MAY 11, 1978

ELECTRO RETURNS TO BOSTON WITH SOMETHING FOR EVERYONE/144

Portable circuit-board tester makes field repair a snap/111

Programmable multiplexer solves data-flow problems/132

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RAM

THE MEMORY OF ONE-CHIP MICROCOMPUTERS

STRETCHING

ROM

Electronics
The International Magazine of Electronics Technology
Vol. 51, No. 10 • May 11, 1978

Highlights

Cover: Single-chipper gets more memory, 105
Twice as much memory as any other one-chip microcomputer comes on the new 3872. Building on its 3870 sibling, it includes 64 bytes of random-access memory in the main memory, where its contents can be modified during program execution.

Cover designed by Art Director Fred Sklenar.

Programmers unplugging bottleneck, 92
There are some glimmers of progress in the struggle to streamline the software-writing process for new computers, from mainframes down to microcomputers. Each type of computer presents its own problems to the programmer, and they take a lot of time to solve.

On-site tester isolates faults automatically, 111
A microprocessor-based field tester permits on-site board testing and fault isolation, thus minimizing board swapping. Moreover, its guided-probe technique automates fault-finding.

Electro/78 will be big, 144
The 1978 Electro show reflects the booming electronics business, just as have its recent predecessors. For a preview of the wide-ranging program, see page 145, and for a look at some products about to bow at Hynes Auditorium in Boston, see page 155.

And in the next issue . . .
A preview of the National Computer Conference . . . multiplexing techniques for liquid-crystal displays . . . a microcomputer with on-chip a-d conversion.

Electronics

Publisher's letter

Whenever a major story, especially one involving an important product announcement, is about to break, word tends to leak out in advance. That's the reason National Semiconductor was being particularly closed-mouth about its entry into the minicomputer market.

Rob Brownstein, our No. 2 man covering the San Francisco region, had heard about a big story coming up at National, but the company was keeping the lid on tight. Yet, to his surprise, the minicomputer announcement became Rob's scoop almost by accident.

In the course of collecting information on new products to be included in our report on the National Computer Conference in the next issue, Rob telephoned National and was invited to come in for what he thought would be a routine product briefing.

"I was completely surprised when the product turned out to be the announcement everyone had been trying to get. Here they had been tighter than a clam, and suddenly I had interviews with National's executives plus technical background from the engineering staff," Rob recalls.

The result is the Probing the News story on page 81, which carries both the general implications of National's move and some technical details of the System/400 minicomputer. As Rob points out in the story, the key to the development was National's roots in integrated circuits, IBM-compatible add-in memories, and IBM-compatible central processing units. It was natural for the company to introduce an IBM-compatible minicomputer system.

The story wasn't all luck for Rob, though. He had to analyze the significance of National's move, based on the company's past capabilities and potential market.

"One thing's certain," Rob concludes, "I'll have a different view of 'routine' phone calls in the future."

Our newest newsletter makes its bow in this issue. It's called Products Newsletter and appears on page 247. Why start a page on product news?

"The main reason," says Mike Riezenman, new products editor, "is to provide coverage of the many news items that develop around products that are not simply new product announcements."

For example, the newsletter will carry items on upgrading present models or adding new options. There will also be news of price changes and second-source agreements. And news of products that have been dropped will appear as well.

"The newsletter gives us an opportunity to get fast-breaking product information to the reader in a brief capsule and still be able to follow up with a longer story reviewing the specifications in a later issue," Mike adds. "Material in the newsletter will deal with products that either are immediately ready for market or will be shortly, rather than long-range projects."

In short, the Products Newsletter will be a page to catch the latest of the many products that are covered in our extensive New Products section.

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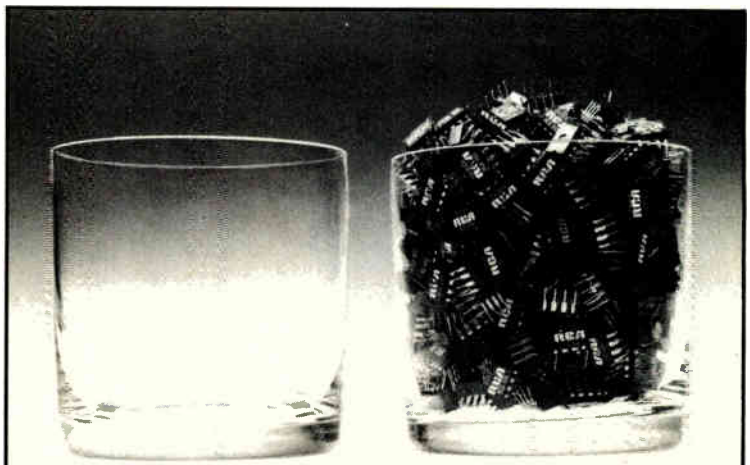

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Type (with single supply)	Input Common-Mode Voltage Range	V_{OM}^+	I_I	Slew Rate	Gate Input Protection Diode
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Bifet TL082CP	5 to (V⁺−5V)	5 to (V⁺−5V)	400 pA	12 V/μsec	No
CA1458E	3 to (V⁺−3V	5 to (V⁺−5V)	500K pA	0.5 V/μsec	—
MC1458SP	3 to (V⁺−3V)	5 to (V⁺−5V)	500K pA	16 V/μsec	—

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Circle 7 on reader service card

News update

■ Engineers at bubble-technology pioneer Bell Laboratories in Holmdel, N. J., have developed a measurement system that uses magnetic-bubble memories to help measure the performance of digital radio equipment and, in some cases, to isolate what causes system errors.

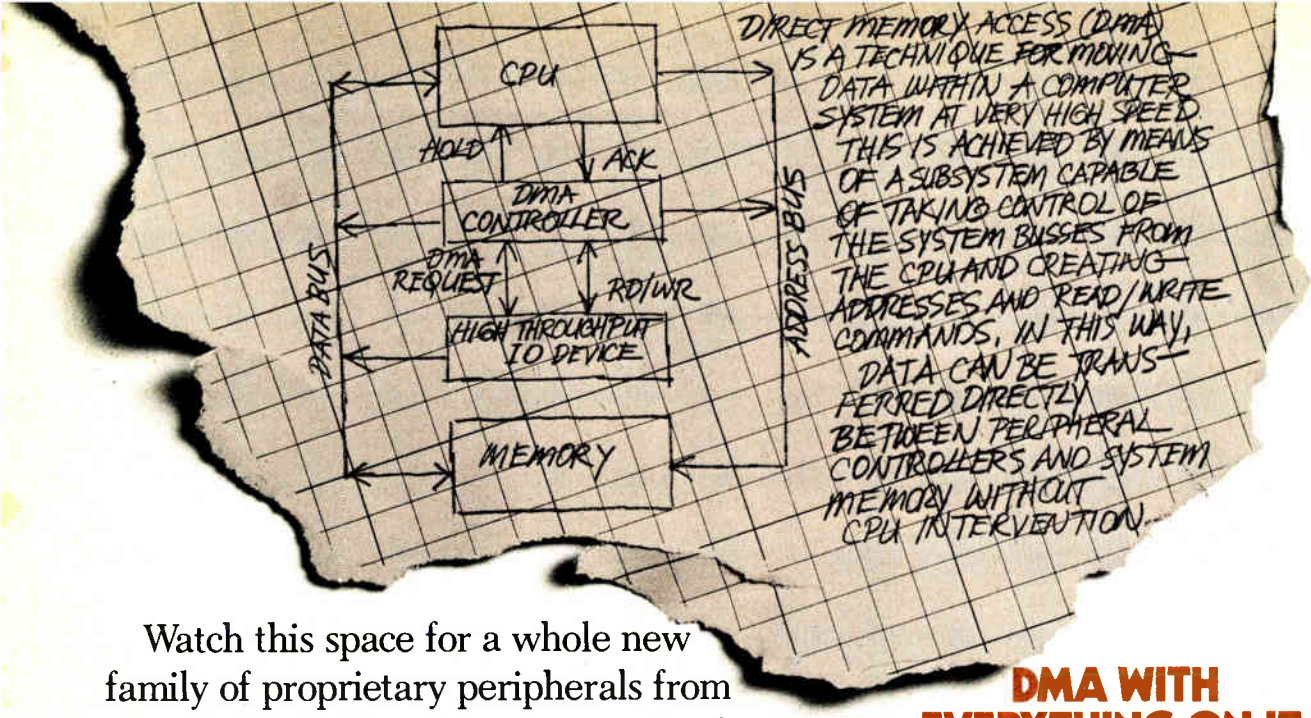
Called Quark, for quantizer, analyzer, and record keeper, the system is Bell's second application of magnetic-bubble memories. The first is in the 13A announcement system now being tested at Michigan Bell Telephone Co. in Detroit [*Electronics*, Aug. 4, 1977, p. 86].

According to Tibor Szekeres, co-designer of Quark, querying the system over Bell's Direct Distance Dialing network causes it to provide either the statistics accumulated in its memory or current information from its continuous measurements.

■ It has been a long time coming, but the missile and surface-radar unit of RCA Corp.'s Government Systems division in Moorestown, N. J., has received its first production contract for Aegis, an advanced surface-to-air missile system that is to provide fleet air defense for the 1980s and beyond [*Electronics*, Feb. 2, p. 74]. The $226 million contract, awarded by the U. S. Naval Sea Systems Command in Washington, D C., comes nearly 8½ years after RCA was awarded a $250-million-plus contract to design, develop, and test the Navy's first computer-controlled, totally integrated shipboard defensive-weapon system.

RCA division vice president and general manager Max Lehrer says the production contract covers the first production Aegis system that is to go on the DDG-47 destroyer, the first of a new class of surface combat ships. The contract also covers the integration of all combat systems on the DDG-47, he says, including the Standard missile (Type II), antisubmarine warfare sonars, and Mark 26 guided-missile launchers, among other weapon systems. Aegis may go on up to 16 DDG-47s and four CGN-42 nuclear carriers.

Bruce LeBoss



Watch this space for a whole new family of proprietary peripherals from Advanced Micro Devices. They're built from your side of the board. They're microprocessor-based solutions from a system viewpoint. For example:

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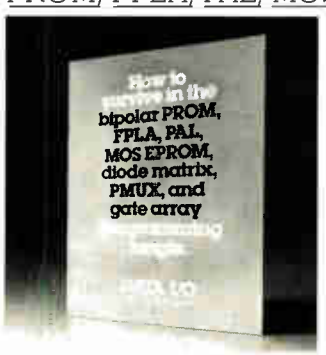

Circle 13 on reader service card

TO-5 RELAY UPDATE

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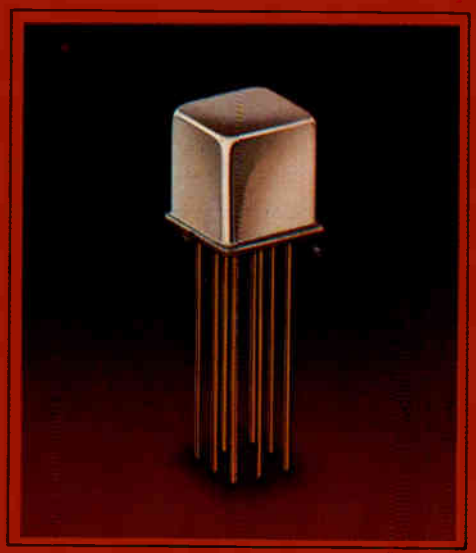

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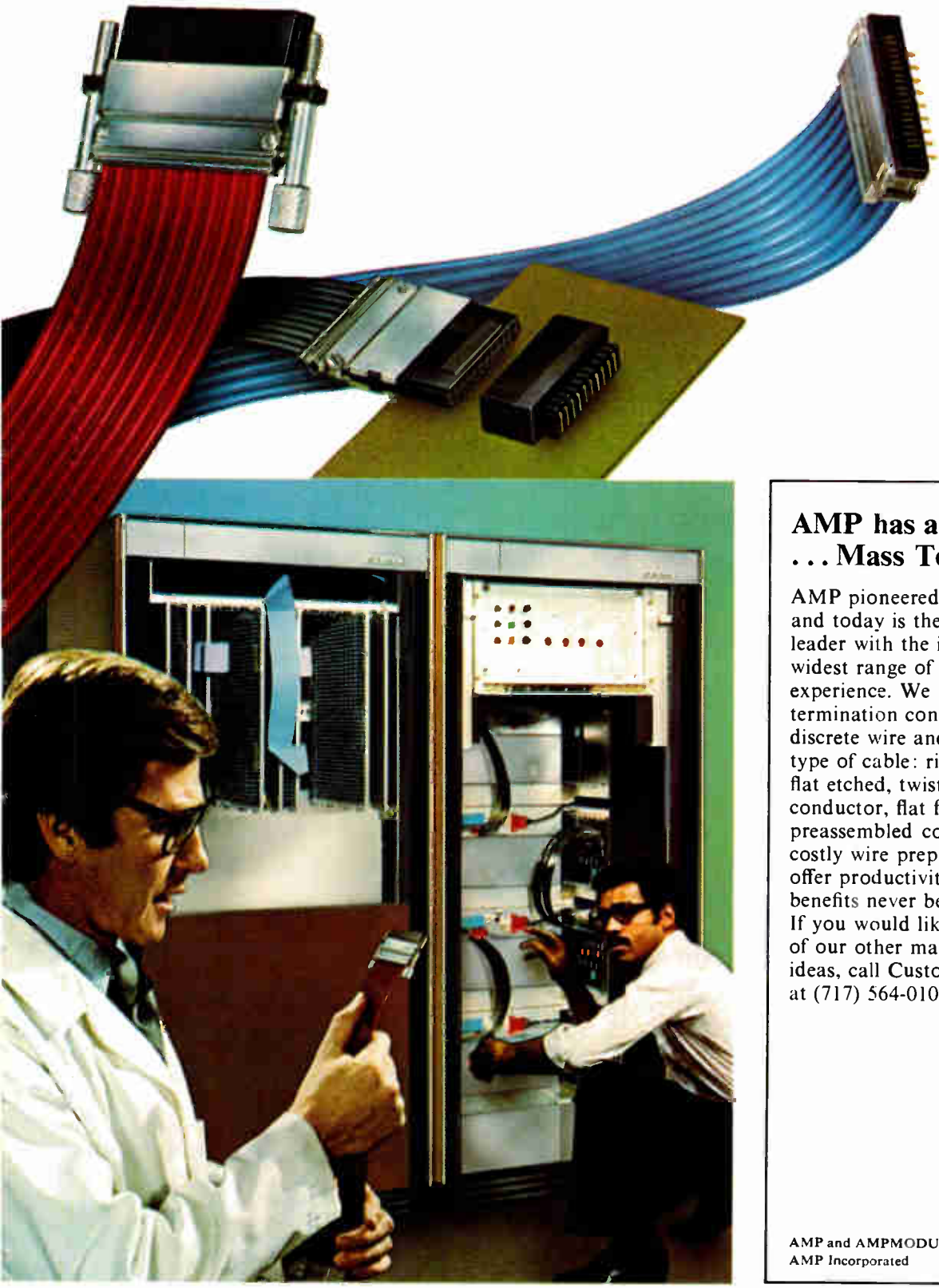

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new fully static 4K RAMs. have it your way.

For even greater speed, the seven 2141 parts are directly pin and function compatible with our three super fast 2147 HMOS parts. So you can have it your way from 55ns to 250ns using the 2141/2147 series, with a virtually identical speed/power product.

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4096 x 1 BIT HMOS STATIC RAMs

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2141-3	150	70	20
2141-4	200	55	12
2141-5	250	55	12
2141L-3	150	40	5
2141L-4	200	40	5
2141L-5	250	40	5
2147	70	160	20
2147-3	55	180	30
2147L	70	140	10

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Editorial

Western Europe's place in the sun

Solar energy sometimes seems too good to be true. The supply is inexhaustible and can be found everywhere (which certainly solves payments deficits). Moreover, sunshine requires no particular pains to prevent pollution.

Yet solar energy is perhaps too attractive. There is one hard fact that its boosters tend to downplay: the hardware needed to turn the sun's rays into useful heat or electricity still is extremely expensive, at present almost prohibitively so.

Thus, proposals for massive tapping of solar energy can become somewhat unrealistic. The recent estimate by President Carter's Council on Environmental Quality that a combination of solar technologies could supply 25% of the country's electricity by the end of the century suggests that the council members were being overoptimistic. Another case where there are doubts about costs is the Sunsat proposal, championed by some representatives of the U. S. aerospace industry. It would involve erecting photovoltaic grids 35 miles square, 22,000 miles out in space, and beaming microwave power back to earth.

Also, the hundreds of billions of dollars in costs that Sunsat's backers toss about is so dazzling that the real potential of solar energy could get lost in the glare. Despite all its merits, solar power will require large investments in time and money for its hardware. And the outcome could well be a modest contribution to total energy requirements.

For a different perspective, U. S. energy strategists might well look at the solar energy programs under way, or just starting, in Western Europe (see p. 85). The basic premise for these highly industrialized countries is that solar energy can, at best, supply between 3% and 5% of their demand by the year 2,000.

What is more, the European research and development programs are pragmatic rather than futuristic. Most of the money is going for such thermal hardware as roof panels, mirror-powered boilers, and the like, that is close to delivering hot water or steam at costs sometimes competitive with conventional means. For photovoltaics, there is less spending, and the major thrust at the moment is for solar panels built around monocrystalline-silicon cells—technology that is well within reach of bringing costs down fast.

Of course, there is also a danger in being too nearsighted in solar energy. For all their pragmatism, European solar energy experts realize that they cannot be ready for tomorrow with only today's technology. So they are putting photovoltaics research and development money into advanced solar-cell materials: amorphous silicon, polycrystalline silicon, and more exotic semiconductor materials like cadmium sulfide and gallium arsenide.

Compared with the dollars that the U. S. Department of Energy will lay out this year to spur solar energy development, the sums allocated by West Europeans look piddling. So despite the as-yet-undefined American effort, the Europeans always have to worry that U. S. companies eventually will do in photovoltaics what they did in integrated circuits: catapult into Western Europe with advanced technology nurtured in the substantial American market. That is a second compelling reason for West European countries to put together solar programs with a sensible mix of technologies to build their markets now and hold them in the years to come.

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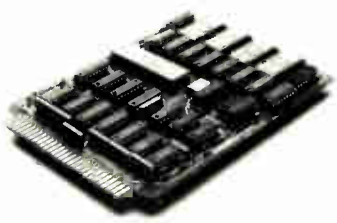

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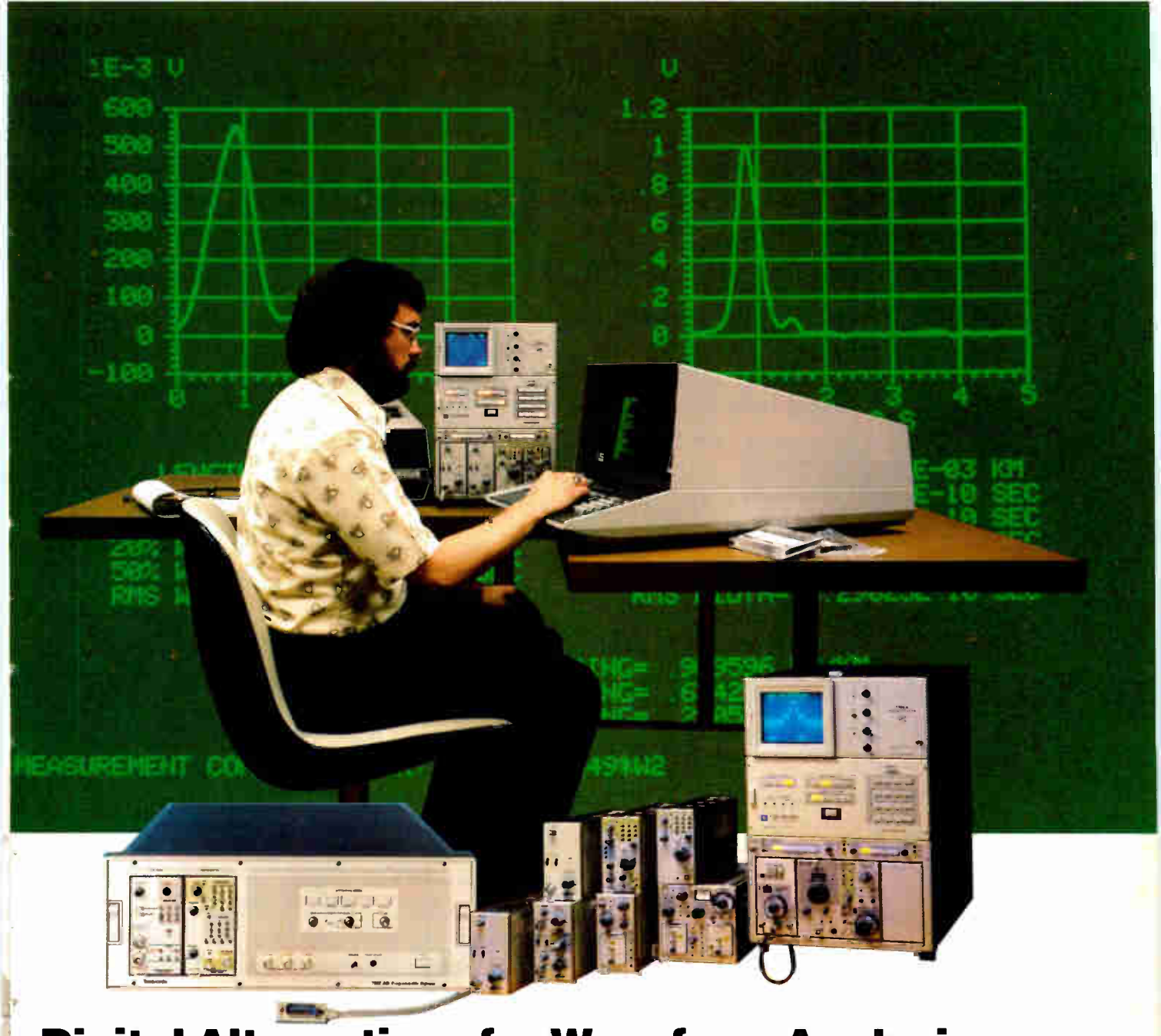

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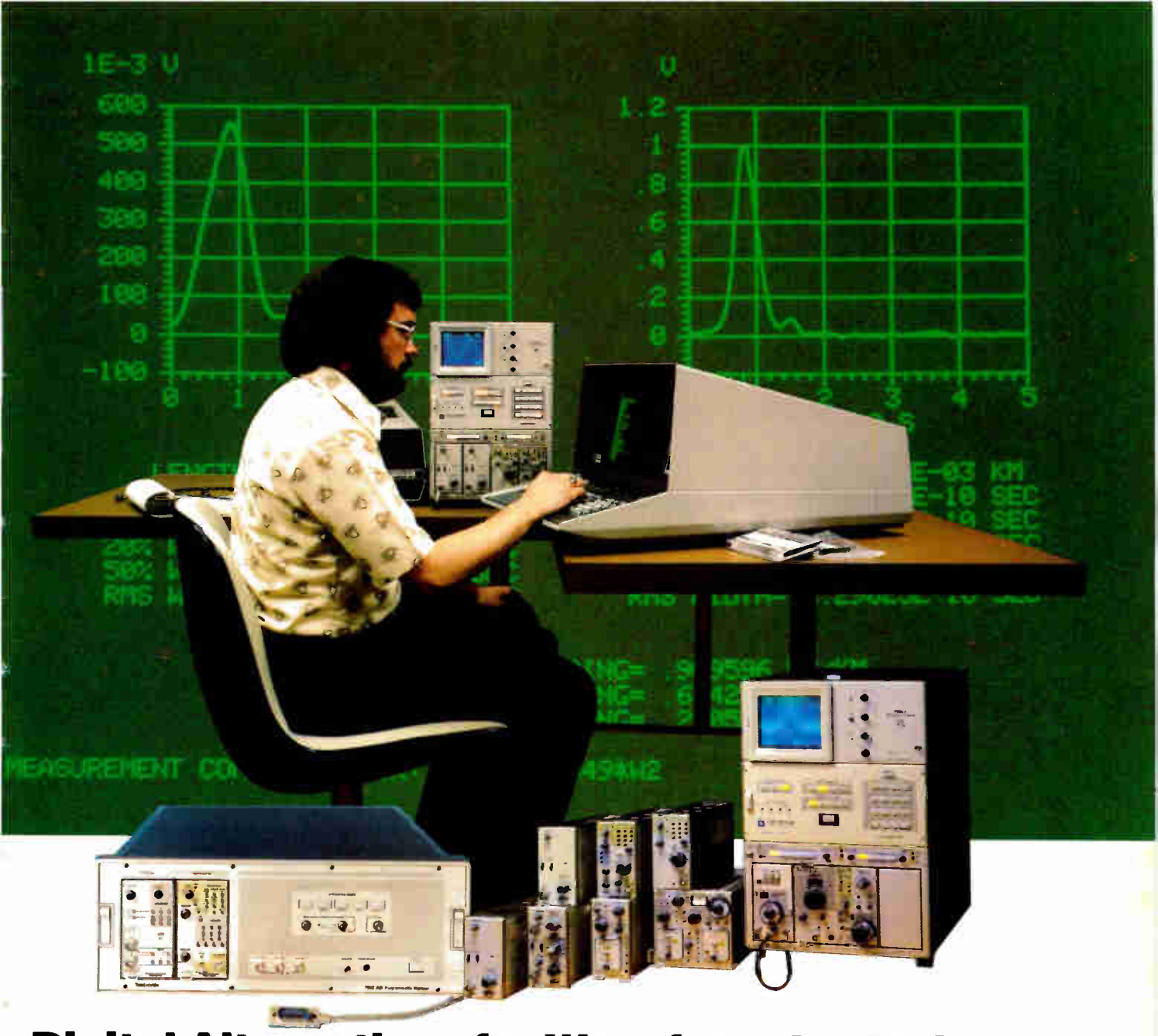

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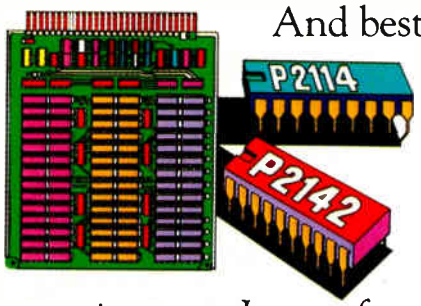

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2114 in volume. to 4K static RAMs.

pullup resistors or output gating. Our 4K static RAMs operate at TTL levels on a single +5V supply, and have buffered three-state outputs.

We guarantee identical access and cycle times on these parts, so you can surpass the performance of clocked static RAMs. For example, you can achieve a data rate of 20 megabits per second with the 200 nanosecond 2114-2 or 2142-2 parts. That's twice the data rate of clocked RAMs with a 200 ns access time. Intel specs guarantee that even at high throughput rates you'll need less than half the power of first generation static RAMs.

You can take advantage of 2114 and 2142 economy and Intel's production availability by ordering directly from: Almac Stroum, Component Specialties, Cramer, Hamilton/Avnet, Harvey, Industrial Components, Pioneer, Sheridan, Wyle/Elmar, Wyle/Liberty, L.A. Varah or Zentronics.

Or ask your Intel salesman how you can get an assembled and tested card, the Intel Memory System in-7000. It gives you up to 16K words on one card, up to 528K in one chassis.

Intel 1Kx4 MOS STATIC RAMs

	Access Time & Cycle Time (max) 0-70°C	Icc (max) @Vcc (max) 0-70°C
2114-2	**200ns**	100mA
2114L-2		70mA
2142-2		100mA
2142L-2		70mA
2114-3	**300ns**	100mA
2114L-3		70mA
2142-3		100mA
2142L-3		70mA
2114	**450ns**	100mA
2114L		70mA
2142		100mA
2142L		70mA

Our entire selection of static RAMs are in the Intel 1977 Data Catalog. For individual data sheets on the 2114 or 2142 components or the in-7000 static RAM memory system write: Intel Literature Department, 3065 Bowers Ave., Santa Clara, CA 95051.

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Reducing the basic seven parts of the multi-chip system to two, with little or no sacrifice in processing power or design flexibility, is the mission of our MC6802-6846 combination. It's the low-cost way to get more of the system on less of the silicon.

That idea followed to its conclusion arrives at the single-chip microcomputer. The third generation MC6801 will put an entire minimum system onto one chip of silicon, yet enhances MC6800 performance. The MC6805 single-chip microcontroller will complement the '6801 for low-end, low-cost applications.

Every one of Motorola's microprocessor-microcomputer products uses the EXORciser* and/or its compatible system development tools for system development. All M6800 software, including FORTRAN, COBOL, BASIC, and MPL high-level languages, is fully compatible.

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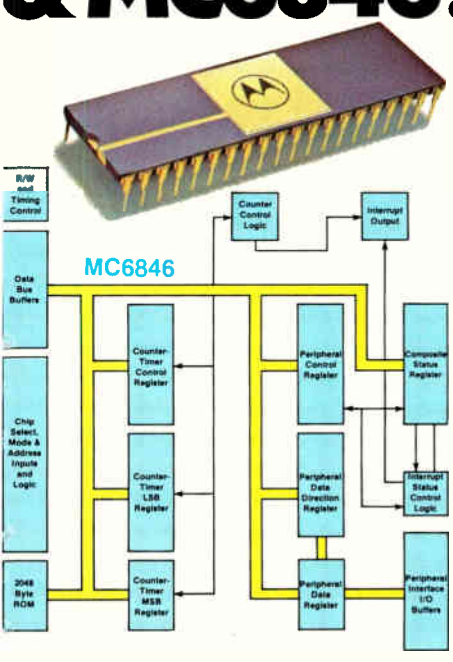
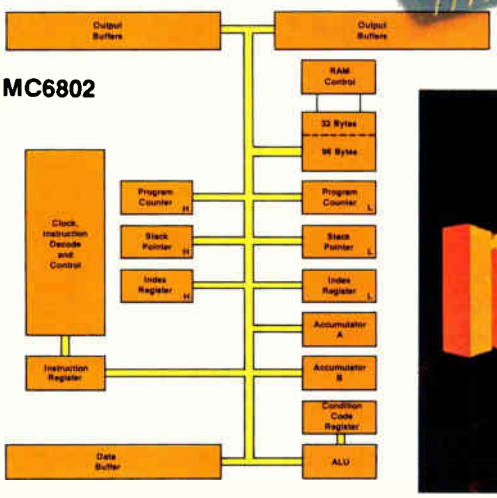
Build systems with the MC6802 & MC6846... and save.





The pair is priced under $15.00 in 10K quantities, and there's no extra cost for software or system development tools since all M6800 Family processors are totally compatible. They are available in quantity, now.

Together, these two chips supply all the power of the MC6800 MPU, plus 128 bytes of scratchpad RAM, 2,048 bytes of ROM program storage, and on-chip clock circuitry. Ten parallel I/O lines for controlling system peripherals and equipment, and a 16-bit programmable timer with three control lines for synchronous control of external circuits also are provided.

M6800 Family functions like the Asynchronous Communications Interface Adapter, MODEMs, Peripheral Controllers, and General Purpose Interface Adapter work with the '6802 just like it was a '6800. Indeed, they can't tell that it isn't a '6800. External multiplexed interfacing or buffering is never required between the MC6802 and any peripherals or memory.

In addition to the standard MC6800 features of the MC6802, it has a couple of unique advantages. The first 32 bytes of RAM can be held in a low-power mode during power down situations, permitting retention of critical data when power is lost.

For enhancement of MC6802 system cost-effectiveness, you can replace the normal 1-MHz crystal with a 4-MHz crystal.

This low-cost, two-chip system is a winner. So you can familiarize yourself with it, Motorola authorized distributors are offering, for a limited time, a special information package with the MC6802 and MC6846, all for the price of the units, themselves.

MOTOROLA INC.

Electronics newsletter

Data General packs power on single board

Probably the most powerful computer system yet offered on a single board was unveiled this week by Data General Corp. of Westboro, Mass. The MBC/1 is built around the company's 16-bit microNOVA microprocessor, and includes standard features that occupy four to five peripheral boards in other single-board computers. Besides the microNOVA central processor, **the board contains 2,048 bytes of static random-access memory, sockets for up to 4,096 bytes of programmable read-only memory,** an asynchronous communications interface, and 32 lines (16 parallel in and out) of digital input/output interface.

The MBC/1 also features the microNOVA's hardware multiply and divide capability, a real-time clock, direct memory access, and a 16-level priority interrupt structure. It has a small operating system, called MBC/M, that provides an emulator for program development using any other Data General operating system, up to the large Eclipse line, and a monitor for program execution on the MBC/1. All of the hardware fits on a board measuring 7.5 by 9.5 inches, which will sell for $695 and possibly under $500 in quantities of 100.

RCA sapphire version of 8085A due in 1979

First fruits of the technology- and product-exchange agreement between Intel Corp., Santa Clara, Calif., and RCA Solid State in Somerville, N. J. [*Electronics*, April 13, p. 41], should be harvested no later than the first quarter of 1979. That is when the RCA division expects to start shipping samples of its complementary-MOS-on-sapphire version of Intel's high-performance 8-bit microprocessor, the 8085A. After that will come a silicon-on-sapphire version of the 8048 one-chip microcomputer. **Meanwhile, RCA is readying its own 8-bit SOS microcomputer** and expects to have samples by year's end. Designated the 1804, it will have 64 bytes of random-access memory and 2 kilobytes of read-only memory together with the 1802 microprocessor.

Motorola's digital scrambler to use unique modulation

Watch for Motorola Inc. to integrate a digital scrambler into its top-of-the-line communications gear. But instead of the inversion scramblers now offered by two-way radio manufacturers, the firm's Schaumburg, Ill., Communications Group has chosen a **continuously-variable-slope delta-modulation technique that turns the voice signals into white noise.** With no speech components, an eavesdropper can't even tell that the system is on the air, the company claims. And Motorola's use of digital complementary-MOS circuits allows a high-security scrambler that, for the first time, can be built into portable transceivers. The equipment, tested by the Salt Lake City, Utah, Police Department, is compatible with existing networks and can be added when it becomes available in the next few months. Portables are coded with one of 2.36×10^{21} unique codes by plugging the radio into a handheld programmer, and users can change codes by altering the code stored in the programmer's memory.

National readies adjustable regulator with a punch

National Semiconductor Corp. will soon announce its highest-current adjustable voltage regulator. The three-terminal device, with a positive-voltage output adjustable from 1.2 to 33 V, is capable of handling a **continuous current load of 5 A but can supply current surges more than 10 times greater.** Semiconductor devices can survive current spikes as long as they don't overheat, says the Santa Clara, Calif., company, and it makes

use of that property by monitoring the thermal gradient, or rise in temperature, along the regulator chip's length. Current cutback occurs within milliseconds, long enough to let spikes through.

RCA drops out of games field, pares CB line

RCA Corp.'s television sales may be ablaze, but the firm isn't doing so well in some of its low-end consumer electronics businesses. After halting production on the Studio II monochrome programmable TV games while it reviewed its position in that business [*Electronics*, March 2, p. 8], RCA has chosen to quit the video games field, except as a supplier of solid-state circuitry to other game manufacturers. The reason: a "disappointing Christmas season for programmable video games." What's more, RCA's **Distributor and Special Products Division is pruning its citizens' band radio product line** to concentrate on single-sideband CB radios and those built into automobile dashboards.

TRAX from DEC cuts applications program time

A minicomputer-based software system called TRAX is said by Digital Equipment Corp. to halve the time required to write applications programs on most mainframe computers. The system, which runs on PDP-11/34 or PDP-11/70 minis, is intended for interactive transaction processing. Julius Marcus, vice president for information systems in the company's Commercial Products group, Merrimack, N. H., says **TRAX will do the repetitive data entry, verification, storage, processing, and retrieval functions,** freeing the user to develop applications programs such as general ledger, payroll, and personnel records management.

Introduced with TRAX was the VT62 video terminal, which contains a DEC-designed microprocessor. The microprocessor allows data editing and verification in the terminal, unburdening the central unit. A typical PDP-11/34 TRAX system with eight VT62 terminals, disk, and tape storage will be $131,840, with 256 kilobytes of main memory. The price for a PDP-11/70 TRAX system with 384 kilobytes of main memory, 20 terminals, disk, and tape storage is $211,420. Deliveries are to begin in July.

Computer makers eyeing System/400

A prototype of its new 32-bit IBM-compatible minicomputer (see p. 81) won't be seen until next month at the National Computer Conference, but already National Semiconductor Corp. **is talking to over half of the top 20 computer manufacturers** about supplying its new System/400 on an OEM basis. Officials of the Santa Clara, Calif., firm say they have no plans to sell and service the System/400 in the end-user market.

Addenda

Fairchild Camera and Instrument Corp.'s Xincom division is about to introduce a charge-coupled-device memory tester that it touts as the **first such system capable of complex device characterization.** The new tester will make its debut at the 1978 Semicon show in San Mateo, Calif., later this month. . . . National Semiconductor Corp. will soon bring out a chip for driving linear arrays of light-emitting diodes. Aimed at LED bar-graph applications as in VU meters for audio equipment, **the LM3914 can directly drive 10 LEDs and runs right off an audio signal.** Features built into the device, which will be ready as samples in the next few months, include moving-dot or continuous-bar illumination and a settable alarm point. The devices may even be cascaded.

5 DAY DELIVERY

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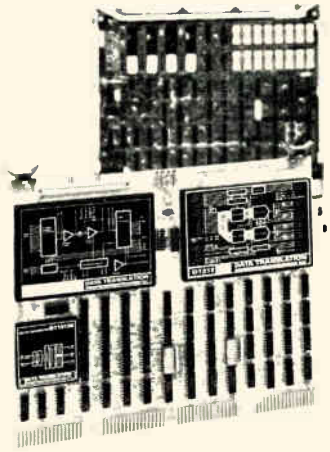

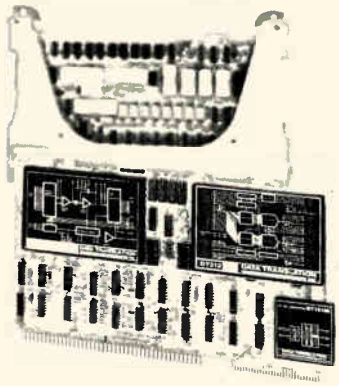

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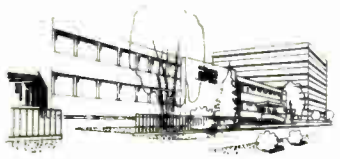
2400 A - 300 Hz/14 MHz

2430 A - 300 Hz/18.6 MHz

The frequency synthesizers / level generators **2400 and 2430** cover respectively the 300 Hz/14 MHz and the 300 Hz/18.6 MHz frequency range. The model 2400 is available with 50 Ω or 75Ω output impedance whereas the model 2430 has three selectable impedances (150 Ω and 600Ω balanced, 75Ω coaxial). These two models also have a tracking frequency output, with 20 MHz offset for the 2400 and with 24 MHz offset for the 2430. Both instruments are endowed with a low-impedance (Z < 5Ω) auxiliary output.

The models **2400 and 2430** are frequency and level programmable, either in parallel BCD code, or through **the IEEE bus with the Interface 414.**

In these three instruments, the output level is particularly well regulated (±0.05 dB within the entire frequency range) and the attenuators are very accurate (± 0.1 dB maximum error).



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Branch exchange still relies on space-division switch

Lightweight PABX from Mitel eschews popular time-division switching for LSI approach to electromechanical-type design

At a time when most manufacturers of private automatic branch exchanges are introducing minicomputer-controlled systems that use time-division switching, Canada's Mitel Corp. is heading in a different direction. It has divided the PABX design problem into two parts—control and switching—and attacked them with microprocessor and other large-scale integrated-circuit technology to develop what it claims is "the smallest, lightest, and least-power-consuming PABX available anywhere."

For starters, the Kanata, Ontario, firm chose to use a Motorola Semiconductor M6800 8-bit microprocessor, rather than a minicomputer, to control functions like call processing and to perform systems diagnosis for its new 256-port-capacity PABX, called the SX-200 Superswitch. Perhaps more significant, Mitel, which had $12 million in sales during its last fiscal year, returned to the space-division switching method in which point-to-point connections are made and maintained for the duration of telephone calls.

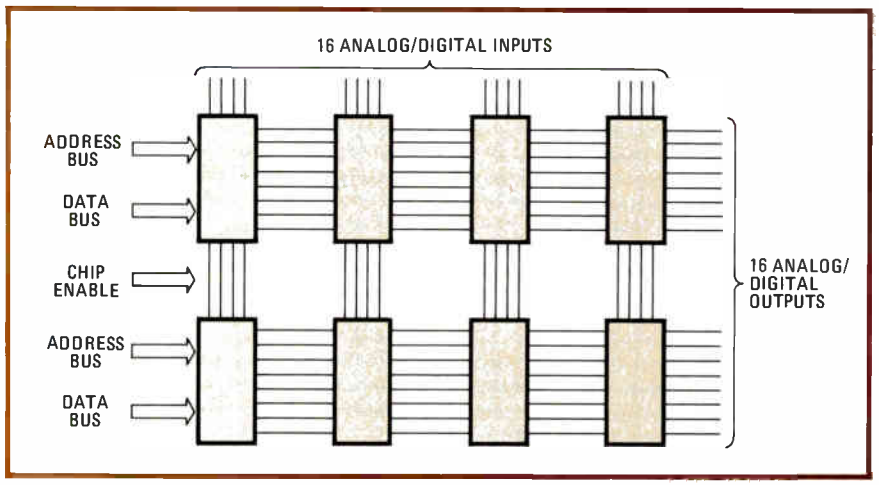
This technique traditionally has involved a matrix of physical connections among electromechanical components. In contrast, the time-division technique avoids the large number of connections by using electronic switches that periodically sample the input signals on lines and trunks at a rate fast enough to prevent the loss of information.

"It appeared to us that with the space-division approach, we could more readily apply LSI technology to the switching element itself and significantly reduce system size and cost," says Chris Elmer, switching-systems product manager. And "because the switch is analog and, thus, not concerned with high-speed clock rates and time slots, we can use low-speed complementary-MOS LSI throughout the system to bring power demand down low." Indeed, power consumption is low, 4 amperes from a 115-volt source, "or nearly half as much as competitive systems use," he claims.

MOS switch. The heart of the SX-200 is a Mitel-developed complementary-metal-oxide-semiconductor switching element that replaces 12 medium-scale integrated packages used in earlier designs. Designated the MT8804B, this 8-by-4 analog switch array incorporates 32 bits of control memory, decoder, and digital logic-level converters that interface with the 6800 microprocessor. Using eight of these 160-mil² ICs yields 256 switching combinations.

Equally impressive is the system's compactness. While the attendant console is comparable in size and weight to competitive designs, all of the switching equipment and a companion 48-V power supply fit in a single cabinet 36.625 by 23.375 by 28 inches and weighing some 250 pounds fully loaded. That is about one fourth to one half the size and weight of comparable-range PABXs from competitors.

Rolm Corp., for example, makes a 184-port system that is sold in the market at which Mitel is aiming. Rolm's small computerized branch-exchange system has a console that is 52 by 25 by 65 in. and weighs almost 700 pounds. "At full capacity, [it] draws at least 15 amps, so its power consumption is substantially greater than what Mitel is claim-



Connections. Eight custom C-MOS 8-by-4 analog switch arrays do job of electromechanical switching matrix. Connected as shown, they yield 256 switching combinations.

ing," says Richard M. Moley, market director at Rolm's Telecommunications division in Santa Clara, Calif.

Bell approved. Initial SX-200 production units began coming off the Mitel line only last month. It has already received a Bell System rating as suitable for use within its system. Does it really have power and size advantages over competitive systems? "It looks that way," says Robert W. Klumb, engineering specialist at AT&T's Purchased Products division in Basking Ridge, N. J., who has evaluated some 10 other systems in the 120-line class of PABXs. He refuses to go into detail.

Another plus for the Mitel unit is its price—"lower than comparable PABXs on the market," says Elmer. From 120 lines and up, the system costs less than $150 per line, and that is with Series 300 features, a Bell grouping usually included in PABX systems, "plus some extras like call forwarding and call back." □

Who will second-source the Rockwell chip?

Now that Rockwell International is introducing its R6500/1, what of alternate sources for the one-chip 8-bit n-channel metal-oxide-semiconductor·microcomputer?

Synertek Inc. of Santa Clara, Calif., recently acquired by Honewell Inc., will be a second source as part of an agreement that calls for Rockwell's Microelectronic Devices division to serve as alternate source for several large-scale integrated circuits coming from Synertek.

However, the picture isn't so clear at MOS Technology Inc. of Norristown, Pa., the original developers of the 6500 family of microcomputer devices. Engineering director Michael Canning says, "We will second-source the 6500/1 when it becomes available." But he will not give his firm's timetable for making and marketing the one-chip microcomputer. What's more, a Rockwell official says of MOS Technology's plans for the 6500/1, "They haven't let us know of any." Additionally, he believes his firm and Synertek are "locked together so tight" on the R6500/1 program that "MOS Technology is virtually out of it."

Canning will not comment on reports that most, if not all, of MOS Technology's original 6500 design team has left the firm, and that this may be a key reason why Rockwell, and not his firm, led the development of the 6500/1. He also will not comment on reports that, for similar reasons, MOS Technology has shelved plans to make and market a 16-bit n-channel MOS microcomputer, to have been called the 6600.

But none of this will not stop Rockwell from forging ahead with its own 16-bit, multichip microcomputer, the Super 65, due out next year. Before that, however, Rockwell will introduce a combination memory, timer, and input/output unit, the 6531, to be followed in the third quarter of 1978 by 3- and 4-megahertz versions of the R6500/1.

Microprocessors

Rockwell develops own one-chip design

The first single-chip microprocessor from Rockwell International, the R6500/1, also marks the first successful n-channel device for its Microelectronic Devices division, a leader in p-channel technology. Moreover, the unit incorporates a feature that makes it easier to apply than some of the other one-chippers streaming out of other semiconductor houses: it can be ordered in a package with pins that give designers access to its internal buses.

For the last four years or so, Rockwell has tried to catch up with the n-channel pack through both internal development programs and a 1975 agreement with National Semiconductor Corp. to exchange technology. Each tack, however, proved unsuccessful.

It required new management, principally a new vice president, Mal Northrup, who took over the division in early 1977, to find the right path—an agreement last year [*Electronics*, April 14, 1977, p. 46] with MOS Technology Inc. to second-source that company's n-channel 6500 processor family. Since then, Rockwell has gotten up to speed on n-channel, turning out large quantities of the multichip 6500 beginning last September. But the device that bows this week owes more to Rockwell than to MOS Technology.

Two versions. "The 6500/1 is entirely our own cold-start design, which took about 11 months to do, and comes in both 1- and 2-megahertz versions," says H. R. Anderson, who manages the 6500 product line at the Anaheim, Calif., division. But the one-chip processor does benefit from n-channel experience gained in making earlier members of the family. These include the multichip sets of 6502 processing unit, 2316 2-K read-only memory, 6520 adapter, 6522 counter-timer, and some random-access memories.

The most notable difference between the R6500/1 and the others is the way it provides a means for debugging prototype programs, he says. Just cramming memory, central processor, and input/outputs together on one chip sacrifices the separate address, data, and control buses that help track the program elements.

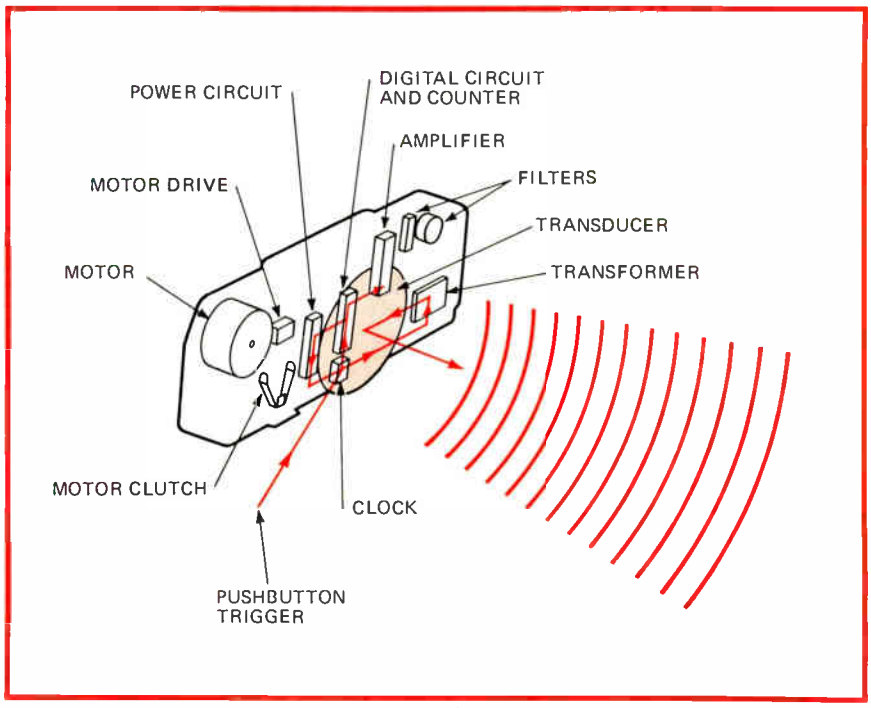
So in many cases when designers use the processor chip to write these programs, mistakes pop up that cannot be isolated between software or hardware. Because they are coded into permanent on-chip ROM, the entire device often must be junked.

Emulator version. Rockwell gets around this drawback by supplying an emulator version of the R6500/1 which gives access to the separate address, data, and control lines the single chip itself does not. For prototyping, a designer hooks up the emulator device to a separate programmable ROM. Because it does all the identical functions, he can write and change programs with a maximum of freedom. "When he's finished, the exact code used in the prototype can then be incorporated into the masked ROM for the R6500 production run," Anderson says.

"Taking the memory off the chip is the only way to go for single-chip program development and debugging," he continues, "because you can isolate the software and look at the lines if something doesn't work." Rockwell's emulator has a 64-pin dual in-line package, of which 40 pins are electrically identical to those of the standard R6500/1.

On the Rockwell chip, which has a 1-microsecond minimum instruction time in the 2-MHz version, are 2,048 by 8 bits of ROM, 64 by 8 bits of RAM, a 16-bit interval counter, and 32 bidirectional input/output lines. It operates from a single 5-volt power supply.

Software-compatible with the entire 6500 family, the 40-pin R6500/1 will sell for under $10 when it is in production in September, compared with about $20 for the four chips it replaces. Emulator parts are available now at single unit prices of $95 for the 2-MHz model and $75 for the 1-MHz version. □



Ranger. Sound waves created by electrostatic transducer helps new camera find range. Motor focuses lens according to time for sound to hit target and return.

Consumer

Polaroid focuses with sound waves

It has become traditional for Polaroid Corp. to drop a little news nugget at its annual meeting, and the April 25 gathering in Needham, Mass., was no exception. William J. McCune, president, unveiled a new version of the five-year-old SX-70 Land camera, one that relies on ultrasonic echo ranging to automatically focus the camera much faster than the manual focus of present versions. (For an automatic focusing scheme that relies on comparing two images electronically, see *Electronics*, April 27, p. 139.)

Main elements of the echo ranging are an electrostatic transducer, a ceramic-crystal-oscillator clock, and four bipolar control chips: the detector, the accumulator-counter, the amplifier, and the motor drive. The transducer acts as both transmitter and receiver for four ultrasonic frequencies that are emitted for 1 millisecond when the electronic trigger is activated when the usual camera push button is pressed.

The frequencies are centered around 50, 53, 57 and 60 kilohertz. The 60-kHz signal is sent out in the first ½ ms of transmission, followed by the other three in descending order of frequency in the next ½ ms. The four frequencies were chosen so as to virtually eliminate any chance of wave-front interference, caused by reflections from targets with different absorption characteristics.

Pressing the trigger starts the circuit's clock. A transformer drives the transducer, which is a diaphragm consisting of a metal backplate over which a gold-coated plastic foil is stretched. When the four-frequency chirp leaves the camera, the clock sends regularly spaced timing signals to the accumulator until the echo returns from the target to the transducer. These timing signals sequentially fill up to 128 accumulator positions that correspond to depth-of-field zones into which the focusing range is divided.

After sending the sound pulses, the transducer shifts to the receiving mode. When the first sound is returned, the detector signals the accumulator-counter to stop, and the counter signals the unit's power transistor to start the focusing motor drive that moves the lens from its park position near infinity.

Lens wheel. Linked to the lens is a lens-count wheel—a disk with slots geared to the lens—that takes pulses from the counter corresponding to each of the 128 positions of the accumulator. The wheel rotates the lens to correspond to the number of filled accumulator positions. A solenoid is then activated to stop the lens

at the precise focusing position.

The whole process requires just milliseconds, and the normal camera cycle continues through exposure and film ejection, which then causes the focusing motor to return the lens to the park position.

The circuitry runs off the SX-70 film pack battery but can be disengaged for full manual focusing. No price has been established for the new camera. It will reach retailers later this year. □

Medical

Communicator aids palsy victims

For some victims of cerebral palsy, a simple conversation can be as exhausting as lifting heavy objects for hours. Their thoughts, as complex and spontaneous as anyone else's, must often be condensed or curtailed because their motor coordination performs the intricate transition from ideas to words so very slowly.

Communications is perhaps the No. 1 problem for such people, and the few aids for printing messages that have been developed for them cannot be readily adapted to the physical characteristics of individual users. Nor has an editing feature been available to allow mistakes to be corrected. But the microcomputer may be able to change all that, as Derek Rowell is finding with what he calls a universal communicator, or Unicom, a system that combines a 12-inch-diagonal TV set, a printer, and a set of three input devices.

Editor. "This is the first unit for the handicapped that will allow messages to be edited. It acts like an intelligent terminal," says Rowell, who is director of the Sensory Aids Evaluation and Development Center at Massachusetts Institute of Technology [*Electronics*, April 27, p. 14]. Rowell's system, developed with a $24,000 grant from the Cerebral Palsy Research and Education Foundation is being used both as a learning-reinforcement tool and as a communicator. It could eventually be used for communication among handicapped persons.

"We gave the grant to Dr. Rowell because he proposed to build a device that was more adaptable and significantly less costly than ones currently available," says Dr. Leon Sternfeld, medical director of the foundation, in New York. The TV set and printer attach permanently to the Unicom; the input devices can be plugged in as needed.

The input devices are a modified typewriter keyboard, a panel of eight keyboard switches, and, for those with the lowest levels of motor control, a single oversized button. The button is useful, for example, for a person who is only able to move a portion of the body, like an elbow or knee.

Two-part screen. For the eight-switch panel and the button switch, the TV screen is divided into two sections, each containing eight 32-character lines; the top half is for forming and editing the messages, the bottom for displaying a menu of letters and words to be selected. With the keyboard input, the unit acts much like an ordinary cathode-ray-tube terminal, with the entire screen used for writing and editing the message. Messages are sent a line at a time to the printer.

Aid. In his right hand, MIT's Derek Rowell holds the single button with which words and letters can be chosen to form messages on the TV screen of his universal communicator.

The single button operates in unison with a slowly moving cursor; the user hits the button when the cursor is beside the desired line. A second hit on the button selects a character or word, which then is transferred to the top of the screen to form the message.

The Unicom, which sits on a table top, has two microcomputer boards, one a processor card using Motorola's 8-bit M6800, and the other a 4,096-byte read-only-memory card. The unit also contains a Motorola 6820 peripheral interface adapter for the input devices, an RS-232 interface for the printer, and what is called a video random-access memory by its developer, Matrox Electronic Systems of Montreal [*Electronics*, June 24, 1976, p. 153]. The memory, of 512 8-bit words, acts as an interface between the microcomputer and the display. Its output is a video signal that drives the TV set to provide its 16-line display.

So far, Rowell has built seven Unicoms, which are now in institutions and private homes. He says he can make the units for $1,800, compared with other units without microcomputer control that sell for up to $2,500. There are no plans yet to put the unit into production.

In the future, he sees the microcomputer portion of the system being applied to other tasks as well—for turning on lights, calling a nurse, or adjusting a bed, for example. He is also working on two new input devices—one a joystick that could be grasped by a person's mouth, the other incorporating an infrared source and detector for those who can only move their eyes. □

Instruments

Heurer introduces the smallest DMM

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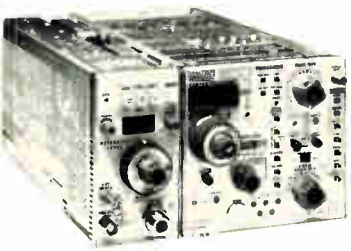

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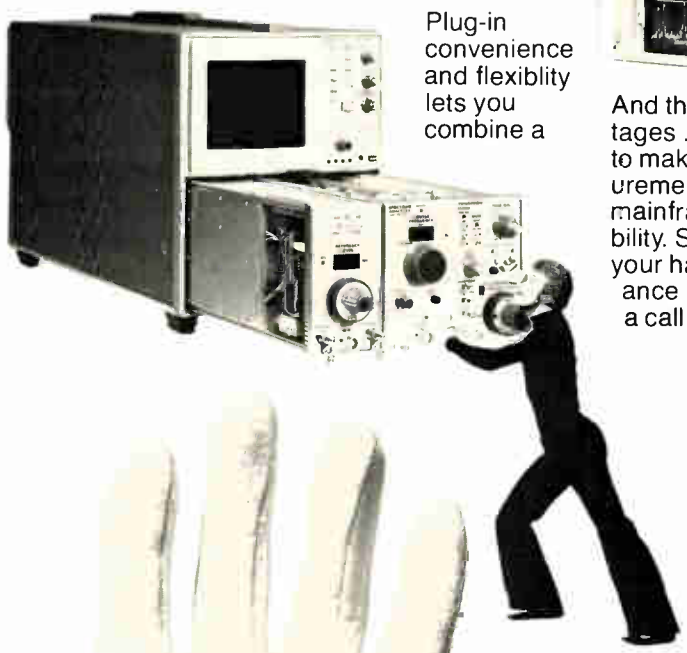

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Circle 43 on reader service card

Small. Jack Heurer holds wnat he bills as the world's smallest digital multimeter. Both meter and probe weigh in at 80 grams.

8020A digital multimeter? The answer to that question is "Yes, indeed!" according to Jack Heurer, head of Heurer-Leonidas SA, an innovative Swiss company best known for its stop watches. Backing up his belief, Heurer launched the DMM 2000 at the Newcom '78 show in Las Vegas last week, billing it as the world's smallest digital multimeter.

"We measured them both to the closest millimeter and ours is only one eighth as big, including the probe," says Heurer about a size comparison between the DMM 2000 and Fluke's 8020A handheld multimeter. Along with its smaller size, the Swiss portable has three other important advantages over cheaper units, he points out. There is true root mean square for ac functions, total radio-frequency shielding, and full readout on the display, since it shows what is being measured as well as how much of it there is.

The price is not as formidable as it looks at first glance, Heurer maintains, because it includes a margin for distributors and others. Heurer Time and Electronics Corp., in Springfield, N. J., will be selling the unit in the U. S.

Two parts. The DMM 2000, shown in the photograph, measures 100 by 40 by 14 mm and is built around a pair of custom complementary-metal-oxide-semiconductor chips. With it goes a probe that carries the function and range circuitry and their control switches. The probe measures 100 by 20 by 12 mm. The meter and probe together weigh 80 grams, with batteries.

The DMM 2000 has the usual five functions—ac and dc voltage and current, plus resistance. There are four ranges for each function, up to 1,000 volts, 2 amperes, and 20 megohms. Accuracy is within 0.5% plus one digit for dc voltage. Polarity indication is automatic. □

Photovoltaics

Germans aim at silicon cells

West Germany is making a serious bet—some $80 million over the next eight years—that AEG-Telefunken and Wacker-Chemitronic GmbH, a world leader in the production of silicon, have the answer to low-cost photovoltaic energy conversion. The move is part of the determination seen in Western Europe to be ready to compete with the United States in the 1980s, not only for European markets, but for worldwide sales (see also p. 85).

Wacker, in the Bavarian town of Burghausen, is counting on a solar-cell material made of polycrystalline silicon in a high-volume and low-cost industrial process. It has laboratory samples of 400-micrometer-thick wafers measuring 5 and 10 centimeters on a side that exhibit conversion efficiencies of better than 10%, depending on the grain size and the process details.

Wacker has formed a subsidiary, Heliotronic GmbH, also in Burghausen, to produce the Silso material. In an eight-year-long government-sponsored program, it plans to produce polycrystalline-silicon cell material whose cost could go down to at least a thirtieth its present level. This reduction should make it possible to produce 1 watt of power at well below $1, which experts say is the price to be met for the widespread application of solar electric power [*Electronics*, Nov. 11, 1976, p. 91]. Currently, it costs roughly $12 to produce 1 watt with terrestrial solar cells.

Heliotronic will be working in partnership with AEG-Telefunken, the giant German electronics concern and Europe's leading producer of solar cells for space vehicles. AEG-Telefunken's role will be to make first functional cells and then power-generating systems from Heliotronic's Silso material. By 1980, Telefunken plans to have prototype solar generators with a combined output of 70 kilowatts; by 1983, its annual capacity will rise to about 150 kw. Capacity will again double to about 300 kw by 1985.

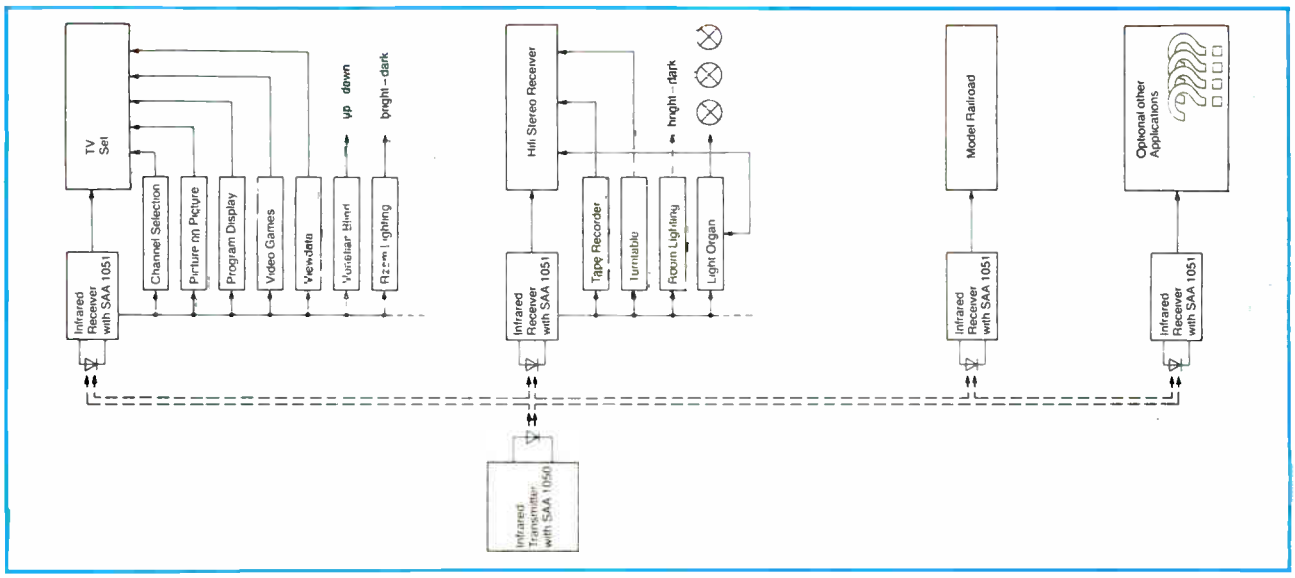
In fabricating its polycrystalline silicon, Heliotronic will use a crystallization process "that has more similarities with metal-casting schemes than with the various known techniques for producing single-crystal silicon," says Heinz Silbernagel, a Wacker director who heads Heliotronic. Conventional processes for growing single-crystal silicon are relatively slower, consume much more electric power, and also cost more.

Industrial scale. The new process allows silicon material to be produced on an industrial scale—with "large-volume output of wafers and a high degree of automation," Silbernagel says. He declines to reveal details because patents are pending. But, as others have also predicted, it is the high-volume output and the use of polycrystalline silicon requiring less processing that will bring about the price decline [*Electronics*, April 4, 1974, p. 99].

Wacker's entry into the silicon solar-cell business is certainly worth noting. Last year, the firm sold about $70 million worth of high-purity silicon, satisfying nearly a quarter of the Western world's demand for the material. The U. S. is one of its biggest customers.

With its Silso material, Heliotronic is entering a market with enormous potential. Worldwide demand for silicon solar-cell material is pegged by the company to reach roughly $500 million in 1985. By 1995, the annual market could reach $10 billion. Silbernagel sees big markets for photovoltaic converters in developing countries, specifically

The New Infrared Remote Control System from ITT Semiconductors



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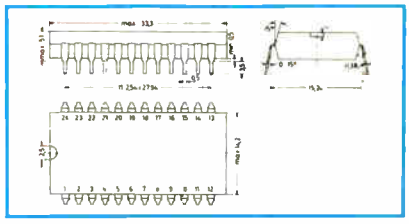

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at remote and unattended sites that cannot be economically tied to power-distribution grids.

Aware of the export potential, West Germany's Ministry for Research and Technology is behind much of the Heliotronic-AEG-Telefunken effort. It has earmarked $65 million for the two companies' work through 1985, covering 80% of the estimated cost of the project. The companies will provide the rest. □

Communications

Snooper locates radio transmitters

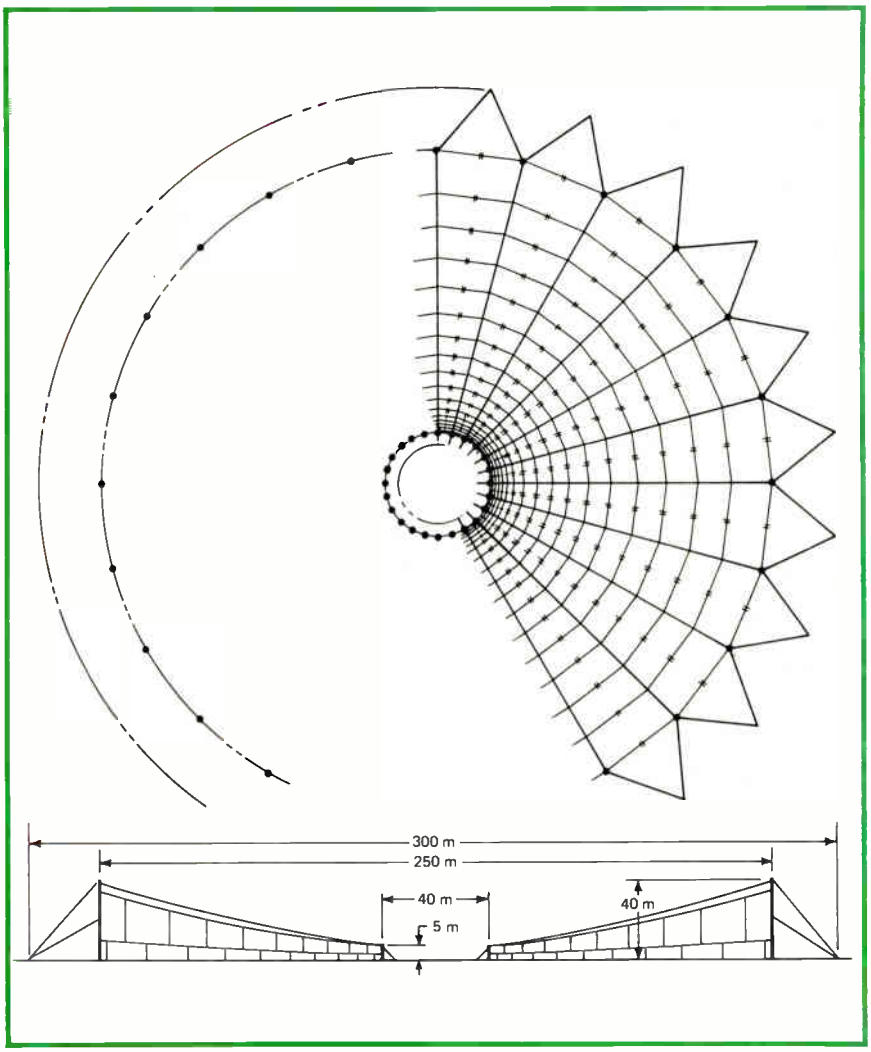
The spy world won't be quite the same following the Communications/78 International Exhibition in Birmingham, England, last month. There, Technology for Communications International Inc. unveiled a system for locating clandestine transmitters that takes a fraction of a second to spot the source of any radio signal in the 500-kilohertz-to-30-megahertz range.

This means that broadcasters, regulatory authorities, and the intelligence community now can be armed with more accurate and faster monitoring equipment, according to Larry Blum, marketing vice president for the Mountain View, Calif., firm. He says he has already sold two of the model 410 systems to undisclosed customers, one of them in the Middle East.

Up to now it has been difficult to detect and locate radio traffic from groups like mobile army units, guerrillas, or spies, for they may communicate for only seconds at a time.

Defects. Conventional detection methods suffer from several major defects, Blum says. Because they pinpoint location by triangulation, they must employ two widely spaced antenna arrays. The arrays themselves are typically composed of concentric circles of vertical monopole antennas interconnected to reflecting screens.

Direction finding involves a relatively slow mechanical goniometer that scans the outputs of the monopoles to produce an array beam for display on a cathode-ray tube. An operator must integrate out the effects of fading and modulation and pick out a transmitted signal as the beam traces around the display.



Listener. Smaller, high-frequency elements at the center graduate outward to larger, quasi-log periodic elements for lower frequencies in giant 300-meter-diameter antenna designed for locating clandestine transmitters. Antenna is in the $1 million-and-up class.

Blum's company has created a new kind of antenna array controlled by a minicomputer. The array is large—300 meters in diameter—but it reverses the standard layout by having the smaller antenna elements for high frequencies on the inside. The elements graduate outward to larger quasi-log periodic ones for low frequencies. This setup cuts the number of elements by 75%, the company says, and reduces the array's diameter to one third of what would otherwise be required.

Sky waves. The array operates by measuring the high-angle sky wave signals that bounce off the ionosphere from the relatively short-range transmitters for which it searches. Given the incoming angle and the height of the ionospheric reflection layer at the time, the minicomputer calculates the distance to the transmitter. The array is horizontally polarized to handle this angular measurement, as well as vertically polarized to measure azimuth. A conventional array is usually just vertically polarized.

If the 410 finds a signal of interest, it records it for computer analy-

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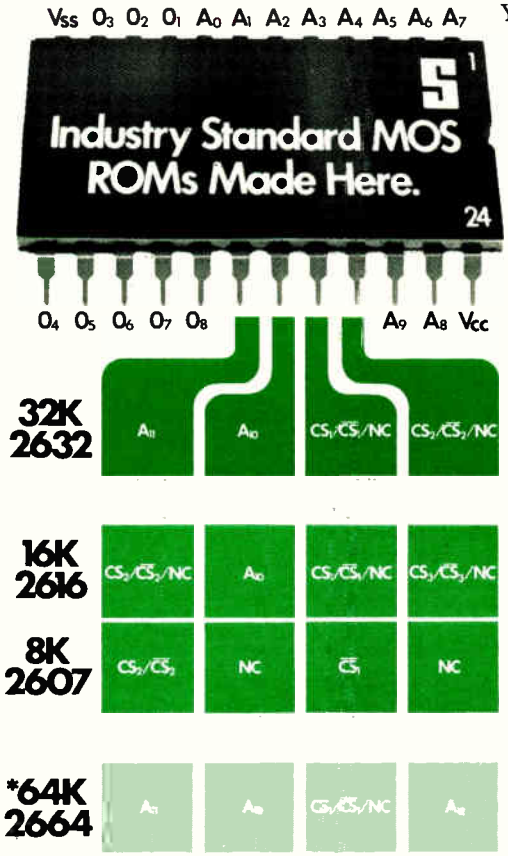

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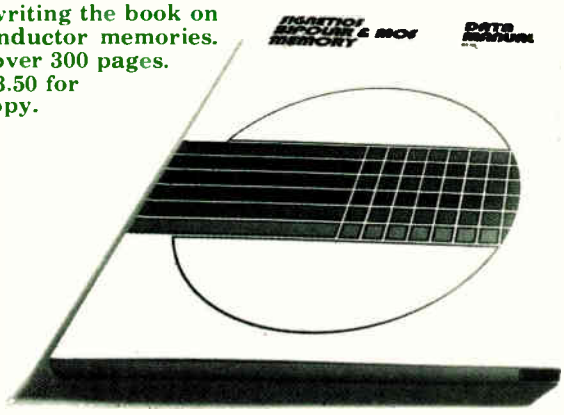

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sis, says Roy Woolsey, senior physicist. This takes less than a second for any frequency-shift-keyed, single-sideband, a-m or fm signal.

Because the firm's approach needs information about a signal's amplitude and phase, the 410 employs a dual-channel direction-finding technique. One channel focuses on the strongest signal, while the other polls the rest of the array. This yields the phase information and also removes any effects of modulation, Blum says. The results are converted to 12-bit data for analysis by a Hewlett-Packard 21MX minicomputer.

The array locks on signals that have skipped only once off the ionosphere. In tests, it pinpointed a 3.056-MHz signal to within 9 kilometers of a known 231-km distance. The 9 km seems far but it is actually close enough to allow the transmission to be tracked to its source using more conventional techniques, Blum says. His 10-year-old company, specializing in antenna arrays, says the model 410 costs $1 million and up depending upon complexity. He puts its market at between $10 million and $20 million a year. □

Military

GAO gives the F-16 a cautious blessing

The decision to put the F-16 single-engine fighter into production before its development is complete will keep costs on their upward course, concludes the General Accounting Office from its examination of the program. But the agency believes that the decision is worth it, because the plane's joint production by the members of the North Atlantic Treaty Organization will yield political benefits and advantages in weapons standardization.

Problems. Three important electronic subsystems—the radar, the weapons-management system, and the avionics-maintenance system—have run into development problems, causing schedule slippage, GAO says. Moreover, the agency points out that the F-16's user, the U. S. Air Force's Tactical Air Command, intends eventually to add several more electronic capabilities that will drive up costs even further.

With the F-16's mission divided between air-to-air and air-to-ground combat, its Westinghouse Electric pulse-doppler radar has to operate for both. In air-to-air operation, the radar has a look-up and look-down capability. In air-to-ground operation, it has modes for ranging, ground mapping, ground-map doppler-beam sharpening, beacon mapping, and sea-clutter removal.

The initially unacceptable doppler-beam sharpening was improved last year, GAO says, but tests of ground mapping and sea modes still showed problems. The Air Force notes, however, that the radar program has been meeting its development milestones. Officials point out that tests of the F-16's subsystems are far from over, continuing through early next year.

The weapons-management system, which coordinates weapons delivery with other subsystems like radar and optical displays, has slipped somewhat because of redesign. Of more concern is the avionics-maintenance system's four computer-controlled testers for ground maintenance. Changes to F-16 avionics during early production will require later changes to the maintenance system, GAO notes.

Potential. Future F-16 capabilities sought by the Tactical Air Command seem certain to increase the plane's unit cost later, the agency reports. TAC wants to add a new electronic countermeasures system mounted internally, rather than on external pods, and a new beyond-visual-range missile. Also, it wants a digital engine-diagnostic-and-control system, a Navstar/Global Positioning System satellite receiver, and space for a digital data link for use with the Joint Tactical Information Distribution System, as well as the new Pave Penny laser target-identification system.

Total program costs were revised upward by nearly 10% to $15.15 billion last fall, GAO notes, largely as a result of inflation. But new equipment on the F-16 will push costs up further, the watchdog agency warned Congress. While the aircraft's budget does not have complete estimates for adding alternate mission equipment and Pave Penny, GAO's estimate is that these systems alone would add another $165 million to the program's price tag.

The F-16, for which General Dynamics Corp. is prime contractor, will be the first major U. S. weapon produced jointly by the NATO allies to a single set of standards. Estimated cost per plane is already $4.76 million, some 5% above the $4.55 million target. Ultimately, production could reach 2,000 planes, with the U. S. Air Force buying 1,388. □

Packaging & production

Electron-beam cuts SAW design time

A two-step electron-beam lithography process for the manufacture of surface-acoustical-wave devices has produced SAW units that operate at fundamental frequencies up to 3 gigahertz. Even more important, it cuts design-to-packaged-device turnaround from up to eight weeks to three days.

Developed by Texas Instruments Inc., Dallas, in part with funding from the Air Force Avionics Laboratory, the process resolves line widths of 0.4 micrometer. A fundamental frequency of 3 GHz is three to four times the center frequency of SAW devices made by conventional photolithography equipment.

Military first. Initially, the devices produced by TI will be aimed at military microscan receivers. Therefore, much of the electron-beam work is still proprietary. Commercial applications of the process, which the firm will continue to pursue, are still one to two years down the road, according to Truman G. Blocker, manager of the VLSI lithography branch at the company's central research laboratory.

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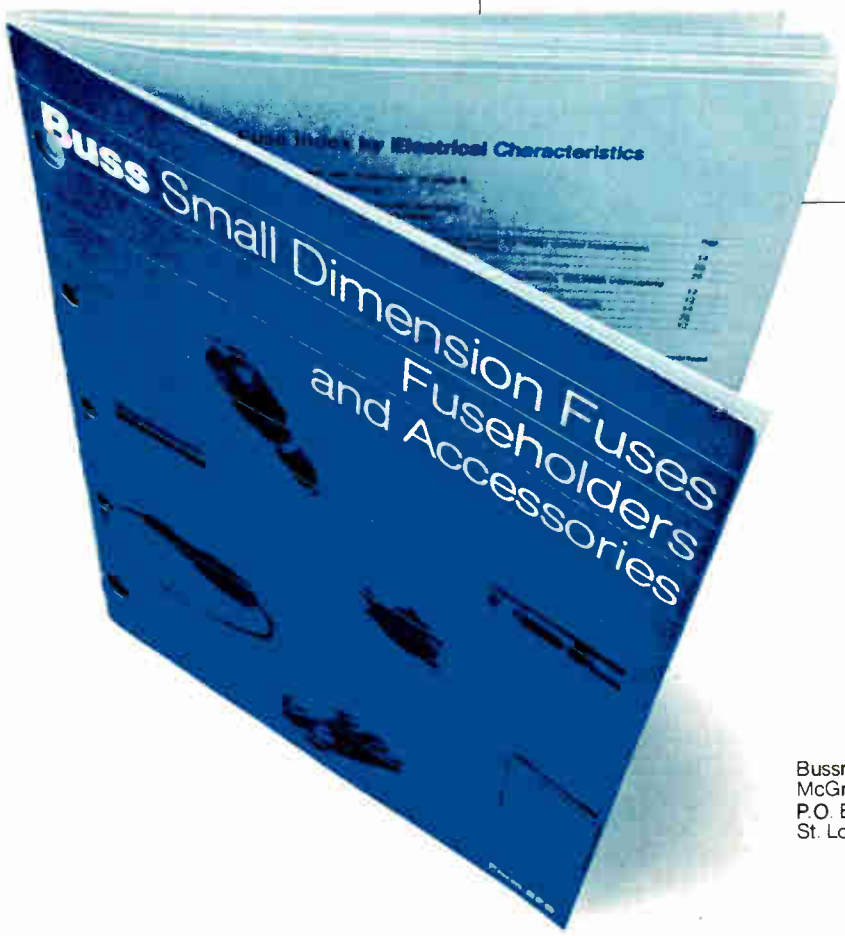

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graphy has the accuracy necessary to set a pattern for the large number of alternating parallel electrode stripes of varying spacing that make up a SAW device. Development is speeded because the pattern can be encoded and checked for errors and a final software copy written in a matter of hours. The masks are then ion-milled and ready for contact printing on the same day.

The two-step process also speeds manufacturing because of slice-to-slice uniformity and elimination of day-to-day recalibration for electron-sensitive resist variations and electron-gun deterioration that can occur in production. In the first step, the electron-beam draws the patterns. In the second step, the mask is printed on the polished substrate surface using a modified conformable mask printer.

Good look. TI examined three other approaches to high-resolution SAW fabrication: direct slice writing, hard photomask printing, and positive-resist conformable printing. But these methods proved to have shortcomings.

Direct slice writing had problems in adhesion of the negative resist pattern to the substrate. The hard photomask process ran up against mask-size limitations and poor resolution. The positive resist was not suitable because of interference reflections from the back side of the polished substrate. Instead, the ion-mill mask with a print conforming to the substrate and subsequent wet etch proved to be the best method. □

News briefs

GenRad to go public
GenRad Inc., the Concord, Mass., manufacturer of automatic test equipment and instruments, plans to make its first public stock offering. Founded in 1915 as General Radio Co., the firm has been privately held ever since, Steven Stadler, senior vice president, chief financial officer, and treasurer, says the main reason for the public offering is to create a market for the stock of 1,500 shareholders, including the company's retirement trust. GenRad, with 1977 sales of $70.1 million, just completed a record first quarter, reporting net sales of $16.1 million and net income of $818,000.

Fairchild acquiring interest in computer maker
Fairchild Camera and Instrument Corp. of Mountain View, Calif., has agreed to buy a minority interest in Magnuson Systems Corp. of nearby San Jose, a recently formed maker of computer systems plug-compatible with IBM machines. Magnuson, whose initial system is to be introduced later this month, was founded last fall by several former employees of Amdahl Corp., a major supplier of IBM-plug-compatible systems, and by Carl Amdahl, the son of Amdahl Corp.'s chairman, Gene M. Amdahl.

Cutler-Hammer to acquire Addington
Expanding its Instruments and Sytems Group formed last October, Cutler-Hammer Inc., Milwaukee, last month agreed in principle to acquire Addington Laboratories Inc. The Sunnyvale, Calif., maker of microwave components, including local oscillators for the ALQ-99 jammer produced by the AIL division of the group, had sales in 1977 of $6 million. Earlier in April, Cutler-Hammer made a similar agreement to acquire Singer Instrumentation operations in Los Angeles, a maker of communications test equipment with 1977 sales of $9.5 million. The Instruments and Systems Group had sales last year of $128.6 million, most of it from AIL.

Univac 1100/42 replacing IBM, CDC computers
The National Oceanic Atmospheric Administration will begin converting its computer operations in September to a new Univac 1100/42 to be installed by Sperry Univac in a $9.1 million contract spanning eight years. The Univac system will have more than twice the capacity of the IBM 360/65 and Control Data 6600 systems that it will replace, NOAA says.

Photovoltaics

GaAs program involves universities

The U. S. Department of Energy is using some of the funds earmarked for photovoltaic solar-cell technology to expand the nation's talent pool in this rapidly expanding field. The effort was disclosed after the department recently awarded Rockwell International Inc. a $1 million, year-long contract to explore new techniques for boosting the efficiency of thin-film solar cells that are made of gallium arsenide.

The contract, to Rockwell's Science Center at Thousand Oaks, Calif., includes provision for four university subcontractors, two of which are predominantly black schools. The purpose of the subcontracts is to generate faculty and student interest and expertise as they work with Rockwell to "develop new crystal-growth techniques, perform materials research, and develop processing techniques," according to the Department of Energy. The universities are Brown, Cornell, Howard, and North Carolina A&T State.

The program's overall goal is to boost the conversion efficiency of 2-micrometer-thick GaAs cells to more than 10% from the 6% laboratory level and to cut production costs to a range of 10 to 30 cents per peak watt, the department says.

The universities. Rockwell personnel will direct lab work in liquid phase epitaxy at North Carolina A&T and solar-cell electrical contacts at Howard. Faculty members from Brown and Cornell will help provide lectures and specialized instruction in solar-cell technology at the other schools. In addition, says a DOE program official, Cornell will analyze the GaAs cells after they are grown, while Brown will develop models of the cell systems.

The GaAs films are built up using both molecular-beam and epitaxial techniques under computer control. Part of the program seeks to deter-

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mine the effect of altered grain boundaries and material composition changes on cell performance. □

Batteries

Lithium cells go down to −50°C

Probably no lithium power cells have faced such continuous cold temperatures as the ones that reached the North Pole April 30. Better known for their power density and long life, they power the satellite beacon package carried by Japanese explorer Naomi Uemura (pronounced way-moor-uh) on his one-man, six-month dog-sled expedition that will cover 6,000 kilometers. He arrived at the pole after a 54-day trek. Ahead of him is a 2,800-km trip down the length of Greenland.

Uemura is taking systematic snow, ice, and air samples for Japan's National Institute of Polar Research and the Water Research Institute of Nagoya University in Japan. His lithium batteries, developed by GTE Laboratories Inc., Waltham, Mass., and produced by GTE Sylvania Inc.'s Communications Systems division, Needham, Mass., have to withstand temperatures down to −50°C. They power a transmitter that sends a 1-second data burst each minute that includes time, temperature, barometric pressure, and battery voltage level.

The signal is relayed by the National Aeronautics and Space Administration's Nimbus-6 meteorological research satellite, which flies over the Pole every 108 minutes, to a ground station in Alaska. From there, the data is sent to NASA's Goddard Space Flight Center, Greenbelt, Md., where a computer calculates Uemura's position.

Double D. The batteries are a critical component on the trip. They are lithium–thionyl-chloride cells that are twice as long as a conventional D cell, according to Anthony Miserendino, manager of lithium battery business development in the Communications Systems division. Sylvania will also use the material in much larger batteries it will supply to the Air Force for backup power for Minuteman intercontinental ballistic missile silos.

The double D cells at the North Pole have a lithium anode, a carbon cathode, and thionyl chloride with additives as the nonaqueous electrolyte. Sylvania has supplied them before to Federal agencies for driving remote sensors.

Until now, the batteries have been specified only down to −40°C. But eight days of testing in a temperature chamber at Goddard, including 43 hours at −50°C, indicated that the cells could do the job.

Each 4-pound battery pack has eight of the cells, with two parallel banks of four connected in series. Each pack is expected to last about 6 ampere-hours. The batteries, each of which is rated at 3.64 volts open circuit, provide between 11 and 12 v and withstand a steady drain of 11 milliamperes, with a surge of 0.5 ampere each minute during the 1-second pulse.

Miserendino says he does not fully understand why the lithium–thionyl chloride works so well at low temperatures. The liquid but nonaqueous electrolyte may offer less impedance than other electrolytes used in lithium batteries, like sulfur dioxide and vanadium pentoxide. □

Li_3N is the latest solid electrolyte

For rechargeable lithium batteries, researchers in West Germany have a new solid electrolyte in mind: lithium nitride. Says Albrecht Rabenau, a solid-state chemist at Stuttgart's Max Planck Institute for Solid State Research: "Even at room temperatures lithium nitride's conductivity is so good that it must be considered the best candidate for an electrolyte in a solid-state battery."

Experimental. So far, the researchers have not made a battery, but only experimented with the material. Since lithium is the lightest known metal, lithium batteries are

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PLANAR NEWS

FROM SGS-ATES

Adjustable and fixed regulators: SGS-ATES leads again with a new range of power linears for industrial and consumer applications.

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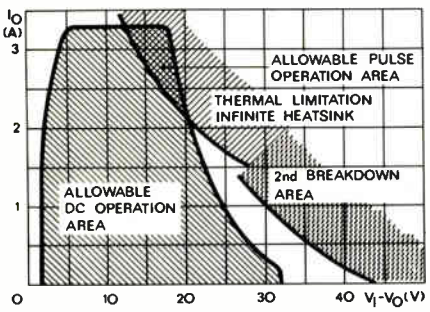

Internally limited allowable operation areas for all types.

Winning performance

Characteristics of both the L 200 adjustable regulator and of the L 2000 fixed regulator series include a maximum output current capability of 2.5 A typ, high thermal stability (0.01%/°C), low dropout (max. 2.5 V at I_L=1.5 A), excellent load regulation (max. 1% of V_{out} with ΔI_L = 2 A); minimum line regulation is 54 dB at V_o = 5 V while ripple rejection is 70 dB at V_{out}= 5 V (60 dB for the adjustable type). All this over a -25 to +150°C junction temperature range.

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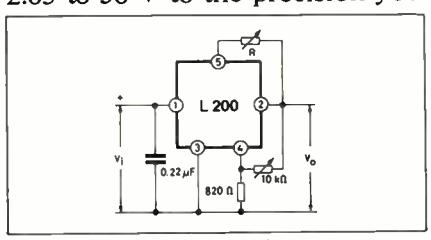
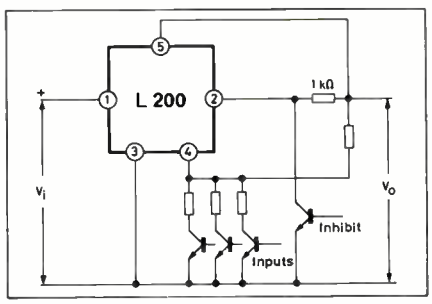
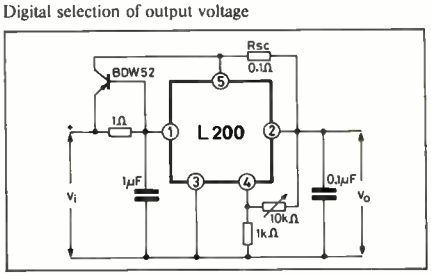
L 200: current and voltage adjustable from 0 to 2.5A (typ) and 2.85 to 38 V to the precision you require. Thanks to its programmability, the L 200 offers you the advantage of stocking one device instead of a complete range of fixed regulators, and the already vast applications spectrum for ordinary adjustable regulators is further widened by the inclusion of current programming and inhibit facilities.



Adjustable voltage and current regulator



Digital selection of output voltage



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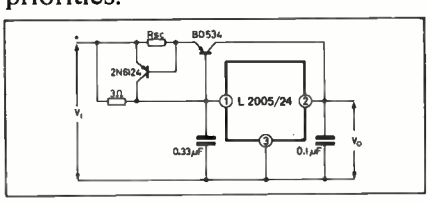

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Broadband cable services sought for rural America

A multibillion-dollar telecommunications equipment market for rural America could develop if the Agriculture Department and Congress both approve a plan to offer new broadband services. The departments' Rural Electrification Administration **is proposing to replace its existing telephone service in order to attract more subscribers** by the addition of cable television plus "a multitude of two-way services."

The department and members of Congress from rural areas favor the REA plan on the grounds that this added income would cut Federal borrowing by REA operators and make them more competitive in the growing telecommunications service market. Two-way REA services that could be included in the proposed legislation are regional systems for natural-disaster warnings and closed-circuit video for interactive courses by medical center for updating medical personnel in rural areas. Projected broadband system revenues in 1988 could rise 42% to $6.4 billion from the forecast $4.5 billion if services are unchanged. REA telephone income this year is pegged at $1.35 billion.

Sen. John Melcher (D., Mont.) and Rep. Charles Rose (D., N. C.) introduced bills at the end of April to permit REA broadband financing, as well as to modify Federal Communications Commission rules that now present cable TV ownership by telephone companies. The FCC says it plans to review those rules, too.

House unit votes $25 million for solar satellite R&D

A proposal to spend $25 million in fiscal 1979 on the accelerated research and development of solar-power satellites has cleared its first big congressional hurdle. The House Science and Technology Committee has voted 30 to 1 to approve H. R. 10601 to establish the program in the Department of Energy with support from the National Aeronautics and Space Administration [*Electronics*, April 27, p. 96]. **Alabama Democrat Ronnie Flippo, the bill's sponsor, says he hopes for a floor vote within a month.** Flippo's office sees the funds as seed money for a long-term program leading to a demonstration of ability of massive photovoltaic arrays in synchronous orbit to collect solar energy, convert it to electricity, and beam it via microwave to earth stations for distribution.

EDP standards enforcement could go to GSA . . .

A turnabout by the General Accounting Office could make the General Services Administration the central authority for enforcing contractor compliance with Federal computer standards on all Government purchases of commercial systems and peripherals. A leaked draft recommendation by the GAO that the President give the Commerce Department authority to enforce compatibility standards [*Electronics*, Feb. 2, p. 39] produced strong opposition from industry. Makers of computers and peripherals anxious to enlarge their share of the Federal market believe the GSA should have authority for enforcing compliance **since that agency already has procurement responsibility for all Government purchases of commercial systems.** As a result, the GAO altered its recommendation in its final report to say "the arguments for designating either Commerce or GSA both have merit."

Washington newsletter

. . . as Congress eyes NBS failure to push standards

The Commerce Department's failure to get its National Bureau of Standards to move faster on standards for computer compatibility was the basis for the industry's resistance to any expansion of its powers in this area. That inaction is still being weighed by Congress in the wake of a GAO study showing that the NBS failure **costs the Government an estimated $450 million annually to convert installations from one maker's equipment to another.** Federal users of computers therefore often prefer to avoid such conversion costs by remaining locked in with a single supplier and seek waivers of competitive bidding rules to do so. Despite a 1965 mandate under the Brooks Act to develop standards, the NBS effort failed, the GAO says, because it relied too heavily on industry to come up with standards; and did not give the program high-level attention, establish priorities, exercise adequate controls, or make the program visible to Congress and the Office of Management and Budget.

Jedec to vote again on ROM pinout standard

It's back to the ballot box for members of the Joint Electron Device Engineering Council JC-42 committee following its failure to adopt a proposed industry standard for a 24-pin pinout for 32,768- and 65,536-bit read-only memories. **Jedec letter ballots require a 90% positive vote for adoption of a standard,** but the initial ROM ballot was 17 to 2, or 89.47%. A revote was ordered by Raymond Johnson, Electronic Industries Association general counsel, after learning that committee members were apparently under the mistaken impression that votes could be changed at a subsequent Jedec meeting.

JTIDS software work to go to Draper Lab

Preparing for a competition on full-scale development of a Class II terminal for the Joint Tactical Information Distribution System, the Air Force is preparing a sole-source contract to the Charles Stark Draper Laboratory in Cambridge, Mass., for the terminal's software design guidelines. **The second of the three proposed JTIDS transceivers will be for fighter aircraft** in the system that provides secure communications between ground-missile sites, troops, support aircraft, ships, and tactical operations and intelligence centers. Large Class I terminals will be used by command control centers, with Class III manpacks—probably incorporating very-large-scale integration—to come. The Air Force says the Draper Lab award will be made by its Electronic Systems division, Hanscom Air Force Base, Bedford, Mass.

More aerospace jobs for engineers forecast by AIA

The number of jobs for engineers and scientists in aerospace will be more than anticipated, rising moderately through the remainder of the year to 176,000. That forecast by the Aerospace Industries Association is based on a 51-company survey that puts the job level at 174,000 by June—up from 173,000 last December and well ahead of the 166,000 at the close of 1976. **Jobs in avionics, basic research, and other nonaerospace categories will show the biggest percentage gains,** rising to 47,000 in December from 45,000 in June. Missile and space-vehicle jobs will remain flat at 50,000, with gains in missile production offset by declines in the space segment. Aircraft job totals will hold steady at 79,000 as gains from rising commercial transport business are countered by declines in military production.

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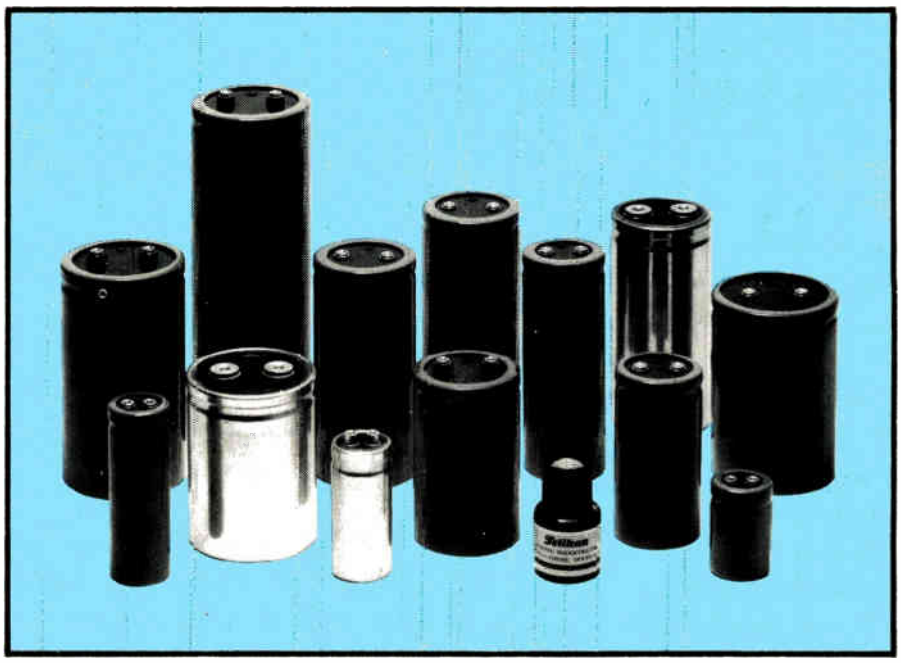

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WVDC Range	5 to 250	7.5 to 150	10 to 200	10 to 450
Capacitance Range (μF)	150 to 330,000	410 to 310,000	180 to 320,000	80 to 390,000
Max. ESR (ohms) at 120 Hz	330,000 μF at 5 WVDC: 0.0062	310,000 μF at 7.5 WVDC: 0.010	320,000 μF at 10 WVDC: 0.017	390,000 μF at 10 WVDC: 0.012
Max. RMS Ripple Current (Amperes) at 120 Hz and 85°C	330,000 μF at 5 WVDC: 36.0	310,000 μF at 7.5 WVDC: 23.9	320,000 μF at 10 WVDC: 18.3	390,000 μF at 10 WVDC: 15.3
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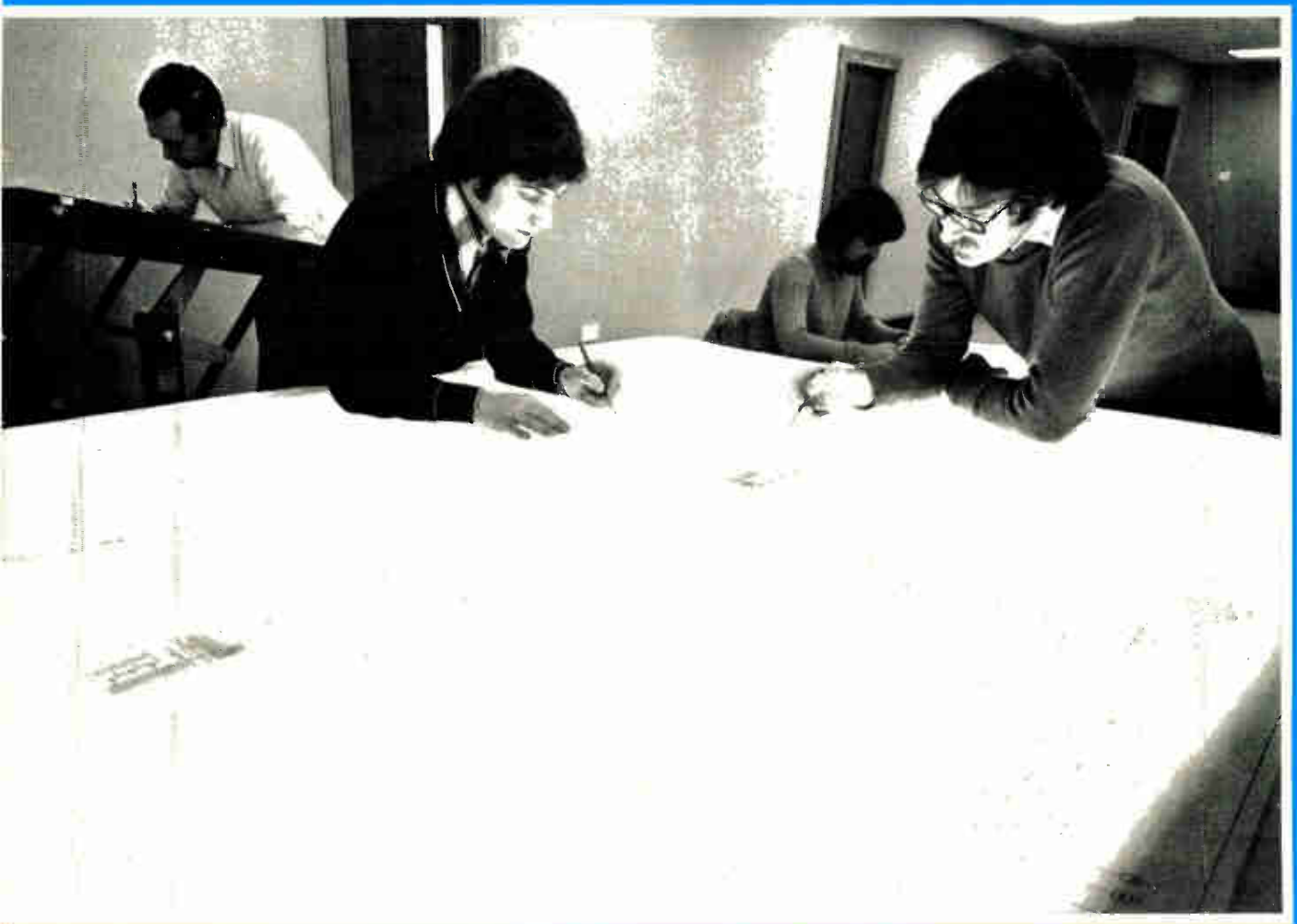
May 11, 1978

Electronics International

Archival storage digitizes data to slim system: page 67

In the works in Great Britain is a VLSI development program that probably will include designers at National's plant in Scotland: page 88



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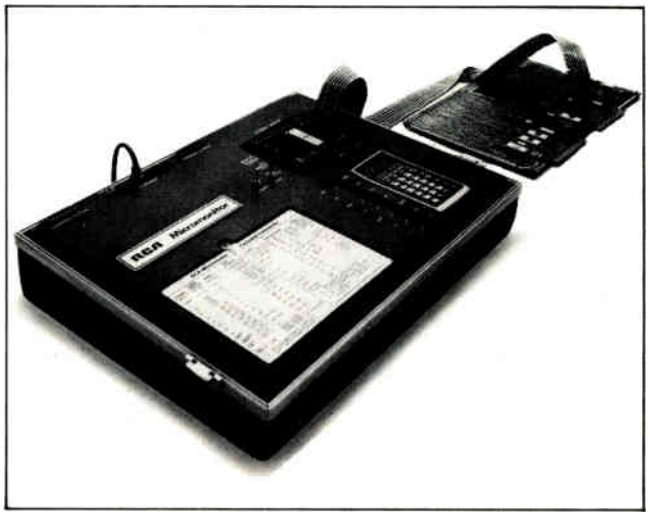

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Circle 63 on reader service card

International newsletter

Siemens to sell big computers from Fujitsu

Fujitsu Ltd., Japan's largest computer manufacturer, and Siemens AG, the biggest electrical and electronics producer in West Germany, plan to sign a formal agreement next month for marketing Fujitsu's large computers in Europe. **Observers say the link-up is a direct move to cut into IBM's 60% world share of the market.** It is a supplement to an existing accord on electronic data-processing equipment. The Japanese company's most advanced large computer will be sold under the Siemens trademark, while Fujitsu will import Siemens' ND2 high-speed printers and other computer hardware for use in systems sold in Japan. The two firms will also cooperate in development of software.

Transatlantic trials of high-speed data transmission planned

This summer will see the start of a new IBM-Comsat series of experiments in high-data-rate satellite transmission, using the Franco-German Symphonie satellite. Still subject to approval by the Federal Communications Commission, the new experiments will link four points for load-sharing and data-base applications. **An earlier experiment, conducted in spring 1977, demonstrated the technical feasibility but linked only two points,** La Guade in southern France and Gaithersburg, Md. The new experiment will link Comsat laboratories in Clarksburg, Md., IBM sites at Gaithersburg and the La Guade research lab, and the German space agency in Weilheim. Data rate will be 1.544 Mb/s.

Three-hour cassette for video recorders due from Philips

Mainly as a response to Japan's sales drive with long-playing video cassette recorders, Philips in the Netherlands will introduce a three-hour cassette compatible with the company's VCR-standard video recorders. **The long playing time for the LVC180 results from a tape only 13 μm thick**—as much as 4 μm thinner than the video tapes the company is currently using. When it goes on sale toward the end of the year, the LVC180 is expected to retail for less than $44. As a further move to meet Far East competition, Philips has cut the price for video cassettes already on the market by up to 35%.

French firm eyes big role in scientific gear

The French conglomerate, Creusot-Loire, is contemplating a full-scale move into scientific instruments. **The company has already acquired half a dozen instrumentation makers** whose turnover is now approaching $200 million a year. A firm decision from the heavy-engineering, steel and nuclear group is not expected for some months and depends on "many things, including government plans," says a company source.

Solution offered for TV, audio makers' woes in United Kingdom

For the United Kingdom's TV and audio-equipment makers to survive, two major steps are necessary, says the National Economic Development Council, a government advisory body. They are: a capacity cut of 20% to 30% together with the creation of larger and more viable companies, and the imposition of lower ceilings on monochromatic imports. **With 11 manufacturers, now operating on average at 50% of present capacity, UK firms are in no state** to withstand an increase in import penetration above the present level of 41% of the market, the report says. Events already are overtaking the report. Two of the smallest manufacturers, GEC and Rank, reportedly are negotiating with Japanese firms, with a view to joint ventures or outright sale. And Thorn Industries, the country's leading

supplier with 26% of the market, **is closing one of its three plants, resulting in a loss of 2,000 jobs.** However, the firm says the production levels will be maintained, because the closing is caused by the impact of large-scale integrated technology and increasingly automated assembly.

Racal regrouping, plans design center for LSI, VLSI

Racal Electronics Ltd. is forming two new operating groups as key elements in its growth strategy. They are a data-communications group, which pulls together modem-maker Racal-Milgo Inc. of Miami, Fla., and teleprinter-maker Racal-Vadic Inc. of Sunnyvale, Calif., under one management, and Racal Microelectronics Systems Ltd., **through which the company aims to keep abreast of developments in large-scale and very-large-scale integration.** The United Kingdom firm plans to spend $3 million on a microcircuit design and test facility to speed the design of LSI and later VLSI into Racal equipment.

Italy ready to aid electronics firms

It now looks certain that the Italian government will give its go-ahead by the end of June for a $450 million plan to restructure the country's electronics industries. Giancarlo Lizzeri, economic counselor at the ministry of industry, says **the government is nearly ready to start up with the five-year plan,** which was approved by the parliament last fall. Along with much-needed financial support for basic research, the plan calls for cooperation between key companies in major sectors like computers and telecommunications to make them more competitive in world markets.

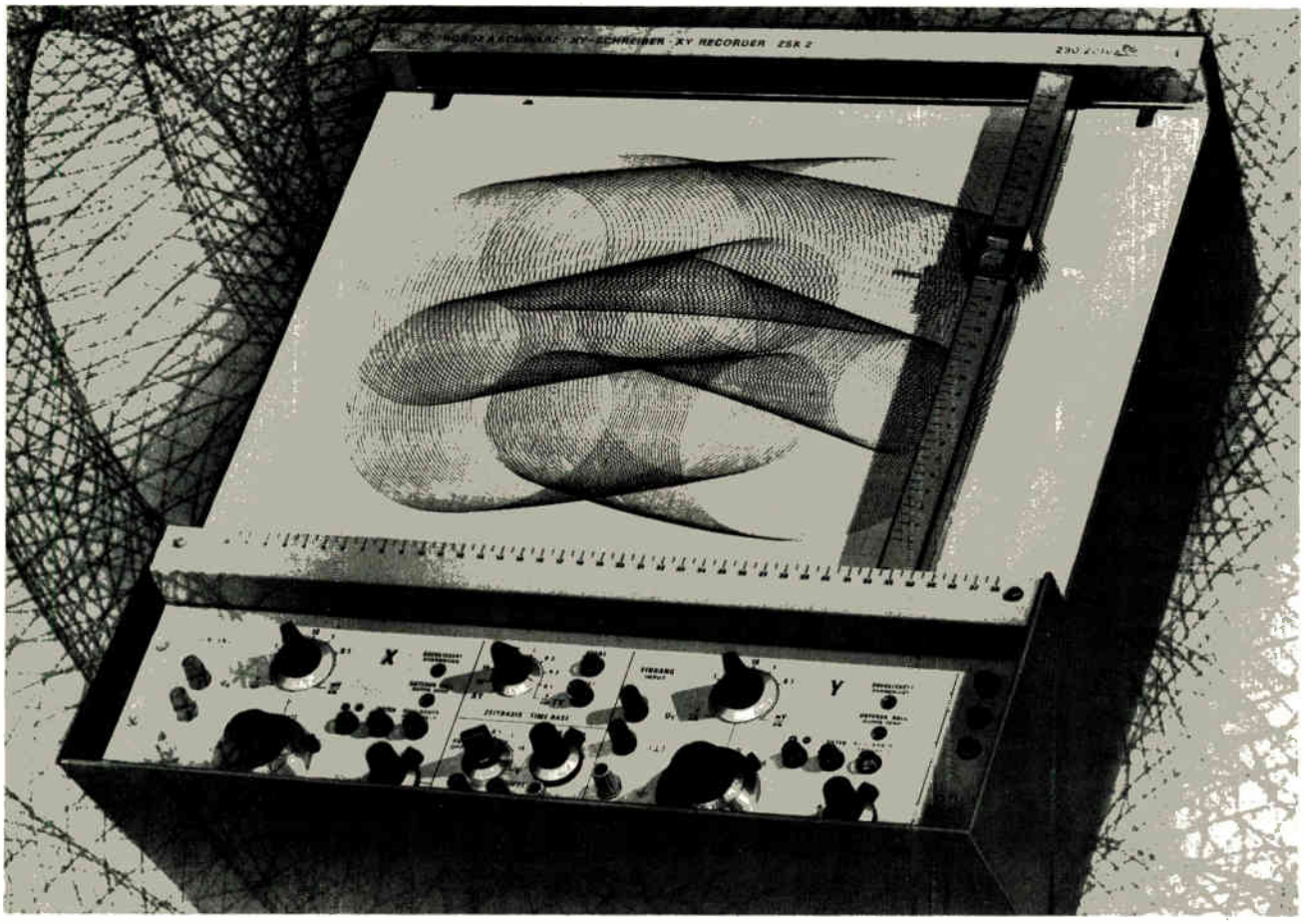
Microprocessor figures call charges for phone users

Telephone users can check the cost of calls they are making with a microprocessor-based timing unit from Monitel Ltd. in Colchester, England. The caller keys in each call's start and stop times and area charge code, **the charge is computed by a Rockwell PPS-4/11,** and a fluorescent digital display displays it. Variable data such as charge rates are initially programmed by a punched card. The $60 unit was developed by a contract research group, Palcentre International in Melbourne, Herts.

Addenda

Scientists at Philips research laboratories in the Netherlands have developed new magnetic materials **that could dramatically speed up bubble memories,** boosting bubble speeds to 30 to 500 m/s compared to 5 m/s in conventional materials. Key to the speed is a magnetic layer having some anisotropy in its plane, as well as a preferred axis of magnetization perpendicular to it. . . . Rounding out its process-control computer family, AEG-**Telefunken is unveiling a small 16-bit system, the AEG 80-20/2.** Its core or solid-state main memory is expandable to 64 kilobytes. . . . Three ITT British companies, Standard Telephones and Cables teamed with STL Laboratories and ITT Cannon, are to develop **an optical-fiber communication system that may replace conventional cable in Ptarmigan,** the British Army's tactical trunk communication system for the 1980s. . . . Small, Budapest-based Videoton saw its $2 million in 1977 Western European **sales of computers and terminals jump to $3 million for this year's first quarter.** The firm is negotiating with Teleprint of Frankfurt for a sales network throughout Western Europe.

New recorder family: precision priced right



For XY and YT plots there's now the recorder ZSK 2 in five different models so you can choose exactly the right one for your application, and at the right price.

ZSK 2 works on the principle of a self-balancing potentiometer. This gives minimal non-linearity (0.1%) and guarantees good reproducibility (0.05%). The high writing speed of >110 cm/s on both axes combined with fast acceleration produces superior dynamic characteristics. Deflection factors calibrated between 10 μV/cm and 11 V/cm, electronic limiting of the writing area for DIN A3 and A4 plus governable zero offset make operation easier, whilst inputs for remote control and ratio recording mean greater variety of use.

The models differ in their inputs:

Universal model 02
Sensitivity 10 μV/cm; floating input amplifiers with guard; timebase generator.

Standard model 04
Sensitivity 5 mV/cm; differential amplifiers for both inputs.

Lab model with timebase 06
Sensitivity 100 μV/cm; floating input amplifiers; timebase generator; offset-voltage source.

Lab model 08
Sensitivity 100 μV/cm; floating input amplifiers.

System model 10
Sensitivity 100 mV/cm; direct inputs Z_{in} 20 kΩ.

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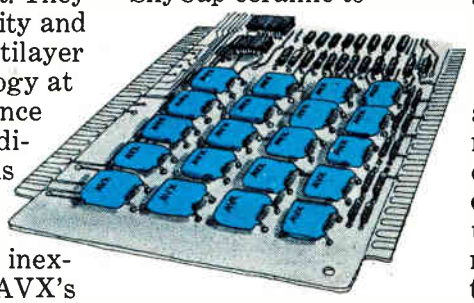
First of all, SkyCaps are inexpensive to buy. AVX's highly automated, high volume production has brought their cost down to the point where they are price competitive with film tantalums and some barrier layer capacitors. Secondly, their performance at operating frequencies often allows a lower value SkyCap ceramic to

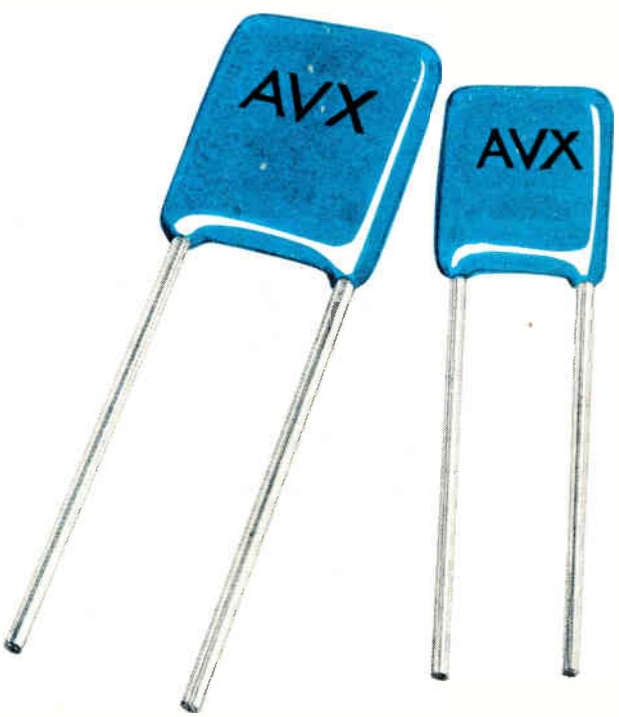


be substituted for a higher value competitive dielectric.

In decoupling applications, for example, a SkyCap will deliver about 80% of its rated capacitance at 10 MHz. Some competitive capacitors deliver only about 20%. Which means that if you're operating in this frequency range, you can use a SkyCap with a much lower capacitance rating, and probably a lower price. You'll also find that other types of capacitors increase in impedance at operating frequency, reducing their performance in decoupling. Impedance of a SkyCap, on the other hand, drops to nearly zero at the 10 MHz level.

When you combine low initial cost with high operating efficiency, you get the maximum in cost/performance. Which may explain why sales of SkyCaps more than doubled in 1977. And why SkyCaps are replacing tantalums, films and discs in EDP, telecommunications and commercial equipment applications.

...look to AVX.



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Archival store digitizes data and saves money

Mini-controlled system uses CCD document scanner and two digitizers for compact storage of data

Archival storage systems can run to millions of dollars for the equipment necessary to prepare the usual microfiches, so they are a natural for the cost-cutting advantages of microcircuitry. A small Brussels firm, Correlative Systems International, has gone to market with just such a system selling for a relatively modest few hundred thousand dollars.

The system, called Videofiche, uses a Fairchild charge-coupled-device array to scan documents. It then digitizes the data and stores it on video tape, passing it through a disk unit. As well as serving as intermediate storage, the disk is a fast storage device for a half-second-or-so retrieval of document images.

Savings. The system eliminates the expensive and complex mechanical microfiche storage and retrieval equipment found in many archive systems. Just as important, it also eliminates the need for manual coding of the document information.

One system is already up and running in the European Economic Community Commission's headquarters in Brussels. In the fall, the firm plans to have a demonstration system set up in California for the Wescon show. That appearance will be in conjunction with General Automation Inc., whose minicomputer drives the system.

Correlative Systems, which authors the software and puts together most of the hardware, is aiming to produce five systems by the end of the year and make one a month in 1979, says president Dan Borrey. He says he will have to move fast, because he expects NCR and IBM to have similar systems by 1980.

CCD scanner. The system's video camera is mechanically similar to any camera used for microfilm applications, but its optical part has been replaced by a Fairchild scanner—a CCD with 1,728 elements—costing about $3,750. The camera output is digitized into a 1,000-point-by-750-line page, which is then transferred to the magnetic disk. The disk stores the data until full and then dumps it onto tape. Before the data goes into the tape, it is mixed with synchronizing signals, turning it into a type of TV signal.

According to Roland Borrey, technical director of the firm, the clever part of the whole system is a pair of 15-megahertz synchronized 4-bit digitizers that not only digitizes the data from the camera and from the video tape, but also removes the white background from the image. The CCD unit scans a line, picking up black and white points. If a sequence of white points is detected, it appears in the data stream simply as a count signal saying, in effect, "X white points start here."

Thus data can be stored much more economically. A 300-megabyte disk can typically store some 6,000 images of A4 documents (21 by 29.7 centimeters), while the standard video-tape reel can hold 75,000 images. Without background elimination, the Videofiche stores would hold on the order of 3,000 and 25,000 images, respectively.

Retrieval takes place from a cathode-ray-tube terminal. The operator calls up a document via its identification number, and the document is retrieved from either disk or tape. Disk retrieval is near-instantaneous, while retrieval from the microcomputer-controlled tape unit takes an average of 45 s or a maximum of 3½ minutes. The camera, the magnetic video-tape unit, and the terminals are controlled by National Semiconductor BLC 80/10 microcomputers, which are second-source versions of the Intel SBC 80/10.

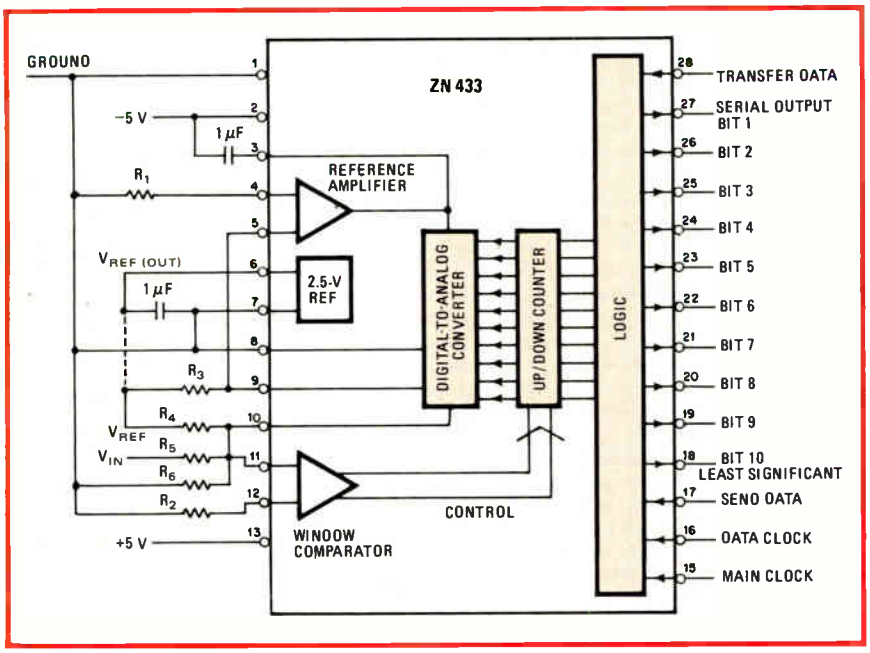
Memories. The terminals each have 64-K random-access memories based on Mostek MK4104P-4 chips and can generate graphics or character images. The microprocessor control allows rolling of the image. "If we oriented the screen vertically, we could show the whole A4 picture," Roland Borrey explains. "But putting it in the horizontal plane, we can only show 40% at a time. This is why we need to roll the image."

The computer is a General Automation 440 with 64-K 16-bit words of memory. The storage size is adequate to handle up to 16 terminals, the company says. □

Great Britain

Tracking a-d chip converts swiftly

The tracking analog-to-digital converter has taken a back seat to successive-approximation units, but for coming digital data-acquisition systems it has its rival licked in



Early conversion. Ferranti tracking analog-to-digital converter chips will team with each transducer in data-acquisition systems for immediate conversion of analog data.

performance, says Ferranti Semiconductors Ltd. Once a signal has been acquired, the firm's new 10-bit tracking ZN433 is 10 times faster than equivalent state-of-the art successive-approximation converters like its nine-month-old sister chip, the 10-bit ZN432.

Because the tracking converter dispenses with front-end sample-and-hold circuits, its systems cost is less than its rival's. In addition, systems management is easier: the ZN433's output is always valid, so it does not have to be polled to perform conversion operations.

Initially aimed at avionics applications, the 28-pin ZN433 is fabricated with Ferranti's versatile collector-diffused-isolation process, a large-scale integrated technology that readily mixes analog and digital functions on chip. Shoehorned into a 150-mil-square chip (see figure) is a 10-bit a-d converter, a 2.5-volt bandgap reference and amplifier, a comparator, and the tracking logic.

At the source. The new chip is designed to meet a requirement for a new generation of digital data-acquisition systems capable of tracking fast-changing signals up to 300 hertz. Samples are now available from the Gem Mills, Lancs., firm.

Before monolithic a-d converters came on the scene, transducer outputs were transmitted as analog levels to the CPU, where an analog multiplexer followed by a high-speed converter sampled each channel sequentially. However, this technique needed expensive and bulky low-noise cable for each channel.

The development of single-chip a-d converters makes conversion at the source economically and technically feasible. Now, with the ZN433, as many as 32 channels of cable can be replaced with a single twisted-pair bus offering 10-bit resolution, says the chip's designer, Andrew Jenkins. Other advantages accrue by going digital at the source: analog multiplexers are eliminated; common-mode noise is considerably reduced; and simultaneous sampling on all channels becomes possible, thus eliminating interpolation errors.

The big edge that the tracking converter has over successive-approximation units is speed of operation when the signal level changes only slightly, Jenkins says. Both types of monolithic units incorporate an easy-to-fabricate converter with an output matched by control logic to the incoming analog level. The difference in converter speeds comes from the way the two control logics operate.

In a successive-approximation chip, conversion is accomplished by setting each bit of the successive-approximation register in turn, beginning with the most significant, and comparing the output with the incoming analog level. If the incoming level is greater, the bit remains set; if lower, the bit is cleared. This tactic means that the conversion time is always fixed at roughly 10 clock cycles for a 10-bit conversion.

Counting. In a tracking chip, an up-down counter drives a converter, whose output is compared with the incoming analog level. The logic is so arranged that the counter counts up if the output is less than the analog input and down if it is greater. If the analog input is constant, the counter hunts back and forth between the two adjacent bit values.

Thus conversion times varies significantly, and that is why tracking converters do not get used too often. At the two extremes, it can acquire a signal in one clock period, or it could take 1,023 periods for a 10-bit conversion.

This attribute rules out the tracking converter in multiplexer applications. But when teamed with a single transducer, it can follow small signal changes swiftly. Changes of less than 1 significant bit are followed at clock rate, 10 times faster than a successive-approximation converter with the same clock speed.

Thus at a 1-megahertz clock rate, the ZN433 can accurately track 300-Hz signals representing variations of temperature, pressure, or other physical parameters. In contrast, a successive-approximation chip with a 20-microsecond conversion time has a bandwidth of only 15 Hz, which can be pushed to 70 Hz with sample-and-hold circuits. Moreover, data from the tracking converter is always valid, updating each clock cycle, whereas the successive-approximation converter retains its last value until the new update.

Performance. Another convenient feature of the converter is its ±5-volt supply. The chip draws 40 milliamperes and has a temperature

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Circle 69 on reader service card

coefficient of 30 ppm/°C over a −55°C to 125°C temperature range. Data loaded into the output shift register is available in parallel or serial form through transistor-transistor-logic–compatible outputs.

Quantity cost of the military version is $50 to $60, dropping to under $20 for lesser-performing versions purchased in bulk. These prices are expensive for monolithic converters, but Ferranti hopes to convince buyers that they are paying for module performance. The military version offers a linearity error and a differential nonlinearity of ±½ least significant bit. Maximum clock rate is 1.5 MHz typically and 1 MHz guaranteed. Supply rejection is ½ LSB/V. Each version has a guaranteed monotonic output.

Avionics is one immediate application for converters of this kind, and, says Jenkins, the ZN433 could readily be used in the serial-data-system standard adopted by U. S. military aircraft. In fact, development was funded by the Ministry of Defence Procurement executive and sponsored by the Instrumentation and Trials department of the Royal Air Force. □

West Germany

Cyclists' intercom gives the word while adjusting its volume for noise levels

Motorcycle riders have a language all their own, since the noise, the wind, and their helmets combine to make conversation impossible on a bike. Still, the various hand signals, drummings on helmets, and so on, are not very reliable.

So engineers at Bayrische Motoren Werke AG, West Germany's largest motorcycle producer, are turning to an intercom system. But it is not just any intercom: its loudspeaker output automatically adjusts itself to the ever-changing noise levels that motorcyclists encounter.

Compact. Designed and built at Habra Elektronik GmbH, a 15-man Munich engineering firm specializing in intercom equipment for light aircraft and tanks, the system has a loudspeaker-microphone kit fitting snugly into the helmet of each rider. A control unit about the size of a cigarette pack easily fits into the pocket in one rider's kidney belt. BMW is now introducing the system for roughly $340 (see photograph).

Good vibes. Helmets of these cycle riders hold intercom loudspeaker-microphone kits. A compact control unit automatically adjusts the intercom's volume to noise levels.

The operating principles of the model 3026 are sufficiently novel that patents are pending, says Franz Hauser, the system's designer and co-owner of Habra. Basic to its operation is a feed of both the noise- and speech-signal components to a broad-band adder stage in the control unit. A diplexer then separates the mixer output into speech- and noise-frequency components.

Of course, the noise frequencies include the voice-frequency spectrum, and their power levels vary considerably. For optimum voice transmission, these ever-changing parameters must be constantly taken into account. But that can hardly be done with manual controls, Hauser says.

Recognizing speech. In the absence of speech, the microphone functions as a noise sensor and the noise level is continuously evaluated. When one of the riders begins to talk, the power level in the voice channel immediately increases, as do the amplitude spikes characteristic of speech.

These power and frequency parameters serve as criteria in speech recognition. The noise level is stored in a digital memory for the duration of the speech and serves as a reference. When speech begins, the new power level is measured and compared with the values stored in memory. The voice-amplitude peaks are stored in an analog memory and used for automatic gain control.

Keeping tabs on the multitude of frequencies and power levels is a small computing device consisting of filter networks and a number of logic-control circuits primarily from Fairchild and Texas Instruments. The voice-frequency spectrum is

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The PSE-11 is coupled to the Level Meter so that according to the measurement mode, the receiver frequency corresponds to 1 x, 2 x or 3 x the value of send frequency. When measuring intermodulation by using the difference frequency method for d_2, the PSE-11 supplies a two frequency measuring signal (at 200 Hz difference), whereby the Receiver is automatically tuned to 200 Hz. The result: just pushing a button suffices for k_2, k_3, and d_2 measurements. Additionally, the SPM-11 and PSE-11 offer:

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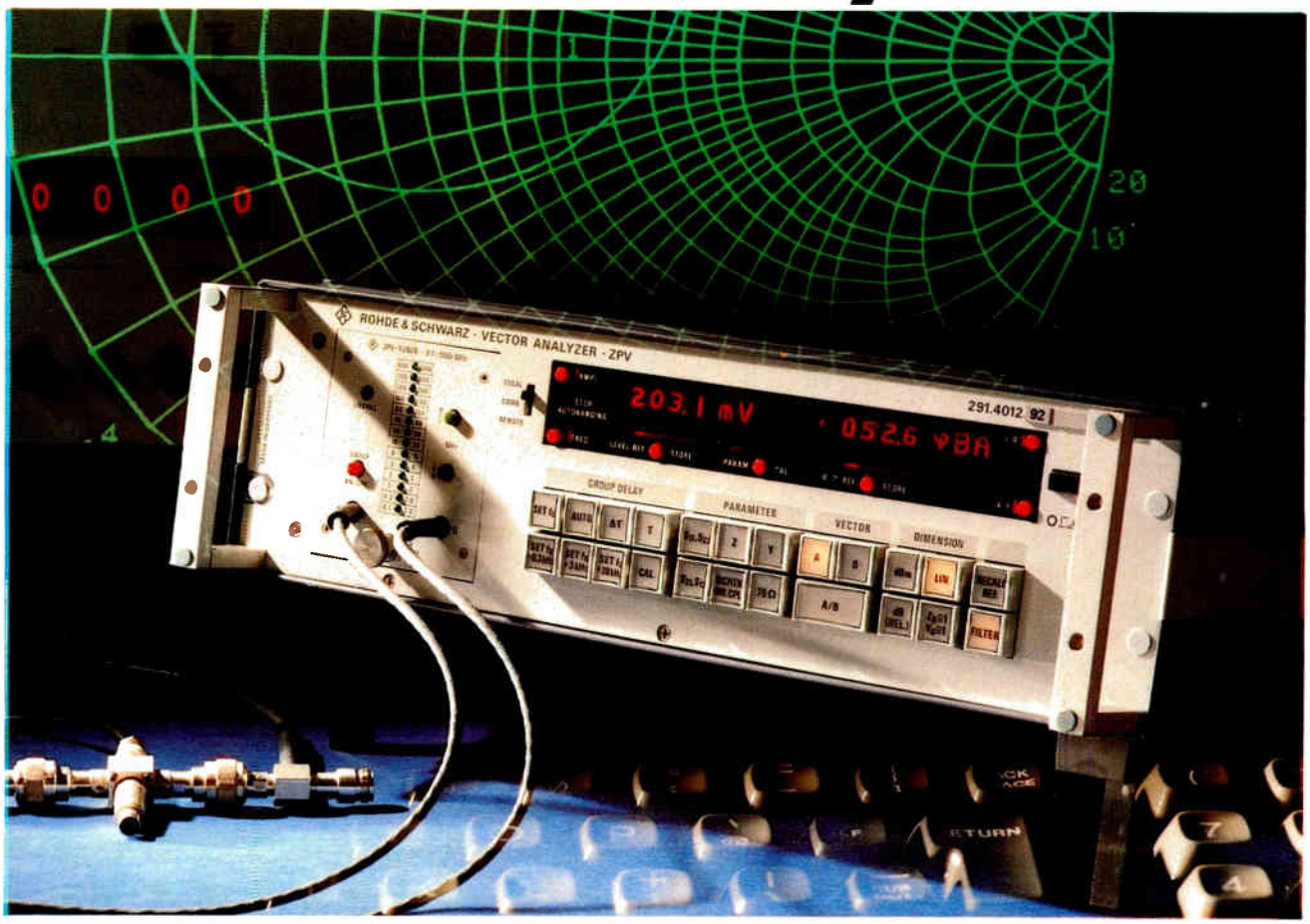
Going new ways: vector analyzer ZPV



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ZPV for measurement and direct digital readout of:

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ZPV for highest operating ease through built-in intelligence: choose type of measurement, store reference value by pushing button, read off result – everything else (selection of measuring and frequency ranges, calculation of values measured and performance monitoring) is handled by the microprocessor.

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Circle 702 on reader service card 1E

Electronics international

One problem that is being solved is the thickness of the control box. The firm is confident it can be reduced to a fraction of its present size, just as calculators have been shrunk to playing-card size. The developers also plan to integrate the LEDs so that each display will contain several diode chips, not a mass of individual diodes. □

Great Britain

Microcircuit manufacturers rush to fill demand for coder-decoders

With British telecommunications moving into the era of digital exchanges and transmission, the lure of a major new market for coder-decoder chips has accelerated activity among the nation's microcircuit suppliers. Four of them have standard parts in varying states of readiness [*Electronics*, April 13, p. 77].

The front-runners in the rush to get products to the market must be General Instrument Microelectronics Ltd. and Ferranti Semiconductors Ltd. Both are teaming with the British Post Office in the development of a single-channel codec chip using a delta-sigma-modulator conversion technique.

Samples. GIM already has samples out to customers and is producing devices in hundreds; Ferranti hopes for first samples in the next two to three months. Also aiming for first samples this year is Plessey Semiconductors, which, unlike GIM and Ferranti, is going for the 24- to 32-channel pulse-code-modulation market. Its fast two-chip codec set can be time-shared between channels, thus minimizing per-channel costs. Completing the quartet is General Electric Co.'s Hirst Research Laboratories, where work is in progress on a multichip codec.

The changeover to digital exchanges in both the public and private sectors will be felt by the British by the early 1980s. The BPO is giving urgent priority to the System X all-digital main exchange. The first trunk, junction, and small local exchanges are due by 1981.

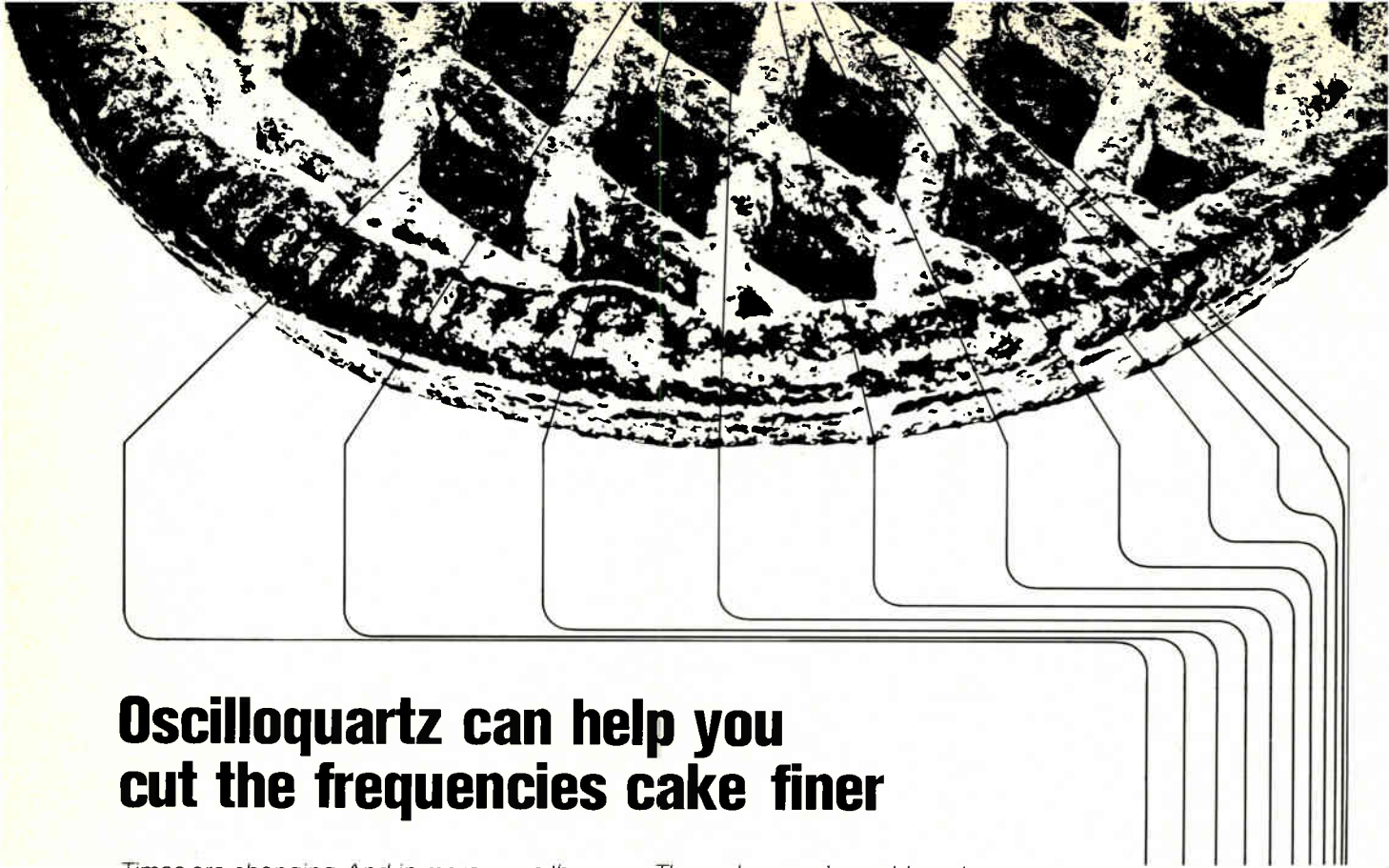
The first use of the post office's delta-sigma modulator will be in the CDSS 1 100-line, all-digital, microprocessor-controlled private automated branch exchange, where it will interface with the subscriber's phone. Outside lines also could each require a codec, but the post office will be eager to connect to the local exchange via a PCM link in which an inexpensive off-chip delta-sigma modulator produces a single-bit-per-sample output that can readily be handled digitally. This would permit an all-digital LSI chip to perform conversion to the European A-law compounding standard and back. There also will be additional business once the big new PABX digital exchanges from Plessey and Ferranti are approved by the BPO.

Processes. General Instrument is using its ion-implanted n-channel MOS process and Ferranti is using its bipolar LSI collector-diffused-isolation process.

Plessey is plowing its resources into an LSI implementation of traditional successive-approximation converters, a task that has daunted competitors because of the high matching tolerances required. But it says these problems can be bypassed by clever circuit design and by the use of advanced new processes.

Hirst labs has plans for a two-chip complementary-MOS codec using a recirculating conversion technique. This technique avoids the need for high-precision components, does not require an overly complex chip, and may be used in time-shared operation, GEC says.

Breadboard and thick-film versions have been built; the next step is the layout of more complex LSI chips preparatory to the final two-chip design. The complexity is about 500 to 700 components for coder and decoder. □



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They are your economical route to spot-on performance in communications and navigation systems, applications where signal multiplication to higher frequencies is required, in synthesizers, time-code generators, counters and spectrum analyzers.
Take a look at the specification. You're getting the sort of short-term stability, spectral purity and long-term aging performance formerly available only in oscillators produced for laboratory work. Yet the cost of the B-1325 and B-1326 is comfortably within the industrial-type oscillator range.
But that's not all. If you're in the communications field, you get more economic mileage out of these OCXOs. You'll need a lot fewer calibrations to stay within the increasingly stringent requirements demanded by the FCC, CCITT and government communications agencies around the world.

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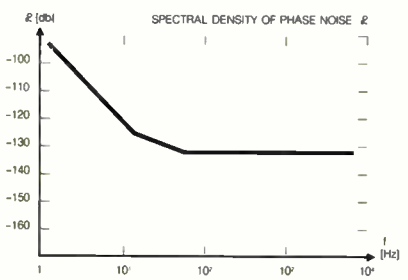

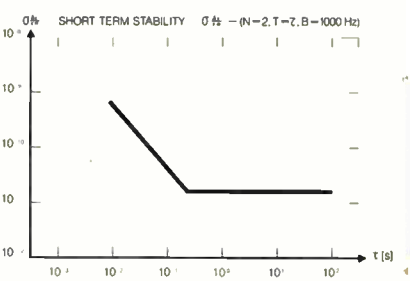

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Low-cost actuator responds to pulses lasting only 100 μs

by Andrew Lloyd, McGraw-Hill World News, Paris

Rugged French unit has response time of 10 milliseconds, sells for under $3

The need for direct mechanical triggering using very-low-level electrical outputs from thermocouples or similar transducers has become increasingly important in today's industrial process control systems. A fast-response actuator for these applications is now being marketed internationally by the French company Laboratoire d'Electronique et d'Automatique Dauphinois (LEAD).

The actuator, which LEAD has dubbed Rhassur after a homonym in French for safety and security, responds to pulses on the order of 100 VA that last 100 μs or so. Responding in 10 ms, the plunger moves between 1 and 2 mm with a force of 100 grams. Despite its sensitivity, Rhassur can withstand shocks up to several g, LEAD president Ferdy Mayer maintains. "It will sell for less than $3," he adds.

The new actuator can be applied to a variety of problems. For example, in a ground-fault circuit interruptor, the circuit breaker has to open the line supply to clear the fault. But since there would be no power to actuate a conventional switch or trigger to do this, a low-level device like Rhassur is a solution. In fact, Rhassur was originally developed for a ground-fault circuit interruptor that LEAD launched in 1972.

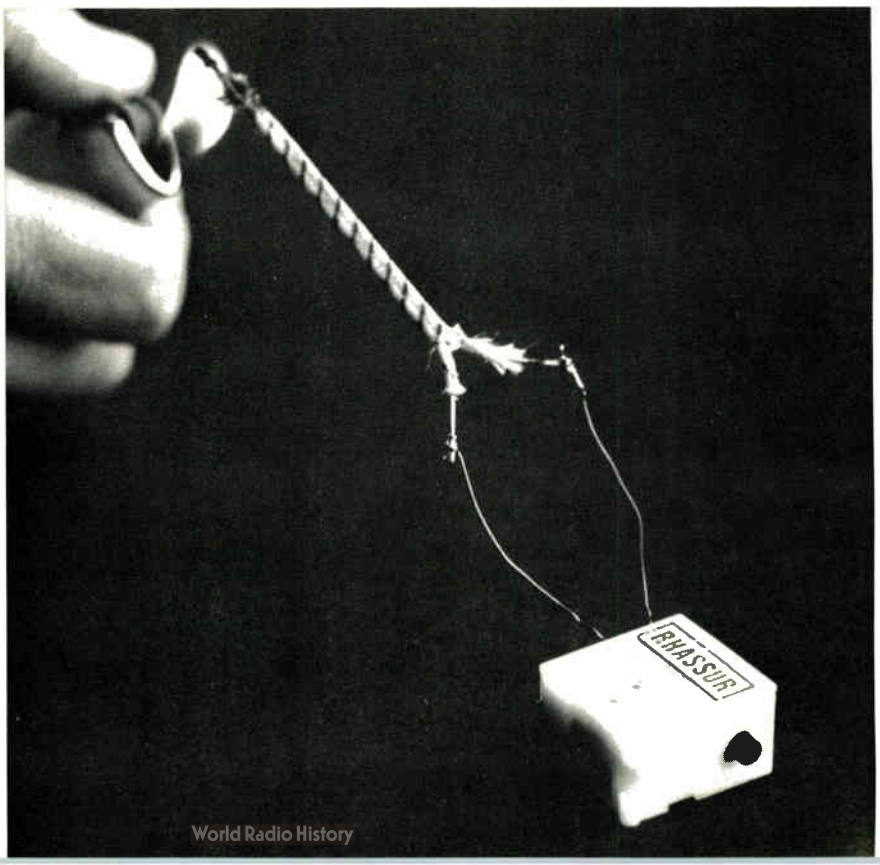
But Rhassur can also provide a new approach to many industrial control problems, Mayer figures. For instance, it makes possible direct triggering from thermocouples and similar transducers that have low-level electrical outputs. The signal can come from an alarm, a voltage step-up, or other source with dc output up to 10 kHz, according to the LEAD executive.

Rhassur works on straightforward principles. When the operating plunger is depressed, an armature is held against a spring by a permanent ferrite magnet. When a pulse is applied to a coil around the magnet's pole pieces, the resulting field offsets the magnet's field so that the spring pulls the armature free of the magnet until the actuator is cocked again.

A wheel that positions an additional pole piece in the magnet's flux circuit adjusts the device's sensitivity. Settings as low as 60 μs for the pulse duration are possible. And Mayer says that a later version will have a sensitivity as low as 1 μVA, opening up new applications.

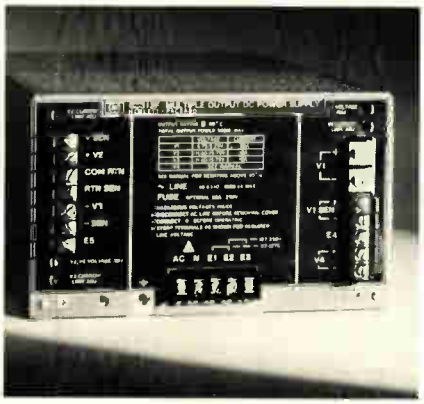
To lessen vibration and shock sensitivity, major design problems, the armature is pivoted at its midpoint, so that shocks tend to cancel out. Also, its parasitic magnetic fields can run anywhere from 4,000 to 20,000 A/m, depending on their orientation. Rhassur meets French electrical standards, and LEAD has applied for Underwriters Laboratories approval in the U. S.

Laboratoire d'Electronique et d'Automatique Dauphinois, 18, rue Thiers, 38000 Grenoble, France [441]



New products international

The CUP relay has a switching capacity of 10 VA maximum and a guaranteed life of 100 million operations at signal level loads and 5 million operations at rated loads. It uses a regular Clare microreed capsule. C. P. Clare International, 102, rue Général Gratry, B-1040 Brussels, Belgium[454]

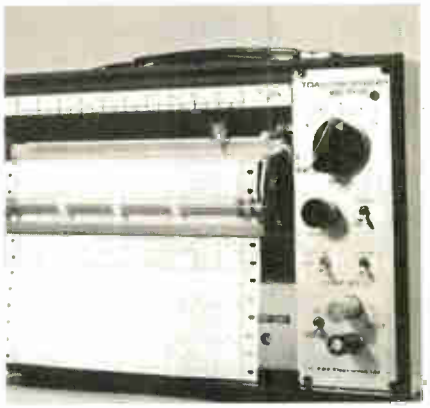


Multiple-output power supply 63312F produces three adjustable output voltages of 5 V, −12 to −15 V, and +12 to +15 V. A fourth output can drive a CRT terminal, a motor or control circuitry. Hewlett-Packard, 7, rue du Bois-du-Lan, P. O. Box CH-1217, Meyrin 2, Switzerland[455]

The type 1440-20B vibration module, part of Dawe Instruments' vibration monitoring system, incorporates a common power supply and a calibration signal generator for operating other modules in a system. Dawe Instruments Ltd., Concord Road, Western Avenue, London, W3 OSD, England[456]

A traveling-wave amplifier, type AF 161P, is designed to be incorporated into ground-based microwave-landing systems in the 5.00-to-5.25-GHz frequency band and fits into 19-in. racks. ITT Components Group, Electron Device Product Group, Brixham Road, Paignton, Devon, England[457]

Subminiature single- and double-pole toggle switches, with right-angle or standard lugs, for printed-circuit boards are designed for low-level 0.4 VA maximum, 20 V dc or ac. Minimum level is 100 μV. They feature self-extinguishing blue diallylphthalate bodies. APEM, BP 1, 82300, Caussade, France[458]

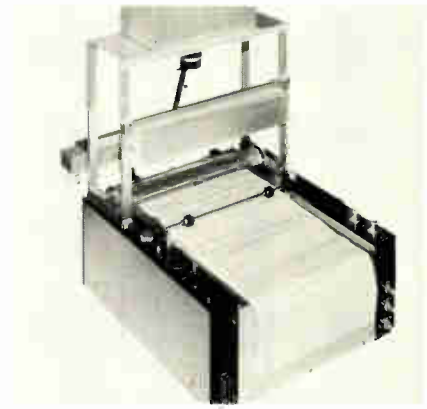


EPR-10B model 150-mm recorder uses one pen to chart a wide range of dc voltage signals. Its input range is from ±5 mV to ±1 V (five ranges) with four chart speeds of 30 and 60 mm per minute or per hour. TOA Electronics Ltd. 1-29-10 Takadanobaba, Shinjuku-Ku, Tokyo 160, Japan[459]

New products international

Type 6158 a-m/fm signal source, part of a series that uses yttrium-iron-garnet Gunn oscillators as active rf elements, covers the 8-to-12.4-GHz range. Output frequency accuracy is within 0.5%. Marconi Instruments Ltd., Sanders Division, Gunnels Wood Road, Stevenage, SG1 2AU, England[460]

The MSI 716 data cassette recorder may be connected to normal teletypewriter, CCITT V24 loop, or parallel interfaces. Maximum data rate is 2.4 kilobaud. The unit can use standard audio cassettes. Computer Marketing, Ecfield House, 641 London Rd., West Thurrock, Essex, England[461]



The FT-4A function tracer reads arbitrary curve data from chart paper, digitizes it, and stores it in a semiconductor memory. With digital-to-analog conversion, the unit can be used as an analog function generator. Riken Denshi Co., 5-5-2 Yutenji, Meguro-ku, Tokyo 153, Japan[462]

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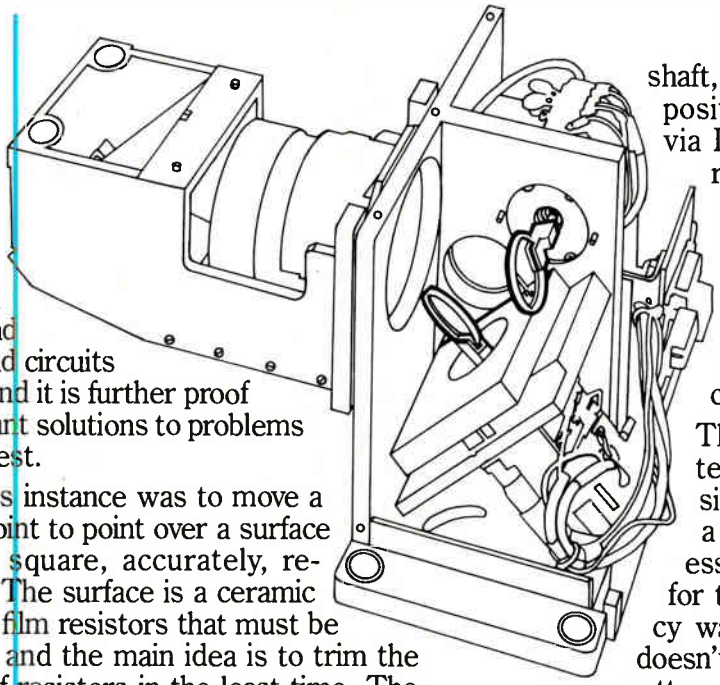
The galvanometer beam positioner

In which a laser reflects favorably on the film resistor business.



No, it's not the Norden bombsight. It is called a galvanometer beam positioner, and it is used in laser-trimming systems. It is a major factor behind the growth of hybrid circuits and film resistors and it is further proof that the most elegant solutions to problems are often the simplest.

The problem in this instance was to move a laser beam from point to point over a surface about two inches square, accurately, repeatably, and *fast*. The surface is a ceramic substrate carrying film resistors that must be trimmed to value, and the main idea is to trim the greatest number of resistors in the least time. The more resistors per hour, the lower the production cost, the lower the price, the greater the demand, and the greater the pressure to trim even faster. And so on, all the way to the bank.

Since a laser trimmer typically spends over a third of its time moving the laser beam from one resistor to another on the substrate, positioning speed is a major factor affecting throughput and the object of intense engineering effort on the part of trimmer manufacturers.

Early laser trimmers (including Teradyne's) moved the laser beam by using a mechanical x-y table to muscle the entire optical system or the work surface from place to place. In effect, this was moving a laser beam the way one would move a 20-ton overhead crane, with the same side effects: vibration, wear and tear, and speed that was (at best) in the two-inch-per-second range.

Teradyne's better solution, introduced in 1971, was to entrust beam positioning to a pair of small mirrors. Each mirror is mounted on a galvanometer motor shaft, with the galvos receiving x-y positioning data from a computer via D-to-A converters. The mirror shafts rotate silently and smoothly in jeweled bearings. The laser head and work surface remain as stationary as Gibraltar, while the reflected beam darts from resistor to resistor at speeds no x-y table can approach.

The optical problems encountered along the way were considerable. To focus the beam over a 2x2 inch surface, it was necessary to design flat-field lenses for the YAG wavelength. Efficiency was another issue; YAG power doesn't come cheap, and every milliwatt saved in transmission is one fewer milliwatt that has to be pumped out. Therefore the lenses were designed for maximum energy transmission and the mirrors coated for full reflection.

The galvo beam positioner has been continuously refined since its introduction. In the most recent edition, a capacitive transducer around each galvo shaft constantly senses angular displacement, which the beam positioner converts into velocity and acceleration data that enable it to optimize jumps and thus close in on the desired position all the faster. As a result, the 20-inch-per-second speed of earlier galvo positioners has been boosted to 200 inches per second, and resistor throughput has soared.

More than almost any other type of test system, the laser trimmer is a money machine. Watching a laser beam tear around an array of film resistors is watching black paste turning into green dollars before your eyes. As in most businesses, some companies can create dollars faster than others. Now their secret is out: They are doing it with mirrors.

TERADYNE

For National, it's a natural

Move into minicomputer market with its System/400 combines company's expertise in ICs, memories, and central processors

by Rob Brownstein, San Francisco bureau

Evolution may be defined as change to a higher and more complex state, and in that sense National Semiconductor Corp.'s plunge into the minicomputer business is undeniably evolutionary.

Although National's announcement that it will market its own System/400 minicomputer may seem a revolutionary move to some, it shouldn't. After all, National's growth over the last seven years, both in product volume and new product technology areas, blazes a logical path to the new system. All the pieces are there: National makes the integrated circuits, from small-scale to large-scale, IBM-compatible add-in memories, and IBM-compatible central processing units.

National's product strategy, like that of Two Pi Co. Inc., the only other maker of IBM-compatible minis (see p. 228), is to offer one that uses IBM System 370 software. In doing so, it hopes to cultivate a new market: those who need the data-processing muscle of the mainframe systems but have budget limitations that have been forcing them to buy processing services or make do with less capable minicomputers.

"There are a number of forces at work in the semiconductor industry that impel semiconductor components companies to become systems manufacturers," Pierre Lamond says. One major force, according to Lamond, National's vice president and director of technology development, is the trend toward large-scale integration.

"With the advent of LSI technology, the dividing line between the component and the system is rapidly disappearing," he declares. By 1985, Lamond believes, it will be possible to have an equivalent IBM 370/158 on a single chip, as well as a chip with 1 million bits of memory storage capacity.

Does National's move signal the start of a trend among semiconductor houses? There are other IC manufacturers with the mix of technologies necessary to build a computer system. And, with the burgeoning activity directed toward digital-to-analog and analog-to-digital converters on a chip, the way is clear for an IC maker to enter the data-acquisition systems market as well.

The list of other IC firms with the bipolar and technology capability necessary for a product like the System/400 includes some big names: Motorola Semiconductor, Fairchild Semiconductor, Texas Instruments, and Signetics. Unlike National, though, they have not engaged in IBM add-in memory products nor have they the experience with IBM-compatible CPUs to become well acquainted with IBM instruction sets and software.

One more. One other IC manufacturer that has the basic technologies and is not committed to a system, although recently announcing a new systems division, is Advanced Micro Devices Inc. of Sunnyvale, Calif. AMD is the originator of the 2901, a 4-bit-slice bipolar processor that is being used by both Two Pi and National to implement the 32-bit IBM instruction processing. In addi-

New machine. National's System/400 vaults it into the minicomputer business with a system using IBM software.

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Solar energy

Led by France, Europe looks to sun

$16 million earmaked for photovoltaics by Paris government, West Germany, Italy, and Common Market Commission

by Arthur Erikson, Managing Editor, International

Aided by the well-heeled U. S. Department of Energy, now spending some $312 million a year to let the sunshine in, American firms have begun to cast long shadows into world markets for solar-energy hardware. Nonetheless, European firms figure there is some room for them on the sunny side of the street. To help them cross over, their governments will spend something like $115 million on solar-energy programs this year.

As in the U. S., most of the money will go for thermal hardware like rooftop heat exchangers and solar furnaces and boilers. But there is also keen concern for photovoltaics; France, West Germany, Italy, and the Commission of the European Economic Community have budgeted a total of about $16 million for photovoltaics development. On top of that, semiconductor companies are putting their own money into solar-cell development.

Motorola Semiconductor Products, for example, figures the world market for solar-cell panels reached $1 million in 1977, according to Bob Hammond, worldwide marketing manager for solar operations. By 1982, sales will be about $230 million, Motorola predicts. West Europe accounts for between 10% and 15% of the world market for solar panels.

Like every significant semiconductor product, solar-cell panels will have a snowballing market. As it starts to roll, prices will drop; the more they drop, the faster the market will grow. Panels built around monocrystalline silicon cells now cost about $15 per watt. By 1980, those prices should at least be halved. A decade after that, prices will be less than $1 per watt. To stay on the curve, European firms need all the backing their governments can give them.

Sun king. So far, Valey Giscard d'Estaing's government in France has done the most. This year, the government decided to set up a Commissariat à l'Energie Solaire and put the country's dispersed efforts in solar energy under its parasol. Named in late March to head the agency was 50-year-old Henry Durand, managing director of the Laboratoires d'Electronique et de Physique Appliquée, one of the major research and development establishments of the Philips group.

Durand, whose agency went into action just this month, says that some $53 million has been earmarked for solar-energy development this year in France. Most of the money turns up in the $38 million that Durand has in his CES budget. The rest comes from the budgets of regional governments, nationalized industries, and spending for R&D by private companies.

The spending will bounce up considerably next year to about $65 million, keeping France the biggest spender for solar-energy development among European countries. All the same, Durand has no illusions about the impact solar energy will have on France's energy supply. "Optimists say it will cover 5% of our needs by the year 2000, pessimists 3%," he reports.

LEP, the Philips research unit that

Funds injected into solar work by EEC

Member nations in the nine-country European Economic Community are gaining access to new solar-energy technology through a program run by the EEC Commission. About $30 million will be spent over a 20-month period running through June 1979, with half the money coming from the Commission's coffers and the other half from local sources, mainly the various national governments.

About $10 million of the $30 million is being spent on 50 contracts covering a broad spectrum of photovoltaic technology. Two of the most promising projects use substrates of single-crystal silicon on graphite, says Wolfgang Palz, a solar-cell expert at the Commission's research directorate. In addition to the work of the Laboratoires d'Electronique et de Physique Appliquée with ribbons wetted by molten silicon, there is an effort at the University of Nijmegan in the Netherlands to deposit silicon on graphite during the vapor phase of fabrication.

The EEC also has development projects going on in amorphous silicon, mostly in Great Britain. And it is helping researchers in Italy and elsewhere to look at materials other than silicon–gallium arsenide, cadmium sulfide, cadmium telluride, and the like. Money is also going for work on four complete photovoltaic systems in the 5-kilowatt range and the preliminary design for a 1-megawatt plant, which should be ready in about a year. With all this activity going on, the EEC countries are still one to three years behind the U. S. on the power plant, Palz figures.

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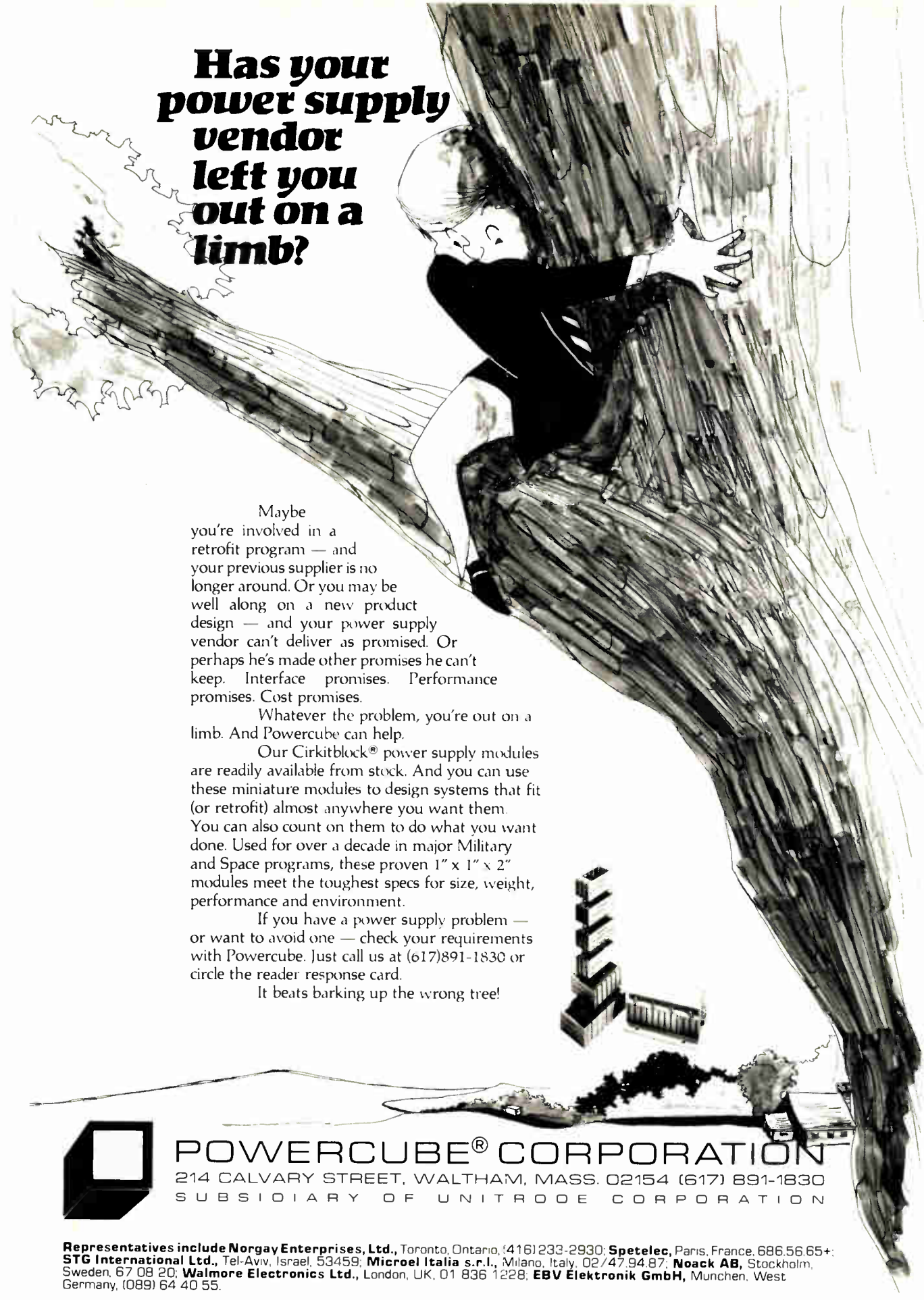

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Electronics abroad

Britain plans to aid IC makers

Government wants $200 million spent over five years on R&D while it works to correct growing trade imbalances

by Kevin Smith, London bureau manager

The United Kingdom's Department of Industry will soon unveil a two-pronged effort to underpin the British semiconductor industry's fight for survival. The government will seek to guarantee domestic equipment makers access to local sources of circuit design, plus wafer-manufacturing expertise in large-scale and very-large-scale integration. Also it wants to correct the trade deficit in microcircuits.

This latest attempt to build up a viable microcircuit industry could have implications for the ten companies with full circuit design and diffusion plants in Britain. Included are the three English-owned companies, Ferranti Ltd., Plessey Co., General Electric Co.; one European-owned and one European company, Mullard Ltd. (which is part of the Philips group) and ITT Semiconductors Ltd.; and five U. S.-owned companies.

Research backing. Central to the program is financial backing for a broad collaborative research program into all aspects of VLSI fabrication technology. Sharing would be the three British-owned companies and, to a lesser extent, the two European ones. Estimates put the total cost of such a program at $150 million to $200 million over five years. The split between government and industry has yet to be decided, but the Department of Industry is hoping for 50–50. Current government support is running at some $12 million a year.

To redress the mounting trade imbalance, the planners hope to persuade U. S. companies to concentrate a greater proportion of their water-fabrication production in Britain. At present, Motorola Semiconductor, National Semiconductor Corp., Texas Instruments., General Instrument Microelectronics, and Hughes Microelectronics all have diffusion units in Britain. Just what kind of financial carrot the Department of Industry can offer U. S. firms to set up or expand operations has yet to be seen, for inducements are already generous.

Volume lacking. While a specialized marketing approach provides British companies with a foothold in the integrated-circuit market, it is not likely to pay for VLSI research. According to current estimates, the combined volume of all three British-owned companies is at the most between a quarter and a third of the $160 million talked about as the entry fee for VLSI research.

Consequently, the government's program is based on the maximum cooperative development between participant companies—with the minimum of duplication. This collaboration will work much like the recently announced research program in submicrometer methods of electron-beam microcircuit manufacture which eventually will involve the government, industry, and the universities.

British pushed out of mass markets

In working up its latest support scheme, the Department of Industry has endorsed the marketing strategy adopted by all three British-owned integrated-circuit companies. All have been forced out of the standard IC market by the full might of the American jelly-bean juggernaut and today are providing a circuit-design service to British equipment manufacturers with varying degrees of success.

At Ferranti's Gem Mill headquarters, inherited from the spent glories of the world's first steam and cotton industrial revolution, have come some advanced products almost always developed in collaboration with specific customers. Its F-100-L was the first 16-bit bipolar microprocessor in the world, and Ferranti Semiconductors was first to the market with a 10-bit monolithic successive-approximation digital-to-analog converter. Its latest 500-cell uncommitted logic array—equivalent to 700 logic gates in complexity—provides one of the neatest solutions to integrating random logic into one or two chips. Ferranti also has implemented a two-chip fuel-injection controller, while a single-chip counter made for Racal's 99 range counter took Racal to the fore in this market.

At Plessey Semiconductors in Swindon, the company's emitter-coupled-logic process has been put to good use in a range of high-speed dividers, and radio communications, radar, and signal-processing circuits that have established a worldwide market for themselves. Like Ferranti, Plessey is pinning its hopes on a range of semicustom uncommitted logic arrays. It has invested heavily in new processes and is well down the road in bubble memory technology and in metal-nitride-oxide-semiconductor and n-channel metal-oxide-semiconductor processes. However, it still has to prove itself in mainstream markets. Finally, GEC Semiconductors provides a basic complementary-MOS technology.

A good look. Frances McLaughlin inspects 4-inch wafers at National Semiconductor plant in Greenock, Scotland, before the masking-etch step.

Early industry reaction to collaboration, which the Department of Industry chose over a strategy of forced mergers, is favorable. Derek Roberts, managing director of Plessey Microsystems, thoroughly endorses the strategy and notes that Plessey is already collaborating closely with Ferranti and would welcome discussions with any other companies involved in the scheme. Another high official, Allan Shepherd, managing director of Ferranti, also backs the strategy and says that the sums talked about in the preliminary outline are of the right order of magnitude.

Looking to Europe. Input to the program could also come from parallel European schemes, as discussions are under way both at the company and governmental levels. Plessey is still talking with France's Sescosem, while Philips, now with a firm U. S. foothold through its acquistion of Signetics Corp. and with plants in France, England, Holland, and West Germany, will have a central role in any negotiations and is actively pushing collaboration. But as the web of negotiations spins wider, the areas for collaboration move from early commercial exploitation to fundamental research.

The possibilities of yet more transatlantic mergers or takeovers add a final dimension to the picture. Plessey, which is steadily building an American presence, sees acquisition as one possible growth strategy. GEC, Britain's largest electrical and electronics conglomerate, has approximately $1 billion in cash reserves to spend and is actively hunting. □

Software

Programming struggle goes on

Frustrated computer makers are beginning to make some progress, but writing new software is a labor-intensive task

by Raymond P. Capece, Computers Editor

It has become a nagging cliche in the computer business, but it is nevertheless a real, even omnipresent, problem: writing new software takes longer than designing and building new hardware, and the resulting delays are maddening to computer makers—maddening because although a new line of computers can be rushed to market by putting more engineers on the job, this just cannot be done with software.

The upshot is that large and small manufacturers are devoting considerable time and money to unplugging the software bottleneck. They are beginning to see a glimmer of success, but along the way they have learned that what appears logical actually does not work out at all.

Typical is the case of F. W. (Fritz) Reindel. He is director of Sperry Univac Inc.'s Roseville, Minn., software development center. It is not that Reindel lacks resources—he has 600 employees writing furiously. Still, the only way to get software written is with a small group: "We find that 5 to 20 people on any one job is the range that produces the best code in the least time," he says. The reason is the documentation, the manuals that let each programmer know what the other is doing. "The documentation can turn out to be a bigger effort than the writing of the software," Reindel explains.

Reprogramming. But the real continuing expense in software comes later. Money must be pumped into the software throughout its life, for documentation and for maintenance, which includes adapting the programs for new machines or just expanding them. By far, the biggest cost is reprogramming—rewriting for the same application. The cost estimates for this amount of redundant programming are startling—something like 60%. That is because it is hard for the second programmer to get into the code and figure out what the first one did.

Larry Walker, director of system design at Univac, stresses that the savings will not come from writing code faster. Rather, he says, "it's how you set up programs to avoid the waste of reprogramming." Aside from the documentation needed to give software longevity, Walker continues, structured programs, or modular software, are needed.

Richard H. Hill, director of systems and product planning at nearby Honeywell Information Systems Inc. in Minneapolis, has encountered similar problems with software generation. But he is not very upset, because he thinks the industry has just begun to face the problem and the image of the programmer is changing. Where once the programmer was thought of as the genius locked in a room carrying all the nested do-loops and go-tos in his or her head, now programming must be approached like hardware: "We are just now in the transition from software's being considered an art to its becoming an engineering discipline," he explains. "That's why we need better management."

There might be an analogy between hardware and software in the development stage, but it stops

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Single-chip microcomputer expands its memory

Over 4 kilobytes of program storage includes 64 bytes of executable RAM to extend the one-chipper into more complex applications

by Harold W. Dozier and Robert S. Green,* *Mostek Corp., Carrollton, Texas*

☐ The 3872 single-chip microcomputer has the most memory of any one-chip processor—in fact, it has twice as much. Its 4,032 bytes of read-only memory and 128 bytes of random-access memory double the storage capacity of its predecessor, the 3870, and are bound to propel the device into many applications beyond the reach of other one-chip processors.

Lots of storage

That quantity of ROM, for example, is enough to store the lookup and decoding tables needed by printers and other peripherals for character generation. Moreover, the extra 64 bytes of RAM is not added to the original 64-byte scratchpad but belongs to main memory. It greatly enhances flexibility, since its contents may be modified in the course of program execution.

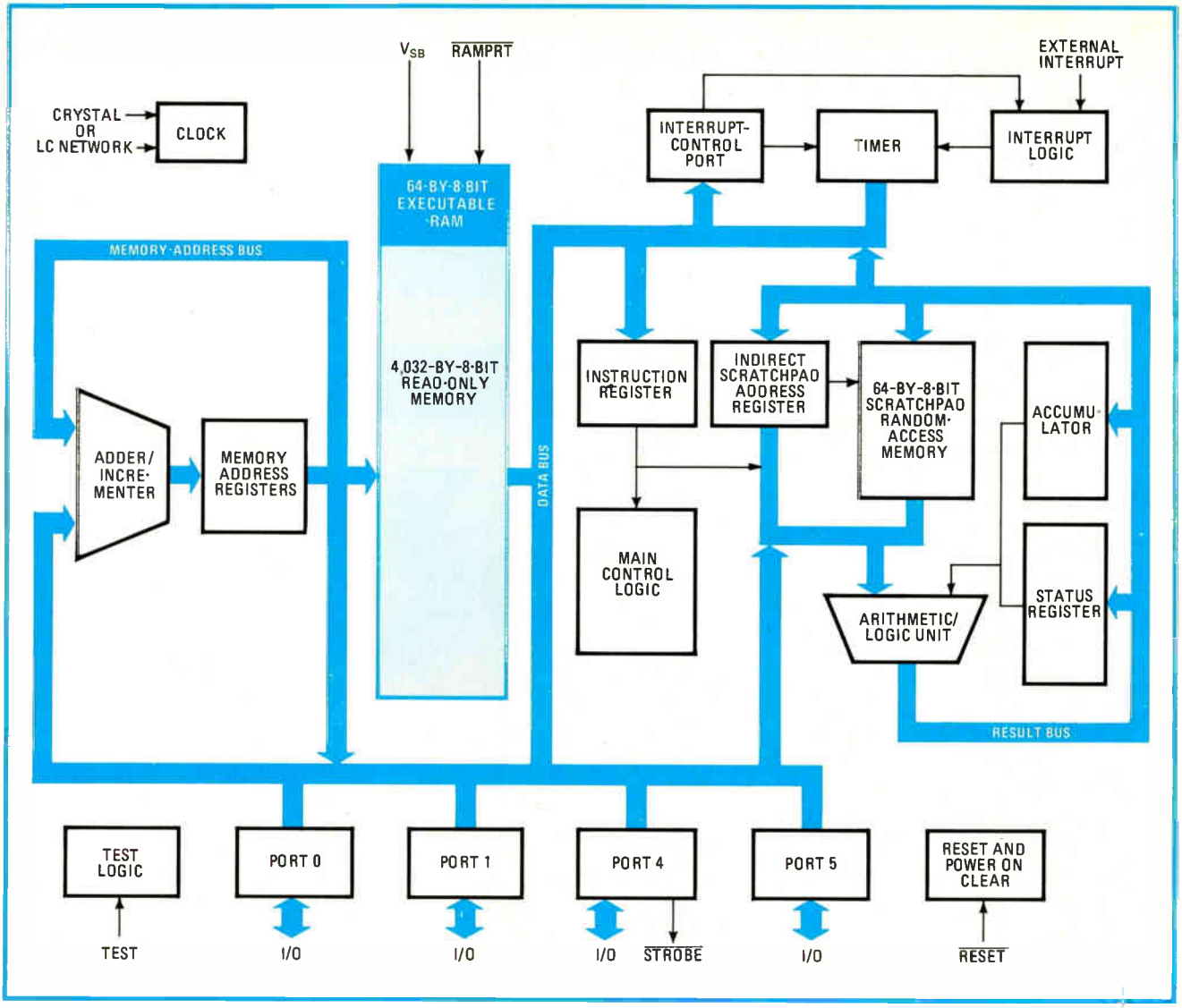
To make the 3872 even more attractive, a very-low-power standby option is available for this added RAM. The high-performance, depletion-load, n-channel process used keeps the RAM's power requirements to a maximum of 3.7 milliamperes at 2.8 volts—well below the usual reduced-power level of 20 to 30 milliamperes at 5 volts.

The net result is that the 3872 can handle jobs that formerly would have required several different devices. From the user's point of view, this not only reduces the parts count of a design, it also reduces masking costs to a single charge for one chip instead of several. If an application does after all turn out to require more than the 3872 can offer, memory can still be added. What's more, the 3872, like the 3870, maintains complete architectural, software, and timing compatibility with the multichip F8 family.

Stretching the 3870

Architecturally, the 3872 is the same as the 3870 (Fig. 1). All that has been done is to "stretch" the 3870 by adding memory at one end of the chip. The 2,048 by 8 bits of ROM tacked onto the existing ROM make a 4,032-byte area, and built onto this is the additional 64 bytes of

*Now with Fairchild Camera and Instrument Corp.



1. Stretched. The 3872 one-chip microcomputer takes the architecture of the 3870 but doubles read-only memory to 4,032 bytes and random-access memory to 128 bytes. The new RAM is added in main memory. An extra address bit handles the extended capacity.

executable RAM (Fig. 2). Yet the dense ROM technique used (less than 0.25 square mil per cell) lets the entire 3872 fit onto a 173-by-268 mil chip—not much larger than the 173-by-208 mil 3870. Thus for a device of its computational power and flexibility, it is not the monster one might expect.

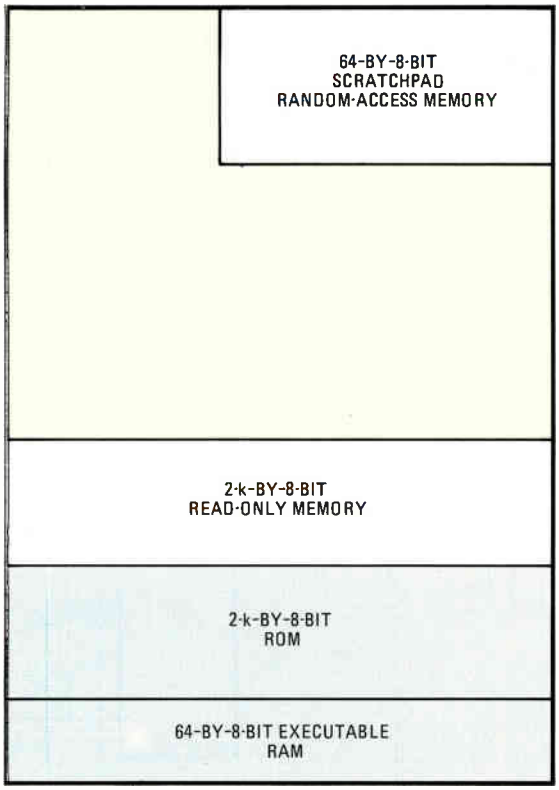
Like its predecessor, the 3872 has 32 bidirectional input/output lines organized as four 8-bit ports. Sixteen of the lines are compatible with transistor-transistor logic, while the other 16 may be individually mask-programmed for either TTL, open-drain, or high-drive. The chip's timer is built in and has a programmable prescaler. It uses a crystal or RC or LC network for timing, but can run with no external components at all.

Low power

Finally, the power drawn by the 3872 is modest. A single 5-v ±10% supply is required, and the chip typically dissipates only 300 milliwatts, or 435 mW at most.

The 4 kilobytes of ROM are addressable by either of two registers. The program counter, called PO in the mnemonics of the F8 microprocessor, is used to access operation codes and immediate operands. The data counter (DC), which increments automatically, is used strictly to address data. For example, the load-memory instruction (LM) takes the data at the location specified by DC and places it in the accumulator. After each DC memory reference is performed, DC is incremented automatically so that it is ready to access the next location in memory—a feature that is extremely useful when working with data tables or when executing memory-search algorithms. And adding an 8-bit displacement to the DC using the add-data-counter instruction (ADC) allows the DC to perform in indexed addressing schemes.

There is also an auxiliary data counter (DC_1) which cannot directly access memory, but which may exchange its contents with those of the other data counter at any time. Thus the contents of DC_1 can be placed in DC ready to access memory, while the contents of DC are conveniently saved in DC_1. As will become plain later, the presence of two data counters permits easy manipulation of the 64 bytes of executable RAM.



2. Foresight. Planning for the 3872 goes back to the design of the 3870, which was laid out with read-only memory running the length of one side of the chip. Adding ROM was then simple, and the executable random-access memory was tacked on to the ROM.

The lowest-order 16 registers of the chip's 64 8-bit scratchpad registers are special-purpose and directly accessible. Each has an individual set of instructions for operation. The upper four registers (C through F) can handle only load and store instructions, while the lower 12 registers (0 through B) have not only direct load and store instructions, but direct add-binary, add-decimal, decrement, AND, and exclusive-OR instructions as well.

Each of the 64 registers is also indirectly accessible with instructions for the previously described operations. The particular register to be accessed is pointed to by the indirect scratchpad address register (IS). There are three versions of each IS scratchpad instruction: one causes IS to increment following the access so that it points to the next higher register, one causes IS to decrement so that it points to the lower register, and one leaves IS unmodified so that it continues to point to the same register after execution of the instruction.

Executable RAM

The extra 64 bytes of RAM are located in the main memory space. As in ROM, instructions may be executed from this additional RAM; unlike the ROM's instructions, however, those in RAM can be modified during program execution using the store (ST) instruction.

In the normal configuration, the lower 4,032 bytes of the total addressable main memory space are ROM and the upper 64 bytes are RAM. However, adding the extra RAM to the program and data counters' normal addressable memory, instead of doubling the scratchpad register array, maintains complete compatibility with the multichip F8 family. For comparison, memory maps of the 3872, the standard 3870, and the multichip F8 microprocessor family are shown in Fig. 3.

A fast scratchpad

The instructions that involve the scratchpad RAM are much faster than those dealing with the executable RAM. Because the scratchpad RAM sits alone on the memory map isolated from the main memory, both the scratchpad and the main memory may be active at the same time. Also, since scratchpad arithmetic does not require the use of the data bus, it frees the bus to pass operation codes from the main memory to the instruction register (IR), thus allowing op-code fetches and scratchpad operations to occur simultaneously. This pipelining means that effectively each scratchpad instruction requires only one machine cycle; whereas main-memory operation in the 3872 takes at least two machine cycles.

The combination of fast-access scratchpad RAM and executable RAM located in the normal memory space provides flexibility that is not available on other single-chip microcomputers.

A standby-power option adapts the 3872 to applications requiring certain variables to be saved in RAM when the main power source is removed. Since the standby voltage ranges between 2.2 V and 5.5 V, only two nickel-cadmium cells (typically 2.5 V) in series are needed, and these may be automatically trickle-charged from the 3872 directly when V_{CC} is restored (Fig. 4).

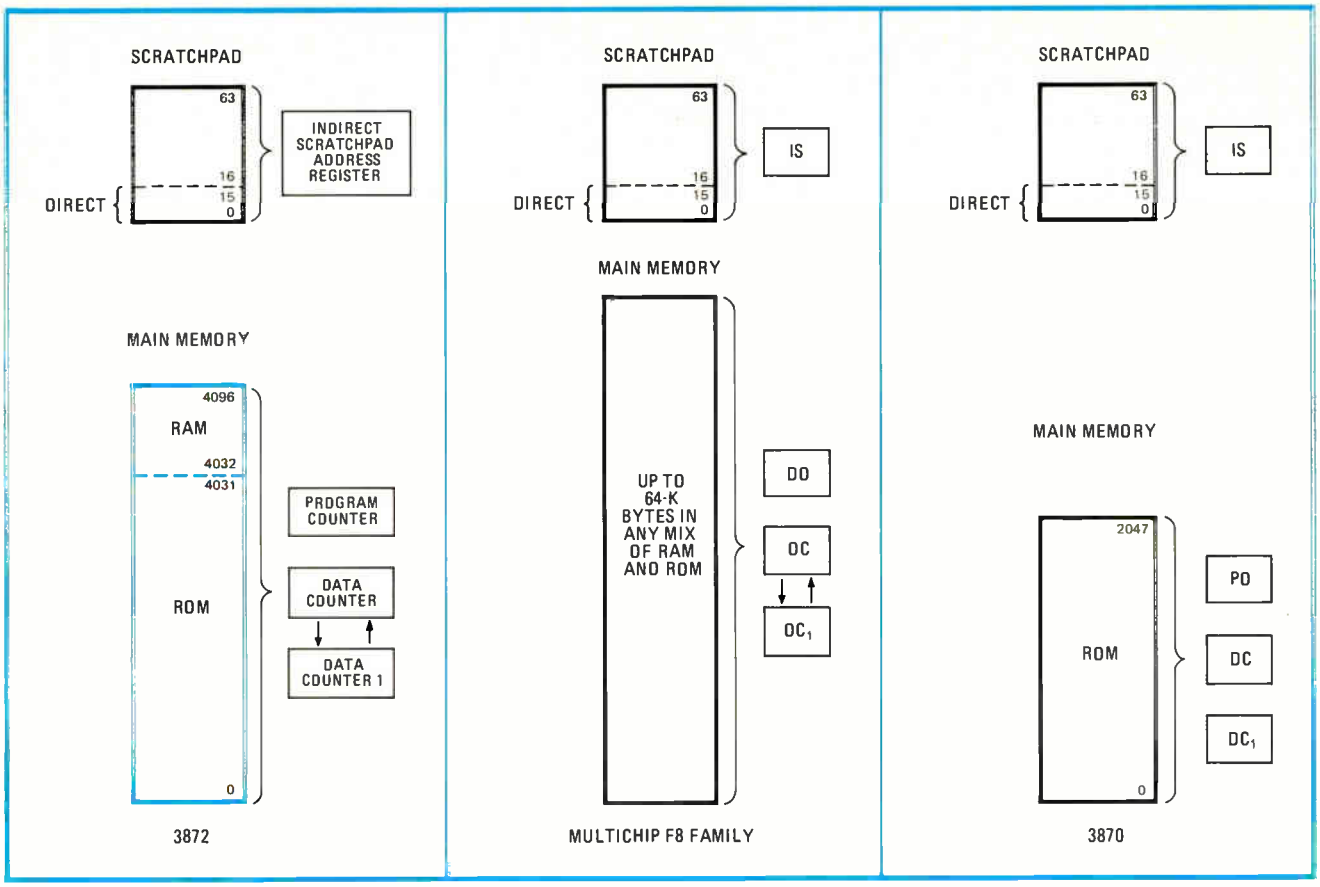
The standby power option is mask-programmable from the same mask as the one used to program the ROM and changes the functions of two pins in the first I/O port (port 0). One of them it turns into the standby power supply pin (VSB), and the other it uses for a memory protect ($\overline{\text{RAMPRT}}$) line, permanently disabling its output buffer to free it totally for this purpose.

Power-fail mode

When power is lost, the $\overline{\text{RAMPRT}}$ line should be brought low before normal V_{CC} falls. Once low, it inhibits any write or read of the executable RAM. However, enough time should elapse before it goes low for the 3872 to be able to store all the necessary data in the RAM. For this reason, some kind of power-fail signal must be provided to alert the 3872 in advance.

For instance, if the 3872 is used in a large system that already possesses a power-fail interrupt (Fig. 5), the signal could be connected to the device's external interrupt pin or maybe to one of its input/output pins, provided that pin is one it samples regularly and often. A simple delay may be interposed between receipt of the interrupt signal and the lowering of the $\overline{\text{RAMPRT}}$ line. Alternatively, the 3872 could generate this second signal by another I/O line.

But if no other power-fail detector is available, one of the two simple circuits shown in Fig. 6 will be entirely adequate. In the first (Fig. 6a), when the unregulated



3. Compatible. Whether used alone or with an external complement of RAM and ROM, the 3872 is architecturally compatible with the 3870 and the multiple-chip F8 family. The only difference is the size and mix of RAM and ROM in the main memory area.

supply voltage falls below the combined zener and transistor cut-in voltages, the output rises and may be fed into the 3872's external interrupt line. Otherwise, two diodes may be connected as shown in Fig. 6b to produce a full-wave pulsating signal, which may be fed into the same line. In this case, the internal timer of the 3872 can be used to time the delay between interrupts, and if no interrupt occurs in 10 to 15 milliseconds, it would be assumed that power has been interrupted.

Keeping RAM safe

Once the desired variables have been saved, the RAM can be made safe by toggling an I/O port pin that drives the $\overline{\text{RAMPRT}}$ line low. Here, a very long RC time constant will keep $\overline{\text{RAMPRT}}$ low well after V_{CC} has dropped.

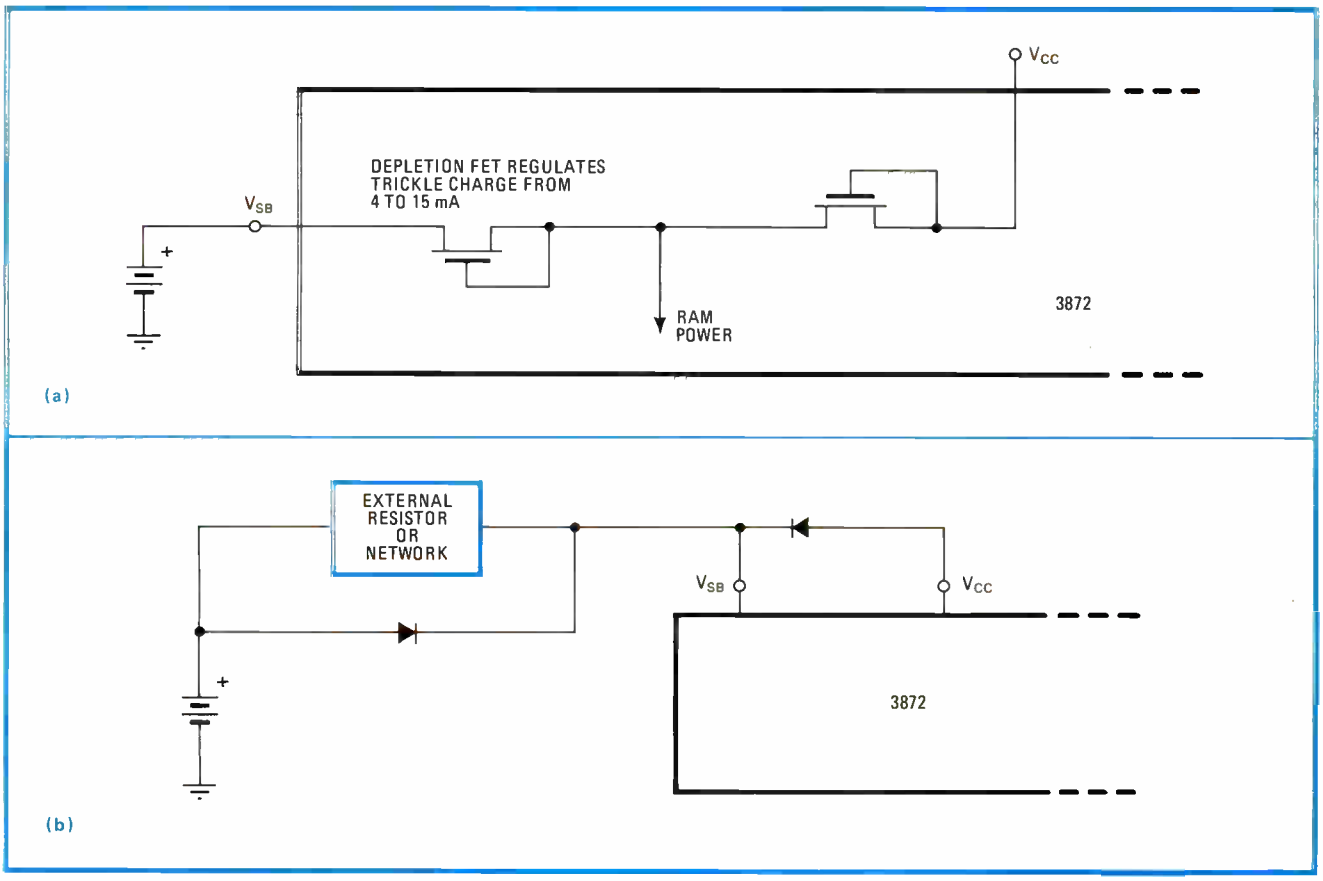
After power is restored, the $\overline{\text{RAMPRT}}$ input must remain low until V_{CC} has risen back to normal (see Fig. 5 again). This can be done by tying $\overline{\text{RAMPRT}}$ to the reset line, so that the 3872 will not start execution until both these lines are high (the threshold of the input circuitry is so designed that $\overline{\text{RAMPRT}}$ must be read as high before $\overline{\text{RESET}}$ is). If the two lines are not tied together, the system could conceivably attempt to restart execution before RAM accesses are allowed. If this possibility exists, it may be prevented simply by programming the 3872 to read the $\overline{\text{RAMPRT}}$ input and refrain from any RAM access until it goes high.

Incidentally, as the foregoing implies, the 3872's reset input ($\overline{\text{RESET}}$) when pulled low places the processor in a reset state; when pulled high, program execution begins at location 0. Both the external-interrupt and the reset inputs are Schmitt-triggered to assure proper operation even with slow, noisy signals. The 3872 also performs a power-on reset after V_{CC} is initially applied and when reapplied following a power loss.

The 3872 microcomputer shares with its predecessor, the standard 3870, such features as vectored interrupts, a timer, and multiple clock modes. The vectored interrupt scheme of the 3872 employs one vector for external interrupts and another for timer interrupts. The main timer is an 8-bit binary countdown counter. A programmable prescaler, associated with the timer, is clocked by the internal clock which runs at half the external time-base frequency, up to 2 megahertz for full-speed operation. Selectable prescale values are divide-by-2, -5, -10, -20, -40, -100, or -200.

Timer options

The main timer may be loaded with a particular value or read at any time, but once it has counted down completely from its original value, it generates an interrupt that automatically resets it to that original value. Thus it can be set to produce a series of perfectly spaced interrupts with no CPU intervention. Alternatively, the timer can be loaded, allowed to count down and interrupt, and then stopped to provide a single programmable delay. There are other options, too. It can be software-configured to decrement upon each cycle of the prescaler



4. Trickle charging. A 2.4-V, 0.065-ampere-hour nickel-cadmium battery keeps RAM alive for 18 hours. The 3872 has internal charging circuitry (a), with a depletion field-effect transistor regulating current to between 4 and 15 mA. For rapid charging, circuit in (b) may be used.

unconditionally, thus measuring pulse width, or to decrement only when the external interrupt input is active, or to decrement each time the external interrupt pin is toggled, thus becoming an event counter. In this last mode, the prescaler is bypassed.

Application of the extra ROM

The 3872 can be used with one of several time bases—an internal oscillator requiring no external components, or a clock provided by a single-phase external clock source, or a crystal. The crystal amplifier and all buffering is provided internally so that the crystal is the only external clock component. Instead, an LC or RC network may be used as a time base.

The most obvious advantage of the on-chip 4-kilobyte program ROM is that it can accommodate a range of applications that require more read-only-memory storage than the 2 kilobytes available on other single-chip microprocessors.

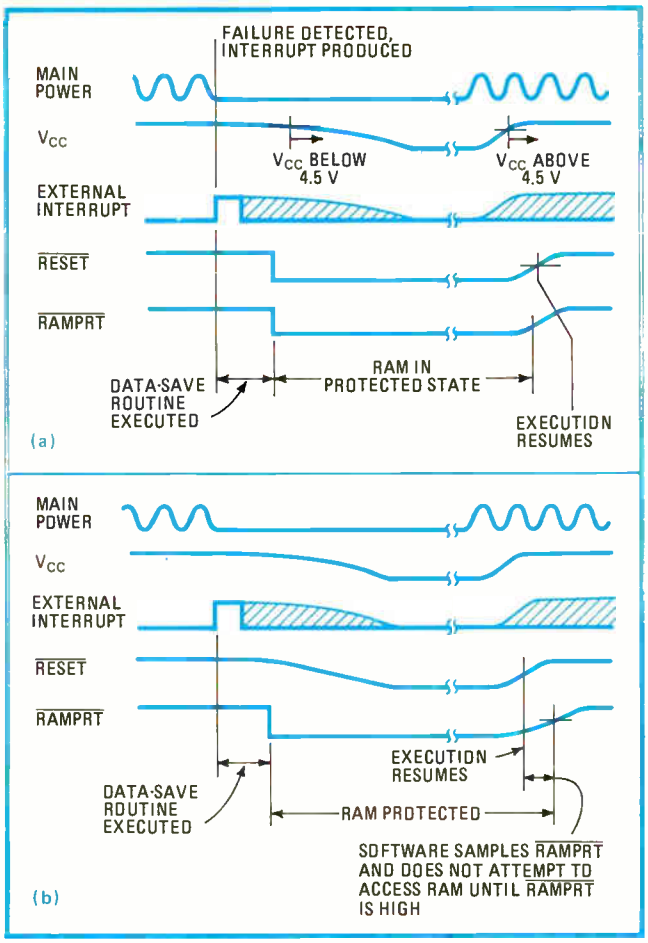
The expanded ROM capacity of the 3872 is also useful in applications where, although the basic program fits into the ROM of smaller single-chip devices, additional ROM is desirable. For example, the ability to handle a variety of display formats, units (English and metric), and operational alternatives would broaden the appeal of the finished product. In fact, many of these desired variations add relatively few bytes of code to the basic program function. Thus a product with perhaps several options requiring 2 kilobytes of code could more than double the number of options with 4 kilobytes of code, expanding them to as many as 15.

Also, there are those applications that now use external RAM for data storage. A 3872 chip used to control a multiplexed display or printer may also replace the character generator by storing that information internally.

The large ROM of the 3872 is perfect for storing a variety of data table functions and is well suited to mass-data storage—for example, storing all the different cooking times and power settings needed to cook numerous foods in a microwave oven.

Look-up tables

Another use is in replacing slow recursive algorithms with a data table. Even though it may be more code-efficient to write an algorithm to compute $f(x)$ for any value of x and thus avoid the large data table, it is certainly faster to perform a simple table look-up. Algorithms used to calculate the values of transcendental functions (sine, exponential, etc.) can be replaced with a data table from which, for a given value of x, the answer $f(x)$ may be read directly. For example, the table can be arranged such that the value of the functions f(0) is stored at memory location H83F, f(1) is stored at H840 (H83F+1), f(2) is stored at H841, etc. If the current value of x for which the function $f(x)$ is to be computed is in scratchpad register 4, the following routine places the value of $f(x)$ into the accumulator:



5. Powering down. If the system has a power-fail interrupt, sequence in (a) can be followed in which $\overline{\text{RESET}}$ and $\overline{\text{RAMPRT}}$ lines go low after data-save routine is completed but before V_{CC} drops to 4.5 V. If not tied to $\overline{\text{RESET}}$ (b), $\overline{\text{RAMPRT}}$ must be read first.

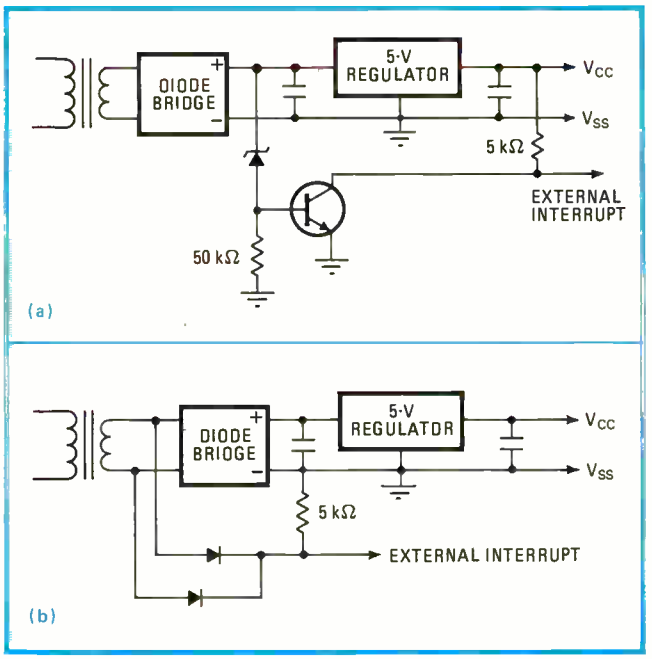
DCI H83F	Load data counter with H83F
LR A, R4	Load accumulator from register 4
ADC	Add accumulator contents to data counter contents
LM	Load accumulator from memory location specified by data counter

Other functions for the table look-up include multiply and divide. By storing a logarithm table in the 3872 chip memory, a multiply or divide routine can be reduced from a long series of shifts and adds. Unlike normal recursive algorithms, the execution of the table look-up method always requires the same amount of time, which allows these routines to become a part of a precisely timed program loop, if desired.

Extra RAM adds flexibility

With an ample 128 bytes of RAM, the 3872 should fit into many applications where the standard 32 or 64 bytes do not provide sufficient variable storage. Line buffers of 64 or 80 characters can be implemented with enough variable storage left over for efficient control of a reader, printer, or terminal.

Because 64 bytes of RAM are executable, a self-modifying code can be used. While such routines are not a standard occurrence in most programs, there are cases



6. Interrupt provision. Transistor in (a) switches off when voltage falls. Filter capacitor maintains V_{CC} till data-save routine executes. Another method (b) feeds 120-cycle ripple to the external interrupt pin, leaving 3872 timer to spot too long cycle of power failure.

where a great savings in execution time can result by replacing conditional branches with self-modifying methods. (Of course, the rest of the routine need not be located in the RAM portion of memory.)

Two data counters allow easy manipulation of the RAM area. For example, a common routine whereby a set of variables are each read, modified, and then returned to the position is as follows:

DCI START	Set up DCs to START of variable set
XDC	
LOOP LM	Read variable
	(Modification routine executed here)
XDC	Exchange data counter contents
SM	Store modified variable
BR LOOP	

Both data counters are initialized to the address of the first variable in the set (location START). Reading the first variable (LM) causes DC to increment to START + 1, while the DC_1 is still pointing to START. After modification, an instruction that the data counter contents be exchanged is executed. Thus when the variable is replaced in RAM, the other data counter still points to location START. However, storing the modified variable (SM) causes that counter to increment to START + 1, and now both data counters point to START + 1 ready to manipulate the next variable in the set.

As for the standby power option, it makes the 3872 attractive for such applications as gas pumps, point-of-sale terminals, push-button radios, and appliances. Although these applications do not require the low operating power of complementary-MOS, it is often essential to save a few key bytes of data in the event of an intentional or unintentional loss of normal power. □

Processor-based tester goes on site to isolate board faults automatically

Guided-probe technique of finding faults and a data store that uses a simple interactive language make field repair easy and cut the costs of board swapping

by Robert E. Anderson and Robert G. Fulks, *Omnicomp Inc., Phoenix, Ariz.*,
and Charles P. Frusterio, Frank S. Meade, and Donald E. Phelps, *NCR Corp., Dayton, Ohio*

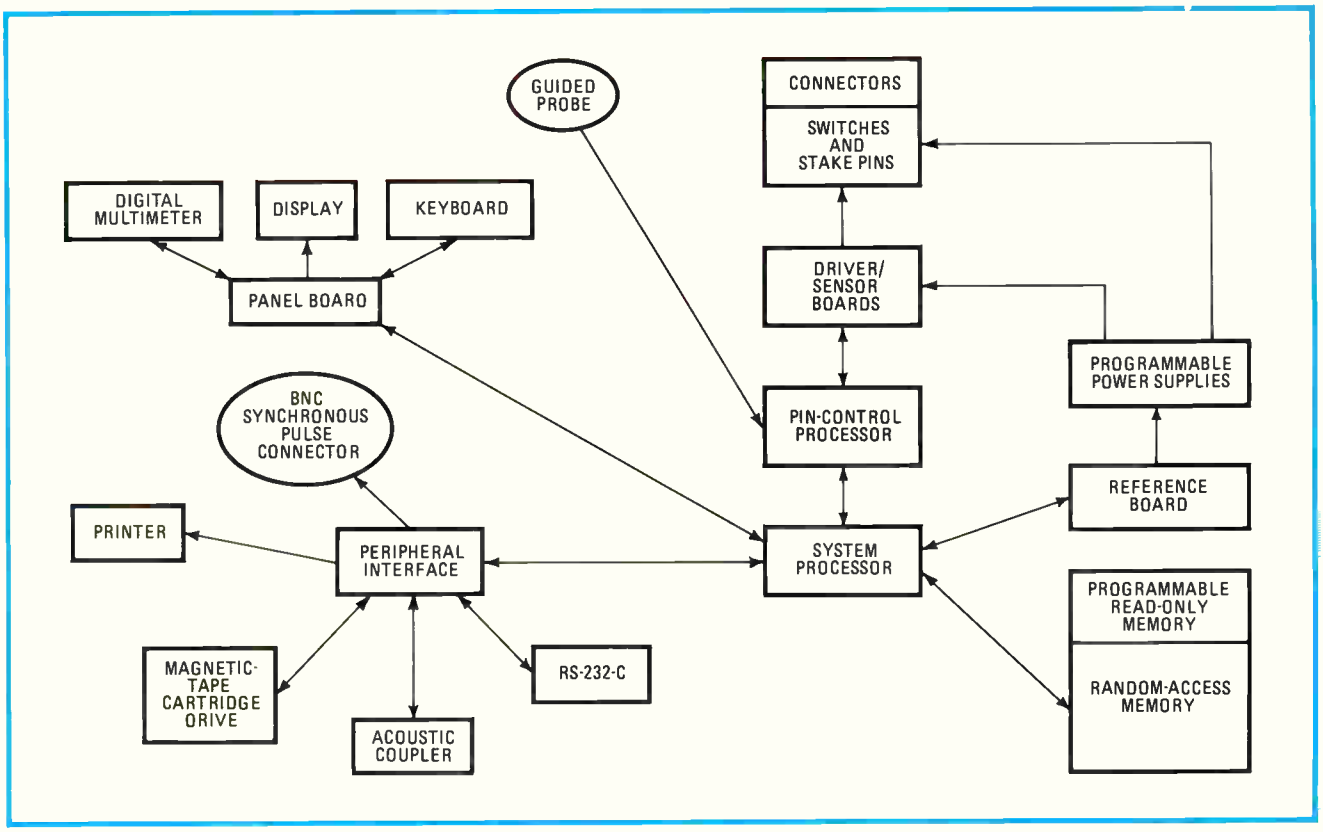
☐ It's no secret that monolithicity can bring big field-service headaches. Complex large-scale integrated circuits in new systems have made traditional trouble-shooting methods largely ineffective. Moreover, the increased cost of the circuit boards involved has driven up the investment in spare-board inventories.

One fast way to relieve these headaches is the test and repair of circuit boards in the field, an approach that is now possible with a portable board tester that can perform automatic fault isolation. The PSP portable service processor [*Electronics*, Feb. 16, p. 41] permits on-site board testing and fault isolation for those applications where some system downtime can be tolerated or removal of the boards and test and repair in a local facility when swapping is required to minimize customer downtime. In effect, the PSP combines the maintenance philosophies of board swapping and on-site repair (see "The best of both worlds," p. 113).

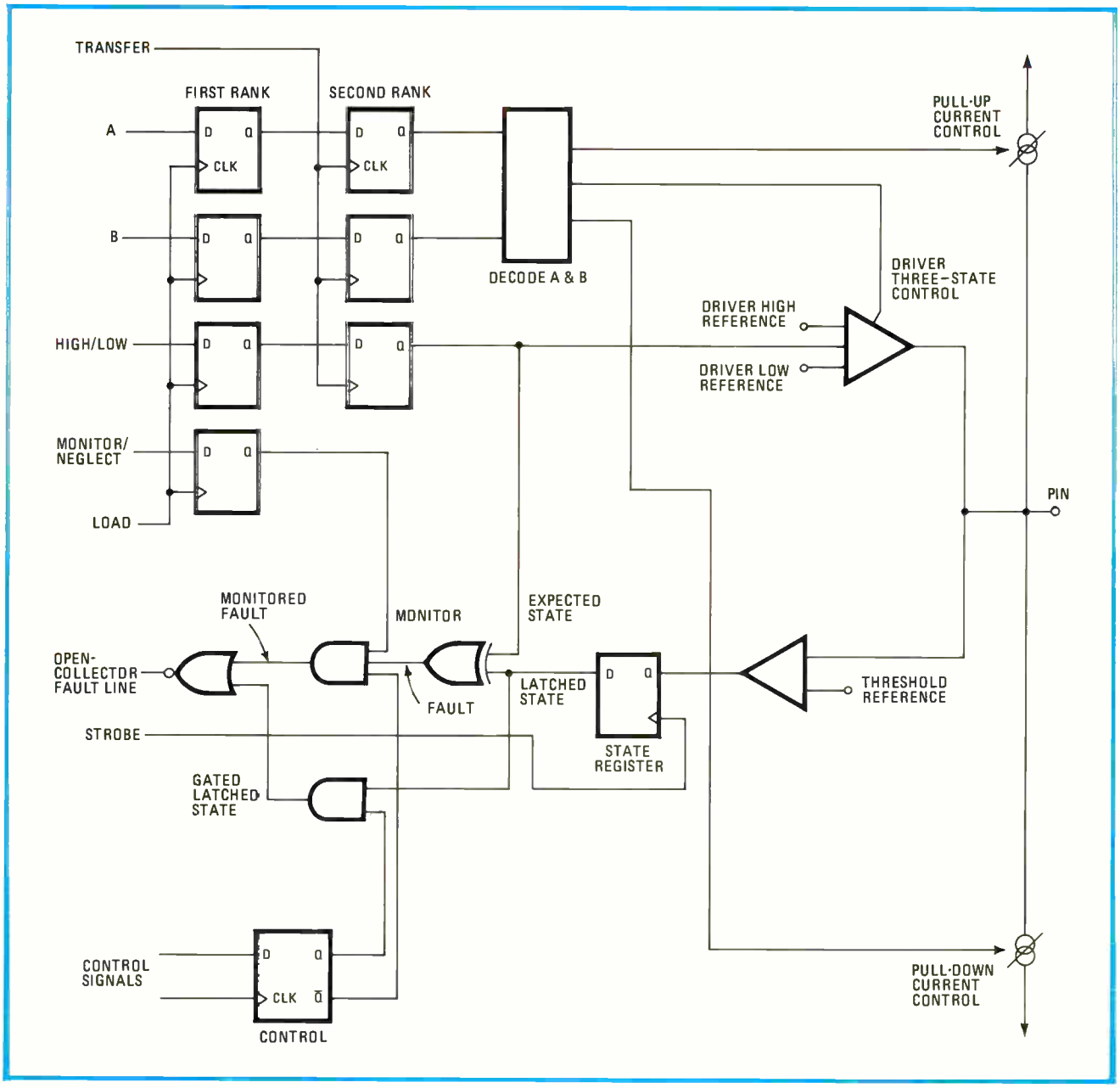
Designing from the ground up

This versatility allows the appropriate maintenance approach to be selected based upon customer needs, without incurring the usual penalty of large spare-board inventories. In addition, the PSP can fulfill other field-service requirements that have required commercial test instruments or special-purpose equipment. Such requirements include programming of read-only memories, component testing, memory loading, peripheral exercising, communications-channel monitoring, and others.

The system architecture (Fig. 1) combines hardware



1. Dual processors. The PSP board tester has two microprocessors. The system processor is the main processor, while the pin-control processor is responsible for board testing in conjunction with the system unit. This setup allows high-speed, independent board testing.



3. Driver/sensor. The driver/sensor circuit decodes signals A and B, located in the upper left corner, to discover whether the pin in question is being used as a driver, a high-impedance sensor, a sensor with a pull-up current, or a sensor with a pull-down current.

three major design objectives: maintain all features typically found on factory test systems; add those features that would reduce the need for custom interface adaptors; and reduce the size and power consumption of the driver/sensor pins so that boards with 192 signal pins could be tested on the PSP. Meeting these objectives required driver/sensor pins that offer a diverse group of capabilities.

First, each pin can be programmed either as a driver to apply a signal to the board under test, or as a sensor to test a signal from an output pin on the board. As a result, it is not necessary to wire inputs and outputs to specific pins.

The logic levels of the pins can be programmed over a ±12-volt range so that boards with transistor-transistor-logic, emitter-coupled-logic, complementary-MOS, n-channel MOS, p-channel MOS, and discrete-logic circuits can be tested without custom interface circuits. Each pin also has a pull-up or pull-down current that may be turned on or off under program control. This avoids the need for external pull-up or pull-down resistors on open-collector, open-emitter, or three-state signal lines and further reduces the need for custom interfaces.

Two ranks of latches permit operation in either the skew mode, in which each pin changes in the programmed sequence, or the broadside mode, in which all pins that change logic state do so on a programmed clock edge. The skew mode simplifies program debugging because the sequential pin changes avoid creating logic races at the board's input pins. The broadside mode

Digital service instruments flourish

The new field-service instruments introduced during the past year have several features in common. They are intended for on-site manual troubleshooting by field engineers. Compared with oscilloscopes, they require less training because the field engineer does not have to understand the technical details of the circuit. Also, they require less interpretation of measurement results.

Two of these instruments, the Data Test Corp. model 1200 [*Electronics*, July 21, 1977, p. 31] and the Tektronix model 851 digital tester [*Electronics*, Sept. 1, 1977, p. 116] are multifunction units that can measure many parameters, such as voltage, current, resistance, frequencies, pulse widths, and transition counts. A digital readout eliminates operator interpretation of the measurements, and a simple setup uses detailed documentation that must be supplied for each product being serviced. This documentation specifies which measurements are to be made at which nodes and at what positions all of the instrument controls are to be set.

The Hewlett-Packard model 5004A signature analyzer [*Electronics*, March 3, 1977, p. 89] represents another approach to on-site component-level fault isolation. It measures signatures at circuit nodes, with a field engineer comparing them with those recorded on a schematic. This approach requires that the product design include extra read-only memory for a program to stimulate the circuit nodes and jumpers to break feedback loops. It also requires detailed documentation defining test setups, listing troubleshooting sequences, and specifying the expected signatures on each node.

The Intel Corp. model 820 μ-Scope [*Electronics*, Sept. 1, 1977, p. 140] is a portable in-circuit emulator that provides field use of the same microprocessor-debugging techniques previously used only in engineering laboratories. While such debugging typically requires higher skill levels than those required by the other new instruments, frequently used test procedures can be included in the field engineer's documentation.

Another new instrument combines signature analysis and in-circuit emulation for 8080- and 6800-based products. The μSA [*Electronics*, Sept. 29, 1977, p. 120] manufactured by Millenium Systems uses in-circuit emulation for the functional test and also to generate the stimuli for signature analysis so that extra read-only memory need not be built into the product. However, it still requires jumpers to break feedback loops and detailed test-procedure documentation.

All of these instruments provide better on-site field-service tools than the traditional oscilloscope for the more complex new products designed with microprocessors and other large-scale integrated circuits. However, they do require more extensive service documentation, and in some cases they require specific features designed into the product.

is used to change a group of pins at the same time, such as on a bus in which pins must change from inputs to outputs or from high to low on a single clock edge.

The state of each pin of the board under test is sampled after a programmable strobe delay following the application of input signals. The minimum strobe is 50 nanoseconds, and the programmable strobe resolution is 10 ns. Such a time resolution permits measurements of gross propagation delay to detect open or missing pull-up resistors and capacitors and to provide a gross dynamic test of the board's response.

The comparison of each pin state with its expected state and the monitoring or neglecting of faults is accomplished within the hardware circuit of each driver/sensor pin. This arrangement permits a much more rapid functional test rate than would be possible with software fault masking and comparison of pin states.

To achieve these capabilities in a small package, integrated circuits designed by Omnicomp's Monolithics division are used on the driver/sensor boards. Custom C-MOS circuits contain the logic functions for two pins each, and custom bipolar ICs contain the linear driver/sensor circuits for each pin.

The states of the A and B signals in Fig. 3 are decoded to establish one of four conditions of the driver/sensor pin: drive, sense (driver in the three-state mode), sense with pull-up, or sense with pull-down. The high-low state signal controls the state of the driver and provides the expected state data to an exclusive-OR gate.

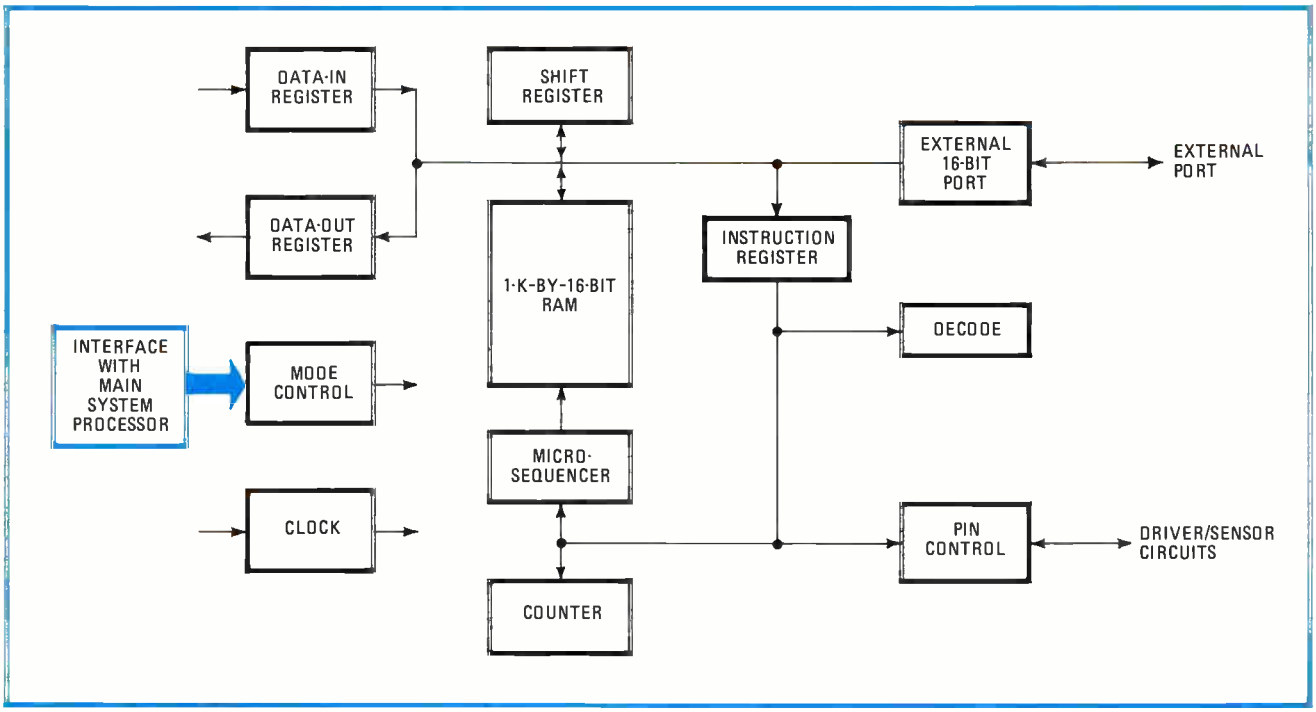
The state of each pin is strobed into the state latches after the programmable delay following the application of input signals to the board under test. It is compared with the expected state in the exclusive-OR gate. The output of this gate is a fault signal that is gated by the output of the monitor/neglect latch so that faults on neglected pins are masked.

The fault-line output of the driver/sensor IC is an open-collector gate that is effectively wire-ORed with all 192 pins. Thus a fault on any pin can be detected at high speed because all comparisons are done in hardware. In case of a fault, the system software can poll each driver/sensor pin to determine which pins are at fault. Control circuits within the driver/sensor IC also permit the latched actual state of any pin to be gated onto the fault line, where it can be tested by the system software.

Three programmable reference voltages with a range of ±12 V and a resolution of 0.1 V determine the high and low voltage levels of the driver circuit and the threshold-voltage level of the sensor circuit. The driver can source 6 milliamperes in the high state and sink 20 mA in the low state.

Controlling high-speed pin changes

A major design goal for the PSP was the ability to test microprocessors, memories, and other dynamic logic circuits that require fast clock changes. The traditional approach to such high-speed testing is a RAM behind each pin, so that test patterns can be loaded into the memories and then rapidly clocked to the board under test. The constraints on cost, power, and space of the PSP precluded this approach, so the pin-control processor was designed as a separate high-speed (50-ns clock) unit that could be programmed separately from the system microprocessor and could change pins sequentially at high speed. The pin-control processor board (Fig. 4) can be used in three different modes:



4. Three modes. The pin-control processor allows separate high-speed operation and programming from the system processor. It can operate under the system processor directly or execute a high-speed subprogram loaded from it. Also, both can work simultaneously.

- Transparent: the normal mode in which pin-change instructions are executed by the system processor and passed directly to the testing system. The pin-change rate in this mode is approximately 50 kilohertz.
- Subprogram: the system processor loads a program segment into the 50-ns RAM in the pin-control processor and waits while it is executed at high speed. A typical application is the refresh routines required when testing a dynamic memory board.
- Multiprocessing: both the system and the pin-control processors operate simultaneously. The main processor loads a program into the high-speed processor's RAM and starts its execution while continuing execution of the main program. A typical application is testing dynamic boards. The pin-control processor generates complex clocks, while the system processor selects data for application to the board under test.

Compacting PSP Basic

A major objective of the PSP software system is ease of use by operators not necessarily trained in using computers. The traditional approach uses an on-line editor with which the source test program is entered and corrected, a compiler that converts it to a more compact object program, and an operating system that executes or interprets the object program. However, the command structure tends to be complex, which makes it hard for the occasional user to remember the necessary commands. Moreover, it requires several minutes to make even a simple change in the test program.

Instead, the designers opted for an interactive programming system, similar to that used by languages such as Basic. With this approach, editing operations are completely transparent to the user. Statement lines are executed and listed in numerical order, so a new line can be inserted between two existing lines simply by using a line number between the existing line numbers. Also, programs can be executed immediately after entering new statement lines.

However, most interactive language structures have serious disadvantages in a test-system application. They are slow to execute and they use memory inefficiently. Both test speed and memory utilization are very important in the PSP, yet the interactive programming features were important, too.

The PSP software actually achieves the advantages of both the on-line editing and interactive approaches by using a compact code format consisting of short tokens into which the statement lines are translated as they are entered. In addition, the instruction set of the processor was expanded so that these tokens could be interpreted directly in microcode. This technique preserved the simplicity of operation of interpreter languages, while maintaining the memory efficiency and execution speed of compiler languages.

In the PSP software system (Fig. 5), test-program statements are entered in a modified Basic language, which includes most Basic statements and high-level test statements in the same format. Each statement line is entered when the execute key is pressed and is then translated into the compact code and added to the test program. When part or all of the test program is listed on the printer, those statement lines are reverse-translated from compact code into PSP Basic. When the test program is run, the compact code is interpreted directly by both microcode and a software interpreter to execute the test functions.

Another advantage of line-by-line translation is the syntax checking as each line is entered. This check detects errors immediately while the user still remem-

bers the statement line, thus simplifying the correction of errors.

Line-by-line translation also provides translation into compact code and immediate execution for test-program statements entered without line numbers. Thus, the operator can program power-supply voltages, and change the states of driver/sensor pins and of the test pin directly from the keyboard as if he or she were adjusting potentiometers and toggling switches on a manual test fixture. This feature is particularly handy when the operator is performing test-program debugging.

The most frequently used PSP Basic keywords are assigned to individual keys on the operator's keyboard. Pressing a key when the CMD key is depressed enters the complete keyword with one stroke. This greatly reduces typing errors and provides the operator with a convenient reference of the available commands.

Reducing the data base

The PSP uses the guided-probe fault isolation technique, in which a series of probing instructions lead the operator back from a failing output pin to the faulty node (IC and pin number). In addition to the test program, software requires two types of information.

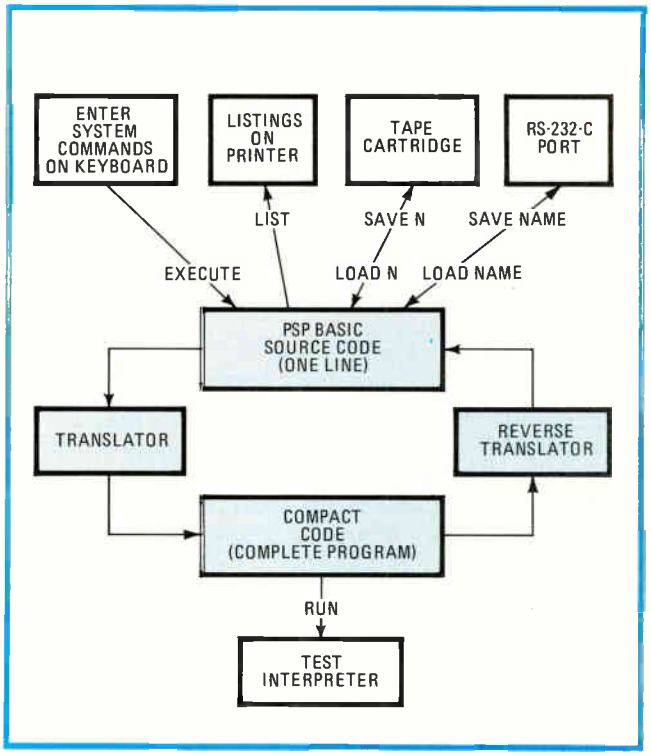
One is a circuit "image": a wire-list description of the interconnections of the components on the board under test. It can be prepared by clerks working from a schematic of the board, or it can be translated from an existing image.

The other necessary data is a table of the expected response at each node. The data base typically used on large production test systems consists of the logic-state data at all tests. Since a large board can have 1,000 or more nodes, and a large test program can contain 1,000 or more tests, the required data base can exceed a million bits and require a disk memory for backup storage of the expected responses. Obviously, this was impractical in the PSP, so some means for compacting the data had to be used.

Techniques for reducing a bit stream of 1s and 0s have been used in board testers for more than six years. One of the most widely used is transition counting, in which the number of logic-state transitions at a node is counted and stored as a signature that represents the correct response at that node. Other widely used techniques measure signatures consisting of 1s-counts, time-weighted transition counts, cyclic-redundancy-check codes, and other codes based upon shift-register sequences.

However, all of these techniques have a common disadvantage when used on complex boards containing feedback loops. The effect of the fault propagates around such loops so that all of the nodes in the loop appear faulty, and fault isolation to a single component is impossible.

The PSP had to be able to isolate faults to a single component even in complex feedback loops, so the simple signature techniques could not be used. Instead, a proprietary data-compacting technique was developed that retains sufficient information about the nodal responses in a form compact enough to fit in the memory. A patent on the technique is pending.



5. Architecture Software is written in microcode, macrocode, and higher-level languages to provide the optimum tradeoffs between execution speed, memory requirements, and user flexibility. Line-by-line translation, compacting, execution, and reversal are performed.

Most circuit boards are tested on automatic production test systems. However, all test systems have unique languages in which their test programs must be written. The PSP's return on investment in field engineering obviously would be reduced if all test programs had to be regenerated for the field tester. Therefore, a series of translator software packages were developed to convert the factory test programs and circuit images into the PSP Basic language.

Translating other languages

These translators, written in Fortran for transportability to whatever computer facilities are most convenient for each company, are presently available to convert the test languages of Computer Automation, GenRad, Micro Systems, and Teradyne. Under development are translators that will handle the test languages of several other commercial and in-house test systems. These test program translations are one of the major activities of the support effort necessary to deploy the PSP in the field.

Pseudorandom test patterns have been used to generate programs for simple and moderately complex boards for many years. Although such patterns are not directly translatable, the PSP does include a pseudorandom-pattern-generation capability that closely emulates the types of patterns generated by the most popular pseudorandom testers. Thus, the information about which types of patterns are to be applied to which pins is sufficient to convert existing pseudorandom test programs for use with the PSP. □

RAMs reduce chip count in programmable delay lines

by Scott M. Smith
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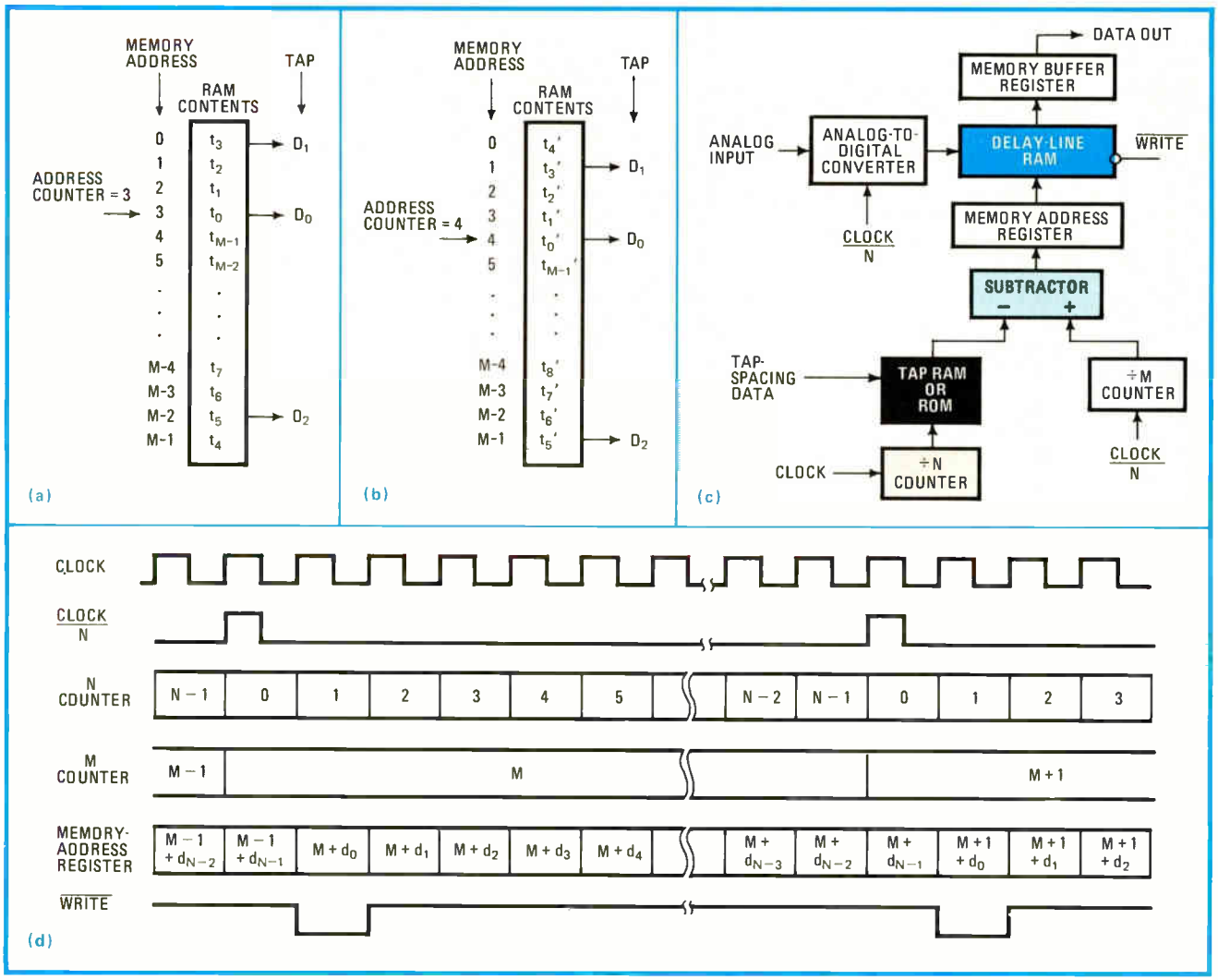
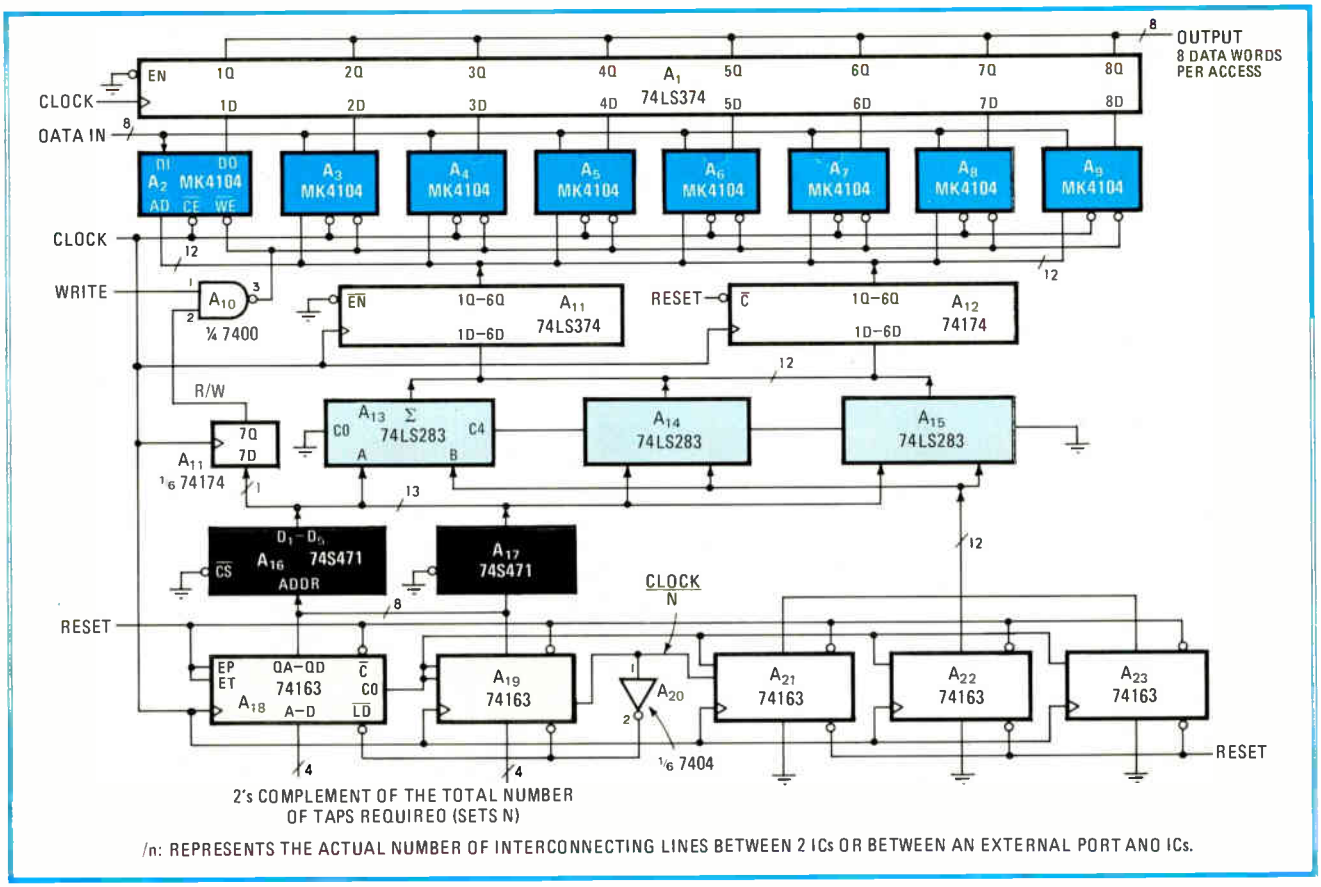
First-in, first-out buffers or variable-shift registers are most often used for the storage elements in digital programmable-tap delay lines (that is, one or more shift registers with multiple-output taps). But random-access memories can store a greater number of samples per integrated circuit and can therefore be used to reduce the total device count. A delay line that uses RAMs will cost much less than its FIFO or variable-length register counterparts if the total number of samples handled is fairly large.

Quite unlike a standard shift register, in which input data is introduced at its standard-input port (first location) and then shifted through, a RAM must have its input data introduced at each individual location. The reason is obvious: the contents of the RAM cannot be shifted, but merely accessed by the system's address counter. Therefore, input data must be entered into the particular RAM location that corresponds to the present location of the address counter.

The memory map in Fig. 1a shows how a delay line is mapped onto a RAM having a length of M words and yields an insight into the factors involved in designing a practical circuit. Three output taps, D_0–D_2, are desired in this example. D_0 represents the zero-delay tap. The RAM address counter points to location 3, which contains



1. Super-long tapped delay. Memory map shows how an N-tap delay line is mapped onto an M-word RAM (a). Input data may be introduced into RAM by incrementing counter and placing sample there. Oldest data sample is destroyed and existing samples are redefined (b). Block diagram of system outlines procedure used to write data, examine output taps (c). Waveform diagram details timing constraints (d).



2. Great capacity. Eight-bit-wide programmable-tapped delay line is implemented with Mostek MK4104 random-access memories as shown. Each delay line is the equivalent of a 4,096-bit shift register. User may specify a total of 255 output taps with any desired spacing.

t_0, the most recent sample in the delay line. The next most recent sample is t_1, with t_{M-1} being the oldest sample. D_1 and D_2 are taps delayed three samples and five samples, respectively, with regard to D_0.

The value corresponding to memory address 3 (t_0= logic 1 or logic 0) would appear at D_0 if that tap were requested. Similarly, the sample at memory address 0 would be fetched if D_1 were to be requested, and the sample at address $M-2$ would be fetched if D_2 were requested.

Figure 1b shows how a new sample would be inserted into the delay line. The counter would be incremented, pointing to location 4 as shown, and the new sample would be written into the location, thus shifting the oldest data sample (t_{M-1}) out of RAM. The memory contents of RAM would otherwise be unchanged; each memory address would be simply redefined as being one sample older. If D_1 were queried, the sample at memory address 1 would be fetched; when D_2 were requested, the sample at location $(M-1)$ would be fetched.

The block diagram shown in Fig. 1c more clearly explains how data is written, and taps are specified and read. A divide-by M counter driven by a clock running at $1/N$ times the system clock frequency is required for pointing to the most recent sample (D_0). Also required is a tap RAM or ROM, which is programmed so that its output is equal to the distance in time (that is, the number of samples) each user-specified output tap is from the most recent sample, t_0. Thus, the spacing between taps is specified. A divide-by-N counter (where N is the number of taps) is needed to address each tap in a sequence that is selected by the user. Note that the N counter must move through one complete cycle for each increment in the M count. The subtractor determines the numerical difference between the tap distance and the zero-delay location and stores the result in the memory address register in order to access the memory address desired. The delay-line RAM is then accessed to obtain the data sample corresponding to the tap selected, or to write in a new data sample. Then the sample that has been read is stored in the memory buffer register, to be shifted out in serial form.

The timing considerations for the circuit are shown in Fig. 1d. As may be observed, provision should be made to ensure that the M counter advances before any new data (write) is stored in RAM, if necessary, to allow the oldest sample to be read before it is overwritten. There are no other major considerations. The taps may be accessed in any order and are selected by appropriate programming of the tap delay memory (tap ROM). The maximum shift rate (the frequency with which new samples are placed in memory) is $f_{s\,max} = 1/Nt_{c\,min}$, where $t_{c\,min}$ is the minimum cycle time of the system.

Figure 2 shows a design example that uses an 8-bit-wide programmable tapped-delay line. The RAM memories, each holding 4,096 1-bit words, form a 4,096-word-by-8-bit array. A_1 is the memory buffer register, A_2–A_9 is the RAM delay line, the memory address register is

A_{11}–A_{12}, and A_{13}–A_{15} is the subtractor. The tap ROMs are implemented by A_{16}–A_{17}. The divide-by-N counter is implemented by A_{18}–A_{20}. Two hundred and fifty-five output taps may be specified. A_{21}–A_{23} is the divide-by-M counter. Note that bit 7 of A_{11} buffers the read/write definition bit from ROM. □

Low-cost watch crystal excites ultrasonic burst generator

by Daniel F. Johnston
University of New Brunswick, Fredericton, N. B., Canada

A small pulse-burst ultrasonic generator having excellent frequency stability can be formed by uniting the miniature quartz-crystal time base found in an electronic wristwatch with an integrated-circuit divider and one logic gate. This circuit will deliver a fixed frequency output of selectable burst width, and it is thus tailor-made for many portable instruments such as underwater location beacons and depth-finding (sonar) devices. The current drawn by the circuit is typically several microamperes.

The generator is shown in the figure. The standard quartz crystal operates at 32.768 kilohertz, is readily purchased, and costs only a few dollars. Crystals from 17 to 150 kHz can be obtained at slightly higher cost if other frequencies are desired.

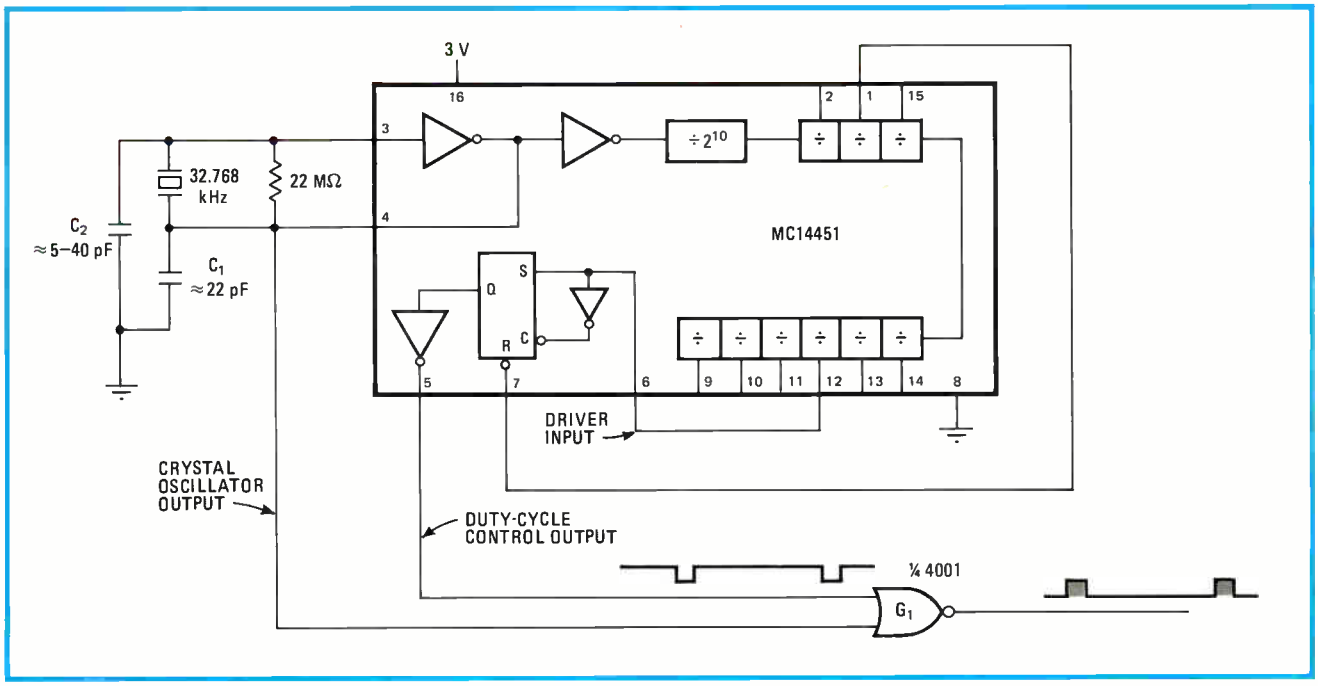
The IC divider is the MC14451, a low-cost divider-and-duty-cycle-controller built with complementary-metal-oxide-semiconductor technology that may be powered by a source of from 1.3 to 3.0 volts. The device contains an 19-stage binary divider (with taps available at any register port from 2^{11} to 2^{19}, inclusive), and a buffered flip-flop circuit for duty-cycle, or burst-width control.

The crystal is placed in a conventional oscillator circuit, as shown, with one inverter of the MC14451 serving as the active positive-feedback element. C_1 and C_2 in the oscillator are trimmed to achieve the required accuracy and are on the order of 22 picofarads for C_1 and 5 to 40 pF for C_2. The output of the oscillator is simultaneously fed to the MC14451 and G_1.

The crystal oscillator signal appearing at the output of G_1 is gated by the duty-cycle control output of the MC14451. To select the burst-width repetition rate, the appropriate buffered output of the divider must be connected to the driver input of the duty-cycle flip-flop, pin 6. Another buffered output, whose output period corresponds to twice the required burst width, must be connected to the duty cycle reset port, pin 7. The duty-cycle control output will toggle as required, switching low for the interval specified by the reset line at a rate controlled by the driver-port signal. The output from G_1 will therefore be a burst of a constant frequency.

Current consumption of the circuit is only 5 μA when a 32-kHz crystal is used and only twice that for a 65-kHz crystal. Thus the circuit can be powered by a small-capacity battery. □

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 $50 for each item published.



Portable. Programmable-burst ultrasonic generator is small, is low in cost, and draws only a few microamperes. Burst-width repetition rate is selected by connecting the appropriate buffered output of the tapped binary divider in the MC14451 to pin 6. Burst width, adjustable from about 31 milliseconds to more than 1 second, is selected by connecting a second buffered output to pin 7 of the device.

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One chip controls keyboard and display

Device simplifies microprocessor interface to alphanumeric displays

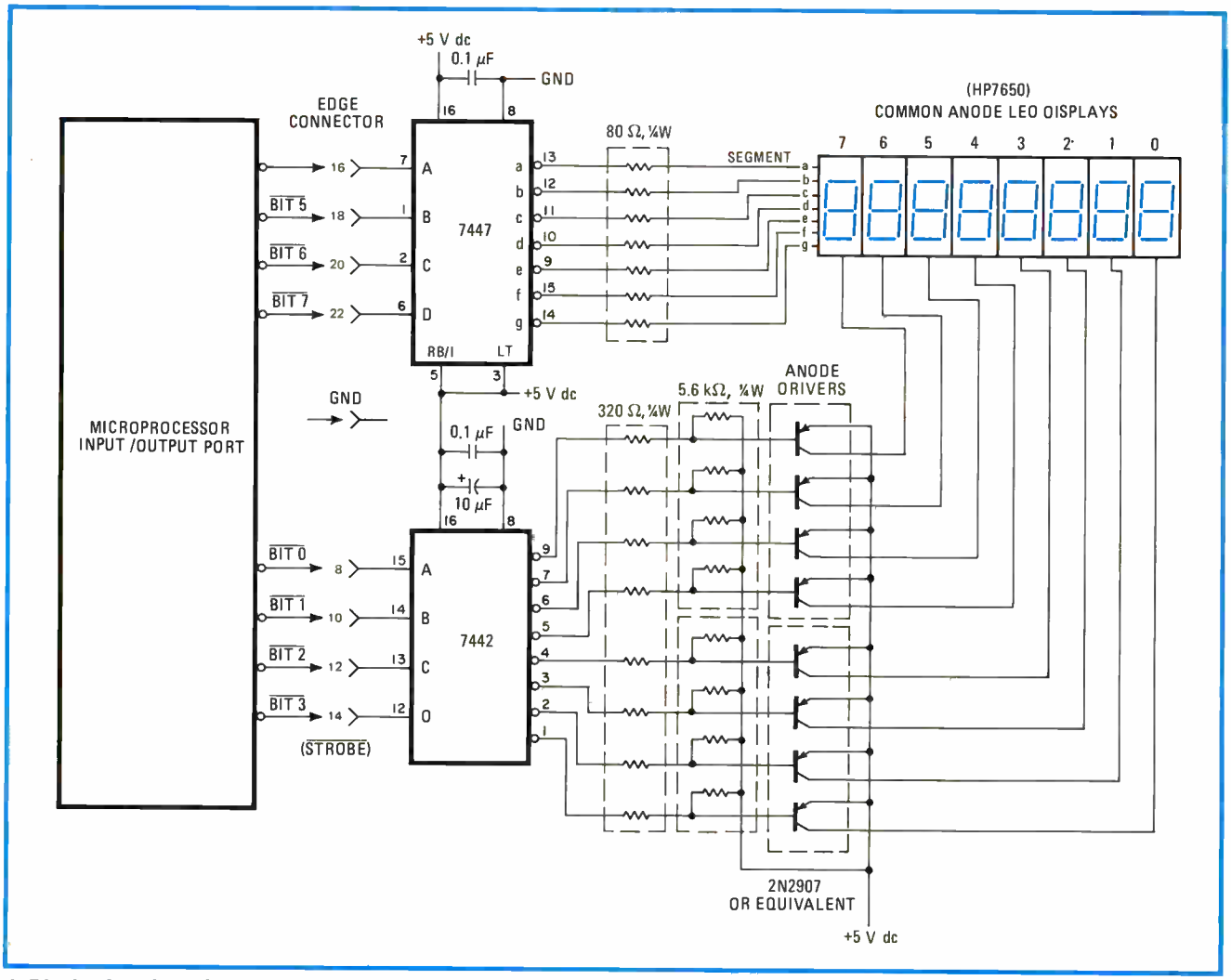
by Lorne Trottier and Branko Matic
Matrox Electronic Systems, Montreal, Quebec, Canada

☐ For all the importance of displays to microcomputer systems, no simple means of interfacing the two has existed. The designer has been forced to build cumbersome hardware controllers, putting them together out of relatively unsophisticated input/output devices like parallel and serial interfaces. Alternatively, he could develop software routines, knowing in advance that they would be slow and waste the processor's time.

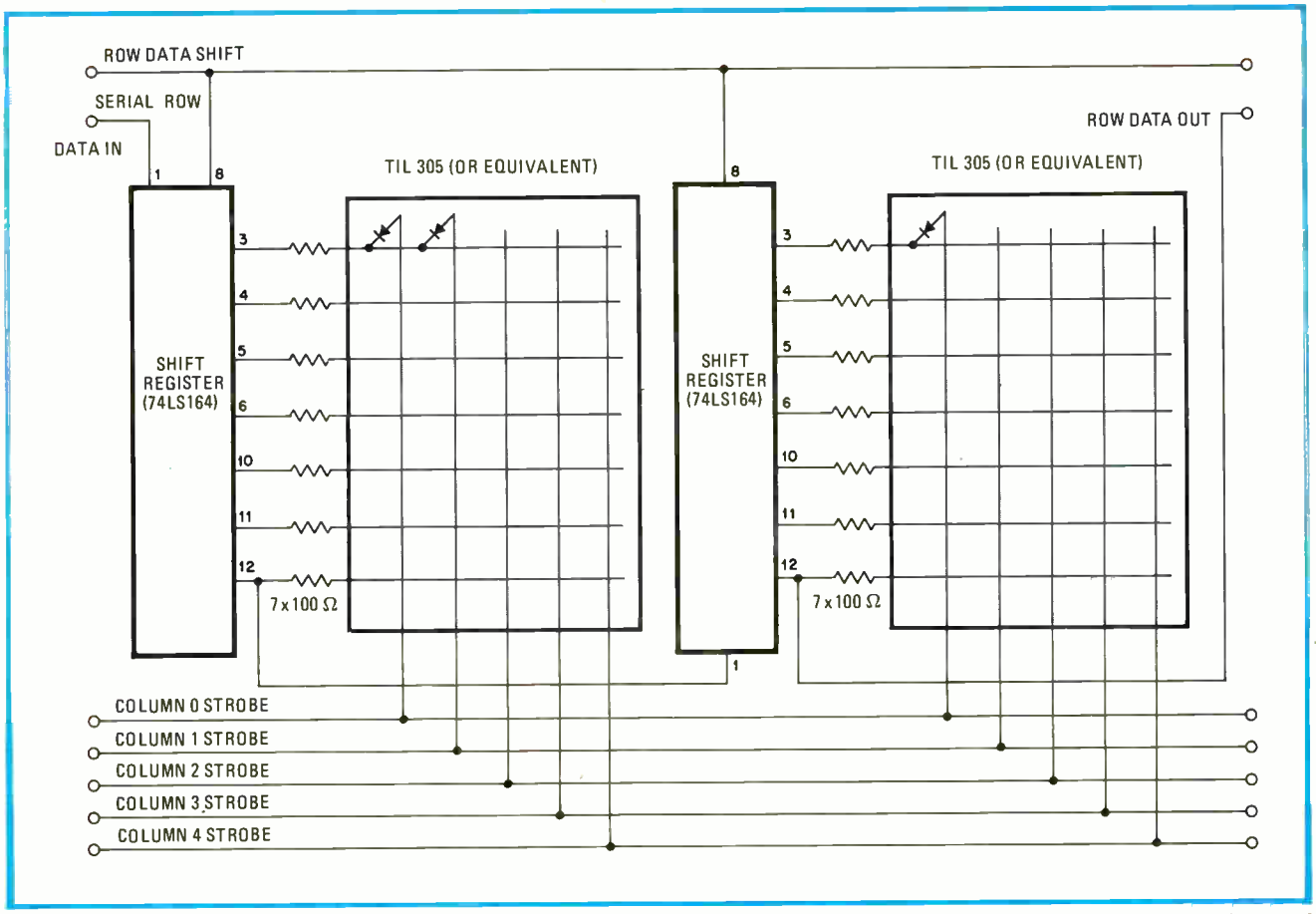
But rescue is at hand. A horde of intelligent I/O controller chips dedicated to display and keyboard interface chores is on the way.

One of the first devices to pack virtually all keyboard and display I/O functions into a single large-scale integrated circuit is the MTX-A1, a controller for alphanumeric displays and keyboards. Called the alpha chip, it is programmed with the standard 64-character ASCII font. Another member of the family, the MTX-B1, will handle popular 14-, 15-, and 16-segment star-burst displays, as well as the usual seven-segment type.

The alpha chip is a microprogrammed controller. It uses standard n-channel, silicon-gate, metal-oxide-semiconductor technology and is housed in a 40-pin dual in-line package. It needs only 5 volts and is compatible with



1. Display interface. Standard microprocessor-to-display interface for driving seven-segment numeric displays requires one I/O port and considerable software overhead to generate the required data and timing signals. It uses up much of the processor's time.



2. Driving displays. Classical method for driving several five-by-seven-dot matrixes of light-emitting diodes requires one shift register and seven current-limiting resistors per array. Integrated display chips with built-in shift registers are also available.

transistor-transistor logic. An on-chip, time-base oscillator operates off an external crystal or LC network.

The display portion of the chip generates all timing and refresh signals needed to drive up to 32 matrixes of five by seven light-emitting diodes. The keyboard portion provides all the scanning signals needed to decode and debounce up to 64 keyboard inputs. Also on chip are a read-only memory for generating ASCII characters and a 32-by-8-bit display-refresh random-access memory, both of which interface directly to the address, data, and control buses of most 8-bit microprocessors.

Why alphanumeric displays are preferable

Because of the huge amount of hardware and software required to drive alphanumeric displays, microprocessor-based equipment has often ended up with seven-segment numeric displays. These are better suited to calculators, being virtually incapable of displaying text. But their simple, low-cost driving requirements and their availability in a wide choice of sizes are an undoubted advantage in microprocessor applications, too.

Nevertheless, the standard technique of using a parallel I/O port to pass on control signals from the microprocessor to these displays (Fig. 1) has required complex hardware and time-consuming software routines. Often more than half of the central processing unit's time is taken up in scanning the keyboard and numeric display.

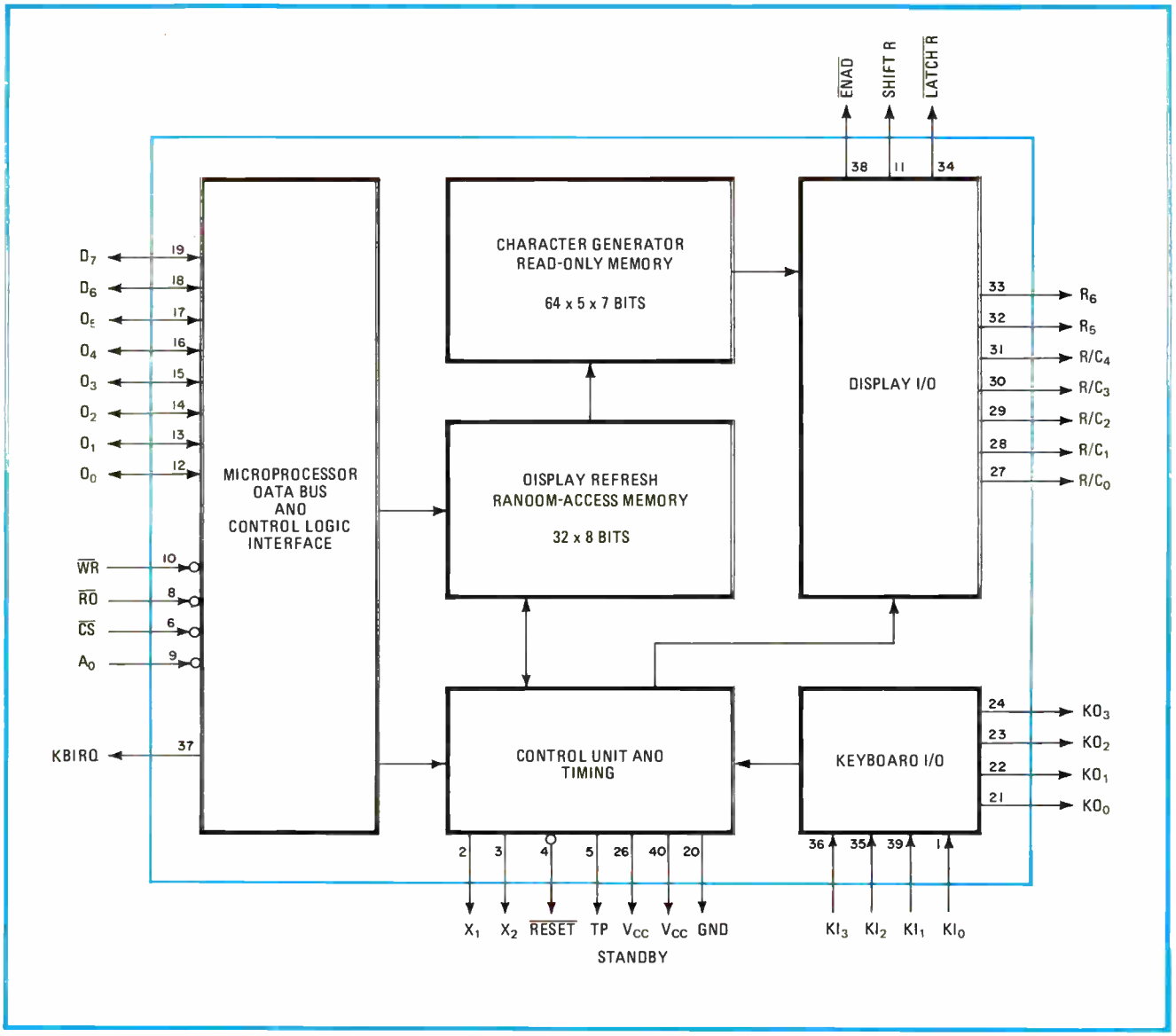
Another big drawback is the risk that a defective segment will result in the erroneous display of a number. This is particularly serious in critical situations that are commonplace in medical and navigation applications.

In contrast, a five-by-seven-dot-matrix LED display has all the advantages of a seven-segment display and in addition greatly reduces the possibility of faulty readings. Besides full alphanumeric sets such as ASCII, it can display Japanese characters and other special symbols. Also, the high quality of the dot-matrix characters adds eye appeal to microprocessor-based systems and simplifies the man-machine interface. A growing preference for full alphanumeric displays is already in evidence, for the number of these products on the market is increasing steadily.

Building an image

The usual way of driving a group of five-by-seven-dot-matrix displays is illustrated in Fig. 2. Each character is an array of 35 diodes lined up in seven rows by five columns. The column lines of all characters are connected to a common column-strobe bus line; rows are connected to shift-register outputs through current-limiting resistors.

The shift registers are connected in a chain of N stages (where N is the number of characters in the display) and are loaded serially with data for a specific column for each of the display characters. The column



3. Block diagram. The MTX-A1 packs onto a single chip virtually all of the functions needed for driving a multicharacter alphanumeric display consisting of several five-by-seven-dot matrixes. It has refresh random-access memory, character-generator read-only memory, and display input/output. Row and column data are multiplexed on the same lines, R/C_0 through R/C_4.

data for the last character is shifted in first and column data for the first character is shifted last. By the time all the data is shifted in, the column data contained in each shift register will be in the correct position.

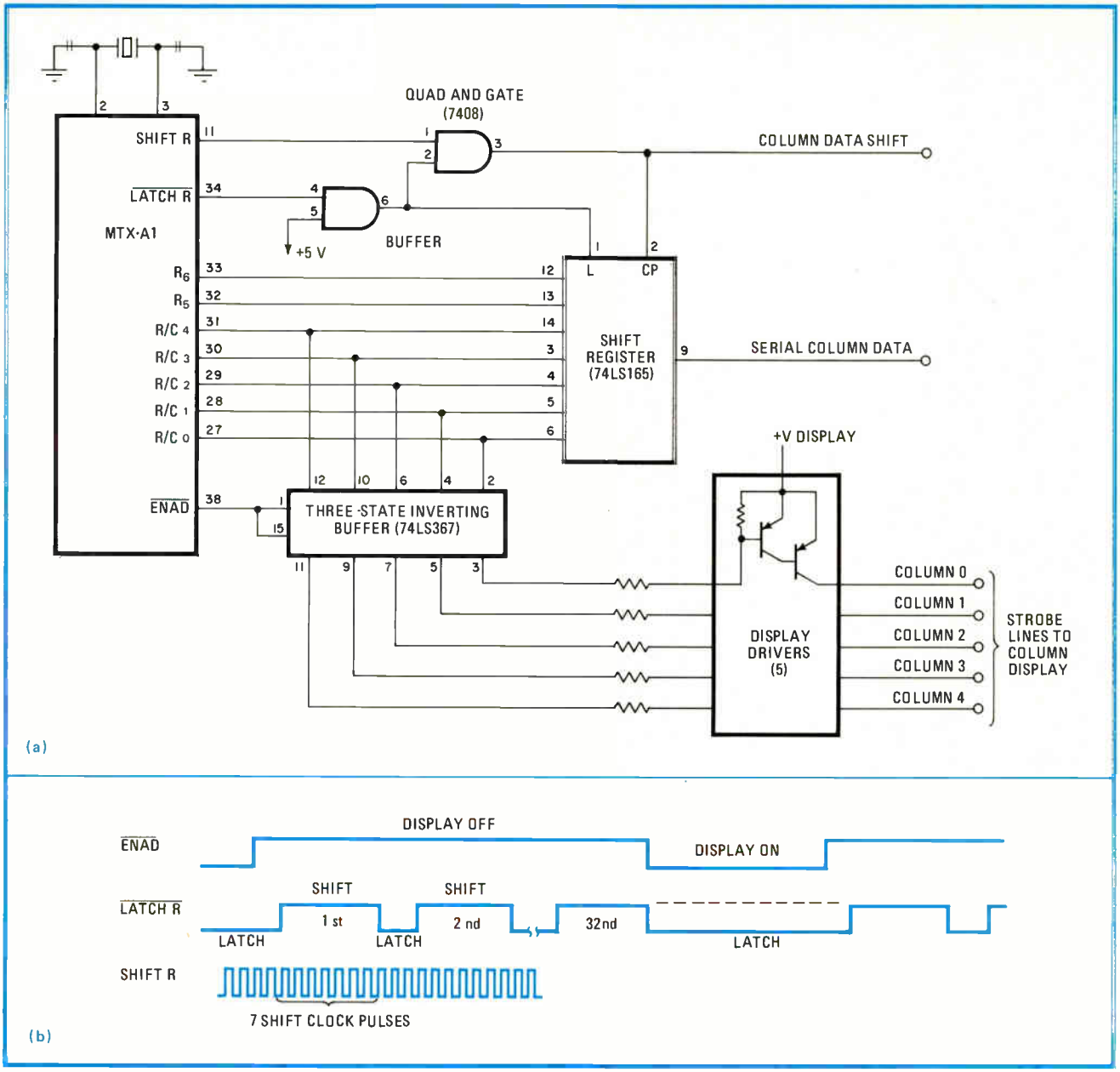
Once this is done, the corresponding strobe line is pulsed high to turn on the column display. Before shifting in data for the next column, the strobe line is set off to turn off the display. Then data for the next column is shifted in and the sequence repeated. The process is analogous to that used in cathode-ray-tube raster scans: the display image is built up by scanning successive slices through the character. The overall recommended refresh rate for this type of display is 100 hertz or better.

Some displays, such as Hewlett-Packard's HDSP-2000, incorporate on one chip the shift registers, current limiters, and LED matrixes for several complete characters. Alternatively, a designer may opt to configure his display from discrete shift registers, current limiters, and other elements, at relatively low cost and for the sake of the large selection of types available.

The MTX-A1 chip diagrammed in Fig. 3 drives multiple-character displays of either type. It supplies all the necessary display control functions—data bus interface, control unit, character-generator ROM, display I/O, and keyboard I/O. In essence, the chip's control unit fetches the current character from the refresh RAM, looks up the correct column data from the ROM, and sends appropriate timing and control signals to the display circuitry.

Interfacing the alpha chip

The circuit of Fig. 4a shows the external hardware required (two and a half TTL circuits plus several transistor drivers) to interface the alpha chip to the circuit of Fig. 2. The timing diagram of Fig. 4b shows how the chip refreshes the display with a burst of data from a given column. The column data is sent out over R/C_0–R_6



4. Display buffer. The alpha chip requires only 2½ low-cost TTL ICs (a) to drive an HP HDSP-2000 display. The shift register converts parallel column data to serial, and the three-state buffer provides a current boost for the column display drivers. Timing diagram is shown in (b).

and latched into the shift register. Row and column outputs, R/C_0 through R/C_4, are multiplexed onto I/O lines, which saves pins. For demultiplexing, TTL buffers are available to deal with the high-current circuits that drive the display.

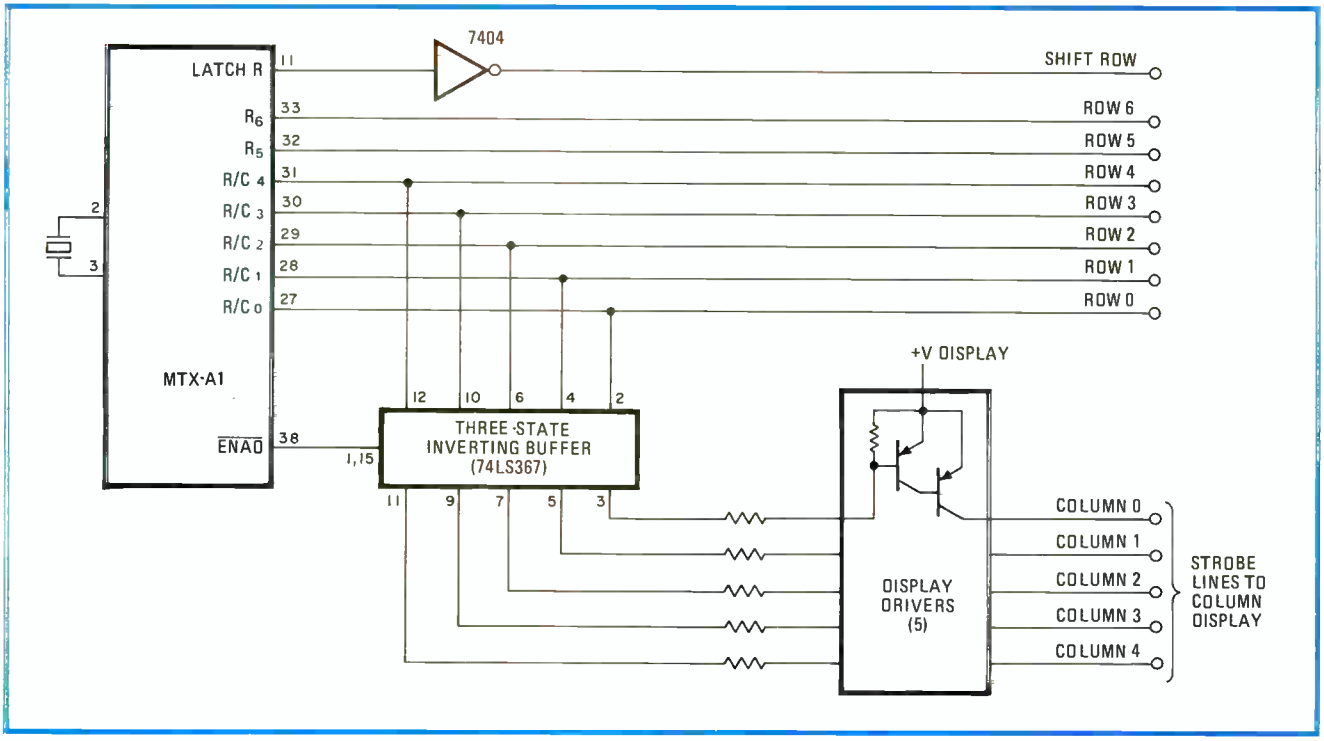
The $\overline{\text{LATCH R}}$ line is gated with the SHIFT R line to produce exactly seven clock pulses. The clock pulses shift one column of data out of the shift register and through other shift registers in the display chain, a process that is repeated until the data in that particular column for all the characters has been shifted out of the registers. The appropriate column line, C_0, C_1, C_2, C_3, or C_4, is set low, and the enable display line, ENAD, goes low, causing a column strobe line to go high, turning on the display.

Display circuits may be further simplified as shown in Fig. 5. Here the alpha chip generates parallel row data, thus eliminating the need for parallel-to-serial conversion and reducing by one the number of shift registers that are required under the usual circumstances.

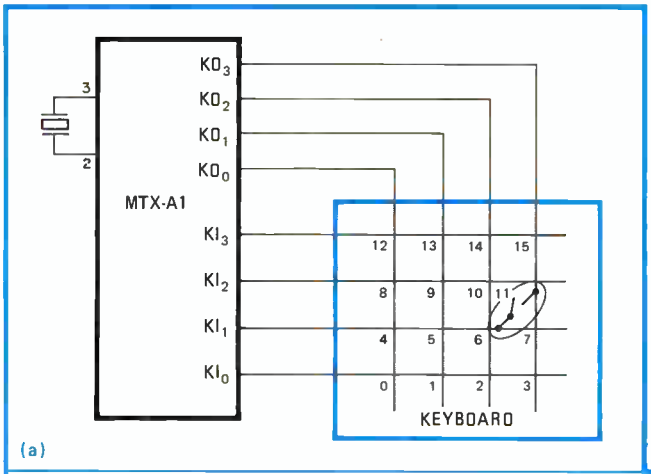
Keyboard scanning

In addition to refreshing five-by-seven-dot-matrix displays, the alpha chip also scans, debounces, and decodes keyboard inputs. Its keyboard-scan controller portion has two basic modes of operation that permit scanning either 16 or 64 keys. Connection diagrams for each mode are shown in Fig. 6.

A total of eight I/O lines is reserved for scanning the keyboard, four lines serving as scanning outputs and four as sense inputs. The essential difference between the two scan modes is the format used on the four scanning output lines, K_{00} through K_{03}. In the 16-key scan mode,



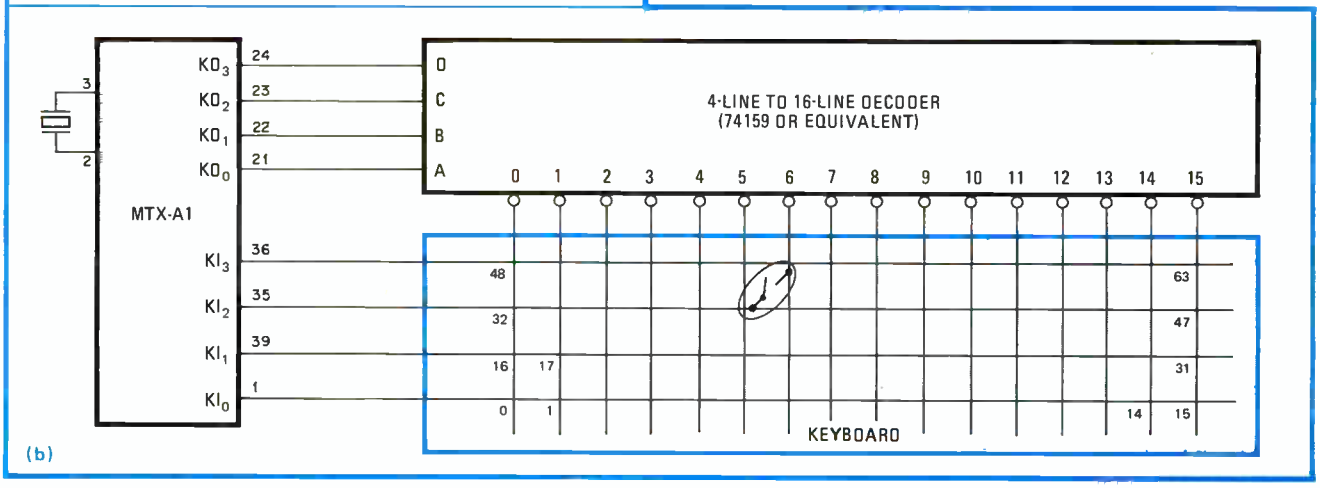
5. Simplified display. One IC can be eliminated in the display buffer for an MTX-A1 controller chip linked to a circuit similar to that shown in Fig. 2. A series of cascaded parallel input shift registers replace the serial input devices used in the classical method.



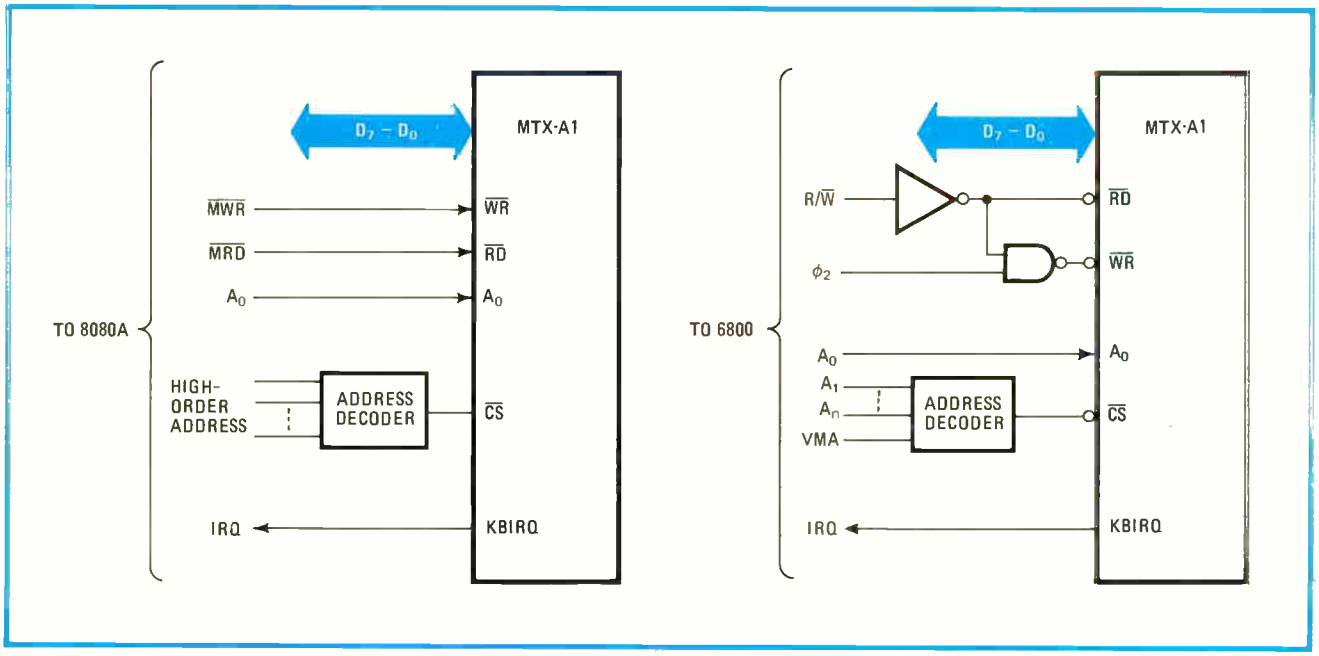
the scanning output lines are strobed low, one at a time, in sequence (Fig. 6a). In the 64-key mode (Fig. 6b), the four scanning output lines act as a binary counter that selects one of 16 lines by a 4-to-16-line decoder.

The keyboard-controller portion of the alpha chip scans and debounces the keyboard with a lockout algorithm, much like those used in calculators. When a key closure is detected, scanning remains frozen on the sensed key. The alpha chip signals this fact to the processor by lowering the keyboard interrupt request line, KBIRQ.

Once this happens, no other keys are scanned until the detected character is read by the microprocessor and the affected key is sensed open. The depressed-key position within the keyboard matrix is encoded as a binary



6. Two keyboard-scan formats. In the 16-key scan format (a), K_{00} through K_{03} lines are sequentially pulsed low by the alpha chip. In the 64-key scan format (b), the same four lines perform as a 4-bit binary counter. K_{10} through K_{13} are input sense lines in both cases.



7. Microprocessors match. The alpha chip interfaces to 8-bit microprocessors with no external hardware except for an address decoder that can be implemented with a simple NAND gate. The 6800 interfaces gates R/W and $\phi 2$ to generate required read and write strobe signals.

address, which is sent by the alpha chip to the microprocessor upon request.

The alpha chip interfaces very simply to a microprocessor. Figure 7 shows it connected to the 8080A and the 6800 microprocessors, which address it as memory-mapped I/O—the commonest kind of interface.

The I/O control lines—chip select, register address, read, and write—route data flow between the various internal chip registers and assorted external buffers. The $\overline{CS}$ line selects the alpha chip and activates it for a read or write operation. The A_0 line is used to select internal alpha chip registers. The $\overline{RD}$ line is strobed low to read data from the chip, and the $\overline{WR}$ line is strobed low for a write operation.

Writing into the chip

In the write mode, the microprocessor writes 8-bit commands into the alpha chip's input address register. This command register is selected by $\overline{CS}$ and $A_0 = 0$ ($A_0 = 1$ is not allowed for write operations on the chip). The 8-bit output register contains data requested by the microprocessor, such as GET commands.

In the read mode, the microprocessor can read either the alpha chip's 8-bit output register or its 1-bit busy flag. The output register is selected and read by $\overline{CS}$, $A_0 = 0$, and $\overline{RD}$. The 1-bit busy flag register is set to a 1 to indicate to the processor when the alpha chip has finished executing the previous command. This register is addressed by $\overline{CS}$, $A_0 = 1$, and $\overline{RD}$.

In addition to interfacing directly to the microprocessor through the address and data bus, the MTX-A1 can be interfaced through a standard I/O port. One 8-bit I/O port is used to simulate the 8-bit bus, a 4-bit port to simulate the $\overline{CS}$, $\overline{AD}$, $\overline{RD}$, and $\overline{WR}$ signals. Furthermore, for applications requiring serial interface for display, a simple terminal can be built by connecting a standard serial universal asynchronous receiver/transmitter directly to an MTX-A1. Although the codes going through the UART will be 8-bit non-ASCII, this feature allows all the advantages of a serial interface.

To reduce the load on the microprocessor, the MTX-A1 has many intelligent commands in its repertoire. The command set comprises two instruction sets: one contains seven microcoded instructions and the other 16 direct instructions. All commands are coded into 8-bit words: the three most significant bits determine whether the instruction is a direct instruction or a microcoded one, while the remaining bits specify a particular instruction in the case of direct instructions or contain microcoded information in the case of microinstructions. A code of 111 in the three most significant bits always signifies a direct instruction; any other code signifies a microinstruction.

Between them, its commands enable the alpha chip by itself to:

- Clear a display.
- Read a keyboard.
- Take on/off control of both keyboard and display controllers.
- Vary the display refresh rate and keyboard scan times.
- Control display length.
- Rotate or shift the display left or right.
- Read data into or write it out of refresh memory.
- Take full control of a cursor, including its automatic increment/decrement functions.

Upon command from the microprocessor, the alpha chip sets its busy flag to a logic 0 and then, after executing the instruction, resets the flag to a logic 1. The microprocessor reads the flag condition simply by checking the flag register to determine when to issue the next command or when to read the data register. The average instruction time is 150 microseconds. □

This is the first vidicon camera designed specifically for use with digital and analog computers. The equipment is designed to shake hands with both types of computer systems. Thus it fulfills many applications as an "eye" for automated industrial inspection, image analysis, biological research and university research.

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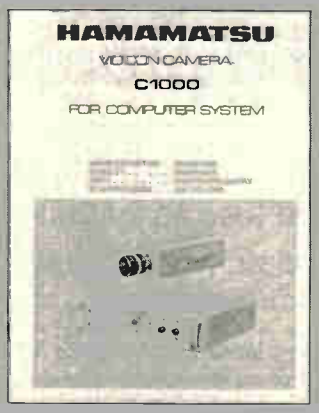
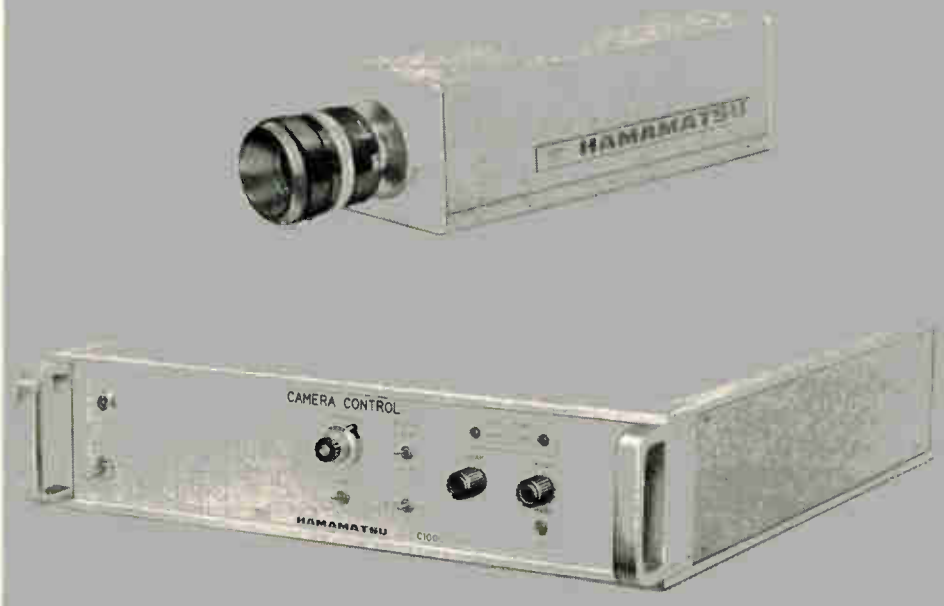


C-1000
the first TV camera designed for computer interface.



NOTES TO THE SYSTEMS ENGINEER

Ordinary TV cameras are designed to produce a picture on a monitor, not interface with a computer. Proper timing pulses are not available and their shape is inappropriate for computer use. The clock is usually a tuned circuit or a low frequency crystal. While fully adequate for viewing, the precision of these circuits becomes a limiting factor in a computer camera system. The pulses occur infrequently and at periods during the scan format that is wasteful of computer time.

The C1000 system was designed to have a basic clock of 25.39 MH_Z with its half frequency accessible to the computer using TTL logic. All sweeps, blanking and unblanking information are controlled by this computer accessible signal. The basic signal and a number of other timing signals are available and can be brought out by use of the M998 I/O buffer, M999 I/O interface, or a user designed buffer. The customer can build his own interface, or buffer, thus saving considerable money.

All of the digital lines are clock controlled to avoid jitter and to insure maximum precision and reproducibility. The video output from the C1000 is fully usable with standard TV monitors thus no function is lost by making the system computer compatible as is the case with some computerized video systems manufactured by others.

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Managing the flow of data is easy with programmable multiplexer

Device dedicated to data management has diode-fuse array that may be programmed with standard PROM techniques to set up bit flow

by Dave Wyland, *Raytheon Co. Semiconductor Division, Mountain View, Calif.*

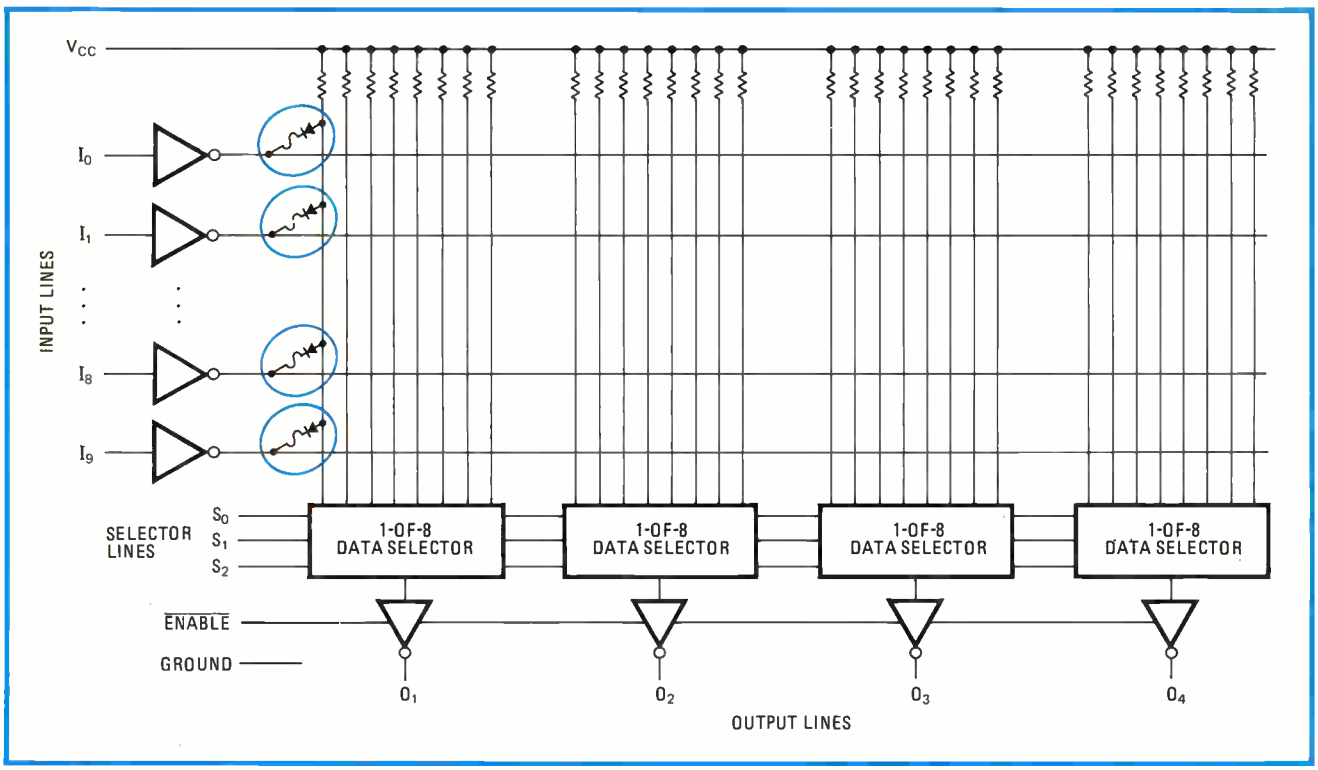
☐ With large-scale integration spreading beyond generalized processing devices to specialized areas of logic and subsystem design, it is no surprise that the task of data routing is a leading candidate for LSI. Such data-flow management can demand a wealth of chips to get the job done; since routing requirements usually vary considerably from one application to another, one-chip solutions have been elusive.

Now a contender for the task has come forward: the programmable multiplexer. This low-cost, medium-speed device reduces chip count and cuts costs without sacrificing performance or flexibility. What's more, it is field-programmable on standard read-only memory programmers with a single adapter card.

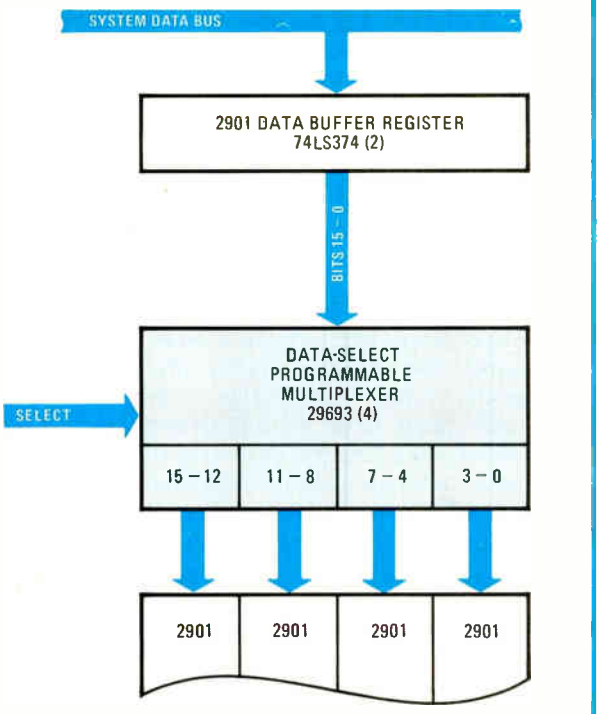
Logic and subsystem designers have found that programmable ROMs and microprogramming techniques have simplified sequential-control tasks and that bit-slice devices have similarly eased the processing of the resultant data. But they often have been forced to use individual bus drivers and small-scale integrated logic devices to solve data-flow problems. Although medium-scale integrated multiplexers have reduced design complexity, they still can add appreciably to the chip count of systems.

Another approach to data-flow management is the field-programmable logic array. It does let the designer select among many different combinations of data from one set of signal lines and to route the data to the FPLA output. However, it tends to be a slow and expensive solution, and it requires expensive programming equipment to boot.

Thus a high-density programmable chip dedicated to data-routing chores is a good alternative approach. Such a choice is available with the programmable multiplexer,

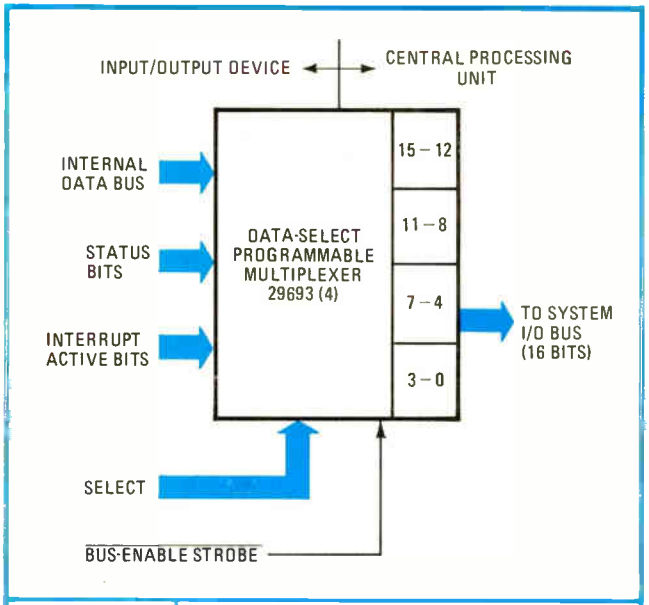


1. Have it your way. The programmable multiplexer's input buffer lines come connected to data-selector inputs through a matrix of diode-fuse links. Unwanted connections are opened by blowing fuses with PROM programming techniques, leaving the desired connections intact.



29693 Select	Description
0	data (unaltered)
1	data, force sign bit 0
2	byte swap
3	byte, sign extended
4	low byte, upper 8 bits 0
5	high byte – 7–0, upper bits 0
6	16-bit data constant
7	(spare)

2. Data-path control. With reduced chip counts, programmable multiplexers can create various data formats, such as byte-to-word conversion, bit masking, and data constants. Here, four of the chips replace 16 74LS151 multiplexer chips.



Select	Data to CPU bus
0	internal data bus
1	status bits, type 1 commands
2	status bits, type 2 commands
3	status bits, idle state
4	interrupt-acknowledge code (constant)
5	interrupt-level status word (assigned bits)
6	data bus, lower 8 bits (word counter)
7	interrupt instruction word (constant)

3. Bus multiplexer. Only four programmable multiplexers are required to supplant combinations of multiplexers and bus drivers in this bus-oriented system. The chips are used to route several input/output lines to the 16-bit system bus.

and the applications examples that follow give an idea of its versatility.

The programmable multiplexer is available in a 20-pin, dual in-line package housing four 8-to-1 multiplexers and 10 array inputs: the 29693. Coming up is a 40-pin chip with 26 inputs and eight 8-to-1 multiplexers.

Programming with fuse links

The multiplexers in the 29693 (Fig. 1) are similar to the 74LS151. The outputs of the data selectors connect to four inverting, three-state drivers, and the inputs, which come from 10 inverting buffers, internally connect to the array of diodes and fusible links.

The user programs the array to arrange the input wiring to the multiplexer. The unprogrammed fuses remaining (those still closed) determine which of the 10 chip inputs connect to each of the 32 data-selector input lines. The user not only avoids laying out a printed-circuit board to provide the necessary routing, but he also can modify the data-flow design by programming another 29693 multiplexer.

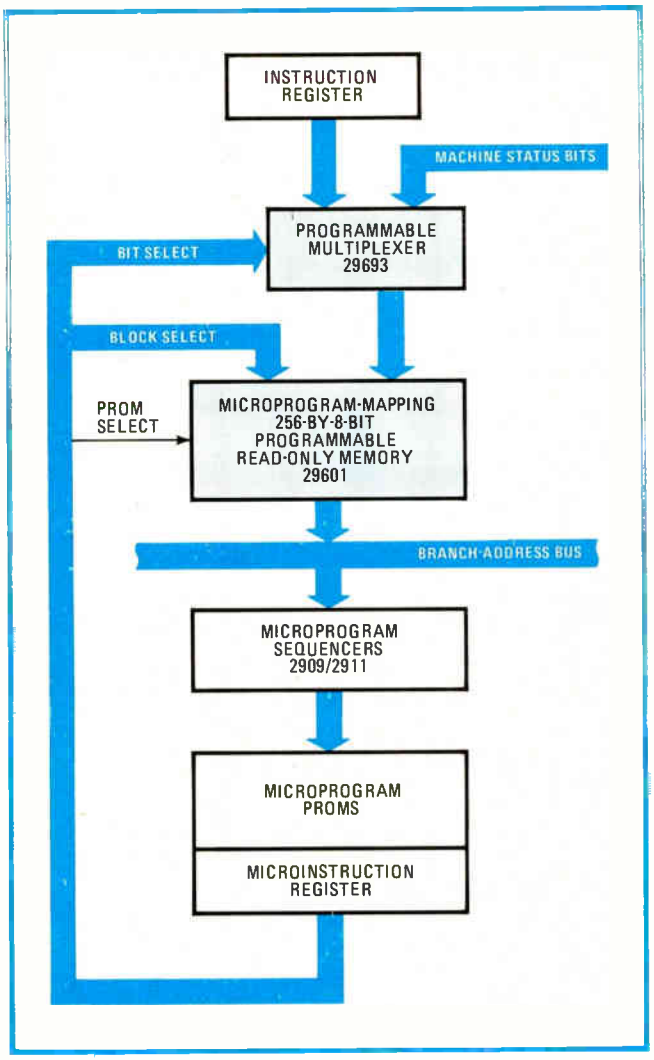
Usually one diode-fuse link remains on each multiplexer input line in data-flow and signal-routing applications. More than one fuse remains in applications using the logic-OR capability of the multiplexer.

A typical application is one in which one link remains along the first line of the data selector that connects output O_1 and the crosspoint of the I_0 input buffer. Since both input and output buffers invert, the signal polarity remains unchanged. When I_0 is high, the output of the corresponding buffer-inverter goes low to drive the input line of the data selector low through the intact diode-fuse combination. The output of the data selector then goes low, causing the output of the inverting three-state driver to go high.

Controlling data flow

If more than one fuse remains intact on any given data-selector input line, a logic-OR function results. If any of the corresponding inputs goes high, the output of the appropriate data selector also goes high. However, if all fuses on the input lines of a given data selector are opened, those lines will always remain high and the corresponding multiplexer output will be low whenever any of those lines are selected.

The concrete advantages of these devices for data-path control are obvious from Fig. 2, where four 29693s replace 16 conventional multiplexer chips. Aside from



4. Winning combo. Although similar to an FPLA, the programmable multiplexer with a program-mapping PROM proves more flexible. Here, the multiplexer selects the various machine-status bits and routes them to the PROM to generate the next microprogram state.

significantly reducing chip count and simplifying board layout, the chips still make it possible to add other data formats often required to solve system checkout or field-service problems that crop up after the system is built. In the past, solving such problems usually required significant engineering changes.

The programmable multiplexer also seems a perfect solution for problems commonly encountered in minicomputer and microcomputer system design. A major trouble spot is the requirement that input/output devices communicating with the system I/O bus must present a variety of data on demand. Depending on the particular system architecture, I/O devices present bit patterns such as interrupts, instructions, and interrupt status words to the system bus. Even single-chip devices, such as universal synchronous/asynchronous receiver/transmitters and floppy-disk controllers generate a variety of status and activity indicators that also must be routed by some means to the system bus at the proper time and in the proper format.

A sample solution to such a problem is shown in Fig. 3, where eight different patterns of data words, status bits, or constants are presented to the system I/O bus as determined by the selector inputs of the 29693. Four chips replace either 16 conventional multiplexers or a circuit mix of smaller multiplexers and SSI logic gates. What's more, the three-state drivers of the programmable multiplexers can drive the bus directly if the system uses a conventional three-state transistor-transistor-logic I/O bus.

Selecting instructions

In Fig. 4, the 29693 forms part of the instruction-decoding section of a microprogrammed machine. In this application, the programmable multiplexer selects machine-status bits from various instruction registers and routes them to a microprogram-mapping PROM, which decodes the line and generates the next microprogram state. While a field-programmable logic array is often used in such applications, the similarly functioning combination of programmable multiplexer and mapping PROM proves more flexible. For one, it allows a greater number of signal combinations and corresponding target addresses. Because it is organized as an indexed look-up table, it is compatible with current microassemblers, whereas only a few microassemblers may be modified for use with FPLAS.

Another example of the flexibility in data-flow control provided by programmable multiplexers is in microprogram sequence control. In Fig. 5, the chips are used to select bits of an instruction register for control of the register-address inputs for four 2901 bit-slice microprocessor elements.

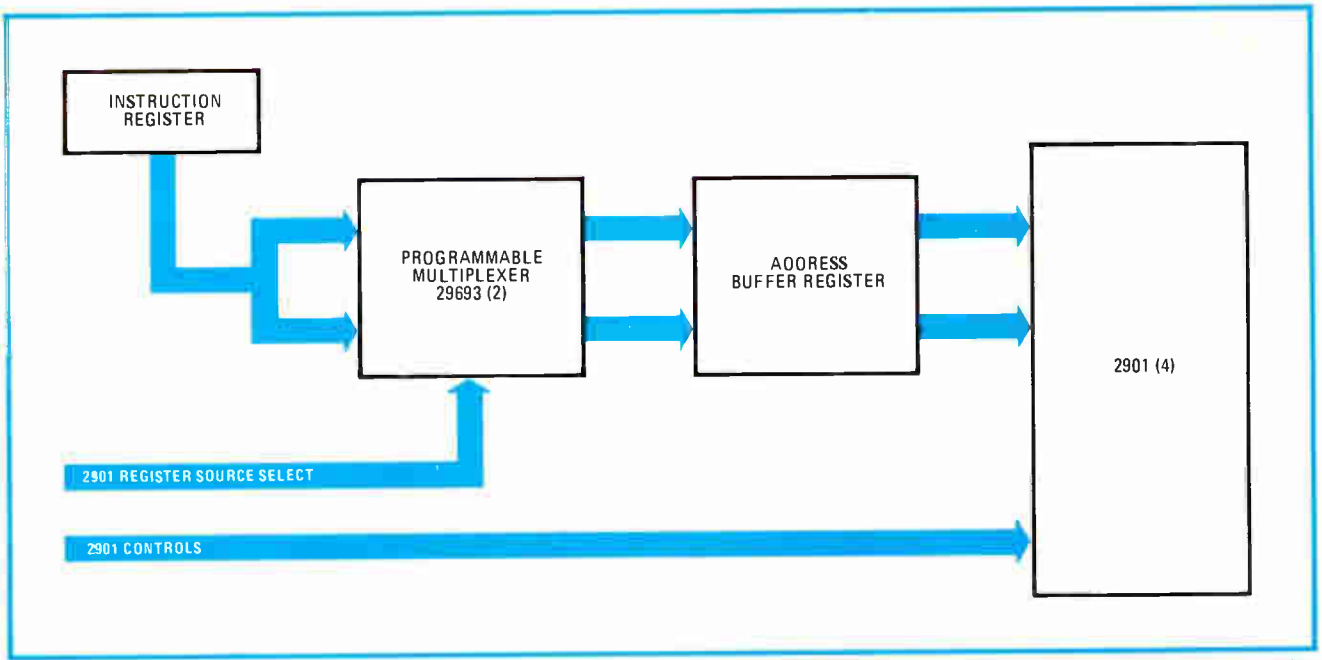
This arrangement simplifies selecting different combinations of instruction-register bits and generating fixed-register combination codes. Moreover, using 29693s to select instruction-register bits for the 2901 register controls in a computer or controller design allows the user to add instruction formats and to change microprogram sequences in order to extend the machine's instruction or command set.

Using the programmable multiplexer as a status-register control avoids having to wire together a collection of gates for status-bit control, although the chip-count reduction may not seem as impressive as in the previous applications. Here the logic-OR capability of the 29693 is used to implement much of the logic circuitry required for status control. Just as important, the programmable nature of the multiplexer allows that logic to be changed without redesigning the layout of the printed-circuit board.

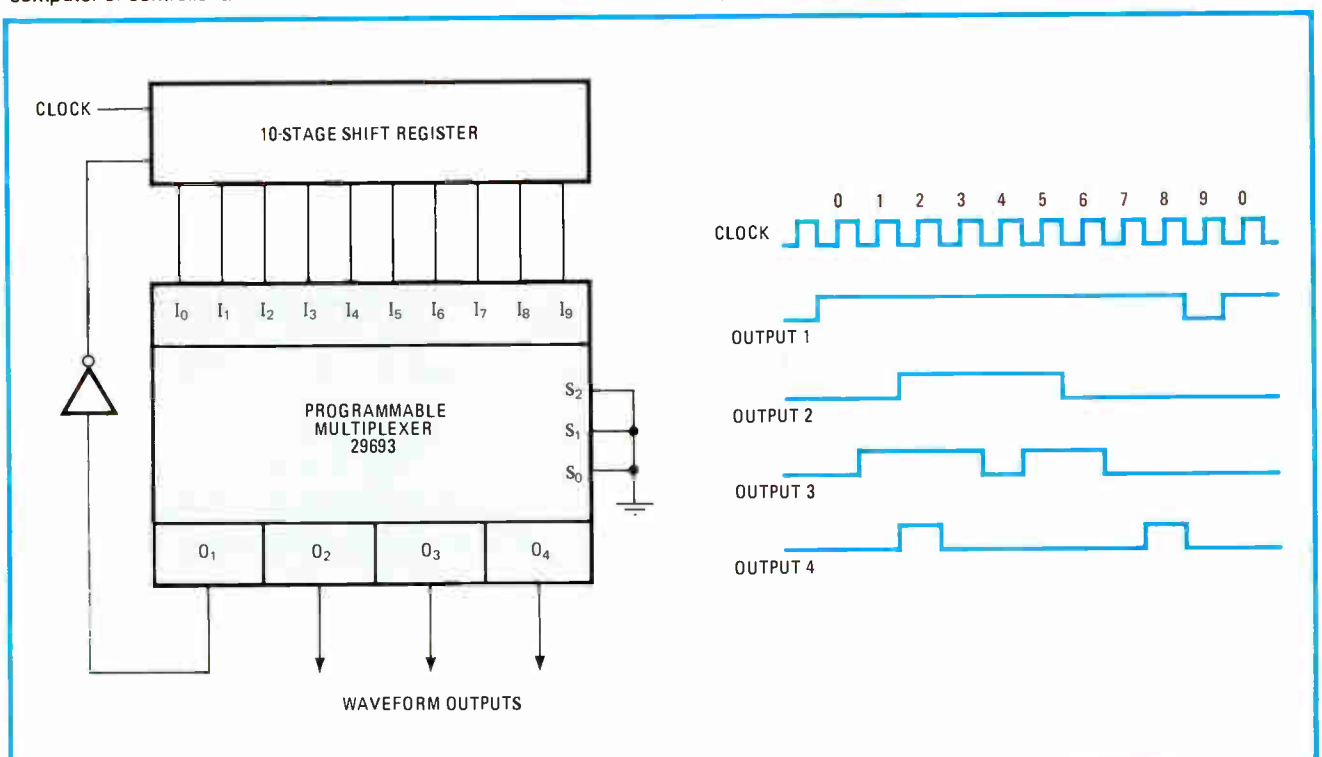
Making a timing generator

Another application that takes advantage of the 29693's ability to OR input signals is the teaming of the chip with a 10-bit shift register (Fig. 6), producing a digital timing generator with eight different patterns. One multiplexer output controls the input to the shift register and is programmed so that it will be high if any shift-register bit other than the 10th bit is high.

By inverting this output and feeding it to the input of the shift register, a single pulse will pass repetitively down the shift register, forming a ring counter. By



5. Programming flexibility. Using two programmable multiplexers to select instruction-register bits for the 2901 register controllers in a computer or controller allows the user to add instruction formats and to change microprograms by programming new multiplexers.



6. Simple waveform generator. A programmable multiplexer and a 10-stage shift register give a digital timing generator. Selecting ORed combinations of shift register outputs in the multiplexer produces eight user-selected timing patterns: four such samples are shown.

selecting combinations of the shift-register outputs and ORing them together, the programmable multiplexer can be made to generate user-chosen waveforms, such as those shown in the figure. The 29693's select inputs, S_0, S_1, and S_2, are used to select among the eight timing patterns, including varying the effective length or recycle point of the pulse in the shift register.

The advantage of using a programmable multiplexer in this application is that the clock signals from the shift register are passed cleanly through it, without generating spikes that would result if a PROM were used to decode the shift register. The direct path from the 29693's input through the buffer arrays and data selectors to the output avoids the spiking that results when the inputs must pass through an address decoder, which generates spikes as the various decoders select and deselect. □

Measuring the peak deviation of an f-m carrier

by Iklil Kayihan
Istanbul, Turkey

Instruments used to find the peak deviation of a frequency-modulated carrier with constant-amplitude modulation are either accurate but much too expensive or simple but almost worthless for performing meaningful measurements. However, the peak deviation can be accurately measured by using most any laboratory oscilloscope at hand, provided the scope has sufficient bandwidth and has a dual time base.

The measurement technique is based upon the principle that the maximum and minimum modulated frequencies are 90° out of phase with respect to the unmodulated carrier and 180° out of phase with respect to each other for a given deviation. As a consequence of the modulation that generates components $f_c+\Delta f$ and $f_c-\Delta f$, where f_c is the carrier frequency and Δf is the peak deviation, a 180° shift between the modulated and unmodulated waveforms can be observed.

Most often the frequency deviation will be relatively small with respect to the carrier frequency, and in this case a slight broadening of the scope trace (carrier waveform) is observed during modulation. With the aid of the scope's delayed sweep and its delay-multiplier control, any portion of the displayed waveform may be expanded in time for observation in detail. A point on the waveform can thus be easily found where the degree of trace broadening amounts to exactly half a period (180°) of the unmodulated wave. The time interval between the initial point (just before modulation) and the 180° shift point is directly related to the deviation.

The measurement procedure is simple:

- Set the sweep rate of the main time base to observe 50 to 100 cycles of the modulated waveform. Make sure that the scope is triggered properly.
- Switch to the intensify mode and intensify two or three cycles of the waveform at about two thirds of the way across the scope face.
- Switch to the delayed sweep and adjust the multiplier to find the first point at which there is a difference of 180° between the unmodulated carrier and the sideband components.

The procedure is clarified with the aid of the modulated waveform in the figure. The solid black trace corresponds to the unmodulated carrier frequency. The two color traces, one dashed and one solid, correspond to the carrier with frequencies $f_c+\Delta f$ and $f_c-\Delta f$, respectively. After N cycles, the color components overlap (they are actually 180° out of phase with each other, but this may not be obvious) and are 180° out of phase with the unmodulated components (see arrow).

The value of N (or equivalently, t_d) determines the value of the peak deviation. If t is the period of the carrier frequency f_c, then $t_d = Nt \pm t/2$. There are N periods in this time interval; thus one period ($N = 1$) has a duration of $t' = t/N \pm t/2N$, and so:

$$f' = 1/(t \pm t/2N) = f_c \pm \Delta f = f_c(1/(1 \pm 1/2N)$$

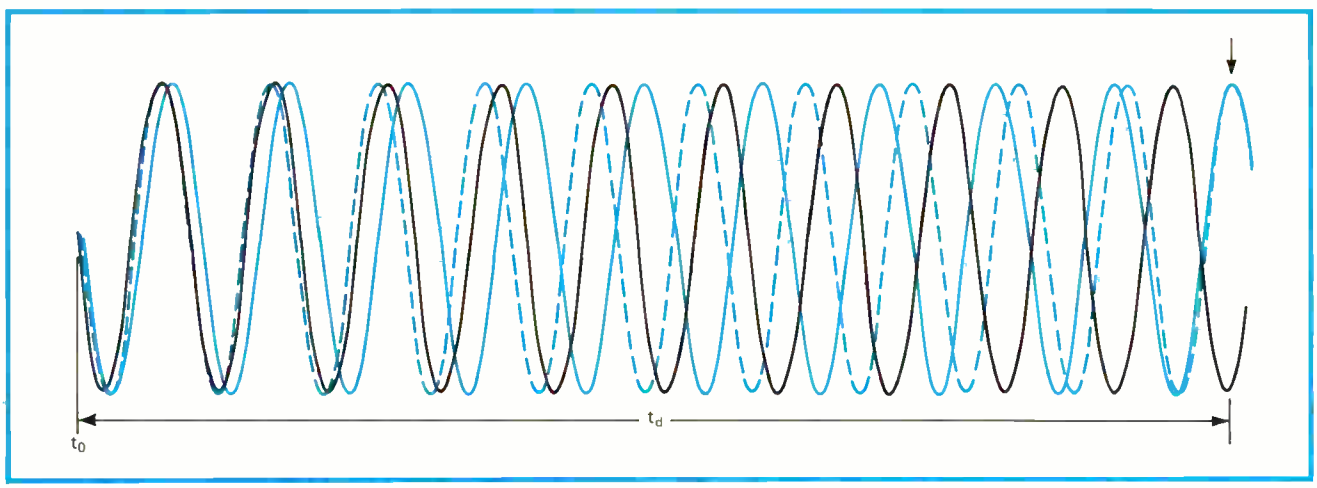
From the general relation $1/(1+K) \sim 1-K$ (for K much less than 1) it follows that the equation for f′ reduces to:

$$f' = f_c(1 \mp 1/2N)$$

or:

$$|f' - f_c| = |\Delta f| = f/2N = 1/2t_d$$

for $N = 1$. This is the peak-to-peak deviation. The peak



Phase to frequency conversion. Peak deviation of a frequency-modulated carrier may be found with oscilloscope. Scope is first placed in intensify mode. Delayed sweep multiplier is used to isolate point at which the unmodulated carrier (solid black) is 180° out of phase with modulated carrier (color). Overlapping of solid- and dashed-color traces occurs at time t_d. Peak deviation is equal to $\Delta f = 1/4t_d$.

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deviation is thus equal to one half that, or $|\Delta f| = 1/4t_d$.

If a delayed-sweep gating signal is available, it can be used to trigger a counter so that it can automatically sum the number of cycles (N) up to the overlap point. The oscilloscope must be operated in the single-sweep, intensify mode when the counter is used. To determine the peak deviation in this case, the carrier frequency, f_c, must of course be known beforehand.

The scope can also be used to check the linearity of the frequency modulator circuit. Position one peak of the unmodulated carrier to the scope's horizontal centerline, then apply modulation. The center of the broadened region should remain aligned about the centerline, indicating equal phase excursions to each side of the carrier. Any nonlinearity will cause a shift off the centerline. □

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 $50 for each item published.

Calculator notes

Z-transform program yields sampled-data system response

by Willy Albanes
Computer Sciences Corp., Huntsville, Ala.

The analysis of sampled-data networks is quickly performed with this SR-52 program, which determines circuit response by evaluating the system's defining Z transform, or discrete-time transfer function. For a specified sampling rate, the program divides a polynomial, A, of the 19th or smaller order by a second similar polynomial, B, thus evaluating the network transform:

$$c(z) = \frac{a_0z^m + a_1z^{m-1} + \ldots a_m}{b_0z^n + b_1z^{n-1} + \ldots b_n} = c_0z^{m-n} + c_1z^{m-n-1} + \ldots \quad (1)$$

where m and n define the order of A and B respectively, $n \geq m$, $z = e^{Ts}$, with T the time between samples and $s = j\omega$. Once the c_i coefficients are found, the program proceeds to determine the value of the function for any increment of T.

The simple servo system of Fig. 1 is sufficient to demonstrate the program's usefulness. The transform for the plant, or active portion of the system, is normally expressed in terms of the s, or Laplace, transform, which defines how the system will process continuous-input signals. When the system is sampled, a conversion to Z-transform equivalents must first be done with the aid of appropriate transform tables, as shown.

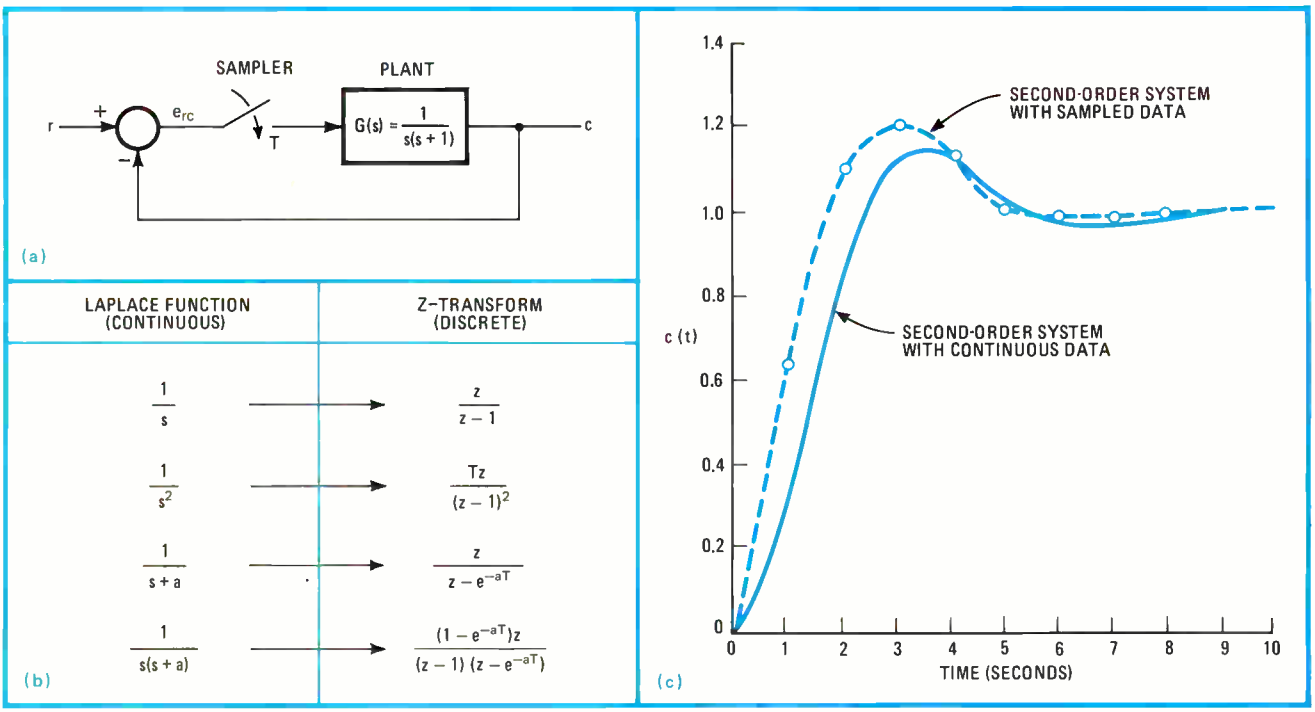
The transfer function is, in general:

$$\frac{c(z)}{r(z)} = \frac{G(z)}{1+G(z)} \quad (2)$$

where for this network:

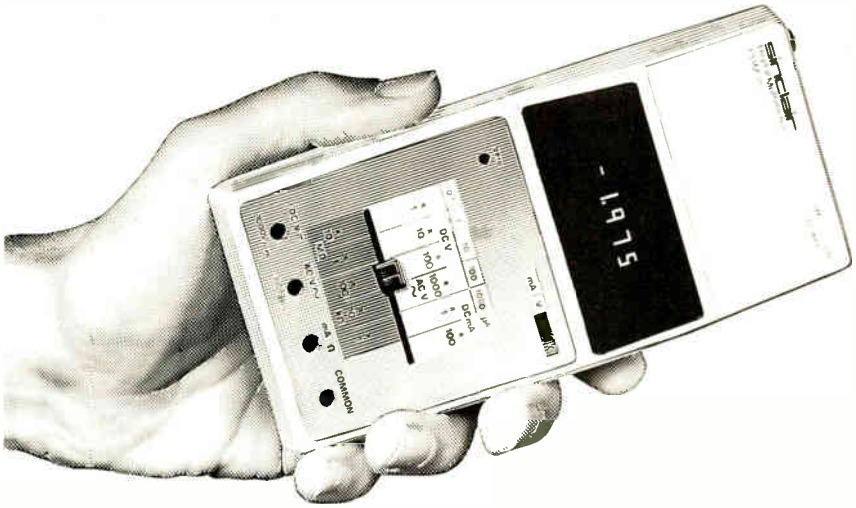
$$G(z) = Z\left[\frac{1}{s(s+1)}\right] = \frac{z(1-e^{-T})}{(z-1)(z-e^{-T})}$$

Assume that the network is excited by a unit-step function, $r(t) = 1/s$. In that case, Eq.1 becomes:



Discrete response. SR-52 program analyzes sampled-data system. In typical example (a), network transfer function is first converted to Z-transform equivalent with aid of conversion tables (b). New transform is then evaluated by program for a specified sampling rate (in this case, 1 second). System response is plotted (c). Here, responses of sampled- and continuous-data system are similar.

The Sinclair PDM35.
A personal digital multimeter for only $49·95



Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 gives you all the benefits of an ordinary digital multimeter — quick clear readings, high accuracy and resolution, high input impedance. Yet at $49.95 it costs less than you'd expect to pay for an analog meter!

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicans, computer specialists, radio and electronic hobbyists will find it ideal.

With its rugged construction and battery operation, the PDM35 is perfectly suited for hand work in the field, while its angled display and optional AC power facility make it just as useful on the bench.

What you get with a PDM35

3½ digit resolution.
Sharp, bright, easily read LED display, reading to ±1.999.
Automatic polarity selection.
Resolution of 1 mV and 0.1 nA (0.0001 μA).
Direct reading of semiconductor forward voltages at 5 different currents.
Resistance measured up to 20 MΩ.
1% of reading accuracy.
Operation from replaceable battery or AC adapter.
Industry standard 10 MΩ input impedance.

Compare it with an analog meter!

The PDM35's 1% of reading compares with 3% of full scale for a comparable analog meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comparable analog meter — and resolution on current is over 1000 times greater.

The PDM35's DC input impedance of 10 MΩ is 50 times higher than a 20 kΩ/volt analog meter on the 10 V range.

The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

Technical specifications

DC Volts (4 ranges)
Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ±1 count.
Note: 10 MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range: 1 V to 500 V.
Accuracy of reading: 1.0% ±2 counts.
DC Current (6 ranges)
Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ±1 count.
Note: Max. resolution 0.1 nA.
Resistance (5 ranges)
Range: 1Ω to 20MΩ.
Accuracy of reading: 1.5% ±1 count.
Also provides 5 junction-test ranges.
Dimensions: 6 in. x 3 in. x 1½ in.
Weight: 6½ oz.
Power supply: 9 V battery or Sinclair AC adapter.
Sockets: Standard 4 mm for resilient plugs.
Options: AC adapter for 117 V 60 Hz power. De-luxe padded carrying wallet. 30 kV probe.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts — from programmable pocket calculators to miniature TVs. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

Tried, tested ready to go!

The Sinclair PDM35 comes to you fully built, tested calibrated and guaranteed. It comes complete with leads and test prods, operating instructions and a carrying wallet. And getting one couldn't be easier. Just fill in the coupon, enclose a cheque/MO for the correct amount (usual 10-day money-back undertaking, of course), and send it to us.

We'll mail your PDM35 by return!

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Ariz. Res. Call Collect 602-955-9710
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Dept. 335, 924 Anacapa Street, Santa Barbara, Calif. 93101
Please promptly send _____ Sinclair PDM35 Digital Multimeter(s) @ $49.95 (plus $3 shipping and insurance) each. I have the option of returning it within 1 week of receipt for an immediate refund.
☐ Also Send AC Adaptor(s) @ $4.95 ea.
☐ Also Send Deluxe Padded Carrying Case @ $4.95 ea.
☐ Also send 30 kV probe @ $29.95
☐ Check or Money order Encl. (Calif. Res. add 6% Sales Tax)
☐ Charge to The Credit Card Checked Below:
☐ BankAmericard/Visa ☐ MasterCharge (Interbank # _____)
☐ American Express ☐ Carte Blanche ☐ Diners Club
Credit Card # _____ Exp. Date _____
Name _____
Address _____
City/State/Zip _____
Signature _____

SR-52 SAMPLED DATA SYSTEM PROGRAM

Locations	Codes	Keys	Comments
000 – 001	46 11	LBL A	*entry point*
002 – 005	43 00 00 55	RCL 00 ÷	*generate c_i*
006 – 009	43 08 00 95	RCL 80 =	
010 – 013	42 06 07 81	STO 67 HLT	
014 – 017	01 42 06 08	1 STO 68	*reset index counter*
018 – 021	36 43 06 08	*IND RCL 68	*a_i*
022 – 027	75 08 00 44 06 08	– 80 SUM 68	*step counter to b_i index*
028 – 031	36 43 06 08	*IND RCL 68	*b_i*
032 – 037	65 43 06 07 85 53	X RCL 67 + (	*c_i location; index is set to a_{i-1}*
038 – 043	08 01 94 44 06 08	81 +/– SUM 68	
044 – 047	85 08 01 95	+ 81 =	*recover numeric*
048 – 051	36 42 06 08	*IND STO 68	*load a_{i-1}*
052 – 055	02 44 06 08	2 SUM 68	*index is now i–1*
056 – 059	43 06 08 75	RCL 68 –	*count number of loops completed*
060 – 065	43 06 09 75 01 95	RCL 69 – 1 =	
066 – 070	22 80 00 01 08	INV *if pos 018	*branch to next loop*
071 – 075	36 42 06 09 11	*IND STO 69 A	*reset overflow and loop*

INSTRUCTIONS

- Key in program
- Enter numerator coefficients of polynomial transfer function c(z):
  (a_0), STO 00, (a_1), STO 01, . . . (a_{19}), STO 19
- Enter denominator coefficients of polynomial transfer function:
  (b_0), STO 80, (b_1), STO 81, . . . (b_{19}), STO 99
- Specify order of transfer function:
  (n), STO 69
- Press A to find c_0
- Press RUN to find $c_1, c_2, \ldots c_i$ for each increment of time

REGISTERS

$R_{00} - R_{19}$	$a_0 - a_{19}$
R_{69}	n
$R_{80} - R_{99}$	$b_0 - b_{19}$

$$c(z) = \frac{z^2(1-e^{-T})}{(z-1)(z^2-2\,ze^{-T}+e^{-T})} \qquad (3)$$

If the sampling rate is arbitarily selected for one per second (T = 1), Eq. 3 will reduce to:

$$c(z) = \frac{A}{B} = \frac{0.632\,z^2}{z^3-1.736\,z^2+1.104\,z-0.368} \qquad (4)$$

The coefficients of A and B (that is, a_i, b_i) are now entered into the program as explained in the instruction set. After the order (n) of the transfer function is specified, coefficient c_0 is found by depressing the A key; each succeeding c_i is found by depressing the RUN key. For the first six coefficients, the results are:

$c_0 = 0.632$ $\quad c_3 = 1.117$
$c_1 = 1.097$ $\quad c_4 = 1.010$
$c_2 = 1.207$ $\quad c_5 = 0.964$

Thus:

$$c(z) = 0.632\,z^{-1}+1.097\,z^{-2}+1.207\,z^{-3}+ 1.117\,z^{-4}+1.010\,z^{-5}+0.964\,z^{-6} \qquad (5)$$

where the coefficients of z^{-j} are the output response at jT seconds for j = 1, 2, . . . ∞. The figure compares the response of this discrete-data system with that of the same system sampled continuously. In this case, the responses are similar.

The user may want to add a PC-100A printer routine to plot the results of the computation directly. If so, he can shorten the sampled-data program to accommodate a 20-coefficient, ninth-order program, to make room in memory for the plotter routine. The program may be modified simply by replacing the number 8 in memory locations 7, 23, 38, and 45 with the number 1. The coefficients of A must then be entered into memory locations 0–9, and the coefficients of B must be entered into locations 10–19. □

Engineer's newsletter

Intel's clock chip teams well with Motorola's 6800

If you're designing with Motorola's 6800 microprocessor, you're probably using one of the two-phase clock generators in the family. But these chips lack some flexibility, point out W. E. McDonald and J. H. Aylor of the University of Virginia in Charlottesville. For example, the 6870A does not provide enough time to access many memory devices; nor can this time be lengthened. The 6871A and the 6871B require additional hardware to get memory slowdown. On the other hand, **Intel's clock chip, the 8224, produces a pulse width that is long enough even for most slow memories,** like the 1702A programmable ROM, and the rise times of its two-phase nonoverlapping clocks are completely compatible with those needed by the 6800.

Clocking the 6800 with the 8224 is easy. Connect a 4.755-MHz crystal between pins 14 and 15 to produce a phase-1 pulse (at pin 11) of 420 ns and a phase-2 pulse (at pin 10) of about 1.05 μs. The supply voltage at pin 9 determines the pulse amplitude, which must be between 4.7 and 5.1 v when the 6800 operates from a 5-v supply. Regulating the supply at pin 9 with a series 330-Ω resistor followed by a 6.8-v zener (tied to ground) assures that this requirement is met.

Solder Al foil to shield your breadboard

The next time you need to determine just what shielding your breadboard requires, try experimenting with ordinary household aluminum foil, using paper-card stock for the necessary structural rigidity, suggests John A. Carroll of Dynamic Measurements Corp., Winchester, Mass. When it's time to connect the pieces or bond a seam so eddy currents can flow, you may not have the aluminum solder on hand to do the job properly. But it's possible to solder the aluminum without using aluminum solder, and yet wind up with a reasonably good connection.

The key to the procedure is to clean the oxide off the aluminum while it is immersed in flux, thus preventing the oxide from re-forming long enough for the joint to be made. Begin by putting a drop of good electronic-type flux, like Kester 1544, on the spot to be soldered. **Next scrape off the oxide coating with a knife or a piece of emery paper. Bring together the parts to be soldered, and clamp them in position.** Clean the tip of the soldering iron, and then melt a drop of solder on it. Bring the iron to the joint and spread the melted solder around, feeding in more solder as needed. Work quickly, for once the joint gets hot even the flux won't delay oxidation for more than a couple of seconds.

Presettable timer will permit real-time counting

In bit-slice computers, particularly those intended for real-time controller applications, a presettable timer/counter permits microprogram (or main program) activity while real-time counting is occurring, notes Kelly G. Tyree, who is with Logical Machine Corp. in Sunnyvale, Calif. **One simple way to implement this function, he says, requires only four circuit blocks**—a dual-input AND gate, a divide-by-1,024 prescaler, an 8-bit presettable counter, and an R-S flip-flop. Clock and clock-enable inputs drive the AND gate, which in turn drives the prescaler. The output from the prescaler clocks the counter, which accepts 8-bit data when its load line is enabled. The counter drives the set input of the flip-flop, and this device's reset line serves as the reset for the circuit. With a 5-MHz clock input, such a circuit would generate a time interval in the range of 200 μs to 50 ms for its complementary outputs.

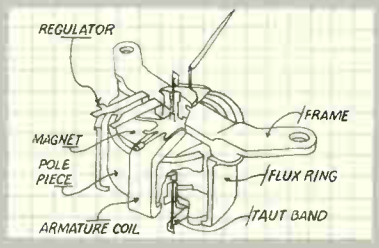
Lucinda Mattera

Specify the panel meter you'd be proud to have designed yourself

Panel meters from General Electric can add a lot to the overall quality of your product. Accuracy. Reliability. Attractiveness.

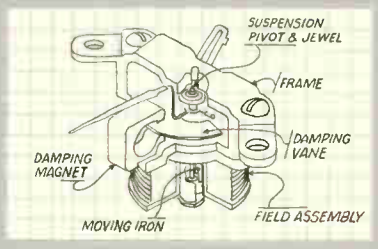
How do you design this kind of quality?

Start with the *suspension system.* The moving parts. You'll want one of two kinds (depending on what kinds of physical abuse your panel meter may be exposed to). In a *taut band suspension system,* the moving mechanism is suspended between two ribbons of platinum-nickel alloy welded securely to a resilient, shock-resistant anchor. This suspension system design keeps friction to an absolute minimum.



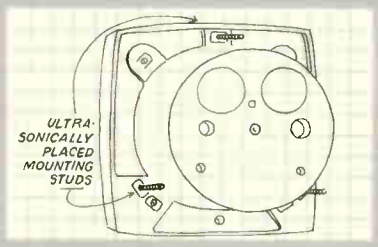
The aluminum pointer is attached to an oversized, high-torque armature coil of fine copper wire, for fast response and accuracy you can count on.

Pivot-&-jewel suspension maintains high performance and reliability in high vibration environments. The armature assembly is supported by highly polished, hardened-steel pivots selected for wearability. The pivots are designed with a radius that will minimize friction level to give maximum performance. The 1/10-carat jewel bearings are of ceramic material that is stronger than glass jewels and has greater scratch and impact abrasion resistance.



Pointers are tapered to a radius point as small as .38 mm, combining high readability with superior reading accuracy. Scales on the meter face are available with mirror backing that will align the reader's eye perpendicular to the face, eliminating parallax error.

Self-protecting features are important, too. All GE panel meters are housed in a tough, *molded case* of high-impact styrene. Special gaskets are available for assembly in BIG LOOK® type panel meters between the window and case to keep out contaminants. Ultrasonically placed mounting studs assure that the meter will fit your panel exactly. Choice of meter styling (BIG LOOK® or HORIZON LINE®) lets you pick the shape and appearance that will best enhance your product. (Color masks are also available for HORIZON LINE® in red, blue, green, black, yellow and white.)



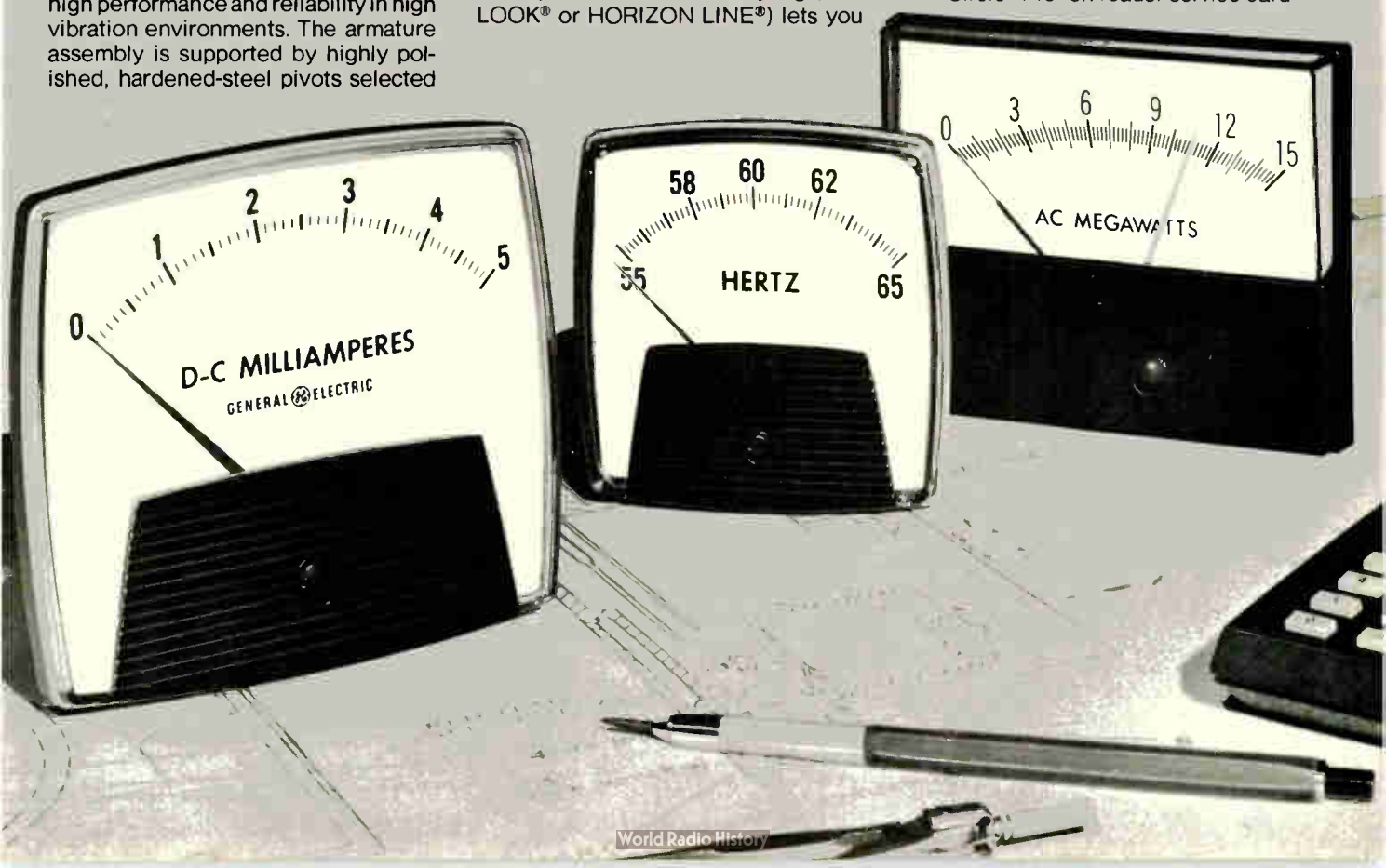
Hundreds of GE panel meters are available for almost any conceivable monitoring or measurement task.

And when you buy a GE panel meter, you also get more than 80 years of meter manufacturing experience and a sales network that is literally worldwide. For a free guide entitled, "Pick the Right Panel Meter," write to General Electric Co., Section 592-82, Schenectady, N.Y. 12345.

Specify General Electric... just for good measure.

GENERAL ELECTRIC

Circle 143 on reader service card



Electro/78

Electro/78 returns to Boston showing increase in booths and exhibitor ranks

Strength reflects feelings of optimism among electronics firms around the city, especially those along Route 128

The last time—it was also the first time—that the Institute of Electrical and Electronics Engineers put on its annual show and convention in Boston the nation was in the midst of its 1976 Bicentennial hoopla. Then, a trip to historic Boston was more than just a chance to attend the technical sessions and shuffle through the booths at Electro; it was an obeisance to America, the opportunity to show the wife and kids where it started.

There's no way to follow that kind of act, so for Electro/78's trip to Boston, May 23–25, (in line with the policy of alternating between that city and New York) the show is simply relying on business, and indications are that business is good.

The numbers tell the story. Show officials have sold out the available space in Hynes Auditorium and have expanded the exhibits area. Latest tallies are 655 booths occupied by 350 exhibitors; in 1976 in Boston, there were 509 booths and 265 exhibitors. In New York last year, there were 511 booths taken by about 300 exhibitors. The theme of this year's show is "Look ahead"; it could well be "Looking up."

The growth of Electro/78 would seem to mirror that of the economy and signal a resurgence of the region around Boston, particularly the electronics mother lode along fabled Route 128. As one show exhibitor from the area puts it: "I haven't heard of a bankruptcy in a long time. The feeling is upbeat and the mood is good."

Program: both pervasive and eclectic. It begins on Tuesday morning with packaging, software, and searching for future electronic products, and it winds up Thursday afternoon with infrared radar and optical communications. In between there are sessions on testing, instrumentation, data conversion—and of course the microprocessor is everywhere. If proof were still needed of the growing pervasiveness of electronics technology, then Electro/78's technical program would provide it.

The prime subject will be computers. Discussions will cover everything from software, computer graphics, and computers in the home to the myriad ramifications of microcomputer design and applications.

It starts with software. Electro/78's organizers have assigned software an early spot on the program. In session 2, the user will gather a highly interesting collection of views on software that gets the most out of a microprocessor.

Edward J. Kleban of ECD Corp. in Cambridge, Mass., will speak on configuration software, as he calls his proposed addition to a computer's operating system. He argues that what is needed is a flexible means of interfacing between computers and peripheral equipment, say, instead of strict encoding formats like EBCDIC or ASCII. His configuration software would prescribe a particular interface format in line with user-supplied parameters. One example: a keyboard with software-assigned keys that could be switched easily between different fonts and sets of characters.

In the same session, Michael Kane of Intel Corp. in Santa Clara, Calif., will discuss the state of the art in microprocessor development tools. His paper, "Microprocessor Development Tools Have Come of Age," points out that techniques used in large computers are now emerging in microprocessor development. Structured programming, for example, makes program modularity possible and thus lends itself to faster and better generation of software and the elimination of redundant programming. Intel's PL/M is a structured language, and Kane shows how relocatable modules of PL/M software can be linked. In this area, he believes, probably the greatest contribution of high-level languages will be complete language compatibility between different microcomputers.

A software house's view is presented by David Benevy of CM Software Inc. in New Providence, N. J. He will describe TAL-80, a high-level language for the 8080 microprocessor. He classifies it as a system-builder's language and has incorporated in it hand-me-downs from large computers like a data-base manager and an advanced operating system. He also goes into some shortcomings of available languages in the context of microcomputer system design.

Michael Rooney, president of Boston Systems Office

Inc. in Waltham, Mass., will debate the tradeoffs of the various methods of microcomputer software development. So many means of development are available, from simple prototyping systems to development systems to crossdevelopment on larger computers or time-sharing networks, that the decision which to use must be made with care, he says.

Looking for direction? Engineers pondering whether to commit themselves to microprocessors, microcomputers, or minicomputers in a manufacturing or control application can find some good guidance and case histories in sessions 8 and 26. The former deals mainly with the 16-bit or high-end microcomputer, while the latter ranges from 8-bit types up to a full-fledged hierarchical 16-bit minicomputer-based plant-management system.

John Trombly, senior engineer at the Andover, Mass., division of Hewlett-Packard Co., organized session 26. He says he aimed it primarily at engineers and managers concerned with producing or testing products more efficiently and at engineers responsible for process control in a plant.

In his overview, Trombly outlines various approaches to hardware and software development for the manufacturing engineer. He goes into detail on a microprocessor-based test system that recently replaced a manual test scheme at his division; it tests portions of a pressure transducer in a patient-monitoring system for hygiene and to ensure that the dome housing the transducer is fully sealed. Employing the 8-bit Motorola M6800, it allows faster, cheaper, and more reliable testing, Trombly says, because there is less downtime.

Two other papers in session 26 deal with applications of microprocessor test systems in electronic component and system manufacture, and a fourth presentation covers a complete plant-management system. The last is the hierarchical system that spans the range from distributed LSI-11 microcomputers handling a variety of shop floor tasks to a central PDP-11/34 or PDP-11/70 host system [*Electronics*, March 31, 1977, p. 36]. Laurie Barber, a product development specialist at Digital Equipment Corp., Maynard, Mass., will describe the plant-management system.

At Analog Devices Inc., Norwood, Mass., three separate Intel SBC-80/10-based test systems are being used for automatic testing of power supplies, incoming inspection of resistor-ladder networks, temperature testing of functional modules, and measurements of how well the temperature coefficients of resistor sets track one another. John Lang, manager of technical services at Analog Devices, and Pablo Roth, manager of test system development, will describe the system. Lang says the fully automatic power-supply test system has freed a bed-of-nails–type tester to screen other components and substantially boosts throughput by testing 15 supplies at a time for various parameters.

Shopper's guide. Systems designers and project managers not immersed daily in the world of microcomputers and microprocessors, but who find themselves shopping for a small computer system, will want

to circle session 8 on the program. Organizer Joseph Austin, an applications engineer at Digital Equipment Corp.'s Components group, has a worthwhile lineup of speakers to guide would-be users in the selection.

The session is "Small Package/Large Performance: 16-bit Microcomputer." Austin's opening overview is intended to help potential small-system users determine if they can live with a microcomputer or if their application requires a minicomputer.

A good cross section of applications is presented. Data General's Richard Pleau, also an applications engineer, will describe a network of the Westboro, Mass., firm's microNovas linked to a larger central computer to control a manufacturing operation, freeing the central system of some of the tasks of handling control programs, manufacturing parameters, and diagnostics. John Cohen, a design engineer at Quadex Corp., Cambridge, Mass., will offer some insights from the viewpoint of the original-equipment manufacturer. He will describe how his company incorporates an LSI-11 in a multiterminal typesetting system.

Ronald Barbee, applications engineer at Dallas-based Texas Instruments Inc., will stress the flexible, easy-to-use, and quickly designed control systems that can be designed with the 9900's bit-oriented input/output structure. Finally, DEC's David Schanin, also an applications engineer, will show how an LSI-11 was used in the winning boat in last summer's America's Cup yacht races [*Electronics*, June 23, 1977, p. 34].

Testing and measuring. Inextricably linked to the explosive growth of the microprocessor and microcomputer market is that of the test and measurement instrument market—particularly logic analyzers and microprocessor development aids. Session 18, "Logic Measurement and Development Products," will examine the need for these products and their evolution.

Observes session chairman James Geisman of Tektronix Inc., Beaverton, Ore., "This category of equipment represents as much as $100 million per year that no one is quite sure how to deal with. It is certain to divert money earmarked for other test and measurement gear, and because of the intelligence in these systems, could divert money earmarked for computer aid, as well." Geisman's aim is to provide a realistic perspective in terms of which both engineers and managers may better evaluate their needs. Of his five speakers, therefore, two represent manufacturers of these products, two represent users who must integrate microprocessor and microcomputer subsystems into their system designs, and the fifth is a market analyst.

Charles House, noted for his work in logic analyzers for Hewlett-Packard Co.'s, Colorado Springs, Colo., division [*Electronics*, Oct. 27, 1977, p. 83], will concentrate on data-domain analysis. Tektronix' Tom Clark will slant his discussion toward microprocessor development aids and outline in-house examples of these, as well as systems that are available from outside sources. He will trace the directions in which development aids are moving—and will end with what he expects their capabilities will be in five years.

From the user's vantage point, Joe Nangle from Digital Equipment Corp. will disclose the problems encountered, and solutions discovered, in designing I/O subsystems for a distributed plant-management system. A minicomputer, microcomputer, and microprocessors had to be integrated within a single system.

From General Electric Co., Bridgeport, Conn., Jerry King will shed light on the two major problems with development aids that he says no current product solves—flexibility and software management. King divides the development-aid market into two categories: those offered by semiconductor manufacturers in support of their own lines of microprocessor products, and those offered by system manufacturers for use with assorted microprocessor products.

Putting it to the test. Two sessions offer managers of test and service departments a perspective on two of today's hottest topics: field-service troubleshooting of microprocessor-based equipment and automatic test systems for components and boards.

For session 15, "A Corporate Commitment to Service: Before You Build It, Service It," organizer Maury Floathe, program manager in the marketing department of Tektronix, has lined up four speakers. John T. Garen, manager of technical support at TRW Inc.'s Customer Service division, Fairfield, N. J., essentially will keynote the session, pointing out that "everyone must realize that product service will have to

be provided years after other efforts have ceased. A year after a customer has a product, chances are he will not remember the salesman's name, he probably never knew the designer's name, but rest assured that he hasn't forgotten the names and phone numbers of the people who are providing service." Garen will focus on board swapping at his company.

Omnicomp Corp.'s Robert Anderson will follow with a paper, written with Donald Phelps of NCR Corp., Dayton, Ohio, on the Omnicomp portable service processor (see p. 111), a board tester with guided probing and automatic fault isolation. Omnicomp, a Phoenix, Ariz., firm, developed the tester with funding from NCR.

Tektronix' Walt Kalin, marketing manager for the Digital Service Instrument division's business unit, hits on the impact of new service instruments on the costs of field service, stressing the need for component-level troubleshooting tools in the field. Kalin cites the Tektronix 851 portable tester as an example. It is a combined digital multimeter and counter-timer originally developed for Burroughs Corp. for service on the B8000 series of mainframe computers.

Terry Brumfield, director of service for John Fluke Manufacturing Co. of Mountlake Terrace, Wash., will point out that, despite the heavy emphasis on microprocessors and other digital circuits, the analog world is still very much alive and service engineers will always need such standard routines as checking for leakage paths and setting voltages.

Session 19 on automatic test equipment was organized by Dick Stein, new-products manager at Computer Automation Inc.'s Industrial Products division in Irvine, Calif. He notes that although the session is called "Using ATE More Effectively," a better title might be "Better Management Information through Automatic Test Equipment." Stein says that he intends to concentrate less on how to test than on how to integrate testers into a production complex and get the most information possible out of the equipment. The point, he says, is that the testers, while performing their jobs, also are an important potential source to management of information on production flow and the relative efficiencies of various manufacturing stages.

Other papers include ones from Faultfinders Inc. of Latham, N. Y., that will cover in-circuit system data logging; from Computervision Inc. of Bedford, Mass., on computer-aided design and how it fits into automatic test systems; from GenRad Inc. of Concord, Mass., on software for ATE; and from Computer Automation on a distributed processing system that provides management information.

Using fiber optics. Two sessions on optical communications should shed some light on recent advances in fiber-optic components and practical systems for industrial use.

An overview of optical-waveguide systems by E. Basch of GTE Laboratories, Waltham, Mass., kicks off session 29. The remaining papers focus on recent advances in fibers and cables, optical-fiber splicing and coupling techniques, and light sources and detectors. Of particular interest are two papers: one details the optical splicing and coupling techniques developed at Bell Laboratories, Holmdel, N. J.; the other, from Lincoln Laboratory in Lexington, Mass., illuminates its work in gallium-arsenide–indium-phosphide lasers and detectors that operate at 1.1-to-1.3-micrometer wavelengths—a low-attenuation region for fibers.

On the other hand, session 35 deals with short-haul, rugged optical systems for high-speed data transmission in high electromagnetic-interference environments. The papers deal mainly with fiber optics, but one by Meret Inc., Santa Monica, Calif., reviews a free-space, optical-communications system transmitting digital data or composite video signals.

A paper from Times Wire & Cable Co., Wallingford, Conn., discusses an operational fiber-optic system for transmitting 12 color video channels, including audio, over a single optical fiber. Another paper, from Hughes Research Laboratories, Malibu, Calif., evaluates its 100-kilohertz optical data link, operational in a high-voltage environment for almost a year.

The two remaining papers will supply some insight into the selection of appropriate fiber cables for industrial environments. Galileo Electro-Optics Corp. of Sturbridge, Mass., provides data on the attenuation characteristics of all-glass and plastic-clad fused-silica fibers over a temperature range of −50°C to 150°C. Siecor Optical Cables Inc. of Horseheads, N. Y., surveys optical cable in the parameters that are currently available.

Solid-state talk. For those interested in solid-state communications circuits, the American Radio Relay League Inc., Newington, Conn., has assembled session 31. A paper from Siliconix Inc., Santa Clara, Calif., details how its high-frequency, power field-effect transistors made with a V-channel metal-oxide-semiconductor process not only exhibit exceptional stability in severely mismatched conditions, but also can double as wide dynamic-range, low-noise transistors in receiver front ends. The paper from RCA Corp.'s Solid State division, Somerville, N. J., discusses a new generation of integrated circuits for frequency synthesis and describes a next-generation IC for fm-radio i-f systems that features deviation muting along with a means for stopping on channel in search-mode receivers.

Also included is a paper from Microwave Associates, Burlington, Mass., that points out the practicalities of using Gunn diodes as basic oscillators in the 10-to-14-gigahertz bands. The final paper, from the Radio Relay League, zeros in on the electrical properties and practical applications of solar-electric cells. A comparison of cost versus utility and the maintenance procedures used for field maintenance should prove worthwhile.

Designing with computers. Organizer J. J. Golembeski says session 5, "Recent Advances in Computer Aids to Circuit Design," will, through a series of semitutorial discussions, acquaint the newcomer to computer-aided design with multilevel simulation efforts. Two papers, one by E. M. Butler at Bell Labs, and the other from a group of Carnegie-Mellon Univer-

sity, Pittsburgh, and at IBM Corp., Armonk, N. Y., will underscore the importance of the statistical modeling approach, which, because of its potential for chip-failure analysis, is making a run at unseating the popular Monte Carlo worst-case method.

Butler will discuss the evolution of statistical bipolar-device modeling and present new data on its use for complementary-MOS ICs in his paper, "Statistical Modeling for Circuit Design." The other paper, "Simplicial Approximation," will discuss "an approach to design centering for yield maximization based upon approximating the feasible region of the parameter space." Translated into dollars and cents, this method will yield high-confidence results and substantial cost savings for analysis of high-yield ics when compared with the Monte Carlo method.

Turning to multilevel simulation, A. R. Newton and D. O. Pederson from the University of California will discuss Splice, a computer program for the simulation of large digital circuits that simultaneously perform circuit, timing, and logic analyses in "Hybrid Simulation for LSI Design." Splice is more efficient than other methods because it performs extremely accurate analysis only when it has to (during circuit simulation) and carries out high-speed analysis only when it must.

For those interested in new programs, a paper by D. J. Miller and M. Blostein of Montreal's McGill University will discuss one in "Scamper—A New Simulator for Circuit Analysis." Their analog program performs linear or nonlinear analyses and, say the authors, will likely become available in the near future through McGill. They claim the program is efficient, fast, and very flexible in terms of easy user interface.

How to convert. For its coverage of analog data conversion, Electro/78 will be zeroing in on the hottest topic in the field—interfacing with a microcomputer system. Two sessions are planned: "Bridging the Analog-to-Digital Gap" and "Microprocessor Interfacing: Today and Tomorrow," a panel session that brings together a formidable group of speakers.

In the latter (session 10), organizer and chairman Narpat Bhandari, a senior scientist at Signetics Corp., Sunnyvale, Calif., will be looking at microprocessor interfacing from three aspects—the analog phase, the digital phase, and the systems phase that marries the two. "We intend to cover what a guy needs to know to design an interface today, and what he should be aware of to do it in the future," says Bhandari. There will be six panel members. Representatives for analog components will be Bernard Gordon from Analogic Corp., Wakefield, Mass., and Paul Brokaw from Analog Devices, while Tom Fredrickson of National Semiconductor Corp., Santa Clara, Calif., and Intel's Kent Simcoe will be the session's experts for digital devices. For the systems viewpoint, the participants will be John Titus of Tychon Co. of Blacksburg, Va., and Dave Millet from Nippon Electric Co. □

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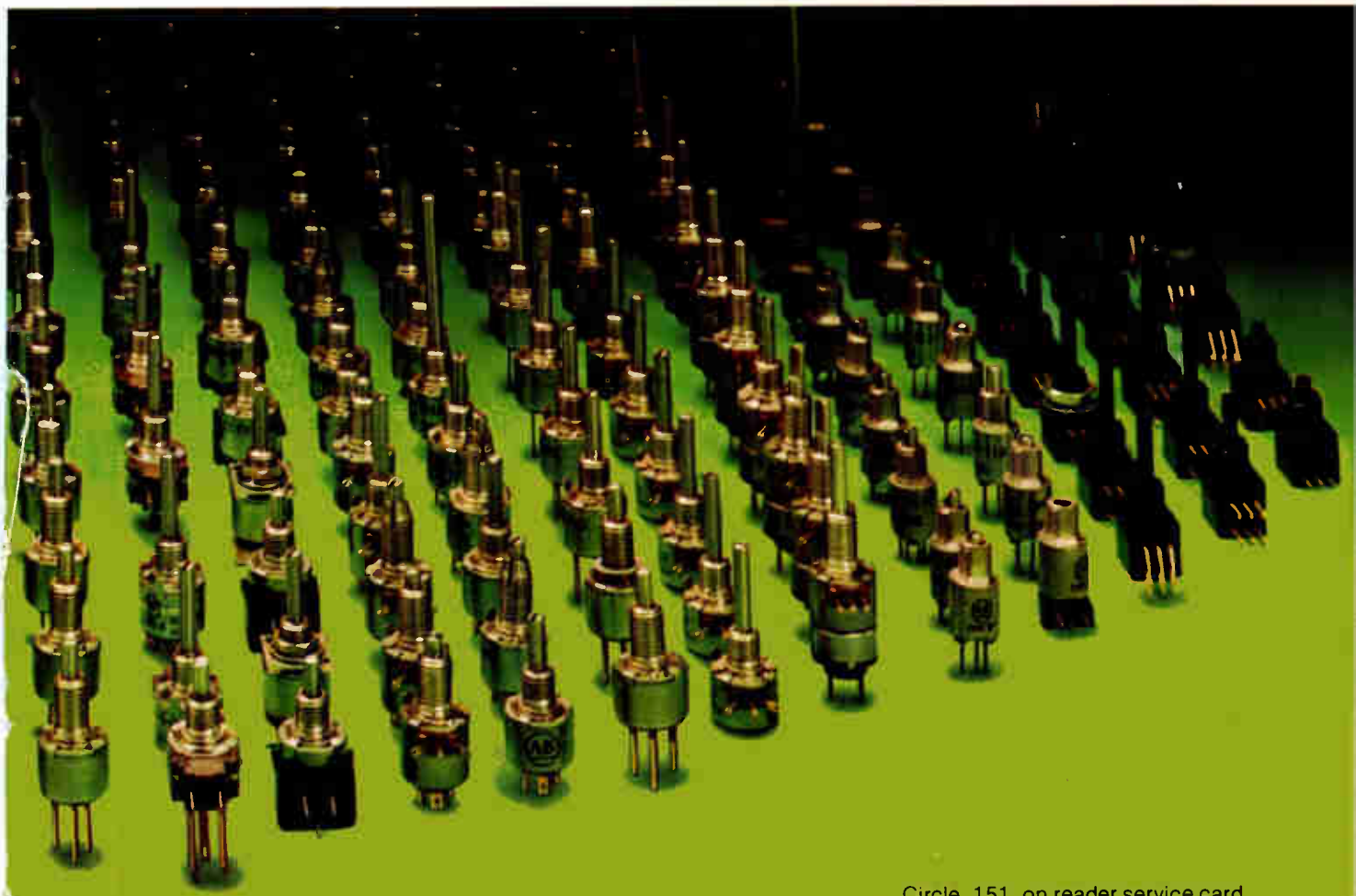

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$329 picoammeter makes debut

Picoampere measurements for the most part have been the concern of scientific researchers armed with expensive equipment. The growing use of low-cost, high-impedance devices such as bi-FET, bi-MOS and FET operational amplifiers, however, has forced circuit designers, as well as quality-assurance and production-test engineers, to reconsider these low-current measurements.

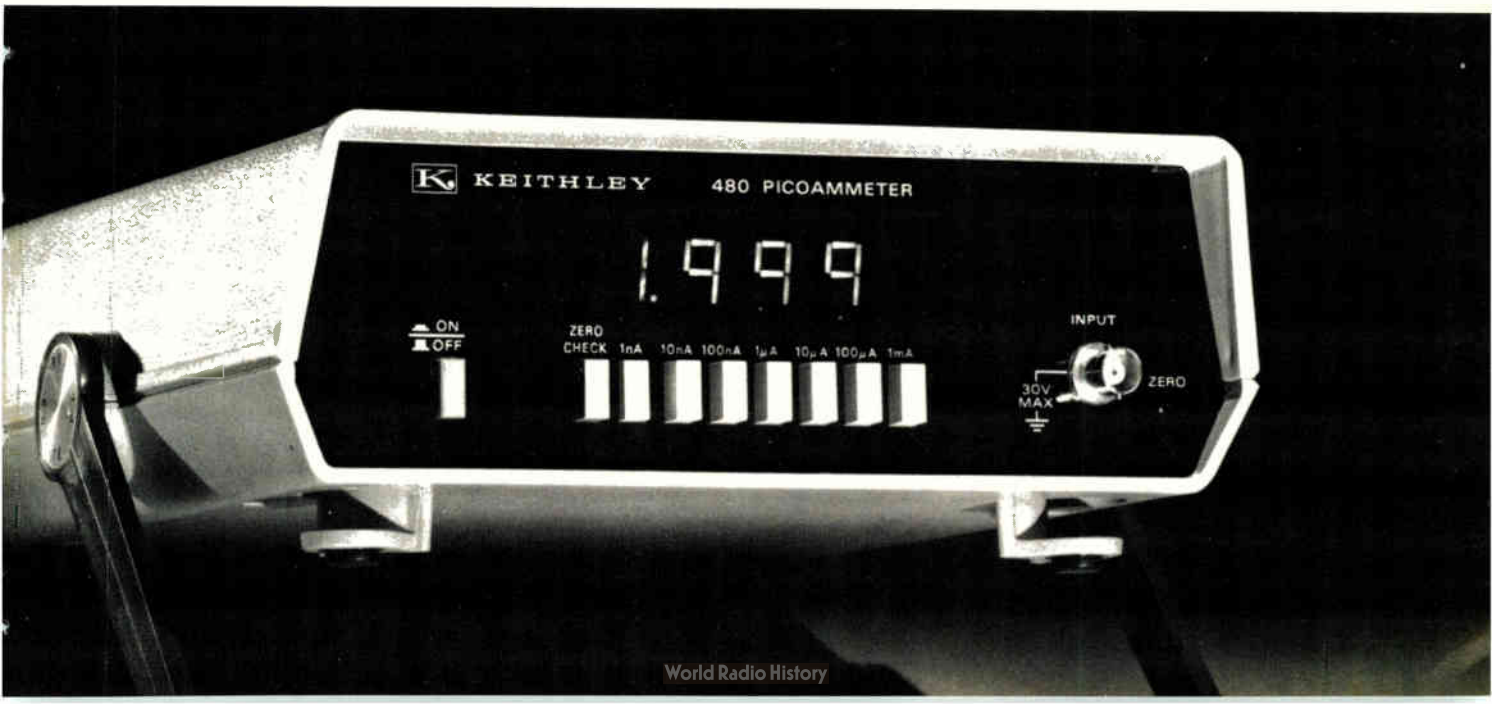
For this application, standard digital multimeters are not sensitive enough (typically 10 to 100 mA) and have a high input voltage drop and relatively large offset currents that vary with time and temperature. Therefore, unless the designer could afford the high-priced scientific electrometer, he was left with two alternatives. Either he could design and construct an op amp with a few range resistors, which can be time-consuming and results in a device with limited range and performance specifications; or he could simply ignore the measurement, relying on the manufacturer's specs, and hope that the small currents would not cause problems.

Now Keithley Instruments Inc. is introducing at Electro/78 its model 480 picoammeter that conveniently measures currents with a 1-pA resolution. Moreover, the 480's price is an attractive $329.

The instrument, an outgrowth of Kiethley's previous experience in manufacturing scientific electrometers and its recent development of inexpensive DMMs, measures current from 1 pA per digit (2 nA full range) to 2 mA with 3½-digit precision. The user simply connects the input into the circuit, selects the appropriate range, and displays the current.

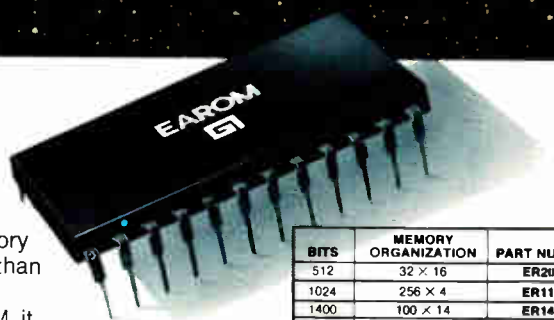
Several features obviate the need for extreme care commonly associated with making picoampere measurements. The input-voltage drop is actively constrained through feedback techniques to less than 200 μV, leaving the circuit under test undisturbed even at semiconductor voltage levels. Insulation leakage in input cabling can be ignored, and a high 50-Hz and 60-Hz ac normal-mode rejection precludes the need for extensive shielding of the circuit being investigated. Also, high common-mode rejection and a floating input permit in-circuit measurements. Moreover, concern for handling and connecting the input leads is eliminated by overload protection from transients of up to 1,000 V.

The 480 picoammeter has a 0.5-in., 3½-digit light-emitting-diode display and a measurement uncertainty of 0.8% plus four counts. Its analog output permits recording of current changes with time or X-Y



EAROM

In a class by itself.



GI's EAROM is the most advanced memory chip available. It can do more things than a RAM, ROM, PROM or EPROM.

EAROM is non-volatile. Unlike a RAM, it doesn't lose its data in a blackout, or from battery failure. Another thing. An EAROM is *electrically* erasable and reprogrammable. So you don't get stuck with costly inventories like you can with one-shot programmed ROMs and PROMs. With an EAROM you're never locked in. You can program and reprogram it. You can erase and rewrite it electrically over and over again—in circuit or at-the-bench without an ultraviolet light. And unlike UV EPROMs, stray sunlight or X-rays can't accidentally wipe out an EAROM's data. EAROM is word alterable, too. There's no need to clear the memory completely.

Only General Instrument Microelectronics makes a full line of EAROMs with bit densities from 512 to 8192. In fact, we wrote the book on EAROMs. Find out how GI microcircuitry can help put your product in a class by itself. Write or call General Instrument Microelectronics Ltd., 57/61 Mortimer Street, London W1N 7TD, England

BITS	MEMORY ORGANIZATION	PART NUMBER	READ ACCESS	ERASE/WRITE MODE
512	32 × 16	ER2051	3μs	16 bit word
1024	256 × 4	ER1105	2μs	32X4 block/4 bit word
1400	100 × 14	ER1400	2.8μs	14 bit word
4096	1024 × 4	ER2401A	2μs	1024X4 block/4 bit word
		ER3400	650ns	4 bit word or 1024X4 block/4 bit word
		ER3401	950ns	
8192	2048 × 4	ER2805	2μs	2048X4 block/4 bit word

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gramming as needed by the user.

As with other Futuredata systems, the new ones can be expanded with optional accessories and software to perform the full gamut of development tasks. The in-circuit emulator package, which the company calls the Microemulator, sells for $1,250; conversion packages for each microprocessor go for $950 each. A Basic compiler is priced at $300, and a variety of other software packages are available at the same price. A line printer can be supplied, as can extra memory modules. Shipments of the new equipment are expected to begin in June.

Futuredata Computer Corp., 11205 South La Cienega Blvd., Los Angeles, Calif. 90045. Phone (213) 641-7700 [372]

Hybrid works with processors

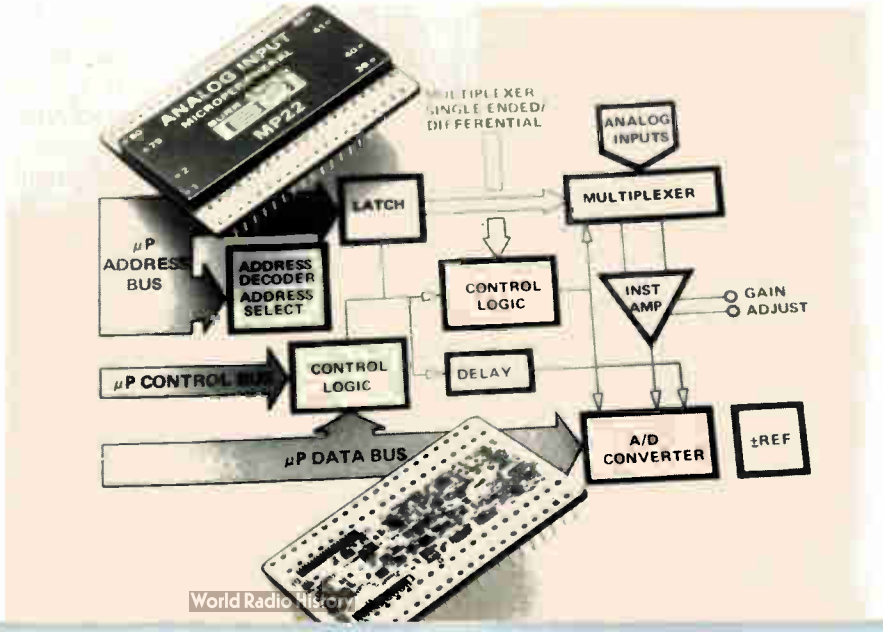
In a single IC-compatible hybrid package, Burr-Brown is squeezing a complete analog input system that not only offers 12-bit performance but also can operate with both the 8080 and 6800 microprocessors. The Tucson, Ariz., firm's new MP22 12-bit hybrid interfaces directly without additional components with 8080A, Z80 and SC/MP (Fairchild) processors. With minimum external logic, it operates with the 8048, 6800, 650X, F-8 and 8085.

"The MP22 also is compatible with minicomputers, such as the PDP-8, PDP-11, Nova, and Eclipse families, since we wanted to cover everything," observes Steve Harward, product manager for the Burr-Brown line. The company's existing MP20 and MP21, both 8-bit devices, handle 8080 and 6800 families, respectively. Containing a 12-bit analog-to-digital converter, instrumentation amplifier, input multiplexer, address decoding, and control logic, the new unit is truly a complete microprocessor-compatible data-acquisition system, he says. External logic necessary to make the MP22 compatible with the additional processors is a transistor-transistor-logic one-shot and timing components, Harward adds. For the 8048, it also needs a 4-bit latch.

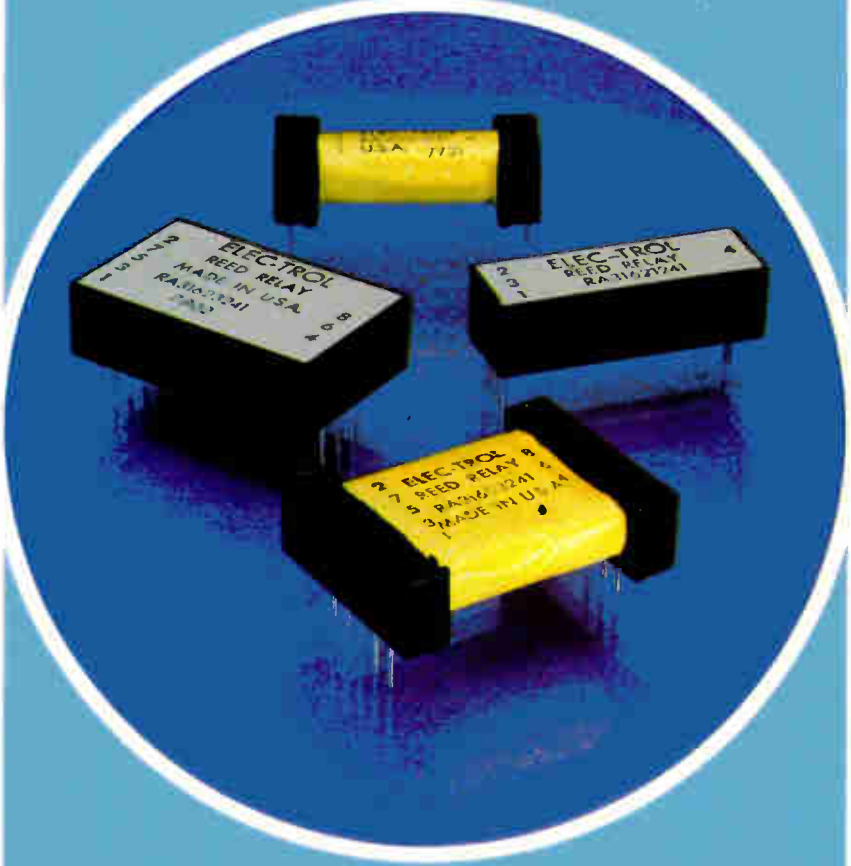
In operation, the MP22's control logic generates signals to halt or interrupt the central processing unit while conversion takes place and to signal when data can be read. Interrupt, halt, and direct-memory-access request signals are handled by internal logic. Either 16 single-ended or 8 differential analog signals are accepted by the hybrid, which can digitize low- or high-level inputs.

The unit's low-drift instrumentation amplifier features high speed at gains above unity and gain programming with an external resistor, allowing input ranges as low as ±5 mv. Gain can be selected from unity to 54 dB.

The a-d converter, built with



ELEC-TROL POWERMITE REED RELAYS



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Elec-Trol Powermite Reed Relay are available in 1A through 4A contact forms in both Open-Line and totally sealed Encased-Line package styles, with either .100" x 1.00" or .150" x 1.00" industry standard terminal spacing. Optional features include magnetic shielding and electrostatic shielding.

For more information use the reader service card, or contact your local distributor, representative, or the factory direct.

Elec-Trol, Inc., 26477 N. Golden Valley Road, Saugus, CA 91350, (213) 788-7292 (805) 252-8330. TWX 910-336-1556.

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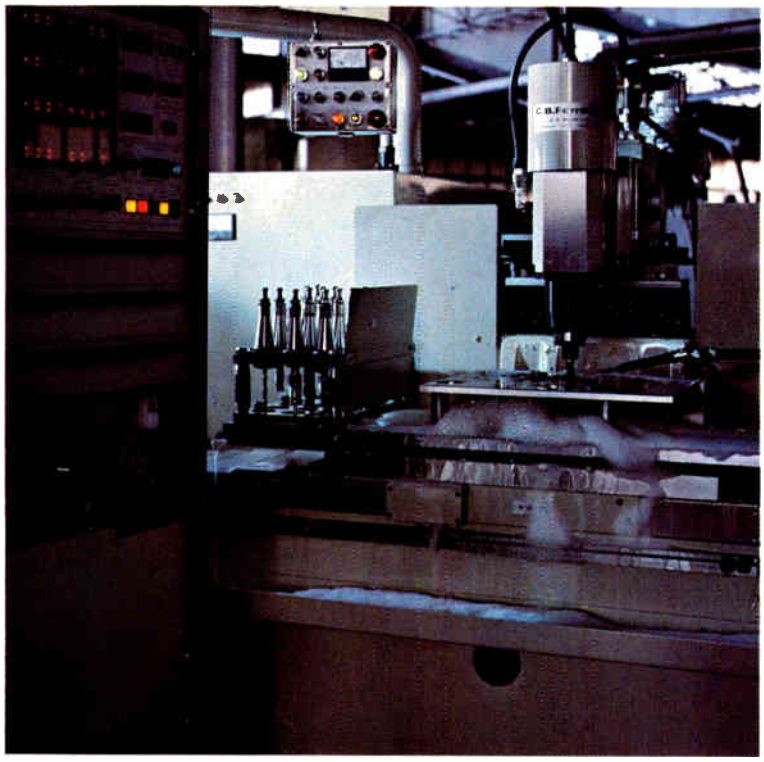
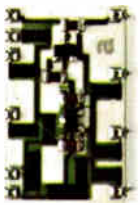
Instrumenta operum





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minimum overrange of +5%. Maximum nonlinearity over the 0°C to 70°C range is 0.05% of full scale +0.05% of input. The maximum gain temperature coefficient is 100 ppm/°C, and input offset is a maximum of ±50 μV/°C.

Coleman adds that the 8710, like all v-f converters, has another advantage over a-to-d units: its single output makes it easier to interface with a microcomputer than, for example, the 16 outputs from a 16-bit a-to-d converter. Also, it is especially good at driving long lines in a noisy environment, since v-f converters have high noise rejection a ratio of 60 dB.

The 8710's price is $149 in quantities of 1 to 24, and it is pin-compatible with the company's 100-kHz, 1-MHz, and 5-MHz modules. Delivery is from stock to six weeks.

Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. 01890. Phone John Toohey at (617) 729-7870 [375]

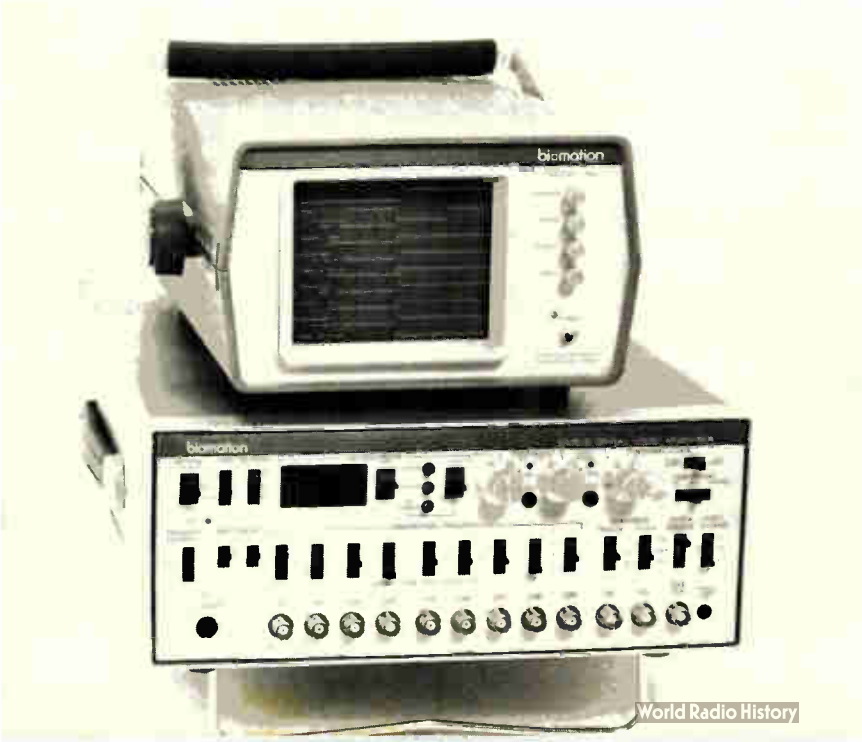
Logic analyzer is streamlined

The $5,900 9100-D logic analyzer to be introduced at Electro/78 by Biomation is 33% smaller, 50% lighter, and $3,000 less than the 8100-D model now on the market. The new trimmer version was made possible by the elimination of the little used fully programmble feature, reduction of channel memory by 50%, and relaxation of the 3-ns pulse-capture time by 2 ns.

The 9100-D features a 10-bit input of nine channels and a qualifier. Each channel can store 1,024 bits of digital data at a rate of up to 100 MHz. Placed in the latch mode, the analyzer will capture and display glitches as narrow as 5 ns. "We built it for those involved with high performance hardware design," Edward Jacklitch, product manager for digital instruments, explains.

The nine-channel input scheme gives the operator a convenient method to display eight channels of data plus a parity bit or system clock line. For wider data-word systems, two optional 10-TC probe pods ($450 each) can expand the input data trap capacity to 30 bits with a 10 bit display, he says.

In place of the usual thumbwheel switches for setting clock or trigger-event delay, the 9100-D has a four-digit light-emitting-diode display. A variable slew-rate activation switch allows the operator to set either clock or trigger-event delays up to 9,999 as displayed on the LEDs. In a second mode, the LED readout indi-



cates the position of the movable delta cursor, used in conjunction with the built-in cursor for measuring the number of clocks between their positions.

Display expansion, up to 20 times, is handled digitally within the logic analyzer. As a result, the brightness of the display does not diminish, as would be the case if the expansion mode on the oscilloscope were used.

A set of snap-on covers is available, as an option, from Biomation. Used to cover the front and rear panels, they offer protection when the 9100-D is used for field service.

Biomation Corp., 4600 Old Ironsides Dr., Santa Clara, Calif. (408) 988-6800. [372]

RAM board corrects errors

Of the many random-access-memory boards offered in the industry's standard single-board computer SBC-80 arrangement, none detects and corrects errors. That makes Mupro's MBC series of RAM boards unique.

To be introduced at Electro/78, it has an error-correction feature that aims squarely at reliability. James Moon, engineering vice-president at the Sunnyvale, Calif., company, claims, "Single-bit error correction and double-bit error detection will make a RAM board 85 times more reliable during the first 10,000 hours of operation than it would be without the capability."

Mupro's MBC approach corrects any single-bit error in any 8-bit byte, and the single-board computer then proceeds as if no error had been made. In each row of eight RAMs, five are assigned by their random-logic circuitry to correct errors introduced by any one of the eight RAMs in that row. Without error correction, these errors would be passed on with the data transferred either between memory and the processor or between memory and magnetic data storage, Moon points out.

In the unlikely event (1 out of 32,768) that two RAMs in a single row introduce errors, the Mupro board detects and flags them. A record of every error corrected or detected is stored in an on-board status register so that a technician on a routine service call need only check the register's light-emitting-diode display to locate and repair troublesome RAM components.

The MBC board series consists of eight boards, four using 4-K RAM integrated circuits and four using 16-K types. The 4-K RAM boards are available in 4, 8, 12, and 16 kilobytes. Prices vary from $605 for the 4-kilobytes capacity to $2,595 for the 64-K board. Less expensive RAM boards are also available that offer only an extra bit for routine parity error checking, and the least expensive versions consist simply of the memory boards without parity check or error correction. Quantity discounts are available, and delivery is 30 days from receipt of order.

Mupro, 424 Oakmead Parkway, Sunnyvale, Calif. 94086 [373]

Bandpass filter has wide range

Useful for applications ranging from satellite communications to vibration testing, the model 3800 self-tracking bandpass filter covers the frequency range from 1 Hz to 100 kHz with bandwidths from 0.001 Hz to 1 kHz. Unlike a lock-in amplifier, the 3800 does not need a reference-frequency input to track signals as much as 20 dB below the input noise. It can track signals over a 100:1 range in four overlapping frequency bands: 1 to 100 Hz, 10 Hz to 1 kHz, 100 Hz to 10 kHz, and 1 to 100 kHz.

The unit has a dynamic range of 40 dB: it can handle input voltages from 100 mV to 10 V. With its 1-MΩ input impedance, the filter can withstand input voltages of up to 100 V without damage. Other key specifi-

cations include an output impedance of 50 Ω, an internal hum level that is 36 dB below maximum output, and an attenuation slope of 12 dB per octave independent of center frequency. Operation is from 0°C to 50°C. The model 3800, which will make its debut at Electro/78, will sell for $2,000. Delivery time is 90 days.

Krohn-Hite Corp., Avon Industrial Park, Avon, Mass. 02332. Phone Ernie Lutfy at (617) 580-1660 [374]

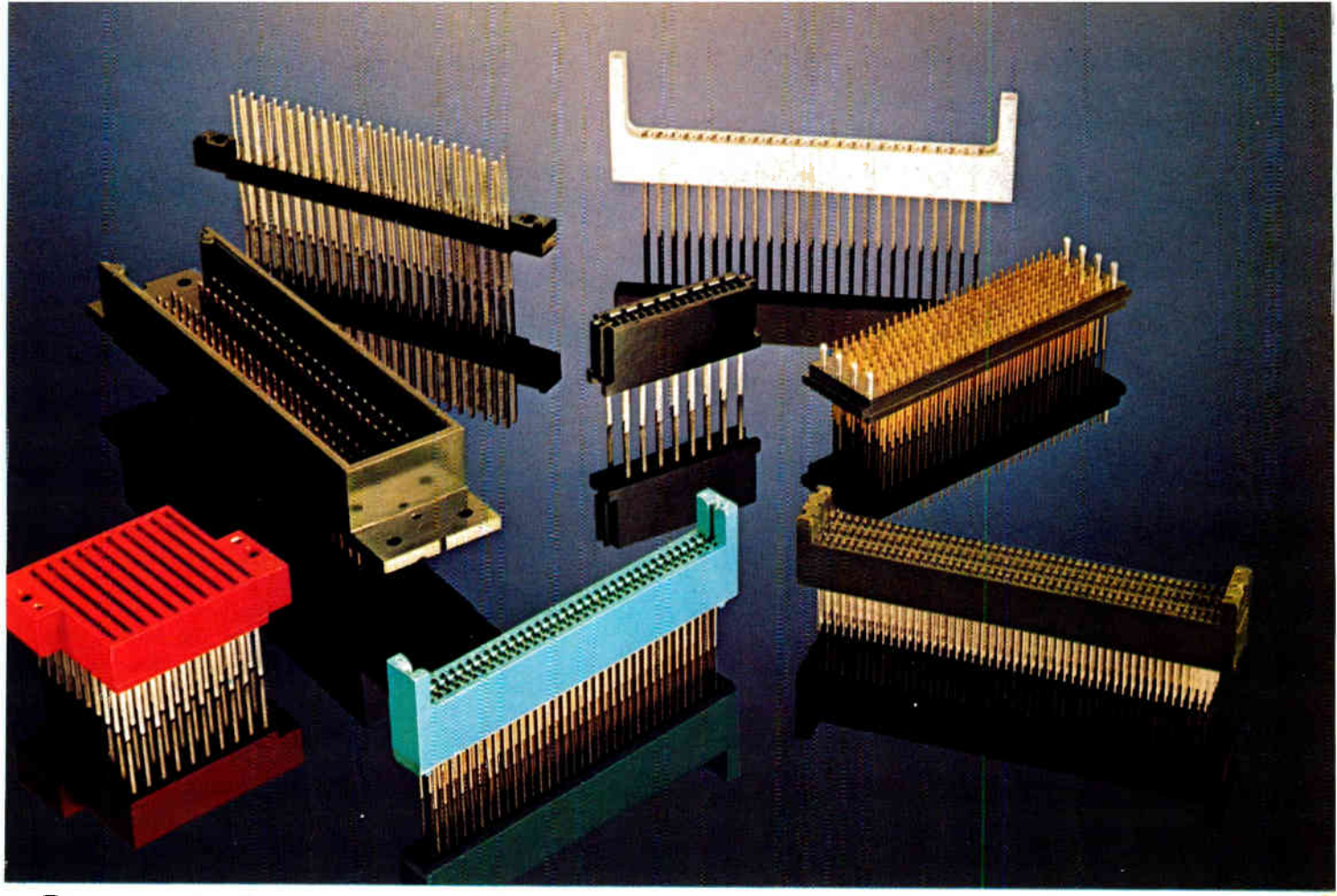
Clock oscillator stands alone

Even though many of the microcomputer and communications chips now coming onto the market have on-board oscillators that require only an external crystal, Motorola Inc. feels there's still a place for crystal-controlled oscillators in separate packages. Besides the greater stability and reliability they offer, the self-contained units have a yet more important advantage. They may be chosen to operate at a frequency that when divided down will provide all the different signals needed to clock all of a system's components.

For its initial entry, the company is readying a trio of thick-film hybrid circuits that will be priced below the previous $5 barrier for crystal-controlled clock oscillators.

"We've sifted through many combinations of clock frequencies to find three that, when divided down, can drive the most popular microprocessors, baud-rate generators, LSI chips, or any combination of the three," explains Calvin G. Chopp, marketing manager for the firm's component products department, Franklin Park, Ill. Motorola is gambling that the $3.75 price tag, in lots of 1,000 or more, will be low enough to force an industry standard and thus ensure the high volumes that it needs to support its low prices. "But as we uncover large-volume users grouped around other frequencies, we will add them, too," Chopp says.

Indeed, the three frequencies—



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Circle 169 on reader service card

16.000, 18.432, and 19.6608 MHz—seem to cover a broad array of dual-clock system applications. For example, the 19.6608-MHz clock can be divided by nine to drive Zilog Corp.'s Z80 processor, by four to get the 4.9154 MHz required by Standard Microsystems Corp.'s COM5016/5036 dual baud-rate generator. The 18.432-MHz circuit will clock Intel Corp.'s new 8085 microprocessor when divided by three, as well as Motorola's MC14411 baud-rate generator when divided by 10. Or it can be divided by 60 and run into a universal asynchronous receiver/transmitter to give the standard 19.2-kilobaud rate that is divisible to most of the common terminal frequencies, Chopp points out.

Motorola is calling its new clock family LOCO II "an acronym for 'low-cost' rather than crazy prices," he quips. But prices are the key to ensuring the parts' standardization and are made possible by projected volumes as well as new materials and process techniques that Motorola will not discuss.

The clocks have a guaranteed maximum frequency error of 0.05%, including the effects of temperature changes, aging, input-voltage changes, and load changes. And at $3.75 they are priced about 35% less then oscillators on the market today with comparable stabilities. But even crystal clocks with error ratings as high as 1% don't fall below $5 until quantities exceed 50,000, Chopp notes.

Motorola is not only going after competing clocks with its new hybrids, but is also "trying to capture that portion of the market that buys crystals and builds its own oscillators," Chopp says, including designers who merely wire crystals up to on-chip clocks. "In systems that use more than one clocked part, two crystals will cost $3 or $4, and usually some kind of harmonic-suppression circuitry is needed, too."

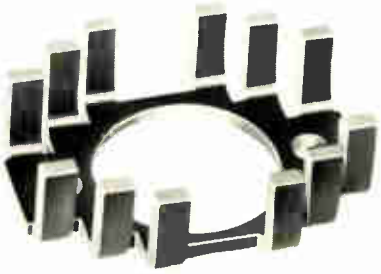
The part will meet its 0.05% specification from 0°C to 70°C and with a 5-v input that can vary ±0.5 v. Input current is 45 mA maximum, and outputs are compatible with transistor-transistor logic. Samples will be available in mid-May; production quantities will be ready in June.

Motorola Component Products Department, 2553 N. Edgington St., Franklin Park, Ill. 60131 [375]

Heat sink hooks to TO-3 base

A heat dissipator for TO-3 semiconductor packages designed for easy mounting and featuring a stag-

Electro/78



gered-fingers configuration has been introduced by International Electronic Research Corp. The LA (for limited area) 363 series is intended to solve thermal-management problems in all TO-3 hybrid, integrated-circuit, high-speed–driver, and switching applications. Its developer claims that its specially designed features can increase efficiency up to 23% over push-on models.

The unit attaches to the TO-3 device base, where most of the heat originates, rather than to the can itself. By relying on the staggered-finger design, it benefits from better heat radiation and cooling in natural environments, since heat can be radiated directly instead of being transferred from one finger to another. Also, the configuration causes maximum air turbulence.

For example, a 4-W TO-3 device without a heat sink undergoes a 100°C rise in case temperature above ambient temperature. But it drops to about 57°C when an IERC, B-5–type unit with 1.25-in. finger height is added. The unit can be attached without removing the TO-3 device from the circuit board, and its diamond shape reduces board space.

The price for quantities of 10,000 or more is 18.2¢ each, and they are available from stock.

International Electronic Research Corp., 135 West Magnolia Blvd., Burbank, Calif., 91502. (213) 849-2481 [377]

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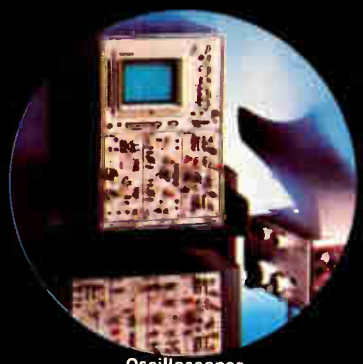

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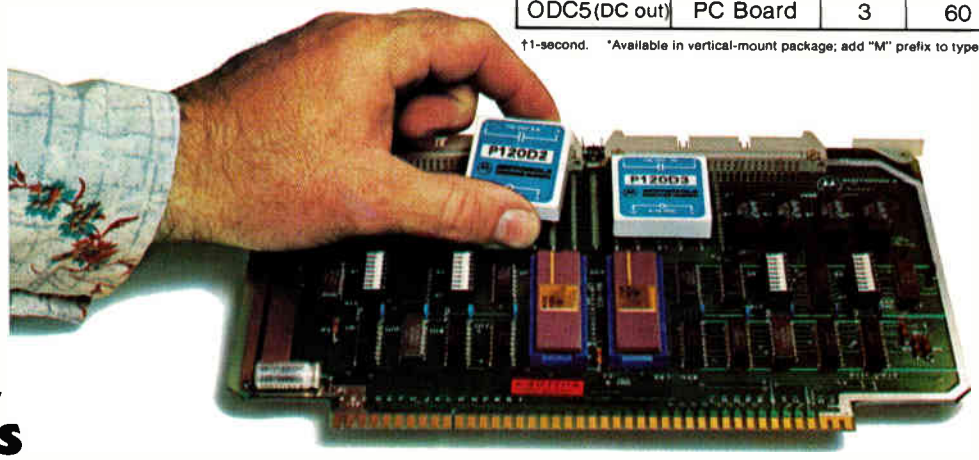
Switch	Type Mounting	Output Current A	Line Voltage V	Peak Surge# A
M120D05A	Chassis	5	120	50
M120D10A	Chassis	10	120	100
M240D05A	Chassis	5	240	50
M240D10A	Chassis	10	240	100
P120D2*	PC Board	2	120	20
P120D3*	PC Board	3	120	55
P240D2*	PC Board	2	240	20
P240D3*	PC Board	3	240	55
IAC5 (AC in)	PC Board	—	95-130	—
IDC5 (DC in)	PC Board	—	10-32	—
OAC5 (AC out)	PC Board	3	12-140	55
ODC5 (DC out)	PC Board	3	60	5†

†1-second. *Available in vertical-mount package; add "M" prefix to type number. #Single-Cycle.



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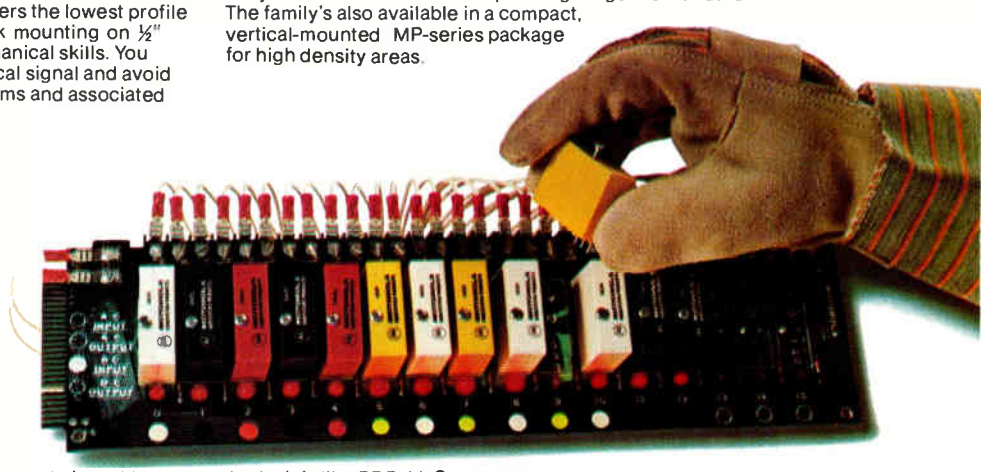

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Circle 181 on reader service card 181

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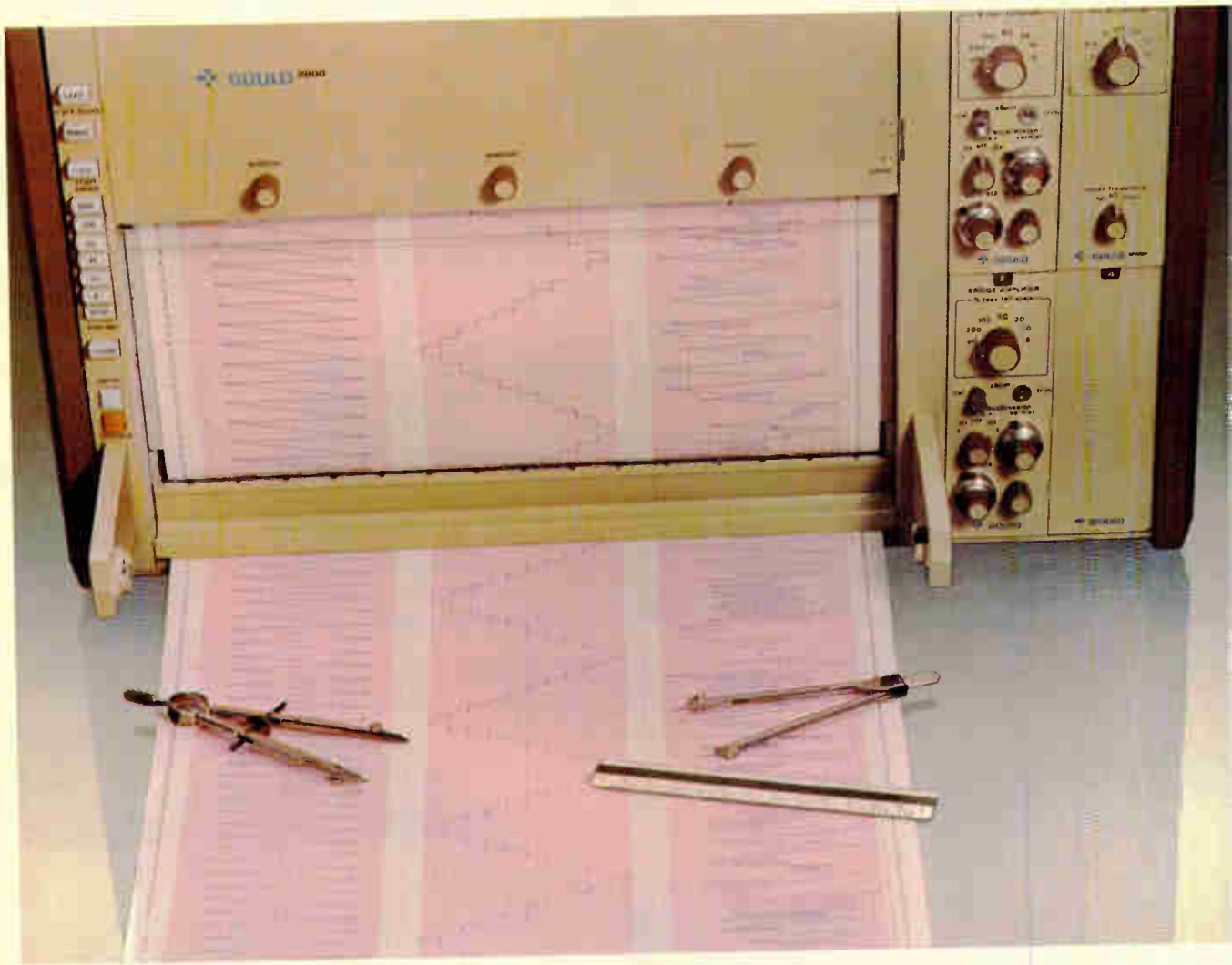

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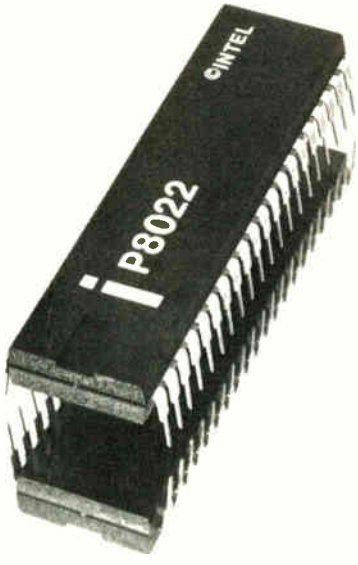
Microprocessors

Intel's 8022 packs a-d converter, plus

With all the hardware features of the 8021, the 8-bit device seeks high-volume markets

Another milestone in microelectronics is about to be passed with the introduction by Intel Corp. of the first microcomputer with an on-board analog-to-digital converter. The newest member of the MCS-48 family, designated the 8022, has all the features of the 8021, as well as the a-d converter and two analog inputs. Intel plans to supply samples starting next month.

"In hardware it's like the 8021, but its software, with over 70 instructions, is like the 8048's," says Jeffrey A. Miller, product manager of the MCS-48/8020 series. Like the 8021, the new 8022 contains other useful features including: a wide 4.5-to-6.5-v single power-supply range to reduce the cost of power regulation; clock generation with a single 3¢ external resistor; zero-crossing detection of ac waveforms that allows triac firing at the correct phase with only one external capacitor; pull-up resistor options that reduce parts count for special interfaces; two high-current digital outputs that each drive loads of up to 7 mA; internal counter-timer; and availability of 64 bytes of random-access memory.



When Intel introduced the 8021 8-bit microcomputer targeted for high-volume consumer, appliance, and automotive applications, it loaded the n-channel device with features to give designers flexibility and to help them reduce parts count and cut system costs. The 8021 was also designed to be the heart of a series of highly integrated, modular microcomputers aimed at several high-volume markets. The 8022 is the first to be added to that series of products.

"The a-d converter opens up a host of potential applications where a system must sense temperature, pressure, humidity, or any analog signal," Miller observes. He suggests ovens, refrigerators, climate-control systems in cars, and process-control applications. Another use would be in remote-sensing microcomputer systems, where the 8022 could, for example, detect process faults in a refinery and relay the exact nature of the problem to a central management computer.

Intel aimed for general-purpose use, Miller points out. One of the input/output ports, for instance, has voltage comparator inputs, which allows such options as a low-voltage touch-panel interface—very helpful in the appliance market, he notes. The 8022 has seven more I/O lines than the 8021, for a total of 28 lines in its 40-pin package; 1,024 bits more read-only memory for a total of 2 kilobits; and external and timer interrupt. Like the 8021, it has a 10-μs instruction cycle time.

As a cooking appliance controller, say, the chip's 2-K ROM stores the control programs, cooking cycles, and timing cycles. The RAM provides direct storage of temperature data, power-level settings, and time settings. The on-chip a-d converter permits direct interfacing for tem-

perature settings and potentiometer control of power levels.

Besides giving accurate phase detection to trigger triacs, the zero-crossing detection also provides a 60-Hz base for timing and time-of-day routines. The interval counter-timer allows precise time delays for cooking cycles and presetting functions, while the high-current digital outputs can directly drive alarms and light-emitting diodes.

Moreover, Miller points out that when used in a cooking appliance controller, the 8022 could replace $5 to $6 worth of components, lowering total system cost. Fewer components also means increased reliability, and the larger ROM gives a designer more flexibility.

The 8022 will sell in high volume for the same price as the 8048, or well under $10 and only double the price of an 8021. Intel also plans to support the 8022 by offering an 8022 emulator board called the EM2 in the third quarter of this year.

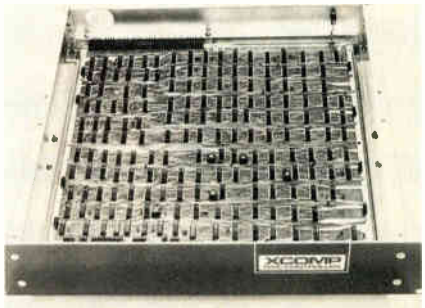
Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 [341]

Hard-disk-drive formatter designed for microprocessors

With the rapidly growing use of microprocessor-based computer systems in banking and other commercial applications, demand is rising for disk storage capacity beyond floppy-disk peripherals ordinarily tied to these systems. The situation might call for upgrading to a hard-disk drive, but the problem has been lack of a formatter with enough muscle to handle this task and still fit into the confines of a single-board computer.

Disk-controller manufacturer Xcomp Inc. has come out with its first hard-disk-controller formatter, DCF10, to help solve this problem. For the single-board-computer system user presently tied into a floppy-disk storage unit, the jump to 5- or 10-megabyte capacity hard disks made possible with the DCF10 should be attractive. The formatter will handle both 2.5- and 20-megabyte capacity disk drives too.

Xcomp has chosen a format of 256-byte sectors, 24 sectors per track, which is the IBM approach and commonly accepted in the industry. Nominal data transfer rate is 310,000 bytes/s. Particularly ap-



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Circle 185 for general information
Circle 136 for detailed specifications

New products

pealing to those upgrading from floppies is the DCF10's simultaneous seek and overlapping seek/data transfers that permit multiple-disk-drive configurations. It provides disk-drive microcomputer systems a capability approaching larger tape-drive computer systems.

The DCF10 will operate with virtually any microcomputer by means of a universal 8-bit central processing unit interface that permits user-designed system attachment. Users may prefer to build their own adapters for the common interface buses. However, Xcomp will soon have available an adaptor for the S100 bus usually associated with hobbyist computers, but now common in small commercial systems.

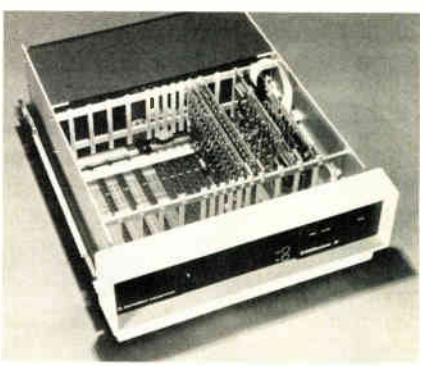
Price for the formatter is $1,260 in hundreds, and delivery is from stock.

Xcomp Inc., 7571 Convoy Ct., San Diego, Calif. 92111. Phone (714) 560-4415 [349]

Design tool upgraded for 2-MHz microprocessors

To design high-performance microcomputer systems based on its M68BXX series of 2-MHz chips, Motorola has upgraded its Exorciser development system and introduced the Exorciser II. The new development system also supports designs based on the 1.5-MHz M68AXX and 1-MHz M6800.

Optional modules are available to tailor the Exorciser II for use with other Motorola microprocessors, including its transistor-transistor-logic and emitter-coupled-logic 4-bit



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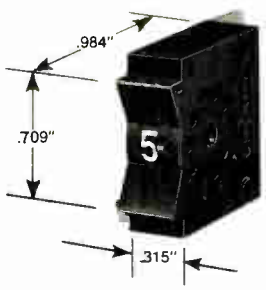

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New products

slices. The new unit features a dual-memory-map mode of operation that lowers development time and cost by allowing full use of the complete microprocessor addressing map, regardless of the addressing requirements of the Exorciser II and its peripherals. This arrangement makes possible a more complete emulation and debugging, since memory in the user's 65-kilobyte map need not be allocated to the debugging program.

The basic system consists of the MEX6800-2 MPU II and MEX68DB2 Debug II modules, power supply, and a 14-slot chassis with cover to hold the user's printed-circuit-board modules. Available immediately, the Exorcisor II comes with 32-K static random-access-memory, 110-V operation, for $7,850; and with 220-V operation, for $7,900. With 32-K dynamic RAM and 110-V operation, it costs $7,250, and with 220-V operation, $7,300.

Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, Ariz. 85036. Phone (602) 244-6900 [343]

Low-profile microcomputer saves on rack space

Based on the BLC 80/10 computer board using the INS8080A microprocessor, the rack-mounted computer model RMC 80/10 incorporates programmable serial and parallel input/output, complete busing, power supply, fans, and three expansion-board slots. It requires only 3.5 in. of panel space height in a commonly used 19-in. rack.

This 8-bit microcomputer has six general-purpose 8-bit registers, an accumulator, a 16-bit program counter, and a 16-bit stack pointer. The program counter allows direct addressing of 64 kilobytes of memory; while the stack pointer permits storage and recall of register contents, anywhere in random-access memory.

The RMC 80/10 may be expanded up to 64 kilobytes by installing BLC 016 16-K RAM, BLC 406 6-K read-only memory/programmable

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OTHER APPLICATIONS
Data loggers - Emergency vehicles - Fire engines - Mobile communications - Police cars

SPECIFICATIONS

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7 electrode mobile head - Prints numerals, letters of the alphabet and symbols - Max capacity: 25 characters per line

CHARACTER SIZE
Height: 3 mm - Width: variable

PRINTING SPEED
Up to 2 lines per second

VERTICAL SPACE
Mechanically controlled, 5 mm step

ASSEMBLING AND POSITIONING
Directly on printed circuit - Works in any position

MAX. DIMENSIONS
Width: 175 mm - Height: 45 mm - Depth: 80 mm

WEIGHT
190 gr

ENVIRONMENT CONDITIONS
Temperature: −10 °C ÷ +50 °C - Relative humidity: 90%

OPERATING LIFE
Printer: › 2.000.000 lines - Head: › 700.000 lines - Easily interchangeable head

POWER
Motor: 4,5 nominal Volts, max. 6 Volts. Current: 150 mA. At start peak 1,2 A for 1 millisecond.
Pins: 35 Volts with negligible consumption.

Circle 715 on reader service card

```
123456789:;<=>?
!"#$%&'()*+,-./
@RSTUVWXYZ[¤]{}
ABCDEFGHIJKLMNO
123456789:;<=>?
!"#$%&'()*+,-./
@RSTUVWXYZ[¤]{}
ABCDEFGHIJKLMNO
123456789:;<=>?
!"#$%&'()*+,-./
@RSTUVWXYZ[¤]{}
ABCDEFGHIJKLMNO
123456789:;<=>?
!"#$%&'()*+,-./
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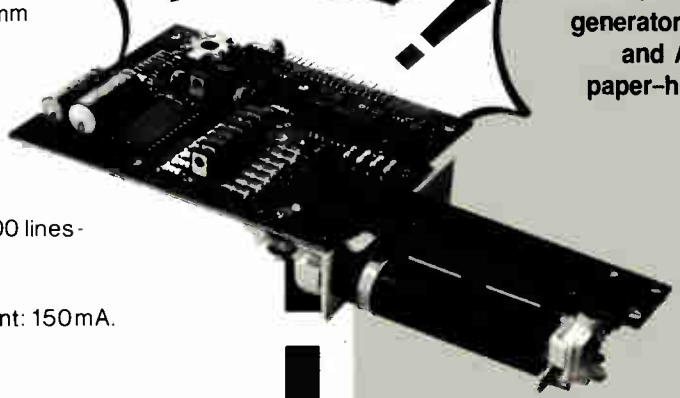

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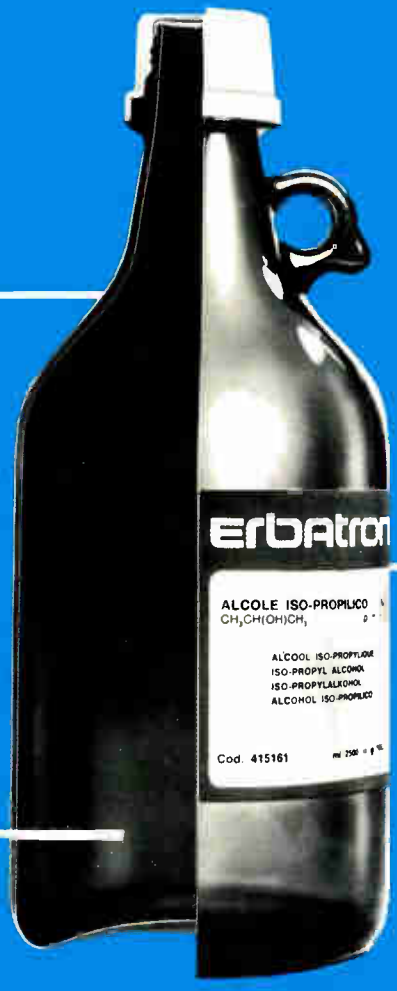

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"Three Martinis? I don't even have time

Why Washington's economic proposals are bad news for the Electronics Technology Marketplace

1. ***Only growing businesses can create employment.***

A big concern in Washington these days—among both legislators and bureaucrats—is unemployment. *And it should be.* So far so good. But all of the proposed solutions involve direct action or subsidy by government. Job corps. Public works. Grants for projects. Subsidize marginal employers. Make work. Throw money at the consumer. That money, of course, is expected to come partly from tax "reform".

It's no big deal to figure out why we have an unemployment problem in the United States. In the last 10 years, GNP has grown less than 3% per year in constant dollars. Employment has grown, too, but not as fast as the labor pool. Thus: Unemployment.

When will our government learn that the only way to create employment is for business and industry to grow? And that the only way business can grow is from *investment?*

2. ***If investors are penalized, where will we get the money to grow?***

One business *has* been growing, and therefore providing more employment. In the last 10 years, while GNP was nearly flat, the U.S. *electronics industries* have grown at a compounded annual rate of about 12% in real dollars. Employment has increased proportionately, *but we can't create jobs without paying for them.*

The American Electronics Association (formerly WEMA) recently surveyed 276 young electronics companies which have created 131,000 new jobs since 1955. They found that to establish each one of these jobs required nearly $33,000 of assets, of which $14,000 had to come from risk investment capital. Take another example. If a semiconductor company wants to grow (and it had better want to if it expects to take care of its customers), it must invest 35 to 50 cents in capital for each dollar increase in sales. There is no way this capital can all come from retained earnings. *Risk capital is an absolute necessity.*

The message is simple. If you want employment to grow, business must grow. If you want business to grow, risk investment capital must be available. This is certainly the case in the electronics industries, and I suspect it is true of business, generally.

In the face of this logic, the Carter tax reform package suggests elimination of the alternative tax on capital gains. The effect of that would probably be to eliminate risk investment capital altogether, and therefore to eliminate growth. The Tax Reform Act of 1969 increased the maximum tax on capital gains from 25% to 49%. That has cut availability of risk investment capital for electronics by at least 50%. The *proposed* "reform" could *eliminate it completely.* No investment, no growth, no employment.

What is needed is a substantial *reduction* in capital gains tax rates. At least back to the 25% maximum, and preferably lower. The AEA data suggests that such a move might even *increase* Federal tax revenues rather than reduce them. But most important, it would give our high-technology industries the money to grow.

3. ***Are we trading lines at the gas pump for destruction of the dollar?***

Remember the lines at the gas pump? Now, just a bit over four years later, we are importing oil at the rate of over $45 billion per year, the dollar is in trouble everywhere, *and we still don't have an energy policy* in the United States. And we have hardly even begun to work on the things electronics technology can do to reduce energy consumption and waste.

In the last five years, the U.S. has accumulated unfavorable trade balances exceeding 54 billion dollars—over half of that in 1977. In the same period, the high-technology companies in our electronics industries have rung up a *favorable* trade balance of over $15 billion. Here again, there is no free lunch—we can't produce export sales without investment. According to the AEA study, $1 invested in member companies founded from 1971 to 1975 now returns $70 per year in export sales. It also returns $15 in federal corporate taxes, $15 in personal income taxes, and $5 in state and local taxes. You would think that with these favorable economics, our government would be *eager* to invest on the winning side. Not so. Besides wanting to increase tax on capital gains, the Administra

'or a beer."

ion is also proposing to phase out he Domestic International Sales Corporation (DISC), and to terminate the deferral of U.S. taxes n income earned overseas.

If these proposals are adopted, an we continue to compete successfully overseas? Our strongest ompetitive challenges are coming rom Japan and West Germany, vhich do not tax capital gains *at ll*, and which do not tax on a current basis the income earned by heir overseas operations. When s Washington going to learn?

This discussion points up nother serious effect of the risk nvestment capital shortage. U.S. ompanies have been forced to ook for capital overseas, resulting n European and Japanese companies gaining ownership positions in U.S. markets, and access o U.S. technology. Long term, his will almost certainly lead to rosion of overseas markets for J.S. electronics products. If ever ve needed *help* from Washington t is now. Instead, we are getting he most damaging kind of proposals for "reform".

4. *"Martinis" is just rhetoric. The real issue is selling.*

Everybody is tired of listening to he opposing sides in the great 'three-martini-lunch" debate. On one side of this shrill dialogue, the notel/restaurant unions and associations are talking about losing 500,000 jobs. On the other, the pious champions of the Administration proposals are talking about the "privileged few dining uxuriously at the expense of the tax-paying majority". The *real* ssue in this debate has not been nentioned by either side.

That issue is *selling*. A successful salesman usually sells the way he customer wants to buy. Lots of customers will not go to lunch with a vendor, will accept no entertainment, tickets, or other non-product inducements. Others like to do business with friends, and are willing to be entertained occasionally. Maybe even go to lunch. Only somebody who never sold anything (this probably includes all of the people who are proposing and debating this latest tax reform) would confuse a sales luncheon with "privilege".

It is proposed that only half of that lunch be a business expense. I don't have time for a three-martini lunch, and neither do my busy, hardworking customers. But I can see where this is taking us! The next thing we know, only half of the advertising budget will be a business expense. Or half of what we spend for catalogs, salesmen's cars, phone calls to customers, or the paint we use to make our products more attractive. If the Administration has its way, we will wind up being told how to sell by people who know nothing about it. Farfetched? Sure. But so was the Tax Reform Act of 1969.

5. *Don't just sit there.*

The ideas, philosophies, programs, and proposals floating around Washington today are certainly terrifying to anybody who has ever run a business, met a payroll, or sold something. But there's one thing that scares me worse, and that's the *apathy* of many of our businessmen. One statistic will suffice: The AEA's extensive study of the impact of investment in high technology companies got only a 40% response. 60% of member companies did not participate. Unless you want to have investment capital and export incentives eliminated, and be told how to sell, *you must do your part.* For some ideas on where to start, see the box below.

Daniel A. McMillan III
Publisher

On March 22, a bipartisan bill calling for restoration of the 25% maximum tax on capital gains was introduced in the House of Representatives (HR 11773). I am sure you will want to call or write your Representative in support of HR 11773, which could come to a vote as early as May.

If you want more information on the AEA survey, including the text of AEA's testimony in Congress, call Ken Hagerty at AEA, (415) 327-9300, or write P.O. Box 11036, Palo Alto, CA 94306.

Electronics covers these and related stories on a continuing basis. Here's a short recent reading list (issue dates and page numbers) if you're interested.

- *AEA survey, DISC, Capital Gains: 11/10/77, p. 12; 3/30/78, p. 76.*
- *Financing Industry, Distribution, & Technology: 1/5/78, p. 103; 2/2/78, p. 25; 3/16/78, p. 24 and 84.*
- *U.S. Investment by Overseas Companies: 3/16/78, p. 90; 3/30/78, p. 72.*
- *Businessmen in Activist Role: 1/5/78, p. 112; 1/19/78, p. 24.*
- *The Threat from Japan: 12/8/77, p. 12; 12/22/77, p. 59.*
- *Executive Concerns, Japan and Capital: 12/22/77, p. 81.*

Electronics Magazine McGraw Hill

This is the Fourteenth of a series of editorials on advertising, marketing, and planning in the Electronics Technology Marketplace. Your comments are welcome.
Electronics Magazine, 1221 Avenue of the Americas, New York, N.Y. 10020

Instruments

Synthesizer is SBC-compatible

Single-board unit covers range from 10 Hz to 2 MHz

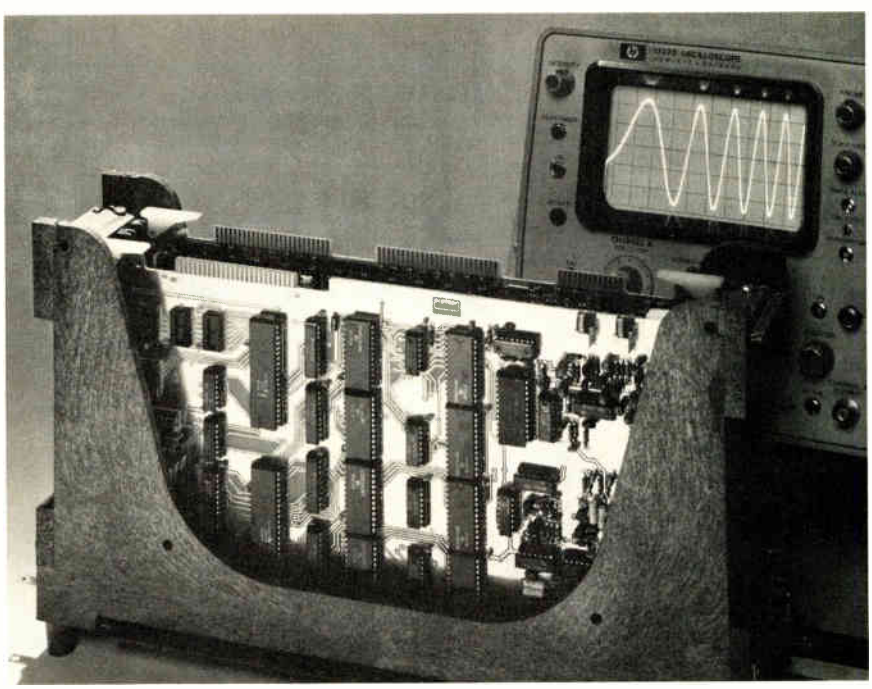
Officials at Proteon Associates Inc. are not claiming to have a first because their PRO80 frequency synthesizer is on a single circuit board, but chief engineer Alan Marshall says he knows of no other such synthesizer that is directly compatible with a microcomputer.

The PRO80 covers the range from 10 Hz to 2 MHz, has a resolution of 0.0023 Hz, and is mechanically and electronically compatible with a variety of single-board computers. They include the Intel SBC-80 and National Semiconductor BLC80 series, or just about any microcomputer operating on an 8080 type of Multibus, says Howard Salwen, Proteon president.

Frequency is computed on a point-by-point basis, Salwen says, and there are no transients, so that frequency changes are phase-continuous, occurring in less than 300 ns. A maximum of about 60 μs is required to load a number representing the new frequency from the microcomputer bus interface to the frequency section, but only 300 ns after the load command, the new frequency is generated.

Salwen says the PRO80 is suitable for test applications where there is a requirement to test as a function of frequency. It can also generate several commonly used communications and tracking waveforms, such as phase-continuous frequency-shift keying and minimum shift keying. For test instrumentation, the PRO80 can be hooked up as a phase-locked loop to make a digital filter whose bandwidth can be easily changed. In the latter use, the synthesizer "looks like an analog voltage-controlled oscillator," Salwen says, "but the user knows the accuracy of the frequency it's making to a precision of 30 bits, with the least significant bit being 0.0023 Hz."

The PRO80 includes a crystal-oscillator frequency standard with a stability of 100 ppm which Marshall says is not intended to be ultrastable, but the standard can be phase-locked to an external reference at 1, 2, 5, or 10 MHz. Further, a 10-MHz reference



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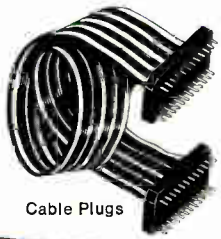
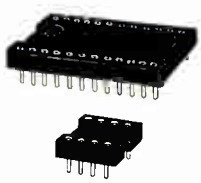
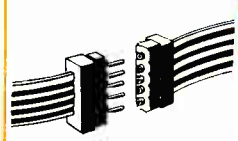
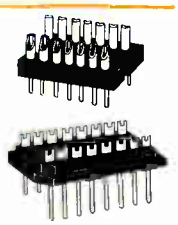

Cable Plugs


Socket/Terminal Strips


DIP Sockets


TO Sockets


Cable Strip Connectors


Adaptors

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Circle 197 on reader service card

output is provided so that the first of up to 30 of the Proteon synthesizers can be locked to the external reference, and the rest will track to that standard.

The PRO80's output waveform is a sine wave, and harmonics are 40 dB below the output from 10 Hz to 600 Hz, and 60 dB below the output from 600 Hz to 2 MHz. Nonharmonic spurious outputs for those same ranges are 70 dB and 60 dB below the output, respectively. Phase noise is specified at −50 dB in 30 kHz, excluding 1 Hz about the carrier. Price is $1,300 each.

Proteon Associates Inc., 24 Crescent St., Waltham, Mass. [351]

Low-cost frequency counter counts directly to 225 MHz

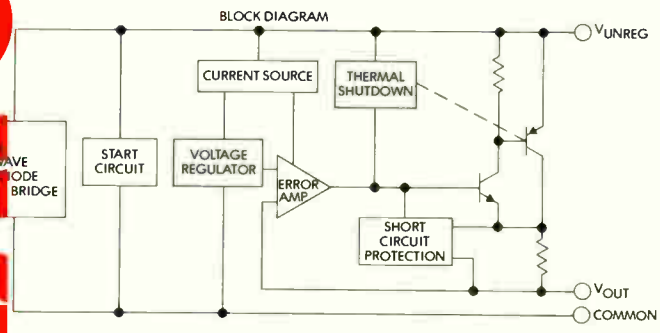
Designed with a minimum of controls, the model 5725C interference-resistant counter is a direct-counting instrument that operates from any 9-to-15-V dc source or, with an optional adapter, from the ac line. It uses a single switch for selecting readings in hertz, kilohertz, or megahertz from 10 Hz to more than 225 MHz. All readings are made through a single input with a nominal sensitivity of 50 mV.

The six-digit counter uses 0.43-inch orange light-emitting-diode readouts. Priced at $295, the counter offers resolutions of 1, 10, 100, and 1,000 Hz by means of four selectable gate times. Audio signaling tones may be measured to 0.1-Hz resolution in 10 seconds. The input impedance is 1 MΩ shunted by 25 pF. Input overvoltage protection is provided up to 250 V rms.

Cased in a flame-retardant, shock-resistant plastic, the 5725C can be mounted in a rack. The interior has a metallic coating that protects

AC INPUT REGULATOR

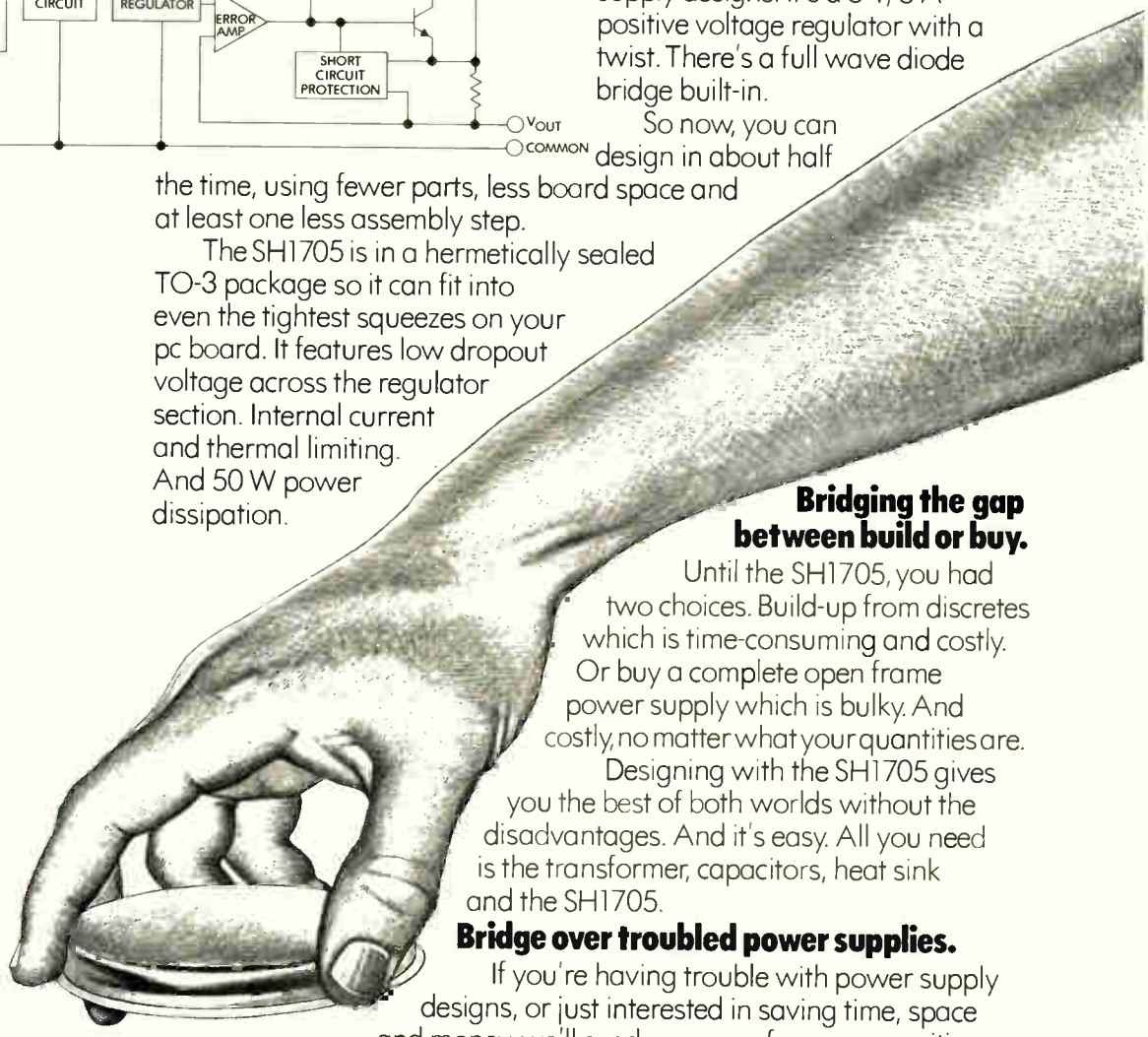
Now there's one less bridge to cross to get to your power supply.



Fairchild's new SH1705 makes it a whole lot easier to arrive at power supply designs. It's a 5 V, 5 A positive voltage regulator with a twist. There's a full wave diode bridge built-in.

So now, you can design in about half the time, using fewer parts, less board space and at least one less assembly step.

The SH1705 is in a hermetically sealed TO-3 package so it can fit into even the tightest squeezes on your pc board. It features low dropout voltage across the regulator section. Internal current and thermal limiting. And 50 W power dissipation.



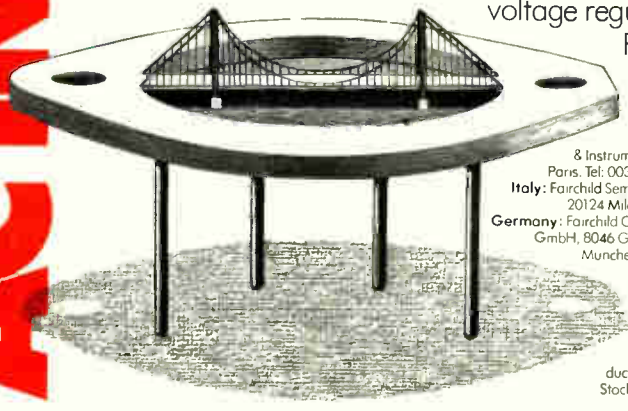
Bridging the gap between build or buy.

Until the SH1705, you had two choices. Build-up from discretes which is time-consuming and costly. Or buy a complete open frame power supply which is bulky. And costly, no matter what your quantities are.

Designing with the SH1705 gives you the best of both worlds without the disadvantages. And it's easy. All you need is the transformer, capacitors, heat sink and the SH1705.

Bridge over troubled power supplies.

If you're having trouble with power supply designs, or just interested in saving time, space and money, we'll send you one of our new positive voltage regulators with a bridge inside. Contact your Fairchild distributor or representative. Or, for more immediate results call your nearest Fairchild sales office.



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Italy: Fairchild Semiconduttori S.P.A., Via Rosellini, 12, 20124 Milano. Tel. 02 6887451. Telex 36522.
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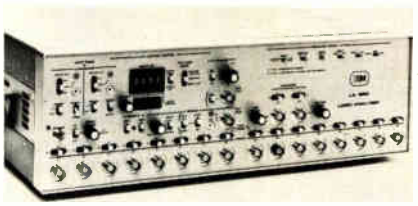
Ballantine Laboratories Inc., P. O. Box 97, Boonton, N. J. 07005 [353]

50-MHz logic analyzer captures 18 channels

The model LA1850 logic analyzer is a 50-MHz instrument that can capture 510 18-bit words. In addition, it has a separate 510-word reference memory, which it can use to make comparisons.

Well suited for analyzing 16-bit computer systems, the LA1850 offers three qualifiers in addition to its 18 channels. It can thus display several channels of information as well as the data and address lines. Comprehensive triggering capability allows the unit to trigger on spikes, after a certain number of events, or after a certain number of clock pulses. The operator can also choose to capture data only if it is one, two, or three clock periods wide. This combination of features both eliminates false triggering on three-state busses and allows the operator to deal with lengthy software loops.



The model LA1850 measures 5.25 by 16.65 by 13.95 inches and weighs 30 pounds. It sells for $6,100 and is delivered from stock up to 60 days.
EH International Inc., 515 11th St., P. O. Box 1289, Oakland, Calif. 94604. Phone (415) 834-3030 [354]

Three-channel 100-MHz scope pulls only 45 W

The PM3262 100-MHz oscilloscope is a portable instrument with two standard channels and a third one

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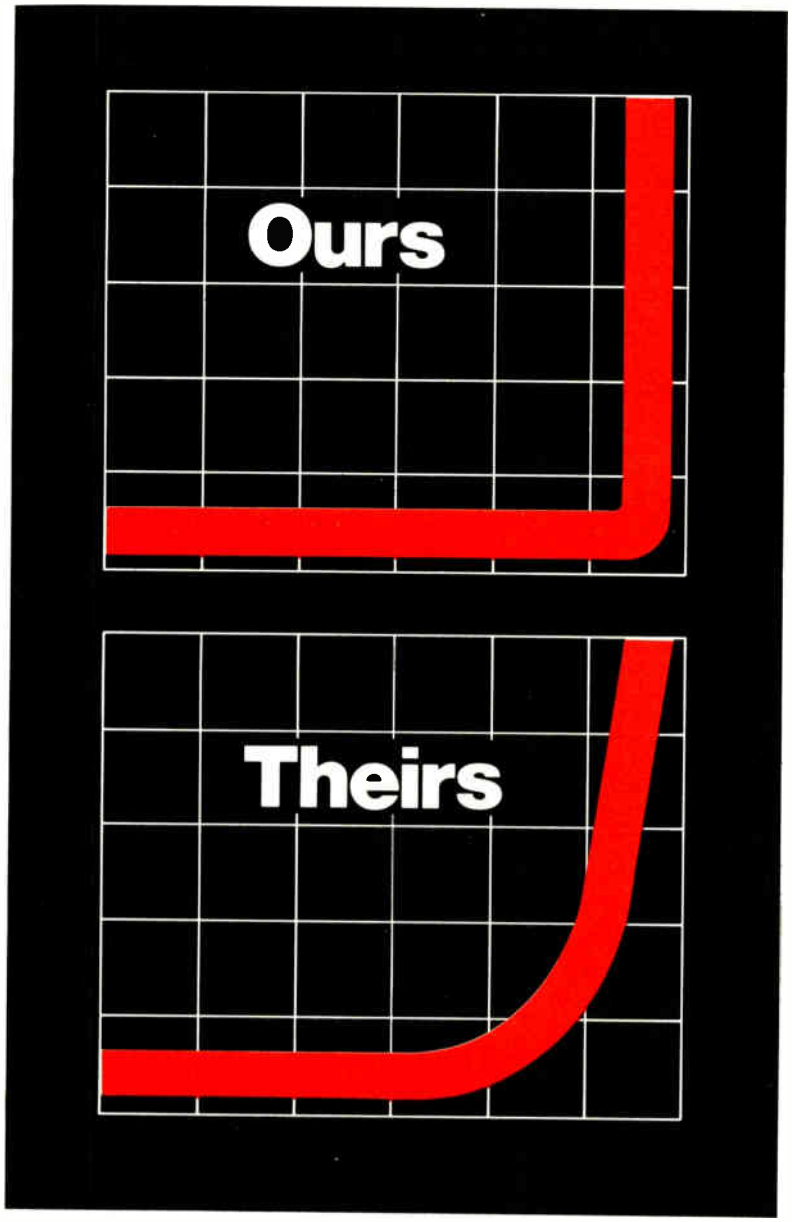

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Teledyne low voltage avalanche zeners are available in a range of voltages from 4.7V to 10V at your tolerance requirement. Let us know what you need, and we'll give you exact specs. And the most pleasant surprise of all may be the price.

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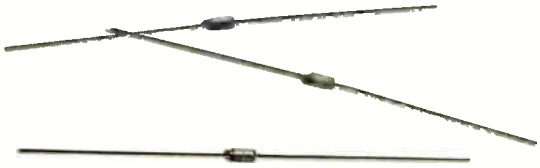

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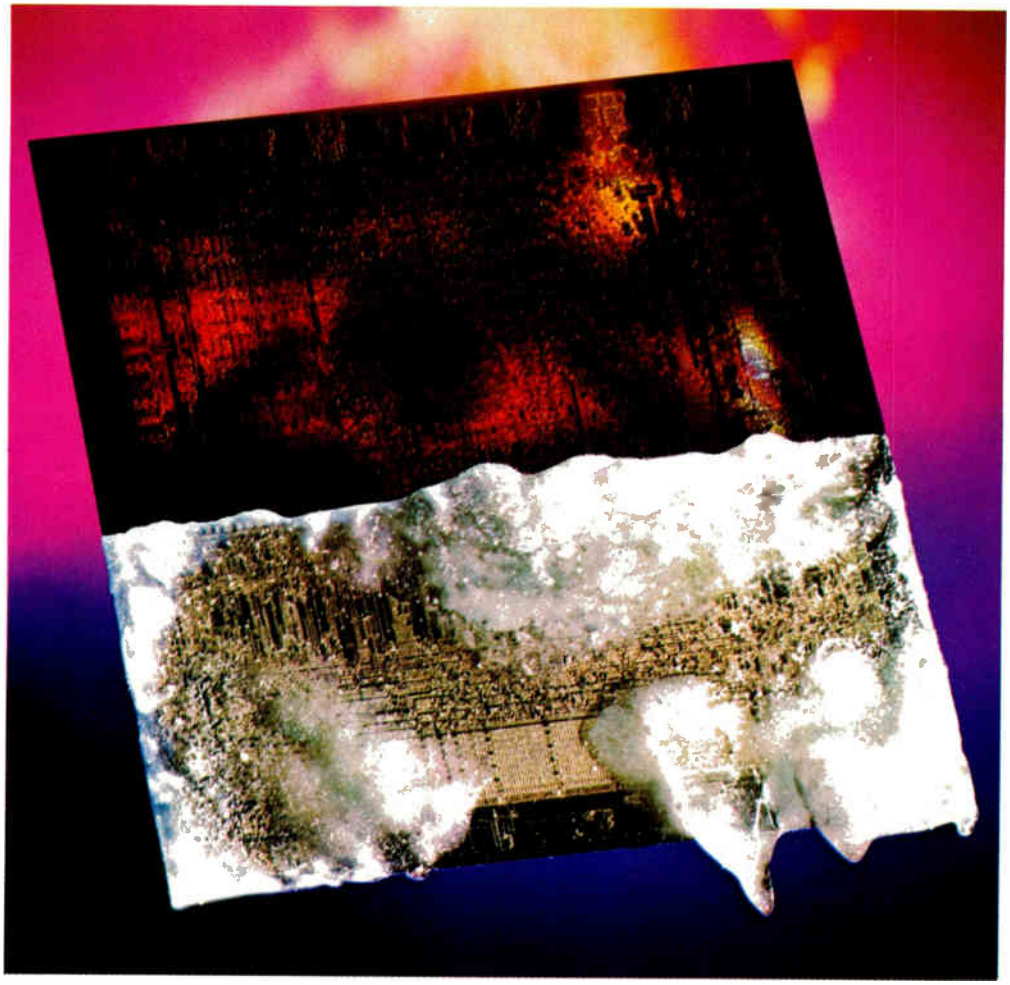
From −55° C to 125° C. Our military temperature range 6800 microprocessors work in the most hostile environments. And at −40° C to 85° C, our industrial versions hold their own too. We even have 1.5 and 2 MHz high-speed 6800s. Today, manufacturers in just about every industry from cars to computers are specifying the 6800. And AMI, a pioneer in MOS/LSI circuits, is making them. With plants in California, Idaho and Korea, we're geared to handle any size order. And we'll go to extremes to get it to you quickly.

Our 6800s beat the 8080 in virtually every important feature. You only have one 5-volt power supply to worry about, and you can hook up to 10 circuits to them without TTL buffering. They have two levels of external interrupt (one is non-maskable), interrupt stacking, an index mode and direct addressing with only two bytes of code.

The AMI S6800 MPU comes with a whole family of memories and peripheral circuits. They include the S6810 128 x 8 static RAM, the S6820 and S6821 PIAs, the S6831 16K static ROM, the S6834 512 x 8 EPROM, the S6850 ACIA, the S1883 UART and the S2350 USRT. And we offer a range of memories, from high-speed VMOS RAMs to low power CMOS.

The 6800 is designed like a minicomputer, so it's simpler to program than the 8080. Especially with our Microcomputer Development Center, which can cut programming time from hours to minutes. It includes a very smart CRT with full debug software, a flexible text editor, a macro-assembler and a built-in PROM burner. A powerful 40-channel Logic Analyzer lets you choose your own layout and format, and modify programs instantaneously.

Want to learn more about our 6800 family? Contact your nearest AMI distributor or write to AMI Microsystems, Ltd., 108A Commercial Road, Swindon, Wiltshire, England. Or phone (0793) 31345 or 25445.



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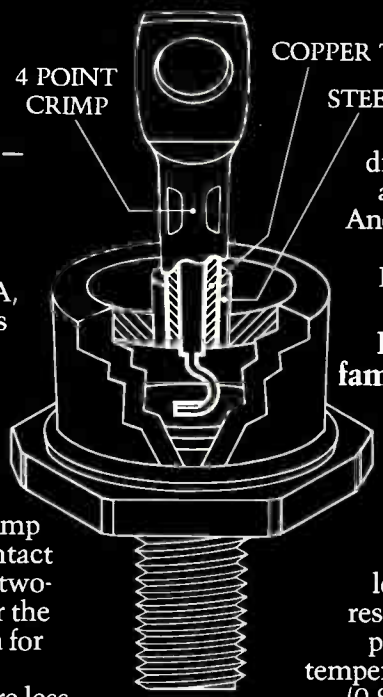

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And since our copper terminals are less rigid than their steel ones, our SD51 family absorbs much of the stress that can often break the glass-to-metal seal during installation.

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Introducing Unitrode's USD545 family of power Schottky rectifiers.

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For more information, just circle the reader service number or call or write: Unitrode Corporation, 580 Pleasant Street, Watertown, MA 02172. Tel. 617-926-0404.

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Semiconductors

Will it work in your switcher?

Transistors for switch-mode supplies are characterized at room and high temperature

Most producers of transistors for switching power supplies fail to provide any high-temperature performance values or, at best, specify only typical values. Thus, designers often are forced to compensate for temperature-induced variations without any precise quantitative data on worst-case limits.

This month, RCA Solid State in Somerville, N. J., joins the ranks of those few suppliers offering transistors fully characterized for switching performance at both room and high temperatures. What's more, its new SwitchMax series has switching speeds nearly twice as fast as those of competitive devices.

The new silicon npn power transistors, types 2N6671 through 2N6678, are specifically designed for aff-line (up to 340-v) switching power supplies, converters, and pulse-width-modulated regulators, according to George S. Scholes, power-distribution market manager for the RCA Corp. division. They include devices with saturated collector currents, $I_C(sat)$, of 5, 10, and 15 A with clamped collector-to-emitter voltages (V_{cex}) of 350 to 450 v and sustaining voltages of 300 to 400 v.

The SwitchMax transistors, says Scholes, "feature high-voltage capability, fast switching speeds, and high safe-operating-area ratings, and are 100% tested for the parameters essential to the design of switching-mode circuits." Switching parameters, including inductive turn-off time (t_c) and saturation voltage, "are tested at elevated temperatures, 125°C for the 5-A devices and 100°C for the 10- and 15-A transistors," as well as at room temperature (25°C), "to provide limit values for worst-case design," he says.

At 25°C, for example, the 5-A transistors have a switching time of 0.4 μs while the 10- and 15-A units switch in 0.5 μs. Similarly, at elevated temperatures the 5-A devices switch in 0.8 μs, while the higher-current transistors have a switching time of 1 μs.

To obtain high-current, fast-speed switching without sacrificing voltage capability, the RCA transistors use a multiple-layer epitaxial-collector/double-diffused structure in which two graded n-type layers are epitaxially grown on a heavily doped n^+ substrate to achieve high second breakdown. Another n-type layer, carefully controlled to provide the desired voltage-breakdown capability, is then grown over the second graded layer to complete the collector structure, explains Leonard H. Gibbons, an RCA division leader on its power-applications technical staff. The impurity dopants diffused to the base region are introduced by ion implantation to obtain a very precisely controlled resistivity into which the SwitchMax fine-geometry emitter pattern is diffused, he adds.

The transistors also employ a trimetal high-conductivity metalization system that permits a designer to solder-mount pellets and clips for ruggedness and, says Gibbons, "still retain a high-conductivity, fine-geometry metalization pattern." The trimetal system "assures low ohmic drops over the metalization and allows metal over oxide to improve current, switching, and second-breakdown capability."

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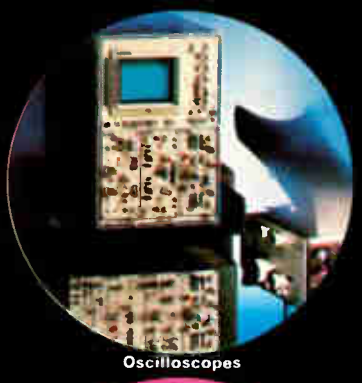
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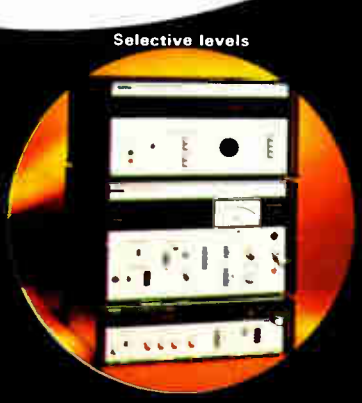
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New products

CA3290 in an 8-pin dual in-line package.
RCA Solid State Division, P. O. Box 3200, Somerville, N. J. 08876. [416]

Schottky-barrier diode senses linear light motion

The PIN-LSC/30D is a Schottky barrier diode with an active area of 1.22 square centimeters. As a light spot moves across this area, it generates current in proportion to the distance from the contact point to the light spot. Thus, linear real-time information is provided regarding both location and movement along a single axis.

The device has a spectral range of 350 to 1,100 nm and a responsivity of 0.55 A/W at 850 nm (peak). It provides a continuous position signal whose accuracy is independent of the light spot's size and is useful for remote optical alignment and vibration analysis applications, among others.

Price of the PIN-LSC/30D is $110.00, and delivery is from stock to 30 days.
United Detector Technology Inc., 2644 30th St., Santa Monica, Calif. 90405. Phone (213) 396-3175 [417]

Power diodes exhibit low forward-voltage drop

The 1N6095-98 series of power Schottky diodes, with dc blocking voltages ranging between 30 and 40 V, are particularly well suited for use with low-voltage power supplies. Forward current rating for the 1N6095 and 1N6096 is 25 A; for the 1N6097 and 1N6098 it is 50 A. All diodes are capable of operating throughout the −65°C to +150°C temperature range.

In quantities of 100 or more, the devices are priced from $3.75 to $5.75. Delivery time is from four to eight weeks.
TRW Inc., Electronics Component Division, 14520 Aviation Blvd., Lawndale, Calif. 90260. Phone (213) 679-4561 [418]

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Circle 213 on reader service card 213

Subassemblies

Supply spans 2:1 input range

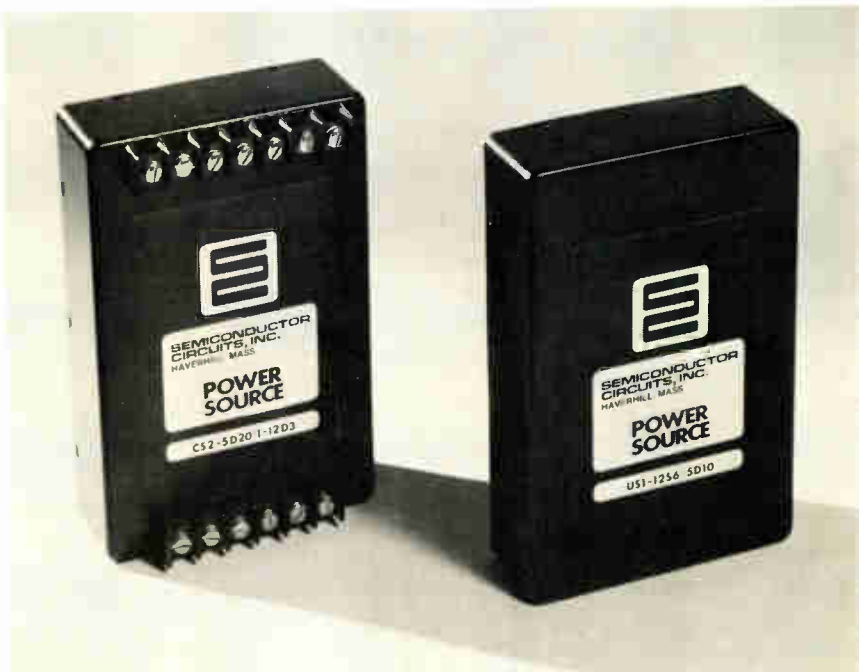
25-W switcher has 75% efficiency; can take both ac and dc inputs

Line-operated power supplies are not usually efficient over wide voltage-input ranges, and many have to be derated in current output above about 40°C. Engineers at Semiconductor Circuits Inc. have attacked both those problems in a new series of units that operate with near-constant 75% efficiency over a 2:1 range of either ac or dc inputs. The US and CS series deliver quadruple, triple or single outputs up to 25 W. Another standard feature is remote shutdown, allowing the user to power down the supply by applying a standard TTL-level logic command.

The encapsulated modules in both series are electrically identical; they differ only in that the US series has bottom mounting pins for printed-circuit-board applications, and the CS series cases are designed for chassis mounting. The US1- and CS1- models accept either 70-140 V ac at 47 to 440 Hz, or 100-200 V dc. The US2- and CS2- models take inputs of either 140-280 V ac or 200-400 V dc. An additional-cost option allows the user to externally connect his supply for operation from 47-to-440-Hz inputs of either 70-140 V or 140-280 V, as well as a dc input of 200-400 V.

The ability to operate from either ac or dc inputs is achieved by replacing the usual power transformer with special input-surge-protected rectifier circuits that interface directly with the prime power source. Says Joseph Perkinson, director of new product development, "These are really high-voltage dc-to-dc converters with a rectifier-filter on the front end that produces the dc from the ac line." He points out that there are several ways to achieve that, and some competitors use a bias circuit powered by a 60-Hz transformer. The transformer, however, automatically precludes operation on dc, wastes space inside the module, and creates heat and inefficiency.

A line-powered or dc-powered primary output switch-mode regulator delivers an overcurrent and crowbar-clamped-overvoltage protected output of either 5 V at 5 A or



If you need a DAC for low-power applications, you probably spend a lot of time looking at power specs.

Our price deserves a second look, too.

Our new MP-7523 is an 8-bit multiplying CMOS D-to-A Converter featuring very low power dissipation — only 12 mW in normal environments. In production quantities, you can get the 7523 for just $2.00 per part.

If you're looking for a low-cost DAC for battery-powered equipment or other low-power systems, the 7523 is hard to beat for price/performance. It uses an advanced thin-film-on-CMOS technology to provide 8-bit resolution with accuracy to 10-bits.

The excellent multiplying characteristics of the MP-7523 make it ideal for a lot of other applications, too. Like ratiometric A/D converters, CRT character generation, low-noise audio gain control, motor speed control and digitally controlled attenuators.

The MP-7523 is presently available only in a 16-pin plastic DIP, rated for 0-70°C. If your application falls within this range, you'll find it offers much better performance than bipolar DACs that cost more than $2.00.

Check the key specs shown below. If they fit your needs, send us the coupon today for a detailed data sheet. If you have an immediate application, contact Standard Products Marketing at (408) 247-5350.

MP-7523 Key Specifications

Linearity*	±½ LSB (±0.2%)
Settling Time	100 nsec
Power Dissipation	12 mW
Feed Through	½ LSB@200 kHz
Multiplying	Full Four Quadrant

*7523 Devices with linearities of ±¼ (±0.1%) and ±⅛ LSB (±0.05%) are available at higher prices.

MICRO POWER SYSTEMS

3100 Alfred Street, Santa Clara. CA 95050 • (408) 247-5350

To: *Micro Power Systems, Standard Products Division*
3100 Alfred Street, Santa Clara, CA 95050 E511

☐ Please send me technical data for the MP-7523 D/A Converter.

☐ I have an urgent requirement. Please have a converter applications specialist phone : ( )_____

Name _____

Title _____

Company _____

Address _____

City/State/Zip _____

☐ Please also send data on your linear CMOS switches, multiplexers and other converters.

Circle 215 on reader service card 215

Guaranteed low noise, wide bandwidth op amps.

Raytheon gives you both in either dual or quad configurations.

Raytheon was the first to offer a true 741-type quad operational amplifier, the RC4136. Now, Raytheon offers the first quad op amp with guaranteed A.C. performance.

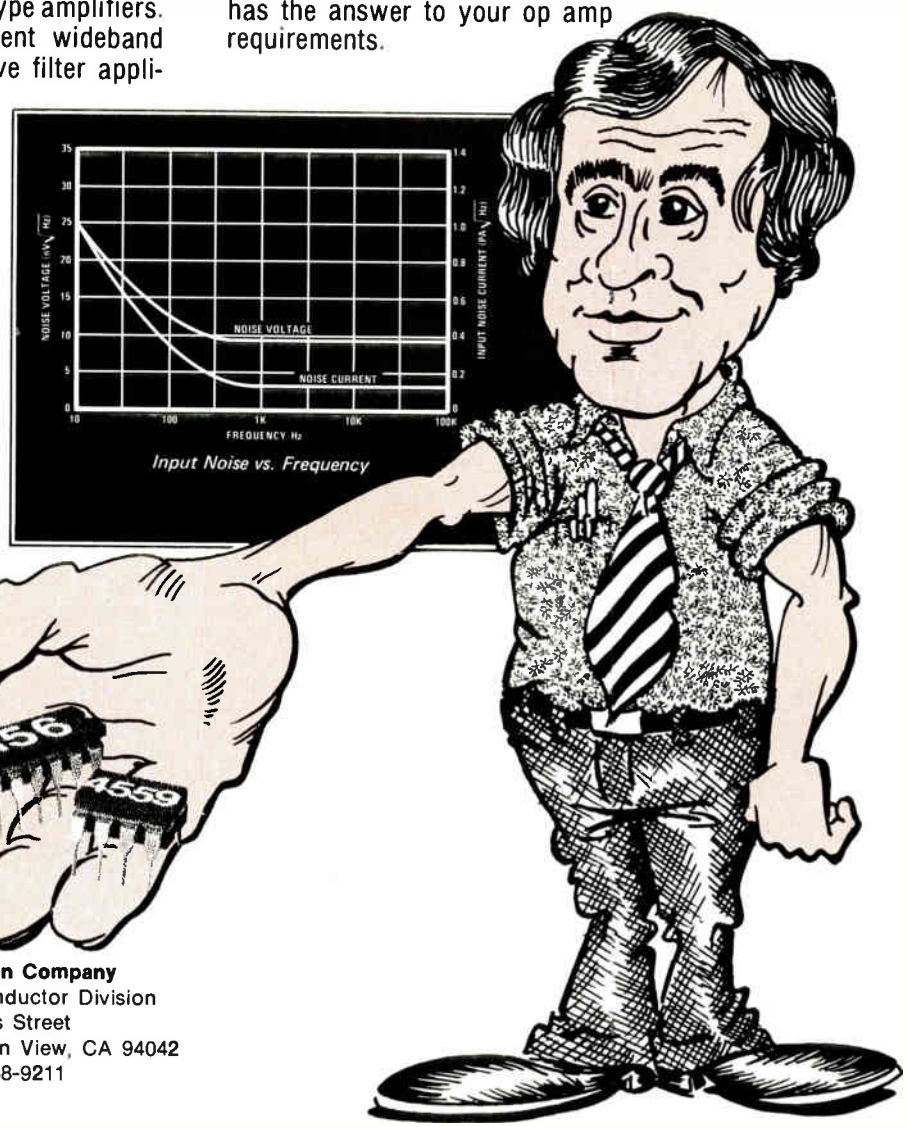
The 4156 quad op amp features guaranteed A.C. performance far exceeding that of the 741-type amplifiers. It offers the design engineer consistent wideband performance for many audio and active filter applications.

The 4559 dual op amp specially designed low-noise input transistors make it ideally suited for use in low-noise signal processing applications such as audio pre-amplifiers.

No other op amp can match the low noise characteristics offered by the Raytheon 4156 or 4559 at non-premium prices.

Check over the table of guaranteed A.C. performance characteristics and you'll be convinced that Raytheon has the answer to your op amp requirements.

Parameter	4156	4559
Unity Gain Bandwidth (min.)	2.8 MHz	3.0 MHz
Full Power Bandwidth (min.)	20 kHz	24 kHz
Slew Rate (min.)	1.3 V/μSec	1.5 V/μSec
Input Noise Voltage (max.) 20 Hz-20kHz	2.0 μVRMS	2.0 μVRMS
Price (100-up) Expoxy-B Dip	$1.68	$.98



RAYTHEON
SEMICONDUCTOR DIVISION

Raytheon Company
Semiconductor Division
350 Ellis Street
Mountain View, CA 94042
(415) 968-9211

Circle 217 on reader service card 217

diode-transistor logic, or 5-v complementary metal-oxide-semiconductor devices. Settling time for the DAC336-8 is 4 μs.

Two DAC336-8 models are available. The DAC336C-8 is packaged in a 16-pin glass DIP for industrial/commercial use and costs $24.00 each. The DAC336B-8 meets MIL-STD-883A, Class B processing requirements, is packaged in a 16-pin metal hermetic DIP, and is priced at $44.00 each. Delivery time for the units is two to four weeks.

Hybrid Systems Corp., Crosby Drive, Bedford, Mass. 01730. Phone Larry Lauenger at (617) 275-1570. [385]

High MTBF feature of SA series power supplies

With a mean time between failures of 100,000 hours and the ability to provide "brownout" protection, the SA Series switching power supplies should prove useful for computer, telecommunication, and other power-sensitive applications. Input voltage changes within the range from 92 to 127 v ac (115 v ac −20%, +10%) or 120 to 165 v dc (150 v dc −20%, +10%) will affect output voltage by a maximum of 0.1% for all supplies except those rated at 25 w for which the maximum is 0.3%. Input frequency

can vary from 47 to 440 Hz.

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Contact Joe Scordato, Product Specialist

Kyocera
INTERNATIONAL, INC.
8611 BALBOA AVE., SAN DIEGO CA 92123
PHONE: (714) 279-8310

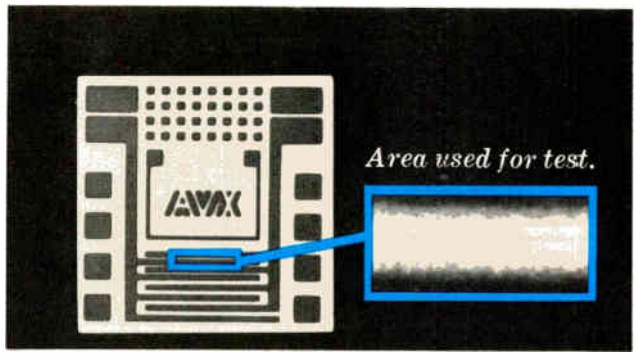
Circle 225 on reader service card

AVX announces the end of silver migration.

Until now, users of thick-film silver conductors have faced a grim choice. When they used a wire bondable silver paste, the silver migrated under voltage and humidity conditions, developing a short between lines. They could buy a silver paste that didn't migrate. But, unfortunately, that paste couldn't be soldered to or wire bonded.

Now, AVX Materials solves both problems with a new palladium-silver series, our products 6050 and 6750. They offer excellent wire bondability and adhesion, high conductivity, good solderability and leach resistance. And, most important, they don't migrate.

Compare the actual test results shown in the photos at left. Then contact AVX Materials Division for complete product specifications. Why make a grim choice. With AVX you can choose the non-migrating silver that fits your exact specifications.



Conventional PdAg conductor.

AVX non-migrating PdAg conductor.

Both materials tested under standard conditions, with 5 mil spaces, 20 VDC, for 20 minutes under water drop.

AVX MATERIALS

AVX Materials Division, 10080 Willow Creek Road, San Diego, California 92131
Telephone (714) 566-9510 TWX 910-335-1547

See AVX Materials at Semicon West, Booth 921
Redwood Building, San Mateo, California,
May 23-25, 1978

Circle 231 on reader service card 231

$3.75

Introducing LOCO II, a new crystal clock oscillator at a new low price.

For just $3.75,* you get LOCO II. The new crystal-controlled, thick-film, DIP oscillator from Motorola.

LOCO II comes in three frequencies—16 MHz, 18.432 MHz and 19.6608 MHz. And these master clock frequencies are divisible to drive μPs and baud rate generators, or a combination of baud rate generators, μPs and LSI chips. All on the same micro-computer board—all from one master clock. Just think of the space that will save.

LOCO II gives you stability, too. It has a rating of ±.05%. That includes calibration tolerance at 25°C, operating temperature, input voltage change, load change and aging. It's the ideal size as well—.820" x .520," with a seat height of .250."

At $3.75, when you get LOCO II, you're getting the right oscillator at the right price.

For price list, rep list and data sheet, call Barney Ill at (312) 451-1000. Or write Motorola, Component Products Department, 2553 N. Edgington, Franklin Park, IL 60131.

*1,000 price. Ⓜ Motorola and LOCO II are trademarks of Motorola Inc.

MOTOROLA INC.
Component Products

See the new Motorola oscillator at Electro 78. May 23-25. Booth #1733.

Circle 233 on reader service card

New products

Packaging & production

PROM program is child's play

For assembly line operation, new unit directs user with traffic lights and sounds

Now that programmable read-only memories are low in cost and commonly used right on the production line, assembly workers need their own easy-to-operate programmers. The laboratory-oriented programmers with their displays, tape recorders, and the like, normally employed by designers to put together prototype systems are much too elaborate for the production front lines.

To meet this need, Pro-Log Corp. has brought out the $1,500 M910, which is not just simple to run, it is downright child's play. The M910 features a traffic light and a tone generator that gives the assembly-line worker clear visual and audible signals indicating go and no-go; the lighting of a green light-emitting diode, plus a simultaneous pleasing tone, means the PROM is programmed acceptably; a red LED, along with a warbling tone, means reject. As a result, the operator gets immediate pass or fail information in an understandable format.

The M910 has four modes of operation, three manual and one automatic, all controlled by the unit's 4004 microprocessor. Operator interface at the panel is purposefully simple—in fact, stark compared with currently available lab-oriented programmers.

Besides duplicating the program from a master PROM onto a blank PROM, the M910 can first check to find out if the latter is actually blank. Once duplicated, the second PROM's program can be compared with the master's for verification. The operator can select any of these three modes exclusively by pushing the "blank check," "duplicate," or

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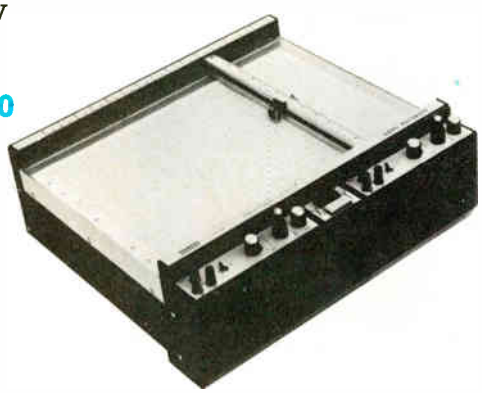

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Circle 117 on reader service card

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These new 24 conductor cables are built to last, too. Semi-rigid PVC insulation and PVC jacket offer good flex life. U.L. recognized self-extinguishing plastic connectors are designed to withstand constant make/break cycling. Contact pins featuring gold over nickel-plated beryllium copper deliver far better conductivity than designs using plain copper. Belden U.L. approved "GPIB" cable assemblies (with metric cadmium plated screws) are available right now in five standard lengths up to 16 m (52.5'). U.L. approved and CSA certified bulk put-ups are also available. Let Belden come through for you. Contact your local Belden distributor or Belden Corporation, Electronic Division, P. O. Box 1327, Richmond, Indiana 47374; 317-966-6661.

BELDEN

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Circle 239 on reader service card

New products

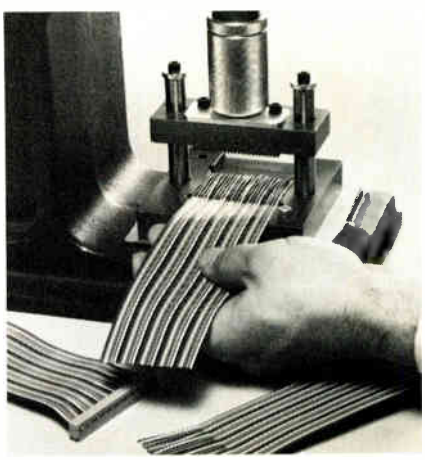
inspection and digitizing process.
Aristo Graphics Corp., 53 S. Jefferson Rd., Whippany, N. J. 07981. Phone (201) 887-2852 [396]

High-volume blower reaches to 30 feet

The model WD300 destaticizer can prevent the build-up of static electricity from a work area for a distance of up to 30 ft. By blowing a cone of ionized air 12 ft in diameter at its widest point, the instrument neutralizes static electric charges that interfere with the assembly, handling, shipping, and storage of microcircuits. Airflow can be switched between 2,000 and 2,550 ft^3/min. The unit measures 20 by 20 by 7 in. and weighs 32 lb. It can be adapted for use on a pivot stand, a roll-about cart, or a window mount. Versions are available for operation at either 110 or 200 v ac. The price is $440, with delivery in three weeks.
Wescorp, 1155 Terra Bella Ave., Mountain View, Calif. 94040. Phone (415) 969-7717 [393]

Splitters cut flat-cable at end or midspan

Two cable splitters for use in the preparation of Scotchflex flat cable are designed for conductor spacings of 0.0425 and 0.0500 inch. Split cables can have their conductors terminated individually or fitted into



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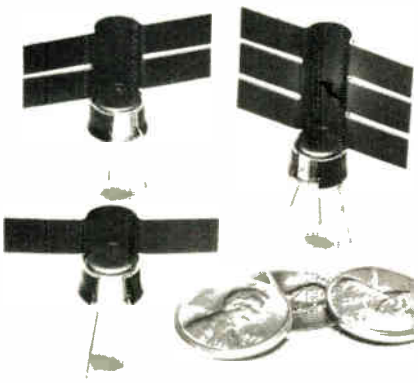


They can be installed after board assembly and are light enough (0.05 gram for the 6201) for use on lead-mounted devices.

Typical case-to-ambient thermal resistances, at a case temperature rise of 75°C are 54°C/w for the 6201 PB, 43°C/w for the 6202PB, and 38°C/w for the 6203PB. The series is offered in anodized finish per MIL-A-8625 Type II. Typical price for the 6201PB is $0.032 each in quantities of 10,000 or more, and each type is available immediately from Thermalloy-stocked distributors, the firm says.

Thermalloy Inc., Dept. M, 2021 Valley View Lane, Dallas, Texas 75234. Phone (214) 243-4321 [398]

Scanner uses CCD cameras to check IC leads

The LS 2000 lead scanner uses a pair of charge-coupled-device cameras and a microcomputer to check the lead-to-lead spacing on most standard dual in-line packages. It saves time and money by separating integrated circuits with bent leads from those that do not need straightening. The scanner, which can process 4,800 units per hour, can handle both plastic and ceramic DIPs with lead spacings of 0.300, 0.400, and 0.600 inch.

Mecel Corp., 1289 Reamwood, Suite B, Sunnyvale, Calif. 94086. Phone David Lempert at (408) 734-0616 [399]

Products newsletter

Intel speeds up 8049 and 8039 by 80% to 11 MHz

As expected, the single-chip microcomputers, 8049 and 8039, originally introduced by Intel as 6-MHz devices have been speeded up to 11 MHz, an 80% improvement. **The new versions will sell for about the same price—about $10 in large quantities.** These members of the MCS-48 family offer a cost advantage over the earlier versions: the designer can use a low-cost 10.7-MHz i-f ceramic filter as a clock source. Main applications will be for high-speed peripheral controllers and line adapters.

More fault-diagnostic muscle built into microprocessor analyzer

The MicroSystem Analyzer originally introduced by Millennium Systems Inc. early last fall has had its ability boosted significantly. With the addition of time-domain analysis capabilities to perform fault diagnosis, the μSA can now isolate faults in microprocessors that are completely dead. It does pulse, interval, and frequency measurement, as well as transition and pulse counting. **But it's no longer necessary for the microprocessor clock to be functioning** because the μSA can analyze the clock, clock driver, and logic circuits, too. The basic unit sells for $1,495 plus $895 for the souped up Sp-1 option, which now adds both signature analysis and time-domain analysis to the instrument.

Motorola jumps into bi-FET product line in a big way

Intent on becoming "a major source for high-technology field-effect-transistor-input operational amplifiers," Motorola Semiconductor has unleashed the first in a series of bipolar FET op amps. **Twelve variations on the basic theme make up the initial offering, and six more are to follow.** One group offers low supply current. Another has somewhat higher supply current but a 5-MHz-gain bandwidth—twice that of the low-current group. A third group offers 20-MHz-gain bandwidth. Hundred-up prices range from $0.75 to $3.50.

Price correction . . .

A typographical error in "How to draw diagrams faster" (March 30, p. 143) inadvertently increased the prices for Second Source Industries' SC-50 graphics drawer. It really is a low-cost system: **the complete setup, including graphics system and plotter, is $16,335**, and the SC-50 with read-only memory, joystick, and add-on memory but without graphics system and plotter is $4,640.

. . . and price changes

Recently announced price reductions include:

*__Corning Glass Works__ has trimmed prices an average of 25% on its line of Corguide optical waveguides.

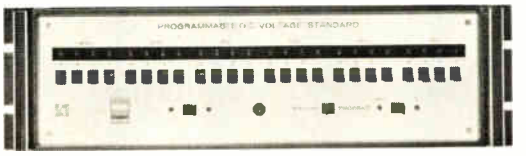
*__Hewlett-Packard__ has instituted an across-the-board cut of $11,000 in the U.S. price in the HP 3000 series of business computers.

*__EECO__ has chopped prices for its D300 and D400 video display terminals by about 15%. The D300 dropped from $1,595 to, for instance, $1,395.

*__Chicago Miniature Lamp Works__ has cut prices up to 40% on certain types of light-emitting diodes in its CM4 series.

*__Norland Instruments__ has lowered tags of its 2001A Waveform Analysis System to $13,150 for the complete equipment package.

The ultimate spec: $1675.



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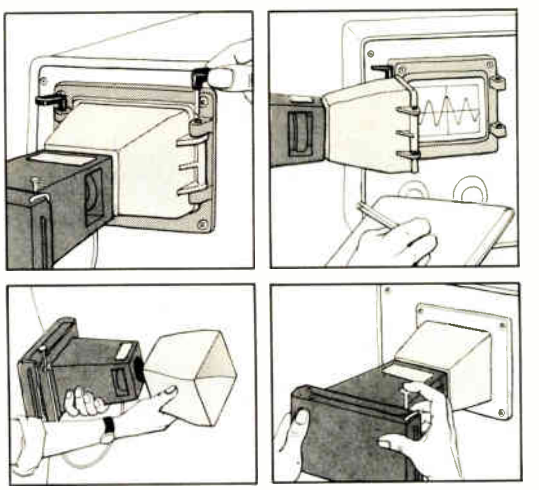

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such parts and equipment. It provides data on the physical and thermal properties and electrical flammability of the materials. Copies sell for $3.50 each or $9.00 for the second edition plus any future revisions that are made while the standard is in effect. Underwriters Laboratories Inc., Attn: Publications Stock Dept., 333 Pfingsten Rd., Northbrook, Ill. 60062

Word- and data-processing supplies. A 48-page catalog describes a wide variety of supplies and accessories for users of microfilm and word- and data-processing equipment. Included are storage, filing and retrieval systems, and microfilm readers and accessories, as well as a dozen ways to store floppy disks. Devoke Co., 3788 Fabian Way, Palo Alto, Calif. 94303 [429]

Thermocouples. A 20-page booklet "Temperature—EMF Tables for Thermocouples" contains all the American National Standards Institute–approved thermocouple-calibration tables as of November 1975. The tables are presented in Fahrenheit and Celsius scales. Also included are calibration graphs, wire codes, extension and compensating wire codes, and error limits. Nanmac Corp., 9–11 Mayhew St., Framingham Centre, Mass. 01701 [430]

Semiconductor mounting. Methods of mounting power semiconductors to prevent unwanted temperature rise and semiconductor damage are discussed in a seven-page application note. It explains how to mount all types of packages—lead-mount, stud, flat-base, and disk. Also covered are thermal-resistance considerations, surface requirements, cleaning procedures, optimum mounting pressures, hardware considerations, and heat-sink recommendations. The note, "Mounting Power Semiconductors," includes diagrams and tables. Semiconductor Divison, Westinghouse Electric Corp., Youngwood, Pa. 15697 [431]

Thermal behavior. The "Microwave Transistor Thermal Characteristics

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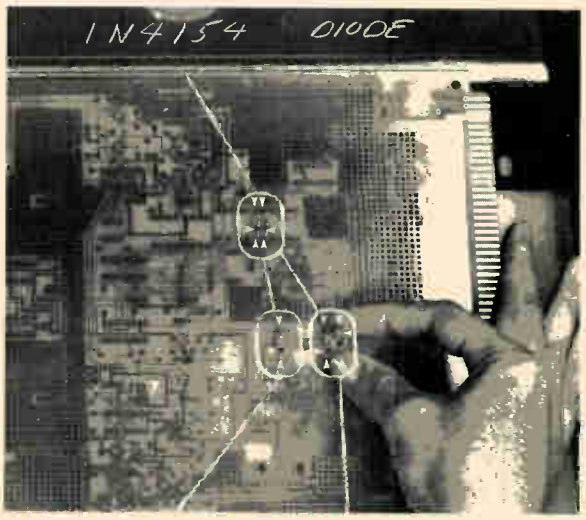

OPERATION

Component images are reflected on a half silvered mirror located above the board. The component images appear directly on the board surface. The operator selects the components from a bin and inserts them in the board. A foot switch cycles the next frame to appear on the mirror until all components are inserted.

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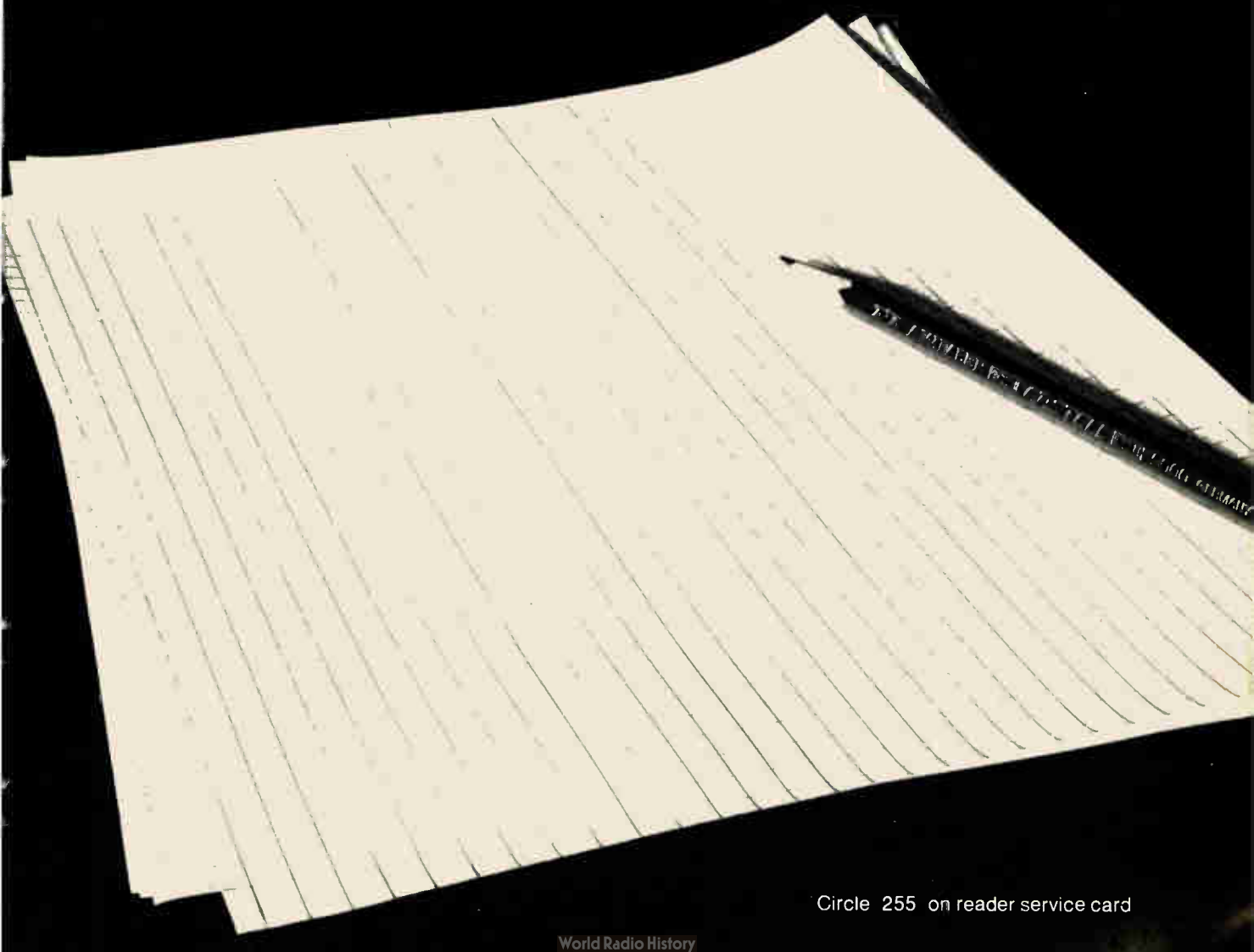

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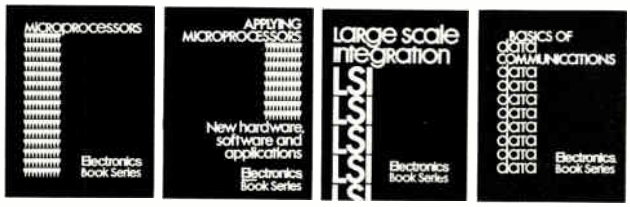

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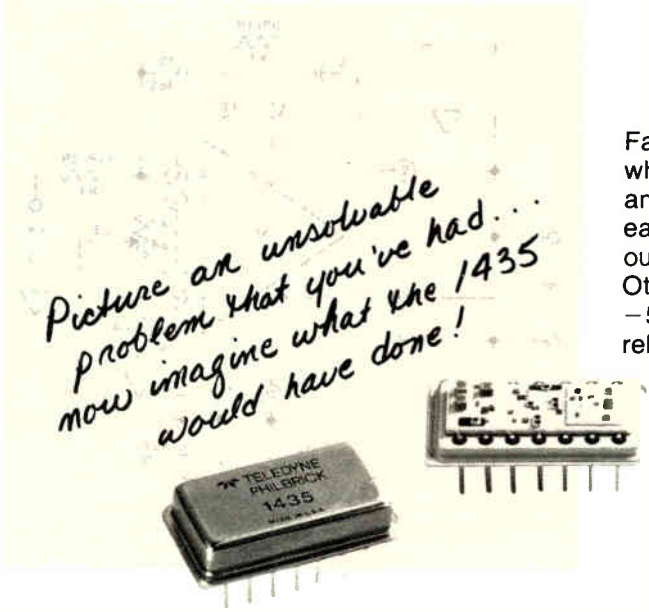

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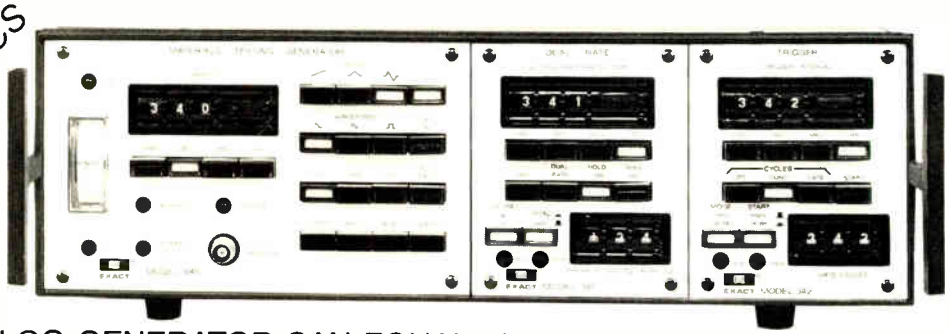

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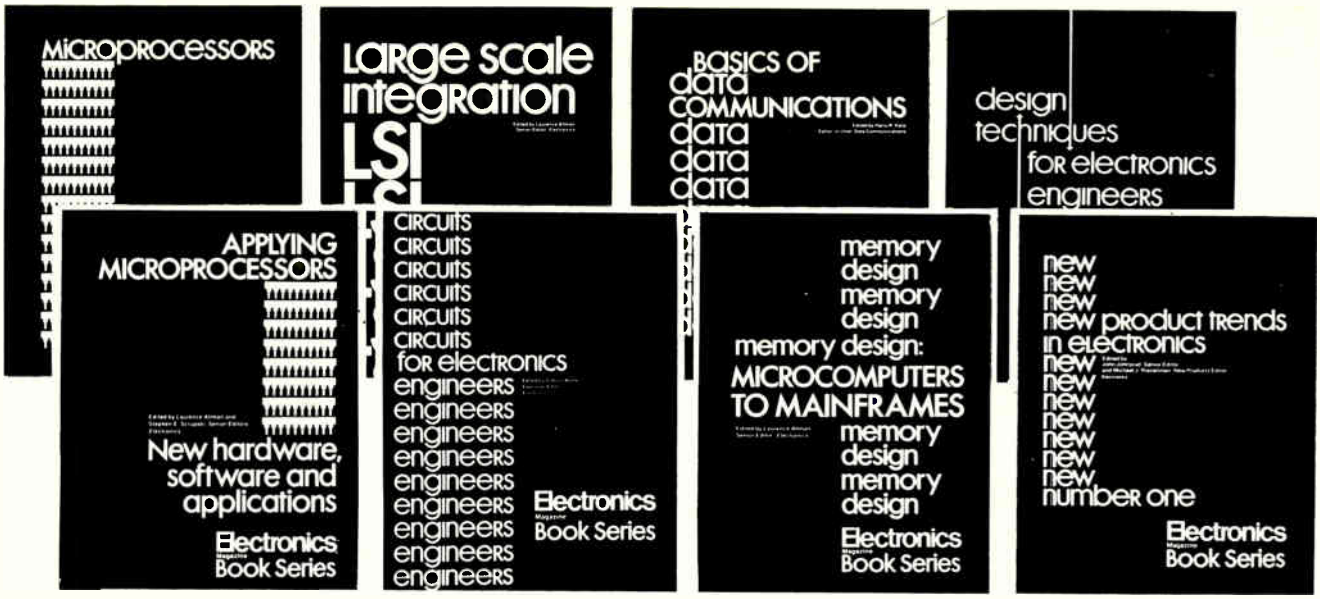

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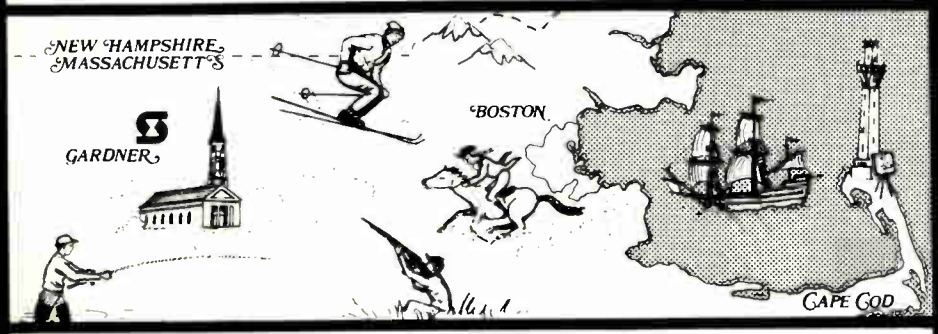

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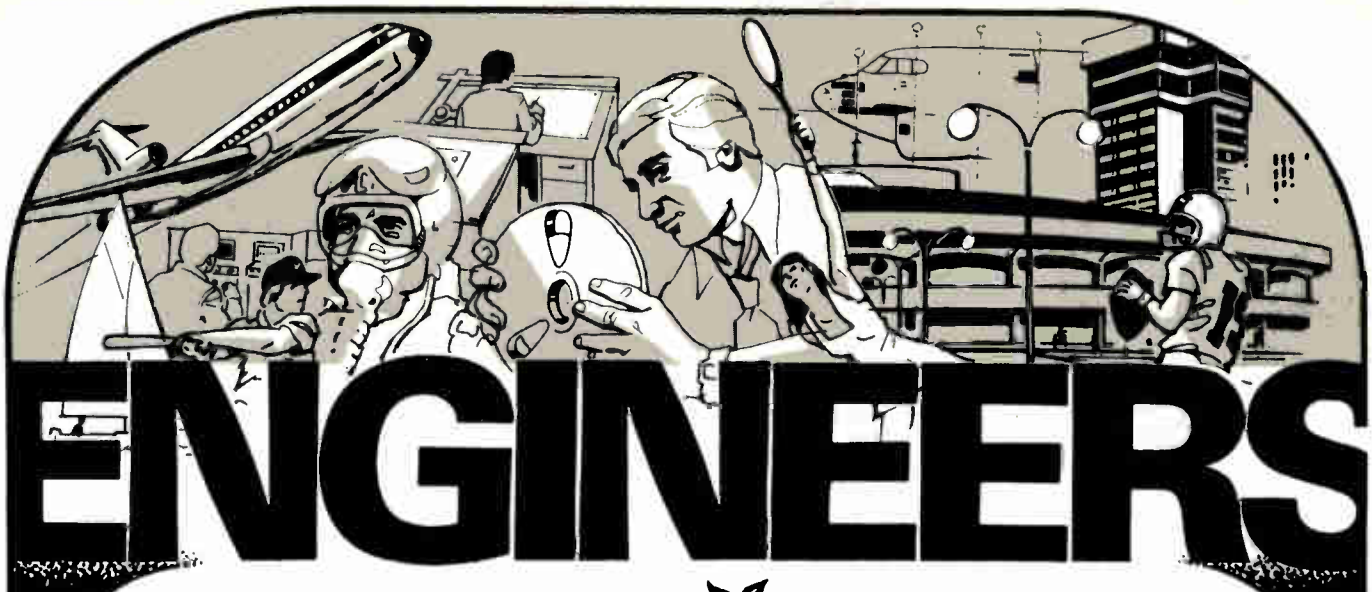

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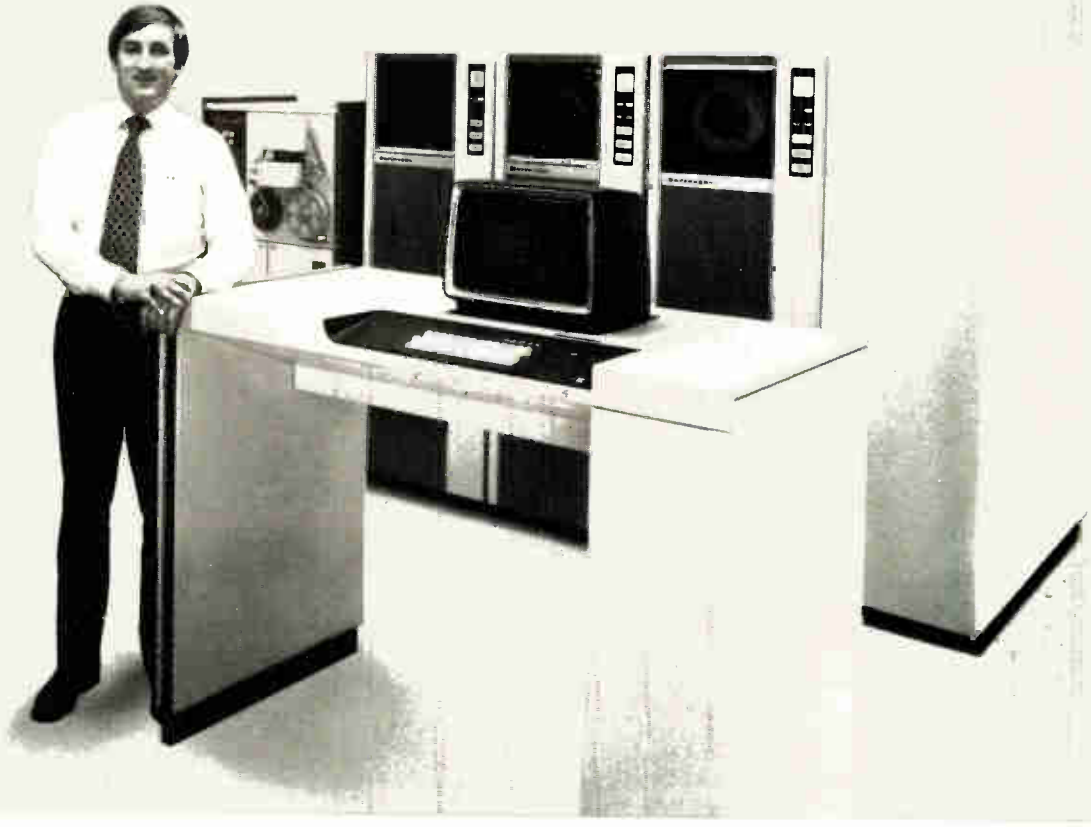

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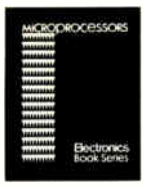

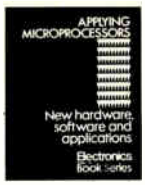

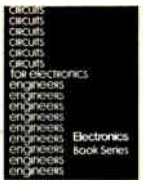

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