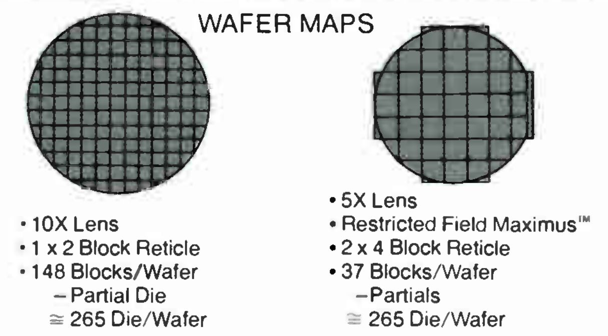

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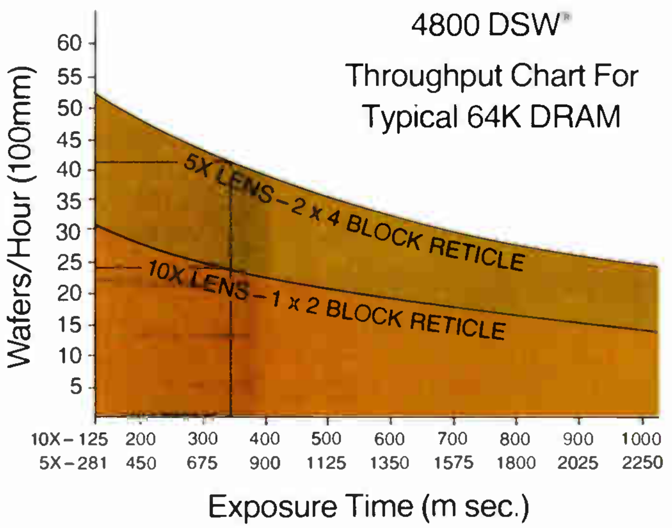

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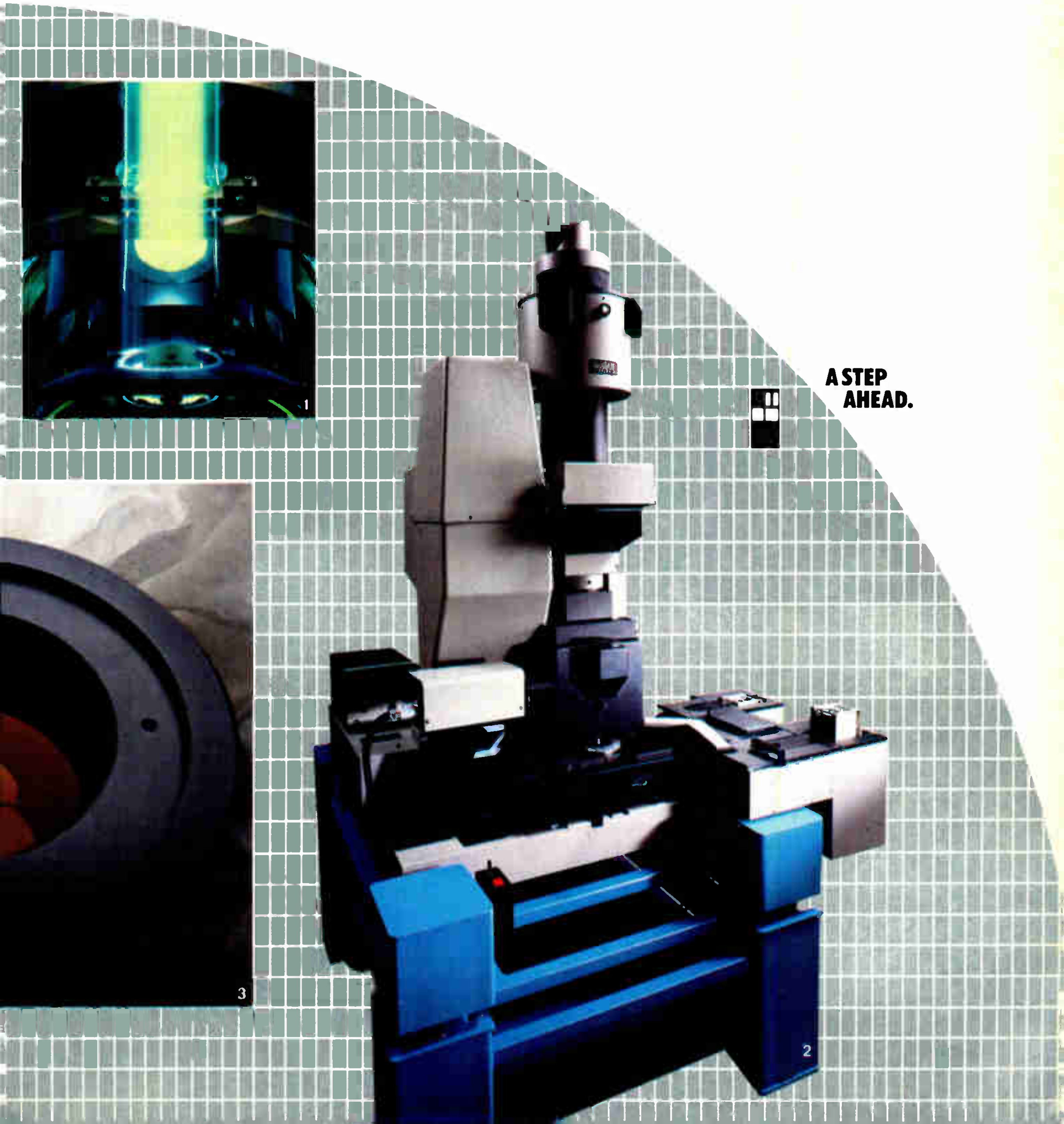

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Huge alumina substrates shrink avionics computer

by Kevin Smith, London bureau manager

Chip-carriers aboard 6-by-4-inch substrates achieve extremely high interconnection density

For its next generation of airborne computers, Saab-Scania AB has developed an interconnection technology based on the use of leadless chip-carriers and unusually large alumina substrates. As a result, the Swedish company packs the entire 650-chip computer system into a volume of 3 by 16 by 23 centimeters, or 1.2 by 6.3 by 9 inches.

The 6-by-4-in. substrates make possible extremely high system interconnection densities. Saab's high-performance airborne computer, for example, comprises no more than eight such substrates: four for the central processing unit, one for program memory, one to hold the communication memory, and two for the input/output channel. Typically, one substrate will accommodate up to 79 chip-carriers.

Cool. Thermal management is excellent: the air-cooled computer comfortably dissipates the 180 watts generated by its 650 low-power and standard Schottky-TTL integrated circuits. To achieve this dissipation, individual substrates are glued to aluminium plates. They are mounted in pairs, and the 5-millimeter channel between them is used for air cooling.

In effect, says Mats Gröndahl, marketing manager for Saab Microelectronics in Linköping, the company's approach represents a new way of packaging aircraft electronics. Now Saab wants to cash in on the development and has begun to market custom circuits fabricated on its large alumina slabs. The company already has its first customers—it has supplied samples to British Aerospace and to British Telecom.

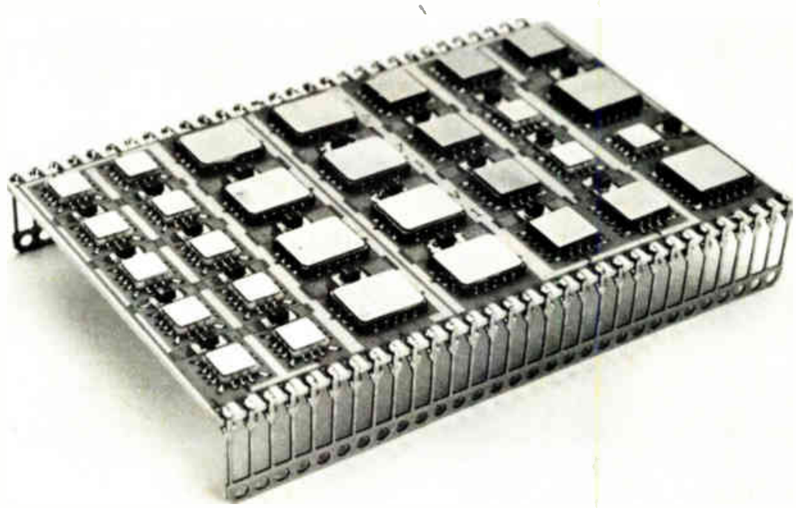
Before the development of chip-carriers, hybrid-circuit manufacturers had tended to use bare chip-and-wire techniques, but the snag with this approach is that the bare chips, once mounted, cannot be pretested or easily reworked. This has imposed a yield limit of around 25 to 30 ICs on the size of the resulting systems.

With chip-carriers, which can be pretested and more easily reworked, there is no such restriction, a factor Saab-Scania was quick to appreciate. By moving to much larger substrates, it has greatly extended the role of the hybrid, assigning to it the interconnection task usually assumed by the multilayer printed-circuit board.

Dense. Since the whole system is fabricated on ceramic substrates, the overall interconnection density achievable is that of hybrid circuits—700 connections per square inch compared with 30 to 60 interconnections/in.^{2} for a board with plated-through holes. Signal tracks are the standard 10 mils wide with 10-mil spacing; the dielectric layer has holes or vias—to carry interconnections between layers—that can easily match these line widths.

Because of the high complexities, Saab uses a modified computer-aided design system from Racal-Redac, originally intended for pc-board work, to lay out the two signal

Goliath. An extremely large substrate, developed by Saab-Scania for its airborne computers, leads to compact systems. Each substrate can accommodate 79 leadless chip-carriers.



layers in X and Y directions. The thickness of the usual intervening dielectric layer is doubled in order to reduce interlayer capacitance. A third conducting layer is used for power distribution, with altogether four dielectric layers between it and the second layer.

The layout is then completed with a final dielectric layer that has openings for connection to the pads of the chip-carriers and for soldering in chip resistors. Two extra signal layers can be added, if necessary, bringing the interconnection density to around 900/in.^{2} (Interconnections are defined as between conductors or a package lead.)

There were some unknowns. To start with, Saab had to find a supplier for the alumina substrates that could provide the needed flatness so that the entire 6-by-4-in. surface could be printed with sufficient precision. Their eventual source was the West German firm of Rosenthal Technik AG, which supplied substrates so flat that "two of them usually stuck together," says Gröndahl.

Techniques were developed for printing the unusually long tracks without discontinuity using gold and two separate stencils. Saab demonstrated that the electrical characteristics of the tracks did not impose too heavy a capacitive load on the signal path and that the result compared favorably with the alternative wrapped-wire board.

Denmark

Densely packed C-MOS chip promises easily wired full- or half-duplex telemetry nets

Full- or half-duplex telemetry networks as simple to wire as a string of Christmas lights are in the offing. All that is needed is a single twisted-pair cable to link control nodes and, at each node, a new complementary-MOS integrated circuit that controls transducers and actuators as directed by a remote microprocessor.

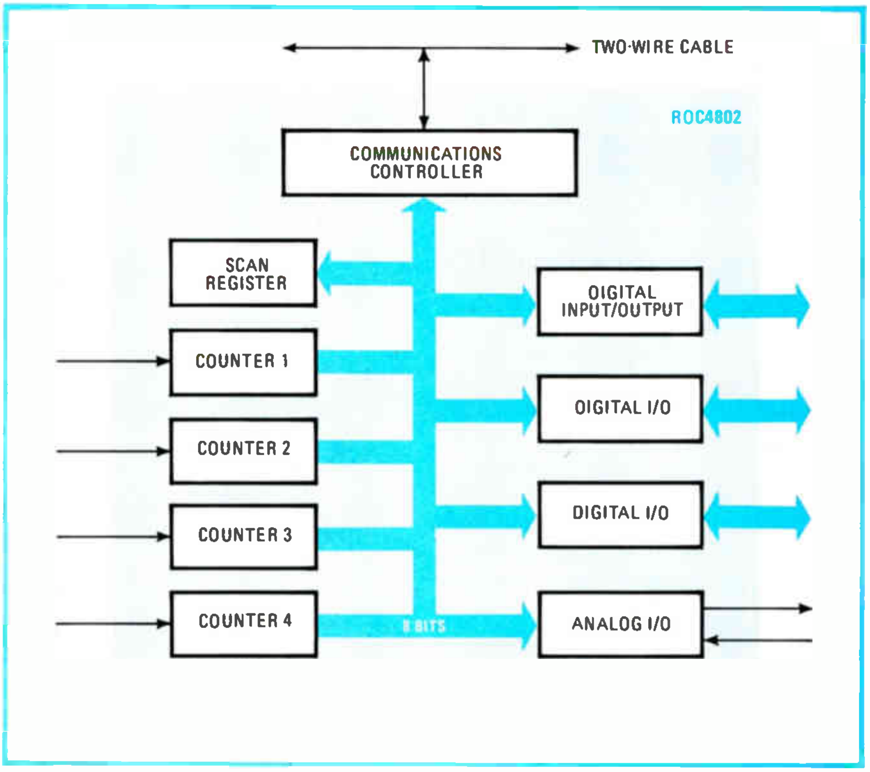
Developed by Danish defense electronics manufacturer Christian Rovsing A/S, Copenhagen, the system's inherent simplicity and expandability make it a natural for process monitoring and control schemes, for energy management systems in office buildings, and other applications calling for data transmission over distances up to 2.5 kilometers in noisy environments.

Appealing. Connecting systems by a single twisted-pair cable, instead of individually wiring transducers and actuators, has tremendous appeal on grounds of simplicity, flexibility and ease of installation. However, development has awaited a cheap and compact electronic package that can interface with the hardware encountered in a process-control system. Rovsing has met this requirement by designing a complex very large-scale IC in C-MOS technology. Designated the ROC 4802, it incorporates more than 10,000 transistors on a chip measuring 184 by 228 mils and housed in a 40-pin dual in-line plastic package.

The 4802 consumes 20 milliwatts of power at a supply voltage of 6 volts. First samples contained a few design faults, but a second design iteration of this extremely complex chip has now been completed and first samples are expected within the first quarter of the year.

The new microcircuit interfaces with a variety of process hardware, as well as acting as a communications controller. The data link operates in a polled mode, the central microprocessor individually addressing and interrogating up to 256 4802s, each of which can be identified by an 8-bit address code that is hard wired into eight address-code input pins.

High noise immunity over the twisted-pair link is achieved by the use of a sophisticated transmission protocol incorporating a cyclic redundancy check of the data trans-



Inside. The bus-organized ROC 4802 C-MOS chip can be used to connect systems with a simple twisted pair cable and can interface with a variety of process hardware.

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Apart from the communications controller, the bus-organized chip also incorporates an analog-to-digital converter with on-chip reference voltage, four 8-bit counters, three 8-bit digital input/output ports, a timer input, a d-a converter, and a scan register. These facilities can be used to interface with just about any kind of process hardware.

The chip can convert a temperature or pressure transducer's analog output into an 8-bit word suitable for transmission to the microprocessor and vice versa. Also, it can sense relay-contact states or directly drive switches, and it can interface directly to the widely used pulse-rate meter, accumulating pulses in one of four counters for interrogation by the remote processor. What's more, the three 8-bit I/O ports provide easy integration with modern digital systems. **-Kevin Smith**

Japan

Japanese-language word processor uses a simplified pen-touch syllabary input

The search in Japan for the most convenient (or the least complicated) word-processing system for general business offices continues apace. The problem is how to handle the nation's complex written language—using Chinese kanji characters and native syllabary characters—with a simplified input so that it can be readily managed by a casual user rather than a professional typist.

Sharp Corp. seems to have licked the problem by designing an inexpensive desktop Japanese-language word processor, the WD-1000, with the average office worker in mind [*Electronics*, Dec. 29, p. 50]. Learning time is remarkably short, according to Atsushi Asada, general manager of the industrial instruments group at Sharp.

The typical user attains a speed of 30 to 40 characters per minute after a week of using the system for one hour a day. This is faster than it sounds, because the average character carries more information than each letter in an English word, and only about 40 fit across a sheet of letter-size paper.

Previous systems either had a pen-touch tablet with an array of perhaps 2,000 or more characters or used a keyboard similar to that found on computer consoles. One firm had a keyboard with more than 200 keys [*Electronics*, May 19, 1981, p. 84]: But Sharp decided not to use a keyboard at all because most Japanese office workers have no previous experience with keyboards. Instead, a pen-touch tablet with the equivalent of 156 pressure-sensitive switches is substituted for the keys (see photograph).

The simplified input scheme adopted by Sharp engineers and the availability of high-density memory enabled them to put the unit into a box the size of a large encyclopedia volume. Thus, the WD-1000 looks almost like a toy, even though it has a powerful Z80 microprocessor and holds about three-quarters of a megabyte of random-access and read-only memories.

Converter. For Japanese text, only 55 phonetic kana syllabary characters suffice for the input of the more than 2,000 Chinese kanji characters that are used together with kana for writing most commonly-used Japanese. In the WD-1000, the character generators can produce 3,082 kanji characters along with more than 500 English and Japanese syllabaries, symbols, and punctuation marks.

The processor handles the kanji input by converting the portion of the text marked for conversion. Paradoxically, the system works better on words, which often consist of two Chinese characters, than on single characters. It works still better on phrases, which it can selectively convert since it has built-in lexical and syntactic processing that is able to distinguish among kanji characters and words with the same pronunciation. The hit rate is 97% or better.

The system uses two separate liq-

Simple. Face of Sharp's new WD-1000 word processor shows the pen-touch tablet for input, the format display to the left, and the character display along the top.

uid-crystal displays to provide many of the conveniences of a cathode-ray tube without the size, cost, or power drawbacks. Text currently being entered or earlier text scrolled from memory is displayed on a single-row 40-character display with 16 by 16 dots per character.

A second display—the format display—shows the page layouts with up to 36 lines of 40 characters per line. Each character is represented on the format display by a single dot. The character display, the impact printer, and the word processor require lots of memory—652-K bytes of ROM (including 4-K bytes of initial loading ROM) and 128-K bytes of RAM. -Charles Cohen

Switzerland

Digital phone sends text and pictures

With a view towards future digital transmissions over public telephone networks, communications authorities in Switzerland are testing the Display Telephone, which allows quasi-simultaneous transmission of speech, gray-scale still pictures and drawings, and text—all over existing phone lines. The system is a joint development of the Swiss postal authorities—the PTT—and Autophon AG, a Swiss firm that is based in Solothurn.

"The trial transmissions now under way serve to find standards and procedures suitable for our future IFS network," says Johannes Zaugg, vice director in charge of telephony at Autophon. IFS, the abbreviation of the German words for integrated communication system, is a digital network to be installed later this decade and the next. Other countries are planning similar networks.

Narrow. The bandwidth of existing phone lines is far too narrow to transmit moving TV-like, gray-scale pictures, as is done with video-phone systems, for example. So Autophon engineers use two memory devices that display one image on the system's monitor while the next is in the process of being stored for transmission. The picture sequence is thus similar to a slide presentation.

The Display Telephone is built as a small console containing a cathode-ray-tube monitor, a transmission unit, an audio section, a gray-scale picture section for image production, a character section for producing and sending text, a light-pen section, and an image mixer. There is one such system at each end of the transmission link.

Although image transmission is a vital function, speech transmission takes priority so that users, as with ordinary telephone communications, will not be subject to restrictions or waiting times. All other information—pictures, text, and drawings—is read out from the memories and transmitted during speech pauses.

To reduce transmission time as much as possible, Autophon engineers are using a dual pulse-code–modulated telephone channel with a net transfer rate of 128 kilobits a second. Because many other types of transmission systems are

Versatile. Display Telephone console houses a keyboard in drawer, view screen, a light pen, telephone handset, and a window for transmitting photos and drawings (upper right).

routed through the same cable in the network, interference must be minimized. Satisfying this requirement is an Autophon-developed modem interfacing with the phone lines and ensuring good channel separation.

To get the most out of the available 128-kb/s data rate, a special circuit recognizes gaps or pauses in the speech and mixes the voice and data signals, with the redundancy of audio signals being exploited in data transmissions. Therefore, the transmission times may vary: sending a video image takes from about 4 s, when audio signals are not present, up to 30 s, when audio is simultaneously transmitted.

Audio signals are transmitted via PCM, the encoding process corresponding to standard compander methods. The channel capacity allows an audio bandwidth of about 8 kilohertz, more than enough for normal speech. "But this wide bandwidth ensures superior sound quality," Zaugg says, "and that is especially important for conversations in a foreign language."

The pictures to be transmitted are placed under a cover on the console, scanned by a camera below, digitized in about 4 s, and then stored. The data is read out of the memory devices and transmitted at a speed depending on the degree of channel utilization. The displayed pictures are flicker-free because a 100-hertz image refresh rate is used.

To send text, the system is used like an ordinary teletypewriter. The memory content, called up by simple keyboard operation, is displayed by scrolling, 56 characters to a line, 14 lines visible at a time. A light pen can be used to write or as a pointer or moving cursor. It can also choose between two line thicknesses and erase previous lines.

The tests now under way are taking place between two Display Telephones at Solothurn and three such units at the PTT administrative headquarters in Bern, over a 40-mile distance. Field trials with several hundred systems will begin in 1986, Zaugg says. Apart from human communications, the system will later access computers. **-John Gosch**

STANDARD-B EARTH STATION COMPLETED WITHIN TWO MONTHS

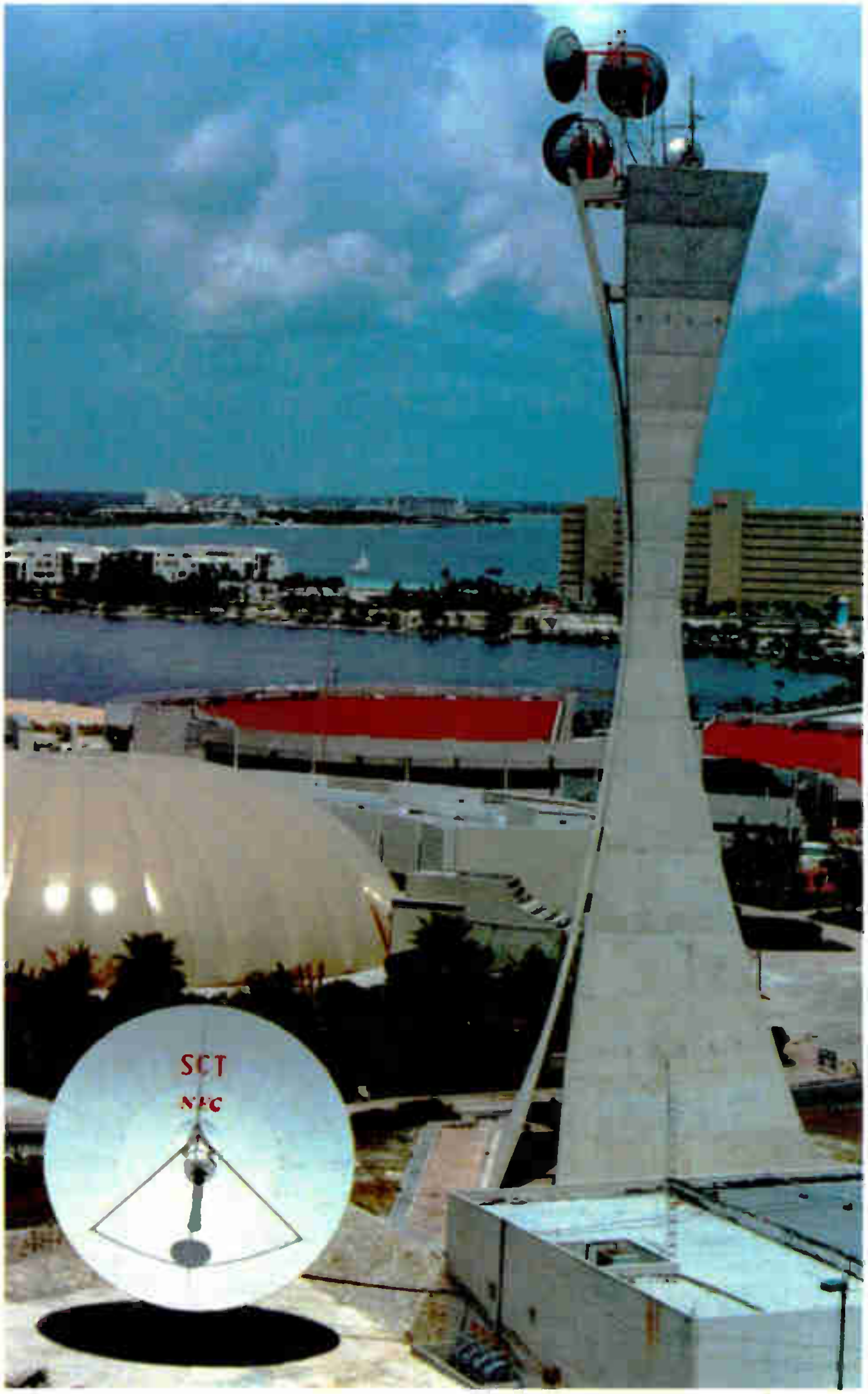
Only two months were allotted for the construction of the Standard-B INTELSAT earth station at Cancun, Mexico. NEC met this tight schedule and helped the Mexican telecommunications authority prepare for the "North-South Summit" held in October, 1981.

Although Mexico already had two Standard-A INTELSAT earth stations—also supplied by NEC—the new station was needed to handle the large volume of communications traffic generated by the conference, which was attended by over twenty heads of state.

NEC is the world's No. 1 supplier of INTELSAT earth station systems, with 156 supplied on a total plus partial system supply basis as of November 30, 1981. When DOMSAT, TVRO, INMARSAT/MARISAT, higher frequency, transportable and mobile stations are also included, the total supply figure is 513 on a total plus partial system supply basis.

Satellites and onboard equipment have also been manufactured by NEC. Among these are most of Japan's applications satellites and all scientific satellites and, in collaboration with the Hughes Aircraft Company, the transponders of the INTELSAT IV and IV-A satellites now in orbit. Moreover, a recent NEC achievement, 20/30GHz and 30/35GHz transponders, promises to relieve the frequency congestion that exists in lower frequency satellite communications.

Standard-B INTELSAT earth station at Cancun, Mexico



NUMBER 122

TRANSPONDERS FOR CS-2 SATELLITES

Communications transponders made by NEC will be installed on two CS-2 satellites now being developed by the National Space Development Agency of Japan.

The transponder for the first satellite, CS-2a, is already completed. It has six K-band and two C-band transponders plus a stand-by system, for the transmission of telephone, color television, facsimile and data signals.

The K-band transponders operate in the highest frequency ranges ever utilized in the world for an operational communications satellite, receiving at 30GHz and retransmitting at 20GHz. Each of the six can relay 65Mb/s TDMA signals, or one color television program, or an equivalent number of telephone calls or other transmissions. The C-band transponders receive at 6GHz and retransmit at 4GHz. Each

C-band unit can relay 109Mb/s TDMA signals or their equivalent.

NEC is also making a transponder for the second satellite, CS-2b, which will be launched six months after the first one is put into orbit early 1983. The two satellites will be used for public services (in case of natural disaster) and by government agencies.

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SYRIA ORDERS TWO MAJOR TELECOMS PROJECTS

Contracts for two big telecommunications projects have been awarded to NEC by the Public Telecommunications Establishment of the Syrian Arab Republic.

Under the first contract, NEC will manufacture and supply three NEAX61 digital switching systems which will accommodate a total of 100,000 subscriber lines. One of the two local switching systems in Damascus and the third, in Aleppo, will have a capacity of 40,000 lines each. NEC will also provide information service consoles, assistant service consoles, a repair center, and two maintenance centers.

The second contract calls for a nationwide microwave network for transmission of 1,800 telephone channels and one color television plus four sound channels. This network will consist of 14 routes with 65 stations, covering a total distance of about 1,850km. It will use NEC's latest 500 Series 2GHz PCM and 6GHz upper band and 4GHz microwave equipment.

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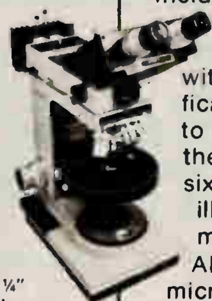

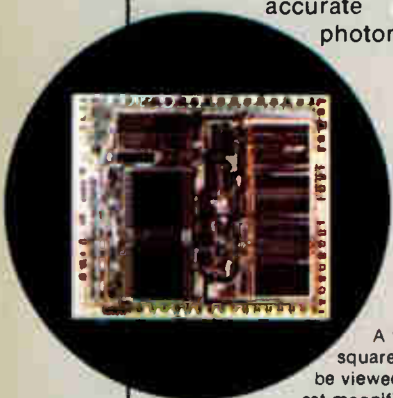

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Cellular mobile-phone fight starts

FCC affirmation of its decision to give half the market to AT&T is certain to find its way into the courts

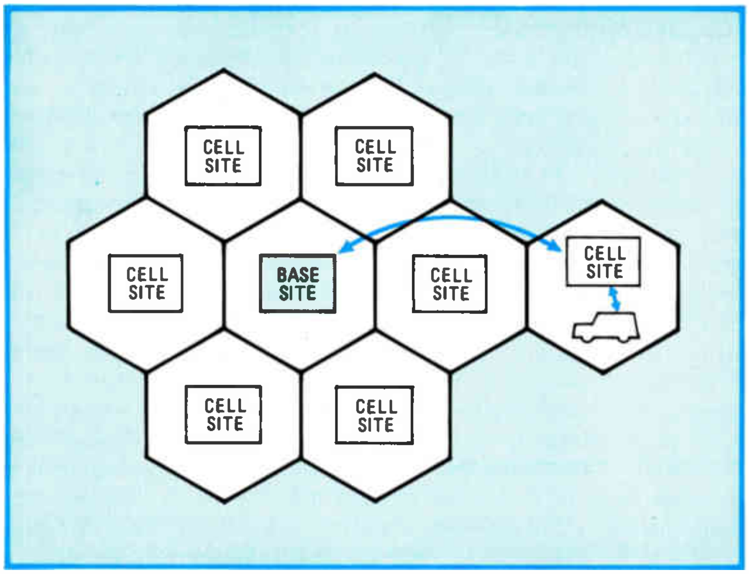
by Harvey J. Hindin, Communications & Microwave Editor, and Ray Connolly, Senior Editor

King Solomon's speed was at least as remarkable as his psychological insight when he ordered an infant whose parentage was disputed to be cut in half. He did not hesitate till the child reached puberty, whereas the Federal Communications Commission took 13 years to order a comparable halving of the billion-dollar telephone-in-the-automobile industry between the local wireline or telephone company and a nontelephone entity.

These entities will include companies that provide traditional mobile-radio service for motor vehicles as well as new entrants that would use, say, Motorola equipment. Like American Telephone & Telegraph Co. and others, Motorola has developed what is known as a cellular radio system, which is said to overcome most of the difficulties of simple car-based systems.

But the FCC's year-end affirmation of its decision to give half the 40-megahertz cellular-radio allocation to the phone company simply means more delay in providing these roving systems to a presumably eager public. "The lawyers are in charge again so the issue is far from resolved," is the way one FCC official puts it.

FCC Chairman Mark Fowler, who voted in the minority in the 5-to-2 vote upholding the set-aside policy, echoes the fear of extensive litigation. He observes that cellular service could be put on hold for 2½ or three years if an appeal to a Federal court results in a reversal of the commission's decision. An appeal has already been filed in Washington, D. C. and a court order is sought stopping FCC issuance of its latest ruling by Millicom Inc., a new New York–based cellular-system developer. Also, a Washington trade group, the Telelocator Network of America, is contemplating legal action.



Pattern. Vehicles in various cells can talk through a base site at the same time. They also may be linked to any phone system. A hexagonal cell is favored by AT&T.

On the other hand, some Telelocator members may take up AT&T on its offer to sell unused cellular capacity to current providers of the obsolete services. Still others are going ahead on their own. For example, Radiofone Corp. of Englewood Cliffs, N. J., has asked the FCC for permission to establish a network using Motorola's equipment in a 20,000-square-mile area from Hartford, Conn., to Wilmington, Del. This net would cover most of New Jersey, eastern New York, and Pennsylvania.

Roberta Cook, deputy chief of the FCC's mobile-services division, says that virtually every part of the commission's ruling has been challenged by more than 25 petitions. For example, a major question still unsettled is how to divide the nonwireline half of the market.

However, legislation introduced by Rep. Timothy Wirth (D., Colo.) has a provision calling for spectrum allocation "without preference based on the provision of other services"—a clause obviously aimed at AT&T.

Mid-February is when the FCC order should be officially published in the Federal Register—the commission document will be issued at the end of this month. After publication, the FCC will accept appeals and comments for 30 days, as required. "There are bound to be at least a couple of dozen appeals," says one Government attorney, "in addition to any court actions."

Chairman Fowler, supported by FCC general counsel Stephen H. Sharp, favored the recommendation by the FCC's Common Carrier Bureau against the set-aside. All

Deposit $100 million, please

In 1980, the radio common-carrier industry collected $400 million in mobile-telephone service and rental fees. The revenue for 1981, estimates Thomas Lamoureux, executive director of the Telelocator Network of America, the Washington, D. C., industry association, will be "close to a half billion dollars," and the American Telephone & Telegraph Co. looks forward to ringing up a $2 billion figure for 1990.

However, the hard fact that a considerable amount of start-up cash is required to develop a cellular network pretty well eliminates basement-based businesses. An AT&T spokesman says, for example, that his company has invested $100 million in its cellular network since experimenting began in the late 1960s. However, Robert Martin, the company's director of business planning, predicts that by the end of this decade AT&T will have received $6 billion in revenue from cellular phone services. A spokesman says the company is prepared to file for its first construction permit by November 1983, and enter 34 markets within the following five years, as the Federal Communications Commission requires.

Motorola Inc., too, has a major investment. James P. Caile, marketing manager at the company's Schaumburg, Ill., Communications Group, says that $40 million has been invested in the company's cellular system. Motorola estimates that installation of its system will cost the customer $1,000, with monthly maintenance, unit rent, basic service charge, and air time costing between $140 and $200. This is a bit more than service currently costs. Customers now must pay $80 to $125 for installation and monthly charges ranging from $115 to $130 for service in large metropolitan areas, says Lamoureux. **-Marsha Thompson**

agree that the ruling may well be rejected by the courts. Fowler also contends that the FCC majority, led by Commissioner Joseph Fogarty, contradicted "the national policy of encouraging competition in all markets" for telecommunications. The Department of Justice and strong segments of the Congress also oppose the set-aside.

While all this legal jockeying is going on, cellular technology is the hope of competitors for the dormant car-phone business. Today, about two dozen very high-frequency radio channels are used, and everyone connects to the same transmitter, which generates a powerful signal in a given metropolitan area. The major problems are the limited number of available channels, the lack of privacy, and the need for an operator to place each call.

For the new cellular system, the FCC has reserved 666 channels in the upper end of the ultrahigh-frequency spectrum, in the process making some television broadcasters unhappy at their loss of spectrum space. Also, instead of one big transmitter acting as a relay station in a metropolitan area, the new system will rely on a multitude of low-power transmitters. Each will serve a small area, or cell; as a vehicle drives from cell to cell, its call will be handed off.

Reuse. Because each cell's transmitter serves a number of frequencies in its area with low power, the frequencies may be used at the same time in adjoining cells with virtually no mutual interference. The result is the equivalent of thousands of channels.

Once a user makes contact with the nationwide network, the in-car phone's stored-program-control electronic switchgear executes the complex steps needed to ring any other phone in the world. This chain of events is complicated enough, but the extra software needed to connect the car to the local cell's transmitter-receiver and then to a switching office creates even more difficulties.

Not only must the switching office perform the usual functions it performs for land lines, but it must also take care of the chores unique to the cellular phone system. Perhaps most important, software at both the cell site and the switching office must monitor the call to determine when a handoff between two cells is required.

In addition, where phone numbers of fixed stations provide information about the location of the called party, there is no such relationship in a mobile cellular system. Thus, the software must allow the switching station and its local cells to seek out the called mobile station. Typically, these functions are performed by a large processor in the switching station, microprocessors in the cell sites, and the mobile phone itself.

No panacea. However, the cellular approach is not a panacea. For example, as James P. Caile, marketing manager for Motorola Inc.'s Communications Group in Schaumburg, Ill., points out, the interference problem is not completely eliminated. In cellular telephony, the frequency reuse statistics, the radiated powers, and the sizes of the cells are planned so that there is a predicted acceptable level of interference.

So with the ruling, the companies are lined up behind the Government's pace car, waiting for the starting flag. Of the competitors, Motorola and AT&T have the most experience testing a cellular system.

AT&T has been working with AMPS (advanced mobile-phone service) through Illinois Bell in Chicago for a few years. [*Electronics*, May 24, 1979, p. 158]. Motorola has supplied its Dynatac cellular system to its customer, the American Radio-Telephone Service, for a series of tests just starting in the Washington, D. C.-Baltimore area. Dynatac, unlike AMPS, is being called the ultimate portable phone to be taken wherever the user goes.

There are others in the field beside these two giants. For example, Millicom hopes to sell its cellular-compatible equipment, as does E. F. Johnson & Co. of Milwaukee, of citizen's band radio fame. Also keeping their ear to the ground are Japanese firms Oki Electric, Hitachi, and Nippon Electric, which supplied gear for AT&T's Chicago test. The market they are driving for could be worth $2 billion by 1990, AT&T estimates, with 1.5 million customers.

One cheering note: although the AT&T and Motorola systems have some technological differences, they are not substantial. In fact, as the FCC has required, the two systems are compatible. Thus, equipment suppliers will not have to contend with two separate designs. □

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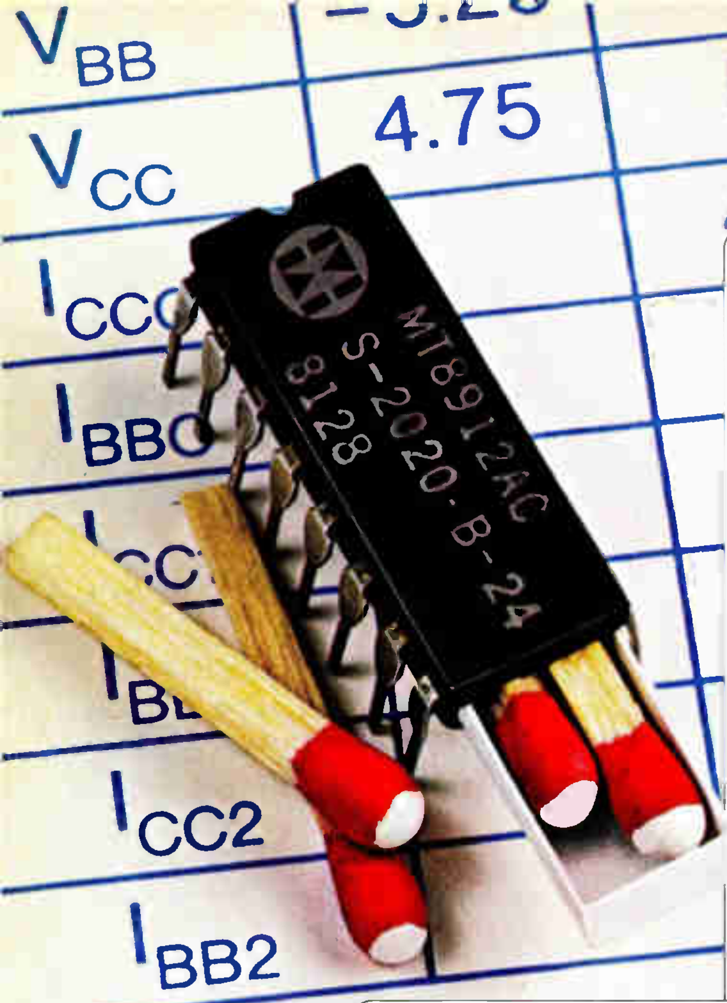

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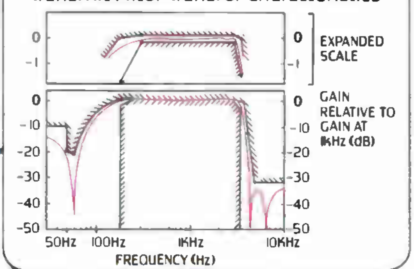
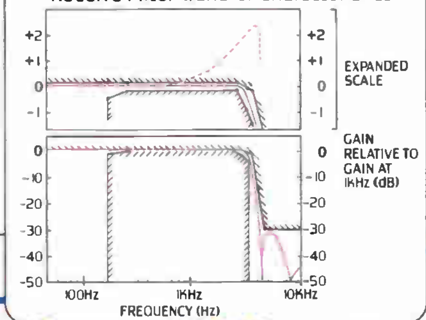
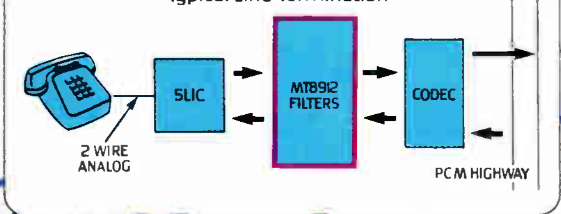


Receive Filter Transfer Characteristics



Typical Line Termination



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Distribution

Distributors see watershed year

Industry leaders expect financial squeeze to spur mergers and await landmark deal with full-line Japanese supplier

by Larry Waller, Los Angeles bureau

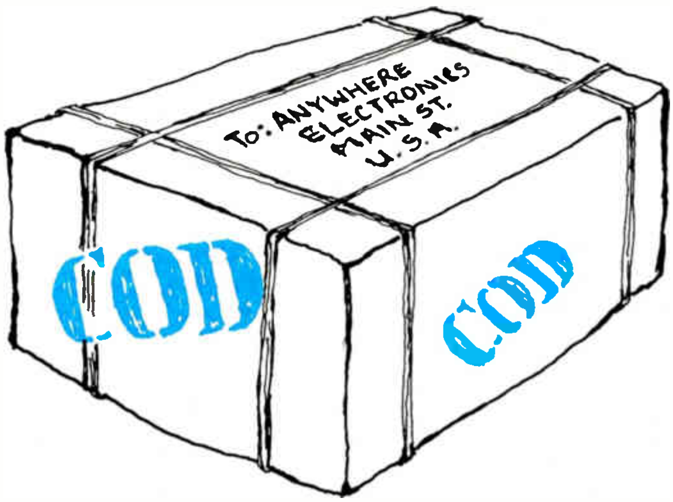
Whatever surprises 1982 holds for the mercurial electronic parts-distribution industry, for once the hard-driving executives who head the leading firms start a year in agreement. Almost to a man, they spot 1982 as one of those watershed periods destined to set the business tone for years. Inspiring such unanimity, seldom seen among this competitive crew, is a list of pressing questions, each one dealing with a major issue.

Though some of these surfaced only recently, they all reflect the bedrock problem: weak customer demand that undermines the economic underpinnings of a field that historically has been underfinanced. Even Tony R. Hamilton, chairman of the largest firm, $800 million Hamilton/Avnet Electronics of Culver City, Calif., admits that times have been tough. "In 1982, we have to settle down and answer the questions raised in 1981," he says.

Two topics are central: financial pressure, including the slow business prospects and high interest rates that trigger mergers and acquisitions, and relations with semiconductor suppliers, particularly the deterioration of the once exclusive franchise system. Moreover, all hands agree that a decision by a major distributor to take on a Japanese firm's entire parts line could blow traditional U. S. supplier-distributor relationships out of the water.

On business prospects, and when demand will turn up, no one wants to go out on a limb with an exact prediction. "Nothing good will happen before July 1," observes industry veteran Jack Darcy, senior vice president of Ducommun Inc., which owns Los Angeles' Kierulff Electronics Inc. "And it could persist through 1982. While this recession is not as deep as 1974–75, it's longer."

John C. Waddell, chairman of Arrow Electronics Inc. in Greenwich, Conn., calls the downturn "the worst semiconductor cycle in 10 years, even more pervasive than 1974–75." Because distributor fortunes are so closely tied to those of the semiconductor industry, itself showing little sign of heading back upward, Waddell flatly declines to pinpoint a turning point.



Different trend. The nature of the current downturn, which features a wicked price-cutting spiral but good unit volume, makes it different from and more difficult to handle than past ones when demand dried up, according to most firms. To keep sales even, distributors have to sell some 25% more, which trims profit to the bone since inventory and personnel expenses stay the same. This inventory bind puts them into the vise of high interest rates to finance it that further dries up cash flow.

Most executives, in fact, tie lower interest rates together with improved price and demand before distribution fortunes start up. "The magic point is 14% and the upswing will follow it by 90 days," predicts Lauren L. Pond Jr., president of Wyle Laboratories' Distribution Group, based in Irvine, Calif. "Things came to a crashing halt at 14% two years ago, then picked up at 12% but crashed again when rates soared to 20%," he notes. Wyle's own sales unit quantity is up 35%, but revenues still dropped by some 10%.

Ironically, some observers point to fast growth and the inability to finance it soundly as a factor in today's squeeze. For example, it takes $1 in capital to support $4 in sales. Electronic parts distribution is in the throes of consolidation that mark a maturing industry, they say. This puts a premium on size because size gains economies of scale in operation and clout with suppliers and lenders. Running head on into this trend during a time of red ink and high interest drives weaker firms into the arms of acquirers.

The upshot was that the acquisitions in 1980 involved more distributors than during any single year in history and include major names such as

Schweber Electronics, Westbury, N. Y., and Hall-Mark Electronics, Dallas. Both were picked up, willingly, by nonindustry firms (Schweber by Lex Service Group Ltd. of London and Hall-Mark by Tyler Corp. of Dallas) for reasons more to do with the need for capital than a paucity of profits, they say.

Big chunks of business moving at a quickening rate into better-financed hands bothers competitors. Hamilton puts it at the top of his worry list. "Can distribution digest all the mergers during 1982" without disruption, he wonders.

If the twin terrors of poor business and high interest rates perplex distributors, they at least will end sometime. But the problem of prickly relations between distributors and their semiconductor suppliers, rubbed raw in a difficult period, is harder to solve. The basic trouble is a conflict of interests, hard to reconcile even in good times. Suppliers want maximum market saturation, without much concern as to whether too many distributors carry their line in a territory, according to distributors. On the other hand, as suppliers see it, distributors want exclusive territorial rights for a product without the healthy spur of competitors.

Precedent set. Out of such give-and-take, compromise has evolved throughout the years. But no single distributor has handled all the major semiconductor lines, not even the giant Hamilton/Avnet—until late 1981, that is, when Wyle shocked the business by signing up to sell all Texas Instruments products. Before, such an agreement with TI had led Motorola Semiconductor and National Semiconductor to drop a distributor. But so far these two houses have not acted. "They won't do anything while business is bad," notes a competitor to Wyle, "but just wait until things improve."

Watching the Wyle-TI liaison warily is Hamilton, who notes its trailbreaking implications. If Wyle successfully offers all semiconductor lines, more shakeups are bound to follow, most observers agree. Darcy of Kierulff also senses "changes in the wind, but we can't see what until '82." Along this path, a bad sign has been picked up by Howard B. Franklin, senior vice president of the Los Angeles–based Bell Industries Distribution division: "Some manufacturers are getting hungrier and adding too many franchises."

These changes will be far-reaching, if they happen, but even they could be swept into the background if a major distributor finally takes the plunge with a full-line Japanese supplier. Most executives single out Hamilton/Avnet as the only firm secure enough with suppliers to chance it, and industry rumors abound concerning talks between Hamilton and Japanese companies. Whether U. S. suppliers would really ostracize any distributor who pushed ahead with the Japanese is an open question, although some executives have so threatened in private. But it is virtually certain that some punishment would ensue.

Hamilton's position on the key issue is carefully worded, recognizing its touchy nature: "It all depends on the U. S. semiconductor supplier—he will determine it." He adds that distributors are concerned about Japanese penetration of the memory market in the past 18 months, but are encouraged by recent U. S. comeback efforts.

It is quite clear that the obvious interpretation of the Hamilton/Avnet position is that it would be forced to take on Japanese lines if U. S. suppliers cannot come up with best-selling products, with the 64-K random-access memory as an example. Competitors are divided about this prospect. "I'd bet on it happening in 1982, but not on who," says Arrow's Waddell. As for reaction, "I can't call that one." Darcy disagrees, saying, "It doesn't have to happen; the chances are better against." He thinks U. S. suppliers have more product to offer than the Japanese and will carry the day.

Although most of 1982 will likely be overcast, skies should clear as problems get taken care of, in the view of industry executives. Distributors count their advantages in a widespread stock-location network with the flexibility to serve a customer base that becomes more pervasive each year, even in a recession. The proof is in the distribution percentage of total component business, which ticks steadily up at about a point a year and by now amounts to about 30%. Furthermore, in good years, distribution's high financial leverage gives a high return on investment; in Hamilton/Avnet's best year, that was 16% to 18%. □

High noon in Southern California

Although distribution is in the doldrums elsewhere, it is stirring excitement in Los Angeles, the site of an old-fashioned competitive shoot-out with newcomer Arrow Electronics Inc. That firm's move into the nation's richest market—about $500 million annually, if neighboring Orange County is included—challenges national chains Hamilton/Avnet Electronics and Kierulff Electronics Corp. and a strong regional firm, Wyle Laboratories Distribution Group, on their own turf. Arrow needs a foothold both to complete its national network and for prestige reasons, its officials say.

The fur already is flying, even though Arrow has had its two branches open only since Dec. 1: headquarters in Chatsworth, with a Newport Beach location in Orange County. Battle lines are forming against Arrow, with Wyle Distribution president Lauren L. Pond vowing, "The three leaders are not about to let Arrow off the ground. They are striking at our home base." Hamilton/Avnet has about $75 million of the business, followed by Wyle with $50 million, with Kierulff in third place. Complaints that Arrow has driven up salaries some 30% or more are already being heard. Such allegations are denied by Grady Pfeiffer, senior vice president of the region. "Most new Arrow employees came to us unsolicited," he says. Pfeiffer himself moved over from Kierulff.

Observers note other firms have gained beachheads, notably Schweber Electronics of Westbury, N. Y., but others, such as Cramer Electronics, have failed. Arrow's immediate prospect is for tough sledding in probably the most highly competitive area anywhere, they say, although Pfeiffer claims the task is easier than in boom times.

-Larry Waller

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Circle 103 on reader service card

Commercial electronics

Gambling pays for game makers

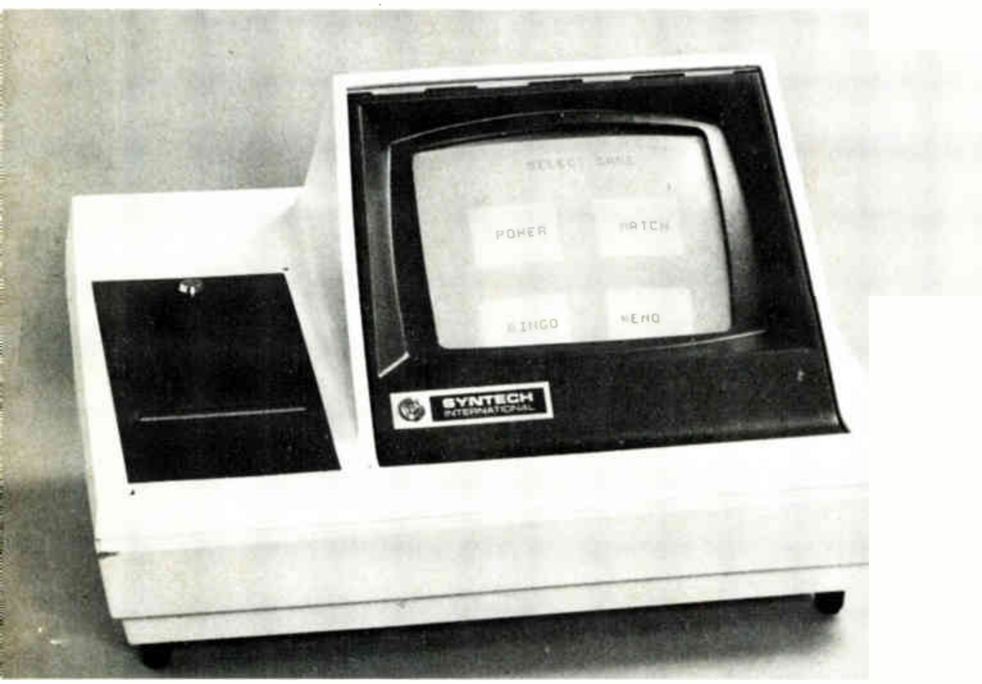
Casino and state lottery systems are going digital with voice recognition and synthesis in sight

by J. Robert Lineback, Dallas bureau

As gaming systems gambol into the digital electronics age, the odds are that legalized games playing may soon acquire a whole new look, sound, and meaning.

Many mechanical slot machines—the familiar "one-armed bandits" with whirling wheels of fruit, bars, and bells—will eventually succumb to solid-state systems that feature full-color video-display screens. And when frustrated punters talk to a machine, speech technology will allow the games to reply. Major casinos will likely step up installation of local networks that link microprocessor-based games to central computers for automated accounting and improved security and maintenance. Even the names of the games could change: digital pinball and "Space War" games may soon sidle onto the casino floor next to video poker and electronic craps.

Just as in the casino of the future, new technologies also promise to be odds-on favorities in the growing state lottery industry. Clerks might become a vanishing breed, for microprocessors and new display techniques have created intelligent lottery terminals that allow customers to place their own wagers. Industry observers expect these materials eventually to feature voice as well. The technology is here, but the only thing blocking these so-called video-instant lottery games is politics, according to equipment manufacturers advocating their use.



The game's the thing. This U-200 terminal from SDSystems, built around a Z80 microprocessor, has a touch-sensitive screen. It can be used for video-instant gambling installations.

In many ways, developments in gambling parallel current technology trends in office, factory, and home systems—the use of very large-scale integration, complementary-MOS memories, and 8-bit and 16-bit microprocessors. What separates these systems from standard commercial products is that they must stand up under close scrutiny from the public, which is concerned with potential misuse and cheating. Clearly, the new technology must provide safeguards as well as obvious business advantages.

For example, with millions of dollars at stake, casinos and state lottery networks must use redundancy to ensure high reliability. On-line lottery and racetrack systems must be able to handle last-minute rushes as bettors scurry to get in on the action. As testimony to the importance of computer technology, two electronic giants, Control Data Corp. and General Instrument Corp., top the list of lottery-equipment service firms.

Do it yourself. "The video-instant games probably have the most significant potential in the lottery business," says Duane Burke, president of the Public Gaming Research Institute (a private organization). "Lottery growth has been primarily through the introduction of new products. The potential is for considerable expansion through these player-operated games because it will appeal to a whole new set of people who are—for the most part—not playing." In the case of lotteries, video-instant devices potentially increase the entertainment value of the games by allowing customers to communicate directly with the

central computer, making their own number selections and, in some cases, receiving prizes on the spot.

In fact, it was technology, not chance, that caused the last state lottery boom in the 1970s. On-line lottery computing systems initially showed up in New Jersey and became an immediate success by boosting public confidence in lotteries, says Guy Snowden, president and co-owner of Gaming Systems Corp., Providence, R. I. Pointing to the success of on-line systems, he predicts the number of state lotteries will double from the present 15 in the next five years.

Going computer. Since the introduction of on-line lotteries, almost a dozen states have converted from paper to computer systems. Typically, lottery clerks sell tickets via high-speed data terminals, which record the wagers with a central processing unit. In a matter of seconds, the bet is assigned a serial number by the central computer, and the ticket is printed out at the remote terminal. After the drawing, winning customers present tickets to the clerk who uses the system and serial number to validate the winnings. Many states require systems to hold winning numbers in memory for at least a year.

William Weglein, marketing support and systems manager for General Instrument's American Totalisator division, estimates that on-line lottery volumes have grown to $2 billion in the U. S. alone. Lottery-system firms usually take a percentage of the handle—between 0.5% and 10%. Amtote supplies five states with systems (New Jersey, Massachusetts, Ohio, Vermont, and Maine) and has some 1,500 employees in its lottery operations.

The lottery boom also attracted Ticketron, a division of CDC, whose move into lottery systems grew out of its involvement in amusement and sporting ticket-sales markets. The division uses CDC's own Cyber 18 computers as its central processing unit and a specially designed Ticketron terminal to enter wagers. In six months, the operation plans to unveil a new terminal for lotteries that fea-

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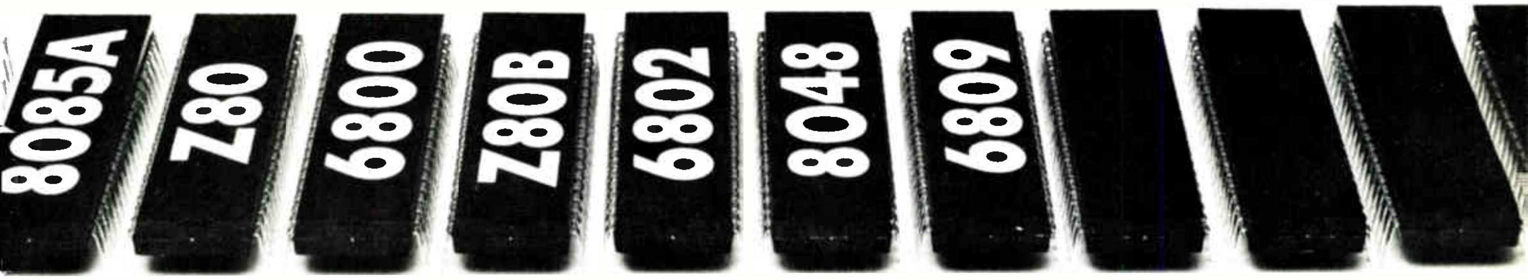

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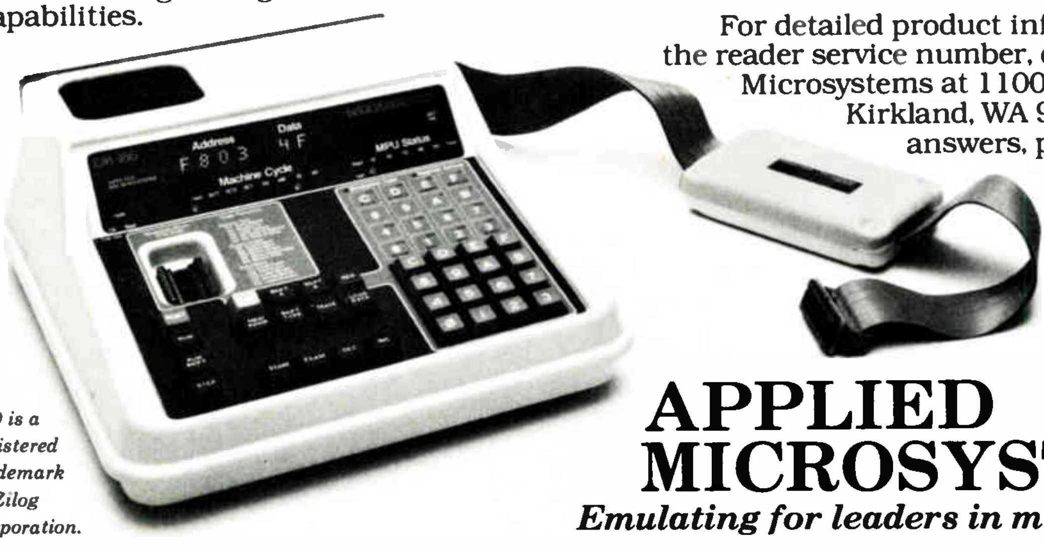

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tures a high-speed printer, says William J. Schmitt, president of the New York City division. Early this year, Ticketron also plans to enhance its system to allow it to handle from 4,000 to 5,000 terminals.

New games. Meanwhile, other equipment manufacturers are plowing new ground with development of customer-operated terminals. Already two firms have introduced video-instant games.

Bally Manufacturing Corp. and Massachusetts teamed up last year to test a new customer-operated system; however, the project was dropped after questions were raised about the legality of the new equipment. The story was the same in New York after it announced plans to test a video-instant terminal built by SDSystems of Dallas. Again, objections centered around the similarities between the new equipment and casino devices.

"In some states, we might see the use of these terminals without new legislation; in others, it might require legislation," states Gordon Graves, chairman of Syntech International Inc., parent company of SDSystems. "It's a controversial issue, just like instant [rub-off] tickets were when they first came out. It will just take time." He expects states will first use video-instant terminals in 1983, noting that "administrations tend to be conservative during an election year."

Graves places U. S. lottery equipment sales and services at $1 billion in 1982. Video-instant gaming systems use the firm's UTT-200 Z80-based terminal with touch-sensitive screen. The UTT-200 is also used by SDSystems for other applications, like banking, ticket sales, and hotel reservations.

The company advocates a lottery system using microprocessor-based terminals hooked together with local networks. This last system would allow a reduction in the cost and provide redundancy, says Warren White, manager of transaction processing systems. Most on-line systems today are using mainframes or large minicomputers as central processing units. ☐

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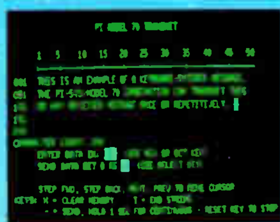

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Business

Tax act gives break to R&D investment

Though new law is complex, it offers direct credit, faster depreciation, and writeoff for donations of equipment

Except for the poor and hungry masses, there is something for almost everybody in the Reagan Administration's Economic Recovery Tax Act of 1981. Among the beneficiaries are research and development project managers who want to boost their budgets.

"Because of the new tax credits, project leaders can 'pitch' their managements for higher budgets at little added real cost," maintains Robert Feinschreiber, a New York tax lawyer who has sifted through the voluminous committee staff report that underpins the provisions of the act.

Although it was passed last August [*Electronics*, Aug. 11, 1981, p. 12], the act is so complex that tax specialists are only now becoming comfortable with it. The full import will not become clear for at least three to five years. It will take that long, Feinschreiber estimates, for rulings by the Internal Revenue Service, court decisions, and follow-on legislation to clear up the many questions raised by the massive revision of the tax statutes that the act represents.

But the fiscal blessings clearly available to companies that despite the recession spend more on R&D are nevertheless quite straightforward:

- First, there is a direct credit against taxes amounting to 25% of any increase in R&D spending above a base figure.
- Second, there is accelerated depreciation of new R&D equipment.
- Third, there is a writeoff of scientific equipment donated to colleges and universities.
- Fourth, there is an incentive for multinational companies to carry out R&D in the U. S.

The tax credit is the most telling aid—a company that spent $1 million for research last year and ups the ante to $2 million this year would actually be out of pocket only $290,000 by committing the extra million to R&D. There would be a saving of $460,000 in profit tax (the full $1 million could be deducted and the standard corporate tax rate is 46%), plus another $250,000 from the direct tax credit.

Savings in subsequent years would be less dramatic because the base for computing the credit would rise, reflecting the increase in R&D spending of previous years. At the moment, the act is scheduled to expire in 1985, but it might become permanent if it results in a flurry of added research effort.

Defining R&D. Less clear is exactly what qualifies as R&D, generally defined as investigation, experimentation, or testing intended to develop a new product or significantly improve an existing one. Market research, on the other hand, does not qualify, nor do cosmetic changes in products.

Thus, tests to see if yellow food mixers have more appeal to housewives than do brown ones cannot be counted. Tests to see if more powerful motors are what is wanted, do.

So, surprisingly, does product-related software of all sorts, according to Feinschreiber. But he warns that companies will need teams of tax lawyers, engineers, and cost accountants to delineate what qualifies for

When it pays to rent

"I'd have to get down and show you the mathematics of it, but it looks as though it's better to lease the system than to buy it," says Robert Piety, controller at Teledyne Semiconductor in Mountain View, Calif. The system under consideration is a GS-1220 color graphics automated design system from Avera Corp. of Scott's Valley, Calif. This piece of equipment comes squarely under the guidelines qualifying it as research and development equipment, and as such its leasing would qualify for an R&D tax credit under the new tax act.

Piety is quick to point out that the final buy-or-lease decision has yet to be approved by Teledyne corporate headquarters, but that he thought enough of the R&D tax savings to submit the suggestion to lease even after the corporate decision makers had approved the outright purchase. "The law was passed in October and we did our purchase-versus-lease analysis in November," he points out. Teledyne has traditionally been a purchase-only company, Piety adds.

The specifics on the Avera system are that its purchase price is $57,250, while its three-year lease is about $2,425, according to Larry Dorie, marketing manager for Avera. "They get 50% return on their taxes as an operating amount, and then on the first year they get an additional credit of 25% on the lease price," he says. And Piety sees a new market: companies that cannot afford to purchase equipment, but can rent it. **-Martin Marshall**

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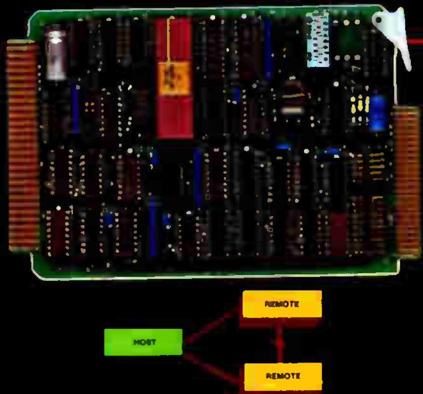

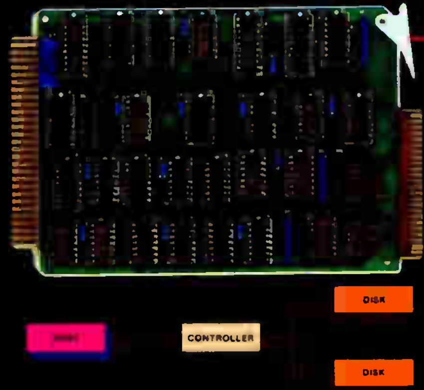

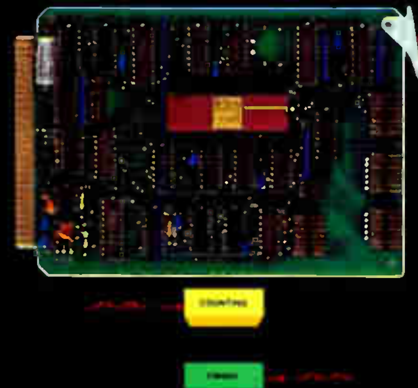

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credit and what does not.

The tax credit emphasizes R&D applied to products, but process development should qualify as well, he figures. Thus, engineers working on new processes for integrated circuits should meet the test, as should those working on improved automatic assembly operations, for example.

Salaries covered. Their salaries, plus part of the salaries of their direct supervisors, would count as R&D spending. So would any monies spent for direct support, like typing research reports or building prototypes. Nothing that smacks of overhead, though, counts.

For in-house R&D, painstaking record keeping will be needed to ensure that the credits will be allowed, particularly for engineers who divide their effort between research and production. The law provides a bonus for companies who are meticulous in this respect: anyone who devotes at least 80% of his time to R&D is considered a full-time research person. For outside contract R&D, the credit is 65% of the amount spent.

The new tax law also provides an incentive to lease rather than buy, according to Deloitte, Haskins & Sells, a San Francisco accounting firm. Tax experts there point out that rental or lease payments for personal property used in a qualifying research activity qualifies for credit.

One controversial aspect of the new law—certain to be tested in the courts, says Feinschreiber—is that credit will be allowed only if the research is being done in the particular business being carried on by the taxpayer. This is an area fraught with danger. For example, New York consultant Touche Ross & Co. cautions that this excludes research joint ventures where one of the partners is in another business.

Touche Ross raises the question, an important one in an area that still is open to debate, as to whether each line of business may be considered separately. If so, research into a new line may not qualify for a tax credit because the taxpayer has not yet begun that business. ☐

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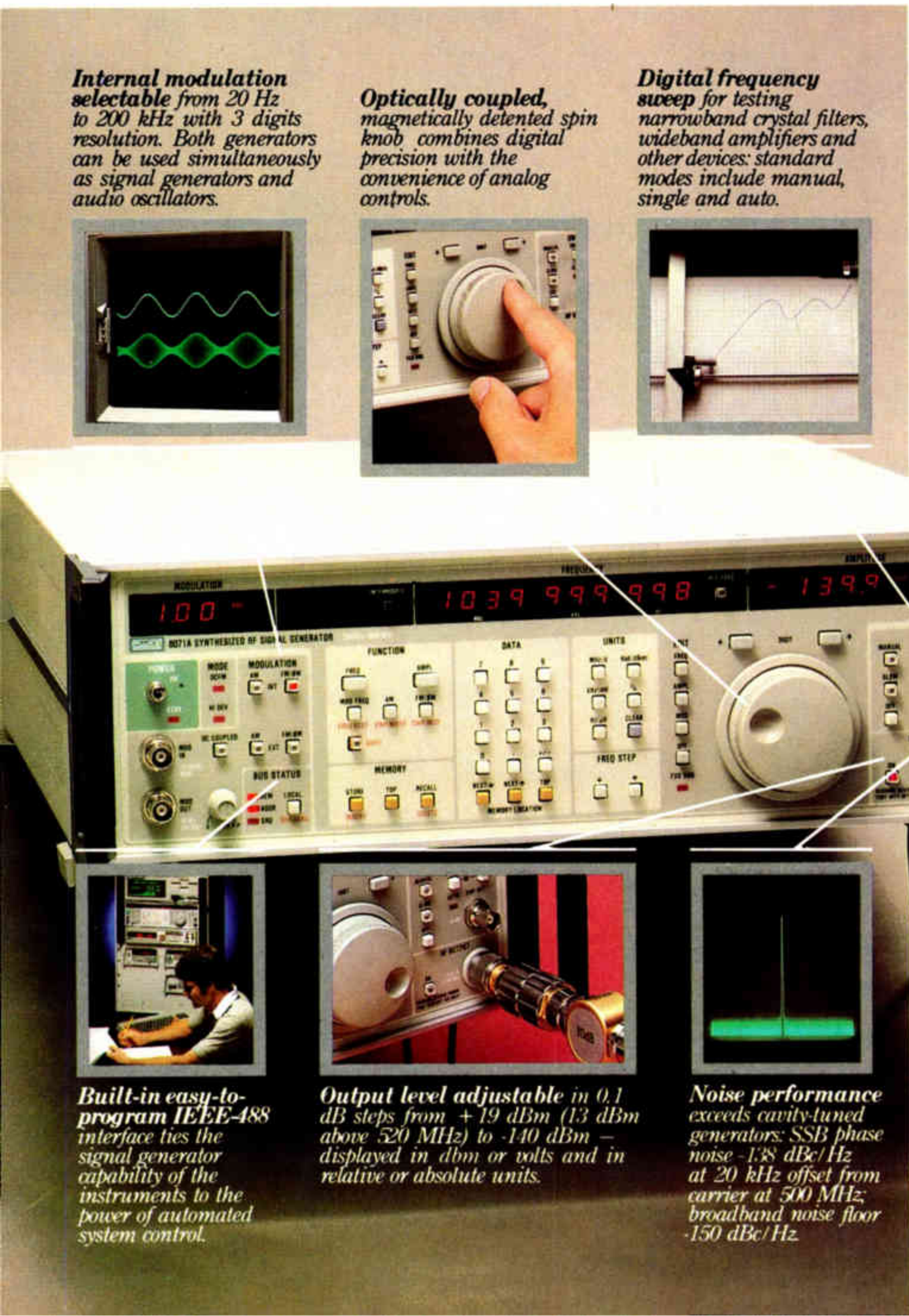

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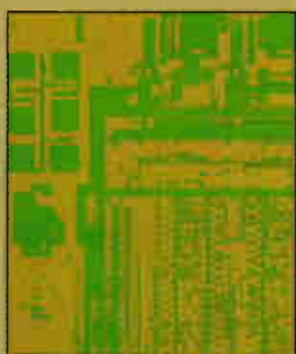

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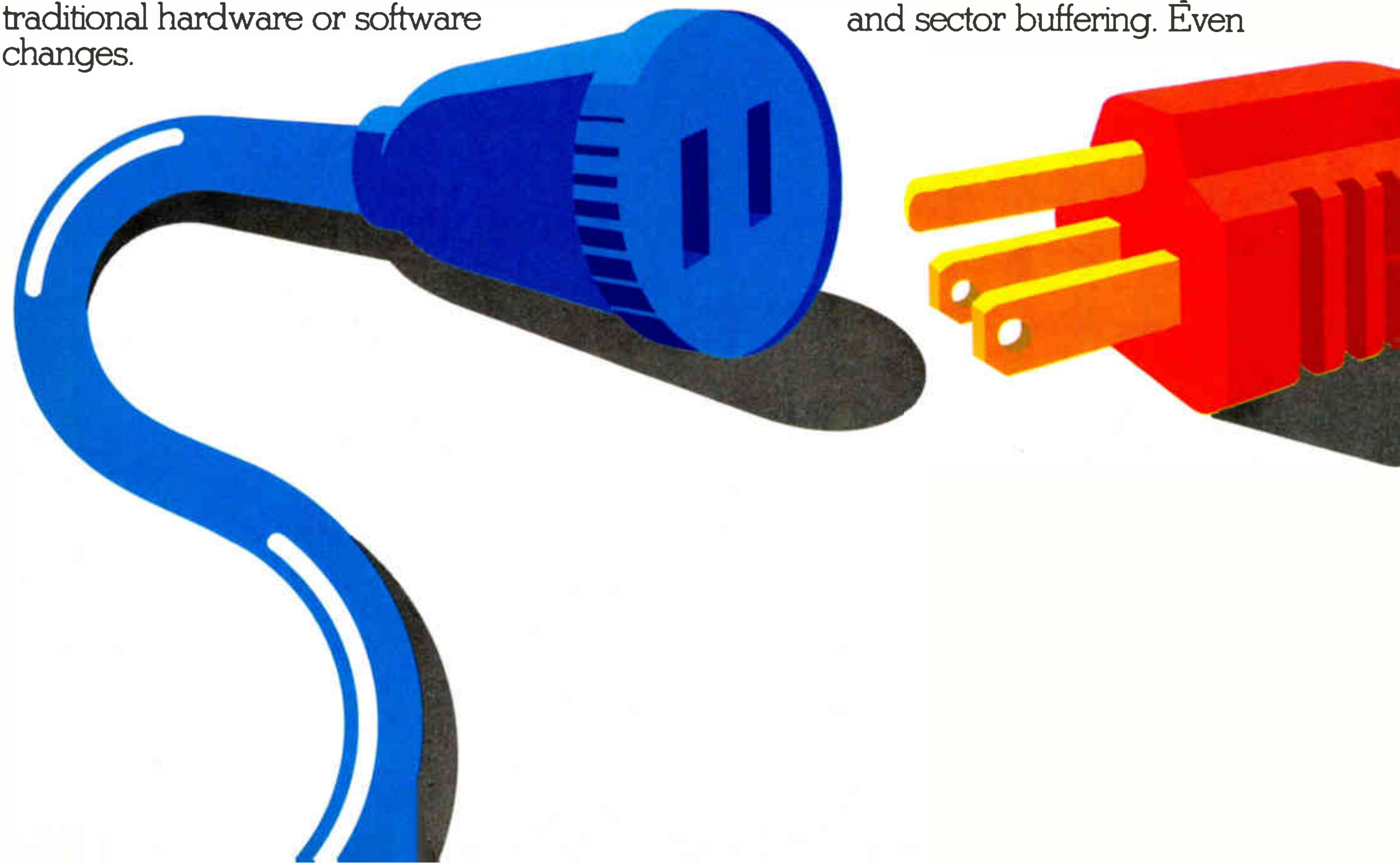

Cutting the high cost of micro-system service

Fluke takes the out of trouble

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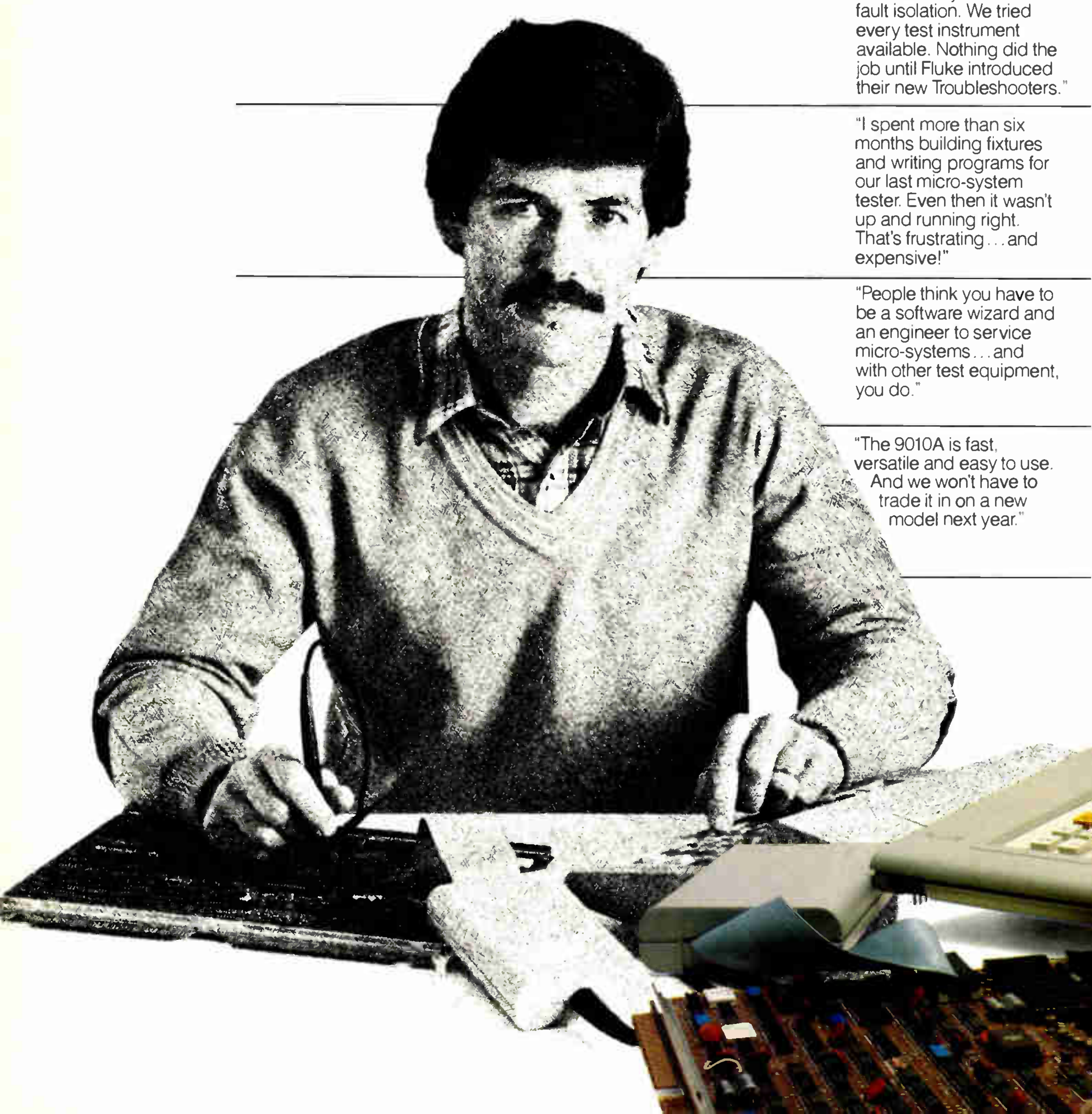

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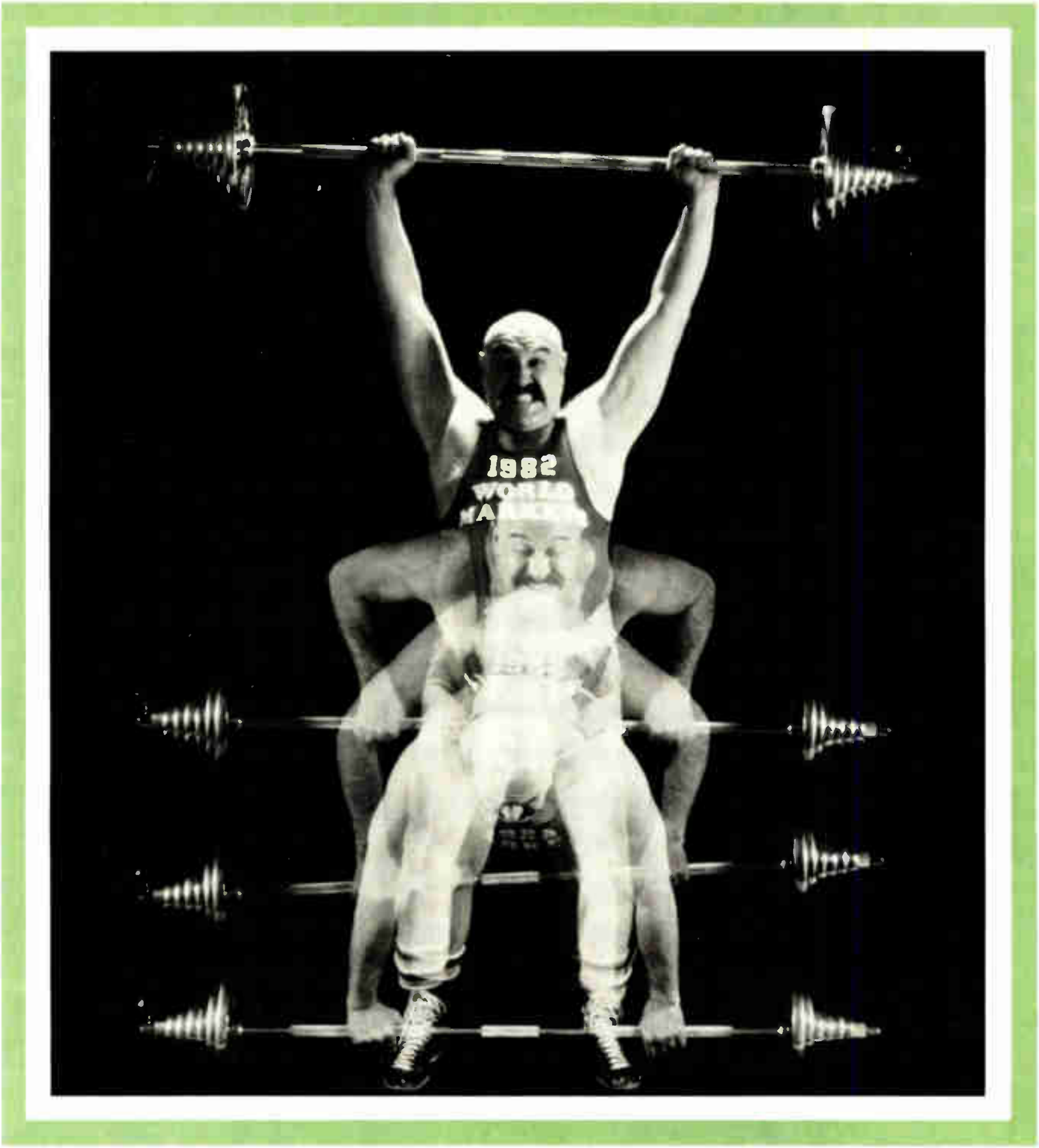
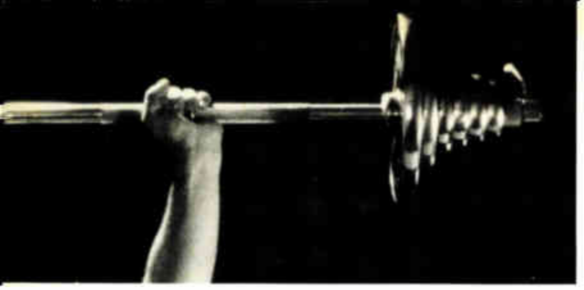


Straining to lift consumption after a slow start

Despite recession, the U. S. will manage a strong finish by year-end; Japan continues steady growth, but Europe faces bleak outlook



United States' markets

In mid-1981, the question in the U. S. was: will a recession really occur? By the end of 1981, with the gross national product declining more than 5% for the last quarter, economists agreed the recession had arrived. The current question is: how long it will last?

Recovery from the recession is hampered by several factors, according to Otto Eckstein, chairman of McGraw Hill Inc.'s Data Resources Inc. He cites a Federal budget in disarray, poor export prospects due to an overvalued dollar, and poor economic performance in most industrial countries. However, DRI predicts a small gain of 0.6% in GNP by the second quarter, with an improved growth rate of 4.8% for the second half in response to the 10% federal tax cut of mid-1982.

"Never have so many reacted so little to so much" is how the McGraw-Hill Economics department describes the public and business response to Reaganomics. Here again predictions point to a slow first-half recovery, with good growth in the second half carrying through into 1983. In fact, McGraw-Hill economists expect the Economic Recovery Tax Act will result in business investment expanding faster in 1982 than any year since 1966.

Consumer spending should increase sharply, suggests DRI, as the July tax cut turns $32 billion back to the public, which could result in more than a 5% gain in real purchasing power in the second half of 1982. Business investment in plant and equipment will not contribute to a boost in the U. S. economy, according to McGraw-Hill's recent capital spending survey. Although firms indicated they planned to increase spending by 9.6%, they also projected a 9.6% rise in equipment prices. So the real capital investment may not change in 1982.

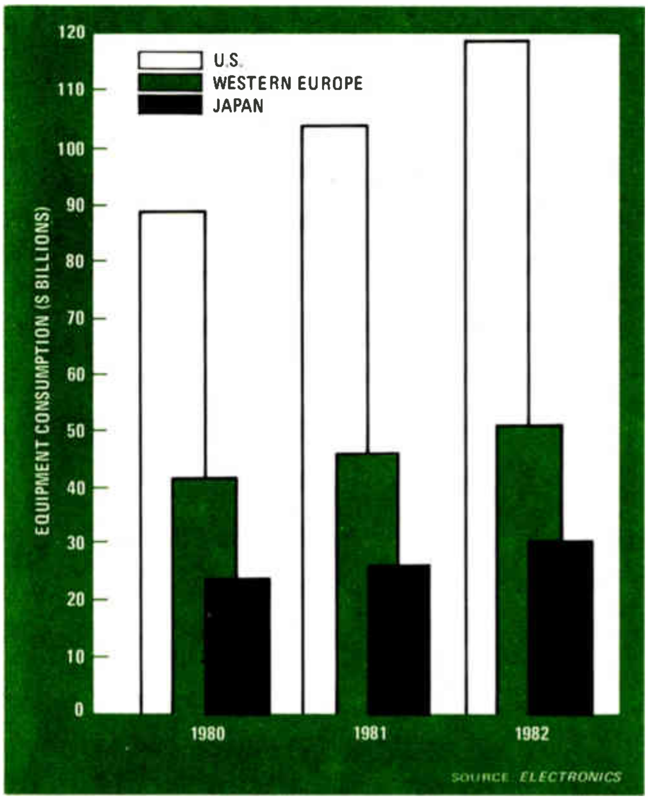
The survey results indicate that a weak economy does more to depress capital spending plans than the Reagan Administration's new accelerated depreciation rules to encourage such spending. However, there was some good news in the study results.

Most respondents indicated they were confident their sales (after removing the effects of inflation) would rise by a welcome 6%. They also predicted their product prices would rise only 7.8% compared to last year's projected 9.9%, an indication that inflation may be winding down.

According to a recent Booz, Allen & Hamilton study, European electronics firms are staunchly defending their traditional markets against the onslaught of U. S. and Japanese competitors. Thus, U. S. firms are reconsidering plans to start up new European facilities, as cost-benefits comparisons for new sites indicate advantages may be marginal with a weak dollar exchange rate. Finally, the study points out that more weight is being placed on the higher cost of local management talent in European countries, coupled with the unforeseen risks and complications of operating an overseas manufacturing facility.

Once again, despite grim concern among semiconductor and semiconductor-equipment manufacturers, the electonics industries appear to be headed for another growth year in 1982. The annual *Electronics* market survey points to 1982 equipment consumption reaching $1.9 billion, a relatively healthy gain of 13.3%.

(Market estimates represent industrywide consumption at the factory level of goods shipped by U. S. and foreign manufacturers. Some product categories have been added, deleted, or redefined this year. Therefore, these totals are not directly comparable to those of previous years. Also, in this report, the dollar amounts are stated at current market prices for the respective year, and no adjustments are made for inflation.)



Semiconductor shipments were predicted to decline by 6.9% in 1981 according to the Semiconductor Industry Association, with a 16.9% rebound in 1982. The SIA envisions a slight upturn in shipments for the first quarter with dramatic gains, as high as 31%, in the last quarter. However, another viewpoint has been expressed by some industry forecasters, who envision a much slower recovery and heavier penetration by Japanese competitors.

Semiconductor equipment manufacturers, battered by cutbacks in capital-equipment investment, question the semiconductor industry claims that equipment budgets for 1982 are equal to or greater than 1981. Cancellations and stretch-outs are what they have been experiencing.

Components, according to the *Electronics* survey, show gains of 10.4% as they reach the $12.56 million level. Data-processing equipment and office-automation systems are expected to surpass $45.96 million, 18% over last year's figures. Communications equipment, in particular that devoted to data communications, shows 5% growth as sales reach $7.26 million. Instrument manufacturers are hopeful that orders will pick up and thus provide a 13% increase over last year.

Industrial electronic equipment will rise close to 30% this year, in sharp contrast to the pessimistic views on capital expenditures to upgrade manufacturing plants. Process-control, energy-management, and sequence-controller equipment appears in demand to improve effectiveness and, it is hoped, to reduce product price hikes. Consumption of process-control equipment, for example, is expected to exceed $1.9 billion, a 15%

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Europe's markets

European market forecasters generally agree that "as Germany goes, so goes the rest of Western Europe." If that rule is true, economy recovery will be slow at best, since West Germany's Chancellor Helmut Schmidt stated his country ended 1981 in its most difficult economic position in decades.

European firms are still reeling from soaring oil prices, investment-inhibiting interest rates, growing inflation, rising unemployment, expensive social welfare programs, and cutbacks in government budgets, to name just a few problems. Electronics firms, in particular, are being bombarded by fierce competition from U. S. and Japanese firms eager to bolster their sagging sales.

But European electronics firms appear to be faring better than other industries like textiles or autos. Although the consumer market appears to have saturated for color-television and audio equipment, sales of video-cassette recorders and video cameras are expected to bring customers into the stores. Computer consumption is still earmarked for healthy growth, but the estimated rate of 13.4% for 1982 is quite a bit less than previous predictions. Communications equipment also faces lower-than-expected growth rates, as the survey results indicate, since many European government budget planners are cutting wherever they can.

Japan's markets

Although Japan's economy is only expected to grow by 4% in 1982, there are few countries that would not swap that modest figure for their lesser estimates. Japan faces pressure from U. S. and other world markets not only to reduce exports to them, but also to increase their share of imports. Another major problem facing Japanese manufacturers is the expected rise of the yen to 200 to the dollar versus 220 last year.

But growth in the electronics sector is expected to climb, with equipment consumption up a bit over 10% to more than $30 billion. Industrial equipment sales are targeted to rise at a strong 22%, as Japanese firms strive to improve their competitive edge with updated machinery and test gear. Other countries, including the U. S., are seeing cutbacks in capital expenditures.

Japan's consumer product consumption is headed for another boom as VCRs continue to gain popularity. Japanese VCR manufacturers, providing the bulk of products sold worldwide, are prepared to turn out 12 million units this year, with 2 million headed for Japanese buyers. The growing attraction of a portable, battery-operated VCR coupled with a color video camera to provide low-cost, instant movies has triggered an explosion in demand for video cameras.

Finally, component sales in Japan are expected to exceed 13% as mainframe computers, office automation products, and consumer electronics move from production lines out to waiting customers. Memory and linear integrated circuits appear set to show the largest gains in semiconductor wares.

Semiconductors

As 1981 ended, some pessimism began to temper optimism in semiconductor sales predictions. On the one hand, respondents to *Electronics'* annual survey estimated total semiconductor sales in 1982 will rise to $8.224 billion at a rate of 19.3%, compared to last year's slight rise of 4.2%. Also, the Semiconductor Industry Association last fall estimated a 6.9% decline in worldwide shipments for 1981 and a 17% gain in 1982, accelerated by a 31% fourth-quarter spurt.

On the other hand, Dataquest Inc., Cupertino, Calif., recently revised its forecast of a 13% rise in U. S. semiconductor consumption in 1982 to a more cautious 6.1% increase. On a more somber note, a forecast prepared by In-Stat, Scottsdale, Ariz., projects a decline of 6.9% in 1982 for U. S. and European semiconductor manufacturers. Industry observers point to high inflation and unemployment, rising inventories, and cutbacks in production as key factors.

The slight increase in 1981 consumption of semiconductors in the U. S. also is a reflection not so much of lower sales as of declining prices for some chip types. Most responsible for the 1981 slump was a severe decline in memory sales due to eroding prices of random-access memories and nonvolatile devices such as erasable programmable read-only memories.

In contrast, consumption figures for microprocessors reflect booming sales, with no weakening in prices, as their applications spread. In linear circuitry, the market is holding up across the board, with an expected 18% overall increase, while optoelectronic chips should experience a 22% growth this year, due to the spread of fiber-optic communications systems. A 5.8% growth in discrete components represents a healthy increase in the market for power devices, although other discretes are losing applications to integrated circuits.

Reports circulated in the IC industry that 16-K RAMs sold for less than $1 each—80¢ in one case—as part of some very large memory chip orders last year. At 80¢, that works out to an all-time low of about 5 millicents per bit. The per-part price of 64-K chips fell below $10 in 1981, and it is now estimated that 200-nanosecond and slower 64-K RAMs will sell for $5 or less by the end of this year, with 150-ns versions coming in at $6 or less.

Byte-oriented static RAM prices are also plummeting, spurred by an announcement from Toshiba Corp. that its 2-K-by-8-bit n-channel static RAM, aimed squarely at microprocessor applications, can be bought for $9.95 each in large quantities. A similar price collapse is now expected for complementary-MOS 16-K static RAMs, since several Japanese manufacturers are in volume production and are quickly moving to the 64-K level with 8-K-by-8-bit n-channel and C-MOS versions.

SEMICONDUCTORS

(millions of dollars)	1980	1981	1982	1985
SEMICONDUCTORS, TOTAL	**6,633.7**	**6,902.8**	**8,233.8**	**14,949**
Discrete semiconductors, total	**1,254.8**	**1,338.8**	**1,416.4**	**1,770**
Diodes, total	488.8	509.3	534.6	614
Signal	51.1	54.2	54.0	60
Rectifier	245.5	250.7	262.5	295
Arrays	20.1	20.5	23.7	28
Zener, total	116.1	120.1	122.0	145
Voltage regulator	89.2	91.7	92.9	109
Reference	26.9	28.4	29.1	36
Special-purpose, total	56.0	63.8	72.4	86
Microwave	46.2	53.6	61.8	73
Varactor (less than 1 GHz)	8.6	9.0	9.5	12
Tunnel	1.2	1.2	1.1	1
Transistors, total	617.9	678.0	727.1	971
Bipolar, total	547.4	587.6	616.0	748
Small-signal (less than 1 W)	198.1	207.7	216.9	237
Power (1 W or more)	242.3	259.3	274.0	363
Duals and arrays	9.5	11.0	12.0	13
Rf, total	97.5	109.6	113.1	135
Small-signal	35.0	40.0	43.0	50
Power (more than 1 W)	62.5	69.6	70.1	85
Field-effect, total	70.5	90.4	111.1	223
Junction, total	20.5	24.4	29.1	39
Small-signal (less than 1 W)	19.7	23.6	28.1	38
Power (1 W or more)	0.8	0.8	1.0	1
MOS, total	37.5	49.0	62.0	157
Small-signal (less than 1 W)	28.0	29.0	30.0	32
Power (1 W or more)	9.5	20.0	32.0	125
Gallium arsenide	12.5	17.0	20.0	27
Thyristors	129.3	130.8	132.0	155
Protection devices (incl. varistors)	18.8	20.7	22.7	30
Integrated circuits, total	**5,189.9**	**5,351.4**	**6,558.2**	**12,715**
Standard logic families, total	1,313.4	1,215.8	1,377.3	2,328
TTL, total	919.4	817.8	897.3	1,526
Standard TTL	341.0	242.8	247.0	440
Schottky TTL, total	578.4	575.0	650.3	1,086
Standard (S)	150.4	170.0	185.3	280
Low-power (LS)	424.0	393.0	432.0	668
High-speed (AS, ALS, FAST)	4.00	12.0	33.0	138
ECL	74.0	85.0	97.0	170
C-MOS	280.0	272.0	340.0	582
Other (RTL, DTL)	40.0	41.0	43.0	50
Microprocessor and microcomputer, total	641.4	825.7	1,115.1	2,566
Microprocessors, total	154.2	198.5	295.0	897
MOS, total	128.1	164.8	251.0	807
8-bit	100.6	124.7	152.3	335
16-bit	27.5	40.1	93.7	330
32-bit	0.0	0.0	5.0	142
Bipolar, total	26.1	33.7	44.0	90
Bit-slice (incl. adjuncts)	20.1	25.2	33.0	65
Full CPU	6.0	8.5	11.0	25
One-chip microcomputers, total	345.0	428.4	550.3	1,057
4-bit (controllers)	180.0	225.0	270.0	444
8-bit	140.0	155.4	194.3	379
16-bit	25.0	48.0	86.0	234
LSI peripheral chips, total	142.2	198.8	269.8	612
Support devices (DMA, MMU, etc.)	52.2	63.8	79.8	195
Peripheral equipment controllers	90.0	135.0	190.0	417
Dedicated LSI circuits	257.0	298.0	351.0	690
Semicustom logic (incl. gate arrays)	47.1	61.0	81.3	230
Memories, total	1,862.0	1,753.2	2,238.0	4,628
Random-access, total	981.0	827.7	1,073.0	2,316

Heavy competition also forced down tags on E-PROMs, at both 16- and 32-K densities, causing the market for these chips to fall off from $264 million in 1980 to about $200 million in 1981. The 16-K devices, for example, which sold for over $25 in mid-1980, can now be bought for $3 in the U.S. and less than $2 in Europe. The 1982 E-PROM market, at $240 million, will not even be back up to the 1980 level.

Other nonvolatile memory markets have managed to remain relatively healthy. Fuse-based PROM sales will be essentially flat over the 1980 to 1982 period, but the market for electrically erasable PROMs zoomed 135% in 1981 and will pop up another 62% in 1982, now that 16-K EE-PROMs have established themselves.

Breaking down semiconductor consumption by technology shows that C-MOS is riding high. The market for C-MOS standard logic families, for instance, will swell to 340 million in 1982—a 25% rise over 1981 sales. Similarly, the consumption of C-MOS static RAMs will grow 41% during 1982, from $107 million to just over $150 million. C-MOS is also a big selling point for single-chip microcomputers and larger read-only memories, especially for portable consumer products.

A hot new area for semiconductors is custom and semicustom circuits such as gate arrays, and C-MOS will play an important role here, too. Consumption of gate arrays and semicustom circuits will grow 33% for 1982 sales of $81 million.

A big jump in 16-bit microprocessor and minicomputer sales was due mainly to the growing market in software for these devices. Next year 16-bit sales will soar even higher now that commercially available 16-bit microsystems are finally hitting the market—for example, the IBM Personal Computer.

Sales of 8-bit microprocessor and microcomputers also rose, but not at as fast a rate as the 16-bit parts. This softening growth will probably continue too, since, as 16-bit sales increase, they will become practically as inexpensive as 8-bit units.

Last year saw linear IC consumption up nearly 12%, and 1982 is expected to be better still. The projected 18% growth will bring the total market up to some $890 million. Process-control and other data-acquisition applications appear as the driving force, with growth rates of at least 30% anticipated for converter chips. Operational amplifiers and interface circuits—which along with data-conversion chips will continue to account for two thirds of the dollar volume—are marked for 15% growth to $193 million and $117.5 million, respectively.

Optoelectronic devices—a $212 million market last year—is expected to more than double by 1985. Applications in fiber-optic communications are pushing demand for light-emitting and laser diodes and photodetectors. Overall growth this year is expected to be close to 22%.

The anticipated modest increase of less than 6% in discrete semiconductors reflects the continued inroads of ICs into discrete territory, along with moderate growth in power and radio-frequency transistors. Although only a small fraction of the market, power MOS field-effect transistors and gallium arsenide devices made the strongest showings in 1981, up 110% and 36% to $20 million and $17 million, respectively.

	1980	1981	1982	1985
Dynamic, total	602.0	405.2	535.0	1,227
4-K	55.0	38.0	29.0	4
16-K	490.0	253.0	223.0	118
32-K (partial or hybrid)	44.0	51.0	97.0	100
64-K	13.0	63.2	182.0	880
256-K	0.0	0.0	4.0	125
Pseudostatic	0.0	4.0	4.0	30
Static, total	379.0	418.5	534.0	1,059
Bipolar	109.0	110.0	130.0	240
n-MOS, total	175.0	201.0	253.0	457
Fast (70 ns or less)	64.0	83.0	133.0	365
Slow	111.0	118.0	120.0	92
C-MOS, total	95.0	107.5	151.0	362
Fast	37.0	53.5	101.0	321
Slow	58.0	54.0	50.0	41
Read-only, total	819.0	841.0	1,060.0	2,109
Mask type, total	230.0	309.0	401.5	807
n-MOS	184.0	258.0	344.0	616
p-MOS	25.0	24.0	22.5	29
C-MOS	21.0	27.0	35.0	162
Fuse-link type	288.0	245.0	277.5	499
Erasable programmable type, total	301.0	287.0	381.0	803
Ultraviolet (E-PROM)	264.0	200.0	240.0	470
Electrical (EE-PROM)	37.0	87.0	141.0	333
CCDs (memory only)	14.5	14.5	16.0	20
Magnetic-bubble (incl. support circuits)	47.5	70.0	89.0	183
Linear ICs, total	676.0	755.7	891.5	1,466
Analog switches	39.5	41.6	46.0	55
Operational amplifiers	153.0	167.7	193.3	298
Instrumentation and isolation amplifiers	8.0	9.0	10.7	17
Comparators	25.5	27.0	31.0	45

	1980	1981	1982	1985
Voltage regulators	65.0	73.0	90.0	120
Timers	52.0	60.0	62.0	71
Other (incl. functional ICs)	13.5	17.0	22.0	40
Data conversion, total	155.0	177.2	233.0	450
D-a converters	77.5	87.7	114.5	230
A-d converters	51.3	59.5	83.5	160
Multiplexers	17.5	21.0	23.0	40
Sample-and-holds	8.7	9.0	12.0	20
Interface (incl. memory drivers)	92.4	102.0	117.5	240
Communications	72.1	81.2	86.0	130
Consumer product ICs, total	393.0	442.0	504.0	807
Entertainment	121.0	128.0	138.0	185
Calculator chips	50.0	46.0	41.0	35
Watch chips	68.0	65.0	58.0	42
Game chips	75.0	100.0	130.0	260
Other (incl. cameras, toys, and organs)	79.0	103.0	137.0	285
Optoelectronic devices, total	**189.0**	**212.6**	**259.2**	**464**
Photovoltaic (solar) cells	17.5	24.0	32.1	63
Photoconductive cells (resistive)	11.5	14.2	20.0	33
Light-emitting diodes (discrete), total	64.5	71.5	86.6	150
Visible	47.0	52.5	65.5	106
Infrared, near-infrared	17.5	19.0	21.1	44
Laser diodes	5.5	8.0	12.5	25
Photodiodes (incl. arrays)	12.6	15.1	18.6	34
Phototransistors (incl. arrays)	23.1	25.8	30.0	52
Optically coupled isolators	54.3	54.0	59.4	107

Components

The components markets overall continue to show the stability and modest growth characteristic of mature technologies. Last year's $11 billion market was up almost 9% from 1980, and this year is expected to be slightly better, with about a 12% growth. Among the brightest spots are those sectors that exploit advances in semiconductor technology, notably the hybrid circuit industry, and to a lesser extent, displays and transducers.

The consumption of passive components this year will likely follow recent trends, with resistors and capacitors growing about 7.7% and 9.6% to $891 million and $1.4 billion respectively. Networks and chip resistors are pegged for a stronger than average showing, with annual growth of about 13% and 30%, respectively, out to 1985.

Chip, ceramic, and aluminum and tantalum electrolytic units will account for most of the growth in capacitors—about 11% annually versus 4% for all the others.

Among relays, with a projected overall growth of 5.6%, solid-state versions will fare better, with a 12% increase in the offing this year to $52.8 million.

With a healthy demand from small-computer makers shaping up, *Electronics* predicts that the use of keyboards and keypads will grow about 22% annually to $275 million in 1985. Other switch types will show a more modest 12% growth rate for this period. Among magnetic parts, transformer cores, coil forms, and other ferrite components are expected to turn around this year, after a 5% decrease last year. Increased switching power

COMPONENTS

(millions of dollars)	1980	1981	1982	1985
COMPONENTS, TOTAL	**10,320.1**	**11,220.2**	**12,545.8**	**16,715**
Resistors, total	**783.9**	**827.3**	**891.0**	**1,109**
Fixed, total	237.3	239.3	246.3	283
Composition	62.5	62.0	62.3	64
Deposited carbon film	20.2	20.3	21.0	23
Metal-film	80.5	81.0	83.0	105
Wirewound	74.1	76.0	80.0	91
Variable, total	276.7	287.7	300.2	343
Potentiometers, wirewound	44.5	45.2	47.7	52
Potentiometers, nonwirewound	111.5	116.7	122.1	141
Trimmers, wirewound	25.9	26.1	26.8	32
Trimmers, nonwirewound	94.8	99.7	103.6	118
Thermistors	53.3	59.2	68.1	89
Resistive networks, total	195.6	218.0	247.0	336
Thin-film	88.1	96.0	106.3	137
Thick-film	107.5	122.0	140.7	199
Chip	21.0	23.1	29.4	58
Capacitors, total	**1,182.1**	**1,251.4**	**1,371.6**	**1,750**
Paper	97.3	100.0	104.7	118
Film	121.4	125.6	129.4	137
Electrolytic, total	451.5	466.4	505.5	627
Aluminum	210.7	212.6	230.1	290
Tantalum	240.8	253.8	275.4	337
Mica	33.1	34.0	35.7	39
Glass and vitreous enamel	12.1	13.6	14.7	18
Ceramic (except chips)	377.0	407.2	460.1	629
Variable	31.0	33.3	35.5	42
Chip	58.7	71.3	86.0	140
Relays, total	**494.8**	**526.0**	**555.6**	**618**
General-purpose	150.0	160.3	167.9	175
Telephone-type	36.7	40.1	44.0	51
Crystal-can	81.1	85.6	92.8	102
Rf	98.6	101.0	101.7	108
Reed	47.2	50.3	52.8	59
Stepping	8.7	8.9	9.0	10
Time-delay	30.5	32.7	34.6	40
Solid-state	42.0	47.1	52.8	73
Switches and keyboards, total	**713.8**	**792.5**	**907.9**	**1,278**
Small-movement snap-action	88.5	93.7	106.0	149
Lighted	94.1	105.1	118.8	167
Push-button	109.4	119.8	140.3	189
Toggle	32.4	36.0	39.7	52
Slide	56.6	62.7	70.3	89
Rotary	100.5	108.0	114.2	136

(millions of dollars)	1980	1981	1982	1985
Coaxial	25.1	28.4	32.4	47
Thumbwheel	27.5	32.8	36.5	43
Dual in-line	32.1	36.9	42.2	58
Keypads, keyboards, and matrixes, total	118.5	133.8	164.9	275
Keypads	14.9	16.8	19.0	28
Keyboard assemblies (incl. capacitive)	93.5	105.7	132.6	229
Matrix programming boards	10.1	11.3	13.3	18
Solid-state (incl. Hall-effect)	29.1	35.3	42.6	73
Magnetic, total	**548.9**	**564.4**	**600.2**	**716**
Ferrite components (coil forms, etc.)	50.4	48.0	50.0	54
Power transformers, total	308.8	319.0	338.0	406
Laminated	202.7	208.1	217.5	252
Toroidal	62.7	64.9	70.7	87
Pulse	43.4	46.0	49.8	67
Af and rf transformers, coils, and chokes	12.7	13.0	14.9	16
TV magnetic components (incl. yokes)	177.0	184.4	197.3	240
Electron tubes, total	**1,393.7**	**1,458.5**	**1,536.0**	**1,819**
Receiving	94.5	78.3	69.5	41
Power and special-purpose, total	416.5	454.0	480.1	584
Vacuum	86.1	89.0	93.0	100
Gas and vapor	24.4	25.0	26.0	29
Klystrons	59.2	68.0	74.3	94
Magnetrons	57.4	61.4	65.6	80
TWTs (incl. backward-wave)	130.9	148.2	153.6	197
Light-sensing (incl. photomultipliers)	17.3	18.2	19.1	22
Image-sensing (vidicon, orthicon, etc.)	41.2	44.2	48.5	62
Cathode-ray (except TV), total	49.3	52.1	56.8	72
Storage tubes	8.5	7.7	7.0	4
Other	40.8	44.4	49.8	68
TV picture, total	833.4	874.1	929.6	1,122
Black and white	29.1	24.0	20.0	11
Color	804.3	850.1	909.6	1,111
Microwave components, total	**179.8**	**194.0**	**211.8**	**283**
Mixers	12.5	14.1	16.0	24
Detectors	8.3	9.4	10.8	16
Amplifiers	35.0	39.2	44.7	68
Passive components, total	46.0	49.0	52.7	67
Waveguide	10.0	10.8	11.9	16
Coaxial and strip-line	36.0	38.2	40.8	51
Switches, total	38.0	40.7	43.9	56
Waveguide	13.0	13.9	15.0	19
Coaxial and strip-line	25.0	26.8	28.9	37
Ferrite devices	32.3	33.6	35.3	42
Power limiters	7.7	8.0	8.4	10

supply use is one reason for the reversal.

Expansion in the telecommunications industry, along with projected increases in military spending, are combining to produce fairly optimistic expectations for microwave components and power electron tubes—9% and 6%, respectively, to $211.8 million and $480 million for this year. Klystrons and traveling-wave tubes, second only to color TV tubes in dollar volume, are getting an added boost in demand from fusion-reactor experimenters; growth for these units is marked at around 9%, reaching $74.3 million and $153.6 million in 1982.

The market for display devices will shift further toward multicharacter assemblies. Liquid-crystal types are predicted to match light-emitting diodes in this category this year and substantially surpass them in total dollar value by 1985. Progress with driver circuits for gas-discharge (plasma) displays will propel dot-matrix types ahead of segmented displays this year. An annual growth of about 15% is anticipated in displays, pushing this market up to about $470 million by 1985.

Pressure and temperature sensors are leading the way in the market for electronic transducers. These two types are expected to grow 11% in 1982, with the total market growing to $435 million by 1985.

Hybrid- and modular-circuit users bought 20% more parts last year, and a comparable increase is expected this year, bringing the total market value up to about $675 million. Nearly half of this represents custom circuitry, which is projected to grow at around 15% annually in the next 3 years.

Data-acquisition components will continue to comprise the bulk of the standard circuits purchased. Data converters alone will continue to make up nearly 35% of the hybrid market, with digital-to-analog units expected to grow to $145 million by 1985, representing approximately a 5% annual growth. Analog-to-digital converters will exhibit a similar increase, accounting for about $90 million by 1985.

	1980	1981	1982	1985
Readout devices, total	**247.2**	**286.6**	**335.8**	**467**
Single-character, total	56.4	55.9	58.8	63
Incandescent	5.0	5.3	5.6	7
Fluorescent	5.2	5.6	6.2	8
Light-emitting-diode	46.2	45.0	47.0	48
Multiple-character, total	190.8	230.7	277.0	404
Gas-discharge, total	82.2	102.8	121.5	179
Segmented	42.0	52.5	59.5	86
Dot-matrix	40.2	50.3	62.0	93
Vacuum fluorescent	7.1	8.0	8.5	11
Light-emitting diode	60.6	65.4	74.9	90
Liquid-crystal	40.9	54.5	72.1	124
Transducers (electronic), total	**251.8**	**282.2**	**311.7**	**435**
Pressure (incl. air, liquid, mechanical)	87.4	97.1	108.1	134
Temperature (excluding thermocouples and thermistors)	44.3	53.4	59.4	104
Motion, linear and angular	39.4	43.2	47.4	58
Fluid-level	36.3	40.1	43.9	67
Vibration	44.4	48.4	52.9	72
Crystals, total	**110.1**	**114.5**	**118.5**	**131**
Discrete, total	46.1	48.4	50.6	59
Communications	33.0	34.9	35.8	41
Color TV	2.7	2.7	2.8	3
Watches	6.0	6.0	7.0	8
Other	4.4	4.8	5.0	7
Assemblies (incl. mounts and ovens)	64.0	66.1	67.9	72
Passive filters and networks, total	**137.2**	**146.6**	**158.9**	**225**
Electromechanical filters, total	51.5	54.2	57.1	68
Crystal	39.0	40.6	42.2	48
Ceramic	8.7	9.1	10.0	13
Other	3.8	4.5	4.9	7
Rfi and emi filters	53.2	56.4	61.2	82
RC networks	14.5	15.9	16.5	22
Delay lines	18.0	20.1	24.1	53
Hybrid and modular components, total	**464.1**	**559.1**	**674.7**	**917**
Operational amplifiers	38.1	42.6	46.4	70
Instrumentation and isolation amplifiers	15.7	19.7	25.0	38
Data conversion, total	138.5	177.3	232.1	279
D-a converters	72.1	90.4	125.0	145
A-d converters	46.9	61.2	75.3	90
Multiplexers	6.8	8.9	11.6	13
Sample-and-holds	6.8	9.0	11.7	14
Converter subsystems	5.9	7.8	8.5	17

	1980	1981	1982	1985
Analog-I/O (data-acquisition) boards	15.0	19.0	23.0	35
Signal sources (incl. oscillators)	3.0	3.4	4.0	6
Active filters	10.1	11.6	13.3	16
Other functional circuits	18.7	19.9	21.0	23
Miscellaneous custom functions	225.0	265.6	309.9	450
Connectors, total	**1,316.9**	**1,376.8**	**1,559.2**	**2,181**
Coaxial, total	108.8	109.4	118.1	154
Standard	58.8	59.3	60.1	68
Miniature	50.0	50.1	58.0	86
Cylindrical, total	333.7	374.9	425.1	622
Standard	81.0	92.0	105.1	140
Miniature	186.2	209.9	240.0	360
Subminiature	66.5	73.0	80.0	122
Rack-and-panel	246.0	251.0	270.1	347
Printed-circuit edge connectors, total	346.5	338.7	391.7	550
Card-insertion	222.2	207.1	238.0	315
Two-piece, metal-to-metal	124.3	131.6	153.7	235
Flat-cable	120.4	136.1	165.4	245
Fiber-optic	4.0	6.5	9.0	25
Special-purpose	157.5	180.2	179.8	238
Printed circuits and interconnection systems, total	**1,771.6**	**1,979.8**	**2,223.3**	**3,401**
Printed circuits, total	1,395.2	1,581.8	1,758.6	2,676
Rigid boards, total	1,314.4	1,490.8	1,647.4	2,509
Single-sided	149.4	139.6	130.7	106
Double-sided	795.3	920.1	1,005.0	1,525
Multilayer	369.7	431.1	511.7	878
Flexible circuits	80.8	91.0	111.2	167
Interconnections, total	376.4	398.0	464.7	725
Sockets and socket panels for DIPs	215.4	235.7	273.8	417
Backplanes	161.0	162.3	190.9	308
Wire and cable, total	**724.2**	**860.5**	**1,089.6**	**1,385**
Coaxial cable	270.5	327.8	435.6	502
Flat cable	77.6	93.4	120.6	168
Hook-up wire	160.0	180.3	192.2	212
Multiconductor, shielded	131.0	158.4	194.7	248
Multiconductor, unshielded	75.1	80.1	95.4	135
Fiber-optic cable	10.0	20.5	51.1	120

ELECT A-32

U.S. markets

Data processing & software

Ignoring the downward slope of the rest of the economy, the U. S. computer industry is racing so fast ahead that many observers predict it will careen into the next century ahead of any other contender. An Wang, president of Wang Laboratories, calls computers in his company's 1981 annual report "one of the greatest growth industries of all time."

Though a little softness may slow the market in the first half of 1982, exceptional overall growth will still be the order of the day—with the two-edged sword of oversupply the cutting edge of any tightness. As yet, though, many tyro firms for office automation, super-mini-, fault-tolerant, and personal computers, and graphic and video-display terminals are plunging onto the fast track and selling all they can produce.

Electronics puts its money on data-processing systems, peripherals, and office equipment for the next year and also for the subsequent three years, given halfway decent economic conditions. The bet is for computers and associated peripheral products to beat 1981's figures by 18% and reach $45.9 billion by next year. Last year, *Electronics* projected a 17% rise to $35.95 billion, and the figures so far peg the 1981 market at $38.8 billion, not far off. Odds are that by 1985, total factory sales into the U. S. noncaptive market of computer and office equipment will come in at $74.8 billion.

The market for personal computers in business is expected to be one of the decade's explosive growth areas. The 1981 *Electronics* survey projects the market for small business and personal computers under $10,000 at $2.5 billion in 1982 and foresees a compound annual growth rate of 36.5% for the following three years to reach $6.4 billion in 1985. Analysts of the computer market expect that International Business Machines Corp.'s foray into the personal computer segment will increase the demand for these small machines and thus expand the total market. Market researchers Future Computing Inc., International Data Corp., and Venture Development Corp. predict that IBM will take 27% to 30% or more of the market by 1986. The current industry leaders, Apple Computer Inc., Tandy Corp., and Commodore International Ltd., will continue to pace the total market growth but are expected to lose a certain share of the market to IBM. Future Computing projects that in 1982, IBM sales will catch up with Apple and Tandy, with each of the three vendors selling about $400 million; however, by 1985 it expects IBM to be at the $1.6 billion level, with Apple at $800 million and Tandy trailing at about $600 million.

In the minicomputer field, the current superstars are the 32-bit superminicomputers. That market grew from $500 million in 1980 to $650 million in 1981; it will leap ahead by more than 50% in 1982 to $988 million and continue to forge upward by a compound annual rate of some 43% to $2.890 billion by 1985, according to the *Electronics* survey (see chart).

More good news is the growing positive trade balance in computers and business equipment. In 1980, the trade surplus—the amount by which exports outdo imports—jumped to $6 billion from the 1979 level of $4 billion. As

DATA PROCESSING

(millions of dollars)	1980	1981	1982	1985
Data-processing systems, peripherals, and office equipment, total	**33,061.2**	**38,836.7**	**45,851.4**	**74,822**
System end-user & dealer sales, total	**12,634.0**	**14,479.0**	**16,909.8**	**26,809**
Desktop computers	945.0	1,500.0	2,500.0	6,428
Small-business, personal (<$20K)	200.0	400.0	700.0	1,210
Small ($20K to $100K)	400.0	512.0	716.8	1,148
Medium-sized ($0.1 to $1 million)	3,746.0	4,100.0	4,428.0	5,990
Large computers (>$1 million)	7,343.0	7,967.0	8,565.0	12,033
OEM micros and minis, total	4,684.4	5,591.4	6,618.2	10,945
Microcomputers	634.4	1,031.4	1,390.2	2,640
Minicomputers, total	4,050.0	4,560.0	5,228.0	8,305
16-bit and below	3,550.0	3,910.0	4,240.0	5,415
32-bit	500.0	650.0	988.0	2,890
Memory systems, total	759.0	826.6	880.0	1,299
Mainframe add-on systems	431.6	458.6	470.0	609
Minicomputer add-in/on systems	94.4	113.5	134.5	210
OEM systems, total	233.0	254.5	275.5	480
Core	84.0	71.0	60.0	40
Semiconductor	149.0	183.5	215.5	440
Data-storage subsystems, total	2,797.8	3,391.7	4,016.8	7,153
Disk pack	869.0	898.5	926.5	1,000
Fixed-disk	650.0	819.7	1,024.0	1,995
Combination fixed disk and cartridge	500.0	675.0	810.0	1,400
Flexible-disk	306.0	428.4	578.3	1,587
Reel-type magnetic-tape	395.0	481.9	578.3	1,000
Cassette and cartridge magnetic-tape	77.8	88.2	99.7	171

	1980	1981	1982	1985
Input/output peripherals, total	3,060.7	3,661.2	4,423.8	7,381
Card-read/punch	80.0	62.0	50.0	30
High-speed line printers (>1,000 lpm)	226.3	271.6	330.0	680
Medium-speed (100 to 1,000 lpm)	781.0	898.0	1,041.7	1,503
Slow serial printers (<100 lpm), total	855.2	1,090.6	1,397.4	2,485
Impact	643.7	836.8	1,087.8	1,880
Nonimpact (thermal, electrostatic)	211.5	253.8	309.6	605
Large nonimpact printers (laser, etc.)	140.0	165.0	190.0	312
Computer output microfilm	208.0	238.0	266.5	355
Optical character and mark readers	400.0	468.0	538.0	818
Magnetic character and mark readers	18.0	17.1	16.5	13
Electromechanical plotters	289.0	380.0	510.0	1,040
Digitizers, graphics tablets, light pens	33.2	42.9	59.7	125
Paper-tape readers and punches	30.0	28.0	24.0	20
Key-entry systems	256.6	241.9	230.0	197
Data terminals, total	3,109.2	3,961.2	5,155.3	9,625
Teleprinter terminals	687.6	859.5	1,020.0	1,395
CRT terminals, total	1,960.0	2,530.0	3,415.5	6,830
Intelligent	780.0	1,100.0	1,485.0	3,330
Other	1,180.0	1,430.0	1,930.5	3,500
Graphics terminals, total	417.6	531.7	683.8	1,370
Storage-tube	135.6	155.9	151.1	121
Vector refresh	50.0	65.0	85.0	130
Raster-scan, total	232.0	310.8	447.7	1,119
Black and white	95.0	125.0	169.0	190

of 1981, the surplus kept swelling—in the first nine months, it was 19% ahead of where it was after the same period in 1980. If that trend is found to have persisted to year-end, the U. S. trade surplus in computers and business equipment during 1981 will have reached a record $7 billion, according to the Computer and Business Equipment Manufacturers' Association.

The association believes that this surplus could increase by at least 10%, if not 20%, in 1982. It notes that business equipment, notably word processing and electronic typewriters, are the main force behind increasing exports. CBEMA also points out that domestically the computer industry has been growing at 16% to 20% a year and that, foreclosing total economic collapse, it is likely to keep on spurting its annual 15% or more, at least for the near future.

Control Data Corp., in a year-end review of conditions in the computer industry, looks for the growth rate worldwide for the industry to be somewhat slower in 1982 than in 1981, but stops short of warning of any catastrophic slowdown. Three reasons for slightly slower growth, according to the firm, are that the growing installed base will necessarily shrink the rate of growth; that there is likely to be a recessionary impact in 1982 delaying capital expenditures by potential buyers of computing systems; and that a slow West European market may dangerously infect the U. S.

As for peripheral products, annual growth rates historically have nicked the 30% mark, but Control Data, bearing in mind its tripartite forecast, puts 1982 prospects at about half that.

Sperry Univac also foresees continuing health for the U. S. computer industry. In the division's year-end business statement and forecast for 1982, president Joseph J. Kroger says, "Despite the current worldwide economic recession, the computer industry is still a major growth business." Noting that each week the competition heats up, and not only in the U. S., Kroger states: "New entries into the industry range from small entrepreneurs to mammoth corporations . . . who have observed the growth opportunities and are seeking a share of the data-processing marketplace." Sperry Univac believes the computer industry will continue to thrive because new areas of computer use are continually finding their way to the market.

	1980	1981	1982	1985
Color	137.0	185.8	278.7	929
Remote batch and job-entry terminals	44.0	40.0	36.0	30
Source data-collection equipment, total	1,533.0	1,733.3	1,923.2	2,920
Point-of-sale systems	465.0	514.5	562.4	815
Banking systems	268.0	295.8	322.5	455
Industrial data-collection systems	110.0	129.0	145.0	250
Other specialized terminals	690.0	794.0	893.3	1,400
Office equipment, total	4,226.5	4,950.4	5,694.3	8,493
Nonconsumer calculators	358.0	394.4	445.6	809
Word-processing	1,250.0	1,625.0	2,047.5	3,268
Dictation	302.5	310.0	326.7	467
Copying	2,257.0	2,550.0	2,789.0	3,800
Facsimile transmission	59.0	71.0	85.5	149
Software, total	**1,714.3**	**2,283.9**	**3,061.1**	**7,555**
Operating systems	404.6	506.2	648.2	1,392
High-level languages (incl. compilers and interpreters)	388.9	492.7	687.9	1,563
Diagnostic and debugging tools (incl. software)	240.4	392.1	512.6	1,112
Computer-aided design software	196.3	320.7	480.3	1,440
Application programs	484.1	572.2	732.1	2,048

Software in the spotlight

The computer industry has taken a turn that would probably surprise the computer pioneers of the 1940s and 1950s—by 1985, software costs for microsystems are expected to outrun the cost of the hardware itself.

Two factors complicate any survey of software, however: often the software comes bundled with the hardware, and also many new programs are developed and closeted in house, for fear that disclosure would dull the developing firm's competitive edge. Nevertheless, *Electronics* expects sales of over-the-counter software at $3.06 billion for 1982. But if everything, including in-house software, were added, the figure might well have topped $40 billion, according to the survey.

Since a computer system really only needs a single operating system, sales of this software will correspond to sales of the hardware fairly well, with only a slight tilt to the software because of its increasing sophistication. In 1981, $506 million was spent on operating systems, a figure the survey spots to grow to $1.39 billion in 1985 at an annual rate of 38%.

High-level languages like Fortran, Cobol, Pascal, Ada, and Forth are also pulling out the stops. They might well overtake operating systems, which are pegged at $648 million for 1982, and bring in a tidy $688 million. However, the trend in the high-level language area seems to be bifurcating, with one limb extending toward universal languages, like Ada, and the other toward very specialized languages like Forth—both will continue to climb from a 26.7% uptick in 1980 to almost 40% for 1982, plotted by the survey.

Another growth area is diagnostic and debugging software, which leaped 63% from 1980 to 1981. *Electronics* predicts a rise of 30.7% from 1981 to 1982, bringing the total to near $513 million.

However, nosing into the lead is computer-aided–design software, which racked up over 63% from 1980 to 1981, to $321 million. Essential to the design of very large-scale integrated circuits, however, CAD software, even in a year of only possible economic recovery, still looks to bound upwards of 50% to reach $480 million by the end of this year.

Most expenditure is for application software since many programs can be purchased for a single system. This might account for the $484 million spent on application software in 1980—but not for the surprisingly slow 1981 climb of only 18.2% to $572 million. However, *Electronics* predicts a rebound at a rate of 27.9% to $732 million in 1982, with $2.05 billion stacked up by 1985.

Test & measurement

The stroke of midnight that bade 1981 goodbye closed a year of mixed blessings for the makers of instrumentation for developing, producing, and maintaining electronic gear. The good news was that the overall U. S. market for these products, at $4.3 billion, was larger than previously expected and that some key areas showed real growth. The bad news was that inflation vitiated the overall growth rate and effectively flattened it.

Prosperity yet remains just around that unturned corner—1982 promises at best to be a repeat of the year just ended, with growth once again puffing to keep pace with inflation.

The stars of the otherwise drab year were areas like development systems, stand-alone in-circuit emulators, logic analyzers, and automated test equipment generally, and these in part contributed to the total growth of the U. S. market. Also a factor was the introduction of many of these products since last year's survey: the emulators are new items, as are signature analyzers and automated field-service testers.

Then, too, the companies surveyed this year were asked to provide a much more detailed breakout within a number of categories—examining the market at this level of detail caused them to increase their overall estimates. This is particularly noticeable in the figures for microprocessor development systems, oscilloscopes, and signal generators and in the automated test systems and equipment segment as a whole.

Those who responded this year also believe they have better data in some areas than in the past. According to one market evaluator for digital multimeters, "the reason our numbers have increased substantially is that we found out how much business [one of our competitors] is actually doing." Also, the industry is now more conscious of the potential demand for products outside their traditional areas, and in the past year they have set about actively developing those markets.

Pieces of ATE

The fastest-growing segment of the instrumentation market was automated test equipment. Sales grew by 20.7% last year, producing $989.5 million in revenues.

In 1981, the integrated-circuit group accounted for the largest share of sales, $379.8 million. General-purpose systems were the major contributors to the group's 17% increase, adding $35.2 million more than in 1980. Of the IC group, however, the fastest-growing segment was benchtop testers, which climbed 21.8% to $29.1 million last year.

This year, demand for IC testers will remain relatively healthy, growing overall by 16.6% to $442.8 million. At the same time, potential customers will have a wide number of domestic and foreign systems from which to choose, so the competition for market share among ATE companies will be fiercer than ever—it looks as if 1982 may be the year for shakeouts and mergers.

Shaping up as even fiercer is the battle for the lion's share of the board-test market. This year that market should rise by a whopping 27.5% to $452.3 million, for the first time outpacing sales of IC testers.

If both market size and growth rate are accounted for, the top performer in the board-test arena is the in-circuit type of tester used to detect assembly faults. In 1981, this market grew by 19.3%; this year it looks to grow by 35.1% to $203.1 million. Spurring that growth will be the demand for board testers with higher pin counts to test boards with even more large- and very large-scale integrated circuits.

Another board-test market to keep an eye on this year is for testers that combine functional and in-circuit capabilities. According to the survey, that market will be the fastest growing in the entire ATE group, increasing by 54.3% to $68.5 million. Automated field-service testers will be the third fastest-growing market, with the 30.52% increase to $92.8 million attributed to the attraction of new product offerings from a number of firms.

General winners

In general test instrumentation, the growth leaders will for the most part again be those instruments that deal with digital design—namely microprocessor development systems, logic analyzers, and stand-alone in-circuit emulators. Universal development systems, which last year garnered a 36% larger sales share, are expected to repeat that performance in 1982, according to the survey, generating about $148 million.

Logic analyzer sales should also help keep many companies in the black this year, with sales up 16.8% to $88.8 million. Stand-alone in-circuit emulators look to more than double that rate—sales should rise by 35.2% to $67.2 million—as users adopt them as stimulus sources for design test. Combined stimulus-analysis measurement systems, however, may affect the latter figures, depending on their acceptance as new tools.

Since the survey reflects the consensus that inflation will continue to deflate capital expenditures, digital-instrumentation growth will be at the expense of analog instrumentation in all but a few areas. One exception is the market for under-100-megahertz scopes: it should increase 15.5% this year to $299.4 million. Accounting for that growth is simply the expansion of the base of installed electronics that has to be serviced, coupled with the fact that the scope has always been the most commonly used tool for that job. In addition, many scopes now also incorporate the other commonly used field-service tool, the digital multimeter, and as the year progresses more scopes will hit the market with similar features. In short, it should be a buyer's year for scopes, with more offerings to choose from and lower prices to pay for the necessary capabilities.

The use of higher-speed electronics in many designs and the increased performance possible with microprocessor-based instrumentation will be two reasons why both spectrum analyzers and frequency synthesizers will enjoy relatively good sales this year. Spectrum analyzers, whose sales increased only 11% in 1981, this year should see a 14.7% rise to $99 million, as wider ranges and more calculating functions make them a more easily and widely applied tool.

Frequency synthesizers also will offer similar advantages to prospective users, improving signal purity and their price-performance ratios thanks to digital electronics. Frequency synthesizers this year are marked for a 16.8% increase in sales, coming off a 17.2% increase in 1981, to end the year with total sales of $83.5 million.

Part of that gain will be at the cost of traditional radio-frequency signal generators, whose sales this year should come up only 9.2%, for a year-end total of $118.3 million. However, with the demand for high-frequency communications systems continuing to increase, microwave signal generators should manage to outpace inflation in 1982, with sales rising by 13% to tot up $26 million by year-end.

Greater use of automated systems built around the IEEE-488, or general-purpose interface bus, will also boost the demand for dedicated controllers for such systems. Last year, sales of such controllers increased 15.5%, and this year too sales will get the best of inflation, rising 13.4% to ring up $87.1 million on their merchants' corporate registers.

. . . and losers

A number of areas in general instrumentation will ascend at a much slower rate than the general inflation predicted for this year, thus roughing up the road for the manufacturers of such products. Panel-meter sales, for instance, will rise only 3.2% to end the year at $130.1 million. Most of that increase will be due to the market for digital units, which are replacing analog units in existing installations as they are needed.

Other areas that lag behind inflation include logic probes, which are pegged for $5.4 million this year, up only 3.9% from 1981, which itself only registered a gain of 8.3% over the previous year.

Other sluggards are recorders and plotters, climbing 9.5% this year to $254.4 million, with X-Y plotters budging the least. Digital waveform recorders are expected to perform best among recorders. An increasing numbers of electronics users turning to digital storage for quicker data acquisition and analysis explains the sales uptick to $10.3 million at a 10.8% rate.

TEST & MEASUREMENT

(millions of dollars)	1980	1981	1982	1985
TEST EQUIPMENT, TOTAL	**3,773.1**	**4,277.0**	**4,901.3**	**7,174**
General test instrumentation, total	**2,184.1**	**2,452.4**	**2,770.6**	**3,802**
Analog voltmeters, ammeters, multimeters	21.7	22.5	22.5	23
Digital multimeters, total	141.1	159.3	178.2	258
3½-digit and below	46.2	50.4	56.8	71
4½-digit and above	94.9	108.9	121.4	187
Multimeter probes and accessories	9.5	10.4	11.5	14
Panel meters, total	122.0	126.1	130.1	143
Analog	87.5	90.1	91.9	98
Digital	34.5	36.0	38.2	45
Counters, time and frequency	75.3	84.5	93.8	120
Microprocessor development systems	370.0	409.1	478.5	665
Dedicated	290.0	300.0	330.0	440
Universal	80.0	109.1	148.5	225
Stand-alone in-circuit emulators	41.2	49.7	67.2	101
Logic analyzers	60.9	76.0	88.8	139
Logic probes	4.8	5.2	5.4	6
Signature analyzers	2.9	5.8	8.9	17
Word generators	6.6	7.5	8.5	14
Oscilloscopes	428.8	487.5	556.4	771
100 MHz and below	237.3	259.1	299.4	407
Above 100 MHz	191.5	228.4	257.0	364
Spectrum analyzers total	77.6	86.2	98.9	153
1 MHz and below	41.9	46.8	53.6	81
Above 1 MHz	35.7	39.4	45.3	72
Frequency synthesizers	61.0	71.5	83.5	128
Function generators	49.0	59.6	67.5	98
Rf signal generators	98.0	108.3	118.3	153
Sweep generators	62.7	67.7	74.3	103
Pulse generators	16.3	18.3	20.1	25
Oscillators	18.7	20.2	21.0	26
Audio waveform analyzers and distortion meters	44.3	49.7	53.7	67
Power meters (below microwave)	4.3	5.0	5.6	8
Calibrators and standards	30.2	33.1	36.1	64
Noise-measuring units (except sound-level meters)	8.4	9.5	10.7	15
Modulation analyzers and meters	18.7	22.5	24.0	30
Temperature-measuring instruments	22.7	26.6	29.7	41
Phase and impedance measurers	3.1	3.9	4.9	7
Amplifiers (laboratory)	45.5	49.1	56.0	72
Recorders and plotters, total	208.3	232.3	254.4	323
Strip- and circular-chart	75.9	83.5	91.9	101
X-Y	47.7	51.9	55.8	73
Magnetic-tape	76.2	87.6	96.4	135
Digital, solid-state	8.5	9.3	10.3	14
Dedicated IEEE-488-bus controllers	66.5	76.8	87.1	115
Microwave signal generators	21.8	23.0	26.0	38
Microwave phase- and impedance-measuring equipment	33.0	35.5	38.0	50
Microwave power-measuring equipment	8.5	9.5	10.5	15
Microwave wavemeters	0.7	0.5	0.5	0
Automated test equipment, total	**820.0**	**989.5**	**1,201.40**	**2,021**
Integrated-circuit testers, total	324.2	379.8	442.8	620
General-purpose systems	200.2	235.4	275.3	360
Specialized test systems	100.1	115.3	132.3	200
Benchtop testers	23.9	29.1	35.2	60
Active component testers	104.3	121.1	135.4	203
Loaded pc-board testers, total	295.1	354.7	452.3	883
In-circuit	126.0	150.3	203.1	370
Functional	143.0	160.0	180.7	321
Combined	26.1	44.4	68.5	192
Interconnect and bare-pc-board testers	42.9	62.8	78.1	141
Automated field-service testers	53.5	71.1	92.8	174
Specialized test equipment, total	**769.0**	**835.1**	**929.3**	**1,351**
Automotive diagnostic	300.0	318.2	348.1	470
Communications test (incl. data communications)	399.7	440.0	497.0	758
TV receiver service	20.1	21.3	22.1	25
Broadcast studio test	19.8	22.7	25.3	40
Radiation-detection and -monitoring	29.4	32.9	36.8	58

Medical & analytical

The coming year looks bright for some kinds of analytical instrumentation, but in general that market will grow modestly. Overall, it should rise by 12.9%, keeping its nose above the inflation rate, to end 1982 with total consumption of $865.3 million.

In contrast, the medical instrumentation market will fare better, providing 1982 growth at a rate of about 15%. Year-end sales figures should push slightly above the $3 billion mark and many segments should substantially outperform the general economy.

One of the more promising areas of analytical instrumentation is the chromatography market, which in general will increase by a rate of 14.5% to $306.6 million this year. Spurring that growth will be a number of factors. In general, industry will be doing more thorough checking of the various manufacturing byproducts in order to comply with stricter government regulations. In the electronics industries, more thorough analysis of materials used in semiconductor production, intended to prevent device defects, will also add to demand.

Among the various types of chromatographs, gas units will provide the bulk of the increase in sales, rising 14.7% to $152.5 million this year. In the long run, liquid and gas chromatographs, both widely used to check industrial effluvia, will be about even. By 1985, consumption of each should reach the $200 million mark.

The fastest-growing segment of the chromatograph market, however, will be that for ion units. In 1981, consumption grew at a rate of 26% and this year it should increase at a just slightly less rapid rate, 19.8%, to end the year at $29.6 million.

Another area of increasing demand occurs in thermal analyzers, used by the electronics industry to measure patterns of heat transfer in semiconductors. This market should grow by 25% to $29.4 million by year end, as electronics users try to develop better means of dissipating heat to increase product reliability.

MEDICAL & ANALYTICAL

(millions of dollars)	1980	1981	1982	1985
Medical equipment, total	**2,342.0**	**2,676.1**	**3,074.7**	**4,470**
Diagnostic, total	1,168.0	1,343.9	1,558.5	2,247
Tomographic X-ray scanners	605.0	697.0	805.0	1,130
Electroencephalographs	49.0	56.0	71.0	110
Electrocardiographs	120.0	131.0	151.0	212
Ultrasonic scanners	98.0	115.4	134.0	193
Automated blood analyzers	263.0	305.0	353.0	540
Nuclear imaging	33.0	39.5	44.5	62
Patient-monitoring systems	215.0	254.0	289.0	440
Prosthetic equipment, total	451.0	516.0	580.0	842
Hearing aids	242.0	270.0	298.0	410
Pacemakers	209.0	246.0	282.0	432
Therapeutic equipment, total	465.7	511.9	589.9	857
X-ray	88.0	95.0	108.0	150
Diathermy, short-wave and microwave	13.0	16.0	19.0	27
Ultrasonic generators	126.0	132.6	151.0	230
Defibrillators and stimulators	47.0	54.7	71.5	110
Dialysis systems	187.0	208.0	234.0	330
Biofeedback units	4.7	5.6	6.4	10
Surgical support equipment, total	42.3	50.3	57.3	84
Blood-flow meters	9.2	10.4	12.1	18
Blood-pressure monitors	28.3	34.1	38.6	56
Electrosurgical units	4.8	5.8	6.6	10
Analytical instruments, total	**680.9**	**766.8**	**865.3**	**1,231**
Chromatographs, total	224.6	267.7	306.6	450
Gas	115.0	133.0	152.5	201
Liquid	90.0	110.0	124.5	200
Ion	19.6	24.7	29.6	49
Spectrophotometers, total	191.0	212.8	237.5	334
Infrared	35.1	38.5	42.1	55
Ultraviolet-visible	45.1	49.0	53.3	68
Atomic absorption	42.8	51.0	63.0	116
Other	68.0	74.3	79.1	95
Mass spectrometers	48.0	53.0	59.3	84
Nuclear magnetic-resonance spectrometers	26.5	29.0	31.8	41
Electron microscopes	13.0	13.0	13.2	14
pH meters and ion-selective electrodes	33.0	36.0	40.5	56
Thermal analyzers	19.0	23.5	29.4	56
Nuclear and X-ray analyzers (nonmedical)	52.0	55.0	59.1	74
Other	73.8	76.8	87.9	122

The automated doctor

Makers of equipment for the medical market will generally have a healthy year. The pacesetter here is diagnostic equipment, which this year should rise by about 16% to about $1.6 billion. Lower-cost tomographic X-ray scanners will help boost that market by $108 million, or 16%, to $805 million. Consumption of ultrasonic scanners will grow at the same rate to end the year with sales of $134 million. Increased use of electroencephalographs to determine whether a patient is still alive will boost demand for those units by 26.8% in 1982, for an overall market size of $71 million.

Among the diagnostic equipment, consumption will increase most slowly for nuclear imaging units. With increased competition from tomographic and ultrasonic units, sales of the newer nuclear imagers should increase only at a rate of 12.7% to end the year at $44.5 million.

In the therapeutic-equipment area, those surveyed predict that sales of defibrillators, as well as stimulators such as TENS units, should climb most quickly. In 1982, sales should rise by 30.7% to $71.5 million. Diathermy units should also see wider use for pain relief, rising 18.8% in sales to $19 million.

In the area of surgical support equipment, which should see a dollar gain of about 14%, the most activity should be in the small blood-flow meter market. Sales should rise about 16.4%, adding about $2 million to the total market size in 1982.

Patient-monitoring equipment and systems should also perform well in 1982. Having expanded at a rate of 18% in 1981, the growth rate this year should be somewhat slower, about 14%. However, even at that rate, the market will add $35 million more than last year to the coffers of the medical electronics merchants.

Communications

Showing itself again to be minimally affected by recessions, the communications sector will rack up another good year in 1982. Barring a deepening of the late 1981 recession, it will show a 12.6% growth over last year, reaching a sales total of $7.2 billion. On the other hand, if the present dip in the economy is not a true bottoming out of the business cycle, growth could be as little as 5%.

Leading the way this year will be those communications industries associated with the office of the future. The biggest unknown factor here is the most important of its players—the new unregulated subsidiary of American Telephone & Telegraph Co., which is scheduled to finally make its appearance in 1982. To sell services, first in the data-communications and then in the data-processing areas, the new company's first service will be known as the Advanced Communication Service. ACS will provide office-to-office data communications through telephone circuits linked by packet-switching techniques. No one knows just what impact this new company—which will spend over $400 million in the next few years just to get started—will have on the $5 billion office-of-the-future industry.

Competition for both the old Bell telephone companies and the yet unnamed new AT&T subsidiary will come from the continued exceptional growth of non-Bell communications firms. According to the North American Telephone Association, they will experience a 30% growth rate in installed private-branch-exchange and key systems. For its part, the data communications industry has always had non-AT&T suppliers and expects to see a 13.4% growth in 1982 to $1.8 billion as more and more businesses install data-generating and -handling equipment in planning for the paperless office.

Just how, and in what areas, both the Bell and non-Bell voice operations and data-handling companies will compete with each other is as yet undecided. The Communications Act of 1934 is still unrevised after several years of congressional effort. Thus, overall policy guidelines are lacking. Most observers expect 1982 to be another year in which policy is made on a case-by-case basis in the courts and at the Justice Department. AT&T has the size and financial resources to ride out this procedure, but the smaller firms in voice and data communications have no such cushion.

More digital

Digital technology will continue to dominate communications in 1982. For example, the launch last year of two geostationary earth satellites by Satellite Business Systems to handle 14-gigahertz digital transmissions (never before used in the U. S. for commercial service) has encouraged manufacturers of both analog-to-digital interface equipment and earth-station–related gear. Typical of this sector, message-switching equipment volumes will rise 9% to $222.5 million. Other industries will benefit from digital communications technology as well. For example, the sales of faster digital data-handling machines, such as facsimile, and faster data-multiplexing equipment are growing at a rapid rate because of escalating costs for transmission line usage. Over a 20% increase is expected in such usage to what in 1982 will be a $231.5 million business.

COMMUNICATIONS

(millions of dollars)	1980	1981	1982	1985
Communications equipment, total	**5,700.2**	**6,426.1**	**7,234.0**	**1,0007**
Radio, total	1,747.3	1,930.9	2,132.3	2,772
Aviation mobile (incl. ground support)	65.1	71.2	77.9	98
Marine mobile (incl. recreational)	35.1	37.0	39.0	49
Land mobile (mobile and base stations)	1,100.0	1,213.1	1,336.6	1,691
Amateur (mobile and base stations)	25.5	27.8	30.4	36
Citizens' band (mobile and base stations)	60.8	61.4	62.0	64
Microwave (incl. antennas), total	228.5	256.1	286.9	408
Analog	195.7	213.8	232.6	299
Digital	32.8	42.3	54.3	109
Broadcast (a-m and fm, incl. antennas)	55.5	59.4	63.6	76
Satellite earth stations	176.8	204.9	235.9	350
Radar (incl. weather and navigation), total	170.1	178.8	187.6	246
Telemetry (industrial only)	70.0	76.5	81.0	105
Telecommunications, total	1,627.0	1,801.5	2,008.6	2,735
Voice-switching systems, total	1,583.0	1,736.5	1,912.1	2,459
Central office	562.0	613.5	688.1	875
PABX	1,021.0	1,123.0	1,224.0	1,584
Data-switching systems	44.0	65.0	96.5	276
Fiber-optic communications systems, total	92.30	144.0	227.5	466
Modules and subsystems	23.5	39.3	59.5	130
Complete systems	68.8	104.7	168.0	336
Pocket pagers, total	81.0	97.0	114.0	164
Tone only	71.0	84.0	97.0	139
Tone plus	10.0	13.0	17.0	25
Data-communications equipment, total	1,393.3	1,620.9	1,837.9	2,624
Acoustic (modems), total	405.0	483.5	532.0	710
Low-speed (less than 2,400 b/s)	122.5	146.0	160.0	210
High-speed (2,400 b/s and over)	282.5	337.5	372.0	500
Multiplexers	147.5	192.1	231.5	377
Programmable concentrators	131.5	151.2	191.1	297
Front-end communications processors	522.3	590.0	660.8	925
Message-switching systems	187.0	204.1	222.5	315
Facsimile terminals	148.3	166.3	191.2	290
Television equipment, total	370.9	410.2	453.9	605
Broadcast equipment, total	123.3	131.4	140.3	170
Transmitters	18.1	19.5	20.9	25
Antennas	18.7	21.2	24.0	34
Cameras	36.0	38.1	40.2	47
Auxiliary equipment	50.5	52.6	55.20	64
CATV, total	197.0	220.9	246.8	343
Studio and head-end	46.5	55.0	63.2	95
Distribution (amps, supplies, etc.)	88.0	98.0	109.1	145
Transmission (except for fiber-optic)	33.0	36.4	40.0	53
Converters	29.5	31.5	34.5	50
CCTV, total	50.6	57.9	66.8	92
Cameras	33.6	37.9	42.8	58
Monitors	17.0	20.0	24.0	34

U.S. markets

Consumer

Despite the recession blues in the U.S. economy, the consumer-electronics segment of the market is expected to reach close to $20 billion in equipment consumption, a healthy 18% gain over 1981. Credit these gains to a host of new products geared to entice the consumer: sophisticated electronic games, microprocessor-controlled microwave ovens, and an assortment of home video gear.

As the public recoils from rising prices at movie and theater box offices, it welcomes the prospect of entertainment brought into the home via satellite transmission, video-cassette recorders, and video-disk players. The suppliers of the video tapes and disks have responded rapidly to offer an overwhelming variety of educational and entertainment films.

What's more, close to $32 billion will be put back into the pockets of the consumer by the July Federal tax cut. This Administration bonanza will create a 5% increase in real purchasing power, according to Data Resources International's recent "U.S. Forecast Summary."

As for categories, black and white TV sales appear to be leveling off at about $560 million for slightly over 1% growth and color TV consumption is expected to hit $4.45 billion, for a modest 3.2% increase. However, an RCA study indicates close to 43 million color sets in U. S. homes today are over six years old and represent a strong replacement market. Projection-TV sets, almost all equipped with remote control, are high-ticket items and are expected to double to 175,000 units or $400 million.

But the glamour baby of the consumer industry is the VCR, with close to 1.4 million units sold in 1981 and consumption expected to rise to over 2 million units or $1.8 billion this year. Not only are VCR unit sales increasing rapidly, but the two-week–programmable, loaded-extra models appear to be hot selling items, driving the total cash outlay way up.

Another interesting study statistic is the growing interest in color video cameras; for every five VCRs sold, one such camera will be included in the package. Camera sales are expected to jump from $180 million to $360 million, as battery-operated VCRs increase in popularity.

The video-disk player, a new contender for the pocketbook of the videophile, is having early trouble competing against the VCR. Early video-disk players, using low-power lasers, were priced at $700, equal to or exceeding VCR prices. The public, responding to heavy promotion campaigns, was disappointed to learn that the device was a playback machine, incapable of recording—which was not made clear in ads. But the simple-to-operate video-disk player, along with low-cost prerecorded media ($25 versus $50 to $80 for video tapes), is expected to quickly capture a $225 million piece of the home video pie.

In the long view, the home entertainment sector of the consumer electronics industry is headed for a strong decade, with sales exceeding $15 billion by 1985 and over $26 billion by 1990, according to the RCA "Video 90" corporate study. These numbers reflect sales of TVs, VCRs, video cameras, video cassettes, and video-disk players and recorders.

A large portion of the healthy growth will be due to additions to the basic source of entertainment routed to the U. S. household. In the late 1970s, the study indicates, video material was supplied directly from networks and independent and public broadcasting stations. In the 1980s, cable television, direct-broadcast satellite, and teletext and viewdata sourcing will be fed into many homes, along with the strong contributions of video tapes and video disks.

CONSUMER

(millions of dollars)	1980	1981	1982	1985
Consumer electronics, total*	**1,4831.2**	**17,018.8**	**20,182.5**	**27,643**
Television receivers, total	4,699.0	4,870.0	5,012.5	5,440
Black and white	544.0	555.0	562.5	580
Color	4,155.0	4,315.0	4,450.0	4,860
Consumer audio equipment, total	5,301.0	5,849.1	6,923.8	9,844
Car audio	1,239.0	1,289.0	1,700.0	2,105
Phonographs and radio-phonographs	700.0	720.0	750.0	847
Radios (incl. table, clock, and portable)	439.0	495.0	550.0	730
Radio-recorder combination boxes	98.7	119.2	139.8	220
Tape recorders and players, total	950.0	1,261.5	1,716.9	3,520
Standard cassette	700.0	750.0	800.0	970
Personal portable (Walkman)	150.7	401.2	795.8	2,400
Reel-to-reel	99.3	110.3	121.1	150
Hi-fi audio systems, total	1,874.3	1,964.4	2,067.1	2422
Components (turntables, tuners, etc.)	1,152.0	1,172.0	1,205.50	1317
Consoles	122.3	132.4	141.6	170
Compact systems	600.0	660.0	720.0	935
Other consumer products, total	4,831.2	6,299.7	8,246.2	12,359
Antennas (TV, CB, and radio)	110.0	117.5	125.0	143
Home video equipment, total	860.8	1,699.0	3,075.0	5,585
Cassette players and recorders	619.7	1,102.0	1,780.0	2,200
Cameras	85.5	180.0	360.0	810
Video-disk players	10.2	80.7	255.0	875
Projectors	80.4	191.3	400.0	800
Satellite receiving stations	65.0	145.0	280.0	900
Electronic musical instruments	479.0	496.1	513.7	580
Intrusion alarms	252.5	297.5	368.6	550
Microwave ovens	741.4	921.3	1,015.1	1,200
Smoke detectors	99.6	104.2	112.2	130
Telephone-answering devices	115.0	149.3	190.1	290
Electronic games, total	768.7	1,046.8	1,286.2	1,996
Video games	142.0	248.4	352.0	640
Nonvideo games	325.0	400.3	482.5	756
Electronic toys	301.7	398.1	451.7	600
Calculators	716.3	717.3	730.2	825
Teaching aids	9.7	19.6	29.5	60
Home intercom systems	20.4	30.1	40.0	70
Watches (digital and analog display)	570.0	600.0	640.0	760
Clocks	85.3	95.5	105.6	135
Home lighting and appliance controls	2.5	5.5	15.0	35
Automotive electronics, total	**1,538.9**	**2,729.3**	**3,064.7**	**5,021**
Convenience (incl. trip computers)	670.8	747.1	1,030.0	1,585
Emission control	268.4	1,567.9	1,551.1	2,910
Electronic ignition systems	431.6	272.0	330.6	365
Voltage regulators	168.1	142.3	153.0	161

*Includes domestic-made equipment, offshore products sold under U.S. labels, and domestic- and foreign-label imports.

Industrial

Business investment in plant and equipment will not be giving the economy a boost in 1982, says McGraw-Hill's 28th annual fall survey of capital-spending plans. The 9.6% capital spending increase predicted for the new year will be wiped out by the projected 9.6% rise in plant and equipment prices.

Even though interest rates are dropping, current economic sluggishness is hardly firing the enthusiasm of tight-fisted company planners. However, *Electronics*' survey indicates that electronic industrial equipment will grow by almost 30% to $5.27 billion this year, suggesting that heavy machinery for auto, steel, and chemical industrials will be bearing the brunt of slower growth.

The estimated 15% gain in process-control equipment, for sales exceeding $1.9 billion, seems to bear out the Commerce Department's forecast of 10% or more healthy growth through 1985. Digital control systems will pass analog systems this year with a strong 22% gain to $271 million versus 5.7% growth to $254 million. Programmable-sequence-controller sales, expected to top $426 million, continue their growth rate of over 20%.

Although most categories of the semiconductor equipment market were either down or nearly flat in 1981, there were a few bright spots. Projection and direct wafer-stepping optical-lithography equipment sales continue to rise from their 1980 base. Projection lithography consumption grew 53.7% to $185 million and step-and-repeat aligners grew 77% to $133 million. By 1985, predicts Mackintosh International, San Jose, Calif., the direct stepper will dominate this field.

Overall wafer-processing sales were down by 19.5% to $121 million in 1981, but plasma-etching equipment sales will expand, according to Salzer Technology Enterprises Inc., Santa Monica, Calif. It sees 1980's $70 million plasma market growing steadily at a rate of greater than 35% a year. Plasma etching, like advanced lithography, is a must for the fine lines of the coming very large-scale integrated circuits.

Although respondents to the study indicated semiconductor manufacturing equipment sales will grow by 18%, to $917 million, recent interviews find members of this group now having second thoughts. They are expressing mounting concern that the Semiconductor Industry Association's projection of a 17% gain in device sales is considerably optimistic.

The energy-management systems market, blessed with government tax incentives, is heading for close to $1.2 billion in sales, more than double last year's figure. Minicomputer energy-management systems represent almost half of the total sales.

Numerical-control systems, offering improved efficiency for price- and labor-conscious machinery purchasers, should show a plump 19.3% growth, with sales rising to $146 million in 1982. Robots, meeting with ever greater acceptance in the manufacturing community, should reach close to $290 million in sales, up 19%.

A 13% increase to $193 million is estimated for electronic pollution-monitoring equipment as local, state, and federal agencies continue their environmental-protection efforts. As government imposes tighter specifications on air and water pollution standards, more refined equipment must be supplied, at high cost.

Data-acquisition equipment, for discrete and continuous processes, is expected to enjoy a robust 19% gain, exceeding $155 million. Another strong gainer for 1982, according to the survey, will be motor-control systems with expectations of sales topping $363 million, almost a 16% increase over 1981.

INDUSTRIAL

(millions of dollars)	1980	1981	1982	1985
Industrial electronic equipment, total	**3,344.8**	**4,113.3**	**5,273.6**	**9,768**
Motor controls (speed, torque)	280.1	313.7	363.6	758
Numerical-control systems	101.7	122.1	145.7	201
Inspection systems, total	67.9	75.3	87.3	135
Ultrasonic	20.5	22.0	23.5	29
X-ray	15.0	16.8	20.6	31
Infrared	10.0	11.8	14.9	26
Ultraviolet	2.3	2.5	2.9	4
Laser	20.1	22.2	25.4	45
Thickness gages and controls, total	45.2	47.0	48.9	56
Photoelectric	28.9	30.0	31.1	35
Radiation-based	16.3	17.0	17.8	21
Process-control equipment, total	1,413.6	1,659.8	1,907.1	3,109
Control systems, total	687.7	826.0	962.7	1,725
Computer-based, total	399.3	461.5	524.0	823
Analog	233.3	240.0	253.5	308
Digital	166.0	221.5	270.5	515
Sequence controllers, total	288.4	364.5	438.7	902
Hardwired	14.8	12.6	12.0	13
Programmable	273.6	351.9	426.7	889
Data-acquisition systems, total	105.2	130.7	155.5	276
Continuous-process	74.9	80.1	88.2	96
Discrete-process	30.3	50.6	67.3	180
Process instrumentation (recorders, etc.)	620.7	703.1	788.9	1,108
Utrasonic cleaning equipment	21.1	23.5	25.0	30
Pollution-monitoring equipment	170.0	171.1	193.0	272
Induction and dielectric heating, sealing	71.1	73.9	76.6	86
Welding controls	32.6	34.8	37.2	41
Energy-management equipment, total	286.1	569.5	1,184.6	2,686
Microcomputer-based (<$10K)	61.1	69.5	84.6	186
Minicomputer-based ($10K to $100K)	100.0	200.0	500.0	1,000
Centralized systems (>$100K)	125.0	300.0	600.0	1,500
Robots (mechanical manipulators)	180.1	243.0	288.0	477
Lasers and related equipment, total	**119.7**	**148.2**	**164.2**	**221**
Gas lasers	92.4	116.4	128.6	173
Other	27.3	31.8	35.6	48
Power supplies, noncaptive, total	**372.7**	**451.4**	**550.6**	**817**
Switching, total	151.0	217.3	289.8	504
Pc-board-mountable (encapsulated)	4.0	6.0	9.1	138
Open frame and card	82.3	120.4	167.7	228
Rack-mountable and other system	64.7	90.9	113.0	138
Conventional (linear), total	221.7	234.1	260.8	313
Pc-board-mountable (encapsulated)	33.1	33.4	36.1	61
Open frame and card	75.6	84.8	88.9	108
Rack-mountable and other system	98.9	99.9	117.6	121
Benchtop	14.1	16.0	18.2	23

U.S. markets

Production

The high interest rates and economic decline of 1981 that have afflicted the rest of the nation also slowed the seemingly recession-proof market in integrated-circuit–processing equipment, pegged at nearly $780 million by *Electronics*' survey. However, a recovery is seen for this field in late 1982 by experts like Fred Van Veen, vice president of Teradyne Inc., and Joseph C. Ross, president of Micro Mask Inc. Ross sees the turnaround occurring between April and June of 1982 with a 23% growth, whereas Van Veen delays the recovery somewhat by giving it a 70% chance of emerging in the fourth quarter of 1982.

Because it increases productivity to cut costs, the assembly and packaging area of semiconductor production equipment will continue to show good growth, thus bucking the overall downward trend. Lead-bonding equipment, which will be fully automated by 1985, should show a growth rate of 21% a year to hit $183 million. The consumption of tape-automated bonding equipment, which is much smaller than that of the wire bonders, is forecast to grow 50% annually.

U. S. consumption of other assembly equipment like die-separation and die-attachment equipment will show a 20% annual growth rate reaching $43 million and $28 million by 1985, respectively. By 1985, equipment designs will favor smaller packages like chip-carriers and TAB. This preference should open up growth areas for new designs of IC assembly equipment. Overall, *Electronics* sees the total consumption of assembly gear more than double by 1985.

On the down side, the rosy 25% growth prediction of 1980 for the printed-circuit-board market has been scaled down for an 11% to 13% growth to almost $2 billion in 1981, with a 15% yearly growth to 1985 (p. 127).

PRODUCTION

(millions of dollars)	1980	1981	1982	1985
Semiconductor production, total	**675.3**	**779.6**	**916.6**	**1,917**
Wafer preparation (crystal growers, etc.)	45.1	35.3	38.5	75
Mask generation (digitizers, etc.)	54.4	43.2	44.0	84
Lithography, total	284.4	414.6	533.1	1,158
In-line handling (scrubbers, etc.)	29.6	36.00	42.4	70
Aligners, total	254.8	378.6	490.7	1,088
Contact (proximity)	4.0	5.0	5.5	7
Projection	120.3	185.0	224.0	281
Direct wafer-stepping	75.4	133.4	200.6	700
Electron-beam	55.1	55.2	60.6	100
Wafer processing (furnaces, etc.)	150.1	120.8	121.0	200
Assembly (wire bonders, etc.)	141.3	165.7	180.0	400

U.S. markets

Federal

Money committed for military electronics will climb some 4.9% next year to more than $26.3 billion, although the percentage growth will not come close to 1981's 19% jump over the previous year. Large increases in procurement of electronics for nearly every category accounted for last year's biggest gains, as did inflated costs for operations and maintenance.

Conversely, the gain in the 1981 commitment to research, development, testing, and evaluation was relatively small, just 2.9%, although that percentage increase in 1982 will be higher—about 5%. Other military spending levels will show similar rates of growth. Nevertheless, much of the money committed in the last calendar year will be laid out in 1982 and years thereafter.

Declines in 1982 Federal electronics spending in other areas—notably the National Aeronautics and Space Administration and mass transit—plus essentially unchanged outlays for most other nonmilitary efforts will push the military market share to 92.9% of the total. NASA's electronics procurement and R&D, for example, will tumble 2.7% to $865 million. Many observers believe this will initiate a precipitous slide in the agency's spending, relegating it to the role of a satellite launch service for the telecommunications industry. □

FEDERAL

(millions of dollars)	1980	1981	1982	1985
FEDERAL ELECTRONICS, TOTAL	**23,021**	**27,124**	**28,356**	**32,622**
Defense, total	**21,064**	**25,110**	**26,333**	**30,587**
Procurement, total	10,464	13,580	14,448	16,572
Communications and intelligence	1,827	2,812	3,130	3,400
Aircraft, related ground equipment	2,894	3,878	4,075	4,258
Missiles and space systems	3,271	4,022	4,145	4,974
Mobile and ordnance	680	972	1,070	1,445
Ship and conversions	1,792	1,896	2,028	2,495
RDT&E	6,922	7,125	7,485	7,850
Operations and maintenance	3,678	4,405	4,400	6,165
NASA	**886**	**889**	**865**	**750**
Transportation, total	**495**	**523**	**540**	**627**
FAA procurement	287	300	312	365
FAA research and development	138	150	157	188
Highway and transit systems	70	73	71	74
Health and Education agencies, total	**459**	**475**	**483**	**508**
Education systems	115	117	118	125
Health-care electronics	344	358	365	383
Department of Energy	**117**	**127**	**135**	**150**

Europe's markets

Time was when economic forecasters in West Europe vied to see who could call the next year's growth in the region to the nearest tenth of a percent. Last year, the crucial call was whether to put a plus or a minus in front of a growth estimate hovering around zero. For 1982, forecasters' rankings will hinge in large part on how close they come to predicting when the long-hoped-for upturn will actually materialize.

No one thinks it can happen in the next few months. As Chancellor Helmut Schmidt explained to the West German parliament in Bonn in late October, the country went into the winter in its most difficult economic position "in decades."

And as Germany goes, so goes most of West Europe. When the figures for 1981 are fully totted up, expect economists at Siemens AG, they will show that the gross national product in the 13 European countries where the company does business edged down about 0.2%. That contrasts with a 1.2% uptick in 1980.

This year, Siemens' economists figure, business in West Europe will tilt upward again and the region will register a rise in the growth rate to 1.8%. But even that meager growth in 1982 will not come about, they caution, unless interest rates go down, the balance of payments improves, and oil-exporting countries eschew further hikes in the price of crude oil.

Investment-inhibiting interest rates and expensive energy, of course, are just two of the economic ailments that afflict West Europe. Inflation is another crippling malady; so are high unemployment, costly social welfare schemes, clamps on government spending, and crushing competition from the Far East. Finally, a prime customer for exports—the U. S.—is in difficulty with a recession of its own to cope with. All these plaints will contribute to keep West Europe in poor times well into 1982.

The West European countries, obviously, will not march out of their recessions in lockstep. Great Britain's economy suffered a 3% slide during the first half of 1981 and bottomed out at midyear, many believe. Some economists think that West Germany, too, hit the economic floor last year and that some sort of rebound has to follow. Better business there would provide pull for the neighboring Benelux countries and Switzerland.

France will try a different tack from her neighbors. Rather than holding tight rein on its budget in order to fight inflation, the Socialist government plans to reflate the economy mainly in order to create more jobs. Even so, few French businessmen can see how any substantial upswing could result before well into 1982. In Italy and Spain, the weather might generally improve over North Europe, but the economic climate is equally as inhospitable. Any country in West Europe whose growth this year tops 1%—it could happen in France—figures to be the leader, albeit hardly a dynamic one.

Luckily, electronic-equipment markets show considerable recession resistance, and after making the rounds in 11 West European countries for its annual survey, *Electronics* forecasts equipment markets in them will total $51.053 billion this year, which works out to a respectable rise of 10.7%. That is not too bad when contrasted with what is happening in industries like automobiles, steel, and textiles, which keep sliding—but it is somewhat worrying when it is recalled that heavy investment in product innovation—crucial to the electronics industries—cannot be sustained for long at growth rates like those in sight for 1982.

A quick look at major headings of the equipment chart (see p. 140) shows why the market is no longer surging. Saturation has arrived in North European consumer electronics markets, particularly for color television sets and audio equipment. Once the pacesetters, set makers have dropped back. Communications-equipment suppliers depend heavily on government agencies for their business, a source that has inevitably dwindled as governments squeeze their budgets to keep inflation in line as much as possible. The computer makers still have large untapped pockets of potential customers to keep their sales on an upward tilt, but the growth rates are a far cry from what they once were.

As for the components suppliers, their numbers are downright bleak. Last year, components markets slumped to $9.521 billion from the 1980 level of $9.890 billion. Next year, they will rise just above that: the forecast is $10.308 billion, up 8.3% over 1981.

Whether for equipment or for components, the figures of the survey distort the real rise (or fall) in markets. As always, participants were asked to give their estimates in local currency at current prices. Thus the true market growth is less than the apparent growth; it must be discounted for inflationary price rises, which vary from product to product and from country to country. The local-currency estimates were converted to dollars for all three years covered by the survey at the rates prevailing in late November 1981. This avoids the year-to-year distortions that result from using historical rates across a wide spectrum.

MARKET REPORT EXCHANGE RATES
(The rates below were used to convert European currencies into U.S. dollars)

Belgium:	41.0 francs/dollar
Denmark:	7.15 kroner/dollar
France:	5.60 francs/dollar
Italy:	1,180 lire/dollar
Netherlands:	2.45 guilders/dollar
Norway:	5.85 kroner/dollar
Spain:	95 pesetas/dollar
Sweden:	5.50 kroner/dollar
Switzerland:	1.80 francs/dollar
United Kingdom:	53.5 pence/dollar (£1 = $1.87)
West Germany:	2.25 marks/dollar

Europe's equipment markets

Lingering recession will stunt growth for much of 1982

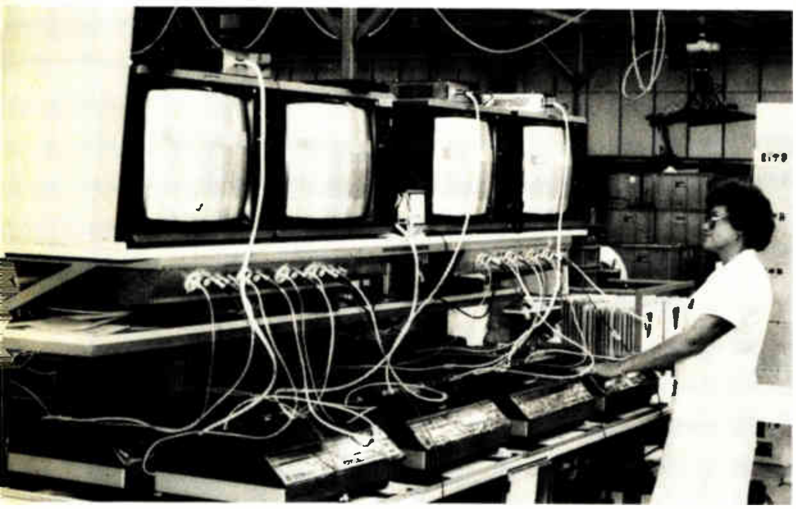
Data processing

By and large, computer makers will be going to extremes in West Europe this year. Except in West Germany, sales of big mainframes should run strong as businessmen buy them to drive ever-growing data-processing and data-communications networks. At the same time, there is a population explosion in the small machines that serve as intelligent work stations in these networks. What's more, sales of stand-alone desktop computers are slated to burgeon.

There is some growth in sight, too, for medium-sized computers. All told, then, markets for computers and related gear will rise a reasonable 13.5% to $20.291 billion this year from the 1981 level of $17.805 billion, according to *Electronics'* survey. As Jochen Rössner, senior market specialist at Sperry Univac points out, "Growth rates of 20% or so are a thing of the past."

That is true in money terms, but not necessarily in the number of systems. ICL Ltd., Britain's native computer maker, reckons that the traditional mainframe market it serves grew some 13% last year. But during the past 18 months, explains Ninian Eddie, the company's marketing director, the cost of raw computing power has been nearly halved, mainly because of the arrival of International Business Machines Corp.'s highly competitive series 4300, series 4100, and series 8100 machines. To mark up a 13% advance in revenue, then, takes a considerably higher gain in number of systems sold. ICL could not pull off such a gain in 1981.

The competition for sales, particularly for first-system installations, is getting tougher. Says Sperry Univac's Rössner: "Business has become more difficult. Given the high interest rates, users weigh investments in new systems very carefully." Rössner also points out that government agencies are keeping a lid on spending. In the future, he is convinced, the mainframe business will be supported more and more by replacement sales.



Bright images. Philips, Europe's largest electronics producer, counts heavily on video-cassette recorders to bolster consumer sales. It has VCR plants running full blast in Germany and Austria.

Along with IBM, which dominates the market in West Europe, the native producers like ICL, Siemens AG in West Germany, and CII-Honeywell Bull (CII-HB) in France, there are new competitors for the mainframe business. Suppliers from the U. S. and Japan have entered the market with machines that are plug-compatible with IBM equipment, points out Hamish MacArthur, director of computer studies in the London office of Quantum Science Corp. He estimates that they and European plug-compatible suppliers like Siemens and ICL have taken some 7.6% of the market for mainframes in the IBM 3031 category.

The heightened competition among mainframe makers, however, has not turned the data-processing community in West Germany into a band of pessimists. Small computers inject considerable optimism. *Electronics* forecasts a spurt in sales of machines priced under $20,000.

In West Germany, for example, small-business systems will move upward for the three years ending in 1983 at rates up to 18%, according to Erwin Mayr, an official in Siemens' data-processing division in Munich. In France, microcomputer sales over the next few years will rocket up 40% to 45% annually, says Humbert Chevrant-Breton, who looks after marketing studies for CII-HB. In the UK, BIS-Pedder, a London-based market research firm, tallied the number of under-$30,000 systems installed in 1980 and found they had doubled during the year to reach a total of 206,000. In Italy, sales of desktop machines surged between 40% and 50% last year and look for much the same rise in 1982, figures Fabrizio Agnesi, a market researcher at Honeywell Information Systems-Italia in Milan. Roberto Taranto, who heads a Milanese market-research outfit that specializes in high technology, puts the rise at 35%.

Japanese computer makers, obviously, are aware of this potential. They are the ones to watch in the small-business-computer field, warns Quantum Science's MacArthur. "They're addressing the world market with machines designed for the task," he says. The new small computer from Nippon Electric Co., he points out, has a keyboard switch to change the character set immediately from the katakana used in Japan to the Latin alphabet.

There is more than small computers to encourage computer makers. Rössner of Sperry Univac cites terminals as showing high growth rates. Siemens' Mayr says that systems for computer-aided design are doing particularly well. So are peripherals like cathode-ray-tube displays. The German Economic Institute in Cologne estimates that the number of CRT displays at data-processing work stations in West Germany will rise from about 250,000 now to roughly 650,000 in 1985.

Then there is word processing. A study by the New York–based market research firm Frost & Sullivan Inc. sees Europe-wide installations of word-processing systems rising from about 100,000 in 1981 to 500,000 by 1990. Another 200,000 units will be replacement systems. During the whole decade the cumulative market value could go to around $6.5 billion, the firm says.

Computer graphics will also score spectacular gains in Europe, Frost & Sullivan notes. Multiplying tenfold, the market value of graphics systems could reach $3 billion by the end of this decade. For West Germany, the Frankfurt-based computer consulting firm Diebold Deutschland GmbH projects annual growth rates of 34% for computer-graphics systems.

Prospects are equally heady for mass-data stores based on video disks—devices so far used only as consumer video players. In Europe there will be about 3,000 such stores integrated into minicomputers by 1983, according to Frost & Sullivan. The number should increase to 12,000 by the end of the decade, which means that by then they will have gained entry into 12% of all minicomputers. In terms of value, the video-disk–store market will rise from $2 million in 1983 to $45 million by 1989, the company predicts.

Consumer

For people in the West European consumer electronics business, these days the buzzword is "video." In West Germany, for example, booming video-cassette recorder (VCR) sales in 1981 had marketers revising their figures upward several times during the year, eventually to reach the 900,000 level.

What goes for Germany in this case goes for West Europe as a whole. Grundig AG, one of the continent's two VCR producers—the other is Philips Gloeilampenfabrieken NV of the Netherlands—says VCR sales in West Europe climbed past 2 million units in 1981, up from 1.2 million in 1980.

There is no letup in sight. In a report issued in October 1981, Grundig predicts that West European VCR sales are sure to reach at least 3 million units in 1982, "but will probably come closer to 3.5 million." Contributing to the expansion, the Fürth-based firm says, will be portable VCRs that will come on the market in large volume this year. And Grundig points out that the European market is growing faster than that of the U. S. mainly because of the strong demand in West Germany.

As for the longer term, forecasters at Philips in Eindhoven peg the number of VCRs sold in 1985 in Germany at 1.6 million, in the United Kingdom at 1.5 million, and in France at 700,000. By then, the VCR penetration into color-television households will have reached 30% in Germany and the UK, putting them on a par with Japan. The figure for France, the Dutch firm predicts, will be 20%, matching the U. S. figure.

Cashing in heavily on the current VCR boom are Japanese producers with their VHS (for Video Home System) and Betamax equipment. In Germany, for example, the Japanese together with European companies selling Japanese-made equipment under their own label, now realize about 70% of VCR sales. But Philips and Grundig are determined to win back the market share from their Far Eastern rivals with their new V2000 system, an 8-hour machine.

For all the excitement over video, color TV is still the mainstay of Europe's consumer electronics industries. This year, the sector will move up to $14.780 billion, up 9.0% from last year's $13.560 billion, the survey indicates. The forecast figure for color-TV set sales in 1982 is $5.238 billion, and that works out to 35% of the consumer-electronics total. The numbers for VCRs are $2.419 billion, or 16% of the total.

All the same, the color TV markets have faded considerably from their bright hue of former years. Market researchers at Grundig, for example, figure that set sales in units throughout West Europe rose only 100,000 units last year over the 1980 level of 10.3 million.

The niggardly rise surprised no one. Saturation levels as the year got under way in the two largest markets—West Germany and Great Britain—reached 82% and 74%, respectively. Much the same kind of saturation prevails in Scandinavia. The number of first-time potential customers in France, Italy, and Spain is much higher, but hard economic times in those countries stifled growth last year and will brake it this year. *Electronics* pegs the rise in color TV sales for 1982 at 3.5%.

Credit much of what little growth there is to replacement sets and to an increase in two-set households. New services like viewdata and teletext also will help, particularly in the UK. There, some 700,000 sets should be sold next year that have built-in decoders to transform teletext information transmitted during vertical blanking intervals of regular TV broadcasts. That is a jump from around 150,000 teletext-equipped sets sold in 1981 and works out to about a third of this year's color TV sales. In West Germany, TV broadcasts with stereo sound will add some lift to the market.

Surprisingly, the black and white TV market is not doing all that badly. More than 5 million sets were sold

WEST EUROPEAN ELECTRONICS EQUIPMENT MARKETS
(millions of dollars)

	1980	1981	1982
West Germany	11,800	12,950	14,100
Great Britain	7,987	9,216	10,318
France	7,744	8,704	9,771
Italy	4,978	5,538	6,369
Benelux	3,149	3,321	3,531
Scandinavia	2,654	2,924	3,183
Spain	1,918	2,120	2,297
Switzerland	1,216	1,357	1,484
Total	41,446	46,130	51,053

in West Europe in 1981, accounting for about one third of total TV-set sales. Most were portables, and their consumption should hold level at about 4 million units annually over the next few years. Large-screen monochrome sets, however, will slowly fade away.

Along with color TV, high-fidelity audio equipment is a mainstay of West European entertainment. And like color TV, hi fi will show only low-key growth this year. The forecast is for 1982 markets of $5.058 billion, only 3.4% over the estimated $4.893 billion for 1981. The outlook for hi fi is at best moderate for the next few years, Grundig market watchers figure. Through 1983, they are looking at growth of only 3% a year. By that time, entertainment-electronics people will be keeping a close watch on video disks, which will be launched in West European markets this year.

Communications

Communications-equipment makers in West Europe count heavily for growth on the government agencies that run the telephone networks and at the same time usually purvey the enhanced services that their networks can carry. Trouble is—from the equipment suppliers' standpoint, anyway—most countries have very close to what they need in the way of telecommunications infrastructures and the days of fast-rising spending are over.

As a result, West European markets for telecommunications equipment will show moderate improvement this year. *Electronics'* survey, which keeps score of military hardware like radar and navigation aids in the communications category and radio equipment as well, forecasts 1982 markets totalling $10.032 billion, a gain of 8.4% over the 1981 figure of $9.256 billion.

The sums, nonetheless, remain substantial. In West Germany, for example, the Bundespost plans to lay out about $4.88 billion this year for communications, just a bit more than it did in 1981. As Hans-Otto Matt of Siemens' Communications group puts it, "Domestically, the culmination point has been reached. The emphasis is now on exports."

The reason for the stagnation is not hard to find. The Bundespost is fast approaching its goal of "full" telephone services for the country—that is, service to 90% of households by the mid-1980s. Outlays for new services like data communications are still too small to keep the public sector growing lustily as spending on the infrastructure slows. In the private sector, where private automatic branch exchanges (PABXs) and teletypewriters dominate, growth will be small, too, says Manfred Beinder, chief economist at the ITT affiliate Standard Elektrik Lorenz AG in Stuttgart.

Much the same condition obtains in neighboring France. There, the Direction Générale des Télécommunications (DGT) is very close to its goal of 20 million telephone lines, set five years ago when the country had only 10 million lines in service. "The PTT's [the parent ministry of the DGT] budgets simply are not growing in real terms and some of them are actually decreasing," explains Daniel Albert, who is in charge of market research for the Syndicat des Industries Téléphoniques et Télégraphiques, the telecommunications suppliers' trade association.

In Spain and Italy, budgets for the telecommunications agencies are under heavy pressure as well; and equipment makers in these two countries have dangerously low order books. The British government has a clamp on spending as well. But British Telecom—the

EUROPEAN EQUIPMENT

	1980	1981	1982
EQUIPMENT, TOTAL (millions of dollars)	**41,446.0**	**46,130.4**	**51,052.8**
DATA-PROCESSING, OFFICE EQUIPMENT, TOTAL	**15,672.0**	**17,885.4**	**20,291.0**
Data-processing systems[1]	10,279.7	11,819.2	13,484.9
Small-business and personal (<$20K)	922.3	1,141.7	1,395.1
Small ($20K to $100K)	2,184.5	2,671.8	3,166.8
Medium-sized ($100K to $1M)	3,281.1	3,725.4	4,212.6
Large (>$1M)	3,891.8	4,280.3	4,710.4
Memory systems (add-in and add-on, all types)	83.1	90.4	107.2
Data-input peripherals	123.3	137.8	154.3
Data-output peripherals	514.2	573.9	654.1
Data terminals	1,337.6	1,620.2	1,946.1
Key-entry systems	154.9	166.9	181.2
Electronic office equipment, total	2,984.4	3,258.7	3,525.4
Calculators (nonconsumer)	643.1	686.5	713.3
Copying equipment	1,266.7	1,406.4	1,568.6
Dictation equipment	90.5	91.8	94.0
Electronic typewriters	250.7	304.4	357.0
Billing and accounting equipment	733.4	769.6	792.5
Source data-collection equipment (POS, etc.)	194.8	218.3	237.8
CONSUMER PRODUCTS, TOTAL	**12,358.0**	**13,560.4**	**14,780.3**
Audio equipment, total	4,668.7	4,893.4	5,057.6
Car audio	617.0	628.5	656.4
Hi-fi equipment, total	1,918.1	2,052.0	2,163.8
Components (tuners, turntables, etc.)	1,420.4	1,541.6	1,645.1
Consoles and compact systems (incl. TV-audio)	497.7	510.4	518.7
Phonographs and radio-phono combinations	401.0	399.5	400.8
Radios	642.3	676.5	679.4
Radio-recorder portables	585.1	602.1	612.1
Tape recorders and players	505.2	534.8	545.1
Television receivers, total	5,481.4	5,548.1	5,687.8
Color	4,914.6	5,059.1	5,238.2
Black and white	566.8	489.0	449.6
Other consumer electronic products, total	2,207.9	3,118.9	4,034.9
Home video equipment, total	980.5	1,752.4	2,555.2
Cassette players and recorders	917.8	1,656.4	2,418.6
Cameras	62.7	96.0	136.6
Electronic musical instruments	224.8	233.4	246.3
Microwave ovens	181.0	242.9	275.4
Electronic games and toys	128.9	149.0	190.8
Calculators (personal and professional)	227.6	234.1	232.2
Electronic watches and clocks	465.1	507.1	535.0
COMMUNICATIONS EQUIPMENT, TOTAL	**8,288.1**	**9,256.4**	**10,032.0**
Data communications	228.3	265.7	309.6
Facsimile terminals	37.1	50.0	72.7
Fiber-optic communications systems	0.5	7.6	15.2
Intercom systems	103.3	112.3	117.5
Paging systems, public and private	68.3	72.0	76.3
Radio, total	977.9	1,073.4	1,148.3
Broadcast equipment	289.6	320.4	335.4
Microwave systems	171.2	177.3	164.2
Mobile, land	480.4	521.6	598.6
Satellite earth stations	36.7	54.1	50.1
Telecommunications systems, total	4,763.6	5,359.8	5,825.3
Telephone and data switching, private (PABX)[2]	1,002.2	1,121.8	1,241.9
Telephone and data switching, public[2]	2,539.4	2,927.7	3,179.3
Telephone and telegraph carrier equipment	1,222.0	1,310.3	1,404.1

telecommunications agency newly split off from the British Post Office—seems determined to press ahead with plans for modernization anyway.

Late last year, for example, British Telecom announced a $384-million-per-year, three-year program to install 150 additional TXE-4A semielectronic large local exchanges plus extensions on 54 TXE-4s already in service. The order will be split among Plessey Telecommunications Ltd., GEC Telecommunications Ltd., and Standard Telephones & Cables Ltd., an ITT subsidiary. Large as it looks, the order will do no more than maintain present production levels, points out Desmond Pritcher, who heads Plessey Telecommunications.

	1980	1981	1982
Television equipment, total	175.0	187.5	197.1
Broadcast (studio) equipment	65.4	67.5	70.4
Closed-circuit television (CCTV)	109.6	120.0	126.7
Navigation aids (except radar)	705.0	745.3	748.9
Radar (airborne, ground, marine)	1,229.1	1,382.8	1,521.1
TEST AND MEASURING INSTRUMENTS, TOTAL	**893.0**	**996.7**	**1,105.4**
Amplifiers, lab	12.1	12.4	12.5
Analog voltmeters, ammeters, and multimeters	45.6	48.5	50.9
Automatic test equipment, total	137.1	159.6	182.9
Component testers	38.6	42.4	47.2
IC testers	40.3	44.7	51.3
Pc-board testers	58.2	72.5	84.4
Calibrators and standards, active and passive	11.1	11.5	11.8
Counters, time and frequency	42.6	46.1	48.2
Digital multimeters (incl. probes and acessories)	51.3	56.0	62.2
Logic analyzers	32.3	38.3	45.5
Microprocessor development systems	95.5	120.0	141.8
Microwave T&M (above 1 GHz)	66.5	73.6	83.5
Oscillators	21.0	22.7	24.2
Oscilloscopes (incl. accessories)	150.4	160.0	168.4
Phase-measuring equipment	0.7	0.7	0.9
Power meters (below 1 GHz)	7.8	8.0	8.9
Recorders (incl. chart and X-Y types)	102.3	111.2	121.0
Signal generators (pulse, sweep, and function), total	73.0	80.4	90.0
Analog	45.4	48.8	53.6
Synthesized	27.6	31.6	36.4
Spectrum analyzers	43.7	47.7	52.7
INDUSTRIAL ELECTRONIC EQUIPMENT, TOTAL	**2,589.2**	**2,726.8**	**3,014.4**
Inspection systems, X-ray	47.9	51.2	54.7
Machine-tool controls (incl. all NC systems)	196.3	202.5	215.6
Motor controls	165.8	171.4	191.6
Photoelectric controls	49.5	71.3	81.4
Pollution-monitoring equipment	17.4	17.9	18.0
Process-control equipment	1,915.3	1,986.0	2,192.7
Semiconductor production equipment	118.0	145.2	173.7
Ultrasonic cleaning equipment	33.7	35.4	37.4
Welding controls	45.3	45.9	49.3
MEDICAL ELECTRONICS, TOTAL	**1,335.0**	**1,383.3**	**1,474.2**
Diagnostic equipment	266.5	281.3	300.8
Patient-monitoring equipment	144.4	153.1	166.3
Prosthetic devices	175.2	189.5	204.3
Therapeutic equipment	78.8	83.1	87.4
X-ray equipment	670.1	676.3	715.4
POWER SUPPLIES, TOTAL	**310.7**	**321.4**	**355.5**
Bench and lab	32.5	34.0	36.1
Industrial (heavy-duty)	70.8	76.5	84.2
OEM and modular, total	207.4	210.9	235.2
Linear	112.9	109.2	114.9
Switching	94.5	101.7	120.3

[1] Includes stand-alone minicomputers but not computers that are integral parts of process-control and similar systems.
[2] Electronic or semielectronic only.
Figures in this chart are based on an 11-country survey made by *Electronics* in October and November 1981. The estimates are for consumption of equipment, valued at factory prices for domestic hardware and landed cost for imported hardware.

Along with TXE-4s, there is a batch of 35 System-X all-digital exchanges on order. They will go into an overlay network intended to provide advanced business services throughout the country. The overlay network also will benefit producers of optical-fiber links. They will share an inital order for $29 million worth of trunk systems with transmission rates of 120 megabits per second. Even better, they can look forward to 1985, when British Telecom plans to shift to optical fiber for all new trunk systems.

By that time, the government agency will have a flock of new competitors selling telephone terminals, small PABXs, and added-value services. They will be deregulated by October 1983, and already companies have begun to position themselves for market shares.

British Telecom, not to be outdone, has started setting up telephone boutiques and stocking them with sleek models from Sweden and Denmark. It also has announced Teletex (high-speed typewriter-to-typewriter transmission with storage facilities) and electronic mail services. And to compete with Cable & Wireless Ltd.'s national fiber-optic network, British Telecom now offers end-to-end digital leased lines at rates from 64 kilobits per second to 2 megabits.

On the Continent, as in Britain, sophisticated new services still cannot match the traditional telephone-network business in market magnitude. But they are generating plenty of excitement nonetheless.

In West Germany, Bildschirmtext, a telephone-based videotex service, is considered a sure source of substantial new business in the mid-1980s. Also rated at high potential is the Bigfon project, which involves broadband fiber-optic networks in several cities. For it, the Bundespost recently earmarked $66 million.

In France, telecommunications-equipment makers will keep a close eye on the computer-based electronic telephone-directory setup currently under trial in Brittany. The directory terminals will be made available in other regions; but country-wide coverage no longer has a high priority. Meanwhile, the videotex experiment with 3,000 subscribers in a suburb of Paris continues; and the DGT is putting in the optical-fiber cable for the "wired city" of Biarritz.

In neighboring Switzerland, it is the Telepac packet-switching data network, to be started in 1982, that is generating news. So is Teletex, which will also begin this year. Also on the work list, say officials at the PTT headquarters in Bern, is an integrated digital communications system, dubbed IFS, slated to go on stream in the mid-'80s. Meanwhile, videotex trials are starting.

Holland, too, is busily engaged in new projects. One is the buildup of the public data-transmission network. In the trial stage is Viditel—the Dutch version of viewdata—in which so far some 4,000 subscribers all over the country are participating. Still another will allow dialing into the public network from car telephones.

In Belgium, one of the biggest projects under way is digitizing networks between telephone exchanges in areas where extra capacity is needed. There is some activity also going on in optical communications. Belgian industry officals say that by 1985, 75% of outlays for ongoing projects will be for digital equipment.

And although they are tuned mainly to export markets, telecommunications-equipment makers in Scandinavia have interesting home markets to furrow. Computer users in Denmark, Finland, Norway, and Sweden, for example, can ship information to one another over the Nordic switched data network, which runs at 9,600 b/s. Sweden late last year put its Teletex system in service, and Denmark expects to follow suit in 1983.

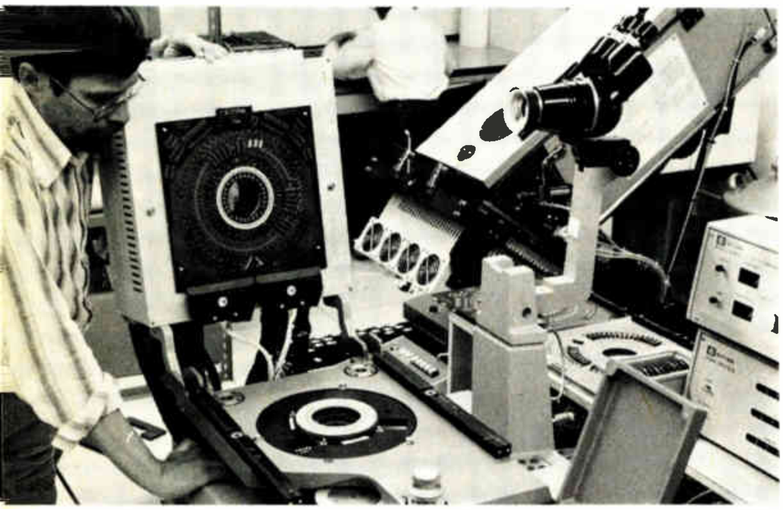
Added stimulus for the Danish market will come from the cautious move toward some measure of deregulation, starting with telephone terminal equipment (the country is unique in West Europe because its telephone services are supplied mostly by private telephone companies). Standard Elektrik Kirk, an ITT affiliate, already has benefited from the deregulation in Britain, having sold 3,500 digital subscriber sets to British Telecom.

Test & measurement

Markets for test and measurement instruments performed reasonably well last year despite the very bleak economic climate in West Europe, and some measure of improvement seems reasonably certain late this year. So even though government agencies by and large will be spending less in 1982, "there is still a good amount of growth ahead," estimates Bill Whitward, international marketing manager for T&M at the Science and Industry division of Philips in Eindhoven.

Electronics' survey forecasts a $1.105 billion year for the sector. That follows on a 1981 figure of $997 million and represents a gain of 10.8%.

Among the largest countries, the UK is forecast to lead in growth, stepping out with a 14.3% rise to $255 million. The optimism stems from a late-1981 turn of tide. There was "a detectable upturn in business after a virtually flat first half," says Ian Allardyce, field marketing manager for instruments at Hewlett-Packard UK Ltd. Colin Gaskell, managing director of Marconi Instruments Ltd., concurs: he reckons his company's sales grew 20% last year.



Chip check. Testing integrated circuits poses a formidable challenge to both their users and producers—so much so that the market for automatic testers is flourishing in West Europe.

Pushing T&M, Whitward feels, is the growing penetration of microprocessor chips into all kinds of electronics gear. That, he adds, "creates a demand for more test and measuring systems, especially for advanced equipment." Doing particularly well, he goes on, will be what he calls "innovative products," such as microprocessor development systems, logic analyzers, and digital storage oscilloscopes. "Run-of-the-mill devices will suffer," he warns. Digital storage oscilloscopes are not singled out in *Electronics'* survey; but microprocessor development systems should gain 18.2%, it found.

Test equipment for semiconductor production will run strong over the next few years, reports Frost & Sullivan, a New York–based market research organization. In a recent report covering both semiconductor production and test equipment, it pegs test-equipment markets at just over $84 million for 1981 and predicts they will be double that by 1984.

Whitward's feeling about innovative products is shared by many others in the business. Emile Van Reepinghen, general manager of Hewlett-Packard's Belgian subsidiary in Brussels, says growth is generated by two things: "On the one hand, it's digital testing and microprocessor development; and on the other, it's automated measurement systems where instruments are linked to processors and programmable minicomputers."

Jouke Rijpstra, European sales manager for John Fluke Co. in Tilburg, the Netherlands, sees business in much the same light. He says good growth prospects are ahead for data acquisition, automatic testing, and sophisticated service equipment to keep high-quality microprocessor-based systems on the air. The 11-country survey backs up this assessment. For automatic test equipment, it predicts markets totaling $183 million, a nice bound upward from the 1981 figure of $160 million. As for logic analyzers, they should score gains of nearly 30% in all West European countries, says Volker Dolch, the founder of Dolch Logic Instruments of Dietzenbach, near Frankfurt in West Germany.

Added stimulus for T&M markets originates in the shift from analog to digital technology in electric equipment, says Fluke's Rijpstra. The shift is taking place, as well, in T&M instruments themselves. "We are getting to the point where it costs nearly the same to make an analog or digital instrument," states Louis Maliaud, marketing manager of ITT-Métrix, Annecy, France. "Digital instruments will increase their share of the market from now on at the expense of analog," he adds. Substantiating evidence is in the equipment chart. It has analog voltmeters and multimeters up only very slightly this year to $51 million. By contrast, the forecast for digital meters is an 11% climb to $62 million.

Europe's components markets

Suppliers wait for 1982 rebound after a disastrous 1981

In the annals of the components business, 1981 will stand as one of the worst years ever. Components suppliers, like other businessmen, were burdened by the stubborn recession in West Europe. To compound the misery, their equipment-making customers ran down parts inventories and are still holding them low. And as if this were not enough, many components markets are tinged with overcapacity, pushing prices down.

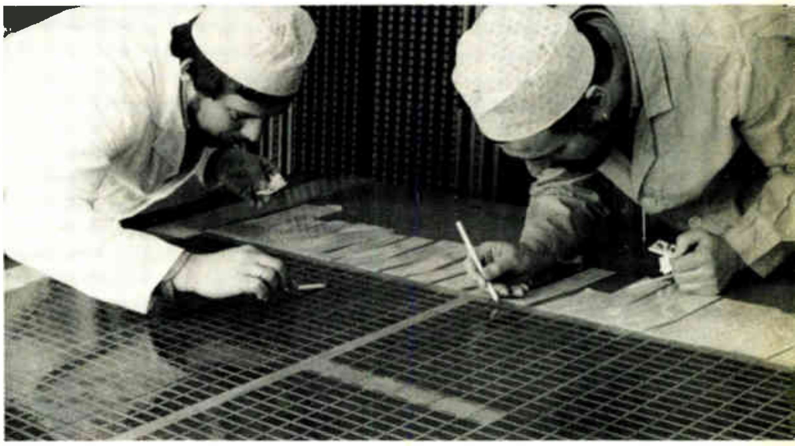
Freighted by so many woes, components markets caved in during 1981. When the debris was fully swept into the dustbins, the market level showed through as $9.521 billion, according to *Electronics'* survey, 3.8% below the figure for 1980. After such a fall, markets have to bounce back, most people think. Reflecting this reasoning, the survey predicts a rebound this year to $10.308 billion, a rise of 8.3% (see chart on p. 144).

The semiconductor sector should bound back with slightly more zing. It almost has to, following last year's disaster. Then, memory makers—particularly those from Japan—became convinced that insane pricing could solve their predicament when demand dropped well below the offer. As a result, the markets for memories glitched by over 20%. Mike Yount, market-research manager at Texas Instruments UK Ltd., characterizes 1981 prices for memories as "suicidal."

There is no argument on that score from Dedy Saban, the Geneva-based vice president and director of marketing for Europe for the Semiconductor Sector of Motorola Inc. Says Saban, "The price deterioration in memories has been phenomenal." Markets for the logic circuits slipped in 1981 and so did linear integrated circuits; all told, then, the figure for ICs was $1.498 billion, off 8.9% from 1980's $1.645 billion.

Again, a rebound seems almost a sure thing. But the feeling pervades the marketplace that nothing really good can happen before the second half of 1982. Saban figures semiconductor markets will move up strongly then, enough to boost them 7% for the year as a whole. Gernot Oswald, who heads microcomputer activities and IC sales at Siemens AG, sees 1982 growth of 12% for ICs. But he is convinced there will be no solid market recovery underlying the rise. "Rather, it will be of a technical nature," he says. Technical or not, this year's rise for semiconductors will carry the markets to $2.655 billion. That works out to a gain of 10.4%, but it still does not lift the sector significantly higher than the 1980 level.

As for passive components markets, they dwindled about 2% last year but will come back this year to $5.679 billion if the survey is anywhere near the mark. There is good news for capacitor makers in the forecasts. They predict that this year will see the end of a three-year decline in capacitor markets. The price erosion of 1981 should end and a gradual recovery follow, figures Philippe Rietzler of Sprague Europe, who heads the group's market research effort in Ferney-Voltaire, a suburb of Geneva on the French side of the border.



Cell mates. The market magnitude of solar cells remains relatively low in West Europe. But there is considerable long-term potential, which keeps companies like AEG-Telefunken in the business.

For tubes, the hue of the market is determined by color television. And since set sales remain on a plateau, so do color-TV tube sales. They will remain at just over a billion dollars this year, the survey shows. But suppliers of non-TV picture tubes have good growth in the offing. Frost & Sullivan, for example, spots the market for professional cathode-ray tubes at $165 million, up from $140 million in 1980. The reason is obvious: the now-ubiquitous computer terminals.

Among the countries, one of the hardest hit last year was West Germany. Total output of components in the country slid back to the 1978 level of $2 billion, reports the Frankfurt-based Central Association of the Electrotechnical Industries (known in Germany as the ZVEI). Oddly enough, sales of electromechanical components actually increased in 1981, says Hans Hein, head of market research for Siemens' components group. Hein foresees a rebound this year—he is looking for gains like 7.5% for active devices, 6.5% for passives, and 15% for electromechanical components.

The market plots of Siemens' Oswald show ICs drop-

WEST EUROPEAN COMPONENTS MARKETS
(millions of dollars)

	1980	1981	1982
West Germany	3,457	3,187	3,401
France	1,824	1,927	2,163
Great Britain	2,003	1,908	2,055
Italy	690	606	674
Scandinavia	714	705	764
Benelux	623	614	648
Spain	343	338	351
Switzerland	236	236	252
Total	9,890	9,519	10,308

Europe's markets

ping 15% in West Germany last year and coming back almost all the way this year.

There will be good gains in memories, logic circuits, and linears as well, enough to lift IC markets to $597 million, a gain of 13%. Lesser rises are predicted for passives and tubes, but these will help carry total components markets in the country to $3.401 billion.

France often does things differently from her European neighbors, and last year components suppliers there really had reason to proclaim "*vive la différence*!" In a word, components markets in that country actually expanded in 1981, climbing some 5.6% to $1.927 billion. Another solid rise is in the offing for 1982, according to the forecast—it predicts markets of $2.163 billion.

Nonetheless, French semiconductor makers have their concerns. The reflation the government is striving for is not certain to succeed. If the home market softens, topping up order books in export markets will be difficult. "I don't think most people really understand how serious the economic climate is, particularly in the components industry," says Paul Mirat, president of Thomson-EFCIS, the major French company in the MOS business. "I see no way that we can expect a real upturn before the end of 1982."

Meanwhile, some overcrowding will be evident in the French semiconductor business. In addition to long-established producers like Thomson-Efcis, RTC-La Radiotechnique-Compélec of the Philips group, Motorola Inc., and Texas Instruments Inc., two Franco-American joint ventures reached heavy production last year. Eurotechnique SA, created by National Semiconductor Corp. and St. Gobain-Pont-à-Mousson, turned out some 2.5 million memory and microprocessor circuits in 1981 and will move up from there in 1982. Matra-Harris SA, set up by the Semiconductor Products division of Harris Corp. and the Paris-based Matra group, knocked out 2 million 4-K complementary-MOS static random-access memories last year and will add 16-K RAMs, 8- and 16-bit microprocessors, and telecommunications circuits to its catalog soon.

Across the English Channel, UK components suppliers—particularly the semiconductor people—had a "pretty awful" 1981, as one of them puts it. Overall, components markets dropped to $1.908 billion from just over $2 billion in 1980, according to the survey. The figures in the chart show a slide of 12% for semiconductors. Pat Brocket, National Semiconductor's director of marketing for North Europe, makes it steeper than that, 20%. Credit much of the decline to the troubles many computer makers—native and otherwise—are having.

And credit the telecommunications equipment makers for the considerable leg up they will provide for the market rise in semiconductors that most people believe is a sure bet this year. *Electronics*' survey spots UK semiconductor markets at $470 million, up about 12.4% over the 1981 figure. Passives will edge up and tube markets stay flat. Overall, components markets will total $2.055 billion, up 7.7%.

The fourth major market, Italy, also took a battering last year, and components sales there fell 12% to $606 million. This year, the survey suggests, there will be a moderate Italian renaissance that will carry the markets back to $674 million. □

COMPONENTS

	1980	1981	1982
COMPONENTS, TOTAL (millions of dollars)	**9,890.1**	**9,521.0**	**10,308.1**
PASSIVE AND MECHANICAL, TOTAL	**5,351.3**	**5,242.5**	**5,679.1**
Capacitors, total	945.7	836.1	895.3
Fixed	897.4	789.3	848.1
Variable	48.3	46.8	47.2
Connectors, plugs, and sockets	994.6	1,032.4	1,135.9
Filters, networks, and delay lines	104.0	104.4	111.4
Loudspeakers, OEM type	154.5	151.3	156.8
Printed circuits and interconnection systems	1,094.0	1,121.6	1,251.3
Quartz crystals	109.3	109.5	119.2
Readouts (optoelectronic and LCD)	71.2	74.7	81.8
Relays (for communications and electronics)	460.4	460.6	487.7
Resistors, total	539.8	505.0	536.6
Fixed	308.7	295.1	311.4
Potentiometers and trimmers, total	231.1	209.9	225.2
Composition	171.9	155.8	165.9
Wirewound	59.2	54.1	59.3
Servos, synchros, and resolvers	55.6	59.5	65.0
Switches and keyboards (for electronics)	342.3	332.7	362.5
Transformers, chokes, and coils	479.9	454.7	475.6
SEMICONDUCTORS, TOTAL	**2,650.6**	**2,404.5**	**2,654.7**
Discrete, total	908.9	807.7	850.6
Diodes, total	377.4	337.7	355.4
Microwave (above 1 GHz)	32.4	29.5	32.2
Rectifiers and rectifier assemblies	198.6	175.8	184.5
Signal (less than 100 mA, incl. arrays)	78.2	68.7	70.9
Tuner varactor	22.0	19.9	22.1
Zener and reference	46.2	43.8	45.7
Thyristors (incl. SCRs and triacs)	127.6	114.3	119.7
Transistors, total	403.9	355.7	375.5
Bipolar, total	378.8	331.7	349.1
Power (more than 1-W dissipation)	165.0	146.6	157.8
Small-signal (incl. duals and arrays)	213.8	185.1	191.3
Field-effect	25.1	24.0	26.4
Integrated circuits, total	1,644.5	1,497.5	1,689.5
Linear ICs, total	402.0	382.6	411.7
Entertainment	165.9	154.4	165.6
Op amps (monolithic only)	73.3	72.0	75.8
Other	162.8	156.2	170.3
Digital ICs, total	1,205.3	1,075.9	1,235.2
Standard logic families, total	690.8	639.9	707.1
Bipolar	317.5	283.7	315.7
C-MOS	373.3	356.2	391.4
Memories, total	356.2	276.9	339.2
Random-access	253.9	180.8	226.2
Read-only	102.3	96.1	113.0
Microprocessor and microcomputer chips	158.3	159.1	188.9
Special-purpose consumer ICs	37.2	39.0	42.6
Optoelectronic devices, total	97.2	99.3	114.6
Discrete light-emitting diodes	33.3	31.3	35.5
Optically coupled isolators & other circuit elements	56.4	56.9	65.1
Solar (photovoltaic) cells	7.5	11.1	14.0
HYBRID AND MODULAR COMPONENTS, TOTAL	**276.1**	**306.7**	**370.7**
TUBES, TOTAL	**1,612.1**	**1,567.3**	**1,603.6**
Cathode-ray (except for TV)	66.8	71.0	76.1
Image-sensing (incl. camera tubes and intensifiers)	59.1	62.0	66.1
Light-sensing (incl. photomultipliers)	29.1	30.9	32.4
Power (below 1 GHz)	109.0	112.6	117.1
Microwave (incl. cooking)	142.5	153.0	166.2
Receiving	34.0	28.7	23.7
TV picture, total	1,171.6	1,109.1	1,121.7
Black and white	52.7	48.2	46.4
Color	1,118.9	1,060.9	1,075.3

Figures in this chart are based on an 11-country survey made by *Electronics* in October and November, 1981. The estimates are for consumption of components, valued at factory prices, used to produce equipment for both domestic and export markets.

Japan's markets

The Japanese economy continued its slow and steady real growth of about 3.9% in 1981, compared with 3.7% in 1980, and it is expected to hit about 4% in 1982. The major difference is that most of the growth this year will be generated in domestic markets, whereas last year about 70% came from exports. There is growing resistance, from the U. S. in particular, to increased exports by Japan, and an expected rise in the value of the yen to 200 to the dollar from around 220 will compound export difficulties.

This will be a difficult year for Japan because trade frictions extend across a wide spectrum, whereas previously the imbroglios were mostly confined to one industry at a time—and a reduction in exports by that industry provided a solution. Even worse, other nations are pressing for an increase in imports from them rather than a decrease in exports by Japan.

Capital investment will be restrained, with smaller firms especially holding back, except in a few fields such as robotics, energy conservation, and office automation. Government and public enterprises will run on budgets that in real terms are almost the same as in the past year.

In fact, the government is in the throes of an administrative-reform plan that aims to decrease the number of workers and the amounts of subsidies. What's more, personal disposable income after deflation for inflation, tax bracket creeping, and the like are forecast to grow by, at most, 3%. However, growth is still expected in the electronics sector, with equipment consumption up slightly more than 10% to more than $30 billion.

Healthy and steady growth is expected in computer and office equipment, forecast to increase by 9% over last year. Manufacturers of small business computers are looking to a growth rate close to 30% per year for the next five years.

Industrial electronic equipment sales are prepared to enjoy a 22% jump as firms replace older equipment with more productive units. In particular, robot production is expected to exceed $75 million, with just about all factory output promised to Japanese firms; less than 5% is aimed for export.

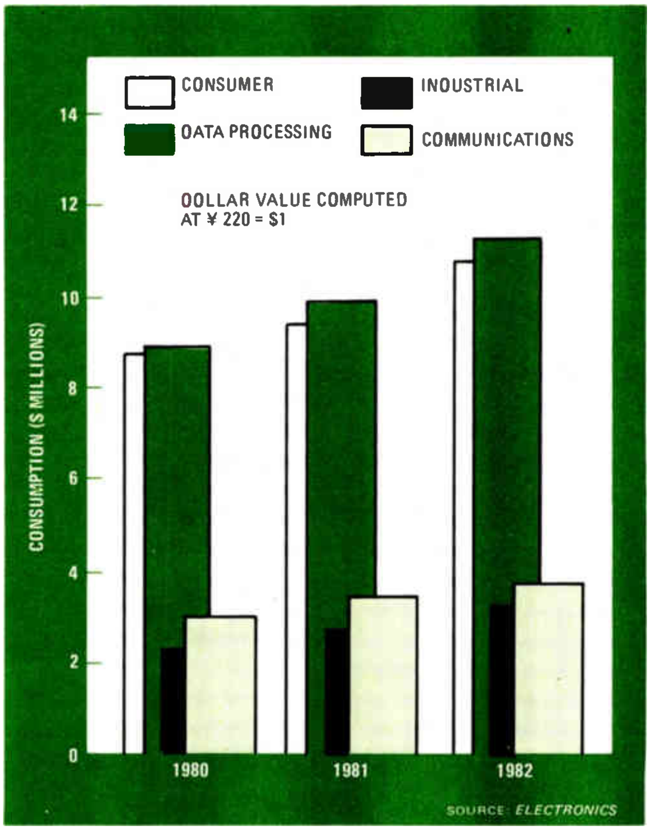
A major boom is expected in the home video market, with sales of video-cassette recorders expected to rise over 30% above last year's 1.5 million units sold. In addition, demand for portable VCRs is outstripping that for table-top models.

The shift to portable VCRs, which allows the owner to do much more than just record and play back movies or TV programs, has additional significance for home video sales. First, the cost of a portable unit is basically higher than a table-top version's. Secondly, it appears that one out of every seven purchasers of the recorders plans eventually to buy a video camera.

With a VCR costing two to three times the price of a table-model color-TV set and a video camera somewhere in the same price range, the combined video-recorder and -camera market offers tremendous impetus for domestic sales in Japan. However, Japanese VCR manufacturers estimate their domestic sales are only a fraction of the anticipated worldwide market and are prepared to produce 12 million units during 1982, with only 2 million slated for domestic sales.

Despite considerable publicity and fanfare, digital audio systems and video disks are not expected to contribute much in sales this year. The high cost of the players—$900 and up—plus the slow appearance of recordings, will delay any major market acceptance.

Component sales for domestic consumption is expected to exceed a 13% growth rate as mainframe computers, office-automation systems, and new consumer electronic products roll off factory production lines. A significant increase in integrated-circuit consumption is anticipated in linear product lines, because newly designed ICs for VCR applications will displace discrete components. A 40% rise in memory chips is predicted to meet the needs of the small business and personal computer markets in 1982.



Japan's equipment markets

$30 billion sales led by industrial, consumer demands

Data processing

Computers and office equipment are maintaining their relentless upward climb with a sales increase of 11% last year and an equal jump for 1982. Large computers continue to be an important factor for sales dollars and prestige, but the most growth is generated by office-automation products such as small business computers and Japanese-language word processors. For the first time, the microcomputer market has split into a professional and advanced-hobbyist market and a youth and games market.

Competition in mainframes continued unabated with Hitachi Ltd. and Fujitsu Corp. introducing new offerings to counter 1980 top-of-the-line introductions from Nippon Electric Co. and the other major factor in the Japanese market, IBM Corp. Even with its three new models, though, Hitachi missed the biggest sales opportunity of the year. The National Tax Administration, which is setting up a system to check on persons with tax-exempt savings and investment accounts, chose a NEC ACOS-1000 to cover half of Japan and a Fujitsu Facom M-380 for the other half.

Much larger supercomputers to compete with the Control Data Corp. Cyber 205 and Cray Research Inc.'s Cray-1 are being developed at Japan's three mainframe makers and may be only two years from completion. Exports will be necessary to build a large market—as the U. S. supercomputer makers are well aware.

At the other end of the mainframe spectrum, small computers used with clusters of intelligent terminals are reportedly thriving either as stand-alone installations or in distributed processing. Medium-sized computers are not doing so well, as the market polarizes toward large and small systems.

For the first time, Nippon Univac Kaisha Ltd. will offer a domestically designed and produced mainframe, the series 80 model 65, which it is buying from Mitsubishi Corp. to compete in the IBM 4341 market segment. It could not wait for Sperry Univac to come along with a replacement machine for customers of its series 90.

Meanwhile Mitsubishi is only about two years away from the completion of its five-year plan to become a manufacturer of IBM-compatible mainframes. Its initial sales would be targeted to the replacement of IBM or program-compatible Fujitsu and Hitachi products at the 30 or so firms in the Mitsubishi group, as well as other firms. Mitsubishi will not make very large computers but will go after the rest of the hierarchy—especially in distributed-processing systems.

With an eye toward the future, mainframe makers such as IBM and Univac are pushing toward the lower end of the computer range. Small business computers are forecast by various manufacturers to grow by 25% to 30% a year for the next five years. In Japan, this type of computer is built for a specific application, rather than being adapted from a minicomputer or small mainframe. It spans the price range from about $1,500 to $15,000, although the bottom figure appears to be falling.

The popularity of turnkey business systems and the difficulty and expenses of direct selling are forcing IBM to shift to dealers, and Hitachi is also increasing its emphasis on dealer marketing. On the equipment side, Univac has a new computer built locally, because its existing U. S.-designed equipment was not suitable for Japanese-language processing using Chinese characters. IBM came up with a solution to this problem by developing and announcing Chinese-character input/output equipment for its System/38 about two years ago, even

Large mainframes. Competition is keen among mainframe suppliers such as NEC, Hitachi, IBM, and Fujitsu, with their FACOM-M380 (shown), vying to capture a larger share of expected $2.455 billion market.

before it was ready to ship the system to Japanese users.

Yokogawa-Hewlett Packard Ltd., anxious to market its new line of Hewlett-Packard business computers, expects to have Chinese-character displays this summer and complete I/O capability somewhat later. (Chinese-character display and printing is far more important than input, because many programs manipulate lists already in memory.) Meanwhile, YHP sells more technical than business computers, even though the market for business computers is far larger.

Also generating excitement are Japanese-language word processors. Many input schemes are used, but output is generally over 34-by-34-dot-matrix printers. Prices go from about as low as $700 to perhaps three times that amount. Individual sales of the 20 or so firms in the business range up to perhaps 100 units a month. Most systems are now stand-alone, but terminals for small business computers and mainframes are becoming more popular in offices.

Professional personal computers starting at about half the price of word processors have been available for some time. For the first time, however, microcomputers have been coming into two distinct flavors: youth or games systems and advanced hobbyist or professional systems. The clearest differentiation is NEC's two new systems: the $1,400 PC-8800 with 184-K bytes of memory expandable to 320-K bytes and the $450 PC-660 that can play three-part melodies.

U. S. minicomputer manufacturers Digital Equipment Corp., Data General Corp., and Prime Computer Inc. are pushing their superminis in Japan for a variety of applications, including computer-aided design and manufacturing and medium-sized mainframe replacement in interactive computing. So far, however, they have had greater success with technical and industrial applications, because Japanese purchasers of business equipment are accustomed to turnkey systems rather than to general-purpose minicomputers.

Consumer

Video-cassette recorders are the engine of growth in an otherwise lackluster consumer electronics sector. Japanese domestic sales will be about 2 million units this year, up from about 1.5 million in 1981. The imposition of a new commodity tax, which started at 5% last October and will rise the same amount each year until it reaches 15%, has not seriously affected growth, although sales eased somewhat at year end. Furthermore, about 25% of all VCR buyers also purchase a new color-television receiver at the same time. Unit sales of video cameras run at about a seventh the rate of VCRs.

However, domestic sales do not reflect the true picture of VCR consumption because the export market is five times larger, with about 40% of units shipped as private labels. Total production of the recorders was about 9 million last year, and production capacity is in place for 12 million this year. In fact, VCR production will run at almost the same level as TV receivers, but prices are almost double those of large-screen sets.

VCRs surge. More than 2 million VCRs and 300,000 video cameras should be purchased in Japan this year for close to $2.5 billion.

Another bright spot is new audio equipment—compact stereophonic systems for personal listening, featuring a cassette tape deck rather than the turntable that has been standard on component stereos. Full-size component stereo systems are doing poorly. Like a-m radio in the past, it is turning into a personal set, rather than a family entertainment system, and thus must become smaller before it can fit into the bedroom, den, or study.

This trend has also given birth to the ubiquitous Walkman-type portable audio systems, about the ultimate in personal stereo. A Sony Corp. engineer points out, though, that the stereo effect is better with the portable units' earphones than it is with small systems having closely spaced speaker enclosures.

In general, small cassette and microcassette recorders and radio-recorder combinations are selling well, but large units are not. Paradoxically, microcassette units are not a hit in the portable products, because there is only one firm offering recorded tapes and only a small number of them. Matsushita Communication Industrial Co. will be selling stereo car radios with microcassette recorders to Toyota, even though the proliferation of gadgets reduces space on the dashboard for the stereo and though cassette storage is awkward.

Players for digital audio disks are scheduled to hit the market sometime this year, but current predictions are that they will not make too much of an immediate splash. Initially, they will sell for more than $900, as manufacturers seek to recoup the costs of special-purpose integrated circuits and tooling. Also much will depend on the availability of records.

Even more disappointing are video-disk players. The only product on the market is the optical disk system offered by Pioneer Electronic Corp. in October; but sales are slow. Victor Co. of Japan and other manufacturers in the video high-density (VHD) disk group are planning to start sales in April, a half year behind the original plans for last October, because Victor was not tooled up to make the players' disks in time.

Another troubling thought for video-disk proponents is a possible spillover from the growing record rental business. Sales of audio records have been severely affected, though of course one factor that does not loom now in the video business is the ease of taping the rented music, since the disk systems are players only.

Last year, both watch and calculator manufacturers cut back production to correct excessive inventories. Although they are going into 1982 in good shape, there is little hope for significant growth this year.

Microwave ovens appear actually to be dwindling in number of units sold. However, more and more new units are equipped with microcomputer control, driving up the average price, and so total consumption value is rising slowly in Japan.

Three consumer firms now have low-price computers designed to be sold through selected electronics stores to the student market—but sales began only at the end of last year, so forecasts are still premature. These units feature at least 16-K bytes of random-access memory and Basic in large read-only memories, with expansion possible, but they are definitely aimed at the home and not at the low-end business market. Of the new units, the JR-100 from Matsushita Communication Industrial Co. has the lowest price at $300 (with 8-K bytes of ROM and 16-K bytes of RAM), whereas Hitachi's Basic Master Junior is priced at $450.

Communications

Fiber optics has gained a firm toehold in its biggest potential market with the successful commercial test by Nippon Telegraph & Telephone Public Corp. of twelve 30- and 100-megabit-per-second circuits late last year. The real business will start next year, about the time the increase peaks in digital coaxial cables.

Until then, suppliers of fiber-optic gear will keep busy in the commercial market that includes communications links along railways and subways, data links in plants, and machine-tool control. Although each commercial installation is small, the total adds up.

NTT has started service with its inexpensive minifacsimile in which its exchanges provide low-cost store and forward service, together with digital conversion and redundancy reduction. This approach to the lower end of the fax market has stimulated sales in every segment. NTT is also developing a machine of the same type aimed at the typical business user of facsimile, but that market is gravitating toward the high-speed G-III class of machines. Last year about 40% more G-III machines were sold in Japan than in the previous year, but heavy

JAPAN'S EQUIPMENT

	1980	1981	1982
EQUIPMENT, TOTAL (millions of dollars)	**23,556.0**	**26,679.2**	**30,219.7**
DATA-PROCESSING, OFFICE EQUIPMENT, TOTAL	**8,802.9**	**9,967.8**	**11,354.6**
Data-processing systems[1]	4,232.0	4.627.3	5,109.1
Small-business and personal (<$10K)	118.2	159.1	340.9
Small-business and scientific ($10K to $20K)	318.2	359.1	400.0
Small ($20K to $100K)	704.6	768.2	822.7
Medium-sized ($100K to $1M)	954.6	1,022.7	1,090.9
Large (>$1M)	2,136.4	2,318.2	2,454.6
Memory systems (add-in and add-on, all types)	215.9	242.7	254.6
Data-input peripherals	159.1	181.8	200.0
Data-output peripherals	863.6	1,045.5	1,340.9
Data-storage subsystems (disk, tape, etc.)	1,181.8	1,386.4	1,568.2
Data terminals	1,200.0	1,400.0	1,613.6
Electronic office equipment, total	804.6	918.2	1,090.9
Copying equipment	468.2	531.8	613.6
Facsimile transmission systems	336.4	386.4	477.3
Source data-collection equipment (POS, etc.)	145.9	165.9	177.3
CONSUMER PRODUCTS, TOTAL	**7,679.2**	**8,257.8**	**9,137.9**
Audio equipment, total	3,319.6	3,553.2	3,691.4
Car audio	604.6	640.9	650.0
Hi-fi (incl. components and consoles)	1,022.7	1,095.5	1,204.6
Phonographs and radio-phono combinations	150.0	154.6	160.9
Radios	92.3	98.6	103.2
Radio-recorder portables	609.1	713.6	722.7
Tape recorders and players	840.9	850.0	850.0
Television receivers, total	2,409.1	2,404.6	2,572.3
Color	2,363.6	2,368.2	2,545.5
Black and white	45.5	36.4	26.8
Other consumer electronic products, total	1,950.5	2,300.0	2,874.2
Home video equipment, total	797.7	1,101.3	1,545.5
Cassette players and recorders	590.9	863.6	1,181.8
Cameras	140.9	163.6	245.5
Video-disk players	0.0	5.0	44.1
Projectors	65.9	69.1	74.1
Electronic musical instruments	250.0	268.2	363.6
Microwave ovens	372.7	386.4	409.1
Telephone-answering devices	16.4	16.8	17.3
Electronic games and toys	318.2	336.4	345.5
Electronic watches and clocks	195.5	190.9	193.2
COMMUNICATIONS EQUIPMENT, TOTAL	**1,645.6**	**1,895.1**	**2,108.3**
Data communications	136.4	163.6	190.9
Facsimile terminals	345.5	418.2	490.9
Intercom systems	56.8	62.3	68.2
Radio, total	305.0	317.3	330.1
Broadcast equipment	115.0	123.2	129.6
Microwave systems	190.0	194.1	200.5
Telemetry (industrial only)	72.7	84.1	90.9
Telecommunications systems, total	472.3	559.1	609.1
Telephone and data switching, private (PABX)[2]	62.3	77.3	86.4
Telephone and data switching, public[2]	410.0	481.8	522.7
Television equipment, total	256.9	290.5	328.2
Broadcast (studio) equipment	104.6	118.2	130.0
Cable television (studio and distribution)	65.9	75.0	89.1
Closed-circuit television (CCTV)	86.4	97.3	109.1

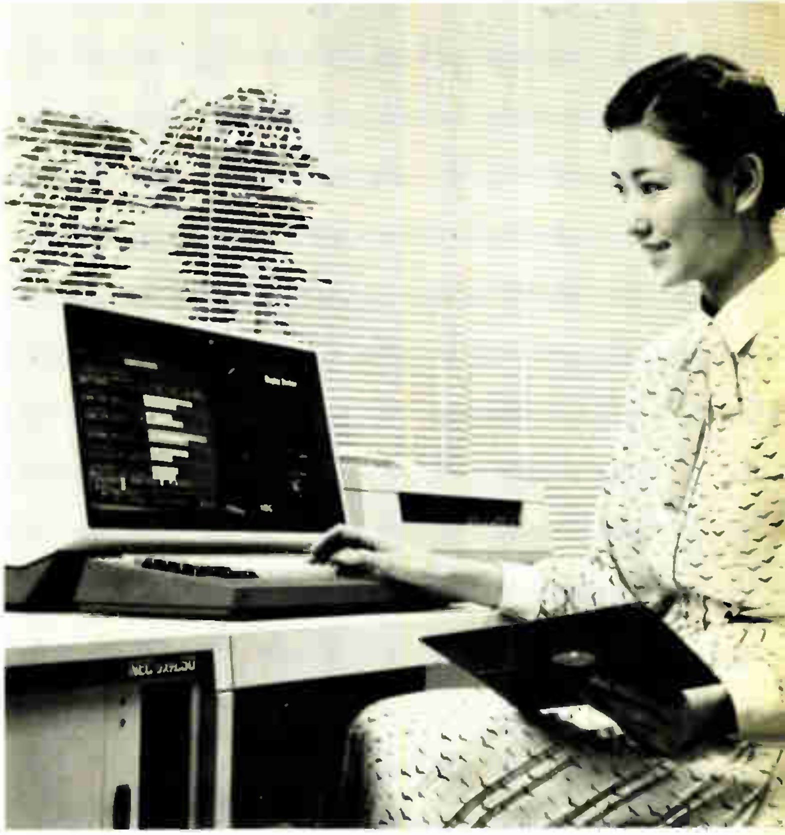
[1] Includes stand-alone minicomputers but not computers that are integral parts of process-control and similar systems.
[2] Electronic or semielectronic only.
Figures in this chart are based on a survey made by *Electronics* in October and November 1981. The estimates are for consumption of equipment, valued at factory prices for domestic hardware and landed cost for imported hardware.

competition reduced prices, affecting the overall consumption figures.

Automobile telephone service is growing rapidly after an introduction only two years ago in Tokyo and Osaka. This year, the Tokyo suburbs of Kobe, Nara, and Kyoto were added, and equipment makers are seeing a resulting sales upswing, they report.

Digital microwave communications are also increas-

	1980	1981	1982
TEST AND MEASURING INSTRUMENTS, TOTAL	**503.9**	**556.4**	**633.7**
Amplifiers, lab	16.4	18.0	19.6
Analog voltmeters, ammeters, and multimeters	30.9	30.9	31.4
Automatic test equipment, total	91.4	111.4	139.1
Component testers	6.4	6.8	7.3
IC testers	85.0	104.6	131.8
Calibrators and standards, active and passive	8.2	8.4	8.6
Counters, time and frequency	19.6	20.0	20.5
Digital multimeters (incl. probes and acessories)	19.6	20.5	22.3
Logic analyzers	9.6	11.8	13.6
Microprocessor development systems	10.5	13.6	16.8
Oscillators	24.6	26.4	28.6
Oscilloscopes (incl. accessories)	61.4	68.2	75.0
Panel meters, total	40.9	43.7	52.2
Analog	31.8	26.4	28.6
Digital	9.1	17.3	23.6
Phase-measuring equipment	3.0	3.0	3.2
Power meters (below 1 GHz)	3.3	3.6	5.0
Recorders (incl. chart and X-Y types)	47.7	52.3	58.2
Signal generators (pulse, sweep, and function), total	45.9	50.0	59.1
Spectrum analyzers	20.9	23.2	27.3
Temperature-measuring instruments (bench and service)	50.0	51.4	53.2
INDUSTRIAL ELECTRONIC EQUIPMENT, TOTAL	**2,335.9**	**2,704.2**	**3,287.9**
Inspection systems	44.1	47.7	50.9
Machine-tool controls (incl. all NC systems)	250.0	254.6	270.5
Motor controls	200.0	209.1	209.1
Pollution-monitoring equipment	31.8	31.8	34.1
Process-control equipment	863.6	954.6	1,181.8
Programmable controllers	86.4	118.2	159.1
Robots (mechanical manipulators)	318.2	500.0	750.0
Sequence controllers	213.6	236.4	254.6
Typesetting equipment (computerized)	10.5	11.8	18.2
Ultrasonic cleaning equipment	100.9	110.0	114.1
Welding controls	216.8	230.0	245.5
AUTOMOTIVE ELECTRONICS, TOTAL	**1,171.5**	**1,776.4**	**2,053.6**
Convenience (incl. trip computers)	477.3	740.9	822.7
Exhaust-emission controls	209.1	277.3	350.0
Electronic ignition systems	46.4	54.1	64.1
Fuel-injection systems	45.5	80.9	121.4
Fuel-metering systems	19.1	39.6	40.9
Safety systems (antiskid, air-bag, etc.)	9.1	10.9	13.6
Voltage regulators	365.0	572.7	640.9
MEDICAL ELECTRONICS, TOTAL	**766.0**	**827.3**	**916.0**
Diagnostic equipment	150.0	156.8	177.3
Patient-monitoring equipment	50.0	57.7	60.0
Prosthetic devices	24.1	27.7	30.9
Surgical support	21.4	24.6	26.4
Therapeutic equipment	29.6	33.2	35.0
X-ray equipment	490.9	527.3	586.4
POWER SUPPLIES, TOTAL	**155.5**	**176.0**	**195.9**
Bench and lab	31.8	38.2	41.8
Industrial (heavy-duty)	29.1	34.1	37.3
OEM and modular, total	94.6	103.7	116.8
Linear	27.7	29.6	32.7
Switching	66.8	74.1	84.1
ANALYTICAL INSTRUMENTS, TOTAL	**495.5**	**518.2**	**531.8**



Small computers. Personal computers and small business systems, such as NEC's 50/35, are headed for a 43% jump to $74 million.

ing. NTT is changing to 200-Mb/s transmission on its 5-gigahertz long-haul circuits. This rate has been in use on 2-, 11-, and 15-GHz channel, but these circuits are short-haul—up to 100 kilometers. Also, purchases of 400-Mb/s repeaters are still alive—many are needed since the average span is only 3 km.

Electronic exchanges for NTT are increasing at about 15% annually, and crossbar switch sales are level or falling. Four D-60 large digital exchanges have been ordered, one each from NEC, Hitachi, Fujitsu, and Oki Electric Industry Ltd. NTT will follow these orders in about a year with some for the smaller D-70 exchanges intended for city switching.

What's more, NTT late last year turned out a set of specifications to which time-division–multiplexed private automatic branch exchanges must conform. Until now, only space-division units have been available, but now firms can receive TDM PABX type approval.

Test & measurement

The largest single market segment in test and measurement equipment—integrated-circuit testers—forged a 23% gain in 1981, almost the figure predicted in *Electronics*' survey last year. The growth would have been even larger if 64-K memory sales had kept pace. This year's increase will be at a greater rate, as semiconductor firms buy random-logic testers for gate-array logic and also for 16- and 32-bit microprocessors in development. A Takeda Riken Industry Co. source says that the random-logic market is like the mainframe market in that buyers stick with the same vendor to protect their software investment.

Board testers are growing at about 30% a year. It is a predominantly import-vendor market dominated by GenRad Inc., Fairchild Camera & Instrument Corp., and Yokogawa-Hewlett Packard. A YHP source gives market size for the three years as $170,000, $230,000, and $290,000.

The oscilloscope market generated a far greater number of units and more excitement than the 10% growth figures in the chart indicate. Hitachi continues to introduce new low-price models in the 100-megahertz-and-below class, while other manufacturers such as Kikusui Electronics Corp. and Trio-Kenwood Corp. have moved up from the service-instrument class with competitive products.

Thus Iwatsu Electric Co. and Matsushita, which shared the market with Tektronix Inc., are being forced to bring out new models. Iwatsu, whose standard 100-MHz scope was priced at $3,200, introduced a version for $2,700. The firm sold more than it planned of the lower-price unit and more than it predicted of the higher-price models. (Minimold semiconductors and passive chip components contribute to the low cost and high performance of many low-price scopes).

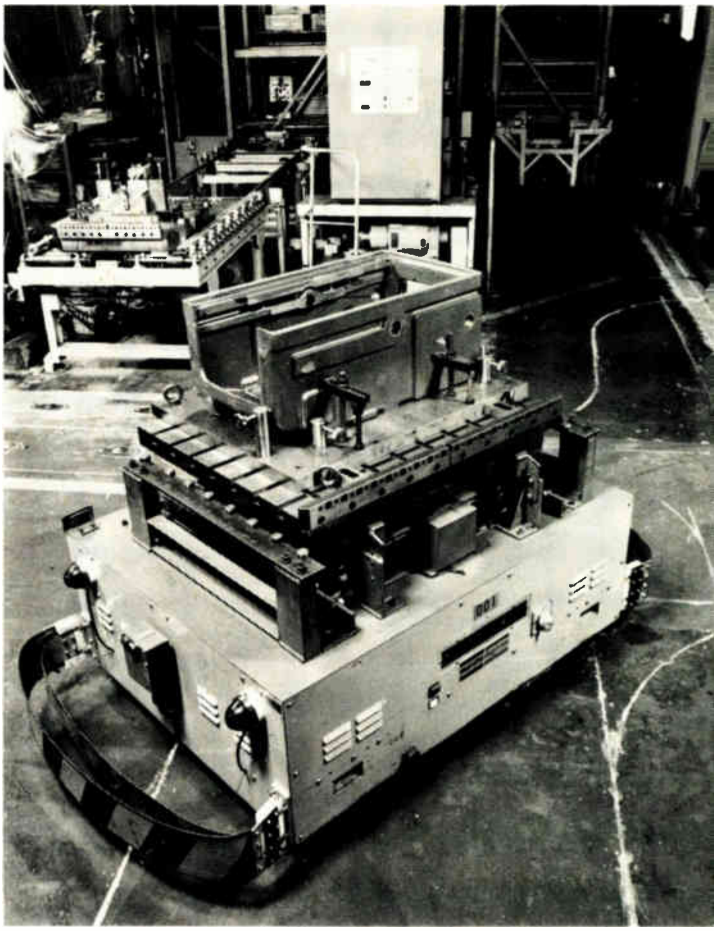
Iwatsu, Matsushita, and Tektronix continue to dominate the 200-MHz-and-up range. Meanwhile, 40-MHz dual-trace units that meet the RS-170 standard for TV scanning are being introduced for VCR production lines. In general, exports are now up to 40% of oscilloscope production and still rising.

This year the race will heat up for 16-bit microcomputer development systems. The leading vendors are Intel Corp., YHP, and Tektronix. Japanese test-equipment houses have not advanced beyond the 8-bit stage. Development systems are available from a number of semiconductor manufactureres, test-equipment makers, and systems houses—with the system-house share growing according to survey figures.

Industrial

Despite lagging capital investment, growth remains high in industrial electronics, as Japanese manufacturers replace worn-out equipment and fine-tune processes for improved labor productivity and energy efficiency. Most industry sources predict that digital systems will predominate this year.

For example, Masaru Shimizu, president of Hokushin Electric Works Ltd., says that only 25% of the market will remain analog. Even individual superannuated controllers can be replaced with similar digital units, because major control manufacturers now have the required single-loop digital controllers.



Driverless vehicles. Industrial robots are accepted as a strong competitive tool and could exceed $500 million in sales this year.

The big news, though, is the trend to what are being called boardless systems, being paced by Toshiba Corp., the firm that started the digital revolution. Almost all control—a few more critical features excepted—is performed from a cathode-ray-tube console. The loop units have neither their own indicators nor controls.

Electronic motor-control systems are growing rapidly, thanks to the trend toward variable-frequency, variable-voltage inverters to control the speeds of motors ranging from steel rolling mills to fans and air conditioners. In applications that used dc motors, the elimination of motor brushes and commutators makes for far lower maintenance and smaller size. In applications that used constant-speed ac motors (such as fans and air-conditioner compressors) control improves and a large energy saving is realized.

Robots, manipulators, and related parts-inserters are being used in an ever-increasing variety of industries, including the electronics industry itself. Especially popular are systems for handling chip components and minimold transistors. Also following an upward trend are numerical-control systems for machine tools.

Japan's components markets

Memory and linear IC chips showing greatest gains

In terms of profits, last year ranked as poor for large-scale integrated circuits, fair for standard ICs, and good for linear and discrete chips. The LSI profits were dragged down by plummeting memory prices and inventory corrections in special-purpose circuits, while soaring VCR sales helped launch the other categories to new highs.

Hitachi and Fujitsu, along with NEC and Texas Instruments Inc., supplied most of Japan's total of about 1.5 million 64-K RAMs. That allotment was actually an oversupply, and prices plunged to below $7 apiece. To cut costs, Hitachi and Mitsubishi came out with parts in plastic packages in the third quarter.

Demand for 64-K RAMs this year, both in Japan and worldwide, is perhaps 10 times that of 1981, and there could be a shortage because of the small number of lines in production. Tomihiro Matsumura, senior vice president at NEC, predicts that it will take until early 1983 before the number of units produced and the price per bit reach 16-K levels.

Meanwhile, NEC is diverting excess 64-K RAM production capacity to making 16-K static complementary-MOS RAMs using similar line-width rules. Toshiba is marshaling essentially all its fine-pattern capacity for the same purpose, and the price of the chips is now down to about $10. Prices for 32-K ultraviolet erasable programmable ROMs are being pulled down by 16-K prices, but firms are going ahead with providing samples of 64-K parts.

The consumption of read-only memories is racing ahead of that of the U. S., as applications flourish. Slow parts used in games and educational equipment have dropped in price to around $10. The faster chips used for Chinese-character generators, microcomputer programs, and the like will follow a similar course once volume rises, for their die size is the same as or smaller than the slower ROMs.

Microcomputers are still to a large extent low-price, 4-bit types, but 8-bit single-chip products are coming along strong. NEC with its μCOM-87 series in n-channel MOS and C-MOS and Hitachi with a C-MOS version of Motorola's 6801 are the only firms with original, high-performance one-chippers. The others mainly use variations of Intel's 8048.

Intel Corp. will probably retain the market for 16-bit microprocessors because Japanese firms do not have a good selection of peripheral parts for their processors. Hitachi is in a better position than most with its 68000 offering, an authorized second-sourcing of Motorola.

Demand continues to be brisk for both low-power Schottky and C-MOS standard-logic devices. Hitachi is the leader in TTL, while Toshiba holds that position in C-MOS—though NEC says it will increase production sharply in an effort to dethrone Toshiba. The C-MOS parts find wide use in VCRs, games, and test equipment, in addition to data-processing equipment.

Consumption of C-MOS liquid-crystal-display drivers should grow as more panel displays come into use. Watch and calculator display ICs, though, underwent an inventory correction in 1981 and will be nothing special this year. The calculator market is being supported by new chips, including units whose only power supply is an array of solar cells, with no battery backup.

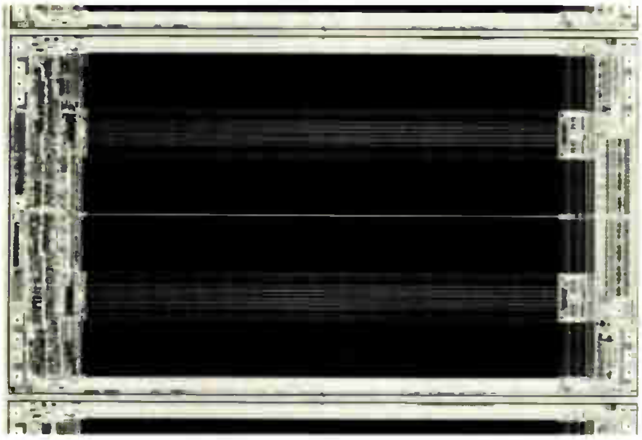
The consumer linear IC business was good last year and will continue to grow this year as designs such as VCR stabilizer circuits are converted from discrete components to ICs. Even one extra IC in each VCR will

JAPANESE ESTIMATES OF WORLDWIDE SEMICONDUCTOR MARKET
(in million of dollars)

	1980	1981	1982	1983	1984	1985
North America	6,148	6,028	6,973	8,624	10,743	13,091
IC	4,871	4,634	5,468	6,999	8,959	11,165
Discrete	1,331	1,394	1,505	1,625	1,784	1,926
West Europe	3,774	3,411	3,726	4,258	5,081	6,094
IC	2,408	2,071	2,337	2,758	3,448	4,310
Discrete	1,366	1,340	1,389	1,500	1,633	1,784
Japan	3,488	4,617	5,694	6,770	7,589	8,606
IC	2,308	2,965	3,795	4,754	5,493	6,427
Discrete	1,180	1,652	1,899	2,016	2,096	2,179
Other	1,015	966	1,114	1,329	1,612	1,962
IC	502	402	474	593	759	956
Discrete	513	564	640	736	853	1,006
Total	14,425	15,022	17,507	20,981	25,025	29,753
IC	10,035	10,072	12,074	15,104	18,659	22,858
Discrete	4,390	4,950	5,433	5,877	6,366	6,895

SOURCE: NOMURA RESEARCH INSTITUTE

Japan's markets



Dense. Memory chips, such as Nippon Electric's 256-K dynamic RAM, are expected to rise 40% over last year's consumption.

amount to something like 10 million units over the year. Multiplexed audio TV, portable audio systems, and microcassette stereo sets will grow apace, while digital audio and video disks should start generating demand. Still, audio manufacturers look to semiconductor makers to drop prices because overall demand is slack.

For compact consumer and industrial products, minimold ICs—wave-soldered to the wiring side of the printed-circuit board—have picked up in popularity. Small-signal transistors in minimold packages are rapidly replacing the formerly ubiquitous TO-92 type, and even power transistors rated at up to 1 watt are available. Chip resistors and capacitors that are attached and soldered in the same manner make it possible to achieve hybrid-circuit compactness on ordinary pc boards without the problems of unpackaged components or wiring bonding.

This type of assembly is also popular in VCRs, with new functions initially implemented in discrete circuits and then converted in later designs to ICs. The typical tabletop VCR has about 230 transistors; the typical portable type about 170. □

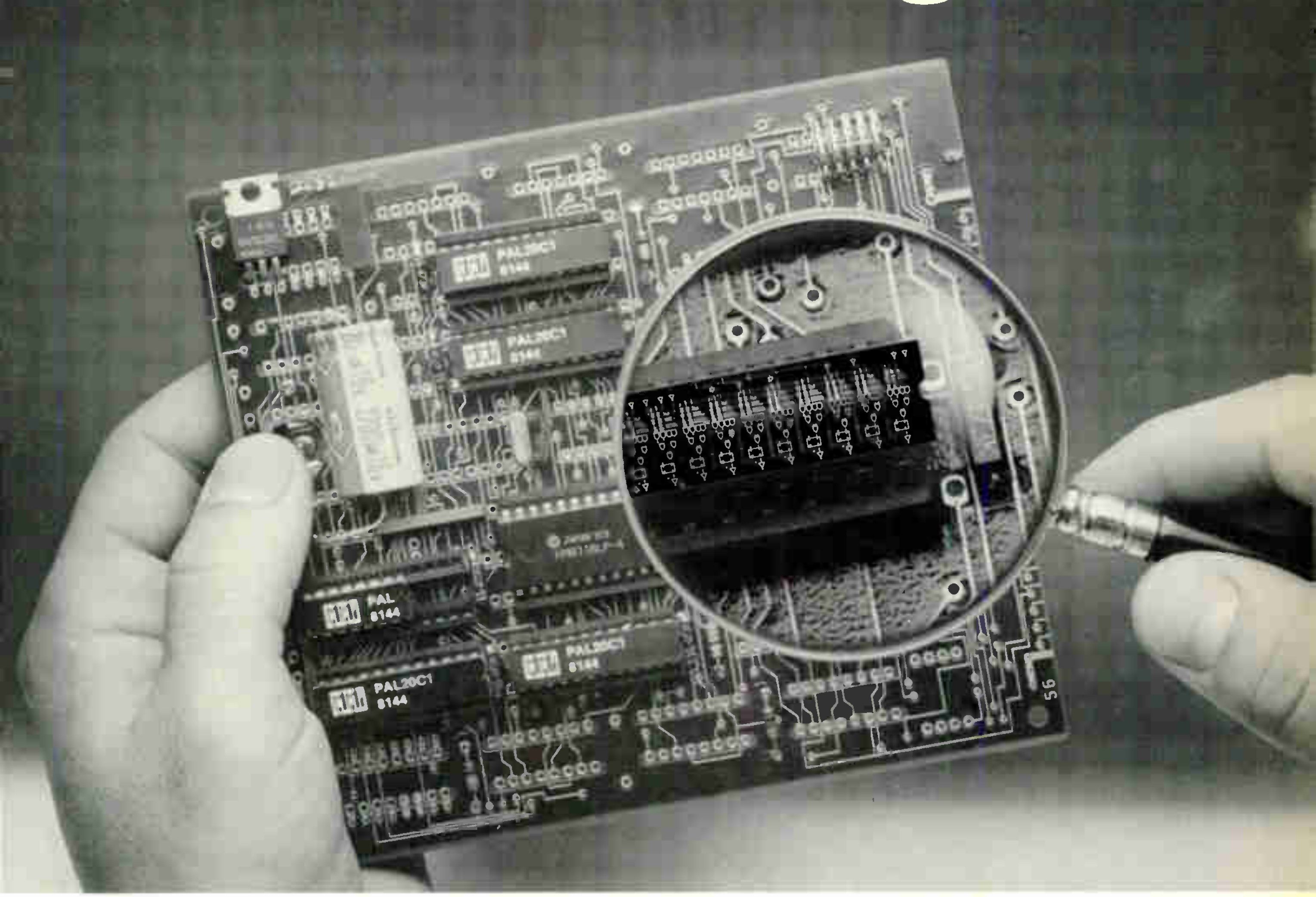
JAPAN'S COMPONENTS

	1980	1981	1982
COMPONENTS, TOTAL (millions of dollars)	**11,092.7**	**12,643.6**	**14,440.7**
PASSIVE AND MECHANICAL, TOTAL	**4,763.8**	**5,381.6**	**5,975.9**
Capacitors, total	909.2	1,045.4	1,227.3
Fixed	854.6	981.8	1,168.2
Variable	54.6	63.6	59.1
Connectors, plugs, and sockets	295.5	340.9	386.4
Filters, networks, and delay lines	195.5	213.6	240.9
Loudspeakers, OEM type	259.1	272.7	318.2
Microwave components	163.6	172.7	186.4
Printed circuits and interconnection systems	477.3	563.6	636.4
Quartz crystals	113.6	136.4	154.6
Readouts (optoelectronic and LCD)	178.2	204.1	229.6
Relays (for communications and electronics)	200.0	213.6	231.8
Resistors, total	647.7	718.2	757.8
Fixed	288.6	325.0	336.4
Potentiometers and trimmers, total	359.1	393.2	421.4
Composition	345.5	377.3	404.6
Wirewound	13.6	15.9	16.8
Servos, synchros, and resolvers	60.0	63.6	70.0
Switches and keyboards (for electronics)	522.8	545.4	581.9
Individual	254.6	263.6	286.4
Keyboards	268.2	281.8	295.5
Transducers	27.7	41.4	54.6
Transformers, chokes, and coils	713.6	850.0	900.0
SEMICONDUCTORS, TOTAL	**4,391.2**	**5,316.9**	**6,324.7**
Discrete, total	1,150.6	1,288.3	1,469.6
Diodes, total	413.8	465.5	520.1
Microwave (above 1 GHz)	9.6	12.3	13.2
Rectifiers and rectifier assemblies	231.9	259.1	281.9
Low-power (less than 10 A)	154.6	177.3	195.5
Power (10 A or more)	77.3	81.8	86.4
Signal (less than 100 mA, incl. arrays)	111.8	127.3	150.0
Tuner varactor	24.1	27.7	31.8
Zener and reference	36.4	39.1	43.2
Thyristors (incl. SCRs and triacs)	90.9	93.6	104.6
Transistors, total	627.3	706.9	818.1
Bipolar, total	495.5	559.1	650.0
Power (more than 1-W dissipation)	240.9	268.2	327.3
Small-signal (incl. duals and arrays)	254.6	290.9	322.7
Field-effect	36.3	43.2	54.5
Power (more than 1-W dissipation)	12.7	15.9	20.9
Small-signal (incl. duals and arrays)	23.6	27.3	33.6
Rf and microwave (bipolar and FET, incl. GaAs)	95.5	104.6	113.6

	1980	1981	1982
Protection devices (incl. metal-oxide varistors)	18.6	22.3	26.8
Integrated circuits, total	3,067.0	3,797.2	4,603.3
Linear ICs, total	603.7	881.8	1,061.0
Communications	45.5	72.7	121.8
Entertainment	434.1	654.6	768.2
Interface (drivers, buffers, etc.)	75.0	96.8	109.6
Op amps (monolithic only)	49.1	57.7	61.4
Digital ICs, total	1,872.4	2,233.6	2,760.5
Standard logic families, total	463.7	550.0	666.9
Bipolar	286.4	336.4	412.3
C-MOS	177.3	213.6	254.6
Memories, total	522.3	615.5	807.3
Random-access	286.4	303.2	422.3
Read-only	181.8	232.7	311.8
CCD	27.3	34.1	28.2
Magnetic-bubble	26.8	45.5	45.0
Microprocessor and microcomputer chips	277.3	363.6	440.9
Special-purpose circuits	590.9	681.8	781.8
Semicustom logic	18.2	22.7	63.6
Optoelectronic devices, total	173.6	231.4	251.8
Discrete light-emitting diodes	122.7	163.6	168.6
Image-sensing arrays	15.0	26.4	33.6
Laser diodes	11.8	14.1	16.8
Photoconductive cells	11.4	12.7	14.6
Solar (photovoltaic) cells	12.7	14.6	18.2
HYBRID AND MODULAR COMPONENTS, TOTAL	**300.0**	**370.9**	**446.4**
Standard	77.3	89.1	103.2
Custom	222.7	281.8	343.2
TUBES, TOTAL	**1,474.7**	**1,574.2**	**1,693.7**
Cathode-ray (except for TV)	46.4	56.8	60.9
Image-sensing (incl. camera tubes and intensifiers)	113.6	127.3	149.1
Light-sensing (incl. photomultipliers)	7.3	8.6	10.9
Power (below 1 GHz)	12.3	13.2	14.1
Microwave (incl. cooking)	250.0	252.3	250.0
Receiving	6.4	8.2	8.2
TV picture, total	1,038.7	1,107.8	1,200.5
Black and white	61.4	62.3	64.1
Color	977.3	1,045.5	1,136.4

Figures in this chart are based on a survey made by *Electronics* in October and November, 1981. The estimates are for consumption of components, valued at factory prices, used to produce equipment for both domestic and export markets.

Use a little logic.



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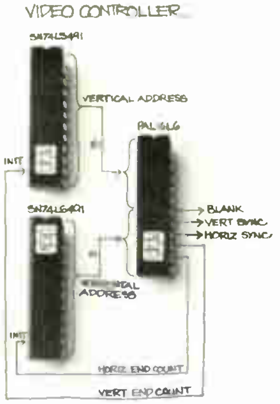

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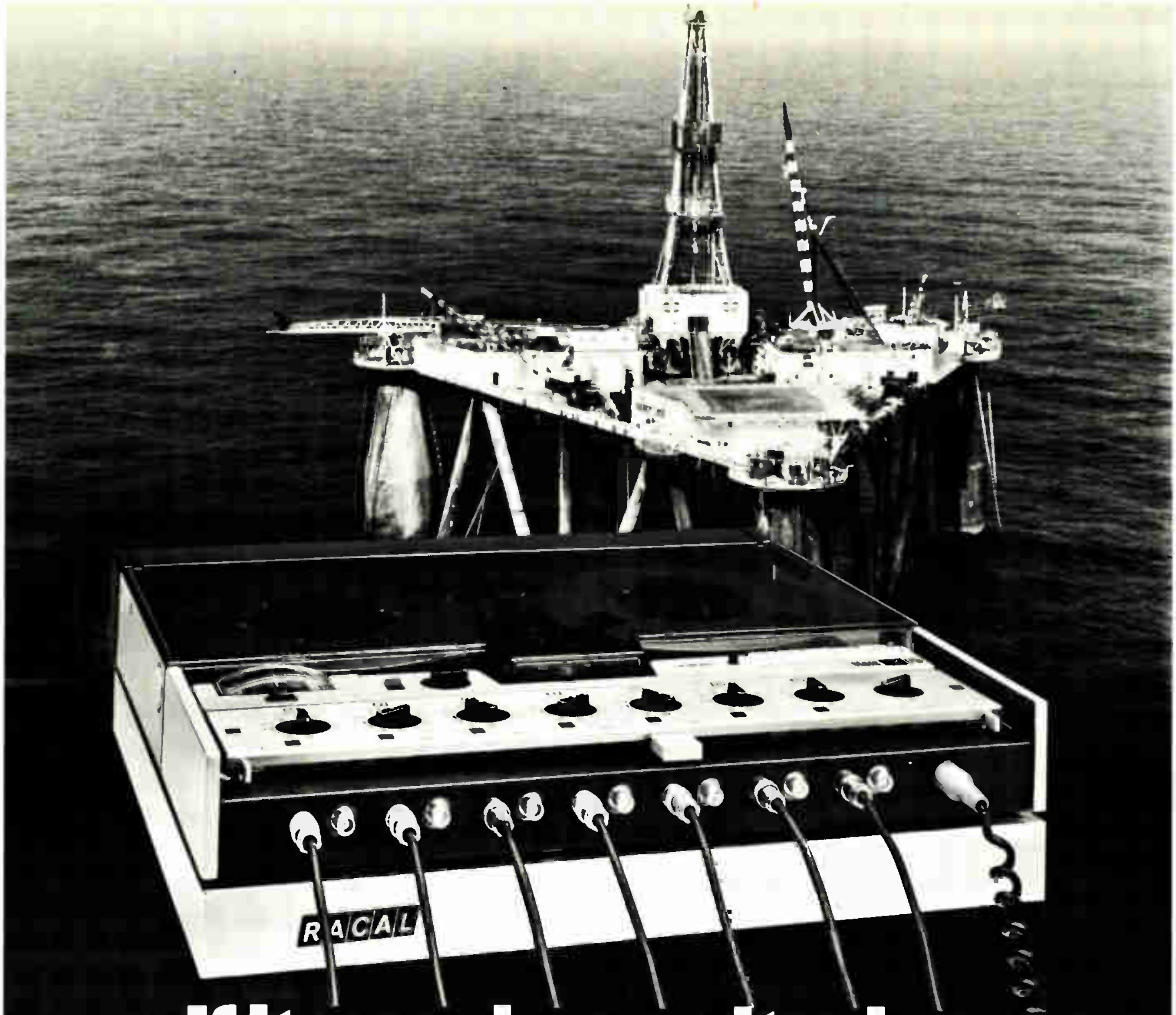
Circle 153 on reader service card


RACAL

Minicomputer blasts through 4 million instructions a second

Using proven ECL technology, pipelined architecture, and a large cache, this new machine performs like a mainframe but is priced like a minicomputer

by William P. Ward, *Gould Inc., SEL Computer Systems Division (formerly Systems Engineering Laboratories), Fort Lauderdale, Fla.*

☐ Processing speeds of up to 4 million instructions per second make a new minicomputer not just the fastest in the industry today but faster than most mainframes, too. Yet only a few years ago all mainframes, except the supercomputers, were at 1 million instructions per second or less.

Right from the start, in 1979, the designers of the Concept 32/87 system (Fig. 1) aimed at building the most powerful minicomputer at the best price-performance ratio currently offered and with high reliability. Because of market pressures, they had to bring it to market within two years. Those goals ruled out new technology. Instead, their approach was to combine proven high-speed semiconductor technology (emitter-coupled logic) with standard minicomputer packaging and clever techniques never before employed together outside mainframe design, such as a highly parallel pipeline architecture and cache memory.

In addition, the new system had to be compatible with the company's earlier 32 series computers. It therefore had to connect to the Selbus—a synchronous bus operating at 26.7 million bytes per second—and use the multiprogramming MPX-32 operating system.

Top grades

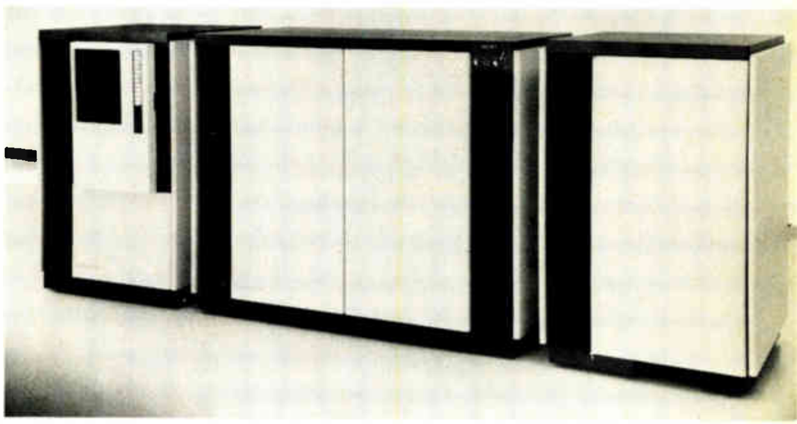
Proven in benchmark test, the 32/87 is six times faster than the company's fastest earlier computer, the 32/77, and three times faster than any competitively priced system. It performs very well running the standard Whetstone scientific numerical calculation computer benchmark Fortran programs. It performs 3,875 single-precision Whetstones per second and 2,449 double-precision Whetstones/s. This compares with 596 and 411 Whetstones/s for the model 32/77. Another Fortran benchmark, Rtsim, is often used to evaluate a system's ability in doing computer simulations. The Concept 32/87 runs the Rtsim program in 21 seconds as against 237 seconds for the 32/77.

Thus, the 32/87 can, in some applications, outperform mainframe computers costing four times as much. Prices for the basic Concept 32/87 computer start at $235,000. Typical systems with peripherals and software have list prices around $400,000.

The ECL 10,000 series of emitter-coupled-logic devices helps the 32/87 achieve this performance at this price. Its typical gate delay of 2 nanoseconds contributes heavily to keeping the machine's clock cycle to 75 ns.

Approximately 220 integrated circuits fit on each of the 32/87's 15-by-18-inch boards. The basic system has 17 dedicated Selbus-based logic boards and 18 for the central processing unit. One model, the Concept 32/8710, has 16-K bytes of cache and so requires 16 CPU slots, while the other, the Concept 32/8720, has a 32-K-byte cache and so requires 18 CPU slots. Inside the main cabinet there is room for an 18-slot Selbus expansion chassis and a memory or input/output expansion chassis in addition to the standard supplied equipment. The integrated memory module containing 1 million bytes can be plugged onto the Selbus. Up to 16 million bytes of memory can be contained in the CPU cabinet.

The CPU architecture allows simple instructions to be executed in a single 75-ns clock cycle. Before, only very large mainframe computers used cache memory and pipelining techniques to execute instructions in one clock cycle. The precise instruction-execution time depends upon the nature of the operation and the characteristics of the data involved. The table shows typical instruction execution times assuming a cache-memory hit—the data and instructions are in the cache when needed by the



1. Fast one. The world's fastest minicomputer resides in the double-bay, 68-in.-wide cabinet (center). The Gould SEL Concept 32/87 superminicomputer outperforms many mainframe systems with its processing speed of up to 4 million instructions per second.

TABLE: TYPICAL 32/87 INSTRUCTION-EXECUTION TIMES	
Instruction (memory to register)	Time to execute (ns)
32-bit integer add	75
32-bit floating-point add	225
32-bit floating-point multiply	900

CPU—which happens up to 98% of the time.

Sixty-four-bit data paths and specialized hardware have also been added to enhance the CPU's floating-point performance. Built-in microdiagnostics trace any trouble to the board level (see "A superminicomputer checks up on itself," below).

The CPU's two parts

Shown in the schematic in Fig. 2, the CPU uses a four-stage instruction pipeline consisting of two major functional units—the instruction and execution units. The first unit prefetches instructions and then decodes them while prefetching operands. The second executes the instructions as directed by microinstructions contained in the alterable control store.

This control store has the microprogram loaded into it from a floppy disk during the CPU's power-up sequence. Organized as 4-K words by 112 bits, it enhances parallelism in the execution unit because its output is buffered in a register (not shown) to allow overlapped prefetching on the next microinstruction. Each microinstruction fetched from the control store is checked for parity.

Though the execution unit operates primarily under this firmware control, it has some hardwired control to enhance performance. Operands also enter the execution unit directly from cache (or from main memory via cache—the unit is oblivious to the difference) over the 64-bit cache output bus. This bus also serves as a means of communications between the execution and instruction units.

The execution unit's major data-handling structure consists of four 64-bit staging registers, a 64-bit shifter, a 64-bit arithmetic and logic unit, and a byte-exponent adder. A 64-bit shift and a 64-bit add can both be performed in a single 75-ns machine cycle. A shifter in the operand input logic automatically right-justifies byte, halfword, and word operands in the course of cache access. This saves the time penalty of the execution unit doing a shift during these operations.

The results of an execution unit operation are always put onto the cache input bus. This bus is the path for storing results in main memory, updating register files, or transmitting information from the execution unit to the instruction unit. Multiple copies of the general-purpose register files are available in both the execution and instruction units so the operands stored in them can be read in parallel.

The instruction unit performs such major functions as: prefetching instructions and decoding and buffering them; computing operand addresses; converting logical into physical addresses when the CPU is operating in a memory-mapped environment or when requested to do so by a microinstruction; and prefetching the required operands. The unit also maintains the program counter and sends the microinstruction starting address to the alterable control store.

Two 64-bit registers help the unit to pipeline instructions. The cache control attempts to keep these two buffers full of prefetched instructions at all times, but gives this job a lower priority than operand prefetches. Not shown is another 64-bit register into which the instruction unit prefetches the target instruction of a branch instruction. Basic branch instructions can as a result be executed in only 225 ns.

Cache details

Cache memory stores both instructions and data and makes no distinctions among different data types. It is available in either a 16-K-byte two-board or a 32-K-byte four-board set. It therefore consists of two or four cache buffer boards and a cache control board.

Figure 3 is a block diagram of a cache buffer board. Major functional parts shown include the data-storage

A superminicomputer checks up on itself

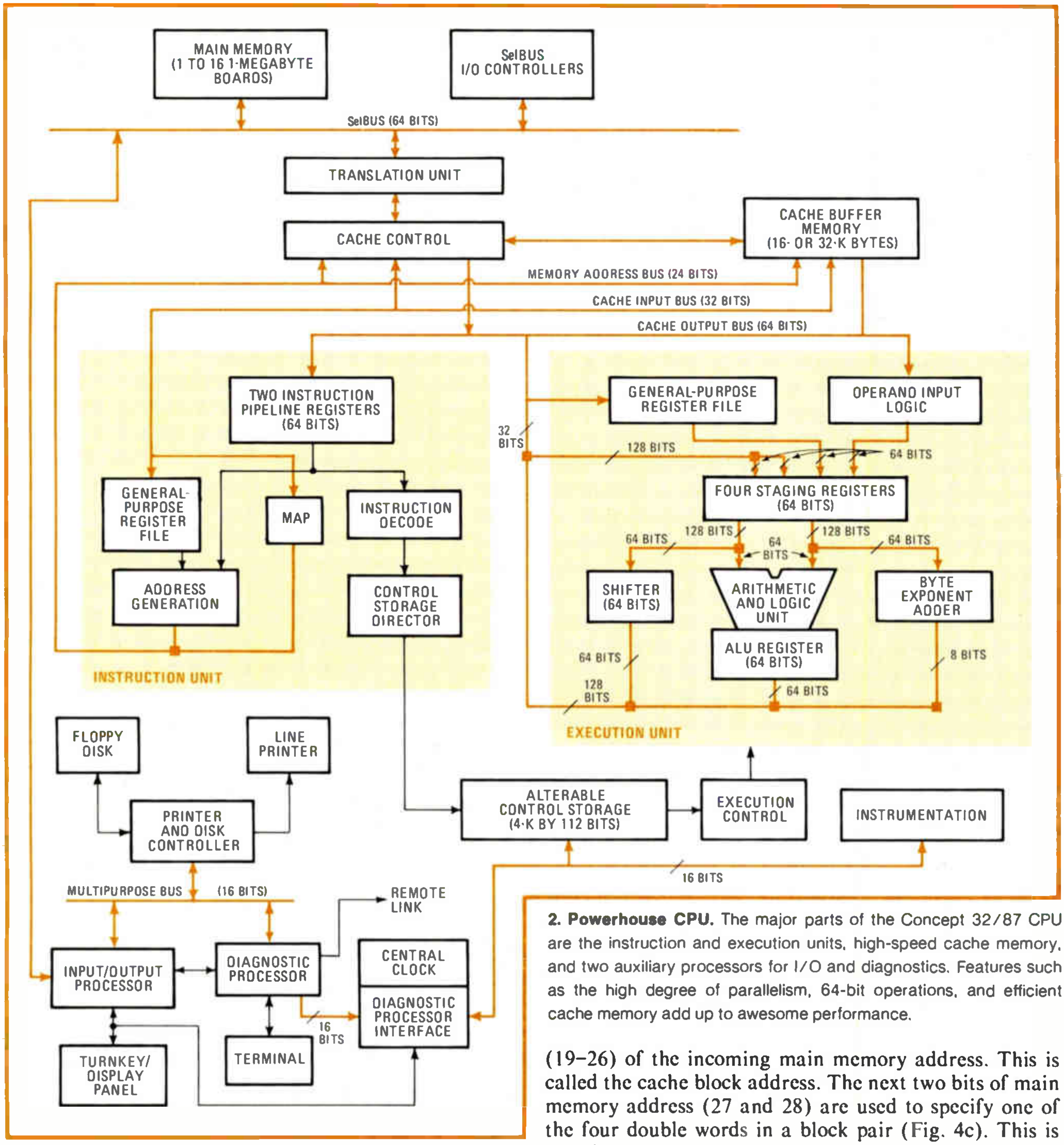
A diagnostic processor and extensive maintenance features are built into the Concept 32/87 superminicomputer. For instance, the central processing unit includes a 1,024-word history file that monitors the CPU's major buses, the microprogram counter, and many control flip-flops. Extensive breakpoint options are available for starting and stopping the history file logging.

The diagnostic processor is a Z80A microprocessor with 64-K bytes of memory and can operate in either the autodiagnostic or the manual mode. Optional remote diagnostics will be provided over the diagnostic processor's RS-232-C modem link. A telephone link will give a remote operator complete control over the diagnostic processor and thus control of the Concept 32/87 diagnosis and repair at a central service site.

The autodiagnostic mode is started at power-up or when the re-boot button is pushed. The diagnostic processor first executes a self-checking operation and lights a light-emitting diode to indicate its test status. Then it loads and verifies its own operating system and lights another LED to indicate that system's status.

The Z80A is also used to load CPU microdiagnostics from the floppy disk into the random-access-memory chips that form Concept 32/87 control store. Then it initiates, executes, and monitors the CPU microdiagnostics. If the system is ready to run, the appropriate CPU firmware is loaded into the control store and the machine is placed in the ready state.

However, if a problem is detected, the operator is notified, and a more extensive set of microdiagnostics is loaded and executed to indicate which board is failing within which functional unit. This ability to pinpoint failures to the board level shortens the mean time to repair. Alternatively, if a failing board is not essential for proper operation, it is disabled and the operator is given the choice of running in a degraded mode.



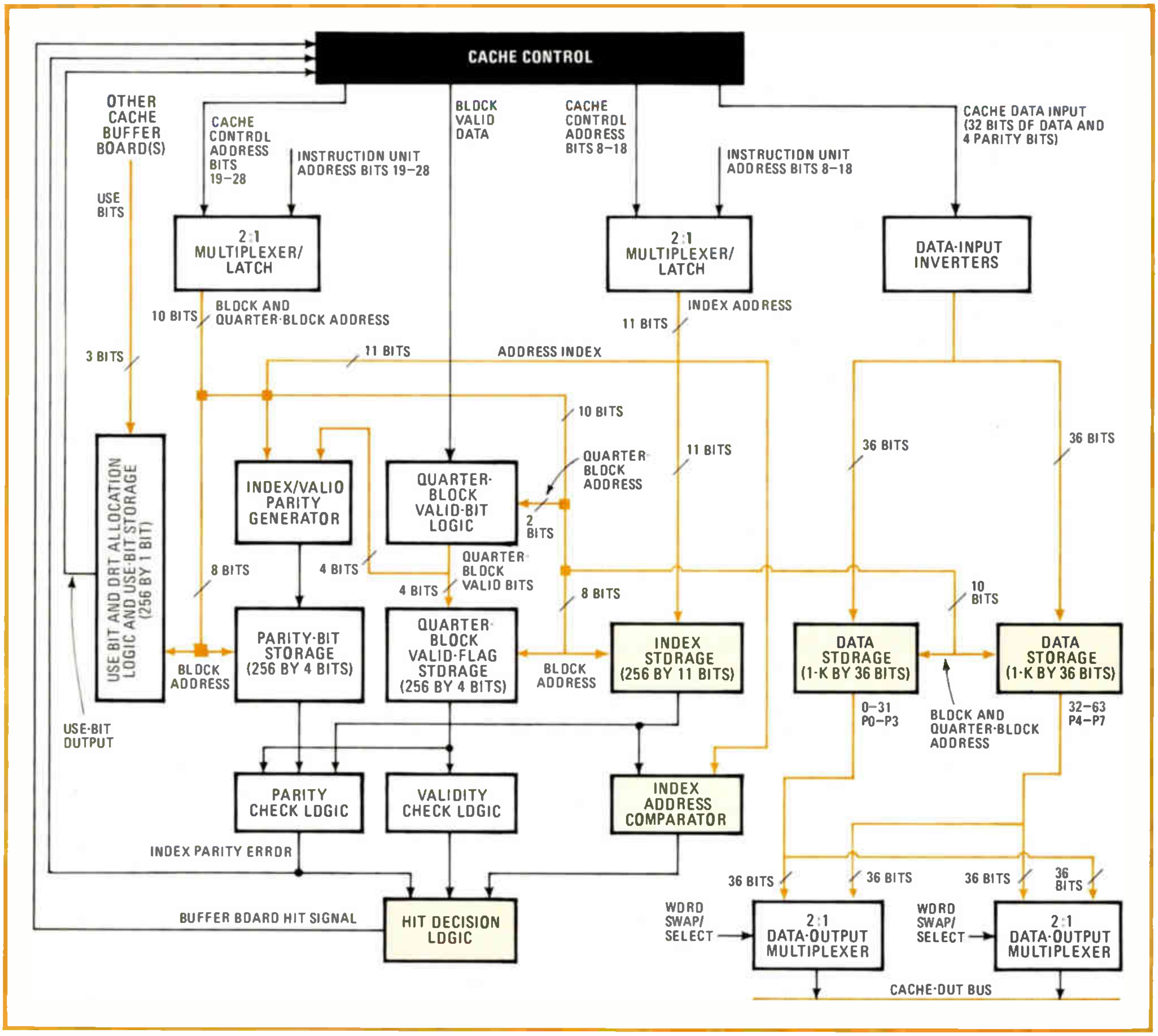
2. Powerhouse CPU. The major parts of the Concept 32/87 CPU are the instruction and execution units, high-speed cache memory, and two auxiliary processors for I/O and diagnostics. Features such as the high degree of parallelism, 64-bit operations, and efficient cache memory add up to awesome performance.

random-access memories, index-storage RAMs, address-comparison logic, and hit-decision logic. Data is stored in the cache one word at a time, whereas data is transmitted from the cache on its output bus two words at a time.

The main memory has a 24-bit address, and 21 of these bits are used to address 2 million double words of physical main memory. The least significant 10 bits (19–28) of the 21-bit double-word address are used for addressing the data buffers in each cache buffer board. Each board has 8-K bytes of data storage organized as 1-K words by 8 bytes. For cache addressing, each data buffer is divided into 256 blocks four words long (Fig. 4a). These blocks are addressed in pairs using 8 bits (19–26) of the incoming main memory address. This is called the cache block address. The next two bits of main memory address (27 and 28) are used to specify one of the four double words in a block pair (Fig. 4c). This is called the quarter-block address.

The 11 most significant bits of the memory address (8–18) are stored in a 256-word index array on the cache buffer board. When a pair of words from main memory are put into one of the pair of data-storage buffers on one of the cache buffer boards, these 11 bits of their memory address are stored in the index array on that board in the position corresponding to the cache block address where the data is stored (Fig. 4b).

When the CPU wants a word from memory, the 21-bit address is presented to the cache control and all cache buffer boards. If the word of data is there—in one of the two or four cache buffer boards—then it compares the 11 most significant bits of the address to the 11-bit index



3. Cache box. The very effective memory cache for both instructions and data has reached hit rates as high as 98%. This is the block diagram of one cache buffer board. Major units are the 1-kiloword data storage units, address comparator, and the hit-decision logic.

address at the corresponding block position in the index arrays of each board to find which board contains the data. Then it determines if that data is valid by looking at the quarter-block valid bit stored on that board at the corresponding block and quarter-block address. If the word of data is there and valid, the cache control delivers two words of data to the CPU.

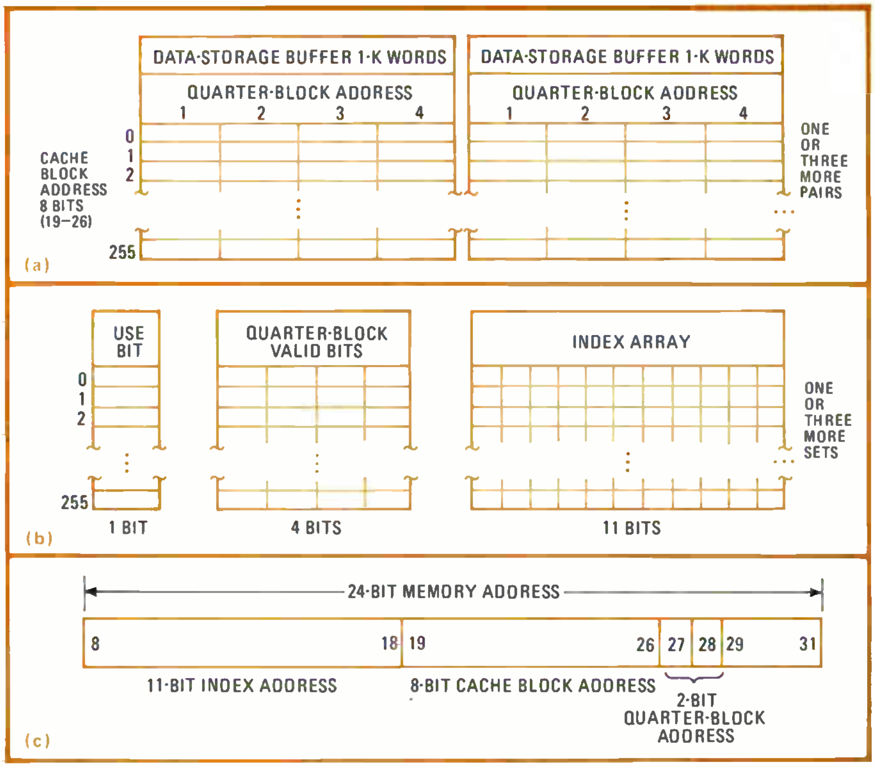
If the word required is not in the cache or is there but invalid, the cache control uses the full 21-bit main-memory address to fetch that double word from main memory, delivers it to the CPU on the cache output bus, and stores it in the cache. The cache control employs the use bits on each board to determine in which board to store the two new words.

The quarter-block valid bits are all turned off on power-up or reset. As quarter blocks—two word pairs—are loaded into the cache, the quarter-block valid bits are turned on in the quarter-block valid bit storage of the selected board in the correct block address position. The cache control continually monitors store to memory traffic on the Selbus for the areas in memory representing data that is also in cache. If there is a store to memory that does not originate from the CPU, the cache control turns off the quarter-block valid bit in the quarter-block valid-flag storage at the block address on the cache buffer board where a comparison was found.

Fresh or stale?

There is a use flag for each block of data that is stored in the cache buffer. The purpose of this flag is to determine which cache buffer board has the most recently used block of data at any given cache block address. All cache buffer boards have an identical set of block addresses and new data may be written into any of the two or four boards. It is desirable to store new data in the cache buffer board that either has no data in that block or has data that is older than the data stored in the other cache buffer boards. This reduces the likelihood of

4. Finding cache. The addressing schemes for locating data in the cache are structured as shown. In (a) are the cache block and quarter-block addresses for the double words in the data storage buffers. In (b) are corresponding block addresses for the use bit, quarter-block valid bits, and the index array on each cache buffer board. The breakdown of the system's 24-bit memory address is shown in (c).



a cache miss occurring for data currently being used by the CPU and ensures efficient use of the cache.

When data is presented to the cache buffer for storage, a decision must be made as to which cache buffer board will actually accept the data. Each board has the capability of deciding whether it should accept the data. The decision is based on the cache buffer board number (1, 2, 3, or 4), the number of the other cache buffer boards that are on line, whether the quarter-block valid flags are set, and whether the use flag for the cache block address is already set.

The cache buffer board that accepts the data should be the one with the lowest number of those on line that does not have the use flag set for the particular block address specified.

In a cache system that has four buffer boards, no more than three boards can have the use flag set at one time for a given block address. Whenever three of the boards have the use flag set for the same cache block address and the fourth board at the same block address is accessed, then the use flag for the selected board will be set for that particular block address and the use flag in each of the other boards will be reset for that particular block address.

It is necessary to prevent the use flag for a given block address being set on all four buffer boards at the same time. If all four were to become set, it would be impossible to determine which of the four had the most recently received data block.

Compatibility with the Gould SEL division's existing product line and MPX-32 operating system was a key objective in designing the 32/87 machines. This compatibility greatly simplified the development project—new hardware was tested with proven software. Moreover, users of earlier machines in the 32 series have an easy and straightforward migration path to the new system.

MPX-32 is a multiprogramming real-time memory-mapping operating system. It uses up to 16 million bytes of physical memory and is designed to manage industrial or other processes in real time whenever the system must rapidly recognize external events. Multiple batch streams, interactive development, and real-time tasks can all run concurrently. Software tasks can be directly connected to external interrupts. Efficient use of I/O peripherals is made possible by temporarily and rapidly spooling their output onto disk. High-priority tasks can be locked into main memory by the user, overruling instructions from the MPX-32, while lower-priority tasks are swapped from disk. This user control over swap scheduling is what guarantees the machine's real-time response. Interactive program development is provided through the Terminal Service Management program. TSM supports up to 96 terminals, each of which allows the programmer to interactively edit, compile, catalog, debug, and run programs.

Instructions to come

The implementation of the Concept 32/87 required the use of two instruction sets. The first and primary instruction set is supported by the current release of the MPX-32 operating system. As on the other series 32 machines, it provides a total address space of up to 2 megabytes. The first 512-K bytes can be used for instructions and data, the upper 1.5 megabytes for data only.

The second instruction set makes better use of the computer's advanced hardware capabilities. An operating system using it is to be released in the future. The new instruction set uses a base-register, index, and displacement-addressing mode that increases the maximum memory size to 16 megabytes. □

Pair of pnp/npn transistors form high-voltage amplifier

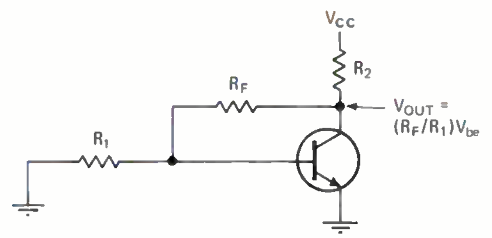
by H. F. Nissink
Electrical Engineering Department, University of Adelaide, Australia

This simple high-voltage amplifier circuit provides a large output voltage swing with low-current consumption and uses only a few components. Its 280-volt regulated supply produces an unclipped output of up to 260 V peak to peak. In addition, rise and fall times of the output for a square-wave input are 150 nanoseconds, and the no-load supply current is only 4 milliamperes.

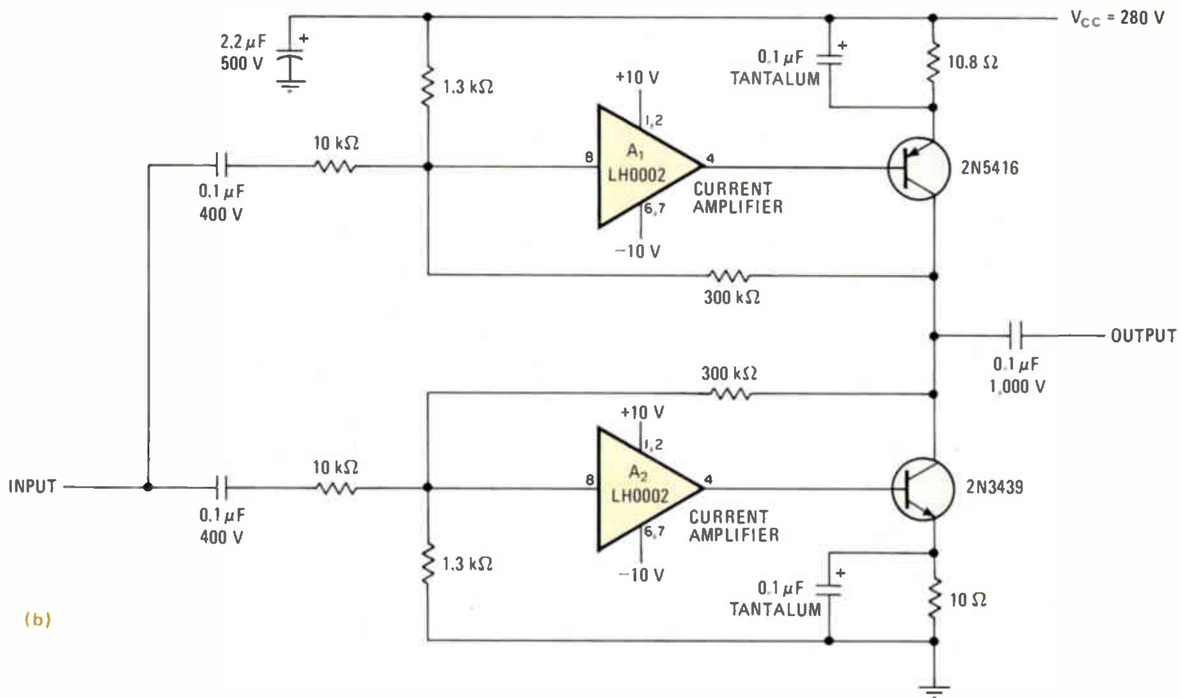
The principle behind this circuit is just a simple transistor amplifier (a) employing collector feedback through resistor R_F. The dc output is approximately $V_{be} \times R_F/R_1$. The circuit has an active pull-down action, with pull-up through R_2. However, if R_2 is replaced with a pnp transistor in a similar circuit, the pull-up and pull-down are through the transistor.

This substitution is the basis for the circuit in (b). Its output-voltage level is theoretically determined by the 300-kilohm and 1.3-kΩ resistors and thus the ac circuit gain is approximately 300 kΩ/10 kΩ = 30. The power supply (±10 V dc) for the current amplifier A_1 driving 2N5416 is isolated from the supply for A_2, which is driving the 2N3439.

The circuit has an input impedance of 5 kΩ and an output impedance of 2.4 kΩ. For the component values shown, the actual gain measures about 27, and the output over the frequency range of 1 kilohertz to 300 kHz is 260 V peak to peak (without clipping) and 100 V peak to peak at 1 megahertz. Because the amplifier is not short-circuit protected at the output, the regulated power supply is limited by the current. This high-voltage amplifier may drive capacitive-type transducers and be used for several other applications. □



(a)



(b)

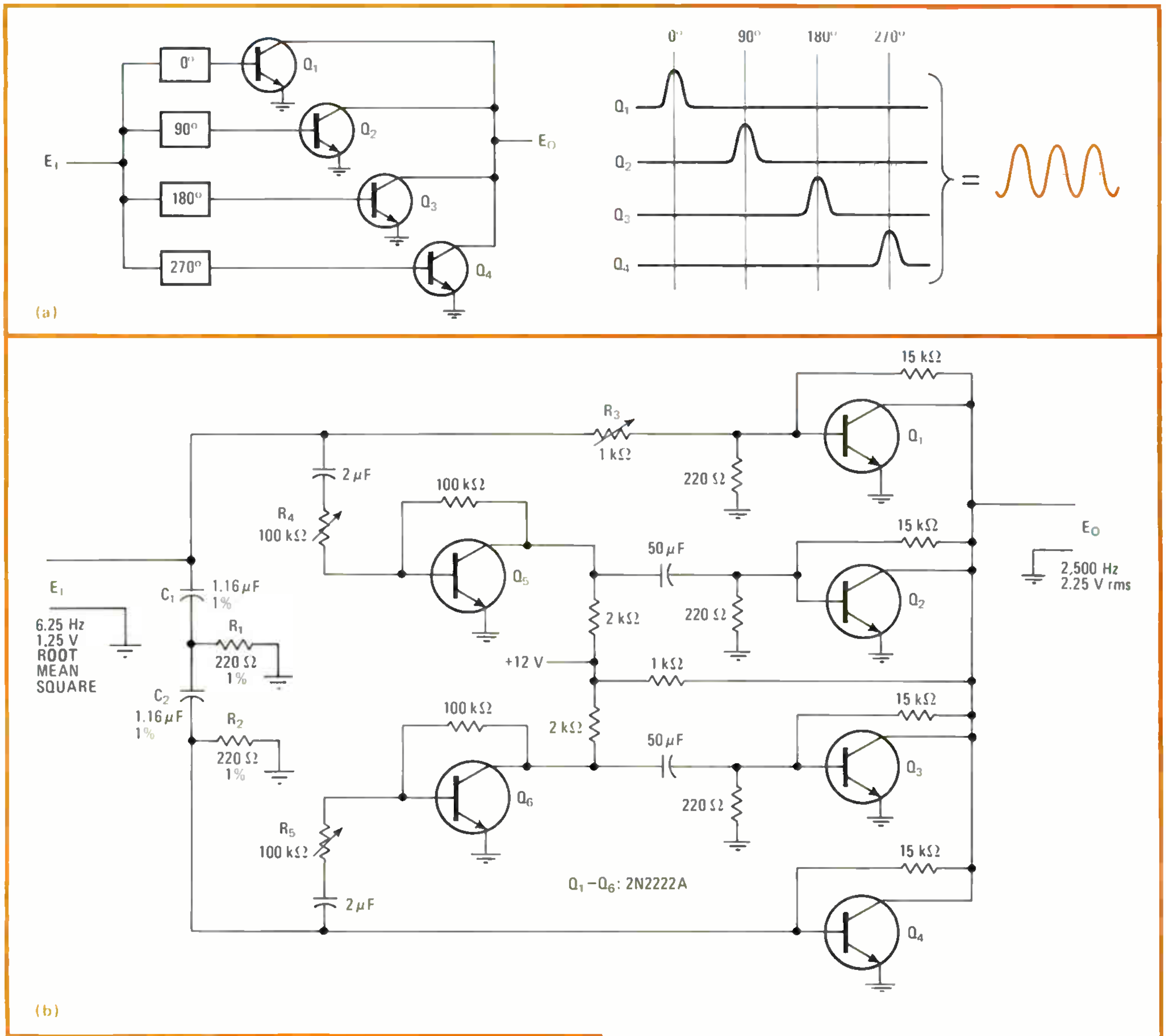
High-voltage amplifier. A simple transistor amplifier (a) employs collector feedback with R_F. Resistor R_2 is replaced by a circuit similar to (a) but with a pnp transistor to form the basis for a high-voltage amplifier (b). The current amplifiers A_1 and A_2 driving 2N5416 and 2N3439 use separate power supplies of ± 10 V dc.

Phase shifters simplify frequency-multiplier design

by Fred Brown
Lake San Marcos, Calif.

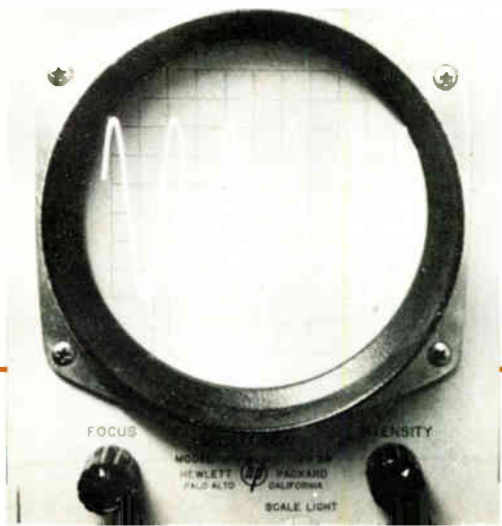
Phase-shift frequency multipliers, unlike conventional multipliers, can produce a spectrally pure output without filtering. However, by using wideband phase-difference networks for phase splitting, frequency-independent multipliers over many octaves may be obtained.

The principle of this type of multiplier is shown in Fig. 1a. A sine-wave frequency is multiplied N times by dividing the input into N different phases that are equal-



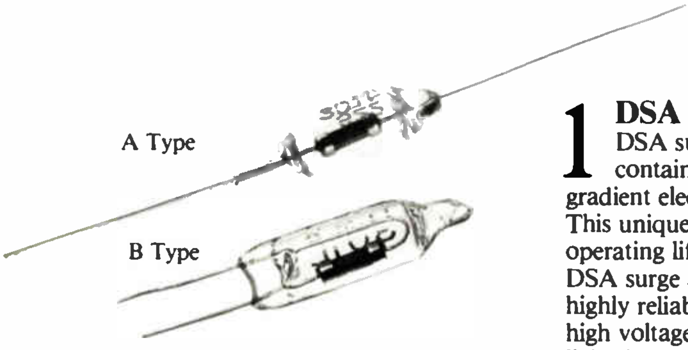
1. Frequency multiplier. A quadrupler is used to demonstrate the principle of a phase-shift frequency multiplier (a). This audio-frequency multiplier (b) quadruples a frequency of 625 Hz to 2,500 Hz. The oscilloscope photograph (c) shows the quality of the output waveform that can be achieved by means of this circuit.

(c)



Dia series

Mitsubishi introduce 4 types of SURGE ABSORBER



1 DSA DIA SURGE ABSORBER (Popular type)

DSA surge absorbers are glass-sealed discharge devices containing specially processed ceramics that produce high gradient electron field emissions in the presence of transients. This unique approach results in fast response and long operating life.

DSA surge absorbers provide an unparalleled fast response, highly reliable and economical way to protect against repeated high voltage transients and surges such as those produced by lightning, switching surge and noise spikes.

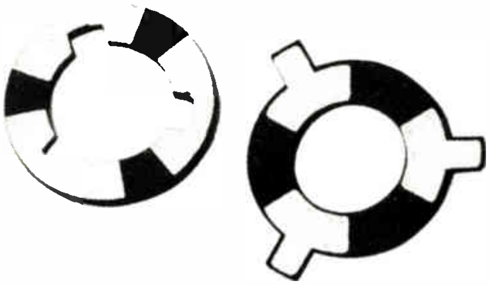
2 DSAZ DIA SURGE ABSORBER Z TYPE

(For low voltage use)

DSAZ surge absorbers are used for computer, also used for extraordinary voltage absorber to control devices of low voltage circuit.

Surges such as 1 × 40μS, 10kV are restricted about 8V to 50V.

It is very easy to set the DSAZ surge absorber.



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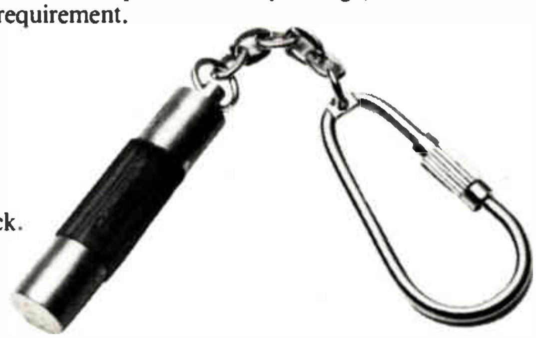

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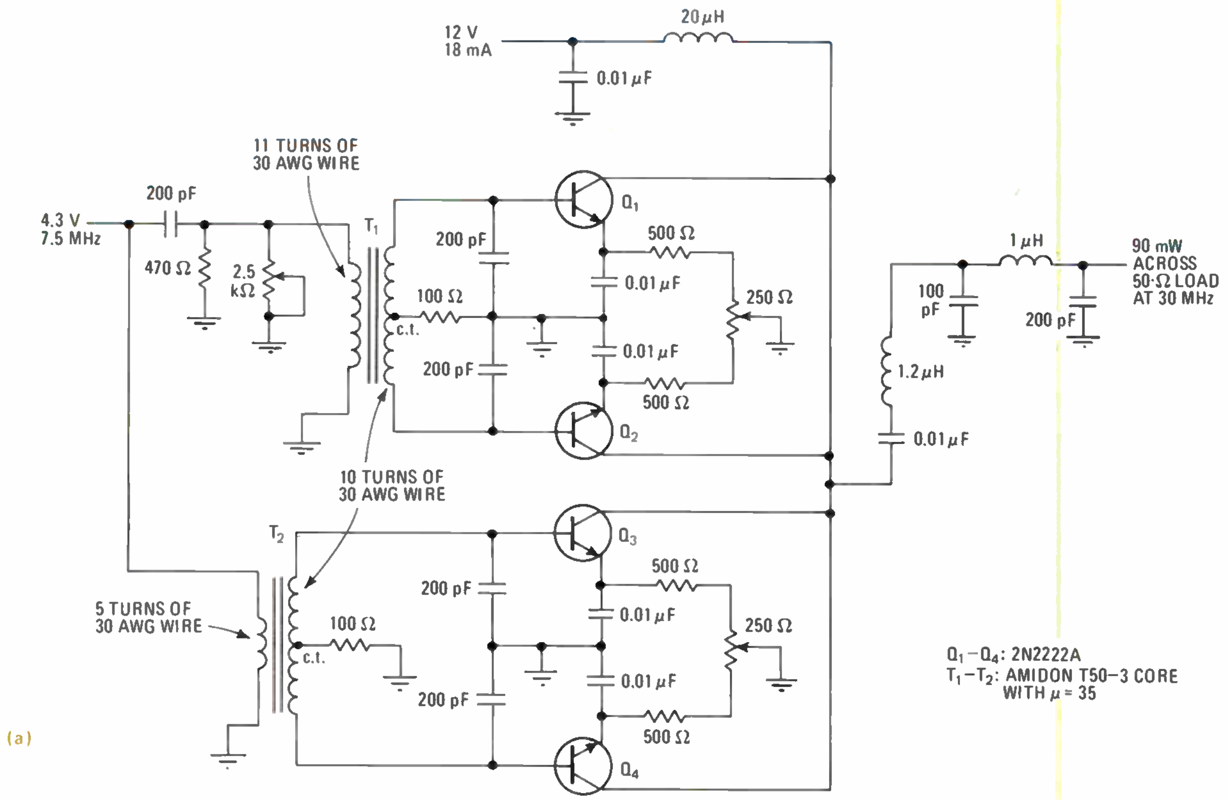
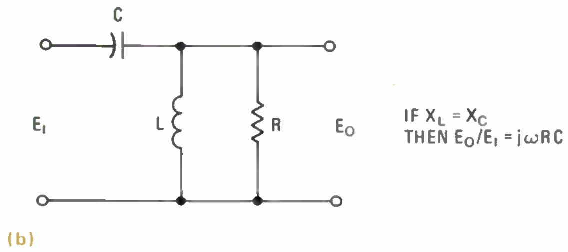




2. Quadrupler. This high-frequency multiplier quadruples 7.5 megahertz to 30 MHz. The LCR network illustrated in (b) is used with T_1 and T_2 to provide a 0°, 90°, 180°, and 270° phase shift for the four transistors. The second and third harmonics are suppressed more than 50 decibels below the desired 30-MHz level.

ly spaced through 360°. These N phases drive N class-C transistors whose outputs are combined to deliver a pulse every 360°/N. The use of N transistors allows the input power to the circuit to be N times as high without saturating the transistors.

This audio-frequency quadrupler (Fig.1b) uses frequency-dependent 90° phase-shift networks R_1 C_1, and R_2, C_2. Transistors Q_1 and Q_4 provide pulses that are shifted 0° and 90° in phase at the output. Phase inversion of the pulses is achieved by transistors Q_5 and Q_6, which drive Q_2 and Q_3 to provide pulses that are 180°- and 270°-phase-shifted at the output. The output pulses that are 90° apart are combined to produce the quadrupled frequency. The af multiplier quadruples a frequency of 625 hertz to 2,500 Hz.

The amplitude of the input signal is adjusted for the proper level at the base of Q_4. In addition, level adjustments for Q_1, Q_2, and Q_3 are controlled by R_3, R_4, and R_5. The oscilloscope photograph (Fig.1c) shows the quality of the ×4 output frequency at 2,500 Hz.

Phase-shift frequency multipliers are superior to conventional multipliers at high frequencies in subharmonic suppression. A high-frequency version of this type of multiplier (Fig.2a), also a quadrupler, uses a simple LCR phase-shift network (Fig.2b) to produce a 90° phase shift.

An interesting property of this network is that when the reactances are made equal, the phase shift between the input and output ports will always be 90°, regardless of the value of R. This property allows both amplitude (varying R) and phase (varying L or C) control.

The inductance L is created by the primary winding of T_1; the secondary winding delivers a 90° and 270° phase shift to Q_1 and Q_2, respectively. The 0° and 180° phase shifts are provided by T_2 to Q_3 and Q_4.

In addition, the L-pi network at the output provides an optimum match to the 50-ohm load and a little attenuation of subharmonics. This multiplier, unlike conventional ones, is capable of suppressing subharmonics and therefore does not require output filtering.

A spectrum-analyzer display showed that the second and third harmonics could easily be reduced by more than 50 decibels below the desired fourth harmonic. □

Designer's casebook is a regular feature in *Electronics*. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $75 for each item published.

Microwave links add flexibility to local networks

Sending data, CCTV signals over 23-GHz links can exorcise cable-laying problems

by James W. Rush, *General Electric Co., Owensboro, Ky.*

☐ Designers of local networks for data communications now can include closed-circuit microwave links as part of their systems. The links will serve admirably where running cable would prove fiendishly complicated—say, between two buildings on opposite sides of a major thoroughfare of a city.

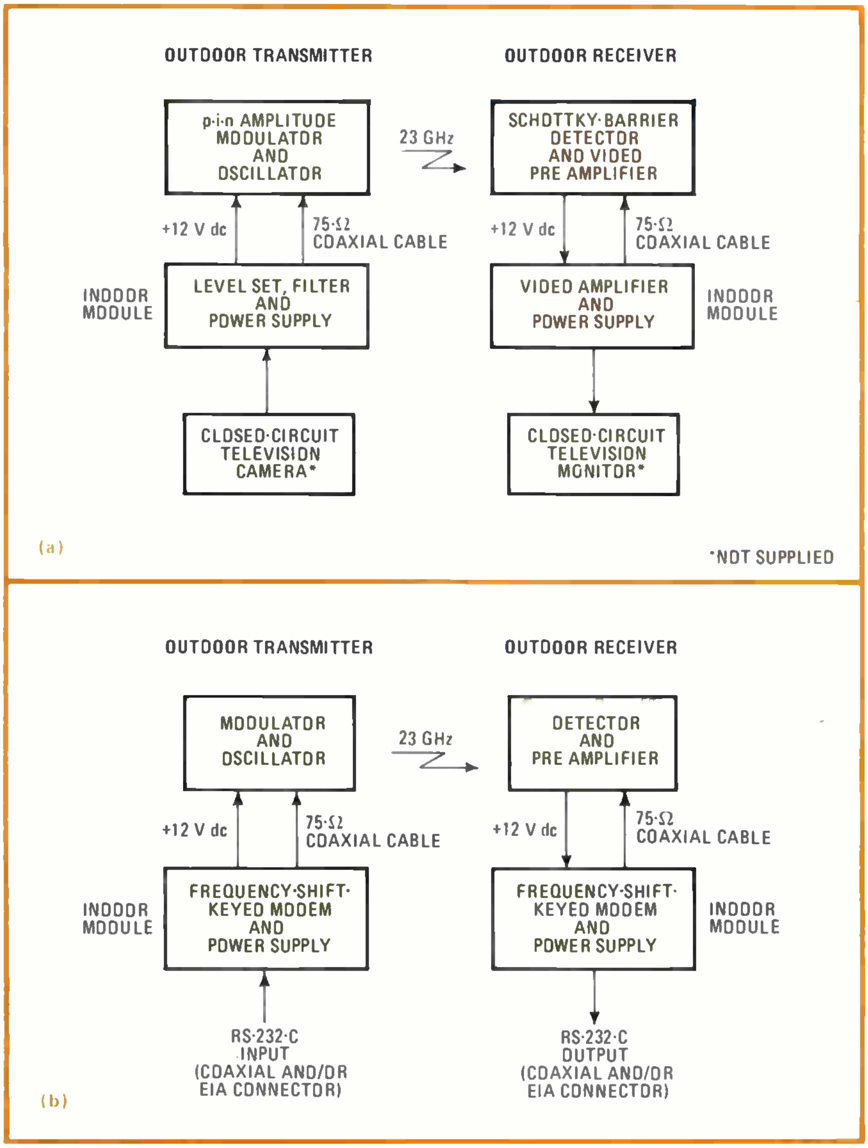
One member of a new family of 23-gigahertz microwave links is designed for data transmission; another transmits a closed-circuit television signal and is intended for security surveillance in buildings, parking lots, and campus-like environments. The third family member relays control signals for the CCTV camera or for telemetry applications making it useful for teleconferencing applications, remote monitoring, and control systems.

The family consists of simplex links, but provision exists for turning them into what amounts to duplex channels. In fact, duplex facilities, interference prevention, compensation for weather conditions, overcoming obstructions to line-of-sight transmission, and factoring in path loss are all individual design considerations that will vary from application to application.

No other microwave system uses the 23-gigahertz band, so there are no problems with electrical interference and siting to solve. Moreover, the bandwidth can accommodate enough channels to serve most applications, and the equipment—particularly the antenna—is compact and easy to install.

The components

The transmitter and receiver sections are essentially similar for each type of link. For example, both the LSD-052A data-communications model (Fig. 1a) and the LSV-042A surveillance model (Fig. 1b) use a p-i-n diode modulator and a Gunn-diode oscillator as a transmitter.



1. Simplex. The GE 19.2-kb/s simplex link uses 23-GHz components derived from police-radar applications. Either a simple amplitude-modulation (a) or a frequency-shift-keying approach (b) is possible.

Why 23-GHz microwave?

Microwave links have many applications such as closed-cable television surveillance and crime prevention, short-range teleconferencing, remote control of CCTV cameras, and transmission of telemetry data. Furthermore, they can be used for reading of remote documents, gages, and other visual readouts and for transmission between asynchronous data terminals at up to 19.2-kilobit-a-second data rates.

Conventional (lower-frequency) microwave communications can fulfill most of these needs. But such systems are costly because of significant tower and waveguide costs and limited spectrum and channel availability. Significantly, they are also large and unsightly.

Higher microwave frequencies minimize many of these problems through smaller antennas with gains similar to those at lower frequencies, more unassigned channels, and far less environmental impact. General Electric chose 23 gigahertz as a basis for its designs because, at this frequency, smaller antennas provide a narrow beam width of less than 4°; it is an uncrowded band; and wider-frequency channels are available. Finally, the low microwave power needed at 23 GHz allows frequency reuse even in the same complex of buildings with low-cost transmitters using highly reliable Gunn-diode oscillators.

All these features do not come without problems. One is potentially high component costs. In the case of the GE links, costs were minimized through the use of components developed for police traffic radar. Due to the relative lack of equipment at this frequency, test-equipment costs are higher. Thus a special low-cost field-maintenance test set has been designed. It is calibrated using the more costly equipment needed only for initial manufacturing.

(The LSV-042D control, telemetry, and teleconferencing model is a variant on the surveillance link, adding a channel for the camera control signals.)

In the modulator and oscillator, materials with low thermal-expansion coefficients combine with frequency-compensation techniques to maintain the stability required by the Federal Communications Commission of a $\pm 0.5\%$ frequency shift over a temperature range of -30° to $+50^\circ$C. A short section of waveguide connects these two microwave elements to a yagi antenna located at the focal point of a 12-inch parabolic reflector.

In the receiver, the outdoor module has the same antenna assembly and housing as the transmitter, with a Schottky barrier diode detecting the envelope of the signal. This configuration allows about 120 decibels of path loss between transmitter and receiver. Each 12-in. parabolic reflector antenna provides about 34 dB of passive gain.

The indoor modules for the data-communications and surveillance links differ more significantly than do the outdoor modules. This divergence is due to the different signals that are transmitted. The digital data signals are transmitted with frequency-shift keying, whereas the CCTV video signal is transmitted by amplitude modulation.

The LSD-052A data-com link uses FSK because this transmission mode allows operation at various data rates without concern for dc continuity. Thus system circuitry is simplified, and FSK allows, for example, the use of matching networks for various interfaces between the customer's equipment and the microwave link.

Standard connections

The link's FSK techniques are suitable for asynchronous data rates up to 19.2 kilobits a second. The link is designed to accept and deliver data to RS-232-C specifications. Therefore the standard 25-pin Electronic Industries Association connector is provided for direct connection to cathode-ray-tube terminals, printers, central processing units, and other digital equipment.

Test data has been taken at 9.6 kb/s to determine the useful range of the LSD-052A. Although wire-based transmission systems are limited by line-frequency pick-up and impulse noise, microwave systems are limited more by their signal-to-noise ratios at the receiver. Therefore the effective range of this link is determined by the maximum distance, under defined atmospheric conditions, at which the S/N ratio is high enough to provide an acceptable bit error rate. For the LSD-052A, the bit error rate is 10^{-7} at a detected S/N ratio of about 19 dB, more than enough for its intended applications (see "Why 23-GHz microwave?").

The a-m way

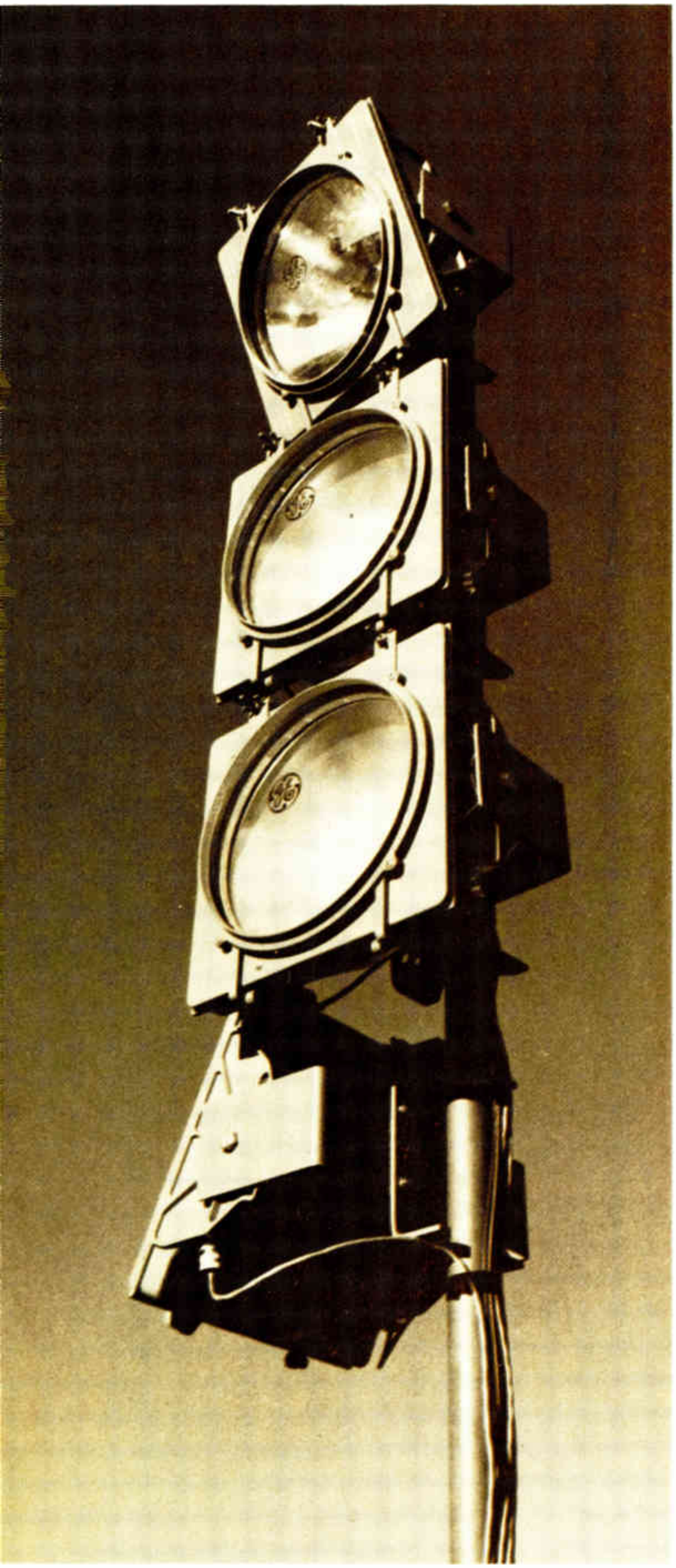
Designed first, the video links use amplitude modulation instead of such schemes as frequency or phase modulation for several good reasons. Perhaps the most important reason is that amplitude modulation allows direct modulation of the free-running Gunn-diode oscillator without extra elements in the resonant circuit, thereby obtaining the required frequency stability at minimum cost.

Also important for cost savings is the ready availability of 23-GHz p-i-n diodes. These units can be used for amplitude modulation with the same waveguide techniques used on the oscillator and detector. Finally, amplitude modulation allows the use of inexpensive envelope-detection receivers.

Also, there is a compelling reason for not using frequency modulation. This technique would require a discriminator, either at 23 GHz or at the intermediate frequency of a more costly superheterodyne system. Such discriminators were not practical at the time the link was designed, and they still are expensive. What is more, the extra range of the more costly superheterodyne receiver is not vital for the link's initial intended applications.

The LSV-042D link adds to the video link electronic control of a CCTV camera when used in the duplex mode. The link interfaces directly with commercially available controllers that usually link the monitor and camera by cable. It uses either FSK or control tones and is set up at the factory for either option.

Two-way communication is usually a necessity in local



networks, and the three simplex microwave links can be operated in a full-duplex mode simply by mounting a transmitter and a receiver on the same pole (Fig. 2). To reduce the possibility of undesirable microwave reflections from nearby objects, the two links are cross-polarized by rotating the antenna assemblies inside the outdoor housing.

This easily implemented two-way link is cost-effective, since full-duplex operation through a single aperature would require costly microwave duplexers and filters. The double simplex-link configuration allows packet transfer of two-way data, full-duplex teleconferencing, and the remote control of CCTV camera pan-tilt heads and power lenses while viewing the return video signal.

Cross-polarization also plays a role in avoiding mutual interference between two or more microwave links at the same location. Such site crowding is likely if the anticipated boom in local networks occurs.

Avoiding interference

The links' 12-in. parabolic antenna also plays a role. It produces a narrow beam about 3° at the lower-power points. If two beams are separated by an angular difference of 10°, about 25 dB of isolation is obtained. With 20° of alignment difference, the isolation is 40 dB. Cross-polarization provides an additional 25 dB to give a maximum overall isolation of 65 dB—more than enough for practical applications.

For any 23-GHz microwave installation, factors to be considered include weather conditions, obstructions to line-of-sight transmission, and path loss. Such systems considerations vary and are worked out by manufacturer and installer together.

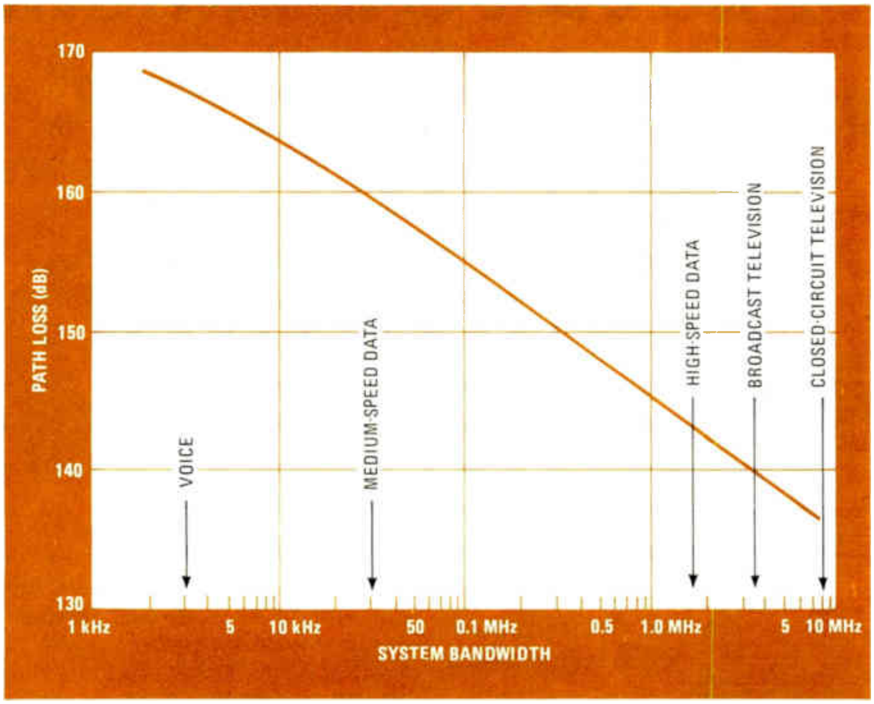
At 23 GHz, the most serious of the various weather effects is heavy rain. If the link is designed to tolerate the heaviest expected rainfall, it can be expected to operate in heavy fog, snow, and sleet.

If the link range is near its limits, video pictures become snowy and the bit error rate for digital systems degrades. So it is important that the system designer determine expected local rain rates, allowable outages (system reliability), and the link's normal fade margin at the desired path length.

When the system design value for rain intensity has been determined, the path range for a given configuration can be identified from graphs that show the path loss for the system in question. For a single-hop system (no repeater stations), range must be traded off with the desired system operational reliability. In contrast, any design value of total path reliability can be achieved for multiple links because all the amplification needed is available. (The FCC regulations limit these systems to five hops.)

When this desired reliability is known from system considerations, the allowable rain intensity can be identified from local rain-rate data. For example, from worldwide average data, if a single-hop reliability of 99.9% is

2. Unobtrusive. The outdoor transmitters and receivers in the free-space microwave links may be pole-mounted. The 12-in. antennas are not unsightly and may be readily cross-polarized to reduce mutual interference effects.



3. Design aids. GE developed many graphs that relate the key parameters of their microwave links. Shown here is path loss versus system bandwidth for an amplitude-modulated superheterodyne receiver system with a 20-dB signal-to-noise ratio.

desired, the system design value of rain intensity cannot be typically more than 0.6 in. an hour to achieve this.

Although weather is an intermittent problem for 23-GHz signals, these microwave communications require a clear signal path between the transmitter and the receiving antenna at all times. The link installer must remember that more than point-to-point visibility is necessary.

For example, the first Fresnel zone (a measure of microwave signal strength) around the path must be clear of objects or obstructions. This requirement accommodates both beam bending around objects along the path and reflections from nearby objects. What is more, the microwave beam can be bent either up or down as it passes through the atmosphere. The direction and degree of bending can have significant impact on the tower heights required for clearance above a path obstacle.

Fresnel's factor

To achieve a visibility envelope that takes into account obstacles near the beam, standard Fresnel graphs are used. These graphs show the recommended off-path clearances as a function of distance between the transmitter and the receiver and the position of the obstacle along the path. Using these curves, it can be shown that if a tall tree is 95% of the distance from the transmitter and the path length is 4 miles, the top of the tree should be no closer than about 4 feet from the centerline of the beam (corrected for atmospheric bending).

These considerations are not often necessary in most applications using the GE-developed 23-GHz system because its range is short compared with long-haul conventional microwave installations. Furthermore, some of these undesired path effects are reduced at 23 GHz and other high microwave frequencies.

Path-loss factors accounted for in the design of the 23-GHz link include transmitter power, antenna gain, receiver noise, and detector gain and bandwidth. All of these determine the range of a system in a given application. All, except bandwidth, are fixed by the initial system design.

The effective range of any microwave link is dependent upon the bandwidth required to transmit the desired information from point to point in the system. Very high data rates, high-resolution video, and many multichannel duplexed systems require much wider bandwidths than do applications with slower data rates, voice communications, and telemetry or control functions. The system bandwidths can vary from 100 hertz or so for telemetry systems to the maximum bandwidths.

With amplitude modulation, the 23-GHz links are limited to 13.5 megahertz of signal bandwidth if the maximum specified FCC frequency drift is allowed in the system. Of course, as in any system in which the minimum usable signal is determined by the noise performance of the receiver, system bandwidth and range are highly dependent variables. The effective range is also determined by the path loss of the system, and curves are available to relate all these variables in the design. The graph in Fig. 3 is typical of this information.

What's next?

When more than one link is used, the network designer must consider interference between systems. Unfortunately, detector-diode receivers, such as those used on the first 23-GHz links, offer little system protection from interference between links because of their inherent broadband characteristics.

However, other interference-reducing techniques may be applied, as mentioned earlier. These include cross-polarization between links and use of narrow beamwidths or combinations of these two. In second-generation, just-introduced 23-GHz links, a more sensitive and selective a-m superheterodyne receiver provides longer ranges and frequency selectivity where necessary that should allow channel assignments as close as about 100 MHz for multiple links over the same path.

To provide more capability with the office-of-the-future digital data systems, new designs under study by GE include data links for pulse-code-modulation transmission at the standard telecommunications rate of 1.54 megabits a second, and communications links between new interoffice data systems with speeds up to 3.1 Mb/s. Moreover, the new microwave systems will have synchronous data capability and interface compatibility with data multiplexers and concentrators for even higher data throughputs. □

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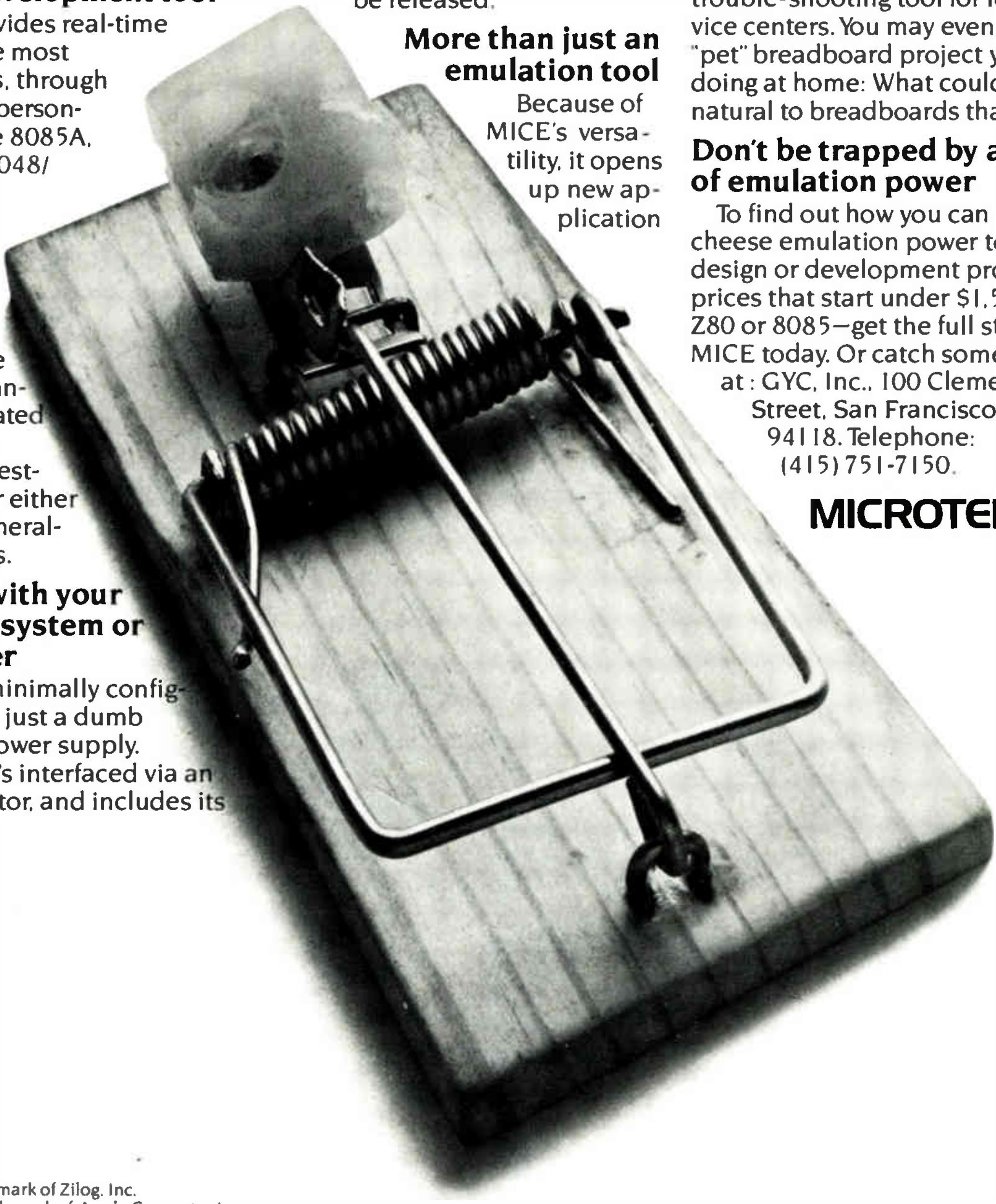

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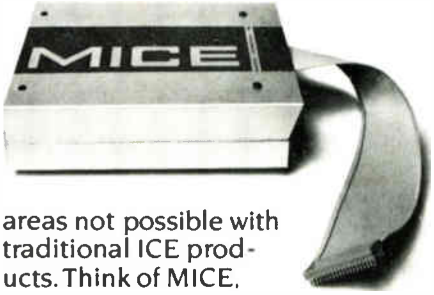

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Compressing display addressing with three-state logic

Using its high-impedance output as a third logic level, standard chip drives 30 light-emitting diodes from nine lines

by Klaus Gillessen, Hartmut Hantsch and Christopher Malinowski, *AEG-Telefunken, Heilbronn, West Germany, and Somerville, N. J.*

☐ One primary obstacle to increasing the resolution of solid-state displays is the cost of producing and addressing a large number of control lines. Although multiplexed matrix addressing has served well in the past, this approach is running out of steam in consumer electronics, for example, where attempts to commercialize flat-panel displays continue to flounder. Digital circuits that make use of a third state to carry information can reduce costs and complexity by minimizing the number of control lines needed and permitting interconnections among display elements, such as light-emitting diodes, with no wiring crossovers.

The Datacomp technique applies topological theory to circuit design to achieve such ends. The technique's first application has been to LED displays, where it requires 50% fewer driver lines than does matrix addressing.

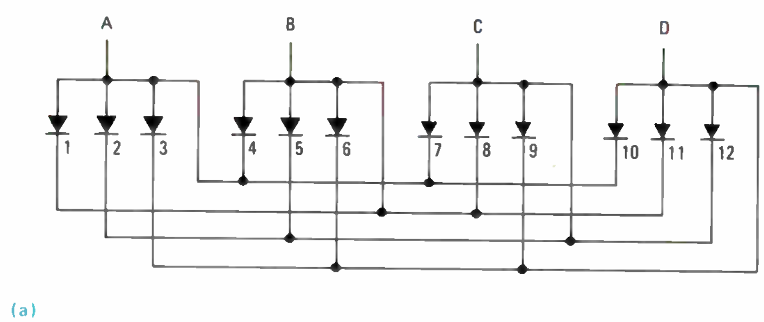
A variant of Datacomp, called Teleparel, yields the maximum number of separately addressable diodes that can be interconnected without wiring crossovers. Unlike other proposed methods, which call for multilevel logic, these two techniques use the widely available open, or high-impedance, state of integrated-circuit output drivers to increase the information density on bus lines.

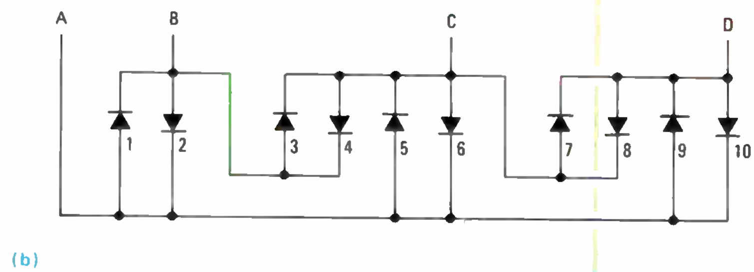
Many display elements, such as LEDs, are passive devices in that they cannot actively sense the open state on their address lines. With the development of active receivers that can translate the three possible states of a line into a binary code, the Datacomp technique may also offer data-processing circuits a more efficient means of communication than can purely binary codes.

LEDs are popular bar-graph display elements for recording-level indicators, tuning indicators, tachometers, and other quasi-analog displays. However, driver circuits for these types of displays can address only from 10 to 16 LEDs since the low-cost IC packages housing the drivers come with at most 18 pins.

In a conventional matrix-addressing scheme, for example, 16 LEDs might be interconnected in a 4-by-4 matrix, which requires eight lines. In general, n address lines allow a matrix display of $n^2/4$ elements. The Datacomp technique allows $n(n-1)$ elements to be addressed by n lines—for a large value of n, an almost fourfold improvement over matrix addressing. No special hardware is needed—conventional ICs provide three-state outputs. In practice, a number of lines, each of which can be high, low, or open, drive a display consisting of many LEDs that are interconnected according to simple schemes described below.

Datacomp displays can address separately the maximum number of LEDs. This economy is achieved by connecting pairs of antiparallel diodes between all pairs of address lines. Figure 1a shows an example of





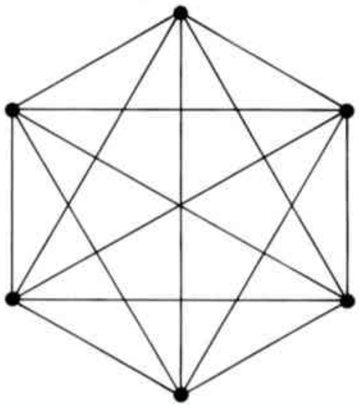
1. Tripling up. By using three-state address lines, more diodes may be separately addressed than with a matrix scheme. In (a) the gain is threefold. A similar approach lets the elements be connected without wiring crossovers, as in (b). In either case, to address a diode, one pair of lines receives the drive voltage while the others are left in the open state.

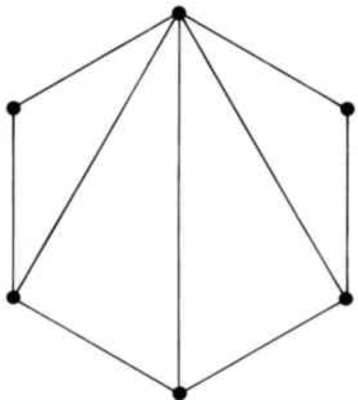
Topology for the circuit designer

A branch of mathematics—the theory of linear graphs—can be employed in designing electronic circuits. There is a strict correspondence between electrical networks and linear graphs consisting of branches and nodes. Thus, a pair of antiparallel diodes connected between two pins can be represented by a branch connecting two nodes.

In the Datacomp connection scheme, all pairs of address lines are connected with pairs of antiparallel diodes. The equivalent linear graph is termed a completed graph and is shown in the figure on the left. If n is the number of nodes, there are $n(n-1)/2$ branches (or $n(n-1)$ diodes) in the completed graph.

In graph theory, Kuratowski's theorem further states that a completed graph generally cannot be planar, that is, have no branch crossings. However, there is another class of graphs—termed outer planar graphs—that have the maximum possible number of noncrossing branches, with all nodes located at the rim. Here the number of branches is $2n-3$ for n nodes—n branches around the rim, and an additional $n-3$ branches with one node in common. This graph is equivalent to the Teleparel connection scheme and is sketched below. Because every branch corresponds to a pair of diodes, $2(2n-3)$ or $4n-6$ diodes may be interconnected without crossovers.





the technique in which only four lines are used to drive 12 diodes.

An LED in a Datacomp display can be addressed by applying high and low potentials to a particular pair of lines and leaving all other lines open. For example, LED 8 in the figure is addressed if line C is high and line B is low. If a given line is high, all LEDs having their anodes connected to this line can be addressed simultaneously.

Fewer lines

Using the Datacomp technique, an eight-digit seven-segment numeric display containing 56 LEDs can be driven from 8 lines, instead of the 15 lines used with the standard driving method. A 240-element Datacomp LED array operated with only 16 control lines has already been described [*Electronics*, March 13, 1980, p. 41].

The interconnections necessary in Datacomp displays cannot normally be realized without crossovers. The same is true for the matrix addressing scheme. In practical display fabrication, however, it is a considerable advantage to get along without crossovers, and with the Teleparel technique the interconnections can then be realized using single-layer techniques like single-sided printed-wiring panels, stamped conductor patterns, or etched leadframes. All these methods are far more economical than double-sided printed-circuit boards with plated through-holes or other two-layer techniques.

Thus, the Teleparel (for Telefunken planar reduced lines) interconnection method was developed in order to maximize the number of separately addressable LEDs that can be interconnected without crossovers. An example with four lines and 10 LEDs is shown in Fig. 1b.

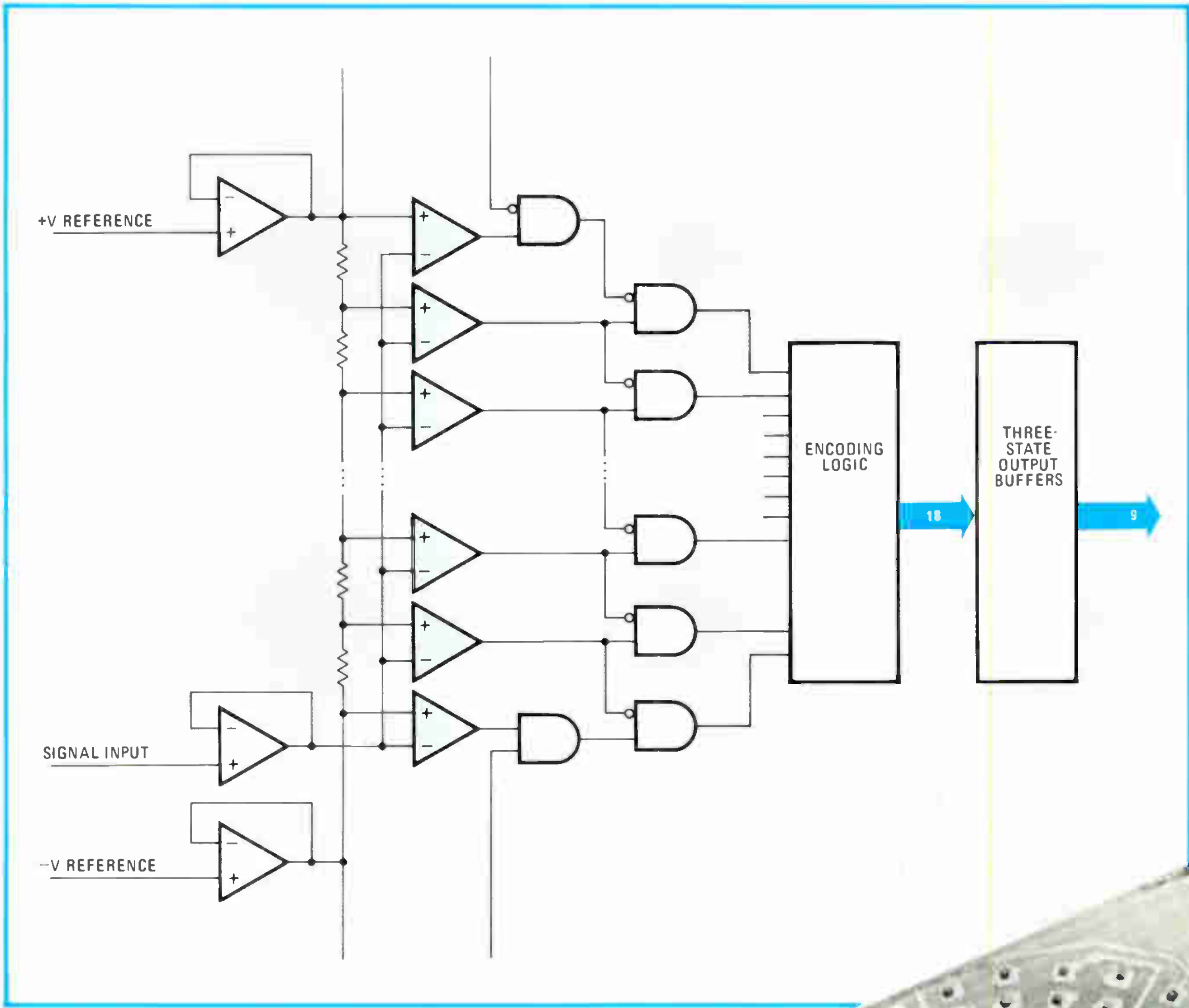
Here, there are two groups of pairs of antiparallel LEDs: the first group forms connections between all neighboring address lines (for example, LEDs 7 and 8 are connected to lines C and D), and the second group connects all address lines B through D to one common line, A. It can be shown that for n address lines, $4n-6$ LEDs can be interconnected without crossovers (see "Topology for the circuit designer," above).

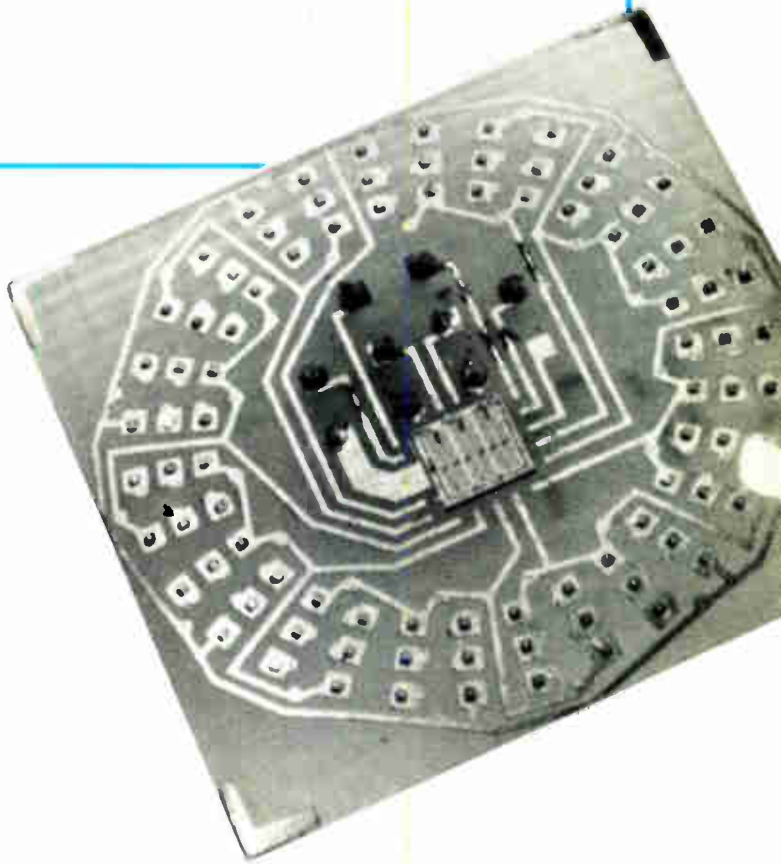
Addressing an LED in a Teleparel display is achieved by applying high and low potentials to a particular pair of lines and leaving all other lines open. In contrast to the Datacomp method, however, not all combinations of lines correspond to single LEDs. Only pairs of neighboring lines or pairs containing line A are allowed combinations that unambiguously address a single LED.

Flying spot display

A new driver circuit, the U1096B, implements the Teleparel interconnection scheme with nine address lines and 30 LEDs. A block diagram of the chip and an application are shown in Fig. 2.

The U1096B IC senses analog voltages and drives 30 LEDs, in this example, for a linear quasi-analog flying-spot display. The chip consists of a flash-type analog-to-digital converter with 31 comparators, three input buffers for signal and input reference voltages, encoding

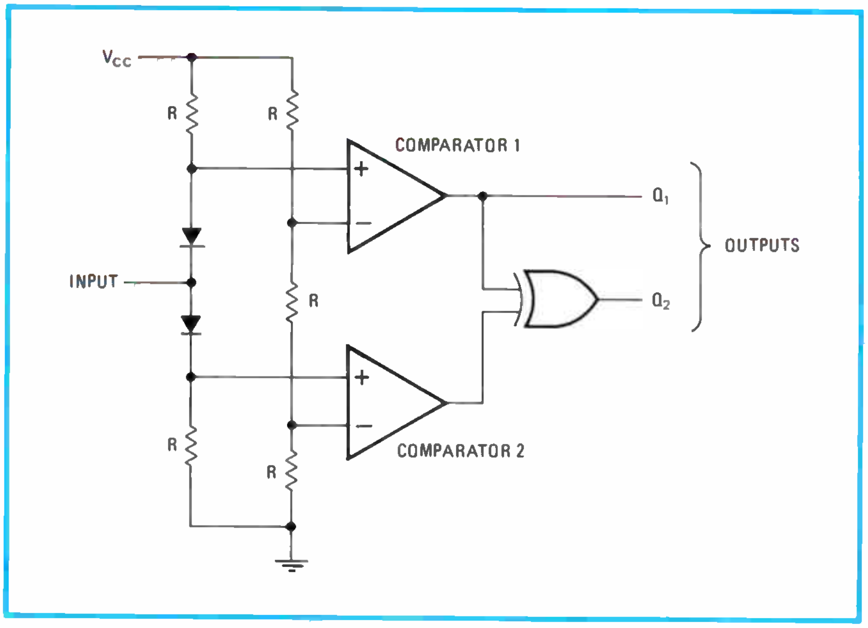




2. Flying dots. The cost and complexity of the tachometer display shown in the photograph are reduced using three-state addressing—9 lines control 30 trios of light-emitting diodes, with wiring on only one side of the printed circuit, instead of the 12 lines and two wiring levels a matrix scheme would require. The U1096B chip converts an analog signal into a digital code on the control lines.

logic, and nine three-state output buffers. A reference voltage is applied across the two reference inputs and divided into 30 equal parts by a resistor chain, thus defining the comparator thresholds. The reference voltage can be chosen in the range of 3 to 15 volts, for threshold steps ranging from 0.1 to 0.5 V.

The output signal of each comparator and the complement of the output signal of the next comparator are combined by an AND gate so that the segments turn on and off in the correct order. In addition, the first and last comparator outputs can be externally controlled by two inputs. In normal operation, these inputs are connected to the supply voltage. In this case LED 1 or LED 30 are on under underflow or overflow conditions, respectively. If several U1096Bs are stacked for displays with higher resolution, the control inputs must be either open or connected to ground.



3. Data expansion. The open state of a bus line can be used to represent information if a receiver like this one is employed to translate the high-impedance state into binary signals. A 2-bit output word is needed to distinguish the three allowed states of the input line.

For such cascading, the resistor chains in the ICs are connected in series and the signal inputs are operated in parallel. Up to five of the units can be stacked, yielding a 150-LED scale with 0.1-V resolution.

The encoding logic indicated in Fig. 2 transforms the 1-out-of-30 code of the a-d converter into the signals for the nine three-state buffers, which use a common 15-milliampere current source. Therefore, LEDs of different colors—that is, different forward voltages—can be used in the same display to divide the scale into segments. Several LEDs may also be connected in series, as long as the voltage limit of the current source is not exceeded.

As another example, consider the eight-digit seven-segment LED display commonly used in hand-held calculators. These are manufactured of either thick-film or printed-circuit substrates upon which the LED chips are directly mounted. Multidigit displays are generally interconnected internally on the substrate, since they are driven in a multiplexed mode to reduce the number of external terminals from 64 to 16. The same display using a Datacomp design needs only 8 external connections, thus halving the density of the internal pc-board wiring, the pin count, and the cost.

As in the above examples, devices directly compatible with present techniques can be readily fabricated, giving immediate savings in products like displays. At the same time, developing active receiving devices to exploit the full potential of Datacomp will lead to a new family of devices. Encoders, transmitters, receivers, and decoders in systems designed for a three-state logic will lead to greatly enhanced capacities on data buses.

A simple implementation of the concept of a Datacomp receiver is shown in Fig 3. The single input can be high, low, or open, and the 2-bit output word Q_1Q_2 is correspondingly 10, 00, or 01 (using positive logic conventions). The Datacomp transmitter then takes a simple form: a three-state buffer, with Q_2 as the control input.

According to proposed multilevel logic schemes, such as a trinary logic in which a third value (or range of values) of the voltage is used, the information density of an n-bit data bus becomes 3^n rather than the 2^n of a binary system. The Datacomp scheme, in contrast, is designed as a combinatorial-binary system (or combinary for short) in which a certain predetermined number out of a total of n lines are in the designated third state at any given time. The information density is thus less than 3^n. This is desirable simply because the open state may be used directly—without decoding—in certain applications, thus saving the cost of extra decoding circuitry, which would offset the benefits of reduced interconnection requirements.

Multilevel schemes

For example, referring to Fig. 1 again, it can be seen that this addressing scheme works only if two lines are in the open state at all times. Any other assignment of the numbers of active and open lines leads to fewer than 12 separately addressable diodes, or else requires additional decoding circuits. Combinatorial-binary logic thus constitutes a special case of trinary logic in which a subset of all n-bit words is selected because of its suitability for operating with both passive and active receivers.

The major advantages of such a concept will be found in the very large-scale integration of microprocessors, where an integrated computing unit must communicate through the same bus with both active receivers, like memory arrays, and passive receivers, like displays. For example, straightforward calculations show that an 8-bit data bus with two lines in the third state can address 1,792 locations—seven times the 256 addressable with a purely binary code.

For a given bus width it is also simple to calculate the optimal number of three-state lines—that is, the combinatorial-binary code that maximizes the number of addressable locations. In the previous example, a factor-of-seven advantage over binary addressing is the best possible. As the bus width increases, however, the advantage increases exponentially. Thus, for a 16-bit bus, the optimal number of three-state lines is five, and the advantage over binary is a factor of 136. □

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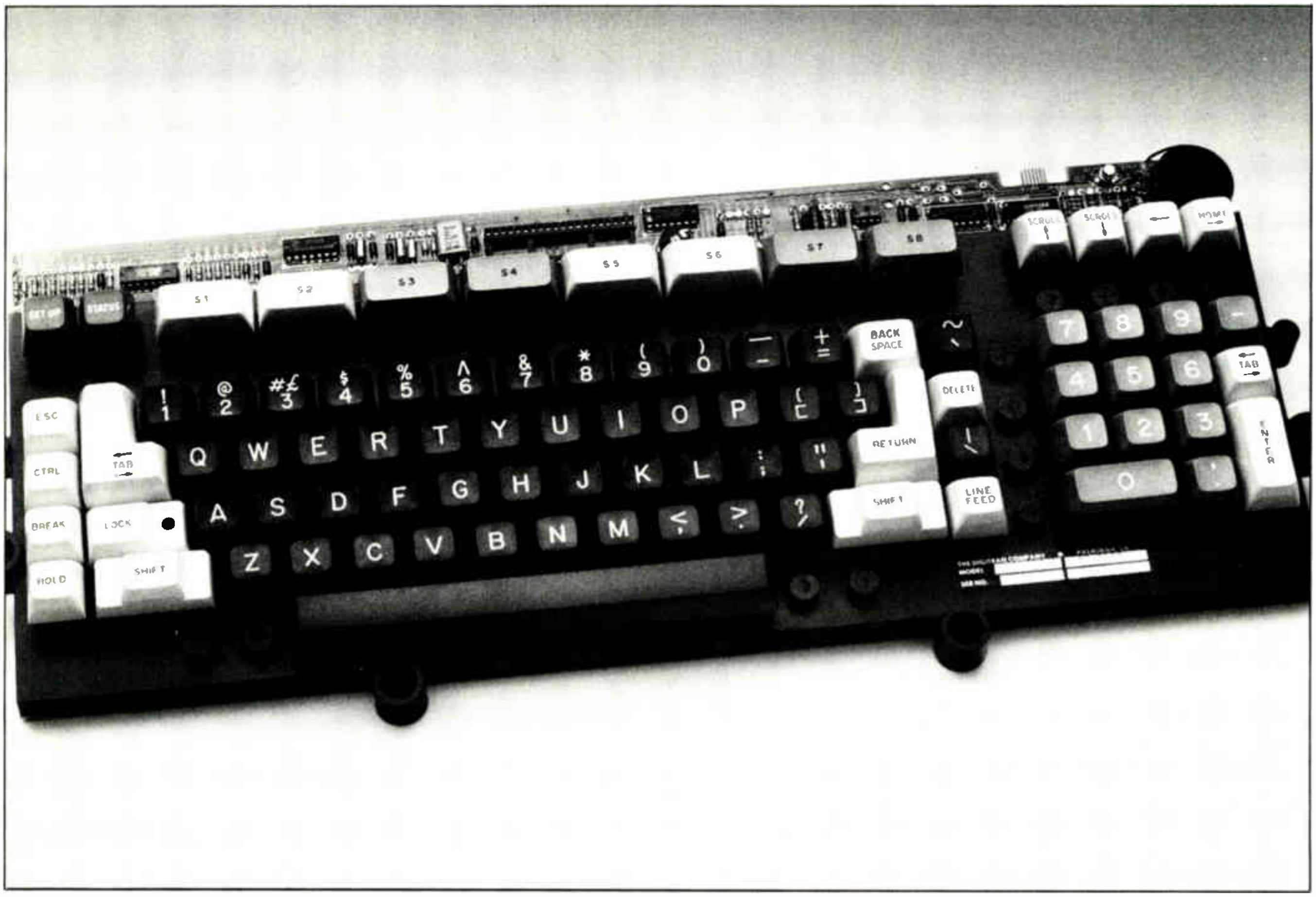

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Opto-isolated RS-232 interface achieves high data rate

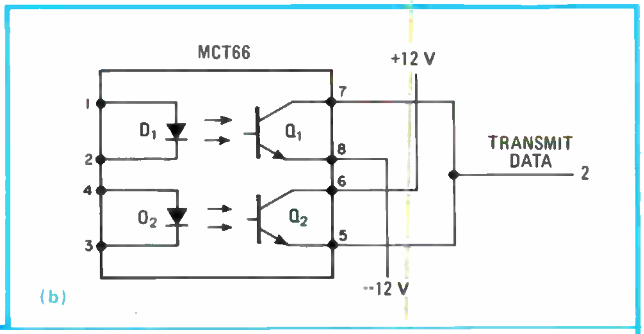
by Vojin G. Oklobdzija
Xerox-Microelectronics, El Segundo, Calif.

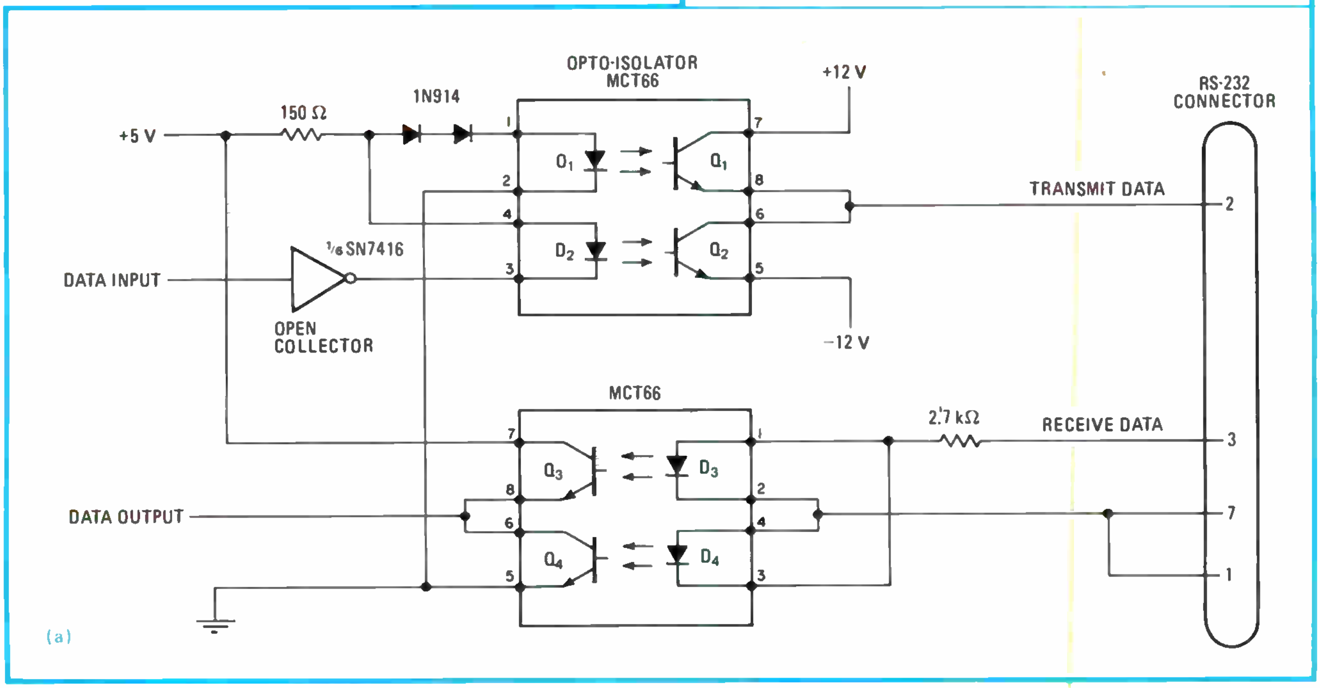
When signals originating from isolated sources are transferred to a destination at a different voltage, coupling circuitry must be used to minimize signal distortion and interference. Unfortunately this circuitry slows down data-transmission rates. However, General Instrument's dual-phototransistor opto-isolator MCT66 may be used to isolate an RS-232 interface and still achieve a relatively high data rate of 9,600 bits per second.

The opto-isolated RS-232 interface (a) uses the MCT66, two diodes, an inverter, and a resistor. If pull-up resistors were used instead of transistors Q_1 and Q_3, the rising edge of the signal would be slow and thus would limit the transmission rate to below 1,200 b/s. This limiting depends on the values of the resistors and the length of the RS-232 cable. However, if the pull-up resistor's value is reduced below 1 kilohm, intolerable power dissipation occurs.

This circuit not only achieves high data rates but also enables the polarity of the signal to be changed, without using an additional inverter, by altering the connections between transistors Q_1 and Q_2 or Q_3 and Q_4 (b). □

Engineer's notebook is a regular feature in Electronics. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $75 for each item published.





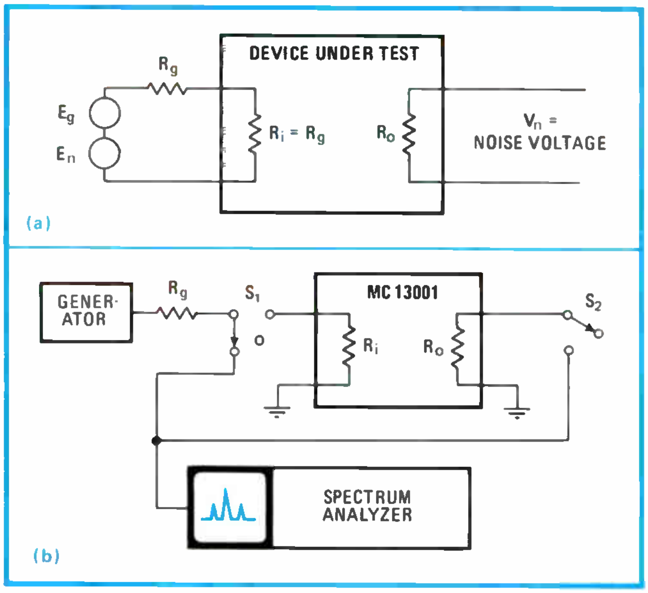
Isolation. General Instrument's dual-phototransistor opto-isolator MCT66 isolates the RS-232 interface (a) and achieves a high data rate of 9,600 b/s. The signal's polarity may be changed by altering the connections between Q_1 and Q_2 or Q_3 and Q_4 (b).

Spectrum analyzer measures integrated-circuit noise figure

by Lowell Kongable
Motorola Semiconductor Products Sector, Phoenix, Ariz.

Now that video detectors are incorporated into an amplifier chip containing intermediate-frequency circuitry (MC13001), only the detector output is available, thus making noise-figure measurement difficult. However, a method using a spectrum analyzer eliminates this difficulty. A bonus is that it can test any frequency.

The noise figure of an amplifier is the signal-to-noise ratio at the input divided by the S/N ratio at the output.



Noise figure. Amplifier's noise figure (a) is determined by the signal-to-noise ratio at the input divided by the S/N ratio at the output. The circuit (b) measures the noise figure of an integrated circuit with a spectrum analyzer. This technique measures the detected low-frequency output of the MC13001.

The noise figure of the device (Fig. 1a) is given by:

$$\frac{(GKTB+P_n)E_g^2/4R_g}{(KTB)GE_g^2/4R_g} = 1+P_n/GKTB$$

where G = amplifier power gain, P_n = all forms of wide-band noise generated within the amplifier, K = Boltzman's constant, T = temperature (K), and B = amplifier bandwidth (hertz). Because $P_n = V_n^2/R_o$, the noise figure in decibels is:

$$10\log V_n^2 - 10\log G - 10\log KT - 10\log 1.2\times B - 10\log R_o + 1.05$$

A multiplier of about 1.2 is applied to the i-f bandwidth to approximate the equivalent noise-power bandwidth. The compensating factor for the spectrum analyzer is 1.05 dB.

To illustrate this measurement technique, the circuit in Fig. 1b measures the noise figure of Motorola's MC13001. The generator is set at a 43-megahertz carrier that is 30% amplitude-modulated with 10 kilohertz. The spectrum analyzer's center scale is set to 43 MHz and its i-f bandwidth made narrower than the IC's.

To obtain the noise figure of an amplifier, the generator must be connected to the spectrum analyzer and adjusted so that a display amplitude may be easily measured and the setting noted. Next the generator and analyzer are connected to the input and output of the amplifier. In addition, the spectrum analyzer's center scale should be reset to 0 and the generator adjusted so that the display equals the original display. If $R_i = R_g$, the gain may be read in decibels directly from the generator attenuator dial and substituted for 10 logG.

The generator is disconnected and R_g is attached to the amps input so that the root-mean-square noise voltage is displayed on the analyzer. The video filter of the analyzer is narrowed to 0.01 of the i-f band and the rms noise value is measured. The analyzer's i-f bandwidth is measured for accurate results.

For the MC13001 where G = 79 dB, a-m = (10 kHz−30%), $R_i = R_g$ = 50 ohms, R_o = 100 Ω, T = 298 K, and B = 1,150 Hz, the noise figure is 5.42 dB. □

Calculator notes

HP-41C calculator analyses resistive attenuators

by Albert E. Hayes Jr.
Albert Hayes & Associates, Fullerton, Calif.

Formulas for designing resistive attenuators (a) usually flow from the pages of standard textbooks. However, when these same pages are tapped for ways of calculating the attenuation of an such a circuit, given the exact values of its elements, only an informational desert is found. This HP-41C calculator program is designed to eliminate this problem.

The attenuation in decibels of a resistive T attenuator is:

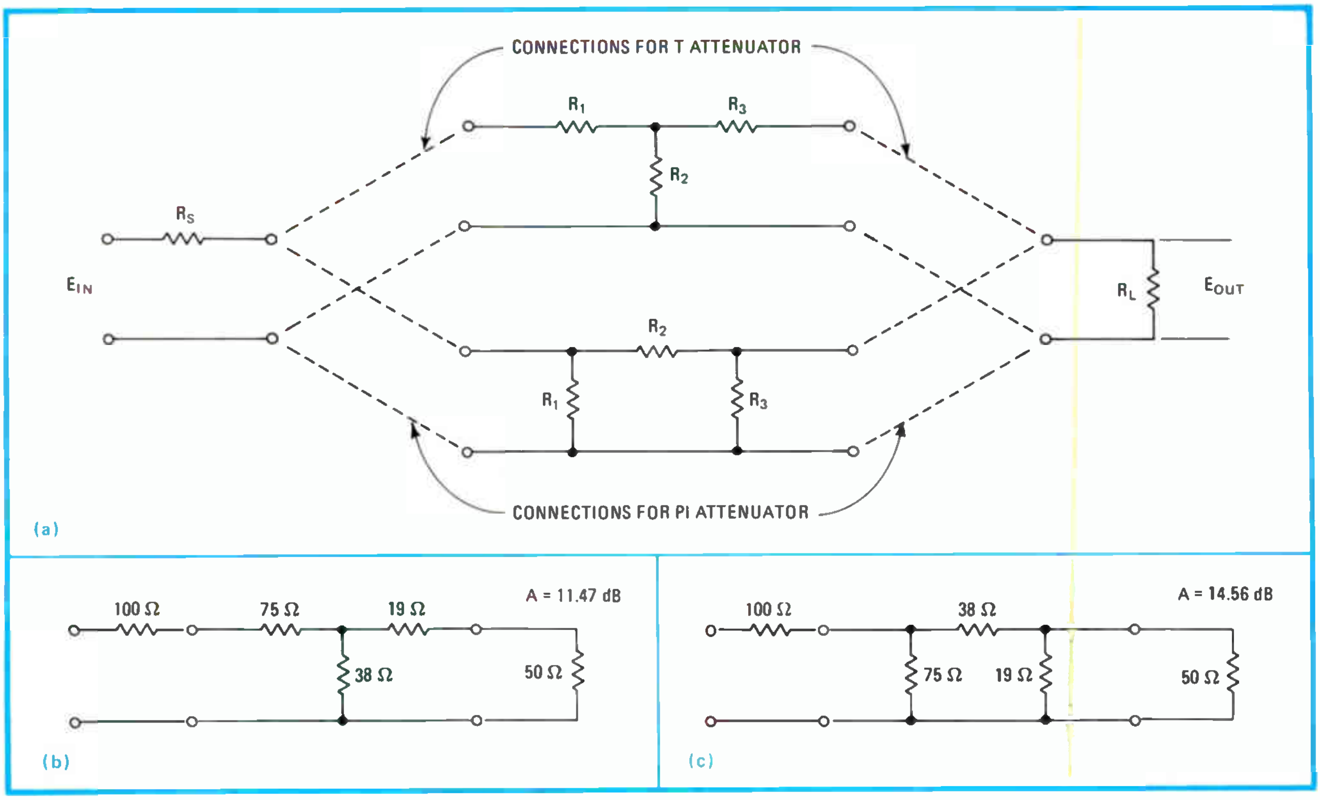
$$20\log\left[1+\frac{R_3}{R_L}+\left(\frac{R_3}{R_2R_L}+\frac{1}{R_2}+\frac{1}{R_L}\right)(R_S+R_1)\right] - 20\log\left(\frac{R_L+R_S}{R_L}\right)$$

For the pi configuration, the attenuation is:

$$20\log\left\{1+\frac{R_2}{R_3}+\frac{R_2}{R_L}+R_S\left[\frac{1}{R_1}+\frac{R_2}{R_1}\left(\frac{1}{R_3}+\frac{1}{R_L}\right)\right] + R_S\left(\frac{1}{R_3}+\frac{1}{R_L}\right)\right\} - 20\log\left(\frac{R_L+R_S}{R_L}\right)$$

The last term in each of the above equations represents the attenuation introduced by the voltage divider that is formed by the source and load resistance (R_S and R_L). This term is present even when the three-element attenuator is removed. A pi or T configuration is selected by pressing 1 or 0 respectively after initialization, as detailed in the instruction table. Selecting 0 at step 5 causes flag 1 to be set. This selection causes the program to automatically branch to the T subroutine at step 23 after the element values are loaded. For example, the attenuation of a T-configuration attenuator (b) is found by entering RTN, R/S, 0, R/S, 100, A, 75, B, 38, C, 19, D, 50, E. The attenuation value (11.47 dB) appears on the calculator's display.

Similarly for the pi network (c), which has the same element values, the computaton is the same as before except after initialization, 1 must be entered to call in the pi subroutine. The displayed attenuation value will be 14.56 dB. □



Attenuator. This program can calculate the attenuation of a T or pi network (a). R_S is the source and R_L the load resistance. Networks (b) and (c) show the usefulness of the program. The program calculates attenuation in decibels.

PRINTER LISTING: HP-41C PROGRAM TO COMPUTE THE ATTENUATION OF A PI OR T CONFIGURATION RESISTIVE ATTENUATOR

Location	Key										
01	•LBL ·ATTEN·	18	STO 03	36	/	54	RCL 00	72	20	90	/
02	CLX	19	STOP	37	+	55	RCL 03	73	*	91	+
03	CF 01	20	•LBL E	38	RCL 00	56	/	74	RCL 06	92	RCL 02
04	STOP	21	STO 04	39	RCL 02	57	+	75	LOG	93	/
05	X = 0?	22	FS? 01	40	*	58	RCL 00	76	20	94	RCL 04
06	SF 01	23	GTO 01	41	RCL 01	59	RCL 04	77	*	95	1/X
07	STOP	24	1	42	/	60	/	78	−	96	+
08	•LBL A	25	ENTER↑	43	RCL 03	61	+	79	FIX 2	97	RCL 00
09	STO 00	26	RCL 02	44	/	62	•LBL 02	80	STOP	98	RCL 01
10	STOP	27	RCL 03	45	+	63	STO 05	81	•LBL 01	99	+
11	•LBL B	28	/	46	RCL 00	64	RCL 04	82	1	100	*
12	STO 01	29	+	47	RCL 02	65	RCL 00	83	RCL 03	101	+
13	STOP	30	RCL 02	48	*	66	+	84	RCL 04	102	GTO 02
14	•LBL C	31	RCL 04	49	RCL 04	67	RCL 04	85	/	103	END
15	STO 02	32	/	50	/	68	/	86	+		
16	STOP	33	+	51	RCL 01	69	STO 06	87	1		
17	•LBL D	34	RCL 00	52	/	70	RCL 05	88	RCL 03		
		35	RCL 01	53	+	71	LOG	89	RCL 04		

Instructions

- Key in program
- Initialize by pressing RTN, R/S
- Select network
  - If T network is used, enter 0, then press R/S
  - If PI network is used enter 1, then press R/S
- Enter appropriate circuit values in ohms
  - For R_S, enter value and press A
  - For R_1, enter value and press B
  - For R_2, enter value and press C
  - For R_3, enter value and press D
  - For R_L, enter value and press E
- Read attenuation in decibels

Engineer's newsletter

MIT to run course on personal computers

Now that personal computers have moved well beyond the hobbyist stage and are making valuable contributions in engineering and in business and executive support roles as well, the Massachusetts Institute of Technology has planned a short summer course on them this year, running from June 21 to June 25. The program will provide an in-depth examination of the personal computer and its applications. Since personal computers will **become the calculators of the '80s for many engineers,** the course will aim to aid the user in the selection and design of personal computing systems and software packages. This understanding will be developed from three different approaches: the technology, the current market structure, and the applications. For more information, write to: James Austin, Director, Summer Session Office, Massachusetts Institute of Technology, Cambridge, Mass. 02139.

Pc service speeds metamorphosis of wire-wrapped designs

Intelligent Devices Corp. has introduced a fast-turnaround service for the manufacture of printed-circuit boards based on custom wire-wrapped designs. Any single-board circuit wire-wrapped into a motherboard can be **converted into pc boards in quantities as low as 20 in four to six weeks.**

The service was originally begun for customers using the company's 8086 and 8088 microprocessor prototyping and design kits and has since been expanded for other designs. For complete information, call or write Intelligent Devices Corp., One Cameron Place, Wellesley, Mass. 02181, at (617) 237-7327.

One op amp suffices for an absolute-value amp

Yishay Netzer of the Electro-Optics Center of Honeywell Inc.'s Defense Electronics division in Lexington, Mass., provides a simple modification of a popular circuit for precision half-wave rectification that eliminates one diode from the circuit and produces full-wave rectification. For full-wave rectification there are several circuits requiring **two operational amplifiers and extra active devices.** In addition, more than two matched resistors are usually needed—for a good example, see "Burr-Brown Applications of Operational Amplifiers—Third Generation Techniques" by Jerald G. Graeme.

However, Yishay Netzer's circuit is a modification of a precision half-wave rectifier circuit where one op amp, two matched resistors, and two diodes are used for rectification. Removing the diode that is across the output and inverting input of the op amp is enough to turn that into a precision full-wave rectifier.

The circuit's operation may be described as follows: for positive signals the diode is back-biased and the input voltage appears unchanged at the output. But for negative input voltages the feedback loop closes through the diode and the amplifier operates as a voltage inverter. Therefore **the negative half of the wave is inverted at the output, producing full-wave rectification.** Because the signal appears across the input for specific input-signal polarities, some op amps with input protection are not suitable. A high–slew-rate amplifier may be needed, depending on the input-signal frequency, to decrease the recovery time of the output from the open-loop conditions. For these reasons this circuit should be used only in the audio-frequency range.

-Tom Manuel

Grown Ups

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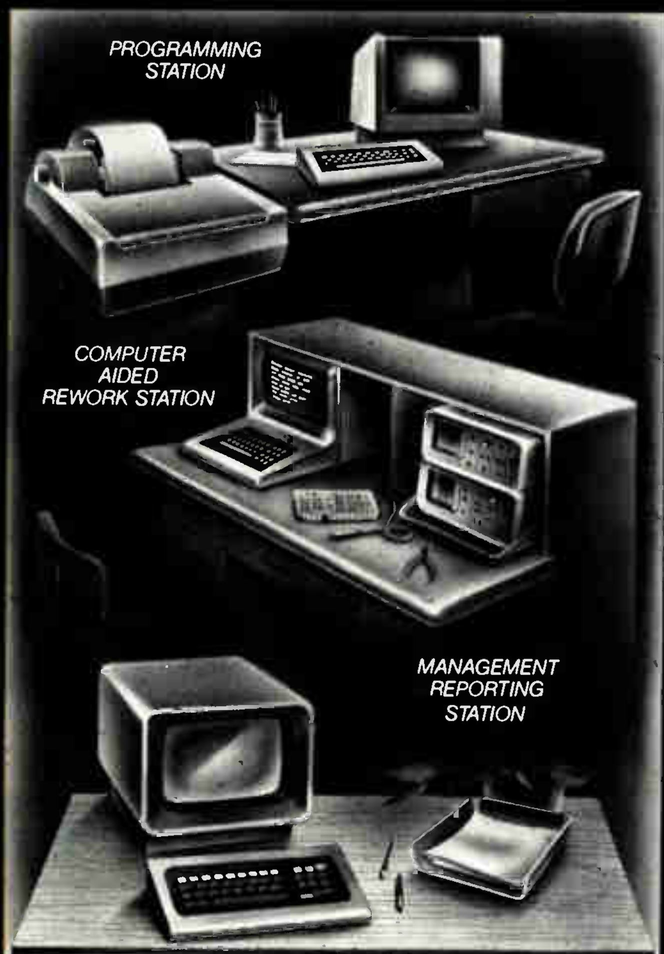

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Product		Part No.	Clock Frequency	Replaces
HD68000 Series MPUs		HD68000-8	8.0 MHz	MC68000-8
		HD68000-6	6.0 MHz	MC68000-6
		HD68000-4	4.0 MHz	MC68000-4
HD68000 Peripheral LSI	DMAC	HD68450*		MC68450
	MMU	HD68451*		MC68451
	IPC	HD68120*		MC68120
	PIT	HD68230*		MC68230
	MPCC	HD68561*		MC68561

Product		Part No.	Clock Frequency	Replaces
HD6809 Series MPUs		HD68B09	2.0 MHz	MC68B09
		HD68A09	1.5 MHz	MC68A09
		HD6809	1.0 MHz	MC6809
		HD6809E*	—	MC6809E
HD6809 Peripheral LSI	PIA	HD6821	1.0 MHz	MC6821
		HD68A21	1.5 MHz	MC68A21
		HD68B21	2.0 MHz	MC68B21
	ACIA	HD6850	1.0 MHz	MC6850
		HD68A50	1.5 MHz	MC68A50
	SSDA	HD6852	1.0 MHz	MC6852
		HD68A52	1.5 MHz	MC68A52
	COMBO	HD6846	1.0 MHz	MC6846
	PTM	HD6840*	1.0 MHz	MC6840
	FDC	HD6843	1.0 MHz	MC6843
		HD68A43	1.5 MHz	
	DMAC	HD6844	1.0 MHz	MC6844
		HD68A44	1.5 MHz	
		HD68B44	2.0 MHz	
	CRTC	HD6845R	1.0 MHz	MC6845
		HD68A45R	1.5 MHz	
		HD68B45R	2.0 MHz	
		HD6845S	1.0 MHz	MC6845S
		HD68A45S	1.5 MHz	
		HD68B45S	2.0 MHz	
	ADU	HD46508	1.0 MHz	Original
		HD46508-1	1.5 MHz	
		HD46508A	1.0 MHz	Original
		HD46508A-1	1.5 MHz	
Memory		HM46810	1.0 MHz	MCM6810
		HM468A10	1.5 MHz	MCM68A10

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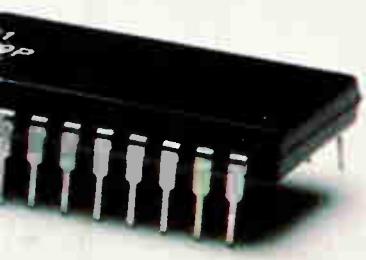

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Data base aids board test and repair

Two-tiered data base, special repair terminals, and bar-code identification system aim at managing board production

by James B. Brinton, Boston bureau manager

Proponents of the factory of the future hope that the data-collection and -evaluation facilities implicit in the requisite equipment will help managers make operations like test, repair, and retest more efficient through more accurate transfer of test or diagnostic data or through analysis of more-global data leading to early warning of impending failures. This is the goal of GenRad Inc.'s Tracs system.

"Tracs's goal is improved productivity," says David B. Ruggiero, marketing manager of GenRad's board-test division. Tracs, for test repair analysis control system, adds sophisticated data-base management to the capabilities of the firm's high-speed packet-switching local network, GRnet, which was introduced about 18 months ago [*Electronics*, June 5, 1980, p. 169].

Mission. Tracs is designed to cut the number of times a board must pass through the test and repair loop, to detect unnecessary loops, to help reduce average repair time, and to increase the probability of a successful repair. It will operate in an environment of GRnet-linked 227X and 179X test systems and new Tracs terminals; GenRad's 2294 multiuser programming station will act as the net's controlling node.

The test systems will generate test results and diagnostics, automatically feeding them through GRnet into Tracs's data base. The data can be accessed through Tracs terminals on repair benches or managers' desks—wherever needed in the factory. Tracs will:

- Automatically collect test results from GenRad board testers, terminal-equipped repair and inspection stations, and system test beds.
- Provide real-time analysis of test results to help spot problems.
- Provide users with easy access to its data base.
- Generate reports on test failure, yields, defects, and trends.
- Automatically pass diagnostic and repair messages around the test loop.

The system uses bar-code labels to identify boards and substitutes its data base for the usual bundle of paper that accompanies a subassembly through production. It uses the data generated by GenRad's 227X and 179X testers as its source of information and supplies failure analysis and diagnostic data with processed data.

In a fully utilized Tracs system, scanning a bar code at a test station might trigger downline loading of appropriate test software from the 2294 programming station, plus transmission of a generalized information base for the generic type of board being tested. At the end of the test, a board's test results would be sent, with its identification code, from the operator's terminal to the Tracs data base at the 2294.

The new GRnet terminal for Tracs includes a touch-sensitive cathode-ray-tube display, a bar-code scanner, and a computer built around a Z80 microprocessor. The terminal has 64-K bytes of MOS random-access memory and self-test firmware.

Easy operation. The terminal was designed to make operation easy. The touch-sensitive screen is keyed to menus that are themselves related to the device being tested, analyzed, or repaired, and easily lost paper is eliminated from the process.

Designed as a turnkey system, Tracs requires limited human intervention only in the setup phase and almost none in operation. According to Richard J. Faubert, product line manager for factory management systems, "any production-oriented person can optimize Tracs for his factory situation by using Tracs's nested menus to enter general parameters, such as shop schedules and calendars, and parameters as specific as acceptable yield for a given board type."

GenRad engineers are said to have talked with about 50 potential customers as they tried to determine what reports and data were most commonly needed in industry and therefore should be supplied by Tracs. With this homework done, plus more than 100 menu classes, Ruggiero and Faubert expect little

customization will be necessary.

Tracs sounds an alarm at designated managerial terminals when any of four conditions occurs. Successive failures of the same type, too much repeat testing (a sign of falling throughput), low yield on a given board type, or a node logged on but not transmitting (a network failure) are automatically noted as "real-time warning" messages on a managerial terminal. If more data is needed to evaluate the problem, the manager can access the data base.

Two bases. There are actually two concurrent data bases in Tracs. One, the repair-loop control data base, holds information specific to the board and board type under test—its pass, fail, and other parameters, plus a board's performance as tested. When a board is through test, the data on it moves automatically to a larger data base containing information on all boards and types and is held there for a user-specified time. This data base can form the basis for historical reports and studies of long-term production trends.

GenRad does not expect customers to buy systems just to get Tracs. "We expect the 2294 and GRnet's remote program generation, down-line loading, and test procedures management capabilities to help them decide," Ruggiero says.

The 2294 is GRnet's master node, as well as a multiuser program-generation site and central data-base–management station. It is based on a Digital Equipment Corp. PDP-11/44 with 1 megabyte of main memory and up to eight display terminals and is capable of operating with multiple disk stores up to 300 megabytes in size.

The pricing of Tracs is variable. For example, a firm already using GRnet could implement it for about $50,000 to $60,000, according to Ruggiero. A small GRnet system including a 2294, required for Tracs support, might cost a user between $90,000 and $150,000, depending on its size. Initial deliveries should take place about midyear.

GenRad Inc., Board Test Division, 300 Baker Ave., Concord, Mass. 01742. Phone (617) 369-8770 [338]

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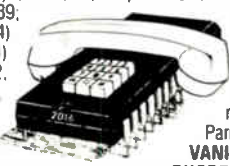

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• Type of relay	DA-RELAY	R-RELAY	DR-RELAY	DX-RELAY	DS-RELAY	NF-RELAY	NL-RELAY	NB-RELAY	NC-RELAY	K-RELAY	NT-RELAY	SE-RELAY
• Features	• DIP terminal • Glass encapsulated reed switch	• Magnetically shielded • Single-side stable • 1 & 2 coil latching	• High sensitivity • High sticking resistance • Single-side stable • 1 & 2 coil latching	• Isolation loss: 40 dB at 300 MHz • 60 mW pick-up • High insulation resistance • Shock: 50 G Vibration: 10 to 55 Hz	• 1500V FCC surge satisfied • High sensitivity • High switching power • Single-side stable and 2-coil latching • Ag-Pd contact type available	• Low profile • High sensitivity • MBB contacts available • Ag-Pd contacts type available	• 6PDT Flat-pack • Low operating power • Single-side stable and 2-coil latching • DIL terminal • MBB contacts available	• Thin height • 3A bifurcated and 5A single contact types • 2-coil latching available • DIL terminal	• Flatpack and Lean line • Single-side stable • 2-coil latching • DIL terminal • Bifurcated contacts	• Patented magnetic system • Long life • Single contact (5A) • Bifurcated contact (2A)	• Large capacity 8A • Compact size	• High sensitivity • High vibration and shock resistance • 2-coil latching available • Low thermal electromotive force • DIL terminal
• Amber sealed types availability		●	●		●	●	●	●	●	●		●
• Mounting method: Plug in									●	●		
• Mounting method: PC board	●	●	●	●	●	●	●	●	●	●	●	●
• Mounting method: Top mount												
• Contact arrangement	1a, 2a	1C	1C	2C	2C	2C, 4C	6C	1C	2C, 4C	2C, 4C, 6C	1C	2a2b, 4a
• Contact rating (resistive)	0.2A 50VDC	20W (20VDC)	20W (20VDC)	30W, 30VDC	0.3A 220VAC 2A 30VDC	0.5A 125VAC 2A 30VDC	2A 30VDC	(Single) 5A 250VAC (bifurcated) 3A 250VAC	(2C) 5A 250VAC (4C) 5A 125VAC	(Single) 5A 250V (100W 500VA) (Bifurcated) 2A 220V (75W 250VA)	8A 250VAC 8A 24VDC	4A 250VAC
• Contact material	Rh-plated nickel-iron alloy	Gold cobalt	Gold cobalt	Gold-capped silver alloy	Gold-clad silver	Gold-clad silver	Gold-clad silver	(Single) Silver nickel (Bifurcated) Gold-clad silver nickel	Gold-clad silver nickel	(Single) Gold-plated silver/silver (Bifurcated) Gold-clad silver/silver	Gold-clad silver nickel	Gold-clad silver alloy
• Life (min operations): Electrical (at rated load)	10^6	10^6	10^6	2×10^6	5×10^5 at 0.3A 220VAC 2×10^5 at 2A 30VDC	10^6	10^6	2×10^5	(2C) 10^5 (4C) 10^5	10^6	10^5	10^5
• Life (min operations): Mech	10^8	10^9	10^9	3×10^7	5×10^7	(2C) 3×10^8 (4C) 10^8	5×10^7	10^7	2×10^7	10^8	10^7	10^8
• Coil voltage	(DC) 5, 6, 12, 24V	(RSD) (DC) 5, 6, 12, 24, 48V (–L, L2) (DC) 5, 6, 12, 24, 48V	(DC) 3, 5, 6, 12, 24, 48V	(DC) 5, 6, 12, 24V	(DC) 1.5, 3, 5, 6, 9, 12, 24, 48V	(DC) 5, 6, 12, 24, 48V	(DC) 5, 6, 12, 24, 48V	(DC) 3, 5, 6, 12, 24, 48V	(DC) 5, 6, 12, 24, 48V	(DC) 6, 12, 24, 48, 60, 110V	(DC) 5, 6, 12, 24, 48V (AC) 6, 12, 24, 48, 115V	(DC) 5, 6, 12, 24, 48V
• Nominal operating power	(1a) 230mW (2a) 325mW	(RSD) 150 to 280mW (–L)70 to 100mW (–L2) 150 to 230mW	(Single-side stable) 96 to 209 mW (–L)56 to 109mW (–L2) 111 to 290mW	130 mW	Single. 400 mW 2-coil latching 360mW	(2C) 300mW (4C) 480mW	Single: 720mW 2-coil latching: 1,600mW	400mW	(Single) (2C) 360mW (4C) 720mW (L2) (2C) 800mW (4C) 1,600mW	(2C) 200 to 400mW (4C) 500 to 700mW (6C) 1,300mW	(DC) 290mW (AC) 0.75VA	192 to 356mW
• UL, CSA, VDE	—	UL	—	—	UL	UL, CSA, VDE	UL, CSA, VDE	*	UL, CSA, VDE	UL, CSA, VDE	UL, CSA	UL

Note * denotes UL, CSA application under way

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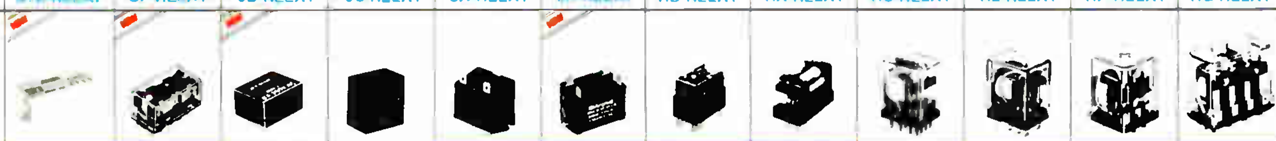

Field Switching Power	Compact Power Sensitive	Compact Power	Compact High Power	1 HP Compact Power	30A Compact Power	Subminiature DIP	Subminiature	Miniature Power	Compact Power	10 Amp Power	20 Amp Power
STE-RELAY	SP-RELAY	JB-RELAY	JC-RELAY	JA-RELAY	JH-RELAY	HB-RELAY	HA-RELAY	HC-RELAY	HL-RELAY	HP-RELAY	HG-RELAY
• High sensitivity • Large capacity in small size • Capable of switching field inductive loads • High inrush capability	• High sensitivity • High vibration and shock resistance • Wide switching range • 2-coil latching	• High dielectric withstanding 10,000V surge • Large capacity 8A in compact size • Flux-resistant	• High inrush current capability • TV-rated type available • High dielectric withstanding 10,000V surge	• High switching capacity 55A inrush, 15A steady • TV-rated type available • High dielectric withstanding 5,000V	• Cont. gap: 3mm • 10,000 V surge between coil and contact • BDV 2K VAC Con/Con 5K VAC C I/Con • 1 Form A type: 117 A (TV-8) • 2 Form A type: 91 A (TV-6)	• DIP terminal • Flux-resistant • Ag-Pd contacts type available	• Compact size • Flux-resistant	• Wide applications • Versatile range • Bifurcated contacts (4C)	• Large capacity • Compact size	• Long life	• Large capacity 20A
						●	●	●			
	● (Faston) No. 187		●	TM type direct chassis mounting TMP type PC board mounting	●			●	● (Faston) No. 187	● (Faston) No. 187	● (Faston) No. 250
●		●	●			●	●	●			
			●		●			●			
1a1b, 2a	2C, 4C	1C	1a, 2a, 1a1b	1a, 1b, 1C	1a, 2a	1C, 2C	1C	1C, 2C, 3C, 4C	1C, 2C	1C, 2C, 3C	2C, 3C, 4C
8A 250VAC	(2C) 15A 250VAC 10A 30VDC (4C) 10A 250VAC 10A30VDC	8A 250VAC 5A 30VDC	(1a) 10A 250VAC (2a) 5A 250VAC	1 HP 125-250VAC	(1a) 30A 250VAC (2a) 20A 250VAC	1A 125VAC 2A 30VDC	3A 250VAC	(1C) 10A 250VAC (2C) 7A 250VAC (3C) 7A 250VAC (4C) 5A 250VAC	(1C) 15A 250VAC (2C) 10A 250VAC	10A 250VAC	20A 250VAC
Silver alloy	Silver alloy/gold-plated silver alloy	Silver alloy	Silver alloy	Silver alloy	Silver alloy	Silver nickel	Silver nickel	Gold-flashed silver-cadmium-oxide	Silver-cadmium-oxide	Silver alloy	Silver-cadmium-oxide
10^5	10^5	10^5	10^7	10^5	10^6	2×10^6	10^6	5×10^5	5×10^5	2×10^5	2×10^6
10^7	5×10^7	10^7	5×10^6	5×10^4	5×10^6	10^7	10^7	(DC) 10^8 (AC) 5×10^7	(DC) 10^8 (AC) 5×10^7	10^7	(DC) 10^8 (AC) 10^7
(DC) 3, 5, 6, 12, 24, 48V	(DC) 3, 5, 6, 12, 24, 48V	(DC) 5, 6, 12, 24, 48V	(DC) 6, 12, 24, 48V	(DC) 6, 12, 24V (AC) 6, 12, 24, 115V	(DC) 12, 24, 110V (AC) 24, 120, 240V	(DC) 5, 6, 12, 24, 48V	(DC) 5, 6, 9, 12, 24, 48V (AC) 6, 12, 24, 48, 115V	(DC) 6, 12, 24, 48, 110V (AC) 6, 12, 24, 48, 115, 220, 240V			(DC) 6, 12, 24, 48, 110V (AC) 6, 12, 24, 48, 115, 220, 240V
240mW	300mW	(Up to DC24V) 480mW (DC48V) 560mW	(1a) 0.9W (2a) 1W	(DC) 1.2W (AC) 1.3VA	1.9W(DC) 3.2VA(AC)	(1C) [illegible] (2C) [illegible]	(DC) 360mW (AC) 0.9VA	(DC) 0.9W (AC) 1.2VA	(DC) 0.9 to 1.0W (AC) 1.2 to 1.3VA	(DC) 1.5W (AC) 2.0VA	(2C) 1.4W (DC) 3.6VA (AC) (3C) 1.6W (DC) 5.2VA (AC) (4C) 2.0W (DC) 7.6VA (AC)
*	UL	UL	UL, CSA	UL, CSA	UL	UL, CSA	UL, CSA	UL, CSA, VDE (1C, 2C, 4C)	UL, CSA	UL, CSA, VDE	UL, CSA

Circle 195 on reader service card

Instruments

1-GHz generator goes for $3,000

Pulse generator with ECL and TTL output omits features of costlier competition

Because the market is ripe for a pared-down pulse generator that is relatively inexpensive but still very fast, Colby Instruments Inc. has developed the 1-GHz PG 1000A. The small firm talked with potential customers for a year before starting work on this instrument early in 1981, says Siegfried Knorr, president. "We're not just shooting blue sky. There's a reasonable market, and not just for R&D, but for computer and communications design where high-speed ECL driving is concerned."

Colby aims its generator [*Electronics*, Dec. 29, 1981, p. 33] to compete with the industry-standard Hewlett-Packard 8080, which with options can sell for up to $10,000. The unit, virtually self-contained, comes in at $2,995, low considering its performance, maintains Knorr.

The single-channel generator has pulse repetition rates of 1 to 1,000 MHz for emitter-coupled logic and up to 350 MHz for TTL. In ECL, the rise or fall time is less than 200 ps, and the output amplitude is variable from 0.5 to 1 V, with a 2-V output option available.

Transition times (20% to 80%) are less than 150 ps, and time coincidence for differential outputs is below 30 ps. Complementary outputs have independently adjustable offset controls with output level from +2 to −3 V (signal plus offset).

TTL as well. For TTL outputs, rise or fall time is less than 750 ps, with a signal-output amplitude of 0 to 5 V. Time coincidence for differential outputs for the Colby generator is less than 50 ps. Small-signal bandwidth is 80 MHz, typically.

The PG 1000A has a number of features common to both ECL and TTL applications, including fast gating and triggering output. The external gating turn-on or turn-off time is less than 250 ps with the trigger output, and 350 ps for internally and externally applied signals. Trigger output is unaffected by the gating signal, according to the firm.

Another attention-getting aspect of the new instrument is its narrow pulse widths (500 ps minimum for ECL, 2 ns for TTL), which are independent of the pulse repetition rate, observes Knorr. Displayed frequency accuracy is ±1 digit and frequency drift is better than ±1 digit. The PG 1000A's displayed frequency resolution in the 1-to-10-MHz range is 1 kHz; over 10-to-100-MHz, it is 10 kHz; and in the 100-to-1,000-MHz range, it is 100 kHz. The duty-cycle range is set by a 10-turn precision potentiometer.

Although the Colby unit is pri-

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marily built for high-speed applications, and so leaves off such expensive items as delay generators to cut costs, Knorr points out that the model 1000A is directly compatible with instruments that have such options. "It can be used with another 50-MHz box, for instance, to get some of these features," he says.

The unit is small to fit in cramped laboratories at 11.5 by 5.5 by 13 in. It weighs 15 lb and requires 110 or 230 V at 50 to 60 Hz, using 30 W.

Standard accessories include 2 coaxial cables, 11 SMA-to-BNC connectors, 2 SMA 50-Ω terminations, and a 2.5-ns transmission line with shorting cap. As an option, for $350, a 80-ns delay line is offered for producing a pretrigger signal. This feature is useful when pulse repetition rate is so low that a waveform is not displayed on an oscilloscope.

First deliveries are planned for the end of February.

Colby Instruments Inc., P. O. Box 84379, Los Angeles, Calif. 90073. Phone (213) 450-0261 [351]

Four-function electrometer detects currents of 10^{-14} A

Addressing the precision measurement needs of semiconductors and large-scale integrated circuits with its 10-fA current sensitivity and 50 TΩ input resistance, the model 614 is as easy to use as a digital multimeter. This low-priced digital electrometer sells for only $1,495 and has a color-coded front-panel format, push-button controls, and a large 4½-digit light-emitting-diode display.

The unit can measure voltages

from 10μV to 20 V and current measurement requires a voltage burden of less than 200 μV. It also measures resistance as high as 200 GΩ and charge between 10^{-14} C and 2×10^{-8} C, a measurement not available on standard DMMs.

The 614 has a rechargeable lead-acid battery pack, which allows off-line operation for 10 hours or more. The battery pack automatically switches on when line power is interrupted and recharges when line power is connected, whether the unit is on or off.

The 614's current suppression is up to 2,000 times the least significant digit on most ranges and permits large offset currents to be quickly nulled. The unit's noise level is less than 15 μV, peak to peak, and its stability is 20 μV per °C.

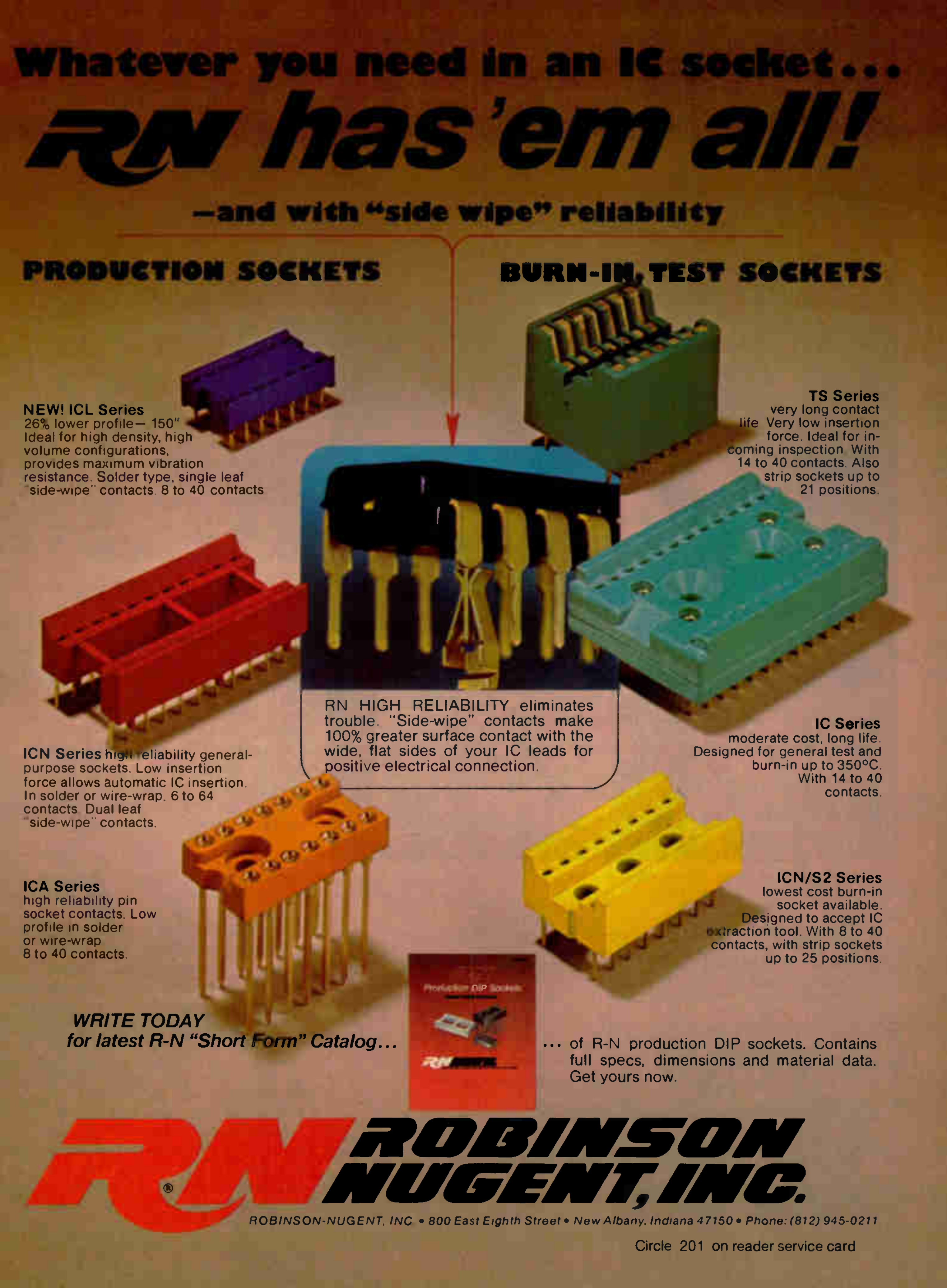
Keithley Instruments Inc., 28775 Aurora Rd., Cleveland, Ohio 44139. Phone (216) 248-0400 [353]

Two-channel counter-timer performs five measurements

With a display value that accurately represents the input signal, the model 310 two-channel counter-timer measures frequency, period, count, frequency ratio, and time. One channel can measure up to 600 MHz and the other 2 MHz.

To measure frequency a two-step prescaler is used; the input impedence is 1 MΩ for direct measurements and the first prescaler and is 50 Ω for the second prescaler. Sine-wave sensitivity is 35 mV root mean square across all ranges. The unit sports a two-step low-pass filter, a two-step attenuator, ac or dc selection for the 1 MΩ input, and a trigger level control that has a light-emitting-diode display.

The 310 has four gate times: 10 ms and 0.1, 1, and 10 s. The time-base accuracy is 1 part per million, trimmable. Time-base outputs of 1 and 10 MHz are provided and these may be used as sources for other equipment or connected to the inputs to test an instrument's front end. A self-test mode applies the time base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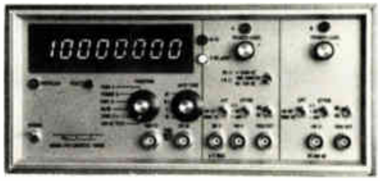

and logic apart from the front end.

Additionally, both channels have trigger outputs. By monitoring this output on an oscilloscope, a precise trigger point may be selected, and stable and accurate triggering can be ensured for complex waveforms. The model 310 is priced at $450, with delivery taking to 30 days.

FSI, 1894 Commercenter West, #105, San Bernardino, Calif. 92408. Phone (714) 889-7623 [354]

Benchtop unit drives aircraft-structure tests

Designed for avionics uses like materials testing, wing and landing-gear fatigue testing, and simultaneous temperature, pressure, and load testing of aircraft fuselages, the benchtop Cyber I Profiler cycles 2 to 16 independent servo actuators.

After the user specifies endpoints in kilopounds of load and the test time base in seconds and milliseconds, the Profiler, under Z8000 control, generates wave shapes to drive parallel channels of temperature, load, displacement, or other servo controllers. The test definition may be saved on a built-in tape cartridge for later reuse.

Remembering 512 programmed segments in addition to various transition waveforms, the Profiler generates each step for a preselected time and optionally checks feedback from load cells or other sensors to verify that the associated servo controllers are actually achieving the desired forces, loads, temperatures, or other test stimulus values. This feature can also hold channels until lagging channels catch up; when all values are correct, the test proceeds. Totaling is done automatically and information recorded on counters is

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The AS885 is more than twice as fast as the standard Schottky arrangement. Typical propagation delay is only 12 ns vs 28 ns (see table).

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As the historical leader in Schottky technology, TI has constantly refined the process until, across the line, the AS Series sets new performance standards. Featuring a typical 1.5-ns SSI gate delay and higher-density MSI, the Series is—typically—twice as fast as the original Schottky family.

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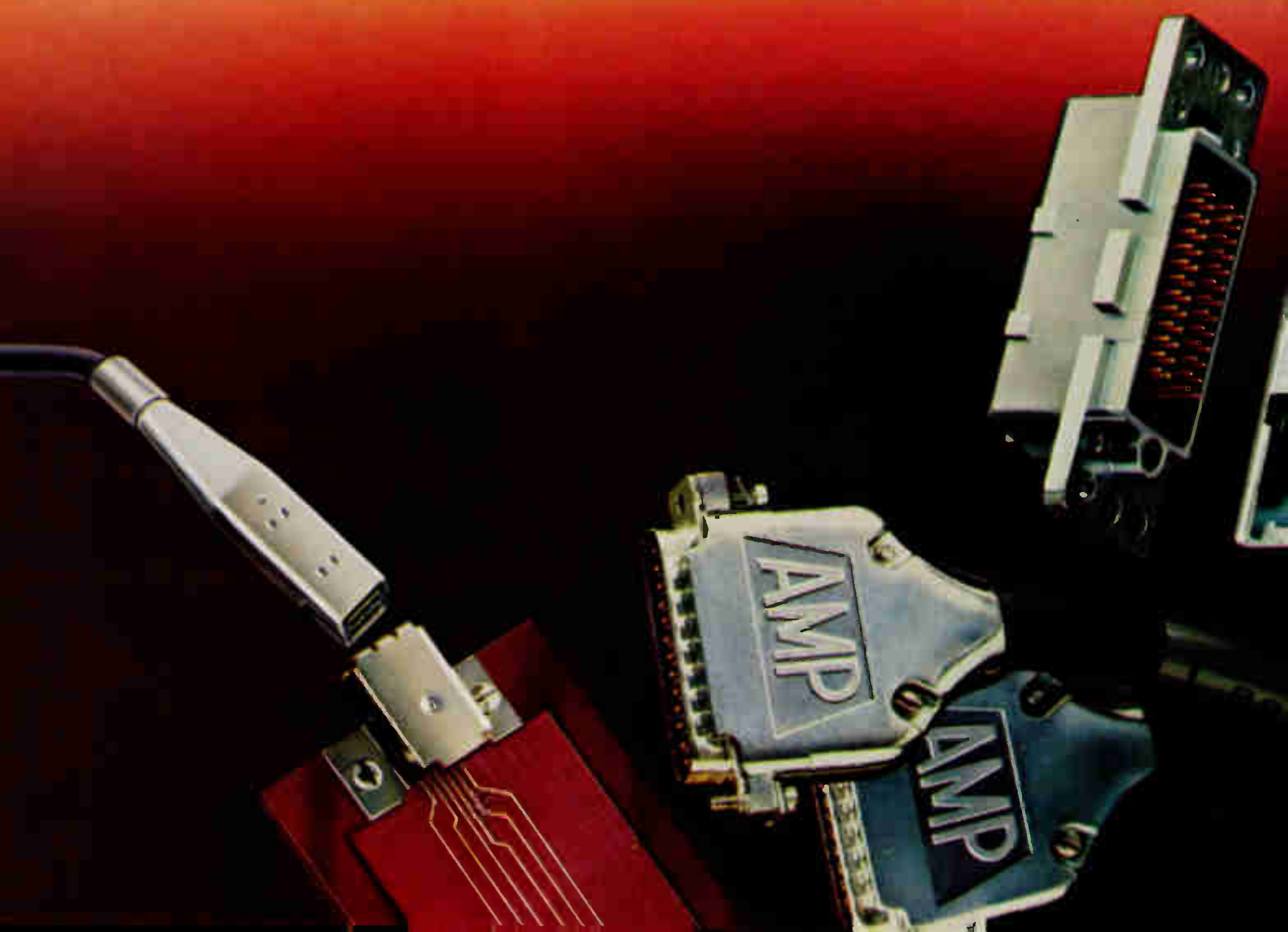

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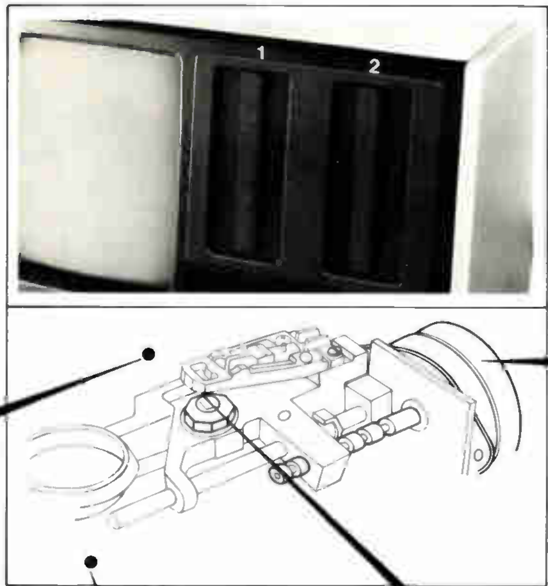

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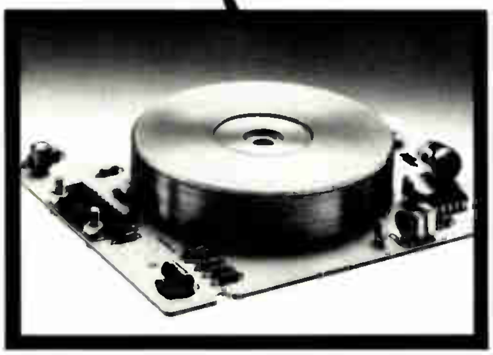

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Semiconductors

EE-PROM looks like RAM to host

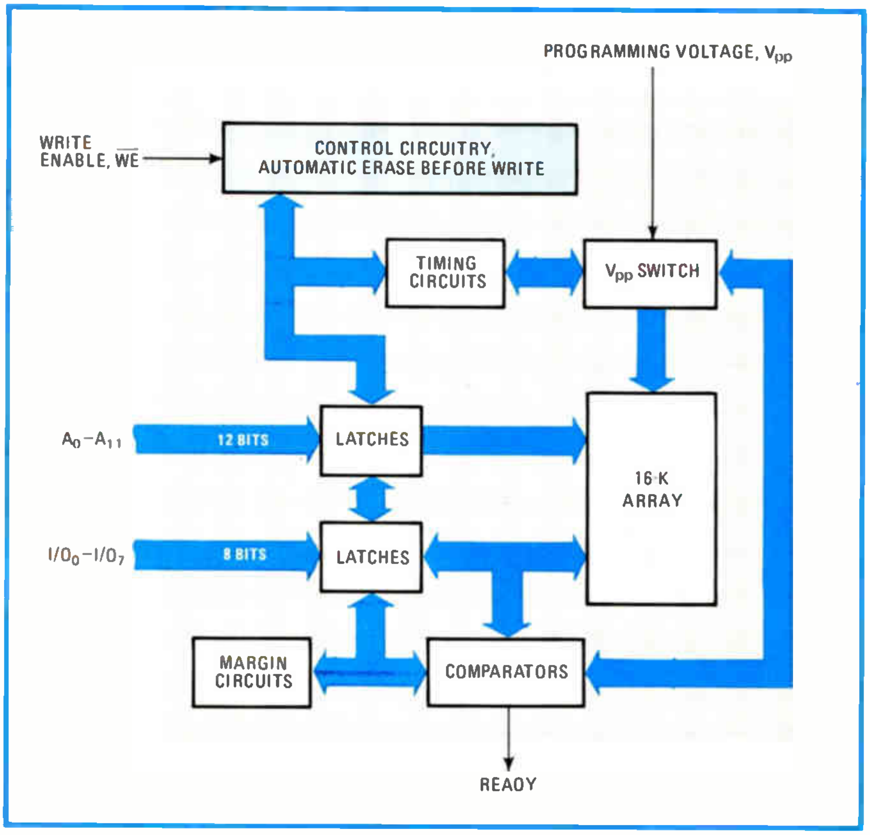
Chip handles the writing-pulse control for its floating-gate tunnel-oxide storage array

The 2817 electrically erasable programmable read-only memory can effect cost savings in systems requiring relatively small amounts of nonvolatile storage. Integrated with the 16-K array are latches, interface logic, and pulse-shaping and timing circuits for freeing a microprocessor during writing intervals, as well as reducing the number of external components needed to operate the memory.

Like its predecessor, the 2816, the part is built around floating-gate tunnel-oxide storage cells and has a maximum access time of 250 ns [*Electronics*, Nov. 20, 1980, p. 50].

Built-in. Unlike Intel's previous EE-PROMs, however, the 2817 incorporates the interface components normally added externally. When the host microprocessor requests a write operation, the request, the byte address, and the data to be stored are latched and the ready line is lowered, indicating that the device is busy. The host processor is then free to attend to other tasks during the 20-ms (maximum) writing time.

The 2817 sets up the necessary erase pulse using a 22-V dc source supplied externally. The latched data is then written into the array and the ready line gives an interrupt signal to the host. As shown in the figure, a comparator feedback loop monitors the magnitude of the charge stored on the floating gates during the write cycle to achieve the minimum possible write time. "Typically the cycle—including automatic erasure—requires only 10 ms," notes John Rizzo, product line manager



RAM-like ROM. The 2817 electrically erasable programmable read-only memory from Intel takes care of its own erasing and write-pulse control; comparators let it minimize writing time.

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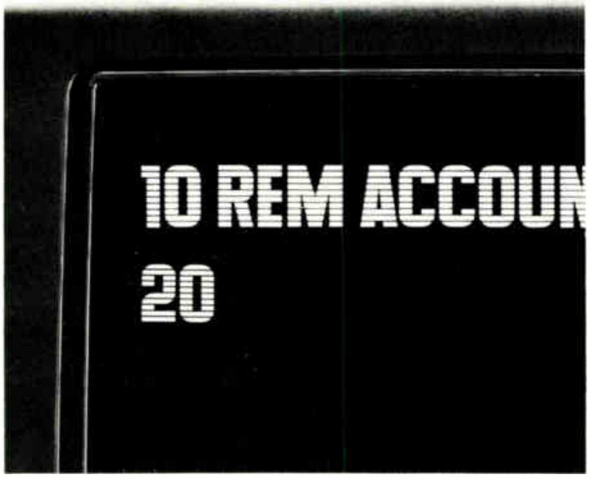

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Ashton-Tate, 9929 Jefferson, Los Angeles, CA 90230. (213) 204-5570.

Ashton-Tate

for electrically erasable memories. "With the arbitration logic and programming-pulse–shaping done on chip, the part looks like a random-access memory to the host processor," he continues.

An external 5,600-pF capacitor is needed to generate the internal clock signals and to set the rise time for the programming pulses. The 2817 draws 150 mA from a 5-V power supply in operation and goes into standby automatically when not enabled. Standby power dissipation is 300 mW. The device is rated for operation from 0° to 70°C, and is housed in a 28-pin dual in-line package with standard pinouts. Data retention time is 10 years, and at least 10,000 write-erase cycles are possible.

Sample quantities are available from stock, and production volumes will be available in the first quarter. The 2817 is priced at $70 in 100-unit lots, and slower versions are available. The 2817-3 with 350-ns access time is $64, and the 2817-4 with 450-ns access is $62.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. Phone (408) 987-6742 [411]

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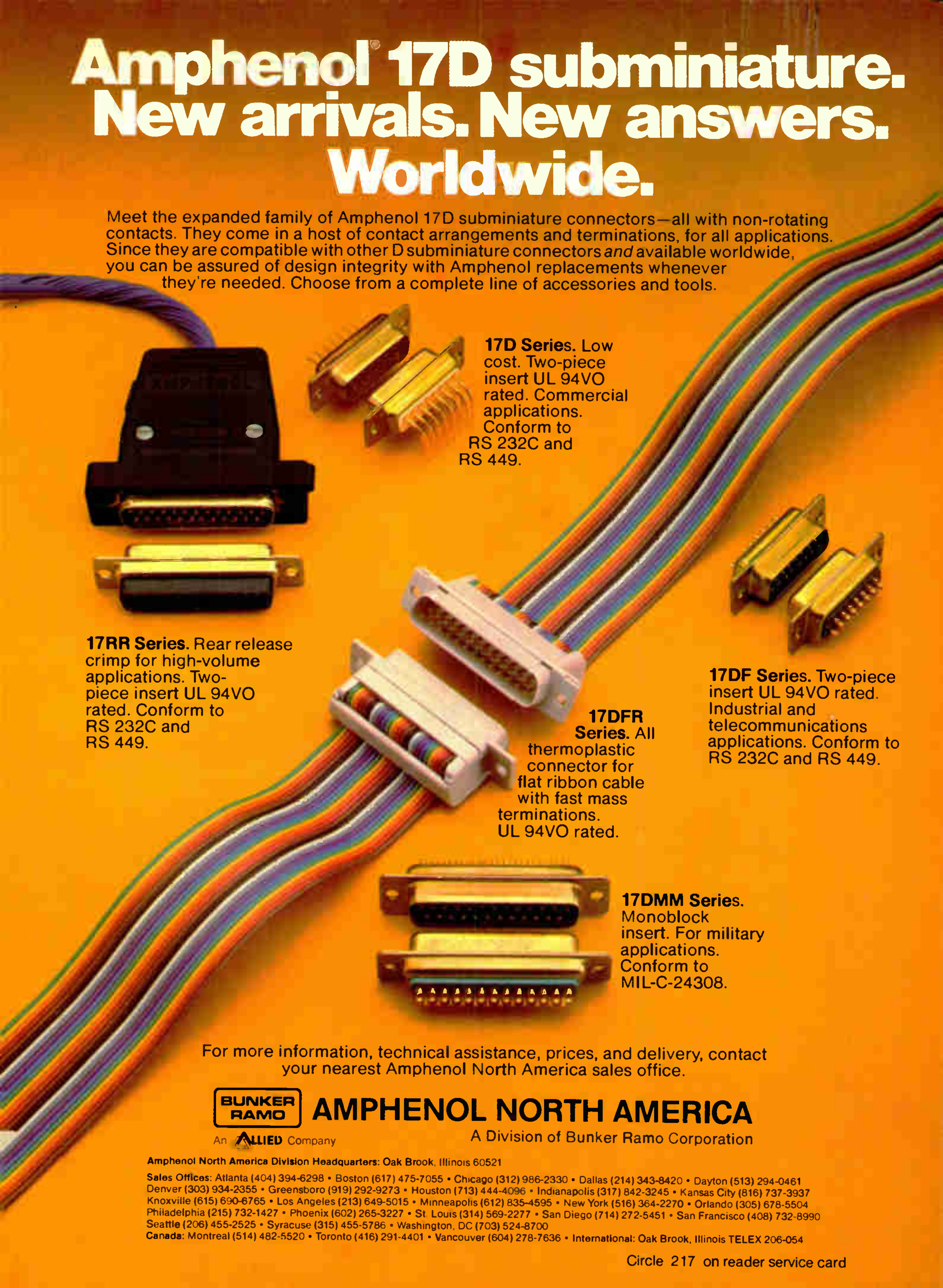
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Circle 217 on reader service card

circuit layout, complexity, and testing, but the break-even point is between 300 and 400 equivalent logic boards. Typically, only 10 weeks are required to produce prototype samples from a logic diagram or device specification.

General Instrument Corp., Microelectronics Division, 600 West John St., Hicksville, N. Y. 11802. Phone (516) 733-3120 [413]

2-K static RAM takes the heat

Boasting an access time of 120 ns, the MKB4802-P81 is a 2-K-by-8-bit static random-access memory that is fully screened to MIL STD 883B, method 5004. Also operating over the −55°-to-125°C temperature range is the -P83, a version with a 200-ns access time. Soon to follow is a device with a 90-ns access time.

Family members with an abbreviated temperature range, −55° to +100°C, the -P91 and -P93, are lower in price. The -P81 and -P83 are $65 and $54.30 each in 1,000-piece quantities, and the -P91 and -P93 are $45.75 and $40.17 each in like quantities.

These n-channel MOS parts come in 24-pin plastic, ceramic, and hermetically sealed Cerdip dual in-line packages. They typically consume 1 W. The memories are pin-compatible with the full line of Bytewyde memories, including RAMs, read-only memories, and erasable programmable ROMs.

Mostek Corp., 1215 West Crosby Rd., Carrollton, Texas 75006. Phone (214) 323-6000 [414]

Bipolar programmable arrays do combinatorial logic

Added to the PAL Series 24 of bipolar programmable-array logic circuits are six devices for performing combinatorial logic functions. The PAL20C1 is a 20 input, single output AND-OR-AND-OR-INVERT gate array. AND-OR-INVERT gate-array parts include the PAL12L10 with 12

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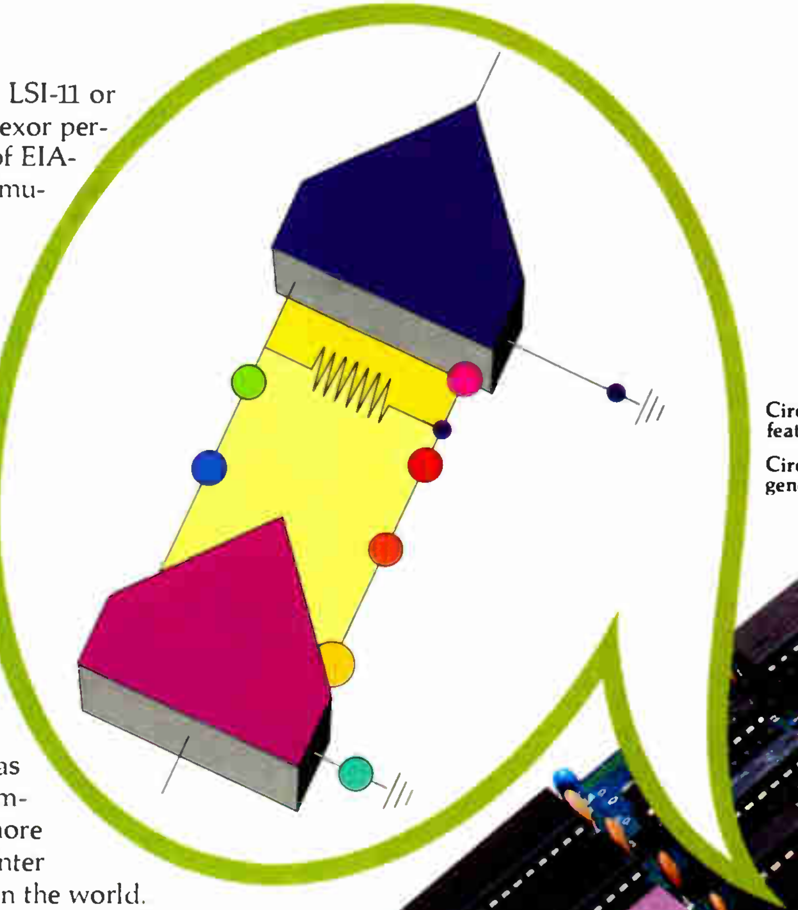


Now you can have it all for your LSI-11 or PDP* 11 system! Full DZ11 multiplexor performance with the added benefit of EIA-RS-422 long line capability—communicates at distances to 3000 feet (914.4m) at rates to 19.2K baud. What's more, MDB's DZ11 multiplexors let you combine RS-422 with EIA-RS-232 in any combination up to a total of eight lines on a single board. Or combine RS-232 with current loop in the same way. Eight and sixteen channel RS-232 DZ11 multiplexors are also available. No more doubling up on boards, distribution boxes, rack space or price. You see the results in your system's performance and cost.

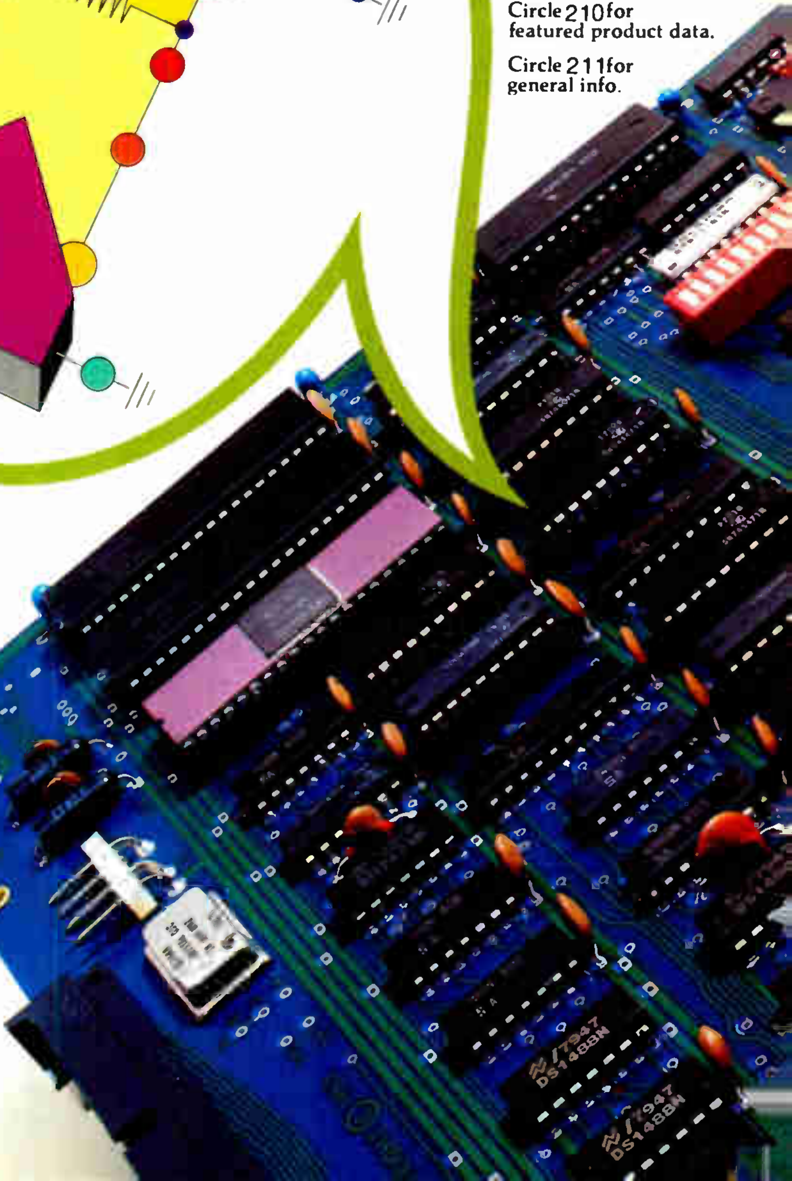
And that's not the only difference we can make to you. MDB has line printer controllers that are completely self-testing and we make more controllers for more computer/printer combinations than any company in the world. MDB offers PROM modules with window mapping, communications interfaces that support X.25 and a unique LSI-11/23 system with 22 bit addressing and up to 4 Mbytes of memory. From purely compatible to purely incredible all MDB products are built with exceptional quality and responsiveness to customer requirements. Our boards are warranted for a full year, many are available off the shelf and they can be purchased under GSA contract #GS-OOC-02423.

Call or write for all our specifications—the MDB differences that make a difference.

*Trademark Digital Equipment Corp.

Circle 210 for featured product data.

Circle 211 for general info.



MDB SYSTEMS INC.
1995 N. Batavia Street
Orange, California 92665
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inputs and 10 outputs, the PAL14L8 with 14 inputs and 8 outputs, and the PAL16L6 with 16 inputs and 6 outputs. Rounding out the AND-OR-INVERT arrays are the PAL18L4 with 18 inputs and 4 outputs, and the PAL20L2 a 20-input, dual-output device.

The chips, which come in 300-mil-wide Skinnydip packages, make possible such multiplexing as quad 4-line-to-1-line, dual 8-line-to-1-line, and 16-line-to-1-line. Using the 24-pin devices, TTL random logic in input/output-intensive systems can be replaced, reducing board space by 80%. The devices draw a maximum of 60 mA and have a typical access time of 25 ns.

In lots of 100, the commercial-grade parts are $8.83 each for plastic versions and $10 each for ceramic models. A military-grade part is also available.

Monolithic Memories, 1165 East Arques Ave., Sunnyvale, Calif. 94086. Phone (408) 739-3535 [415]

4-K C-MOS RAM sports 200-ns access time

The complementary-MOS MWS-5114 4-K static random-access memory combines the benefits of low power consumption with high speed in versions that have 200-, 250- and 300-ns access times.

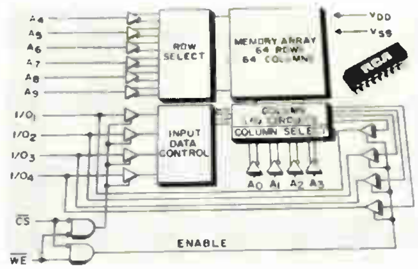
Organized as 1,024 words by 4 bits, the RAMs are fabricated in ion-implanted silicon-gate C-MOS technology and operate over the 0° to 70°C temperature range. The devices are specified to retain data at voltages a low as 2 V over the entire temperature range. This feature allows them to be applied in battery-backup systems in which power is provided by a standby battery when normal electrical power either fails or is intentionally shut down.

All inputs and outputs to the devices are TTL-compatible, providing the benefits of low power C-MOS and the high speed of TTL in mixed-technology systems.

Initial versions of the 18-pin devices are available now in plastic,

with ceramic parts to follow soon. In 1,000-piece quantities, the 200-ns version is priced at $5.82, while the 300-ns model goes for $4.40.

RCA Corp., Solid State Division, Route 202, Somerville, N. J. 08876. Phone (201) 685-6423 [416]



Industrial, medical sensors handle 200 lb/in.²

Designed for medical, automotive, and industrial uses, the X-ducer line includes two piezoresistive pressure sensors. The MPX50D, a differential-pressure type, is for the 0-to-50-kPa or 0-to-7.3-lb/in.² range, while the MPX200A, an absolute-pressure type, is for the 0-to-200-kPa or 0-to-29 lb/in.² range.

The MPX50D has an unconditioned output of up to 100 mV (triggered at 5 V). Its overpressure capability is 200 kPa. This part is also available as a temperature-compensated and signal-conditioned gage sensor. The MPX200A has a 100% overpressure capability and a typical nonlinearity of ±0.05% of full scale. It also is available as a signal-conditioned and temperature-compensated sensor module.

A pressure port fitting, a receptical for connection to ⅛- or 1/16-in.-diameter hoses, permits mounting to boards and chassis. The port has metal rivets to secure the package for reliable chassis mounting and protection against vibration. This feature lets the MPX50D be used as a pressure gage, vacuum gage, or differential sensor. In small quantities, the parts sell for $26 each, with delivery from stock.

Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Ariz. 85036. Phone (602) 244-4557 [418]

Discover TRW's advanced technology components

in precision motion systems...	in RF hybrid amplifiers...	in Schottky rectifiers...

Gearmotor with optical encoder and square wave output

This new gearmotor from TRW Globe Motors contains an internal tachometer with TTL compatible output and an external optical amplifier and Schmitt trigger to provide a square wave output.

These devices are designed for any application where the absolute angular position and velocity of the shaft must be known and controlled at any time ...making them ideal for use in tape drives, floppy discs, business machines, audio-visual equipment and many other applications.

They can be supplied with gear trains of any ratio up to 1,000,000:1 reduction with high accuracy. Brakes and dual channel encoders for providing information on rotational direction are also available. The basic motor is 38cm. (1.5in.) in diameter and weighs 298gm. (10.5oz.).

Circle 272 on reader service card

Low noise, high power, wideband RF hybrid amplifiers from 1MHz to 4GHz

TRW RF Semiconductors offers a complete series of these devices covering a wide variety of applications from 1MHz to 4GHz. All are internally matched to a nominal characteristic impedance of 50 or 75 ohms, in both input and output and use TRW gold metallized silicon dice.

Low noise and ultra-linear RF hybrids with multi-octave bandwidths are ideal for CATV distribution, communication radio, instrumentation, optical fibre cable, TV transposers, radar and navigation applications.

High power hybrids with wattages for use in Class A or Class C operation are designed for efficient operation in mobile radio, TV transposer/transmitters, microwave links and military communications.

They can considerably reduce your design cycle as well as manufacturing time and costs.

Circle 273 on reader service card

High rectification efficiency for switching power supplies

The very low forward voltage drop (0.5V) of TRW Power Semiconductors SD21 and DS211 permit a 25% increase in the efficiency of computer and peripheral low power (35-100V) switching power supplies—when replacing regular PN diodes.

They are housed in T0220 cases and have a 45V reverse voltage rating. The SD21 is a 15A single chip with a V_F of 0.58V at 125° C. The DS211 uses a 2X7A dual chip in a centertap configuration. Each chip has a V_F of 0.58V at 125° C.

The 100V reverse voltage ratings of the SD131 and SD151 make them the first Schottkys to achieve this high V_{RMM}. They allow rectification of a 12V output at much higher efficiency than PN diodes, because of their V_F of 0.6V at 60A and 30A at 175° C.

Circle 274 on reader service card

TRW ELECTRONIC COMPONENTS

DIVISIONS OF TRW INC.

5725 East River Road • Chicago, Illinois 60631 • 312-693-7730

When reliability really counts... there's no substitute for RCR carbon composition resistors.

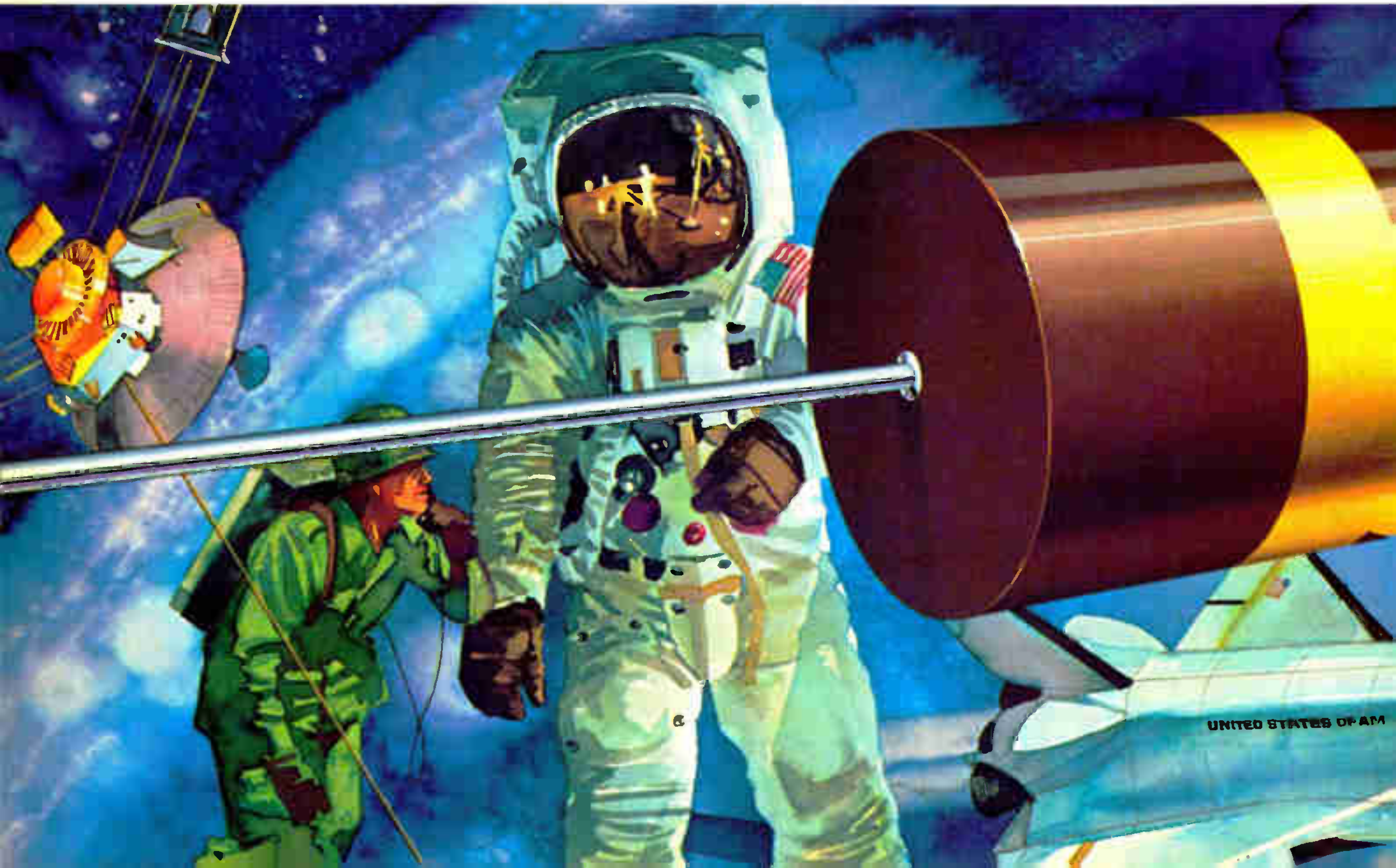
Allen-Bradley has always been the largest supplier of military grade hot-molded carbon-composition fixed resistors.

Through many decades of the most demanding military and aerospace applications, Allen-Bradley carbon comps have established an unequaled reputation for reliability. The reason: our continual commitment to quality.

Today, we are investing millions to continue our commitment into the future. We've recently installed additional new production equipment in our huge new El Paso plant to provide more capacity to meet the rising demand for established reliability carbon-composition fixed resistors.

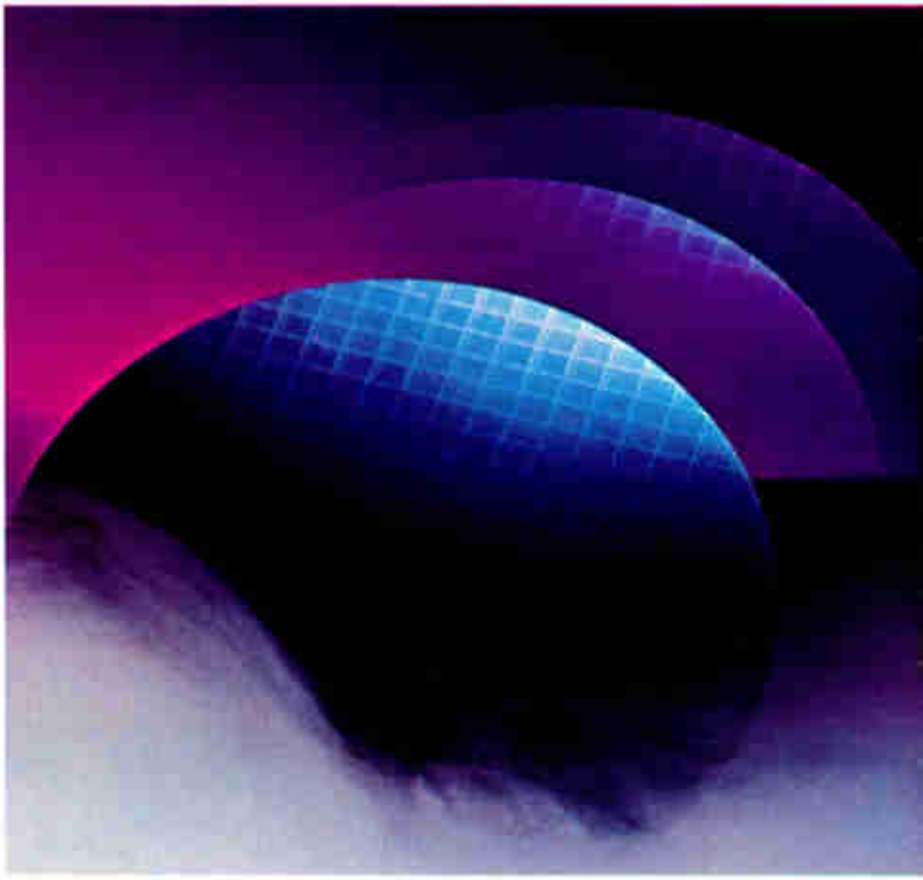
Complete RCR line, full qualification.

The Allen-Bradley line of military grade resistors is complete. All military types: RCR05, RCR07, RCR20, RCR32 and RCR42. All resistance values from 1 ohm to 22 megohms. All tolerances, 5% and 10%. All exceed the S level (best level) of Established Reliability. Ongoing life tests have accumulated over a billion unit test hours without a single failure. The Allen-Bradley hot-molded carbon composition fixed resistor is one of the most reliable electronic components available today.



One Source. Every critical step of the way.

Announcing the Model 300 ... another dividend on your

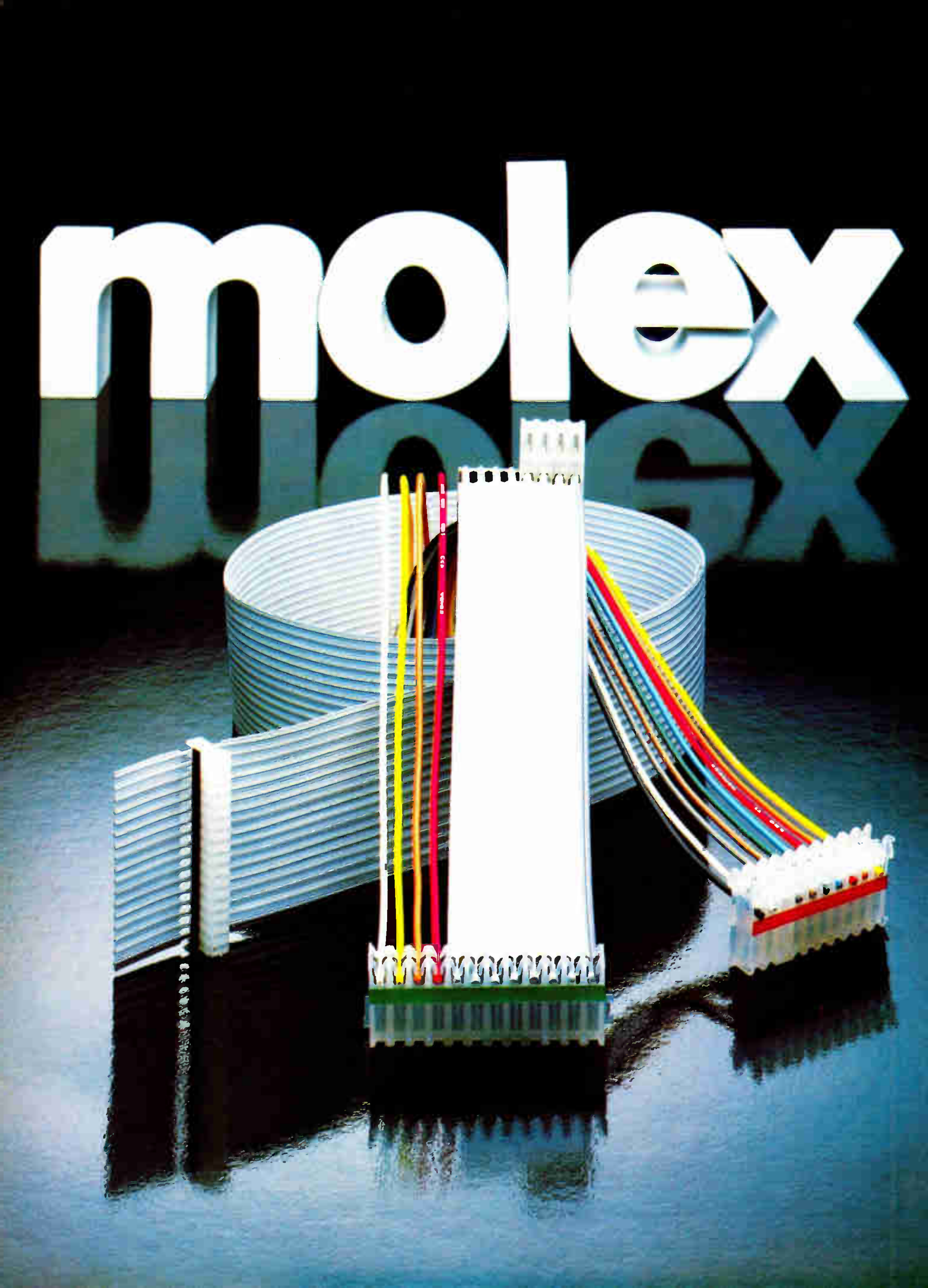


Perkin-Elmer now offers a cost effective route to higher packing densities, higher yields and therefore greater production economies... utilizing the same process, the same floor space, the same personnel, the same spare parts and the same tooling.

These economic advantage's are made possible by the new Micralign Model 300 with a specified overlay accuracy of 0.5μm, machine stability of 0.25μm and resolution of 1⅛μm at 300nm.

Dramatic improvements in optical fabrication techniques developed at Perkin-Elmer's world renowned optical facilities are now available to you in the Model 300. To take full advantage of the improved optical performance many supportive design improvements have been made, including

—optical mounting techniques
—vibration isolation
—air flow and internal



molex

For mass termination component cost savings and appliéd labor reductions:

Molex has the answer.

Molex is the only manufacturer that offers cable systems on five center lines.

If your application calls for ribbon cable, discrete wire, or a combination of both in the same connector, Molex* Jet-Flecs* insulation displacement connectors can provide a complete system to meet your requirements on .050″ (1.27mm), .098″ (2.5mm), .100″ (2.54mm), .156″ (3.96mm) and .200″ (5.08mm) center applications.

The photo depicts harness and non-harness board .156″ and .100″ center connector versatility. What the photo cannot show is the vast selection within the Molex system including 3 reliable contact designs.

Jet-Flecs .156″ connectors accept wire gauge sizes from 18-28 AWG and Jet-Flecs .100″ connectors accept 22-28 AWG. The Jet-Flecs connectors are drop-in replacements for standard KK* crimp products. There is no need to redesign your present product or application to utilize the advantages of the Jet-Flecs system since the connectors will mate with Molex KK headers accepting round or square pins.

Cost savings up to 40%

When using insulation displacement, your applied costs are lowered by 30 to 40%. This is accomplished by replacing the strip, crimp, and insertion steps with one simultaneous mass termination operation.


Cable Arbor Press

The components and cable are only half the system. The big advantage Molex offers is the complete range of application tooling. This equipment ranges from single wire hand tools to fully automatic assembly machines.

Molex's application equipment is in two main categories, cable assembly and discrete wire assembly.

For cable termination, an arbor-type press is available and a semi-automatic terminator for higher production rates.


Harness Board Assembly Tool

Discrete wire termination can be accomplished with the use of an arbor-type press, a semi-automatic single wire terminating machine, a harness board assembly tool (which is compatible with your present harness board), or a fully automatic multi-wire assembly press.

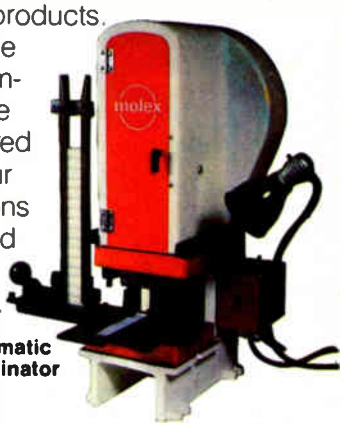
Many of these unique application tools are available for demonstration in your manufacturing facility. Or, if you choose, one of the Molex equipment demonstration vans can visit your facility and show the complete array of tooling which is available to help lower your costs.


Fully Automatic Multi-Wire Assembly Press

Molex and distributors now offer cable system assembles!

Molex franchised distributors nationwide have value-added equipment to manufacture your systems quickly and economically with stock products.

High volume OEM assemblies can be manufactured to meet your specifications and shipped directly from Molex.



Semi-Automatic Cable Terminator

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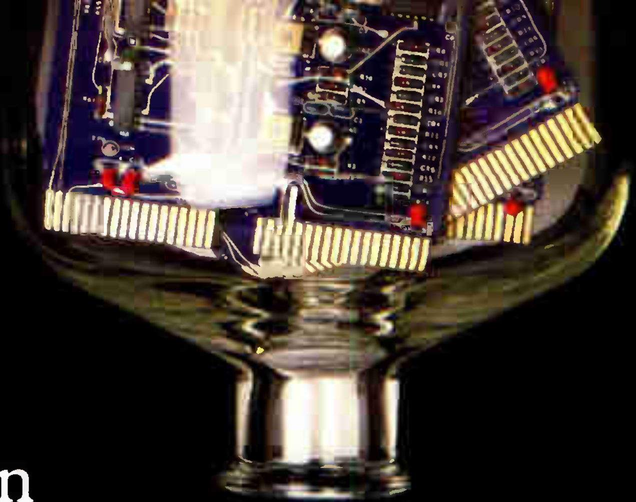
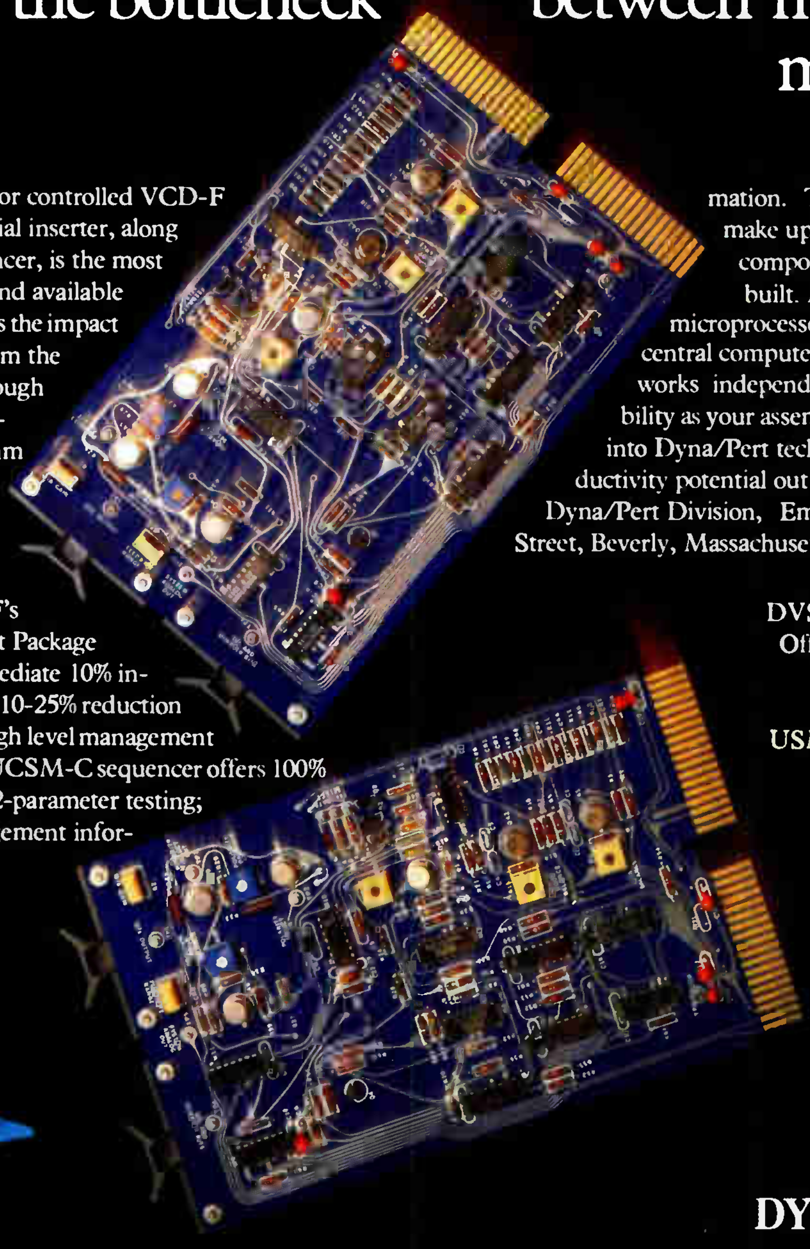


Dyna/Pert's axial insertion technology eliminates the bottleneck between manual and mechanical.



Dyna/Pert's microprocessor controlled VCD-F variable center distance axial inserter, along with the UCSM-C sequencer, is the most productive system of its kind available today. Because it eliminates the impact of board handling time from the overall machine cycle, through careful programming techniques. And it features 5 mm tooling: the smallest center distance between holes of all available inserters. What's behind this added productivity? The VCD-F's Productivity Enhancement Package (PEP). PEP offers an immediate 10% increase in test rated output; 10-25% reduction in board run time; and a high level management information system. The UCSM-C sequencer offers 100% error-free VCD-F input; 2-parameter testing; and comprehensive management information. Together, these machines make up the most productive axial component insertion system ever built. And as with all Dyna/Pert microprocessor controlled machines, no central computer is needed. Each machine works independently, for increased flexibility as your assembly systems grow. So look into Dyna/Pert technology, and let your productivity potential out of the bottle. Call or write Dyna/Pert Division, Emhart Corporation, Elliott Street, Beverly, Massachusetts 01915, (617) 927-4200.

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Circle 231 on reader service card

Computers & peripherals

OEMs offered bare printer

9-by-15-dot thermal print mechanism with 8049-based controller puts out graphics

Advances in printer technology at Hewlett-Packard have been available previously only in the form of finished products, either end-user packaged printers or those complete printers designated for an original-equipment manufacturer's label. Now HP is breaking that pattern by offering the model 13287A, a thermal print mechanism intended for integration into the printing systems of other firms.

The mechanism prints bidirectionally at 120 characters per second using the normal mode of 80 characters per line. With a compressed mode of 132 characters per line, it can print at 190 c/s. Although many other low-cost printers use a 5-by-7-dot character cell, the HP 13287A contains a 9-by-15-dot cell. The extra dots not only make the alphanumeric characters appear sharper, but are useful for graphics applications. The mechanism has a resolution of 90 dots/in., both horizontally and vertically, for graphics.

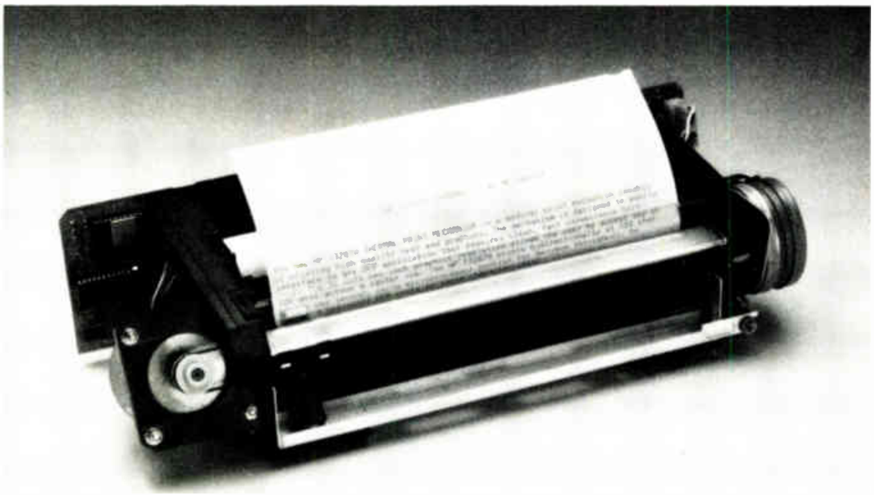
The 13287A mechanism accommodates 8.5-in.-wide black or blue thermal printing on roll paper. This paper is specially treated so that it is sensitive to the thermal variations caused by the electrical discharges at the print head. The print head is capable of producing a full 128-character ASCII set as well as creating line drawings and 64 different international characters.

The 13287A can print an 8-in. raster row, using as many as 720 dots across the row. It measures 13.9 in. wide, 5.6 in. deep, and 3.0 in. high. The mechanism weighs 3.5 lb and dissipates 23 W while printing and 3 W while idle.

Perhaps the most important part of the print mechanism, however, is the intelligent controller. The 8049-based unit, according to Bruce Brackett, marketing manager for HP's Vancouver, Wash., division, "makes the integration of the 13287A into systems a simple matter. The integration consists of adding a power supply, packaging, and an 8-bit TTL interface."

The controller is a single printed-circuit-board assembly mounted at the back of the print mechanism. It accepts commands over an 8-bit parallel interface. These commands come in hexadecimal format, as ASCII characters or as dot data over the bidirectional bus. The controller also provides status information to the host.

The U.S. list price for single



New products

quantities of the HP 13287A is $590, but since it is an OEM item, the volume discounts—which can be up to 38% at 4,000 units—are expected to apply. Deliveries are 10 weeks after receipt of order. The print mechanism, Brackett expects, will find its way into cathode-ray-tube–based systems, medical systems, data-logging applications, and automatic test equipment.

Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, Calif. 94303. Phone (415) 857-1501 [361]

General-purpose terminal bows with $465 price tag

In the race to produce the lowest cost terminal, the Alpha Star runs $465. Its maker credits the low price to marketing it directly: it is available from the firm through Visa, Mastercard, company purchase order, cash, personal check, or money order. It is also available with a free 15-day trial.

The Alpha Star's ergonomic design includes contoured matte-finish key caps, palm rests on the keyboard, a green-phosphor tilting screen that displays 24 lines of 80 characters, a diffusing nonreflective bezel, and a thin detachable keyboard. The terminal's contrast and brightness controls are on the front of the terminal.

Alpha Star displays upper and lower case characters and true descenders. It features reduced intensity, reverse video, and limited editing. The 18-lb unit includes a programmable printer port and either an RS-232-C or 20-mA current loop interface. A built-in numeric pad and three programmable keys

Price breakthrough: $499.

For a CMOS microprocessor development system.

Our new CDP18S693 costs less than any other 1802 microprocessor development system on the market. And the development system can even become your final target system.

The incredibly low $499* price includes:

- CDP18S601 computer Microboard.
- ROM/audio cassette controller Microboard.
- Five-card chassis and case.
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- Audio cassette tape I/O drive for mass storage.

You get these capabilities:

- Extended BASIC resident in ROM with full floating-point arithmetic.
- 2K-byte monitor program with extensive memory manipulation.
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Or, for $799,* you can get the CDP18S694. It has all the capability of the 693, plus:

- ROM-based 1802 Assembler/Editor.
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System expansion:

- Expand your Microboard system capability, choosing from over 40 expansion boards and hardware accessories.
- Memory expandable to full 65K bytes.
- Virtually unlimited I/O expansion capability using any combination of analog and digital I/O boards.
- Run-time BASIC 3 firmware for final system configuration.

Develop software for any 1802-based component design, or for any Microboard system in BASIC or assembly language.

At these prices you can't afford not to get into CMOS.

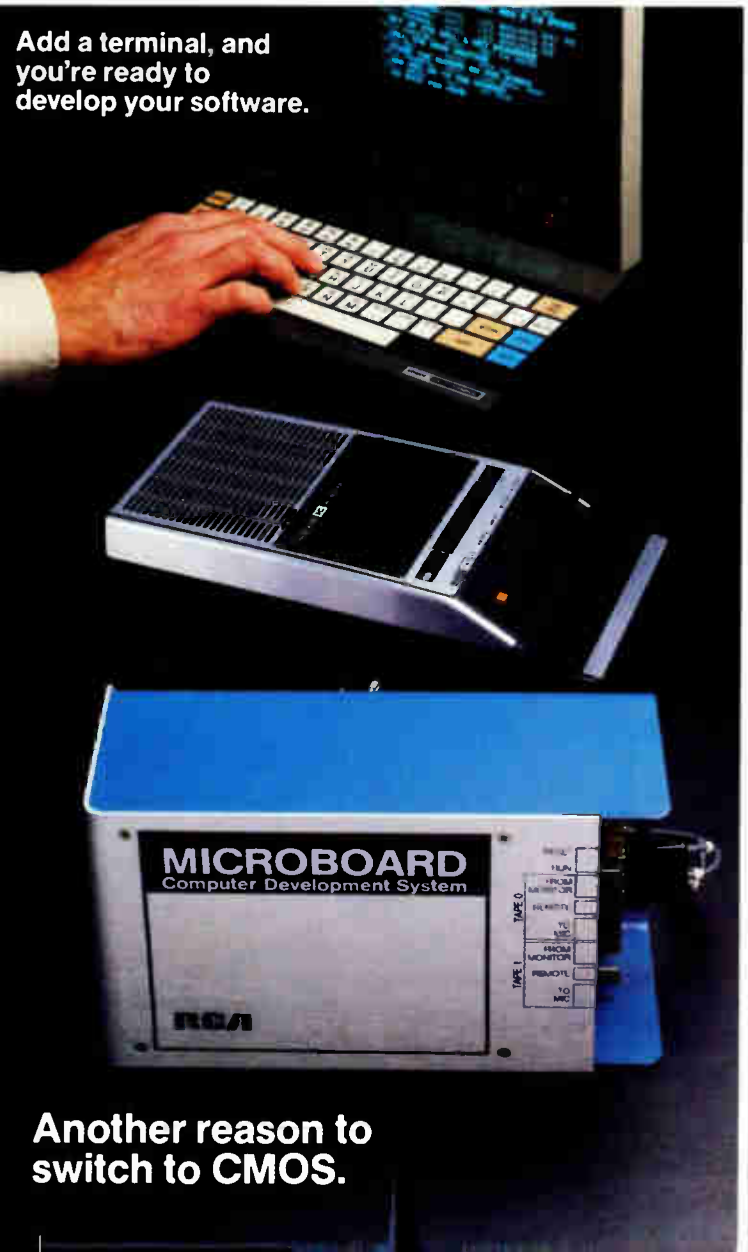
For more information, contact any RCA Solid State sales office, sales representative or distributor.

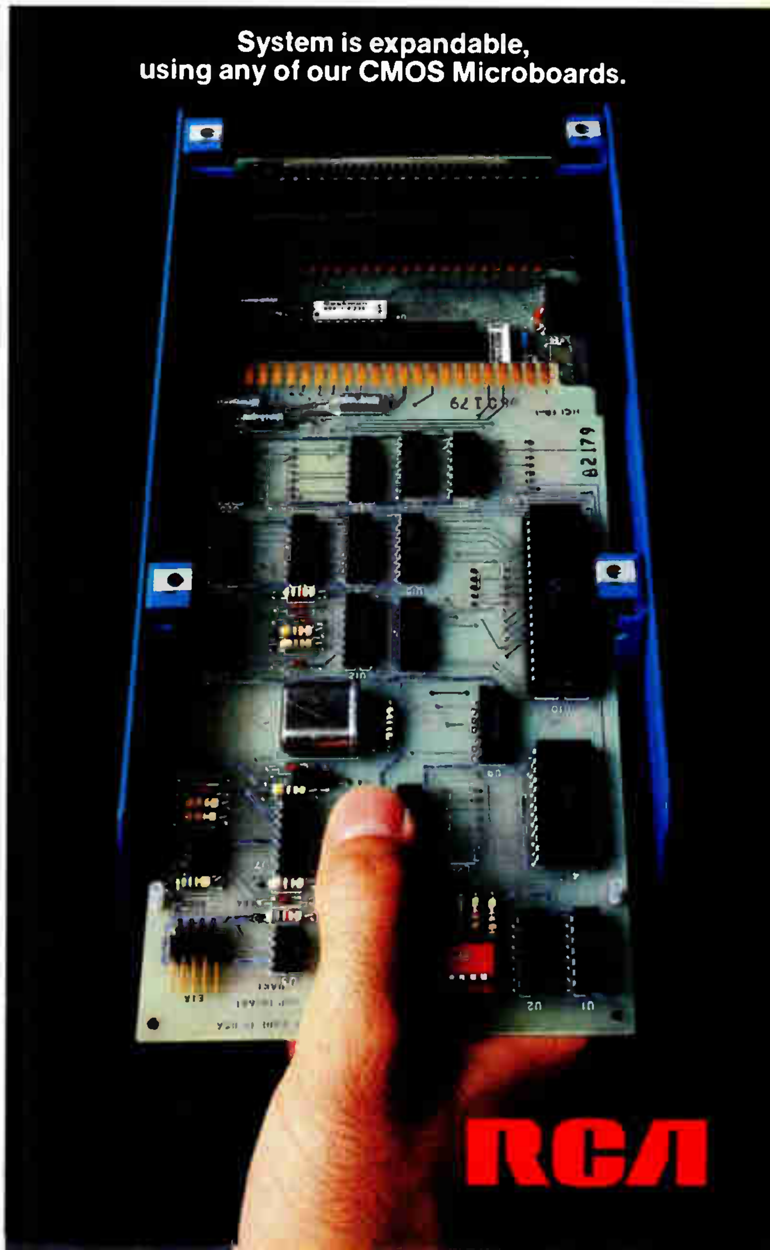
Or contact RCA Solid State headquarters in Somerville, N.J. Brussels, Belgium. Sao Paulo, Brazil. Hong Kong.

Or call Microsystems Marketing toll-free (800) 526-3862.

* U.S. optional distributor resale, single unit price.

Circle 235 on reader service card





round out the 9836A's features.

Emulog, which also produces CRTs compatible with models from Data General and Burroughs, has set up a subsidiary, Phasar, to market the Alpha Star.

Emulog, 3730 Yale Way, Fremont, Calif. 94538. Phone (415) 490-1290 [366]

Development system adds voice to computers

Adding speech output as a machine-to-man interface for almost any computer is the purpose of the VoiceWare Development System, which lets users program digitized voice vocabularies potentially large in size using disk storage.

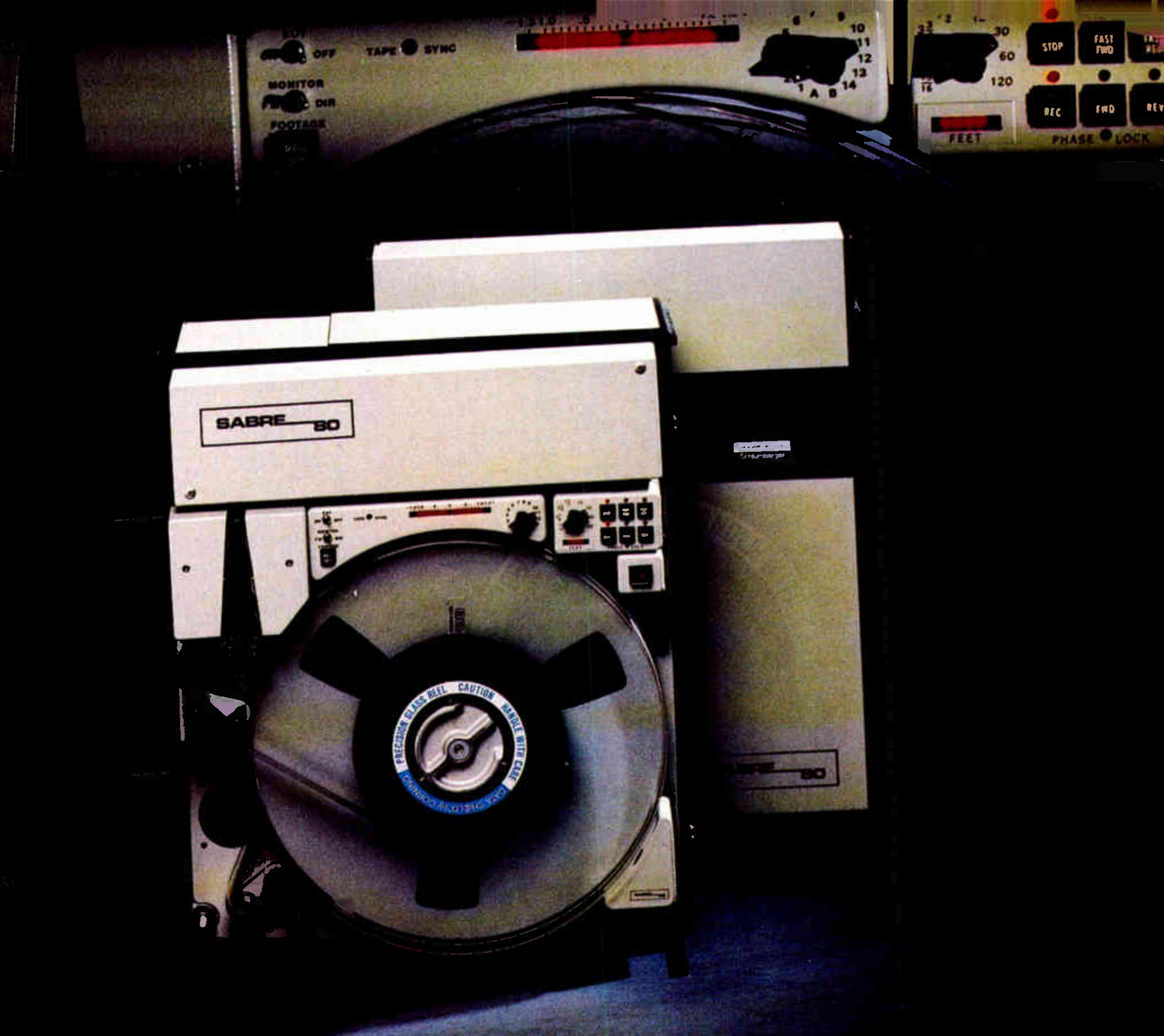
The VoiceWare system produces high-quality voice at bit rates as low as 4,800 b/s using a proprietary process for voice digitization called Parametric Waveform Coding. The basic system includes an intelligent cathode-ray-tube terminal incorporating a central processing unit with 64-K bytes of random-access memory, four RS-232-C serial interface ports with local self-testing capabilities, dual 500-K-byte 5¼-in. floppy-disk drives for digitized voice storage, a voice digitizer with microphone input, and a Lisa voice synthesizer with a speaker output. The synthesizer is housed in the VoiceWare system and is Multibus compatible.

The $25,000 system can be used to support such applications as push-button data-entry and retrieval, voice-based electronic mail, and computer-aided instruction. The system takes 90 days for delivery.

Centigram Corp., 155A Moffett Park Dr., Sunnyvale, Calif. 94086. Phone (408) 734-3222 [363]

Board turns terminal into graphics display unit

A single board, the SG100, gives graphics capabilities to the TeleVideo 950 alphanumeric display terminal. The board provides 1,225-by-240-dot resolution on the 950's 12-



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- FM bandwidth from DC to 500 kHz
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Circle 237 on reader service card

in. screen, and it has an addressable plot area of 65,536 by 65,536 dots.

The SG100 plots vector and raster graphics and handles ASCII and APL, as well as user-defined character sets. The board is compatible with such popular software packages as Tektronix Plot 10 and ISSCO's Disspla. In addition, it also has a microprocessor-based vector generator that is supported by inexpensive software.

The SG100 board also allows the 950 to be connected to hard-copy output devices through an additional specified board. For example, the 950 may be connected to a DEC LA120 printer that is equipped with an SG120R graphics board. The SG100, which is available now, sells for $1,495.

Selanar Corp., 437-A Aldo Ave., Santa Clara, Calif. 95050. Phone (408) 727-2811 [364]

Desktop unit runs Pascal, has graphics plug-in card

The HP 9836A, a desktop unit constructed similarly to the HP 9826A introduced in June 1981, is aimed for use in computer-aided–engineering and –test applications.

The 9836A has a 12-in. screen, larger than the 9826A, and extended alphanumerics and graphics capabilities, including underlining, reverse video, blinking, half-bright, and a half-shifted dot scheme that improves character legibility.

The basic unit is equipped with a 12-in. screen and dual 5¼-in. flexible-disk drives, with five options available. In addition to HP Enhanced Basic and HPL, the 9836A can handle HP standard Pascal, which includes documentation supporting Pascal and Motorola MC 68000 Assembly language source code, and four minidisks containing the system software.

An HP 98627A interface card supports a color or monochromatic external monitor for displaying graphics at a resolution of 512 by 390 picture elements. Power protection can be obtained through an

optional card with a battery that rides out momentary power glitches and generates an interrupt to the user's program if power stays down for more than a few cycles. Also available for the 9836A is a 256-K-byte random-access-memory card and VisiCalc software.

The basic system with Pascal is $15,750. Delivery is in 18 weeks.

Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, Calif. 94303 [367]

Unit serves as printer and communications terminal

Though it looks like a typewriter, the keyboard-send-and-receive model 630 KSR is really a printer that combines the print quality, reliability, and the print-wheel interchangeability features of other Diablo 630 printers with communications terminal capabilities.

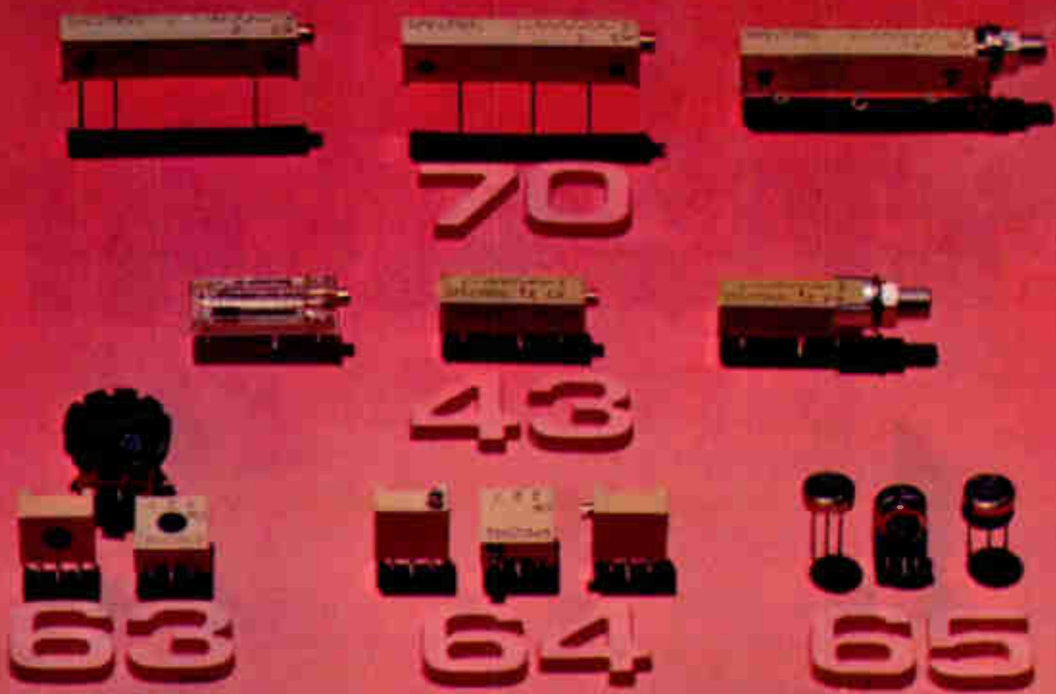
The 630 KSR has an RS-232-C serial interface, a 16-byte input buffer, an expanded 2,688-byte print buffer, word-processing firmware features, and transmission rates ranging from 110 to 9,600 b/s. As a printer, the 630 includes bottom paper feed and multipart paper printing features. Fitted with a bottom paper-feeding option, the unit prints six-part forms.

A word-processing firmware option available for the unit gives it right-margin justification, text centering, line editing, vector plotting, two-color ribbon capabilities, and other word-processing functions. Available now, the printer/terminal sells for $3,325 in large quantities.

Diablo Systems Inc., 24500 Industrial Blvd., Hayward, Calif. 94545 [368].

 Circle 41 on reader service card

Numbers You Can Count On!



Five of the Most Popular Cermet Trimmers

These five cermet trimmer models are available at your local Spectrol distributor and versatile enough to cover almost every standard trimmer application! Each of these quality trimmers features • brush wiper contact for low CRV • superior setability • excellent stability • completely sealed construction. All are competitively priced. Give us a call or send for data sheets.

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ITALY **SP Elettronica SpA** Via Carlo Pisacane 7, 20016 Pero (Milan) Italy • 35 30 241 • TELEX 330091

GERMANY **Spectrol Electronics GmbH** Oberauerstrasse 15, 8000 Munich 70 West Germany • (089) 7145096 • TELEX 52/3014

PUERTO RICO **Spectrol Caribe Corporation** Las Marias Industrial Park, Anasco, Puerto Rico • (809) 826-3012 • TELEX SCC PR 3452012

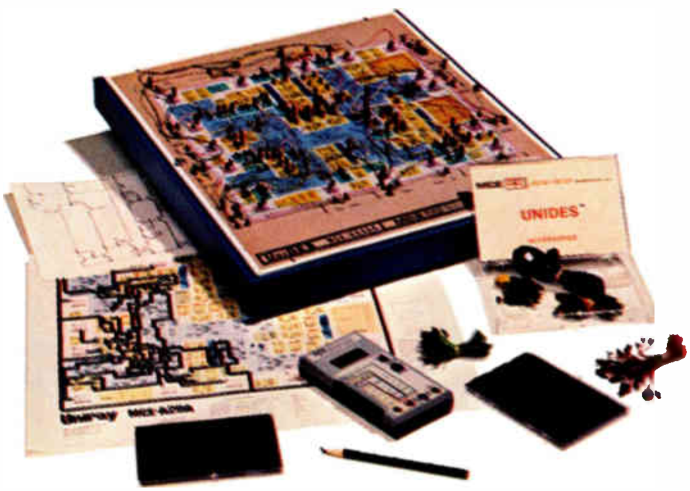
Circle 241 on reader service card

A world of infinite possibilities—from concept through wafer production to tested finished devices—is yours when you choose MCE to assist in your custom and semi-custom IC development programs. MCE also can offer you a wide range of technical services, including: design, layout, integration, wafer fabrication, and both electrical and environmental testing.

MCE MICRO-CIRCUIT™

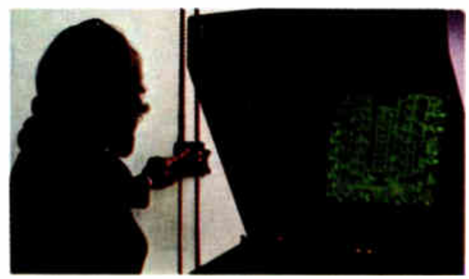
Design it

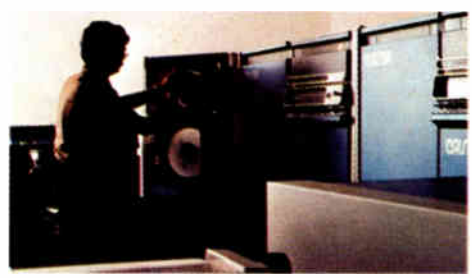
1.



MCE design aids and tools speed the economical development of your ICs by: providing the Uniray concept which contains a large number of uncommitted components on each array... offering Bipolar Linear and CMOS Gate Arrays that provide many functions... supplying convenient layout worksheets for each array... giving instructions about interconnecting components... and including kit parts and data sheets.

2.





MCE can integrate your IC designs in the shortest time possible by: providing the UniDES™ board (MCE's powerful new circuit development and evaluation system) to evaluate circuit performance, to determine interconnect errors and judge performance... circuit simulation by computer models before generating production masks... and computer-aided mask design.

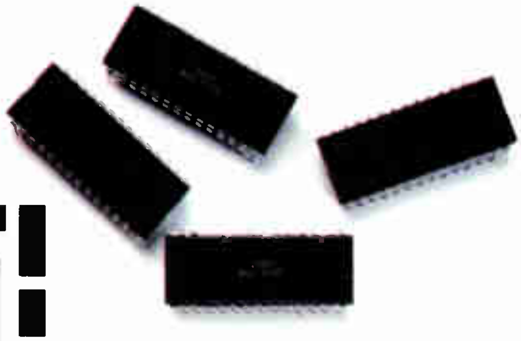
MCE's basic philosophy lets you become involved in a joint IC development program to whatever extent you desire. Our "universal array" (Uniray™) concept for semi-custom circuits gives you most of the advantages of full custom IC integration—at a fraction of the cost and turnaround. And our full custom design programs offer the lowest possible unit cost due to optimum die utilization. We're ready to serve you throughout the development and production cycle of your Bipolar and CMOS ICs, whether they're custom or semi-custom.

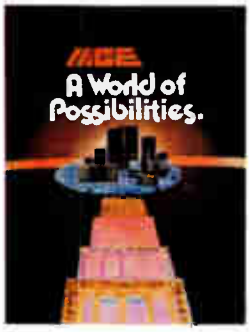
Yourself.

3.

MCE's full IC production manufacturing facilities can support you with: all the steps necessary to produce highest quality ICs... computer-aided circuit simulation, artwork and layout services... technologies for producing a wide range of products for both analog and digital functions... a variety of packaging... laser trimming on all wafers... AC and DC final unit testing... and environmental testing as required.

Circle 243 on reader service card





Gentlemen: I'm very interested in how you might be able to support and assist me in developing my integrated circuits. Please send me a copy of your new capabilities brochure **"A World of Possibilities."**

Name ______________________

Position ______________________

Company ______________________

Address ______________________

City ______________ State ________ Zip ________

Phone (   ) ______________________

MCE Design, Applications and Marketing Centers

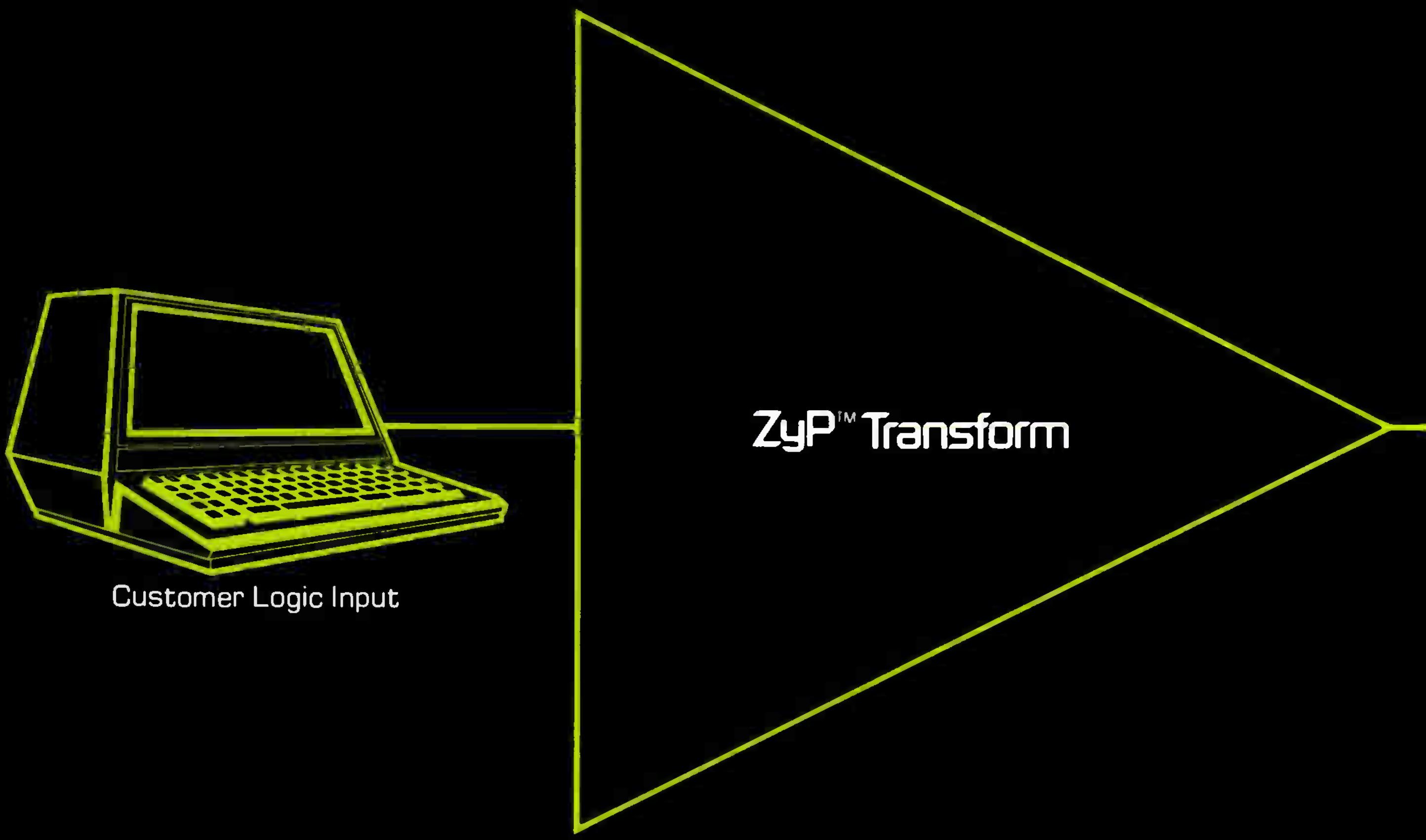
Micro-Circuit Engineering Inc., 1111 Fairfield Drive, West Palm Beach, FL 33407. Telephone (305) 845-2837, Telex 513463 (MCE NPAB).

Micro-Circuit Electronics, 1270 Oakmead Parkway, Suite 101, Sunnyvale, CA 94086. Telephone (408) 732-6090, Telex 171895 (M CELECTR SUVL).

Micro-Circuit Engineering Vertr. GmbH, Pirckheimer Str. 124, D-8500, Nürnberg, W. Germany. Telephone 0911-533993, Telex 06-22748 (SVOLKD).

Micro-Circuit Engineering Vertr. GmbH, Blumenstr. 9A, D-8013, Haar/München, W. Germany. Telephone 089-463085, Telex 05-212965 (MCEMD).

The ZyP™
The First Comprehensive CAD VLSI



Design custom MOS even if you've

ZyP™ puts you in control.

Now you or your company's logic engineers can design full custom MOS circuitry without any specialized training in silicon device physics or IC topological design. With the fully automated ZyP™ design system, you define your system logic by inputting a logic network listing into an alpha-numeric terminal right in your office. The ZyP™ Transform incorporates a logic simulator which allows you to simultaneously verify logic functionality and system timing. After verification, your logic network listing is input to a software module which routes your circuit and produces computer graphics information used to make photo masks. Then your logic simulation files are automatically transformed into a test program. You input your logic requirements—and the ZyP™ Transform does the work.

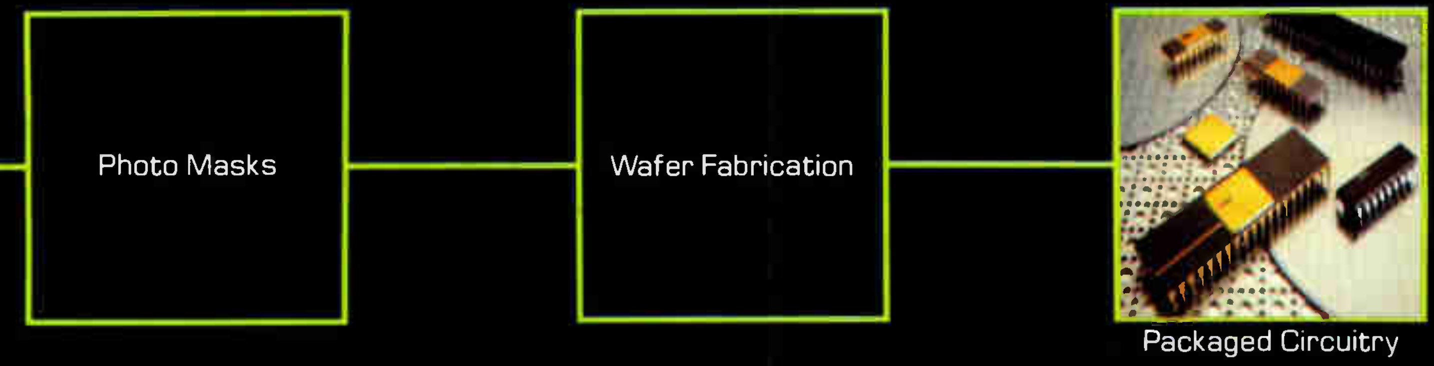
Everything you need available today.

The ZyP™ design is based on standard cells—logic building blocks that are linked together in the pattern of your choosing to form custom circuits. The ZyP™ standard cell library is the most extensive of its kind commercially available. There are three libraries, one for NMOS, Si Gate CMOS and Metal Gate CMOS processes. Over 500 elements are available in each library with more being added all the time. ZyMOS supplies you with the complete documentation necessary to design even the most complex VLSI circuitry.

Prototype circuits in as little as eight weeks.

The ZyP™ design system gives your logic engineers the tools, flexibility, and control to design exactly what you need in custom circuitry on your time schedule. Once you have the network files you can have the performance, low power consumption, high reliability, propriety and low production costs of a custom circuit in as little as eight weeks.

Transform Design System For Logic Engineers



never worked with silicon before.

The ZyP™ design system gives you the benefits of full custom while getting your products to market ahead of the competition.

ZyMOS offers total support.

ZyMOS guarantees production of all ZyP™ design system circuits in our ultra modern Silicon Valley fabrication facility. A variety of packaging options are offered. In addition to the ZyP™ design system, ZyMOS offers traditional full custom design and wafer fabrication services. Our total commitment to quality custom MOS is reflected in our new 30,000 square foot headquarters which houses the latest fabrication and test equipment. ZyMOS' highly qualified personnel are on hand to help you with design and discuss your needs. Send the attached coupon to 477 N. Mathilda Avenue, Sunnyvale, CA 94088 or call ZyMOS Marketing: (408) 730-8800.

YES, I want to ZyP™ from logic input to packaged circuitry on my schedule!

- ☐ Send me more literature!
- ☐ Have a ZyMOS representative call on me!
- ☐ I'm interested in attending a 1-day seminar on ZyP,™ please contact me!

Name________ Title________

Company________ Application________

Address________ City________

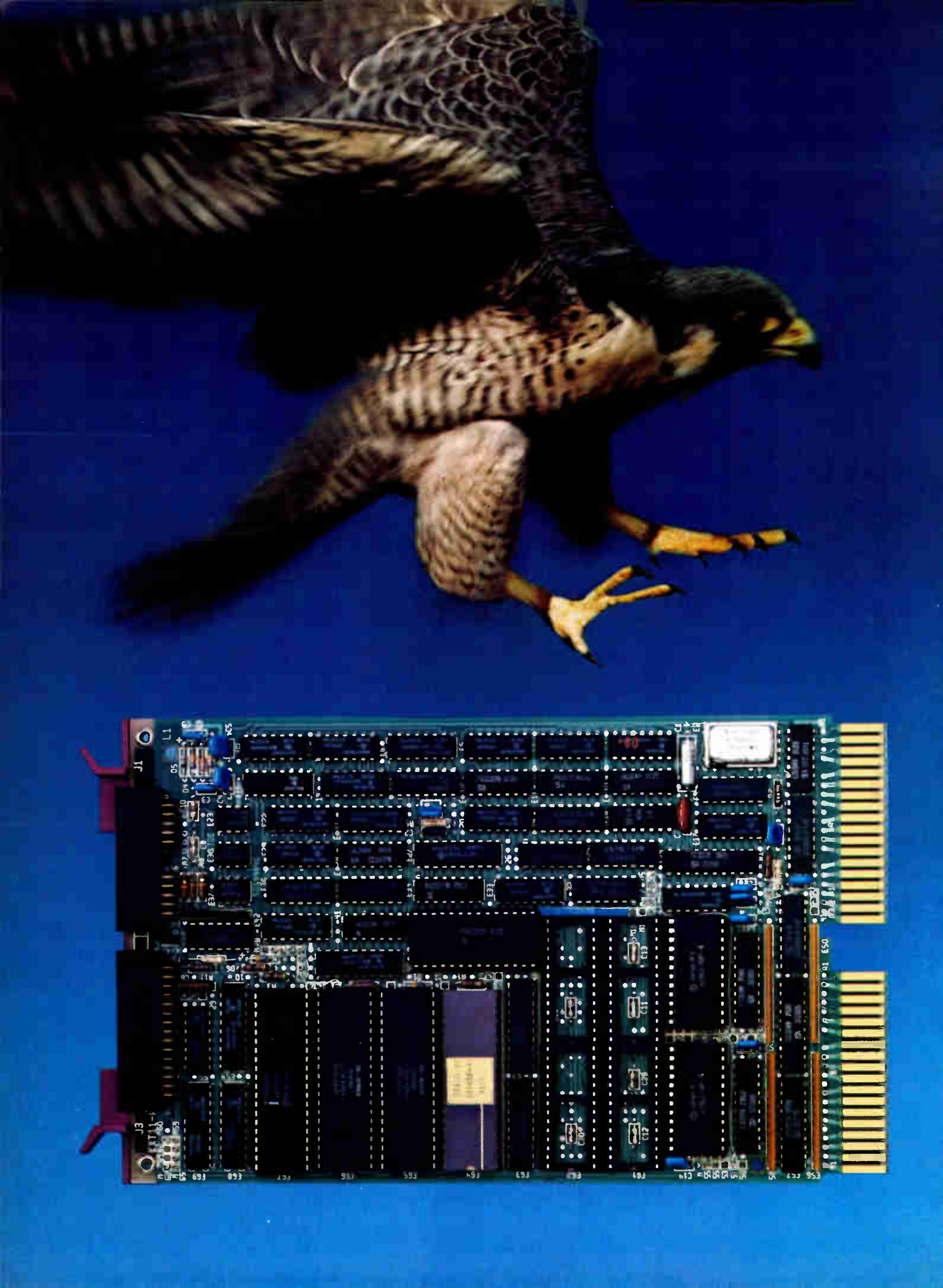
State________ Zip________ Phone________

ZyMOS

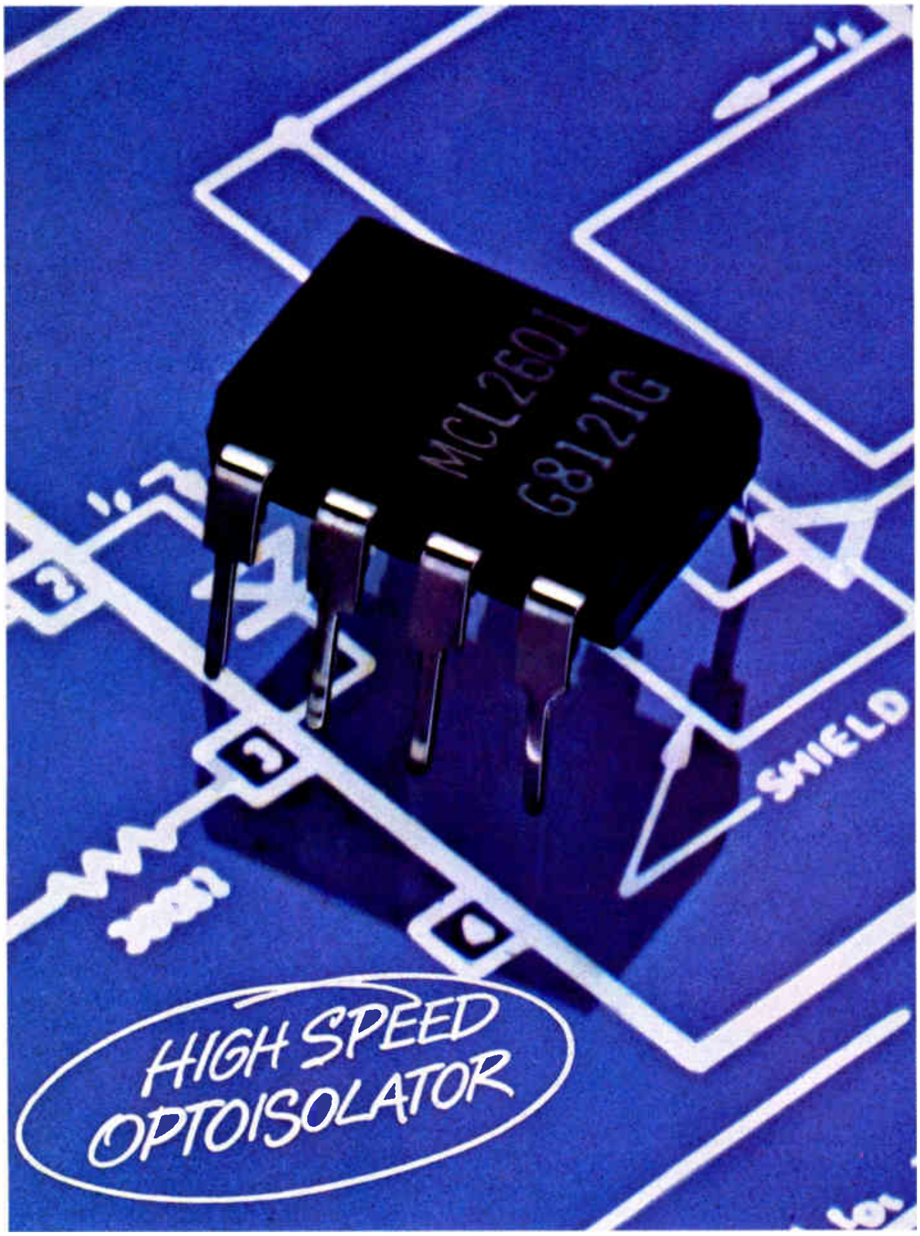
Where Silicon Solutions Are Custom Made.

ZyP™ is a trademark of ZyMOS Corporation.

Circle 245 on reader service card



By the time you've read this, it will have worked over 65 million times.



If you're an average reader, it should take you about five seconds to read the headline. Which is just long enough for our new 75ns optoisolator to finish its 65 millionth operation.

The MCL2601 is our fastest optoisolator. It's truly logic compatable without additional components and is a pin-for-pin replacement for the HCPL2601. It can be used in logic interfacing applications, as well as microprocessor systems.

And for applications that don't require the MCL2601's high common mode rejection capability, there's our high speed 6N137.

There are over 110 General Instrument optoelectronic distribution locations. Which is good to know because there are only two major 75ns optoisolator makers. And we're half of them.

For a data sheet, contact the Optoelectronics Division, General Instrument, Dept. MCD-3, 3400 Hillview Ave., Palo Alto, CA 94304. In Europe, contact General Instrument, Dendermondsesteenweg 502C, 9120 Destelbergen, Belgium.

The light heavyweight

GENERAL INSTRUMENT

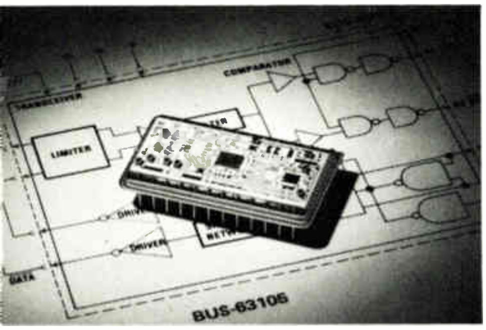
Components

1553-bus hybrid uses one active IC

Transceiver conforms to aircraft bus standard now gaining wide acceptance

Now that the military is satisfied with the present version of the aircraft data bus standard 1553, ILC Data Device Corp. is announcing a second-generation military hybrid transceiver meeting the specifications of the 1553 aircraft data bus. The BUS-63105 takes advantage of large-scale integrated circuits—all the active components are on a single chip, leading to price reductions of a third and greater reliability compared to earlier hybrid versions.

"Since finally settling on the bus standards sometime around 1978,



the military is needing ever greater numbers of these interface components," comments Steve Muth, product engineer at the company. "Not only are all new aircraft being designed with 1553 buses, but upgrades of older planes are getting the system, and it is going to be applied to tanks and ships also. Furthermore, the standard is being accepted in Europe as well."

The transceivers are required for interfacing instruments and controllers with a single shielded twisted-pair cable that cuts the bulk and cost of wiring on aircraft and allows simple upgrades of existing systems. The transceivers require two external transformers for isolation and perform Manchester encoding-decoding under a special protocol.

The receiver section accepts a phase-modulated bipolar pulse stream at its input and produces a two-phase TTL signal at its output. The unit operates with ±15-V or ±12-V power supplies. The receiver filter has been improved to reduce the error rate of the system. The circuit is packaged in a 24-pin double-width dual in-line package and is available from stock for a price of $199 in lots of 100.

ILC Data Device Corp., 105 Wilbur Place, Bohemia, N.Y. 11716. Phone (516) 567-5600 [341]

CATV chips keep noise and distortion to a minimum

Designed to operate over the 40-to-450-MHz frequency range, the CA5000 series of hybrid community-antenna–television amplifiers have a maximum interchannel modulation distortion as low as −59 dB for an output of 0.2 V and a maximum 6.5-dB noise at 450 MHz.

The series comes in three versions: the 5600 with a gain of 34 dB, and the 5100 and 5200 with 18 dB of gain. The devices operate from −20° to +100°C and may be stored between −55° and +100°C. The 5100 typically uses 180 mA at 24 V.

Available immediately, the 5100 sells for $59.15 in lots of 1 to 99, and the 5200 costs $61.15 in like quantities. Pricing and delivery for the 5600 will be available within 90 days.

TRW Semiconductors, 14520 Aviation Blvd., Lawndale, Calif. 90260. Phone (213) 679-4561 [344]

Miniature quartz crystal ages 10 ppm during first year

Measuring only 8.38 by 3.94 by 2.03 mm or about one fourth the size of an eight-pin mini dual in-line package, the CX-1 1-MHz quartz crystal is 48 times smaller than the industry-standard HC-33-packaged crystal. Its small size will find it a home in 4- and 8-bit microprocessor clock circuits, where it will occupy only 10% of the board space of conventional crystals.

Two versions are available. CX-1H is used in series (two cascaded inverters) oscillators, and the CX-1V in Pierce (single inverter) oscillators.

The units' maximum drive level is 85 μA, and the Q factor is 35,000 for the CX-1H and 100,000 for the CX-1V. Shock resistance for the devices is 1,000 g for 1 ms for ½ sine wave. Frequency stability, exclusive of calibration tolerance, is ±0.008% at 0° to 70°C. During the first year, the device ages only 10 parts per million.

The units' small size is achieved through a proprietary process in which an ultraminiature resonator is etched from a quartz wafer and fine-tuned by laser trimming. Both versions are available with leads in a low-profile, hermetically sealed ceramic package and in a leadless version. In quantities over 1,000, each is $4.55, with delivery from stock in 8 weeks.

Statek Corp., 512 North Main St., Orange, Calif. 92668. Phone (714) 639-7810 [343]

GaAs optocouplers link C-MOS ICs to power devices

Suitable for coupling low-output and complementary-MOS integrated circuits to power devices, a series of optocouplers features a current-transfer ratio of 500% and an electrical isolation rating of ±1,000 V. These couplers are useful for motor-speed controls, meters, and numerical-control systems.

Having a gallium arsenide diode as an infrared source that is optically coupled to a high-gain phototransistor, all of the optocouplers are packaged in hermetically sealed metal-can packages and operate from −55° to +125°C. Three units, the 4N47, 4N48, and 4N49, are packaged in TO-78 metal cans and are available in Jan, Jantx, and Jantxv versions. They can withstand a collector-base voltage of 45 V and a

*SA 600 disk drive photo and media platters courtesy of Shugart Associates, and head arm assembly courtesy of INFOMAG.

Literate IC's for your Winchester disk drive.

SSi's first read/write Winchester IC developed in 1976.
In 1976, Silicon Systems developed its first read/write monolithic bipolar integrated circuit for the IBM-type 3350 Winchester disk drive. Dubbed the SSI 104, it integrated all of the required read/write, control, and data protection functions on one chip in a flat pack that could be mounted directly on the head arm assembly. The SSI 104 soon became the industry standard.

Now meet the SSi family of IBM-type Winchester IC's.
Today, SSi offers a whole family of IC's for the IBM plug-compatible Winchester market. The SSI 104 and 105 read/write circuits and associated servo amplifier are available now for use with the IBM-type 3340/3350 ferrite-head series; and two new circuits, the SSI 114 and 116, are soon to be introduced for the new IBM-type 3370/3380 thin-film-head series. SSi's "literate" chips not only read and write data on the disks, but they also detect fault conditions and provide for head selection.

IC's for micro's, mini's, streamers, and tape drives too.
For the rapidly expanding 5¼-inch micro and 8-inch mini-Winchester market, Silicon Systems offers its SSI 115; and for 14-inch IBM non-compatible drives there's the SSI 108. In fact, SSi has also developed more than a dozen custom IC's for rotating memories of various designs, including floppies, streamers, and tapes. So if the exact chip you need is not already in our line—we have the technology and experience to make it for you.

☐ Please call me.
☐ Please send me product information on your SSi family of disk-drive read/write IC's.
☐ Please send me a copy of your "Custom Integrated Circuits" brochure.
If you're in a hurry, call Roger Budris at (714) 731-7110, Ext. 135.

Name ______________________

Company ______________________

Address ______________________

City __________ State __________ Zip __________

Phone ______________________

Silicon Systems incorporated
14351 Myford Road, Tustin, CA 92680

SSi Silicon Systems incorporated

collector-emitter voltage of 40 V. The maximum continuous collector current for the devices is 50 mA and the maximum continuous power dissipation (at 25°C) is 300 mW. These units may be used as either phototransistors or photodiodes.

Housed in TO-72 cans, the 3N261, 3N262, and 3N263 dissipate a maximum of 190 mW continuously. Pricing ranges from $4.50 for the 3N261 to $10.63 for the 4N48, in 100-piece quantities. Delivery takes six weeks after receipt of order.

Texas Instruments Inc., Central Literature Response Center, P. O. Box 202129, Dallas, Texas 75220 [345]

Relay isolates 8 kV dc, carries 18 A dc continuously

A small and lightweight single-pole, double-throw vacuum relay designed for power switching can carry up to 18 A at 8 kV direct current. The 1½ oz, 1.25-by-0.75-in. HC-4 has molybdenum and tungsten contacts that resist arc erosion and a ceramic envelope that allows radio-frequency applications up to 30 MHz. It operates in under 6 ms and has a 26.5 V dc nominal coil voltage for a 355-Ω coil.

The HC-4 is useful for high-power load-switching applications like radar, antenna couplers, safety interlock switches, laser welding equipment, motor or lampload switching, and switching in explosive atmo-

Circle 256 on reader service card

Circle 44 on reader service card

Circle 46 on reader service card

New products

spheres. In small quantities, the HC-4 sells for $94 each, with delivery from stock in six weeks.

Kilovac Corp., P. O. Box 4422, Santa Barbara, Calif. 93013. Phone (805) 684-4560 [346]

Unit holds both channel and signal filters

With both channel and signal filters in one package, the ST-128B and -128C 128-kHz pole-type mechanical filters are useful for carrier telephone and telecommunications applications.

The channel filter contains 10 torsional-mode resonators with four poles that permit a 0.6-ms minimum group-delay distortion. The units have a maximum insertion loss of 1 dB and 600-Ω source and load resistances. The filters operate over 0° to 50°C and may be stored from −30° to +70°C.

The mechanical signal filter incorporates four torsional-mode resonators to furnish a 120-Hz 3-dB bandwidth, a 131.8-kHz center frequency, and a 4-dB (±2 dB) minimum insertion loss. The unbalanced source and load resistances are 1.2 kΩ. In large quantities, pricing ranges from $50 to $60. Delivery takes 10 weeks after receipt of order.

Seiko Instruments Inc., 2990 West Lomita Blvd., Torrance, Calif. 90505. Phone (213) 530-3400 [347]

Unit accepts nonstandard synchro and resolver signals

A 14-bit hybrid converter translates analog synchro and resolver inputs into TTL-compatible parallel digital signals. Aimed primarily at military

applications like monitoring and control of radar antennas and artillery-fire–control systems, the SDC/RDC1740 boasts a 12 revolution-per-second tracking speed, internal signal isolation, and reference inputs up to 350 V dc.

In addition to accepting signals at three of the most common transducer voltage levels, the converter allows resistive scaling of inputs for interfacing with nonstandard synchros and resolvers.

Signal and reference input frequencies can be either 400 Hz or 2.6 kHz. The converter's step response for a 179° step settles to 1 least significant bit, or 1.3 minutes of arc, in 150 ms. The unit has three-state latched outputs that are buffered for a byte-selectable interface for microprocessor-based systems and six TTL load drives. It operates on ±15 V and +5-V power supplies, is accurate to within ±4 arc min, and consumes 1.8 W, maximum. The SDC/RDC1740 costs $530, with military screened versions retailing for $636. Delivery takes 10 weeks.

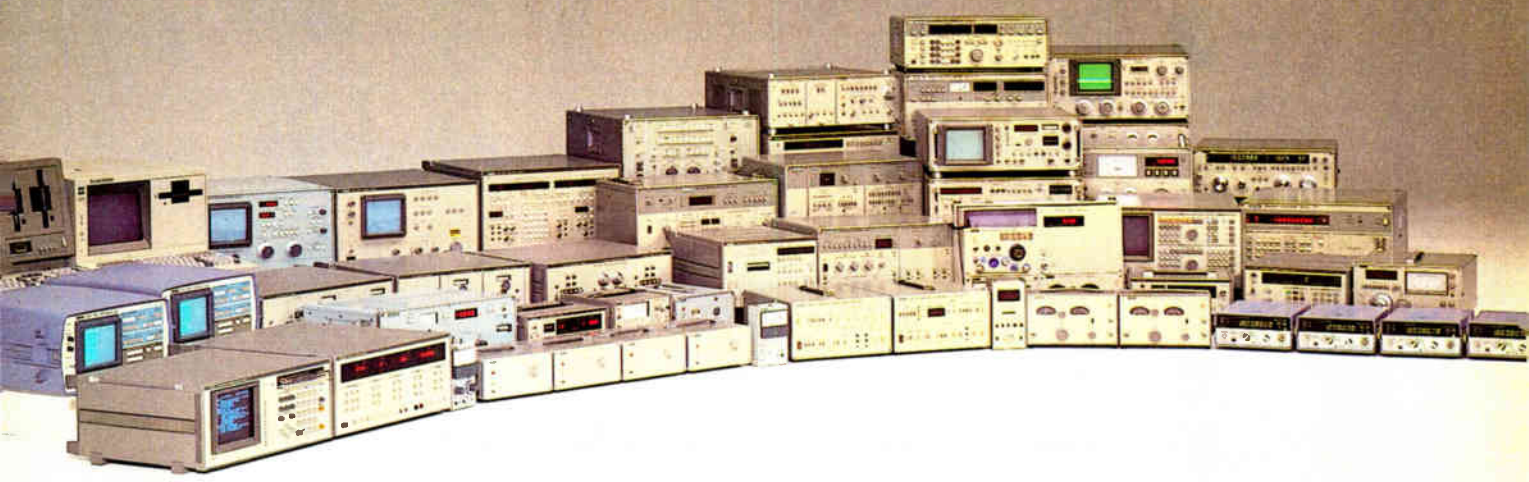
Analog Devices Inc., Route 1 Industrial Park, P. O. Box 280, Norwood, Mass. 02062. Phone (617) 329-4700 [349]

10,000-pF capacitor withstands 200°C

Providing long circuit life in temperatures as harsh as 200°C is the purpose of the ET and ETR series of capacitors. The units offer capacitance ranges of between 0.5 pF and 10,000 pF. Their insulation resistance at 25°C is greater than 100,000 MΩ, and at 200°C it is greater than 100 MΩ.

Available in axial- and radial-leaded configurations, the capacitors are for use in oil-well logging and downhole instrumentation as well as radar and microwave equipment. The devices can be ordered in a range of tolerances and values, with the average price beginning at $1.98 each.

Corning Glass Works, 3900 Electronics Dr., Raleigh, N. C. 27604. Phone (919) 876-1100 [348]



Undivided Analysis

The MS420A Network/Spectrum Analyzer from Anritsu
From the Anritsu line of superb instruments comes an analyzer that combines all the functions of a network analyzer and a spectrum analyzer—in a single, self-contained unit. The remarkable MS420A is a highly sophisticated instrument for measuring magnitude, phase, and delay characteristics, as well as for performing spectrum analysis and more. All at your command.

Precise frequency control
The MS420A covers the entire audio and RF range from 10Hz to 30MHz. And in network analysis, an internal frequency synthesizer gives you precision control to 0.01Hz, so you can analyze even high-Q resonant circuits.

Real-world signal levels
Synthesizer output is variable from −110 to +15dBm, and analyzer input can vary from −130 to +20dBm. This 150dB measuring range lets you test at actual service levels.

Razor-fine analysis
Minimum bandwidth of the MS420A is a mere 3Hz, so you can examine spurious components even in the immediate vicinity of a signal.

It's a "smart" controller, too
The MS420A can be controlled through GP-IB (IEEE-488). And with the Personal Test Automation (PTA) option, the MS420A can actually measure automatically and control peripheral devices such as automatic parts handling equipment. The plug-in bubble memory even preserves all your control settings and PTA programs for future use.

The MS420A is a total analyzer—from Anritsu's total line of measuring instruments.

Anritsu

ANRITSU ELECTRIC CO., LTD.
OVERSEAS MARKETING DIVISION
10-27, Minamiazabu 5-chome, Minato-ku, Tokyo 106, Japan
Phone (03) 446-1111/Telex: 0-242-2353
Cable: ANRITDENKI TOKYO

ANRITSU AMERICA, INC.
128 Bauer Drive, Oakland, NJ 07436, U.S.A.
Phone: 201 337-1111 Telex: 642-141 ANRITSU OKLD

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Phone: (STD0582) 418853 Telex: 826750 ANRSEU G

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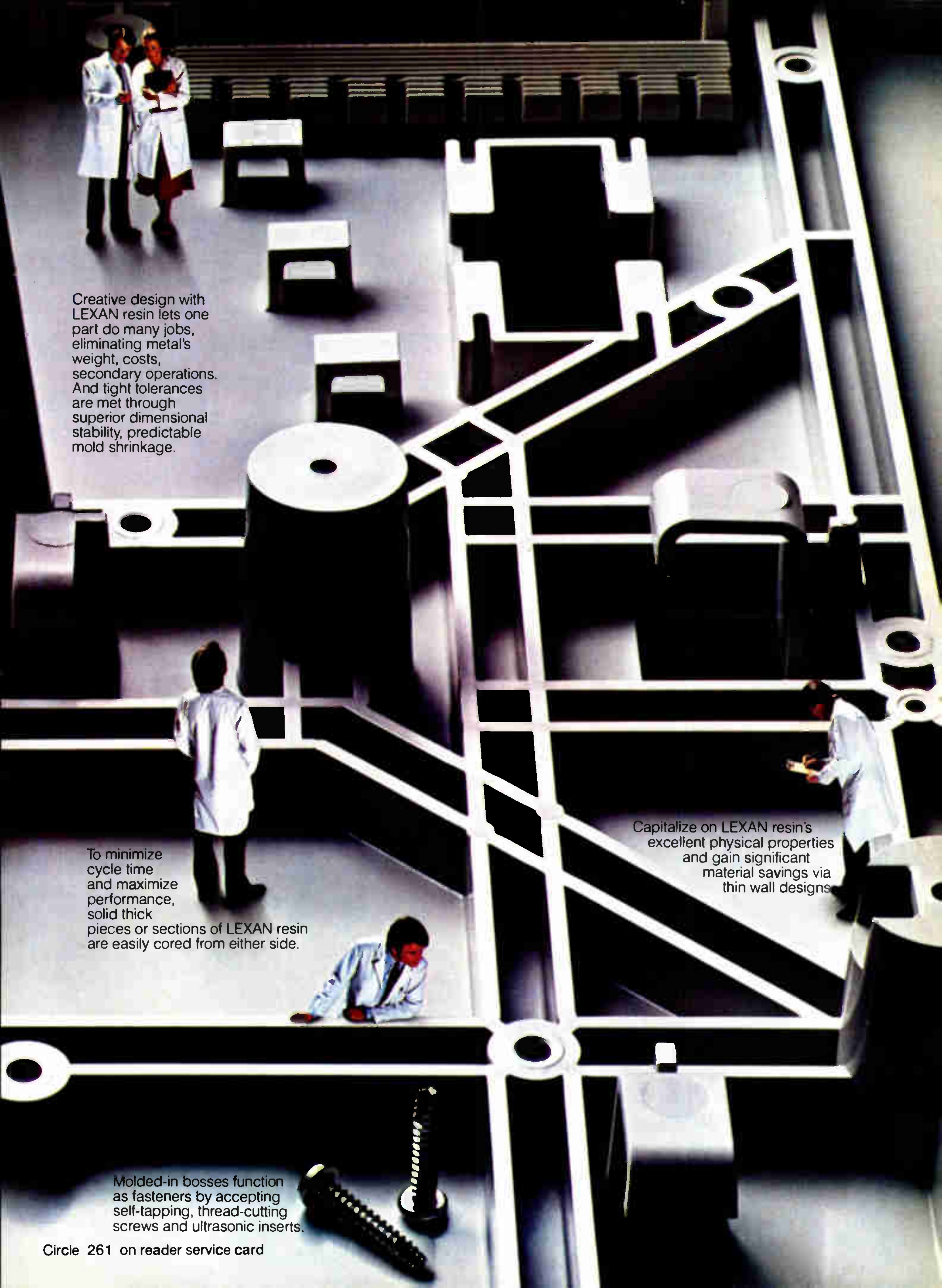
Av. Passos, 9 1-8°Ander, 20.051-Rio de Janeiro-RJ, Brasil
Phone: 221-6086, 224-9448 Telex: 2131704 ANBR

Circle 259 on reader service card

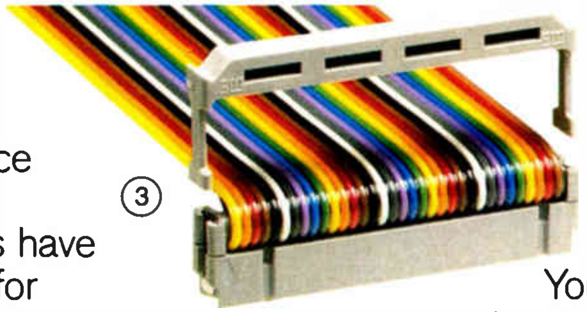

LOOK TO LEXAN® RESIN FOR THE DESIGN EDGE
Whether it's new designs or design modifications, we can help all the way. Help turn parts into systems. Help utilize solid injection molding to produce large finished parts as well as small ones. Help minimize costs while maximizing performance. Help choose the right grade, develop working prototypes, secure agency approvals. In short, we've got the experience and resources to help you see the way design can be. Call us at (413) 494-4837. Or send for our free design brochure:
LEXAN Products Division, Dept. 492, General Electric Company, One Plastics Ave., Pittsfield, MA 01201.
We bring good things to life.
GENERAL ELECTRIC
LEXAN resin's superb strength and durability mean slender snap-fit arms that resist snap-offs.
With LEXAN resin, parts that locate, align or hold components can be designed-in rather than added on.
By designing-in ribs, fillets and radiused corners, rigidity and strength are optimized while weight and costs are minimized.


Creative design with LEXAN resin lets one part do many jobs, eliminating metal's weight, costs, secondary operations. And tight tolerances are met through superior dimensional stability, predictable mold shrinkage.
To minimize cycle time and maximize performance, solid thick pieces or sections of LEXAN resin are easily cored from either side.
Capitalize on LEXAN resin's excellent physical properties and gain significant material savings via thin wall designs.
Molded-in bosses function as fasteners by accepting self-tapping, thread-cutting screws and ultrasonic inserts.
Circle 261 on reader service card

CLICK A

Scotchflex® interfaces with a positive

"Click" is the sound of decisive socket-to-header interface in Scotchflex® Brand connectors from 3M, The Source for premium mass termination systems. Sockets and headers have important design features for easier assembly and greater mechanical dependability than ever before.



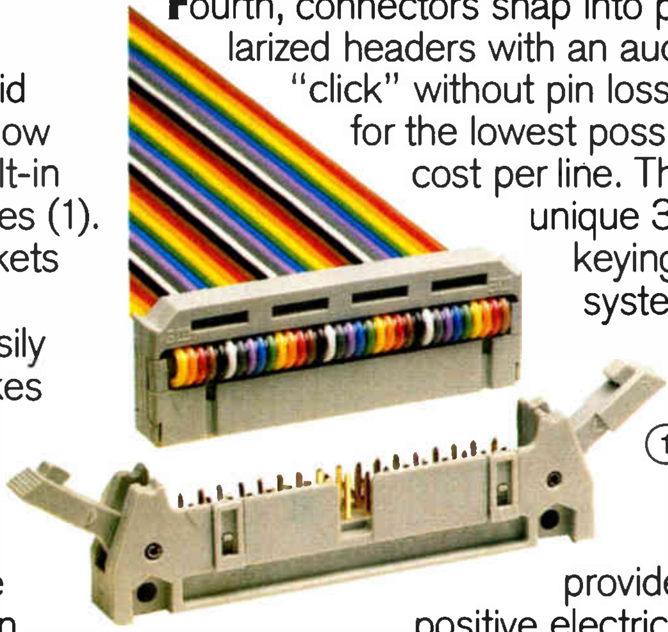
3

Third, one-piece strain relief clips (3) take fewer steps to assemble. You get higher productivity and lower inventory costs since you need only one type of socket and a supply of efficient, inexpensive clips.

2

First, Scotchflex headers (.100" x .100" grid series) now have built-in retainer/ejector latches (1). They snap up to lock sockets firmly in place. They snap down to disconnect sockets quickly and easily . . . good news where density makes access tough.

Second, mating socket connectors have designed-in metal spring clips (2) that lock the covers to the bodies for maximum cover retention The clips double cover retention strength, and let the connector be disassembled and reused if necessary.



1

Fourth, connectors snap into polarized headers with an audible "click" without pin loss, for the lowest possible cost per line. The unique 3M keying system (4) provides positive electrical polarization, prevents even a partial mismatch, and helps reduce equipment damage and field maintenance.

ND EASY.

sound for 6-way better assembly.

Fifth, 3M's patented U-contact is ultra-simple. But it's superbly functional, proven reliable in thousands of applications.

Sixth, Scotchflex Brand sockets and headers in this grid range include 10, 14, 16, 20, 26, 34, 40, 50, and 60-pin sizes. They give you the same dependable mechanical and electrical performance as other 3M components.

Long service life is a prime measurement as well; only Scotchflex products have successfully passed 40-year life-cycle testing. (Test data available on request.)

4

Click and Easy: words that describe these products' capabilities right down to the pins. Combine with off-the-shelf availability (from our

established national distributor network) and superlative technical assistance, and you can see why 3M is The Source for the very best mass termination has to offer the electronic designer. And there's one more thing.

The Sourcebook—Free

All the technical data you'll need for Scotchflex Brand mass termination products is in our complete Scotchflex catalog. It's yours free. Ask your 3M Scotchflex distributor, or write Electronic Products Division/3M, Building 225-4S, 3M Center, St. Paul, MN 55144.

"Scotchflex" is a registered trademark of 3M.

SPECIFY THE SOURCE

3M Hears You...

3M

Circle 263 on reader service card

Bare and loaded board testing takes a quantum leap forward!

with the introduction of Trace's new Series TA-9 Test Analyzer System.

From this moment on, you will have an entirely new concept of high speed board testing. You are about to discover an analytical system so advanced that its capabilities will dwarf and obsolete any you have used or known.

☐ The Trace Series TA-9.

Conceived and developed by the same people who revolutionized board testing procedures with their TA-4 and TA-5 Systems, the Series TA-9 virtually eliminates the division between tester and computer.

Through a dramatic, new design principle, the tester, itself, has been transformed into a true computer, containing both program and data memory. This significant change opens the door to a vastly broadened range in the selection and control of test algorithms. A range never possible before. And, for the first time, both bare and loaded boards may be tested at high speeds, with a system that pinpoints even the minutest areas of error.

The network program may be put into the data memory either from a known good board, uploaded from a floppy disk, or transferred in from a data processing computer. A new system of Crosspoint™ switching, originated by Trace, allows infinite variation of the matrix configuration. Instructions, based on high level, macroinstruction machine language are carried out in 2 clock cycles. The Series TA-9 requires fewer instructions to function at speed advantages of 100 to 1 and more over microprocessor controlled units.

The Series TA-9 is always at the command of the operator. Programs may be created, edited and revised quickly and easily and existing programs may be saved or incorporated into the new mode.

☐ A new era of testing evolution.

The Series TA-9 is designed to stand alone. But the use of a data processing computer, in conjunction with it, can increase its versatility even more. It will never become obsolete. Because it has been designed to become the basic system for a series of modular units, now under Trace development and testing, that will continue Trace's leadership in technological advances in the testing industry. The Series TA-9 will grow in its capabilities to meet your expanding needs.

☐ Before you invest – investigate Trace

If you are considering a new testing system, it will pay you to look into Trace and the new Series TA-9. Because Trace is the acknowledged leader and innovator in the field.

After all, you'll have to work with the system you choose, for a long, long time!

Write, wire or phone for the complete TA-9 story!

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Take Anywhere Tape Recorders

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- DC to 60 kHz frequency range
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- Differential tape drive, phase locked to internal crystal reference. Ensures ultra dependable bench and mobile use
- 5 hours continuous operation from self-contained Battery Pack
- Optional plug-in Mains Adapter/Battery Charger
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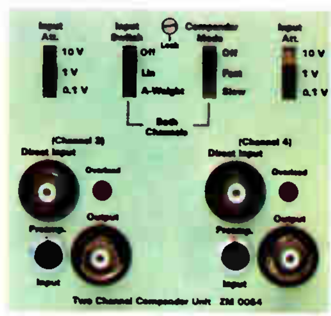

Plug-In Two Channel Compander Unit for automatic level regulation plus effective dynamic range of over 70 dB. Each channel includes Direct and Microphone Preamplifier Inputs, supplemented by "Lin" and "A" weighted input modes

See for yourself. Call or write today for a demonstration or additional information.

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40 chara. 2 Lines

5 x 7 DOT MATRIX ALPHA-NUMERIC

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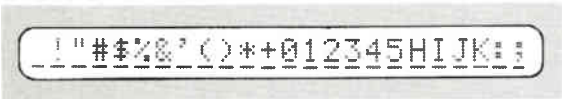
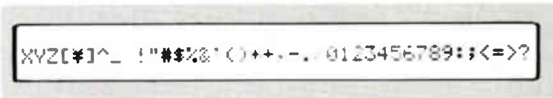
- Reliability under stringent temperature ranges.
- Compatible interface with TTL and CMOS
- CMOS-level compatible, consequently 8-bit parallel outputs from a microcomputer can be easily connected.
- 128 row characters can be on display.
- +5V ~ 7V single power supply.

Now SHARP makes the readout easier to see and greater versatility available by adding 40 and 80 alpha-numeric Dot Matrix Display Unit with 5 x 7 dot.

LM-24102



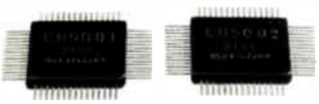
LM-40101



LM-80101

Driver ICs also available.

LH-5001
LH-5002
LH-5003
LH-5004



Dot Matrix LCD Drivers.

SHARP'S 5x7 DOT MATRIX LCD UNITs.

Parameter	Character number (character x line)	Unit outline WxHxD (mm)	Character size WxH (mm)	Supply Voltage (V)
* LM-06151	6 Character. 1 Line	60x40 x14.5	4.8x7.5	+5,
* LM-14151	14 Character. 1 Line	93x47 x13.5	2.65x3.75	+5,
LM-24102	24 Character. 1 Line	175x46 x12	3.3x5.05	+5, −5
* LM-24151	24 Character. 1 Line	174x51 x13.5	3.3x5.05	+5,
LM-40101	40 Character. 1 Line	175x45.4x15	2.32x3.28	+5, −5
* LM-40151	40 Character. 1 Line	177x46 x13.5	2.32x3.28	+5, −5
LM-40201	40 Character. 2 Lines	230x50 x15	3.4x4.8	+5, −5
LM-80101	80 Character. 1 Line	310x90 x12	2.32x3.28	7V−13.5V

*Character generator built-in.
•All types (except LM-06151) can display cursor line (5 dots)

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International Division
Electronic Components Sales Dept.
22-22, Nagaike-cho, Abeno-ku, Osaka 545, JAPAN
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Tel: (201) 265-5600 For further information,
Contact: Mr. M. Miyagawa

EUROPE: SHARP ELECTRONICS (EUROPE) GMBH
Sonninstraße 3, 2000 Hamburg 1, F.R. Germany
Tel: (040) 28511 Attention: Mr. Y. Goto

Power supplies

Lab supply is modular

One to four outputs under external control can grow as load demands increase

The Programmable Power Unit is a modular test-laboratory supply with one, two, three, or four outputs that are individually under the control of a computer or terminal through an IEEE-488 or RS-232-C link. The outputs can be any combination of three types— ±5 V maximum at 12 A, ±18 V at 10 A, or ±32 V at 3.5 A—and expansion modules allow larger loads to be carried.

The unit can run automatically without requiring system monitoring, shutting itself down when overload setpoints are exceeded. But each output's setpoints (nominal voltage and voltage and current limits) must originate from the controller. Thus little possibility remains that changes from the programmed cycle occur accidentally. Buttons on the unit's front panel control only input selection to the digital meter and connection to the ac power line.

The user can slew from one output to another during programmed testing over some chosen voltage range, and available outputs can be combined in any configuration. The controlling computer can record the levels of each output automatically. The user can monitor current or voltage levels on the unit's panel meter or on a terminal screen to spot problems before catastrophic failure causes shutdown.

A fault-delay feature of the unit can also be programmed by the user to mask the overload program for a period of 0 to 199 μs when the unit is powered up. This is necessary to avoid automatic shutdown due to the momentary power surge that often occurs at that time.

Modular expansion, particularly useful at burn-in testing sites, allows the ±5-V output, for instance, to be inceased to 72, 132, or (with four expansion modules) 252 A. At ±18V, outputs could grow to 35, 60, 85, or 110 A; at ±32 V, 30, 43.5, or 57 A can be had.

The price for a single-output unit is $4,380. For two outputs the price is $5,130, for three it is $5,880, and with four outputs, $6,630. Delivery is in 60 days. Price and delivery are not yet available for the expansion modules.

Carlton Industries Inc., 22661 Lambert, Unit 207, El Toro, Calif. 92630. Phone (714) 770-7846 [381]

Fan-cooled switcher offers variety of outputs

Power supplies having one to four outputs, with one that provides two high-current output channels of 400 W each, are offered in the RSF series of fan-cooled switching regulated supplies. The RSF500 single-output models range from 2 to 28 V dc, having output currents from 100 to 18 A. Multiple-output units have additional outputs from 5 to 28 V for currents ranging from 20 to 2 A.

The RSF100 series are dual-output models offering a combination of any two voltages from 2 to 28 V at currents from 14 to 80 A. The total power output is limited to 500 W.

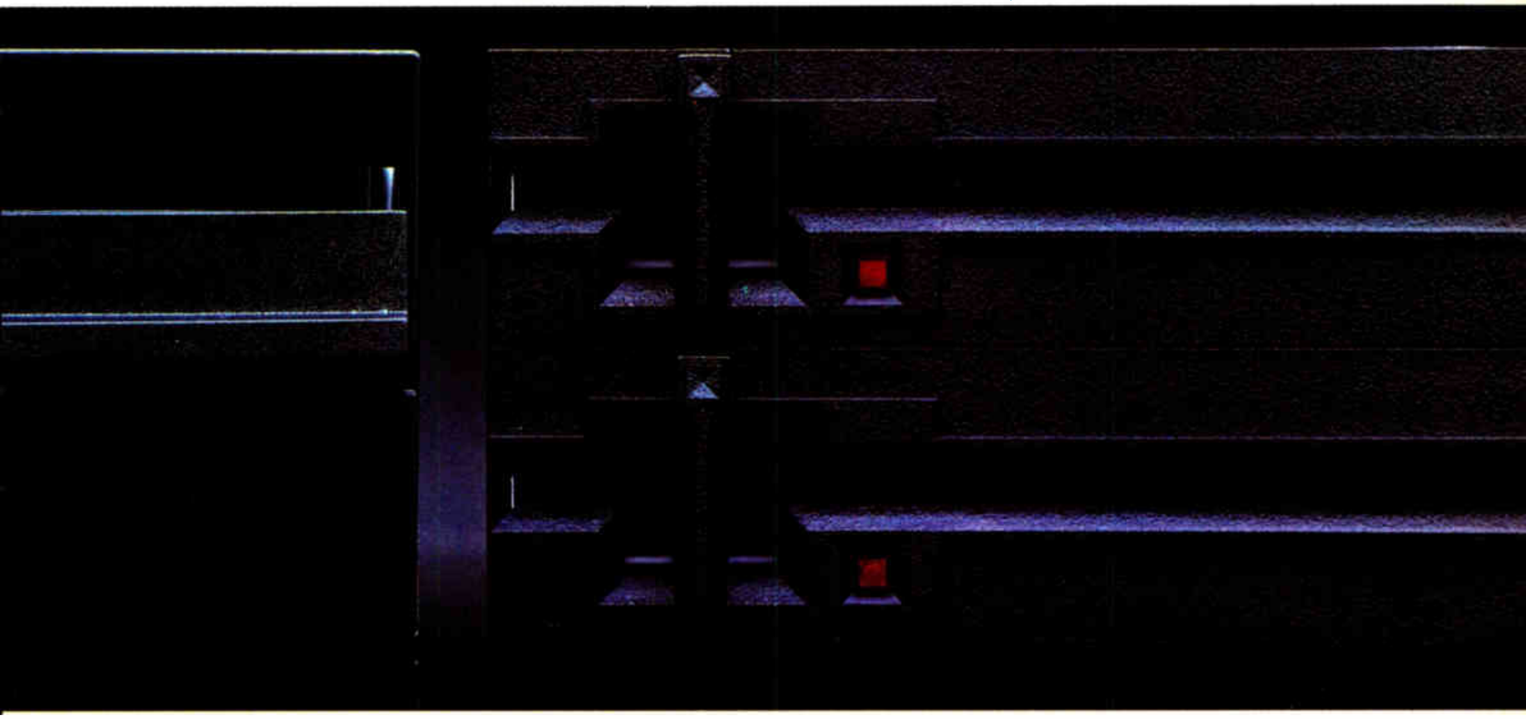
Standard features include overvoltage protection on all outputs, foldback current limiting, and short-circuit protection. A 115-/230-V ac selector switch is standard, along with electronic soft start and overtemperature protection that automatically resets when the unit returns to the normal operating temperature. A full output is obtained up to 50°C, derating to 70% at 71°C.

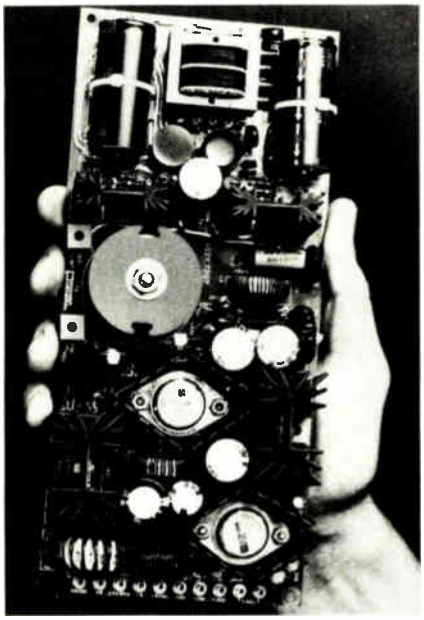
Single-output units are available now; multiple-output orders will be taken during the first quarter, with delivery six to eight weeks after receipt of order. Single-output models begin at $575 each and quads sell for $745.

ACDC Electronics, 401 Jones Rd., Oceanside, Calif. 92054. Phone (714) 757-1880 [384]

100-W single-board supply puts out ±5, ±12, and 30 V

The 5100 series of 100-W switching power supplies, built on printed-circuit boards for disk drives, printers, and terminals, offers up to five output voltages. Of the four models





in the series, the 5100-1, for example, produces outputs of +5 V dc at 10 A, −5 V dc at 1 A, +12 and −12 V dc at 1.5 A, and a selectable 12 to 30 V dc at 0.4 to 1.0 A.

The power-supply input offers switchable voltage ranges of either 85 to 130 V ac or 170 to 250 V ac, at 47 to 470 Hz. A full rated output is provided over an ambient temperature range of 0° to 40°C with a 2%/°C derating up to 71°C.

The units in the 5100 series offer line regulation of ±0.1%, load regulation of ±0.2%, and a transient response of 300 μs to within 1% of the final value. The supplies offer input-to-output isolation of 1,200 V ac and an input surge current of 15 A. The units feature convection cooling, which requires no external heat sinking. Each supply sells for $179, with delivery four weeks after receipt of order.

Power General, 152 Will Dr., Canton, Mass. 02021. Phone (617) 828-6216 [383]

Uninterruptable supply allows 1.5-h holdup time

Designed for computer systems with Winchester disk drives, the EHV-150 is an uninterruptable dc power supply providing a total available power of 400 W. Standard outputs are 5 V at 25 A and 24 V at 9 A. Also included are three other fully regulated outputs tailored to specific user requirements.

The EVH-150 provides glitch-free transfers to onboard battery power in the event of ac line loss. The onboard battery pack allows holdup times of 8 minutes to 1.5 hours depending on the load. Longer holdup times are available with the addition of an optional battery pack.

The EVH-150 includes delayed shutdown and startup logic, as well as TTL-compatible signals that indicate battery failure, ac line loss, low battery, and overtemperature conditions. The supply occupies 5¼ in. in a 19-in. rack, requiring 15 in. of depth to include all connectors and cables. In large quantities, the unit sells for $875, with delivery from stock to six weeks.

EHV Systems Inc., 226 Terminal Rd., Setauket, N. Y. 11733. Phone (516) 751-6066 [385]

Protector acts as line conditioner, backup supply

Combining in one unit the functions of line conditioners and uninterruptable power systems are the DLP-8 and -12 models of the Switch Mode line of protectors, which provide protection against noise, brownouts, and blackouts. All power conversion and control functions for these protectors are carried out at frequencies higher than the 50-/60-Hz line frequencies, thus eliminating heavy and expensive line-frequency magnetic chokes and transformers.

The DLP-8 can handle computer ac load requirements up to 1.0 kVA, and the -12 can handle up to 1.5 kVA. Both units have integral sealed batteries capable of a minimum of 5 minutes operation at full power in the event of a complete failure.

The line protectors can operate from a center voltage of 115 V ac or 230 V ac and have a frequency range of 25 to 500 Hz. The output voltage and frequency may be set at the factory to any standard level. Frequency is maintained to better than ±1%, and voltage is regulated to ±5% over the full output range, with load factors ranging from 0.5 leading to 0.5 lagging. The DLP-8 sells for $2,995 and the -12 for $3,995, with delivery 10 weeks after receipt of order.

Displex Inc., 21 Brewster St., Glen Cove, N. Y. 11542. Phone (516) 671-8900 [386]

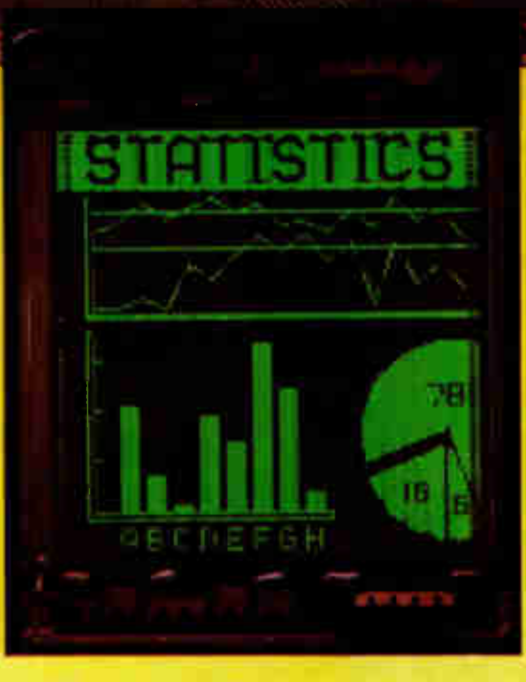
Unit provides up to 4,000 W of ac backup power

Responding instantly to brownouts, blackouts, or temporary local power failures, Tripp-Lite's Insta-Power can produce 117 V ac from batteries. Available in 200-to-4,000-W models, the standby power system features an automatic, heavy-duty regulated battery charger and load-transfer switch, square-wave inverters, and full ac-line isolation.

Some models feature circuit-breaker protection on the dc line and status indicators with a test switch. Usable with solar- and wind-power systems, the standby power supply may be hooked up to cash registers, communication equipment, cable-television systems, test equipment, and emergency lighting. Pricing begins at $199 each for the 200-W models, with the 4,000-W version going for $1,650. Quantity discounts are available. Delivery is from stock.

Singer Products Co., 875 Merrick Ave., Westbury, N. Y. 11590. Phone (516) 333-2000 [388]

High-clarity. One way itron fluorescents will brighten your displays' future.



The brilliance and conciseness of our new high density 128 x 128 and 256 x 64 dot matrix display panels—made possible by our advanced double-matrix structure—exemplify the wealth of benefits afforded by "itron" fluorescent units. Let's enumerate some of the other reasons they'll enhance your designs' future.

Take alphanumerics. As the inventors of fluorescent technology, we naturally offer the widest selection of 14-segment and dot matrix arrays—from 5 mm to 15 mm in character heights, and packages ranging from 14-segment 8-character mini-units to complete 240 character 5x7 dot matrix plug-in panels, and everywhere in-between.

Their proven performance record, combine with cost-conscious pricing and ease of installation to make for time and money savings. And, their easy readability—even under high ambient light conditions and at extreme viewing angles—as well as low power requirements, are other good reasons why "itron" flourescent displays will embellish your equipments' capabilities. As there're many more things to be said for "itron" fluorescent displays, contact us for particulars.

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MicroSpell works with your word processor. And if you have the best word processing system, why settle for anything less than the *best* spelling corrector?

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Other spelling programs function primarily as spelling checkers, merely pointing out words with suspect spelling. It's left up to you to determine the correct spelling and then type it in.

MicroSpell, the only spelling program that knows how to "spell," corrects the error automatically. Here's how it works: MicroSpell will read your text, carefully looking for words that might be spelled incorrectly. When it comes across a word that it's not absolutely sure of, it stops and shows you that word, along with its context. Then it searches through its own built-in dictionary and presents a list of guesses which it "thinks" might be correct. All you have to do is press a key and the misspelled word is corrected. There is no need to bother with your own dictionary, or even to type in the change. MicroSpell will do it all for you!

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MicroSpell uses word stems and suffix stripping routines, so its dictionary of 25,000 word-parts can deliver over 150,000 words to you. And if that's not enough, MicroSpell will let you add thousands of additional words, so you can create and store specialized dictionaries of technical terms, unusual expressions, even acronyms. And you can let MicroSpell know just when any of these special dictionaries are wanted.

MicroSpell is highly interactive and designed to complement word processing systems that create ASCII text using a CP/M® compatible operating system. It requires minimum disk storage capacity of 70K per drive.

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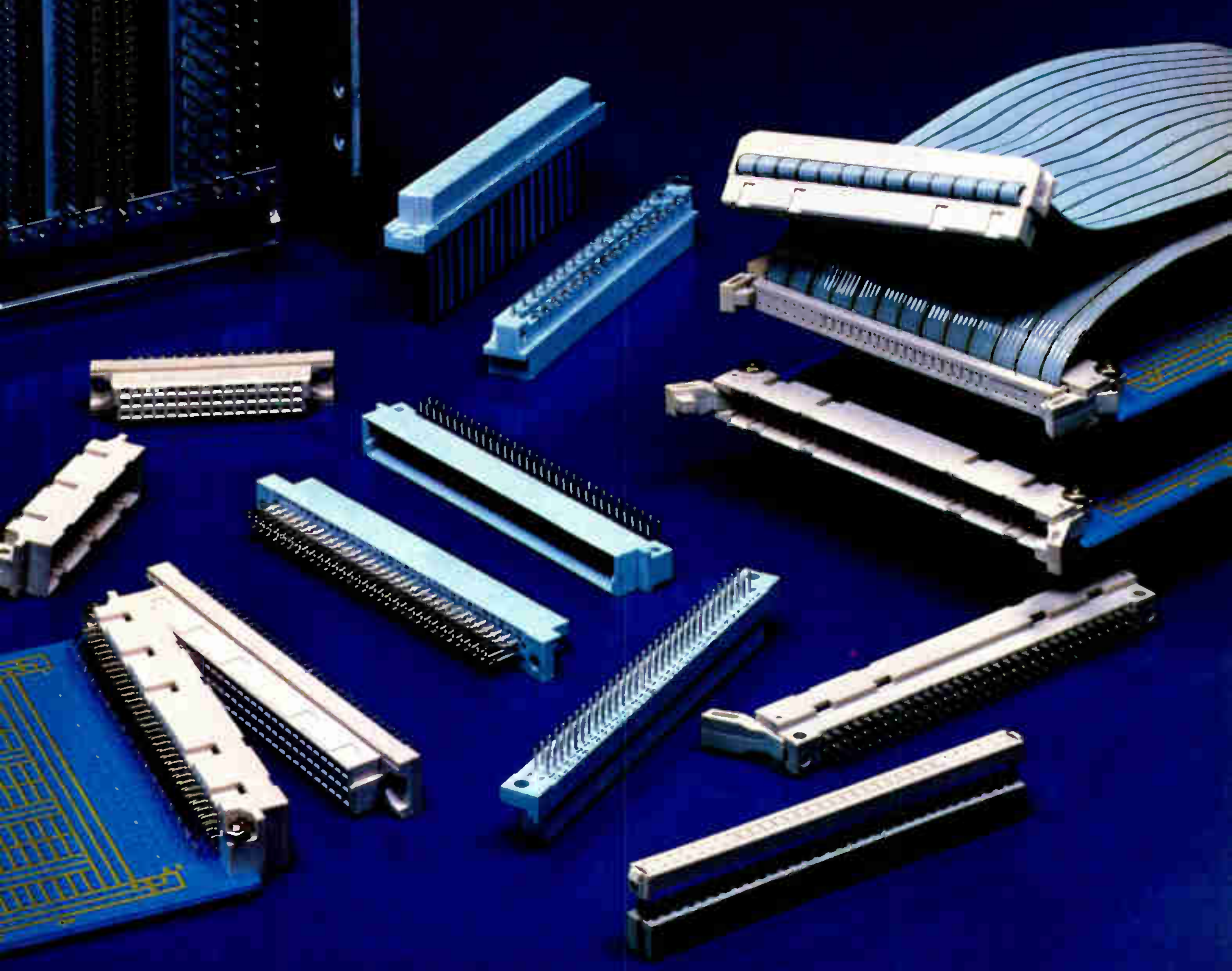

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For some odd reason, computers have always been faster than the companies they come from.

In fact, it now takes one outfit we know of, eighteen months to deliver almost anything you order from them.

A wait that could make anyone with intentions of starting a hot new computer company (or finishing a hot new project at work in a hurry) decidedly lukewarm about the whole idea.

Which is why we've made arrangements for you to get our new MPT/100 from our stocking industrial distributors: Schweber, Hall-Mark, Kierulff, Almac/Stroum and in Canada, R.A.E. Or from our manufacturer's representatives listed below.*

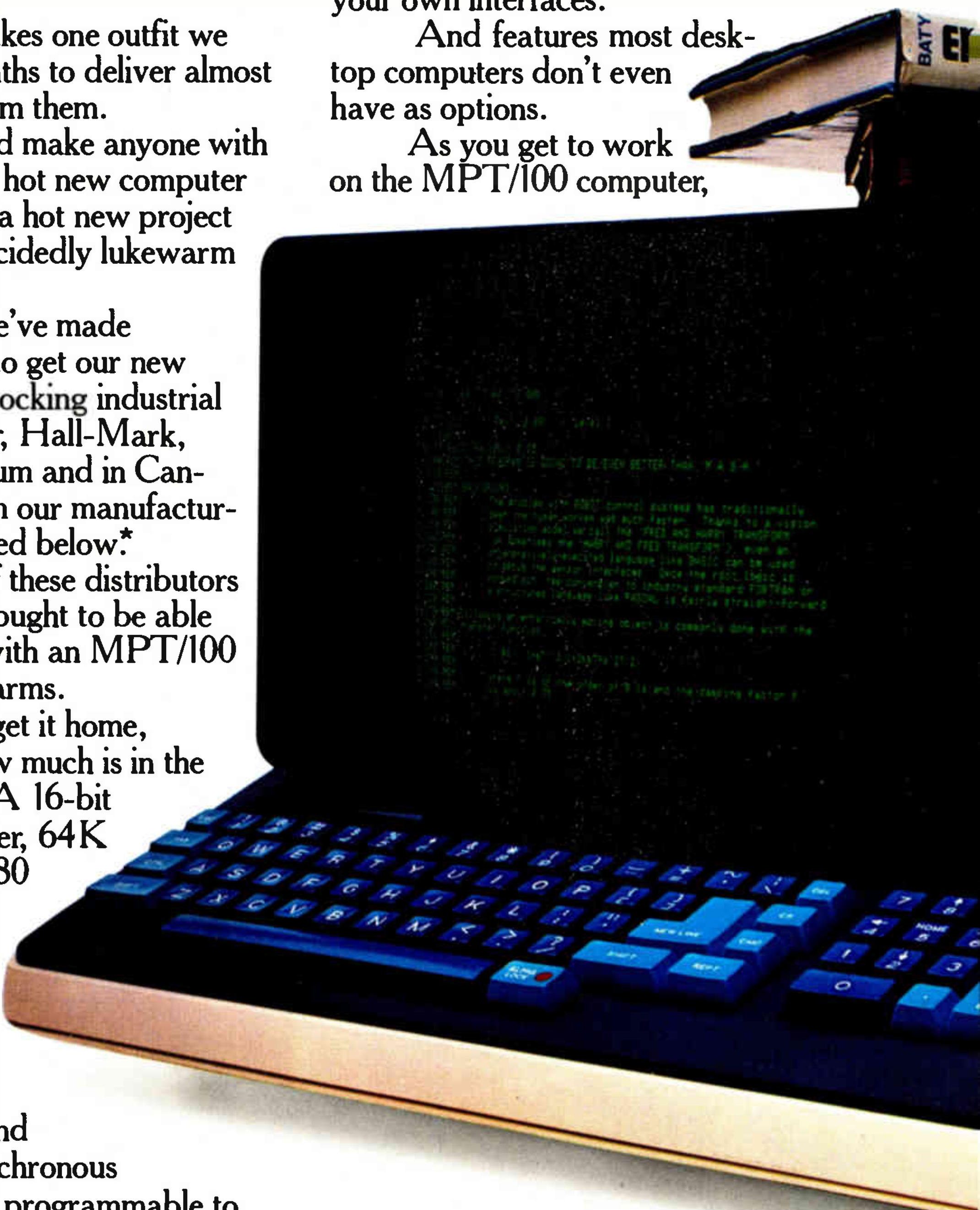
Walk into any of these distributors any morning and you ought to be able to walk out the door with an MPT/100 computer under your arms.

And when you get it home, you'll discover just how much is in the MPT/100 computer. A 16-bit microNOVA® computer, 64K bytes of memory. An 80 column by 24 line screen. Full keyboard with numeric pad. 716 KB of on-line storage on 358 KB minidiskettes.

Out back you'll find two synchronous/asynchronous communications ports programmable to 19.2K baud. And an I/O bus that accepts microNOVA® peripherals, including Data General Winchester-type disks, as well as your own interfaces.

And features most desktop computers don't even have as options.

As you get to work on the MPT/100 computer,



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You may be wondering why we are making such a big deal over software.

For the simple reason that at this point, it is costing a good deal more to get a computer programmed than it is to get the computer.

If such thinking still seems somewhat alien to you, allow us to tell you a story about how a very successful systems house came to do business with us.

They assigned two teams to the same laboratory instrumentation project using a computer company and a semiconductor company.

The team that used Data General finished the project in four months. And went into production. The team using the semiconductor company finished in seven months. And immediately updated their resumés.

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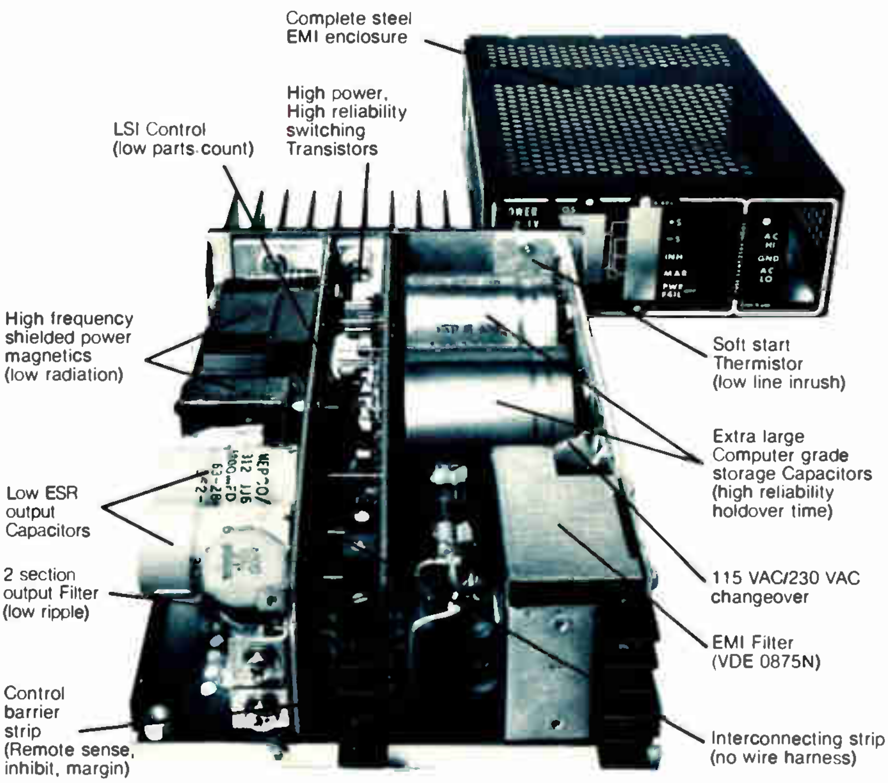
We take care of our own.

Circle 55 on reader service card

Three Interconnecting modules, no hard wiring and you get the Switching Power Supply of the 80's

Customer: What's the significance of the 3 modules?
ACDC Salesman: In the past, everybody including ACDC produced specific switchers for given applications. You know, assemble the components in a box, wire them and then tweak and test and trim, etc. In our RS/RT switchers, we produce large quantities of three basic modules, and then test the daylights out of them, followed by full load, high temp burn-in.
Customer: What modules are you talking about and how do they work?
ACDC Salesman: O.K., we produce input modules, converter modules and output modules. We have 16 different board modules that make up 50 different power supplies. We take various combinations out of stock and assemble them in a chassis, interconnecting them through a mother board. It's fast, reliable, and it eliminates hard wiring.
Customer: I see, you can make up most any switcher I could want right out of stock. You say no hard wiring...what's wrong with wiring?
ACDC Salesman: Harnesses are a point of potential failure. There are possible cold solder joints vulnerable to everything including shipping vibration, not to mention noise considerations in how the harnesses are placed throughout. No one has ever successfully introduced a switching supply without hard wiring until our RS/RT Series.
Customer: When you say you test the daylights out of them, give me some details.
ACDC Salesman: O.K. First, all of our active devices are 100% screened. We stable bake, temperature cycle, and then 100% electrical test. All to MIL-STD-883B. The modules themselves are computer tested. When we assemble them into the final unit, we first Auto-Test, then burn-in for 48 hours at 50°C under full load, cycled, Auto-Test again with computer print out- serialized. You get one copy of the hard test data and we keep a copy. In other words we all know exactly what you're getting.
Customer: Everything sounds good, but what about the cost?
ACDC Salesman: Simple. We save you money because instead of building a hundred of these and fifty of those, etc., we continuously build thousands of the same modules each month. That saves us, and you, money. We test everything thoroughly and that eliminates warranty returns, reworks and all those costly problems. Believe me, if you've ever seen the production of power supplies, you'd know we have a uniquely superior product here...and, at a fantastically low price.
Customer: It sounds to me like you've brought power supply technology up to date.
ACDC Salesman: Thanks...we think our RS/RT Series are the switchers of the 80's.



RS Series/Single Output

SINGLE OUTPUT					
OUTPUT VOLTS	OUTPUT CURRENT				
	RS50	RS100	RS150	RS300	RSF375
2	10.0	20 0	30.0	60 0	—
5	10.0	20.0	30.0	60 0	75
6	8 0	9.0	25 0	50 0	—
12	4 5	9.0	13 5	27 0	31
15	3 6	7 2	10.8	21 0	25
18	3 0	6.0	9.0	18.0	—
24	2.5	4.5	7.0	13.0	15
28	2 0	4.0	6 0	11.5	—

RT Series/Triple Output

MULTIPLE OUTPUT				
	TRIPLE			QUAD
	RT100	RT150	RT300	RQ300
MAIN OUTPUT	5V 20A	5V 30A	5V 60A	5V 30A
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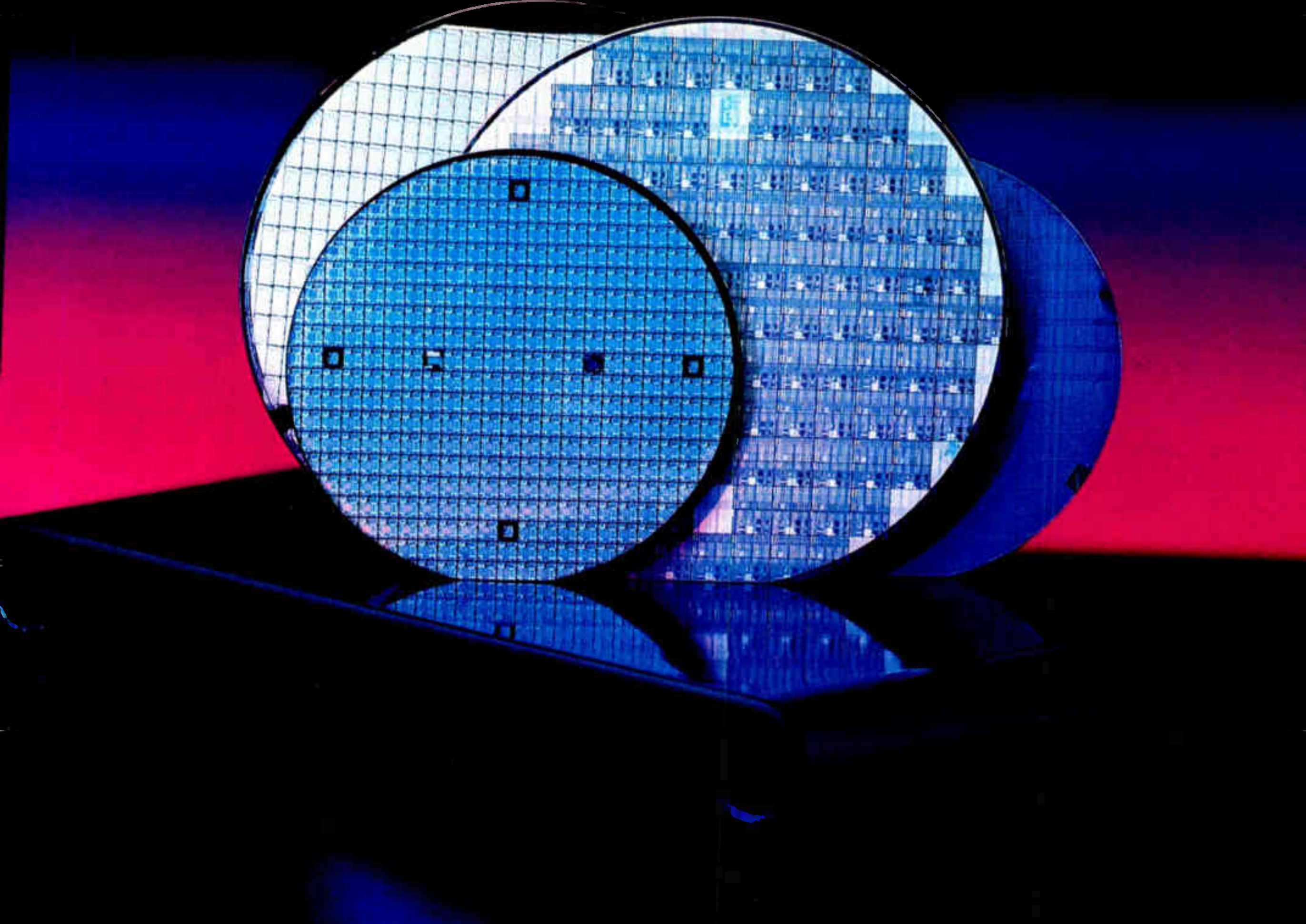

New literature

Designing a keyboard. Stackpole Components Co. is now offering a work sheet on how to design mechanical-switch keyboards. It includes a grid layout printed on vellum paper for quick freehand drawings with a starting row of key caps. For copies of the "KS-200 Keyboard Designers' Work Sheet," Bulletin No. 76-0004, contact Doyle Evans at Stackpole Components Co., Box M, Farmville, Va. 23901, or call (804) 392-4111. Circle reader service number 421.

Computer care. The prevention or elimination of common computer problems is the topic of a 220-page book by Rodnay Zaks. It explains how to care for a computer and its peripherals including floppy and hard disks, cathode-ray-tube terminals, printers, and tape units; how to plan a computer room; how to preserve and retain documentation for a system; how to handle security and computer theft; and how to administer preventive and obtain remedial maintenance. It is available for $11.95 by contacting Sybex Inc., 2344 Sixth St., Berkeley, Calif. 94710 at (415) 848-8233. Outside California, call toll free (800) 227-2346. [422]

Office equipment. A catalog that lists hundreds of word-processing supplies and accessories like flexible and mini disks, cassettes, disk cartridges and computer tapes, ribbons, and furniture from manufacturers such as IBM, Lanier, Honeywell, Data General, Xerox, Diablo, Qume, Wang, and Apple is available free by contacting American Data & Computer Supply, Great North American Stationers Inc., 2828 Forest La., Suite 2071, Dallas, Texas 75234 at (214) 243-3232, extension 26. Outside Texas, call toll free (800) 527-0832. [423]

Apple computer products. "A Rainbow of Applications" describes approximately 350 products that may be used with the Apple Computer. It includes programs for business and home applications, education, science, entertainment, language, and utilities and a wide assortment of peripherals like music and speech synthesizers, add-on memories, printers, and game controllers. The book is available for $2 (an additional $5.50 required for shipping and handling charges outside the U. S.) by writing to Rainbow Computing, 19517 Business Center Dr., Northridge, Calif. 91324. [424]

Creating a development system. A 220-page textbook by John Paul Froelich, "TRS-80, More Than Basic," presents a monitor program that converts the TRS-80 model I or III microcomputer into a development system for programming in the instruction code of the Z80 microprocessor. It discusses the hardware of both model I and III systems; how to obtain written text useful in tracing system development; and the hardware for programming erasable read-only–memory devices. The book is available for $10.95 plus $1 shipping and handling charges (Virginia residents add 4% sales tax) from Group Technology Ltd., P. O. Box 87, Check, Va. 24072. [425]

Digital integrated circuits. A 504-page book published by the IEEE Press contains 72 reprints on digital MOS integrated circuits that are arranged in four parts: MOS digital-circuit design, digital very large-scale integrated MOS memory cells and circuits, and MOS digital-circuit applications. "Digital MOS Integrated Circuits," edited by Mohamed I. Elmasry and sponsored by the IEEE Solid-State Circuits Council, is available in a clothbound edition to non-IEEE members for $38.95. Members may buy a paperback version for $19.45. For a copy, send payment along with order to IEEE Service Center, 445 Hoes La., Piscataway, N. J. 08854. [426]

Office automation. The latest information on word processing, teleconferencing, data banks, micrographics, electronic calendars, computer graphics, and electronic-mail, -filing, and -retrieval systems and integrated office-automation systems is offered in a 256-page book by David Barcomb. The book, Order No. EY-AX015-DP, is available for $15 by contacting Digital Press, Digital Equipment Corp., 12 Crosby Dr., Bedford, Mass. 01730. [427]

Image production. "Polaroid Instant Photography in the Microelectronics Industry" is the sixth in a series of booklets to ease and improve quality control. It provides instructions for producing photomicrographs and macrophotographs of microelectronic images for record keeping, marketing, design engineering, training, and publishing. The booklet also covers topics like film selection, equipment, aperture setting, depth of field, lighting techniques, filtration, and the causes and corrections of common problems. The 44-page publication may be purchased for $4 from Polaroid Corp., Applications Books, P. O. Box 311, Cambridge, Mass. 02139. [428]

Software selector. Choosing computer software tools may be made easier with the use of the "Proceedings of the NBS/IEEE/ACM Software Tool Fair." This publication describes more than 33 tools that were demonstrated at the San Diego Tool Fair last March. Copies are available for $6.50 prepaid from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Order by stock number 003-003-02362-1. [429]

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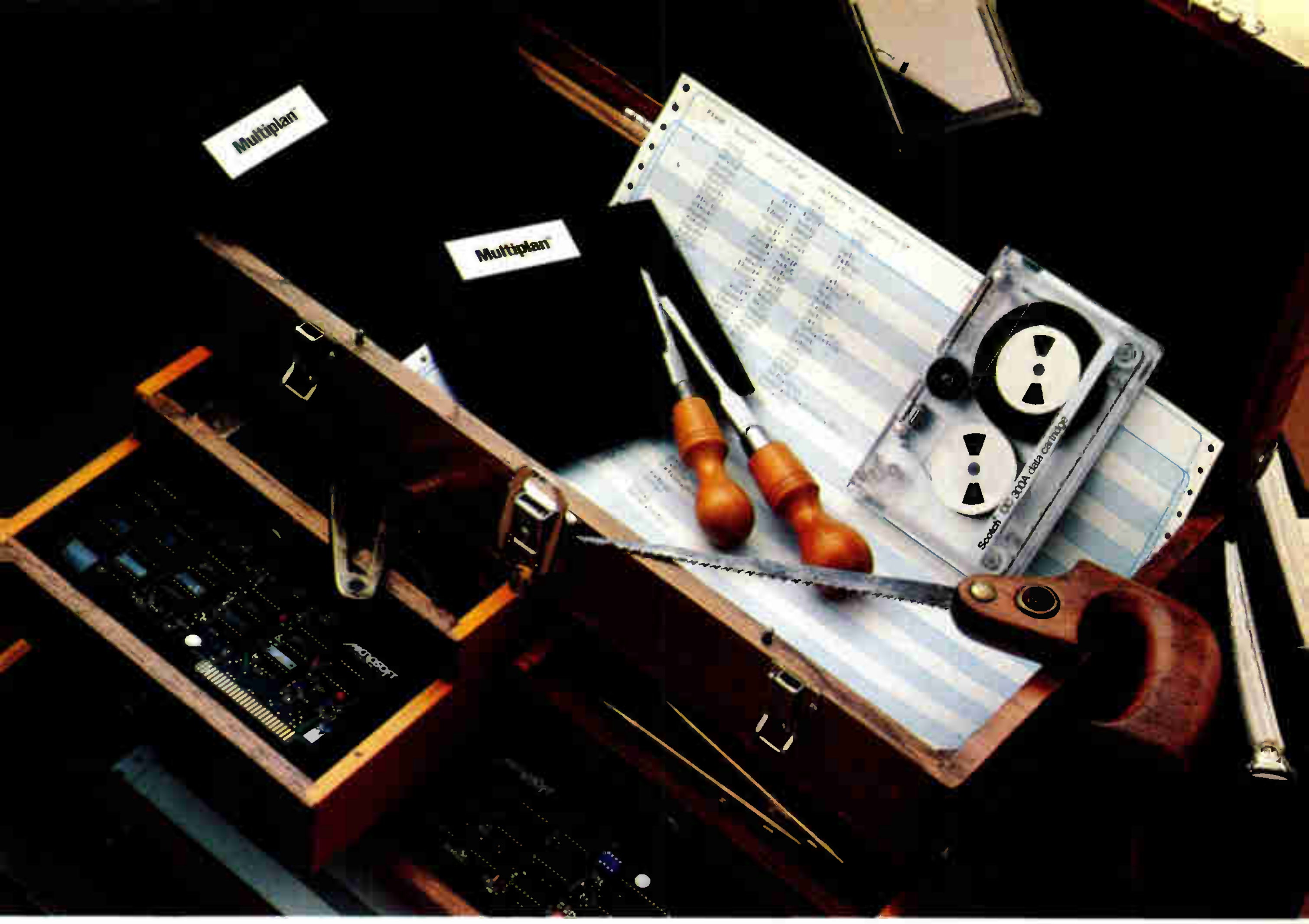

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The Model 6100 is comparable to TEK's Model 465B and HP's 1742 but displays more traces (six compared with three), and offers more screen brightness, more flexibility, greater simplicity of operation and a two-year warranty that substantially reduces the second year cost of ownership. The Model 6100 also features an auto-dynamic focus circuit for clear, sharp pictures and a metal housing that minimizes RFI interference.

Now for the surprising news: Despite all the extra features, the 6100 costs less than either the TEK or HP scopes.

For versatility of operation, an alternate trigger permits viewing a very wide range of non-synchronous signals. For simplicity of operation, a level-lock on the trigger level control for both A and B channels activates a peak-to-peak detector that automatically sets trigger level and triggers without operator intervention.

Rugged and compact, the 6100 is completely modular. Like all KIK-scopes, the construction is on plug-in boards that are supported by a board swap-out program that assures fast maintenance turn-around and minimum down-time.

And, just to give you a little added assurance, your KIK-scope comes with a 30-day "satisfaction-or-your-money-back" guarantee.

This new 100 MHz KIK-scope along with eleven other models for engineering labs, field service and production line applications, is described in our new brochure. Write for it. It's free.

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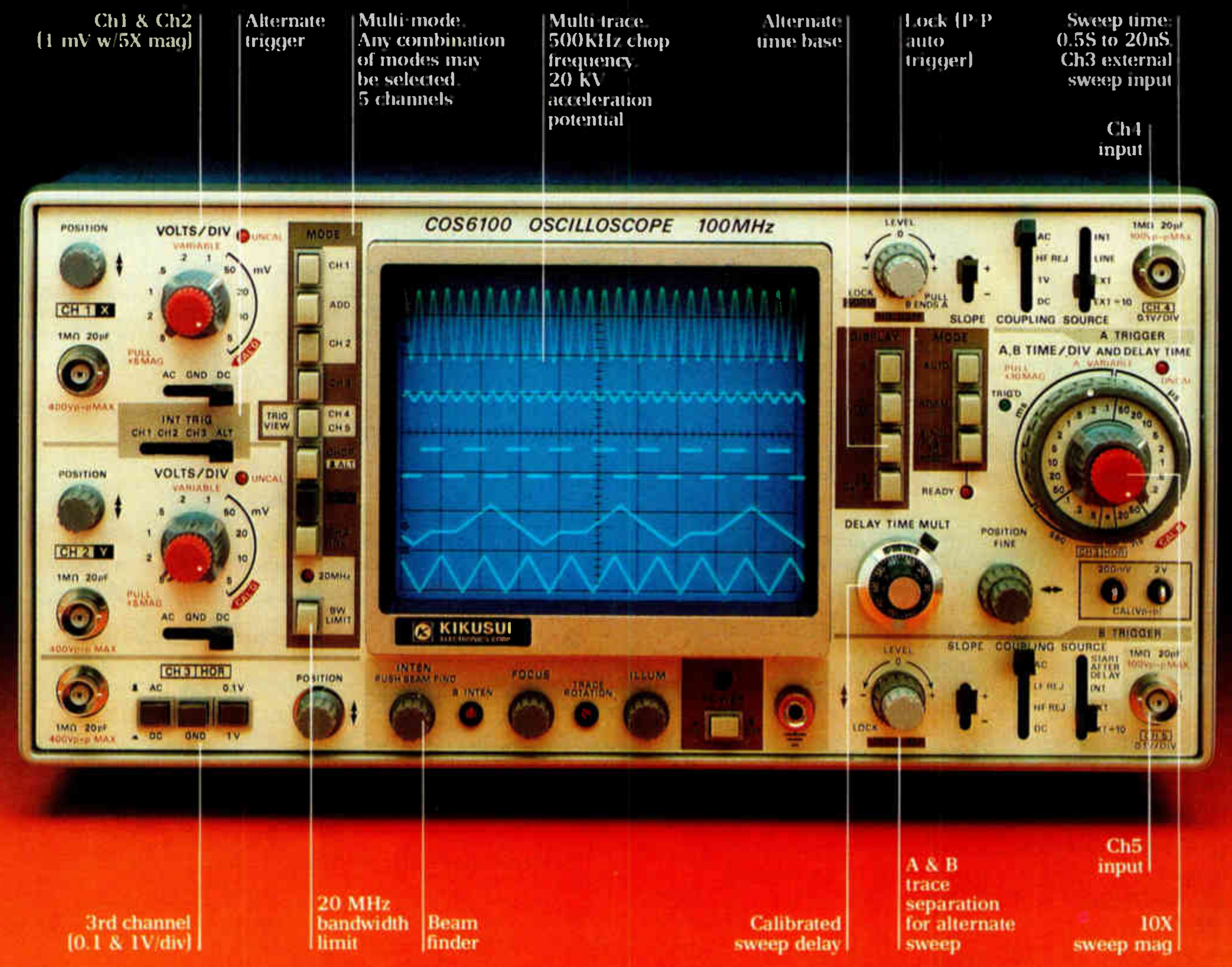


Circle 72 on reader service card

New products/materials

Silicone elastomer SSE comes polymerized with a viscosity of 250,000 centipoises (customized viscosities are available on request) for semiconductor devices and potting sensitive electronic components. After being exposed to a temperature of 200°C for 4 hours, SSE will cure without a catalyst to a white, resilient material with a dielectric strength of 550 v/mil, a continuous operating temperature of up to 275°C, and a heat resistance of up to 300°C.

The silicone elastomer has a shelf life of six months when stored at 40°F or below and is available from stock in 1-lb jars ranging in price from $25 per pound for 1 lb to $14/lb for 100 lb and in 2.5-oz bottles ranging from $7.50 for one bottle to $5 each for 49 bottles.

Transene Co., Route 1, Rowley, Mass. 01969 [476]

Norland Optical Adhesive 61 is a clear, colorless, one-part liquid photopolymer with a viscosity of 350 centipoises that will cure in minutes when exposed to ultraviolet light. It can form tough, resilient bonds to glass, metal, fiberglass, and glass-filled plastics and to make fiber-optic splices and terminations.

NOA 61 has a tensile strength of 3,000 lb/in.^{2}, an elongation of failure of 38%, a refractive index of 1.56, and a shelf life of four months when stored at room temperature.

Norland Products Inc., P. O. Box 145, North Brunswick, N. J. 08902 [477]

A cyanoacrylate evaluation kit consists of five metal tubes that each contains 3 g of different cyanoacrylate adhesive grades—Permabond 101, 102, 200, 750, and 910—and is geared to aid the user in selecting the proper grade for a particular application on the ground of viscosity, bond strength, and its resistance to temperature and chemicals. The adhesives are single-component, colorless, transparent liquids that can form strong bonds in seconds at room temperature on materials like plastic, rubber, porcelain, wood, and glass. The kit sells for $8.75.

Permabond International Corp., 480 South Dean St., Englewood, N. J. 07631 [478]

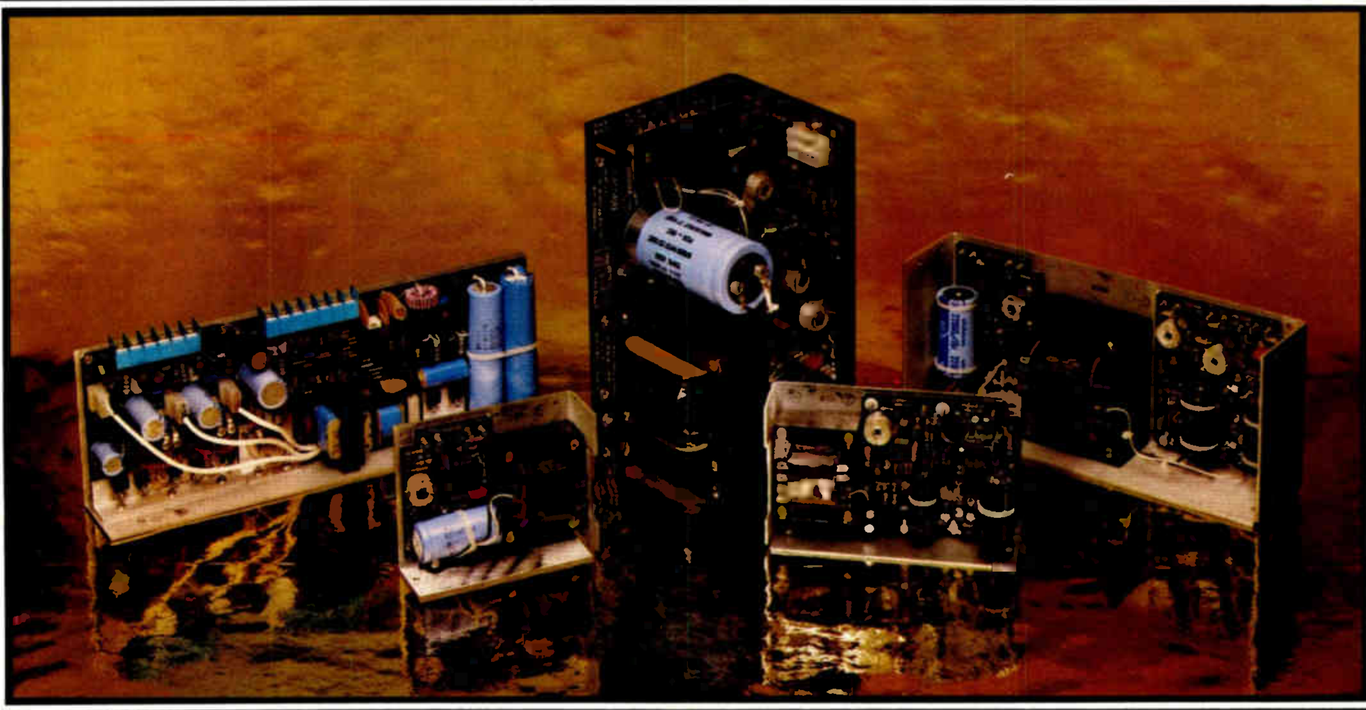
Eccosil 4954 is a red silicone-based material with a low viscosity of 50,000 centipoises and a high thermal conductivity twice that of the Eccosil 4952. It will cure overnight at room temperature or at elevated temperatures to form a flexible silicone rubber capable of withstanding temperatures up to 500°F continuously or up to 600°F intermittently; optimum properties develop in four to six days at room temperature.

Eccosil 4954 will bond to most other silicones. To form a bond with other substrates, a thin coat of Primer S-11 must be applied to the substrate and dried for 30 minutes before Eccosil 4954 is applied. It is priced at $92.99 per gallon.

Emerson & Cuming Dielectric Materials, Dewey and Almy Chemical Division, W. R. Grace & Co., Canton, Mass. 02021 [479]

Xersin 2050, a one-part post-soldering protective coating for printed-circuit boards, is used instead of epoxy and urethane coatings when high-temperature operation is not required. It can be applied by spraying or brushing and will dry in 45 minutes at ambient temperatures. Drying time can be accelerated by using an air blower or a low-temperture oven. Xersin 2050 can be easily soldered to make repairs on pc boards without the addition of a flux and will perform up to a temperature of 257°F. It comes in quart and gallon containers and 55-gallon drums and is priced starting at $16 a gallon.

Multicore Solders, Westbury, N. Y. 11590 [480]



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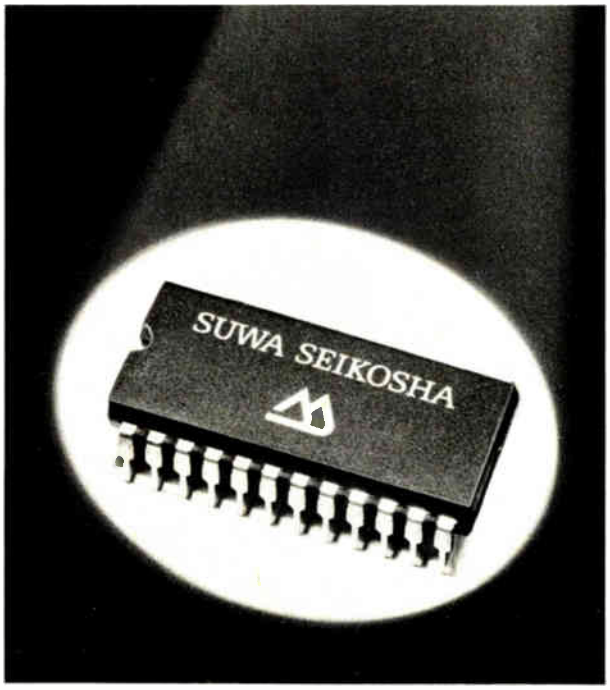

Suwa Seikosha, a major manufacturer of the famous SEIKO watches, was the originator of the quartz watch. As the pioneer of quartz watch technology, the company has consistently developed and manufactured its own miniature electronic parts and ICs. Today this accumulated "Mechatronics" technology is being applied to the development of a variety of new products in addition to watches.

A new Suwa Seikosha plant at Fujimi was set up in April 1980 to concentrate on the manufacture of CMOS LSI and other semiconductor parts. These units include: "Melody ICs," microcomputers, memories, speech synthesizers, and others. Suwa Seikosha, as a leading CMOS LSI maker, is aggressively exploring many future possibilities that will employ the company's most advanced technology.

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  - SEK7 Series
- **TIME STANDARD IC** (Standard Pulse Generator)
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  - 8650
  - 8651
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  - SMM2364 (8K × 8-bit Mask ROM)
  - SMM2365 (8K × 8-bit Mask ROM)
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- **MICROCOMPUTER**
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Model 4088 is a microprocessor-based hybrid recorder which accepts up to 30 channels of a wide variety of input signals. Analog inputs are converted into digital signals and printed out as dot traces and digital data in six distinct colors through a stepping motor and high-speed wire-dot printer.

* Easy-to-read traces in six distinct colors using a wire-dot printer.
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Circle 94 on reader service card

Computer maker unveils Winchester

After seeing the need for a 5¼-in. Winchester-technology disk drive for its personal and desktop computer lines filled by another company [*Electronics*, Sept. 22, 1981, p. 267], Hewlett-Packard Co. has decided to step into the market with its own drive. Like the 9800H from Microcomputer Systems Corp., of Sunnyvale, Calif., HP's new model 9134 emulates the protocols of HP's 8-in. floppy-disk drive, the 9895, and **it will interface with both the HP 80 series of personal computers and the HP 9800 series of desktop computers**. Unlike the MSC unit, the HP has a formatted capacity of 4.6 megabytes and costs $4,500, compared with 4.8 megabytes and $3,995. But, HP has also packaged the drive into a Winchester/floppy combination, the model 9135, which includes a 270-K-byte 5¼-in. floppy-disk drive and sells for $5,500.

40-Mb/s data link transmits to 400 m

Enhanced versions of Augat's 40-Mb/s fiber-optic data-link equipment now can handle transmissions to sites as far away as 400 meters, four times the previous range. Formerly dubbed the Family 3, the renamed **CD40 has a TTL-compatible transmitter and receiver,** which sell together for $299 in lots of one to four and for $176 in hundreds. Delivery from Augat's Fiber Optic division in Attleboro, Mass., takes two weeks.

Add-on drives raise Intellec capacity

A start-up firm in San Jose, Calif., plans to carve out a piece of the market for upgrading Intel's Intellec development systems through the introduction of 10- and 29-megabyte Winchester-disk–drive add-ons. Data Management Labs will offer its model 1010, a 10-megabyte Winchester drive packaged around a Shugart SA 1004, for $8,995. For those with larger storage needs, the model 4030, with an unformatted capacity of 29 megabytes, will be offered for $9,995. The 4030 uses a 14-in. Winchester, while the 1010 uses an 8-in. drive, **and each model includes an 8-in. floppy disk to which the user can assign a double or single density.** Both systems have a Multibus interface card that plugs into a slot in the Intellec. The controller for each drive has an error checking and correcting depth of 48 bits with a correction span of 5 bits. Both models are divided into virtual partitions, appearing to the Intellec as standard disk subsystems.

Two 8-bit converters occupy a single chip

Recently born in Wilmington, Mass., are twin 8-bit digital-to-analog converters on a single chip. Analog Devices offers the dual d-a converters complete with on-chip latches and microprocessor interfacing circuitry. The new format not only saves board space, but **also provides much improved tracking with temperature when compared to separately packaged d-a converters.** The use of a common data bus, capable of loading either converter's input register, also allows the AD7528 to fit into a 20-pin dual in-line package. Pricing in 100s is $9.95 or less than $5 per converter; delivery is from stock.

Price cut 55%, system unbundled

A 55% price cut brings PasPort, Intermetrics Inc.'s Pascal cross-compiler line, down to $6,750; the Cambridge, Mass., firm also is unbundling its pricing to permit separate purchase of system components like PasPort's primary run-time library and Target interpreter. The minicomputer-based development system for microcomputer software, which sold for $15,000 at its introduction last May [*Electronics*, May 19, 1981, p. 227], now has two compatibility options at $500 each. **These will let PasPort work with cross-assembler/linker packages** from Intel and Microtec in integrating Pascal and assembler code on host microcomputers. Intermetrics says PasPort now can target Motorola's MC68000 as well as Intel's 8086 microprocessor. The system runs on Digital Equipment Corp.'s PDP-11 and VAX-11/780 hosts.

64-K S-100 memory is FDA-approved

For some time, Sonics Microsystems Inc., has been building diagnostic imaging systems for medical use. Now the Fort Lauderdale, Fla., firm is offering subassemblies manufactured and tested to the standards set by the Food and Drug Administration. **The first units, 64-K S-100-bus–compatible dynamic random-access memory boards**, are said to be more reliable than boards built to commercial standards. The MOS RAM board is directly compatible with many Z80-based systems and costs $545 in single units.

File manager lets small computers act big

Offered for its MicroNova, Nova, and its desktop MPT/100 systems, Data General Corp.'s file management package gives its small machines the functionality and ease of use characteristic of larger machines and operating systems. **The package from the Westboro, Mass., firm consists of two modules:** a sort/merge utility, and a module for indexed sequential access method. Isam is a single-pass data extractor, avoiding the multiple iterative sorts often required when data is accessed. The sort-merge aids in building and maintaining data bases. The package is priced at $1,250.

Options add uses to LSI test system

Further enhancing the A300 analog large-scale integration test system are three options being unveiled by Teradyne Inc. Operating under control of the Boston, Mass., firm's Pascal/Steps test software, the new offerings include **the PL875 ultrahigh-frequency test module, the M618 video signal generator, and the M623 amplitude-modulated–frequency-modulated signal generator.** Prices range from $19,000 to $29,500, with deliveries due to start in mid-1982. Earlier, in November 1981, Teradyne announced a Teletext signal generation capability for the A300.

Lab tests for interference

Now making electromagnetic interference measurements according to Federal Communications Commission Docket 20780 regulations and Verband Deutscher Elektrotechniker standards is Chomerics Radiation Test Services, a test laboratory formed by Chomerics Inc. The Woburn, Mass., firm's laboratory **will test electronic devices for pass/fail analysis with respect to their emi radiation.** Chomerics operates two facilities in its laboratory—a 1,700-ft^2 anechoic indoor 3-m test site and a 10-m open-field test site. Both are equipped with tunable dipole, biconical and log periodic antennas providing reception capability from 20 to 1,000 MHz.

System routes data directly to disk

The Sample-to-disk system, due March 1 from New England Digital Corp., White River Junction, Vt., captures 16-bit data at up to 50 kHz and stores it directly on disk for later processing. **At $24,000, the system stores 100 seconds worth of samples.** Its applications include the study of biomedical and speech signals, vibration analysis, archival data storage, and the testing of systems ranging from loudspeakers to sonar.

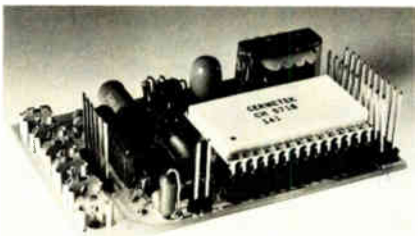
Cermetek introduces the CH 1810. Direct Connect Protective Hybrid Telephone Line Interface.

A FCC Registered DAA

If you are thinking of designing a modem into your product, you need three system elements: an interface to your system, a modem signal processor, and a FCC approved DIRECT CONNECT PROTECTIVE HYBRID which interfaces the modem to the switched telephone network.

The Cermetek DCPH (Direct Connect Protective Hybrid), which we call the CH 1810, is a module that provides a complete DAA function. It is registered under part 68 of the FCC rules and regulations for direct connection to the public network. FCC re-certification is not required when the CH 1810 is integrated into your system, providing that the included label is externally attached listing the registration number and ringer equivalence. This allows you to bring your design to the market quickly without costly FCC certification delays.

The Cermetek DCPH can be used as a telephone line interface in a variety of environments besides modems, such as



answering machines, FAX machines, Auto-Dialers, Burglar Alarms, Remote metering Devices (utilities), Automatic Fuel Pump stations, and cash registers.

Additional features of the CH 1810 are switched or lease line connections programmable or permissive interface, 2 to 4 wire conversion, analog loop-back, ringing detection, billing delay squelch, and surge protection.

The CH 1810 is directly PC board mountable and occupies less than 5 square inches.

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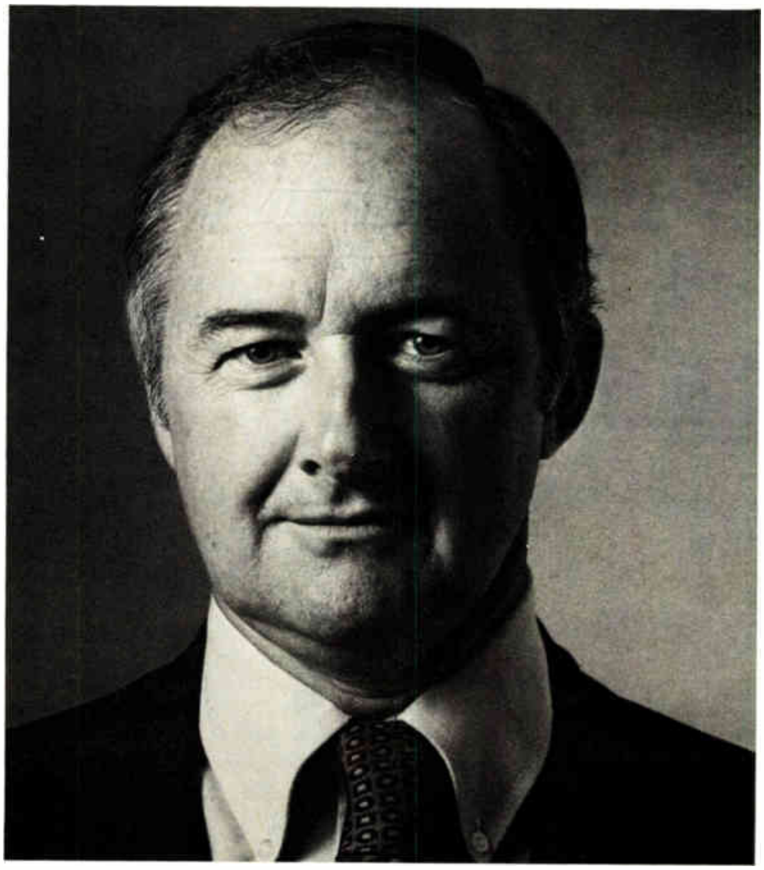

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Career outlook

Spotlight on schooling

Whether or not there is a shortage of engineers is becoming a moot question, even as the debate spreads beyond the professional circles that usually fret over such matters. Now newspapers and magazines are adding their voices. At the same time, attention is being directed to a peripheral concern that vitally affects the engineer supply, as well as the careers of those who are already in the profession: education and continuing education.

Late last winter, Richard W. Damon, president of the Institute of Electrical and Electronics Engineers, said he wanted the institute to develop a long-range plan for education. In line with that goal, he asked for a review of the IEEE's educational activities [*Electronics*, March 10, 1981, p. 240]. Now, the first step toward that review has been taken.

It occurred at an IEEE convocation on educational activities in Savannah, Ga., at the beginning of last month. Mission statements were formulated at five workshops—"The IEEE Member," "The College Student Preparing for a Career in Electrical Engineering," "The Precollege Student with a Potential Interest in a Career in Electrical Engineering," "The Public," and "The Educational Mission of the IEEE." The mission statements include what they term "prioritized five-year objectives," as well as plans to implement those objectives. The statements also have been accepted in principle by the IEEE board of directors.

Three sectors. Perhaps of greater immediate interest are the remarks made at the convocation by Damon. He summarized the concerns of the meeting, as well as of the institute, in three broad areas. First, for the members, "we need a well-developed curriculum of high-quality courses of continuing education, in various formats, and with a variety of distribution and teaching techniques."

Second, for the training of engineers, "we need to establish the problems [that exist] with our present supply of engineers and with the educational facilities and teaching staff. We can use our accreditation procedures to assure a quality education. With other technical societies, we can help bring government, industry, and universities together."

Third, Damon noted what is becoming an increasingly popular concern when he said, "we need to improve the public understanding of technology, by instructing adults and by improving the offerings at the high-school level."

Damon pointed out that the IEEE has multiple constituencies, among them the working engineers and those in training for careers as engineers. For the former, he emphasized the need for a continuing-education curriculum with a variety of distribution needs. These would include "short courses with traveling lecturers or with local instructors and self-study courses through a variety of media including printed material, telecasting, and video tapes."

Meet the needs. Damon also mentioned the desirability of developing a curriculum for "each of the technical areas of IEEE interest and then finding ways to get the courses prepared. "We must offer what is needed, not just those courses for which a volunteer turns up." Such courses, he said, would be distributed via "the network of IEEE connections to the members, including the activities boards, conferences, section meetings, and conventions."

Turning to the student constituency and the much-discussed engineer shortage, Damon noted that the role of the IEEE in this area has generally been limited to student activities and accreditation. Now, he said, the institute should broaden its activities and use its clout to "determine if there are problems with the supply and training of engineers, and, if so, what should be done."

As for the public, Damon noted that it is this constituency that makes the policy decisions regarding the technological issues. "It has been noted that the American public is virtually illiterate as to scientific and technical matters. We must find the means to raise the technological consciousness of the public. □

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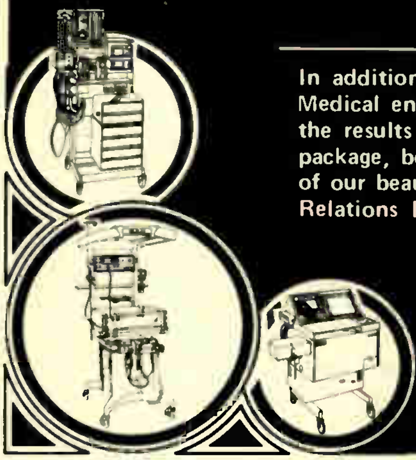

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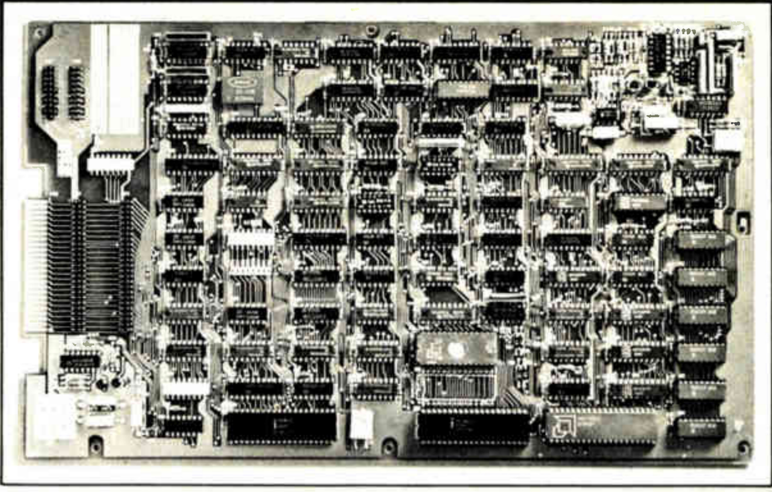

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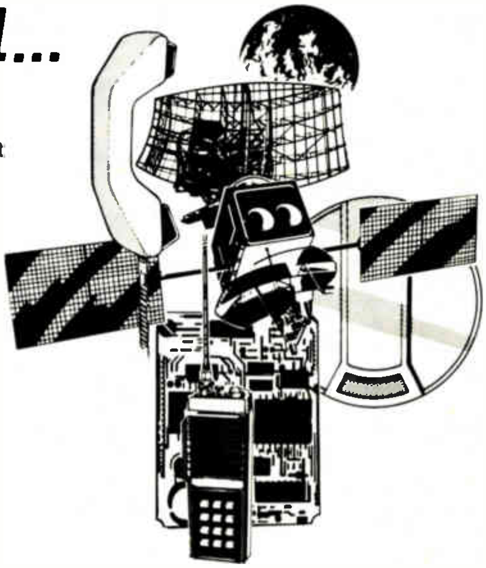

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