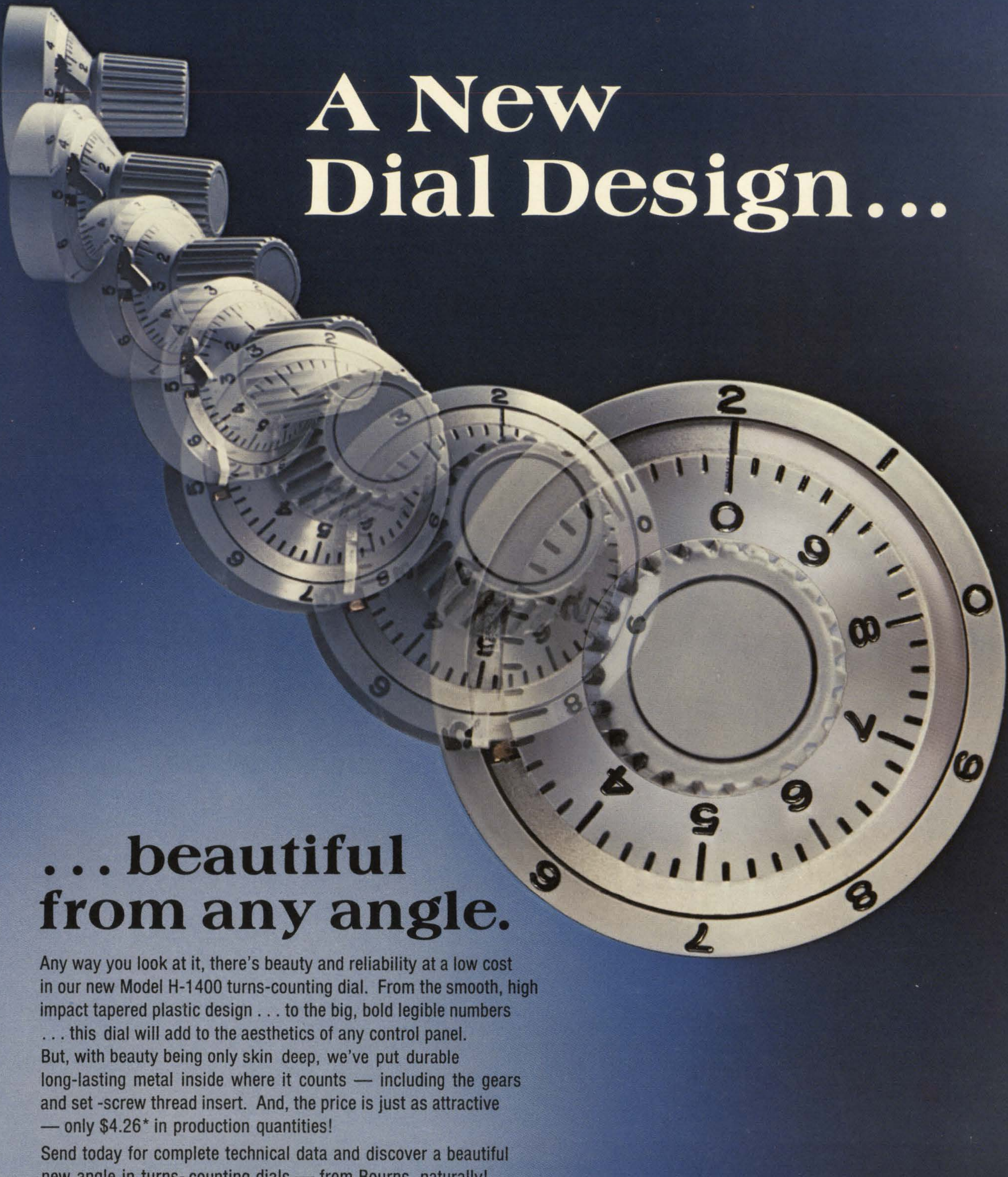
Electronic Design® 12
VOL. 25 NO. 12
FOR ENGINEERS AND ENGINEERING MANAGERS
JUNE 7, 1977

Computers talk with the world, but not always with ease. The main problem lies in nonstandard standards. But there are other problems — and advances. That's true, also, for semi memories, cassette and cartridge recorders, PROM programmers and CAD programs for circuit design. For late developments, see p. 36.

A New Dial Design...



...beautiful from any angle.

Any way you look at it, there's beauty and reliability at a low cost in our new Model H-1400 turns-counting dial. From the smooth, high impact tapered plastic design . . . to the big, bold legible numbers . . . this dial will add to the aesthetics of any control panel. But, with beauty being only skin deep, we've put durable long-lasting metal inside where it counts — including the gears and set -screw thread insert. And, the price is just as attractive — only $4.26* in production quantities!

Send today for complete technical data and discover a beautiful new angle in turns- counting dials — from Bourns, naturally! Direct or through your local distributor.

TRIMPOT PRODUCTS DIVISION, BOURNS, INC. 1200 Columbia Ave., Riverside, CA 92507 Phone: 714 781-5123. TWX: 910 332-1252

*Domestic U.S.A. price only, H1411, without brake.

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For Immediate Application — Circle 130
or for Future Application — Circle 230

Electronic Design

VOL. 25 NO. 12

FOR ENGINEERS AND ENGINEERING MANAGERS

JUNE 7, 1977

NEWS

TECHNOLOGY

PRODUCTS

DEPARTMENTS

Cover: Photo by Steve Grohe, courtesy of Data General Corporation

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64-bit RAM's without aspirin.

Advanced Micro Devices, Inc. • 901 Thompson Place, Sunnyvale, California 94086 • Telephone (408) 732-2400 •
Distributed nationally by Hamilton/Avnet, Cramer and Schweber Electronics and regionally by Arrow, Bell, Century Electronics, Future Electronics and RAE Electronics.

Advanced Micro Devices announces brand new, trouble-free 64-bit RAM's. Am27S02A/3A, the world's fastest. Am27LS02/03, the world's best low-power, high-speed combination. And Am29700/01, the world's only non-inverting 64-bit RAM.

They're a whole new 64-bit RAM family. Rebuilt from top to bottom. No re-hash of eight-year-old designs. Internally compensated ECL circuitry. Optimum speed/ power performance.

Modern LSI process techniques: Two-layer metalization. Ion-implantation. Three-micron EPI. Washed emitters. It's today's TTL RAM technology—designed to run extremely well over military specs. And even better over commercial.

They're cooler and faster.

Cooler and faster than the part has ever been. They're designed with a temperature-compensated regulator system built in for stable performance over supply and temperature variations.

A transparent option is also available at no extra cost. It'll allow you to see the complement of the data in during the write cycle without lowering the part's overall speed.

Everything but the glitch.

The output circuitry is preconditioned so that true data is present at the outputs when the write cycle is completed. There's no "write/ recovery glitch."

We don't take data sheets lightly.

Our new 64-bit RAM's will meet every single spec on those data sheets. And we mean every one.

Here's what you do: Send us your name on your letterhead and the part number you're interested in. We send you two free parts. You throw away the aspirin.

The specs.	THEIR LOW POWER COM'L/MIL	OUR LOW-POWER 27LS02* & 27LS03 COM'L/MIL	THEIR HIGH-SPEED COM'L/MIL	OUR HIGH-SPEED 27S02A* & 27S03A COM'L/MIL
MAX ADDRESS ACCESS tAA	80ns/100ns	55ns/65ns	35ns/50ns	25ns/30ns
MAX CHIP SELECT ACCESS tpZH/L ($\overline{CS}$)	60ns/80ns	30ns/35ns	17ns/25ns	15ns/20ns
MIN WRITE PULSE WIDTH tpw ($\overline{WE}$)	80ns/100ns	45ns/55ns	25ns/25ns	20ns/25ns
MAX WRITE RECOVERY tpZH/L ($\overline{WE}$)	80ns/100ns	30ns/35ns	35ns/40ns	20/ns25ns
MAX POWER SUPPLY CURRENT	25mA/25mA	35mA/38mA	110mA/110mA	100mA/105mA

NOTES: COM'L = 0°C to 75°C V_{cc} = 5v ± 5%
MIL = −55°C to 125°C V_{cc} = 5v ± 10%

*open collector output

Advanced Micro Devices

Bipolar LSI. N-channel, silicon gate MOS. Low-power Schottky.
Multiple technologies. One product: excellence.

CIRCLE NUMBER 14

Across the desk

Wage busting: more than a matter of perspective

Assuming you have quoted Edward Leeson accurately in your article on wage busting (ED No. 4, Feb. 15, 1977, p. 26), I find it inconceivable that Leeson would be appointed executive director of any organization more prestigious than, perhaps, a motorcycle gang.

His inappropriate language notwithstanding, Leeson's mind deviates down curious paths of logic. He faults the concerned engineer because "they can't seem to live in a free enterprise system." Yet, he seems to find nothing at fault with 16 industrial organizations, which supposedly compete within the same system, finding it necessary to form an industrial union that parades under the flag of an "industrial council"—the National Council of Technical Service Industries. Evidently, a need was felt to unite in order to agree privately on the best way to do business with the Government.

Leeson has also concluded that loss of respect for engineers who want to organize might be forthcoming. The companies have already telegraphed their "respect" in no uncertain way. Leeson throws in the matter of seniority. According to your article, that word seems to be quite elastic and, under the circumstances, little more than amusing.

It would be interesting to have Leeson explain exactly why a floor sweeper is entitled to less respect than an engineer—or for that matter himself.

The best way to keep the Government out of the wage picture is to eliminate the conditions that would make this solution attractive—conditions created by the members of NCTSI that they knew, when they bid, are patently unfair and totally unconscionable. But it is highly doubtful that the chief executive officers of the firms mentioned are aware of all the details of the existing problem and even more doubtful that they are aware of the official position of the NCTSI, as expressed by Leeson.

Peter L. Krohn
170 Shawnee Ave.
Easton, PA 18042

Wage busting not limited to a few companies

Thank you for your timely article on wage busting. It was comprehensive, and portrayed the plight of many engineers in service contracts. However, I feel that using company names rather than simply "contractor" did not enhance the article, but made it appear that the problem rests with a few particular companies. This is eminently untrue, and the sole purpose of the movement started by the coalition of Aerospace Professional Employees, and subsequently joined by IEEE, is to correct the problem by legislation in Washington, and was never intended to denigrate employers.

I purposely avoided company names when testifying before the Senate hearings last May at Merritt Island, FL, but substituted "previous contractor" and "present contractor," which were duly recorded in the Congressional record.

Alleviating the wage-busting problem transcends companies, or even NASA and the Air Force, since the practice of awarding contracts to the low bidder is a dictate they all must follow—and companies must bid low to win, as pointed out in your article.

Charles O' Neal
Senior Engineer
Planning Research Corp.
Kennedy Space Center, FL 32925

Wage busting is not the real issue. . .

Your article on wage busting correctly points out that wage busting has

(continued on page 8)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St., Rochelle Park, NJ 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld upon request.

Across the desk

(continued from page 7)

occurred among professionals. However, an important point not stated is that forced reduction of the salaries of professional persons performing essentially the same duties (as the result of recompetition) has not occurred on service contracts in several years. While I cannot speak for the federal government, my discussions with federal officials assures me that wage busting of professionals in any future recompetitions will not be tolerated. Therefore, it would seem that anti-wage-busting legislation is the right issue but at the wrong time.

A natural retort to this statement might be, "If wage busting is wrong, why not outlaw it, whether or not it is likely to happen?" Unfortunately, HR 314, the proposed bill to bring professionals under the Service Contract Act of 1965, does not simply outlaw wage busting. Instead, HR 314 requires salaries be regulated by the U.S. Department of Labor. Many knowledgeable people on Capitol Hill believe that wage busting is only the emotional, "up front" issue, with the real goal of HR 314 being to raise service-contract salary costs enough to equal the salary costs of civil servants if they were doing the same work. From there, it is a relatively easy step to terminate all service contracting in favor of a total in-house effort by "big government."

Just as I cannot speak for the government, I cannot speak for all contractors. However, the major push for HR 314 is coming from Brevard County, Florida. My company, PRC Systems Services Company, is a major employer of professionals under service contracts in that county, with a major design-engineering contract at Kennedy Space Center. We recruit nationwide for our Florida project, and we pay professional salaries that compare favorably with data published by such prestigious bodies as the Engineers Joint Council.

Although we pay nationally competitive salaries, it would be unrealistic to expect that every one of our engineers considers himself fairly compensated. Indeed, we know that a few of our employees are not paid at the level they commanded in the halcyon days of Apollo. We believe that, compared with others on the basis of relative productivity, they simply are not worth their former salaries. It would be naive to expect them to agree.

A most unfortunate result can be predicted from HR 314 if it becomes law. If a company must pay a salary to any individual that is higher than management believes he or she is worth, then the company is going to look for a replacement it considers effective at the legislated salary level. The end effect will be that, in the main, those individuals who are pushing for HR 314 will be laid off precisely because of HR 314.

I, for one, find it difficult to see the positive contribution of a law that forces unemployment among the lesser qualified, less effective engineers in Brevard County, who will be replaced by technical expertise imported from out of the state.

If wage busting is the real issue, then we are prepared to support an executive order or, if need be, legislation that outlaws wage busting. In fact, we heartily endorse HR 4873, proposed by the National Society of Professional Engineers, which, if it became law, would accomplish that end.

George E. Monroe
President

PRC Systems Services Co.
7600 Old Springhouse Rd.
McLean, VA 22101

Wage busting is the real issue

Mr. Monroe states incorrectly that if bill HR 314 is passed, the Department of Labor will then regulate the salaries of professionals. The Department of Labor Survey, a survey of professional, administrative, technical and clerical pay, better known as the PATC, lists the salaries of over 340,000 engineers who are employed by "free enterprise" firms throughout the United States. The PATC survey has been described as excellent by the Chairman of Surveys of the Engineering Manpower Commission, an "industry management"-dominated commission of the Engineers Joint Council.

Another myth is that engineers' salary costs would become equal to the costs for civil servants. This is absolute nonsense! The fringe benefits for government employees lie in the area of 70% of their salaries while the national norm for private industry lies in the area of 30%. What's more, contracts becoming an in-house effort by "big government" is a myth as well. Private industry has more flexibility in coping with changing work situations than the government. Work efficiency is higher in private industry than in government —it is next to impossible to fire an incompetent civil servant. The Office of Management and Budget's policy, OMB A-76, is to rely on private enterprise to perform service contracts.

As to the claim by Mr. Monroe that his company's wages are competitive, I ask him to tell how many of his senior engineers are making $13,500 to $16,500 per year. With over 10 years' experience, they should be making $23,000 or better.

If, as Mr. Monroe states, he is employing incompetent engineers, I must express my outraged indignation as a taxpayer.

As for the NSPE bill, HR 4873, IEEE lawyers have examined it and recommended that IEEE not support it in its present form—it doesn't employ a third party to see that engineers are being paid their proper worth. Engineers can still be paid low salaries on a new contract. The bill has absolutely no teeth to enforce the proper payment to engineers, because it leaves the wage decision to the procurement officer.

Mr. Monroe states that the major push for HR 314 is coming from Brevard County, Florida—my colleagues from Huntsville, Alabama would disagree, I am sure. Wage busting is going on throughout the country on service contracts. In fact, the most recent instance to come to our attention is at Fort Huachuca, Arizona.

The knowledgeable people on the Hill know that by Mr. Monroe's definition, an engineer who is laid off when the contract runs out and then rehired by a new contractor for substantially the same work for less money is not considered wage-busted. These fair-minded people say it is wage busting.

The IEEE has informed me that Mr. Monroe has submitted a bill to them that will amend the Service Contract Act of 1965 by extending its coverage to professional employees. A clause would give the Secretary of Labor the same authority to enforce the provisions of the new bill as he has in the "blue collar" and "white collar" bill. This is indeed encouraging, for I have no desire to be in an adversary position with any contractor. I am certain we can accomplish much more if we work together.

I conclude by pointing out that everyone is covered by the umbrella of the Service Contract Act except the

(continued on page 19)

MEASUREMENT COMPUTATION news

product advances from Hewlett-Packard

JUNE 1977

The new 5004A Signature Analyzer displays a hexadecimal signature unique to a data node in one of HP's new products designed for troubleshooting using the signature analysis technique. This technique allows building economical component-level servicing into new products.

in this issue

Signature analyzer simplifies microprocessor system servicing

Few, indeed, are the electronic product areas untouched by the microprocessor revolution. But despite the benefits of microprocessors, the question arises, "How will the products be serviced?" Swapping defective modules for good ones creates inventory and handling costs. HP now offers a timely, more economical alternative—**signature analysis**, for servicing down to the component level. It even eliminates the need to design the product as a modularized one, in some cases.

(continued on third page)

Trace serial data with parallel-mode logic analyzer

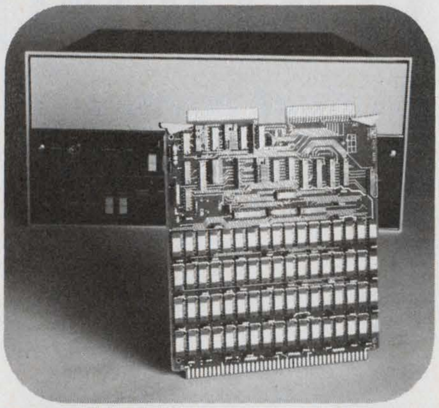
A new serial-to-parallel converter now makes it possible to use the measurement capabilities of HP's 1600A and 1607A Logic State Analyzers for the serial data domain. This accessory, the 10254A, accepts data in serial form and formats it into a parallel word for presentation as one line on the logic state analyzer's tabular display. Just as with parallel data, the logic state analyzer can be set to capture and display the data sequence beginning with a particular word, or data leading up to the word, or data at some point downstream from the word, enabling the user to find the part of the program where malfunctions occur.

If both the 1600A and 1607A are being used at the same time, with the 10254A converter, both serial and parallel data can be displayed in two tables on the 1600A display.

For more details, check B on the HP Reply Card.

The 10254A serial-to-parallel converter (lower unit) interfaces the HP 1600A logic state analyzer (upper unit) to serial data streams so serial data flow occurring at a node or on a bus can be presented as a table of binary words on the logic analyzer's display.

Cache speed memories at semiconductor prices



The addition of high-speed semiconductor memory options to the 21MX-E Series computer results in up to 30% overall system performance increase over previous memory modules.

In the time it takes light to travel 100 meters, an HP 21MX E-series computer with new high-speed memory can retrieve information and be ready for another access!

A major contribution to this speed is the new N-Channel MOS/RAM memory. New 4K RAMs cycle in 320ns.

The new structure of the HP 2102E controller has almost eliminated its time overhead. Cycle time of the system then is 350ns, almost equivalent to that of the chips.

To ensure reliability, all memory parts and boards undergo vigorous burn-in and proprietary diagnostic tests to discover and correct faults that would not have otherwise been detected.

The new HP 12741A memory modules meet stringent environmental specifications, i.e., 0-55°C, up to 95% humidity, plus tough shock and vibration tests.

Available in 32-kbyte modules, the new 350ns memory may be ordered with 21MX E-Series computers, all HP 1000 Systems and 2126A DisComputers. Because HP offers full asynchronous interface with memory, field retrofit is possible; a change of controller is necessary.

With a memory cycle time at 350ns, the new memory exceeds that of many cache memory schemes, without the usual associated high cost.

Check D on the HP Reply Card for further information.

HP 7920—the disc that doesn't keep your CPU waiting

The new 50 megabyte (formatted) HP 7920 disc has some of the fastest access times in the minicomputer industry. Seek times—track to track—are 5 ms, averaging 25 ms, worst case is only 45 ms.

Designed with a light carriage/rail system for lower mass, and a linear voice coil motor with high force inputs, higher accelerations are possible and therefore greater speed.

Speed in stopping and accurately positioning the head is equally important. High-speed feedback circuitry, deriving a signal directly from the surface of the disc, allows optimization of over-shoot and settling times.

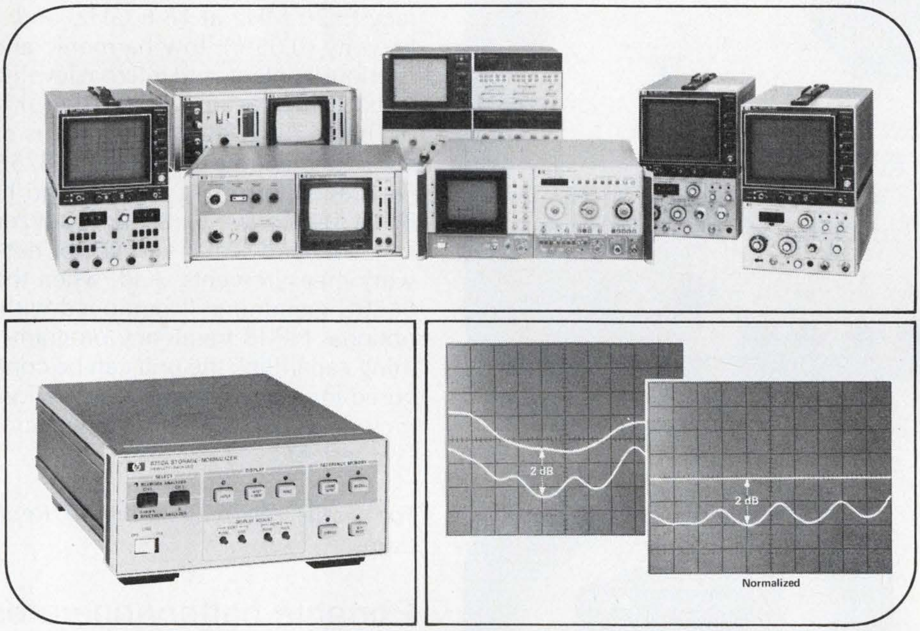
Reliability is also designed into the discs. The Error Correction Code hardware and algorithm are together capable of correcting one single-burst data error per sector, if the error is of length ≤ 32 bits. For burst errors of >48 bits, 99.999% are detected.

A dual filtration system of the HP 7920 contributes to reliability by removing 99% of particles 0.3 microns or larger. Also, in the event of a blackout or circuit break, an emergency head retract prevents head crashes.

For further information, check O on the HP Reply Card.

The addition of the high-speed HP 7920 disc to a 256k byte HP 3000 Series II computer results in a 20% improvement in system response time in interactive sessions and a 30% improvement in throughput.

Enhance swept measurements with digital storage and normalization



HP network and spectrum analyzers (top) gain additional accuracy, measurement speed and operational simplicity when the HP 8750A storage-normalizer (lower left) is used with them. In the example shown, test system frequency response variations are easily removed through normalization.

Here are some advantages the new HP 8750A Storage-Normalizer, a versatile accessory instrument for HP network and spectrum analyzers, can bring to swept measurement applications:

Remove frequency response errors—calibrate the test system's response and store it in the 8750A's memory. Then, subtract it from the measured data for increased display accuracy (i.e., a "normalized" measurement).

Flicker-free slow sweep measurements—response of narrowband devices requiring very slow sweeps is displayed fully and brightly because measurement data are displayed from memory at a fast rate with continuous memory refresh.

Direct comparison measurements—instead of having to scale deviations between two traces, the deviation itself can be displayed in a single, calibrated trace.

The 8750A is directly compatible with current model HP network analyzers and several HP spectrum analyzers, (existing models can be retrofitted). Even instruments not directly compatible, such as HP 140 series spectrum analyzers, can be used by adding a simple low-frequency oscilloscope for the digitally stored and/or normalized display.

The 8750A can "freeze" CRT displays for simplified photography. X-Y recordings are also easily made because plots all made at an automatic 30 second rate, independent of actual test system sweep speed.

Performance details, applications ideas, and instrument compatibility information are all in the 8750A data sheet. For your copy, check R on the HP Reply Card.

Understanding and measuring phase noise in the frequency domain

Hewlett-Packard's new Application Note 207 describes the theory and practice of making phase noise measurements from 5 Hz to 13 MHz from the carrier. Emphasis is placed on the correction factors required for making noise power spectral density measurements with wave and spectrum analyzers. Examples are given for both manual and automatic measurements.

For your free copy, check S on the HP Reply Card.

Troubleshoot complex microprocessor-based circuits

(continued from first page)

Signature analysis is based on the time-honored technique of signal tracing. HP's Model 5004A Signature Analyzer converts lengthy bit streams in the product into short, four-digit hexadecimal "signatures" when its requirements are designed into a product. By tracing signatures—good and bad—through the circuits, the faulty component can be isolated rapidly.

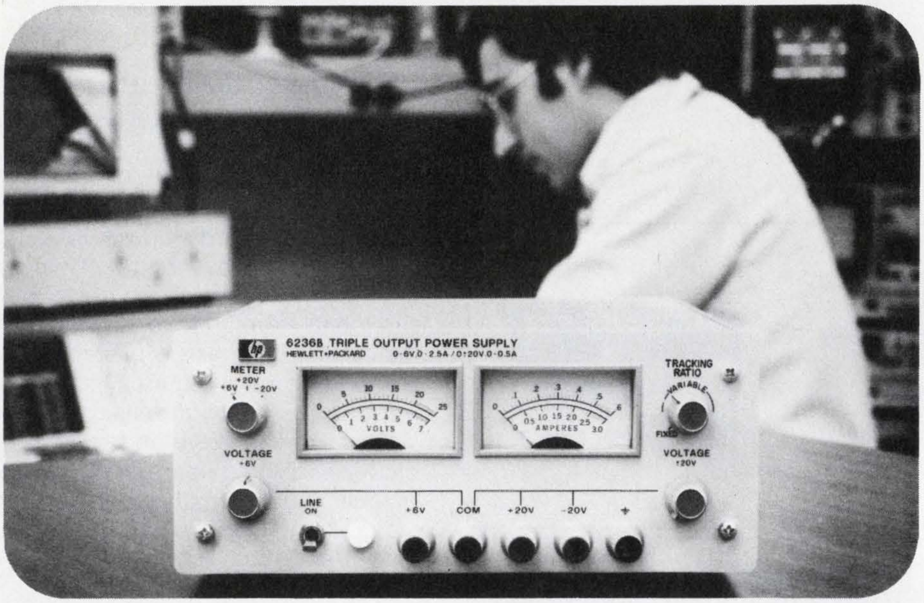
Here are some benefits:

- Increases product's value to user by lowering cost of ownership.
- Lowers warranty costs.
- Lowers material costs since product needs not be modularized for servicing purposes.

We've made a major commitment to this time and money-saving technique ourselves: the majority of HP's new microprocessor-based products are being designed for service using signature analysis, and several of them are already on the market.

Look into the 5004A signature analyzer's cost savings now. Check H on the HP Reply Card.

New triple output power supplies for use in microprocessor systems



New power supplies include the 6236B and 6237B (above) for operating microprocessor systems during the product design stage, and (shown below) the 62312D OEM modular supply for equipment component use.

Triple output supplies give you operating voltages for most microprocessor systems in one convenient package. HP offers two new triple output laboratory supplies for your system development work, and a new triple output OEM modular power supply for use in end-product equipment.

Models 6236B and 6237B, designed for lab use, offer fully metered, adjustable wide-range outputs with convenient operating controls. The 6236B main output is 0 to +6V at up to 2.5A, while the 6237B is 0 to +18V, at 1.0 A. Both have adjustable plus and minus outputs of 0 to 20V at 0.5A.

When operated in the fixed tracking mode, the dual outputs match within 1% as a single voltage control sets both. Switching to the variable tracking mode allows the negative output to be separately set lower than the positive one, yielding three different output voltages. All three outputs are fixed current limit protected.

The new HP 62312D triple output OEM modular Supply is specifically designed as a complete component unit for powering microprocessor systems in end products. All outputs are independently adjustable and isolated from each other and the chassis, providing a wide selection of voltages and

polarities from one basic model for a variety of systems. The main output is rated at 4.75V to 5.25V at 3A, while the other two each range from 4.75V at 0.38A to 12.6V at 0.6A at up to 40°C. The supply may be operated up to a 70°C ambient with current derating. It also features remote programming terminals to control the main 5V output for margin testing.

Protection features include an internal AC fuse, fixed foldback current limit and standard over-voltage protection on the main 5V output (optional on the other two outputs).

For more information on triple output laboratory supplies, check M on the HP Reply Card.
For information on the OEM Modular supplies, check L on the card.

Higher power, wider coverage with new microwave sweeper plug-in

At least 10 milliwatts of leveled output power over the frequency range from 2 to 18.6 GHz is what you get with the new HP 86290B RF plug-in for the HP 8620C Sweep Oscillator. You also get excellent frequency accuracy (±20 MHz at 18.6 GHz) and linearity (0.05%), low harmonic and spurious content, and internal leveling to ±0.9 dB over the full 2 to 18.6 GHz.

The 86290B/8620C Sweeper is directly compatible with the HP 8755 Frequency Response Test Set and HP 8410 Microwave Network Analyzer for wideband scalar and vector network measurements. And, when the 8620C mainframe is equipped with optional HP-IB frequency programming capability, the unit can be configured for many versatile applications, including a 2-18.6 GHz frequency synthesizer.

For details, check Q on the HP Reply Card.

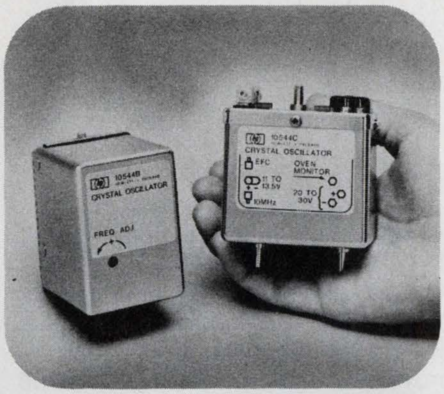
Portable battery-operated calculator delivers a printed record

The HP-91 scientific printing calculator provides you with a full range of scientific and arithmetic functions—complete with a printed record—all in one compact calculator. And because the HP-91 prints and operates on AC or its own built-in batteries, you can use it anywhere—in the office or the remotest field locations.

For more information, check A on the HP Reply Card.

Thermal printing system can print—with labels—statistical summations, contents of the operational stack, or the contents of all sixteen addressable memories.

Two compact quartz oscillators rival performance of lab units



HP's new oscillators are particularly useful in communication and navigation systems and instruments such as counters, synthesizers and analyzers.

Two new 10 MHz compact component oscillators offer outstanding frequency stability, spectral purity and aging rate as well as ruggedness and fast warm-up at moderate prices.

They were designed to meet the high performance standards and time base requirements of several new HP instruments.

Key specifications include:

Aging rate: <5 parts in 10^{10}/day
Phase noise: >150 dB for > 1 kHz offset
Warm-up: 5×10^{-9} of final in 20 min.
Temperature co-efficient: $<1.5\times10^{-8}$ change for −55°C to +71°C range

Short term stability	Averaging time
1×10^{-8}	10^{-4} sec.
1×10^{-9}	10^{-3} sec.
1×10^{-10}	10^{-2} sec.
1×10^{-11}	10^{-1} to 10^{1} sec.

Size: 72×52×62 mm

Magnetic and gravitational field performance are also specified.

The two models are 10544B and C. The main difference is the connectors: Model B has a printed circuit connector board; C has filter feed-thru terminals for power connections and a snap-on RF connector for the 10 MHz output. Model C also has provision for shock mounting.

Check C on the HP Reply Card.

New Coaxial and Waveguide Catalog and Microwave Measurement Handbook

The new 1977-78 edition of the popular **MICROWAVE CATALOG** is now ready for RF and Microwave engineers. Intended for design engineers, production test personnel, quality assurance and metrology labs, the catalog contains 84 pages of product descriptions on over 300 microwave measurement accessories. Product sections include attenuators, detectors, couplers, filters, power sensors and many more.

Over 20 pages are devoted to a **MICROWAVE MEASUREMENT HANDBOOK SECTION**, summarizing common scalar measurement techniques of attenuation, impedance, power, frequency, and noise figure in coaxial and waveguide systems. Measurement tables offer comparison of accuracy vs cost for common measurements; equipment selection tables list model numbers needed for specific measurements by band, and important characteristics of products are described.

For your free copy, check U on the HP Reply Card.

Fast, on-line capacitor testing in inspection and manufacturing

With front-panel thumbwheel switches, high and low limits can be set for fast testing of capacitors.

For high-speed GO/NO GO measurements on the production line or during inspection, two new C meters check capacitors to 0.1% accuracy.

Both the 1 MHz Model 4272A and the 1 kHz Model 4273A are capable of 8 measurements per second.

With the 4272A, capacitors from 10 pF to 1000 pF full scale are measured to 0.001 pF resolution. Using the 4273A, capacitors from 100 pF to 10 μF full scale are measured to a resolution of 0.01 pF.

Go/no-go indications on the front panel are also available at reed relay and TTL outputs on the rear panel. A digital output for digital printers is also available for hard copy.

For more information, check F on the HP Reply Card.

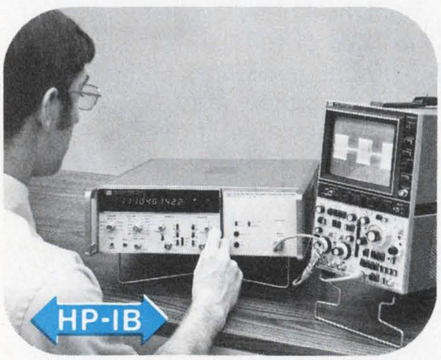
of Hertz and Gigahertz
...part 3 in a series

The super performance counter

When your needs exceed the capabilities of the best of universal counters, consider a super performance unit such as HP's 5345A. It has a range of dc to 500 MHz, 20 mV sensitivity, sub-nanosecond gating throughout, and also gives you:

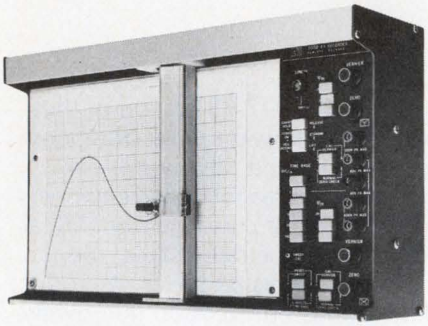
- reciprocal counting for greatest resolution per given gate time.
- time resolution of 2 ns for single shot events and 1 ps for repetitive events via time interval averaging. HP's unique jittered clock ensures accurate averaging for all input repetition rates.
- external gate times down to 20 ns. This, plus the 5345's high accuracy for brief gates, permits frequency profiling within a burst or characterizing rapidly swept cw signals.
- frequency averaging for greatly increased pulsed RF resolution.
- superb measurements to 4 GHz with the 5354A Auto Frequency Converter. It acquires in <2 ms, tolerates up to 500 MHz p-p deviation, measures RF pulses down to 250 ns. (100 ns manually). With frequency averaging, short microwave pulses can be measured about 100 times more precisely than with any conventional counter.
- HP Interface Bus option for easier, more economical systems design.

For the 20-page data sheet, check I on the HP Reply Card.



The HP 5345A super performance counter can accurately measure short RF pulses or rapidly swept signals.

No need for add-on options with NEW full capability X-Y recorder



The 7015B lab X-Y recorder is a low cost, one-pen instrument that features maximum electrical and mechanical flexibility to fit many and varied applications.

A new low-cost FULL CAPABILITY X-Y recorder, the HP 7015B, offers full capability recording without the need for costly add-on options or external equipment. The single, all inclusive price provides these four full capability features:

Internal Time Base can be slowed to ¼ hour sweep and has automatic pen control and remote triggering for sweep start and reset.

Matched Input Filters eliminate or reduce the always present signal noise. (Noise of less than 0.1% of full scale *can* start degrading the trace!)

Remote Pen Lift can mean the difference—during a quick plot—between an acceptable graph and one that must be redrawn by hand.

TTL Level Remote Control provides an easy interface with external equipment or systems.

> *Attention OEMs*
> *To bring recording quality to your systems, consider HP recorders. We support worldwide what we sell.*

The 7015B also offers top-of-the-line quality in its disposable pen writing system and continuous duty servo motors for operator convenience and low cost of ownership. It has sensitivities from 5mV/cm or 10mV/in on charts up to A4 or 8½ × 11″.

For more information, check N on the HP Reply Card.

New microwave coaxial switch has 50 dB isolation at 26.5 GHz

A dc to 26.5 GHz coaxial microwave switch is now available. The HP 33311C is a SPDT switch which features all-matched ports by using internally switched 50Ω loads to terminate the unused secondary port and improve the isolation. Isolation is >85 dB at 18 GHz, >50 dB at 26.5 GHz.

Excellent repeatability results from use of "edge-line" design which switches only the center conductor. After 1,000,000 switchings, repeatability is typically 0.03 dB. APC-3.5 connectors allow operation to 26.5 GHz and are fully SMA compatible. SWR is <1.5 to 16 GHz, <2.3 to 26.5 GHz. Insertion loss at 16 GHz is <0.8 dB, <1.4 dB at 26.5 GHz. The switch will handle lW average and 100W peak.

The 33311C is electrically switched and self-latching. Coils draw 3W at 24 VDC and automatically disconnect after the 30 ms switching time.

The small size (5.5 × 7 × 1.5 cm) and environmentally rugged construction makes the 33311C ideal for designing into microwave systems.

For more technical data, check E on the HP Reply Card.

Internally switched 50Ω loads in this SPDT switch provide all-matched ports to 26.5 GHz.

New HP-IB brochure cites more than 58 interfaceable products

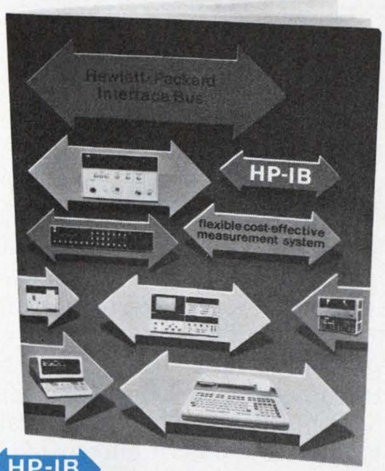
The recent development of a standardized interface enables engineers to create flexible, cost-effective systems quickly and easily.

The Hewlett-Packard Interface Bus (HP-IB) is our implementation of IEEE standard 488, and it is also in accord with the main IEC document approved by member nations during 1976. With the bus, you can link instruments to perform automatic measuring and testing. Under management of a computing controller, an HP-IB system virtually runs itself.

Now, a new 12-page brochure is available, covering:

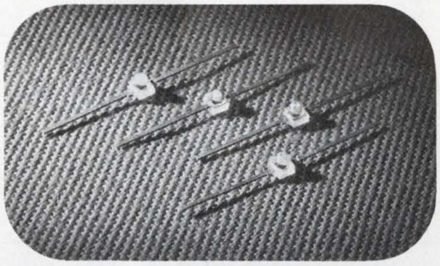
- Evolution and benefits of the standard interface
- How HP-IB operates
- Typical applications
- A list of more than 58 HP-IB products currently available for "do-it-yourself" systems
- Selecting a computing controller
- Preassembled HP-IB systems

For a copy of this informative and helpful brochure, check T on the HP Reply Card.



HEWLETT-PACKARD COMPONENT NEWS

Simplified optical design and higher channel density with new high radiant intensity emitter



The clear optical port and offset wire bond also allow the HEMT-6000 to function as a photodiode. The typical responsivity is 0.35 amps/watt centered at 700 nanometers.

Designed for maximum efficiency at 700 nm wavelength, this visible, near-IR source is low cost and easy to align. The HEMT-6000 uses a GaAsP chip designed for optimum trade-off between speed and quantum efficiency. Axial radiant intensity is typically 250 microwatts/steradian. Bandwidth is dc to 5 MHz.

Applications for the HEMT-6000 include bar code readers, optical mark sensors, optical scanners, safety interlocks, tape sensing systems and fiber optic drivers.

For details, check J on the HP Reply Card.

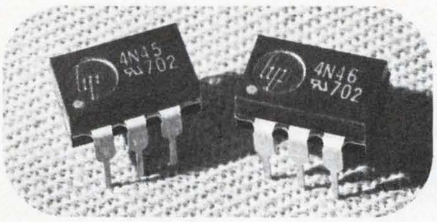
New 6-pin optical couplers available for first time

Two photodarlington devices are announced from Hewlett-Packard. These Models 4N45 and 4N46 optocouplers feature low input current with high gain. Current transfer ratio (CTR) is typically 1000%.

The 4N46 has a 20V minimum output voltage rating and a 350% minimum CTR at an input current of only 0.5mA making it ideal for use in low input current applications such as MOS, CMOS and low power logic interfacing. The 4N45 has a 250% minimum CTR at 1.0mA input current and a 7V minimum output voltage rating.

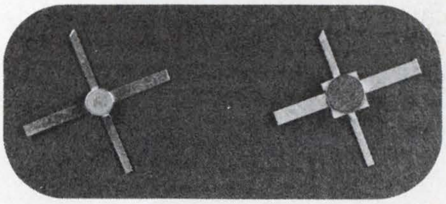
Applications include uses as telephone ring detectors, digital logic ground isolation, low input current line receivers, line voltage status indicators or logic to reed relay interface.

For additional details, check G on the HP Reply Card.



The 4N45/46 optocouplers contain a GaAsp light emitting diode optically coupled to a high gain photodetector IC.

HP microwave transistors now registered with EIA



2N6617 has been assigned by the Electronic Industries Association to Hewlett-Packard's HXTR-6101 low noise transistor. Specified at 3.0 dB noise figure at 4 GHz with 8 dB minimum associated gain, it is packaged in a 1.8 mm (0.070 in) diameter hermetic metal/ceramic package.

2N6618 has been assigned to the recently introduced HP HXTR-6103. Noise figure is 2.2 dB maximum at 2 GHz with 11 dB minimum associated gain. The 2N6618 is supplied in a 2.5 mm × 2.5 mm (0.1 in × 0.1 in) hermetic metal/ceramic package.

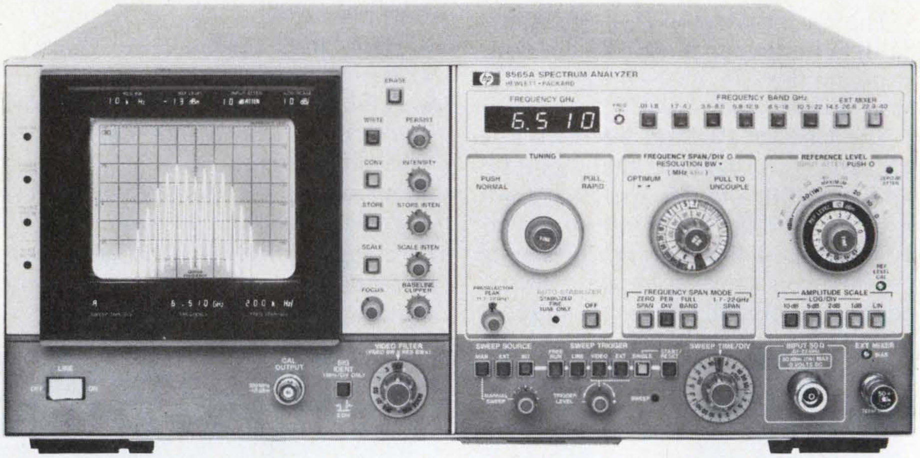
These transistors are intended for use in radar, EW and communications systems in the 1 to 6 GHz range.

For additional details, check K on the HP Reply Card.

Measure to 22 GHz with new easy-to-use spectrum analyzer

HP's new microwave spectrum analyzer, model 8565A, combines wideband performance (10 MHz to 22 GHz frequency coverage) with greatly simplified operation and unambiguous displays. The analyzer features absolute amplitude calibration, automatic preselection from 1.7 to 22 GHz, and flat frequency response for meaningful comparisons of multiple signals. In addition, the 8565A offers wide ranges of frequency spans (from broad spectra to close-in analysis), resolution bandwidths (from 1 kHz to a wide 3 MHz), and amplitude scale factors that provide from coarse to fine resolution.

Even with this breadth of performance capabilities, operation of the 8565A is remarkably straightforward. Most measurements are a simple 3-knob sequence. With a wide span selected, pick out the signal of interest with the TUNING control. Then zoom in on it with the FREQUENCY SPAN/DIV control. As you narrow the span, the resolution bandwidth, sweep time and video filtering are all *automatically* set to keep the display calibrated. Then set the signal amplitude to full deflection with the REFERENCE LEVEL control, which then indicates the signal's power level.



Wide range, spurious-free displays plus simple operation and digital display of control settings all contribute to the HP 8565A Spectrum Analyzer's usefulness in microwave applications.

To add to the operator's convenience and confidence, the value of each pertinent parameter—even the ones automatically established—is digitally displayed on readouts in the CRT bezel assembly. These data are captured when using a scope camera.

The 8565A Analyzer can measure to 40 GHz using the HP 11517A Waveguide Mixer. And the analyzer can be used with the HP 8444A Opt 058 Tracking Generator to make >90 dB swept response measurements in the 10 to 1300 MHz range. A useful complement to the 8565A is the new HP 8750A Storage Normalizer (described elsewhere in this issue). The 8750A can digitally store a reference signal which can then be compared to a later input signal.

For more information about this versatile microwave instrument, check P on the HP Reply Card.

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HEWLETT hp PACKARD

MEASUREMENT COMPUTATION news
product advances from Hewlett-Packard

May/June 1977

New product information from

HEWLETT-PACKARD

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Palo Alto, California, 94304 U.S.A.

Across the desk

(continued from page 8)

engineer. This is the injustice that must be corrected.

John L. Alexander
President

Coalition of Aerospace
Professional Employees, Inc.
P.O. Box 2251
Satellite Beach, FL 32937

Ed. Note: Subsequent to writing his letter, George E. Monroe submitted to the IEEE a proposed amendment to the Service Contract Act. His proposal does not attempt to raise what many engineers at Cape Kennedy consider "depressed salaries," but it does propose provisions that would prevent these salaries from being "busted" in the future.

Me an editor?

Maybe. If you would enjoy interviewing industry authorities, and writing and editing articles on the latest technological developments, you might enjoy being an editor.

We have openings at our home office in New Jersey. Write to Mike Elphick, Managing Editor, Electronic Design, 50 Essex St., Rochelle Park, NJ 07662.

Power supply, not case is doubly insulated

You were quite right to focus attention on safety (ED No. 24, Nov. 22, 1976, p. 114). This is a subject that we have been giving a lot of attention. So much so that we incorporated double insulation into one of our latest oscilloscopes. You made this point in the article but unfortunately the caption on p. 116, which says that doubly insulated cases make battery-operated instruments safer is misleading.

The case is not "double-insulated." In fact, this feature applies to the power supply according to International Electrotechnical Commission Standard 348 for metal-encased Safety Class II equipment. Such an instrument is, of course, intrinsically safe with respect to line-voltage accidents and can be compared with a battery-operated instrument in this respect.

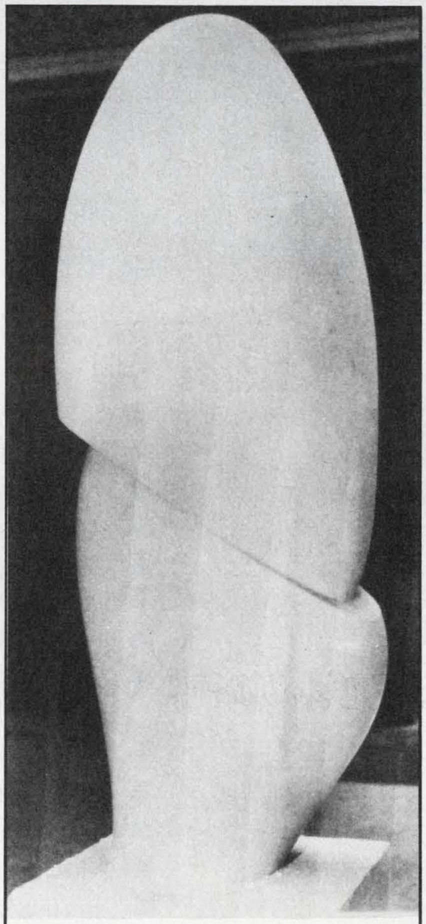
This feature does indeed permit the user to "float the instrument," as you say, but the same care should be observed when measuring "signals riding on high voltages" as in all circumstances where such voltages are involved.

We do want to stress that the feature does not give immunity from the need to take such normal precautions and is not claimed to do so.

A. S. Lodder
Press Officer
Science & Industry Division

N.V. Philips
Gloeilampenfabrieken
Eindoven
the Netherlands

Misplaced Caption Dept.



Through over-zealous cost cutting, our competitors have produced parts with serious flaws —shrinkage, warping and misalignment.

Sorry. That's Hans Jean Arp's sculpture "Coupes Superposées," which stands in the Isaac Delgado Museum of Art, New Orleans.

Multi-User/Multi-Task DOS
COMMAND PERFORMANCE

muPro-80D Multi-User, Multi-Task Disk System

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- Multiple Task Real-Time Operating System
  Supports up to 256 concurrent tasks
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  List File Directory
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  Copy and Compress Disk
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- I/O Device Characteristics transparent to user
- Concurrent Interrupt-Driven I/O
- Calendar Maintenance - Date, Time
- Supports BSAL-80, Linking loader and Text Editor
- Operating System Requires 16K Bytes

Hardware

- Dual Diskette Drive - 512K Bytes
- Soft Sectored - IBM 3740 compatible
- High Speed Seek - 76 track seek in 100mSec.
- Single Card Controller installs directly into muPro-80 chassis
- Double-Sided Recording - Optional
- Controller accomodates up to two dual drives (four diskettes), or four single drives
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Laser radar lets copters track tiny obstacles

A 2.5-W CO_2 laser radar enables helicopters to detect wire and other obstacles and to follow terrain. But before it could be used in helicopters, some tough design problems had to be solved, including:

- Stabilizing the 10.6-μm laser frequency against the severe vibrational environment of a helicopter. Generating circularly polarized transmissions to improve the detectability of small obstacles like one-eighth-inch wire strung across helicopter paths.
- Providing an electronically programmable scanner that can instantly switch from identification to ranging modes.
- Incorporating a digital signal-analysis system to identify the nature of target returns.
- With just 2.5-W average power, the 10.6-μm radar system can detect a one-eighth-in. field wire at a range of 1500 ft, according to its designer, Dr. Robert Mongeon of United Technologies Research Center, East Hartford, CT. Moreover, degradation of frequency stability in flight is negligible, Mongeon reported at last week's Laser Engineering and Applications Conference in Washington, DC.

Stabilization-system requirements were demanding because the components for the laser radar are all hard-mounted—no springs or cushions—in the helicopter. In the stabilization system, an electronic servo system controls the length of the laser cavity by expanding or contracting piezo-electric elements that hold the cavity mirrors. This compensates for detuning due to linear displacement of the mirrors. In addition, angular detuning of the laser is rejected and discrimination of the lowest-order transverse mode from competing higher-order modes is improved by the laser's "hybrid unstable resonator configuration." Pioneered by United Technologies, the technique is very important to maintaining frequency stability, Mongeon points out.

In typical unstable resonator designs, laser efficiency is reduced because part of the laser beam is allowed to leak out of the main laser path. In Mongeon's design, a weak-waveguide effect is used to recapture parts of these losses.

Circularly polarized radiation is incorporated in the laser to improve the reliability of returns despite the angle of a target, such as a wire, to the helicopter beam. It is provided by using a germanium plate set at Brewster's angle in the path of the transmitted and received radar-beam optics.

An electronically programmed scanner with two motor-driven prisms permits the system to first perform a line-scan in a terrain-avoidance ranging mode, then to go into a log-spiral scan to detect obstacles.

Targets are distinguished from background returns by a digital signal processor. A system of logic determinants in the processor instantly evaluates the probability of the returns being from a wire. Moreover, the system is configured to detect the more complicated cases where the background returns merge with wires.

The transmitter-receiver has an optical-heterodyne design; a second CO_2 laser is included as the local oscillator. The detector has over 100-MHz bandwidth and doppler tracking electronics in the receiver compensate for velocities of a few hundred knots, and also the scan angle in use.

Printer-calculator combo plots graphs, writes words

Plugged into one of Texas Instruments two new calculator models, a thermal printer produces hard-copy records more graphic and more comprehensible than current printer/calculator combinations. These conventional systems can only print numbers. But with either the Programmable 58 or the Programmable 59, the PC-100A, also from TI, can print out headings, prompting messages, and program codes, as well as plot data. Yet the price —as little as $324.90 for the printer and the less expensive of the two calculators—is much lower than that of computer systems or time-shared terminals usually used for graph plotting.

Combined with either the SR-52 or SR-56 calculators—to be discontinued this month—the PC-100A, which replaces the PC-100 and costs $199.95 adds no new features. But a system consisting of the PC-100A and one of the new calculator modes is powerful enough to replace batch processing or time-sharing on computers, and thereby eliminate both the wait for and expense of computer time, says Peter Bonfield, product manager in TI's Calculator Products Division in Dallas. In fact, so dedicated is the company to replacing a single central computer with separate calculators that it is giving the more expensive Programmable 59 to each of its engineers, as well as to each new engineer that joins the company. The cost of the TI 59—which retails for $299.95—should be more than covered by increased productivity, Bonfield explains.

The TI 59 (TI has dropped the "SR" designation on its programmables because it considers the "slide rule" reference obsolete) can store 480 program steps and has 60 data memories in its standard format. The memory space can be reconfigured for up to 960 program steps with no memory space or as few as 160 program steps with 100 memory spaces. The allocation can be made from the keyboard or in a program.

The TI 59's magnetic card programmer is like that of the SR-52, with an added wrinkle that ensures confidentiality. A flag at the beginning of the program allows normal operation, but prevents the program from being listed on paper tape. Such a requirement is paramount for some military applications as well as for such fields as insurance and stock brokerage, says Bonfield.

The less expensive TI 58 lists for $124.95 and has all the features of the 59 except the mag-card programmer; it also has less memory space. The standard configuration, 240 program steps and 30 memories, can be changed to as many as 480 program steps and no memory spaces or 60 memory spaces and no program steps. By comparison, the SR-52 has 224 program steps, 20 memory locations, and goes for $249.95. Using what TI calls "solid-state software," off-the-shelf programs from the TI library can often be run in either new calculator without taking any program steps. Stock programs are stored in read-only memories encapsulated in plastic modules that plug into the back of the machine.

This technique is a refinement of one used by Sharp Corp., which had ROMs in dual-in-line packages to configure its calculator to specific applications, such as engineering, surveying, and navigation.

Now four memory chips can be tested at once

A test system for 16-k memory chips exercises four devices at the same time and cuts test time from 18 s to 7 s per part or less, depending on the yield and number of bins. The system consists of the 5581 Parallel-Memory Tester from Fairchild-Xincom, Chatsworth, CA, and the 7194 four-station environmental handler from Sym-Tek, San Diego, CA.

Recently introduced at the Semicon West Show in San Mateo, CA, Fairchild-Xincom's 5581 Parallel-Memory Tester features dual-head operation, with each head testing two parts. When testing for pattern sensitivity, all four sockets are active at once.

As long as the addresses are multiplexed, the 5581 can test RAM or ROM parts that have up to eight data lines and 65-k addresses.

Because of their many discrete address pins, nonmultiplexed parts are generally limited to one test head.

The 5581 works with Sym-Tek's temperature chamber/handler which is configured as four individual, asynchronous handlers sharing a common temperature chamber. Two small, cylindrical test heads from the 5581 interface to the front of the Sym-Tek handler and provide four test sockets. "Soaking" at temperature, four columns of parts to be tested, are gravity-fed to the sockets from the top of the chamber. The 5581 then checks each part in turn for dc parametrics and basic functionality.

Once each socket holds a potentially good part, the algorithmic pattern generator creates a number of test patterns. The same pattern is applied to all four parts. A range of access times is used to select devices of different grades, and tested parts go to one of the four bins.

The Fairchild-Xincom 5581 Parallel Memory Tester, together with Sym-Tek's 7194 Multi-Station Handler will sell for less than $200,000.

CIRCLE NO. 319

Microcomputer with 8085 is the lowest priced, yet

The first microcomputer board to use the 8085 microprocessor is less than 40% of the price of previous boards capable of operating in multiprocessor systems. Complete with RAM and ROM, system clock, serial and parallel I/O and programmable timer, the 80/05 goes for under $200 in OEM quantities.

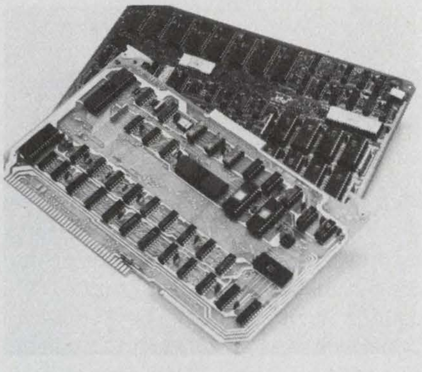
Developed by Intel Corp., Santa Clara, CA, the 80/05 plugs into the same bus as the SBC 80/20 single-board computer, and, like it, can be joined with several other microcomputers or controllers that logically share system tasks. Its low price, just over a third that of the 80/20, may spur designers to apply multiprocessor solutions to a wider range of computing and control problems, says George Adams, Intel's SBC 80 product manager.

Bus capacity is up to four 80/05s or high-speed controllers. When an external-priority network is added, up to 16 masters can share the bus.

The 80/05 contains 512 bytes of low-power static RAM and two sockets for up to 4 kbytes of 8716 EPROM or 8316 masked ROM. Software, which is compatible with the 80/20 and other 8080-based systems, configures the 22 parallel I/O lines by assigning two 8-bit and two 3-bit ports to input or output uses as needed. Sockets permit I/O line drivers appropriate to the application to be used.

Shareable plug-in boards that can operate from the SBC 80 bus—which has a maximum data transfer rate of 5 Mbytes/s—include the SBC 310 high-speed math unit (see photo). Using Intel's 3000-series bipolar microprocessor, the SBC 310 can do floating-point 32-bit multiplication in 91 μs and division in 102 μs maximum. The SBC 732 analog I/O board performs 16,000 12-bit a/d conversions per second on 16 differential or 32 single-ended inputs, and also contains two d/a channels.

A number of additional boards are under development at Intel: a double-density diskette controller, a four-port programmable communications interface card for RS232 serial I/O and parallel interface to the Bell 801 automatic calling unit, and an opto-isolated digital I/O card.



Intel's SBC 80/05 μC board (bottom) is shown with SBC 310 plug-in, high-speed math unit.

Rugged minicomputer is conduction-cooled

A fully enclosed minicomputer for harsh environments cools itself by an unusual thermal conduction technique rather than forced air. It can also run any program written for a DEC PDP-11/34.

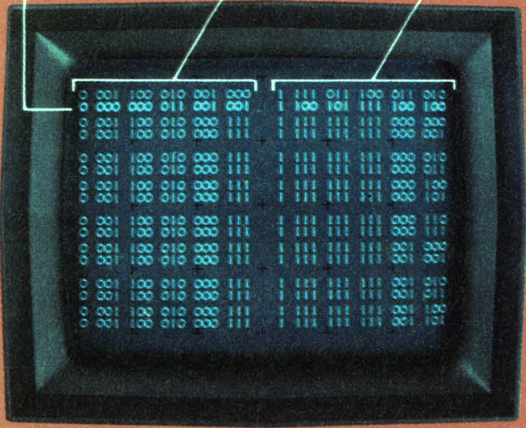
Implemented in TTL/MSI, the rugged SECS-11 from EM&M's Severe Environment Products Division, Chatsworth, CA, gets rid of internally generated heat by using a distributed heat sink, ICs are mounted atop a heavy copper bus that conducts heat away from the devices to the PC card's edge.

In the card cage, thermally conductive pressure plates route heat from the bus into heavy metal plates at the top and bottom of the cage, then to radiating fins at the front and rear of the enclosure. No fans are used, and no switches protrude through the enclosure.

Emulating both the instruction set and I/O scheme of the DEC machine, the SECS-11 gives access to all the software for the 11/34 and can replace it in any configuration of peripherals. The mini's architecture decodes the DEC instruction set in ROM. Internal microcodes then control the machine at a 10-MHz rate. In fact, many of the DEC instructions are executed faster than the 11/34—users can expect a 20 to 30% improvement in throughput, according to new-products manager, Bill Mandl.

With a 1024 × 32 capacity that allows for an extended instruction set, SECS-11's decoder ROMs permit hardware single-precision floating point, and double-precision fixed point arithmetic to be performed.

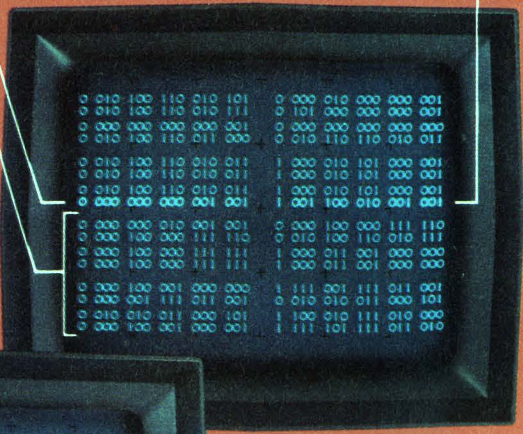
Trigger word *Write-qualified addresses* *Data written into corresponding addresses*



Watch variable transactions of read/write or write-only operations and see both addresses and data as they occur. Or watch memory transactions such as fetch operations and see, in real time, both addresses and resulting operation codes.

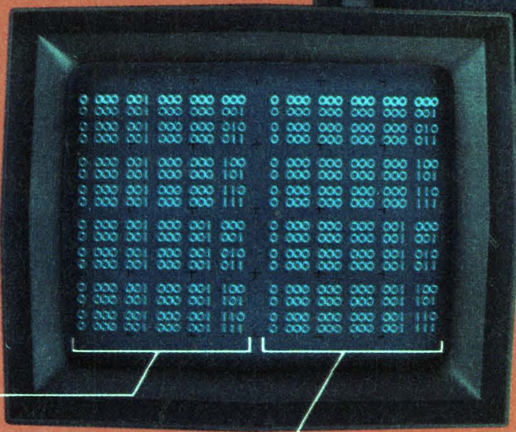
Interrupt trap cell address *Indirect pointer to I/O subroutine*

I/O interrupt driver



Observe DMA (Direct Memory Access) within your system. Whether it's your processor or other specially designed memory access units interfacing with system memory, you can view dynamic action of both addresses and data in real time.

Verify that interrupt linkages are correct by observing program flow prior to the request for interrupt and seeing that the proper subroutine is being executed following interrupt. You can also use digital delay or word triggering to watch I/O driver subroutine activity in real time.



Addresses qualified to be DMA read transactions

Data from disc memory

If you're designing minicomputer based systems, only HP Logic State Analyzers show you real time like this.

Logic State Analyzers effectively put you inside your operating minicomputer system for faster design and debugging. Here's the difference HP's real-time view makes.

HP's 1600S Logic State Analyzer (priced at \$7100*) plus 10254A Serial-to-Parallel Converter (priced at \$975*) gives you a better way to spot and diagnose intermittent system operation. They give you greater insight for better understanding of your system's capability. The combination can mean earlier product introduction, lower development costs, a faster return on the development investment.

Your local HP field engineer has all the technical details. Give him a call today. And also ask him about HP's FREE seminars—An Introduction to the Data Domain.

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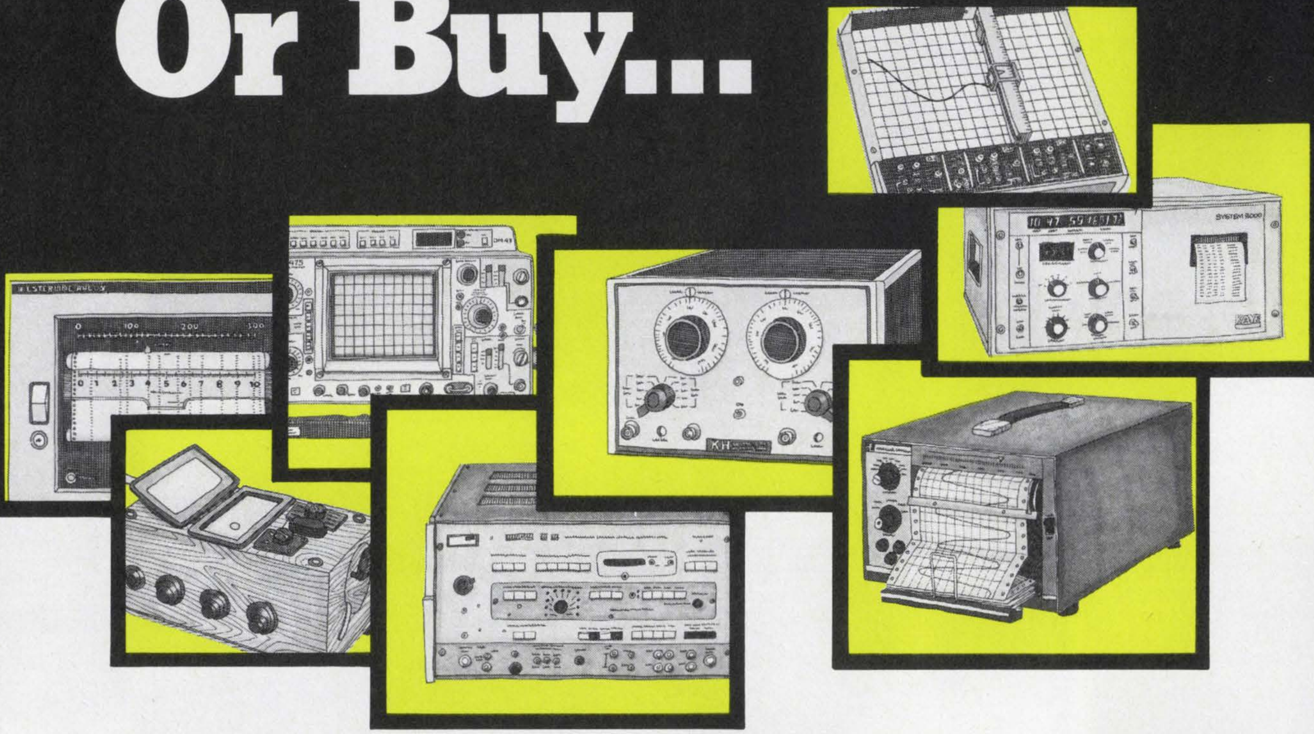

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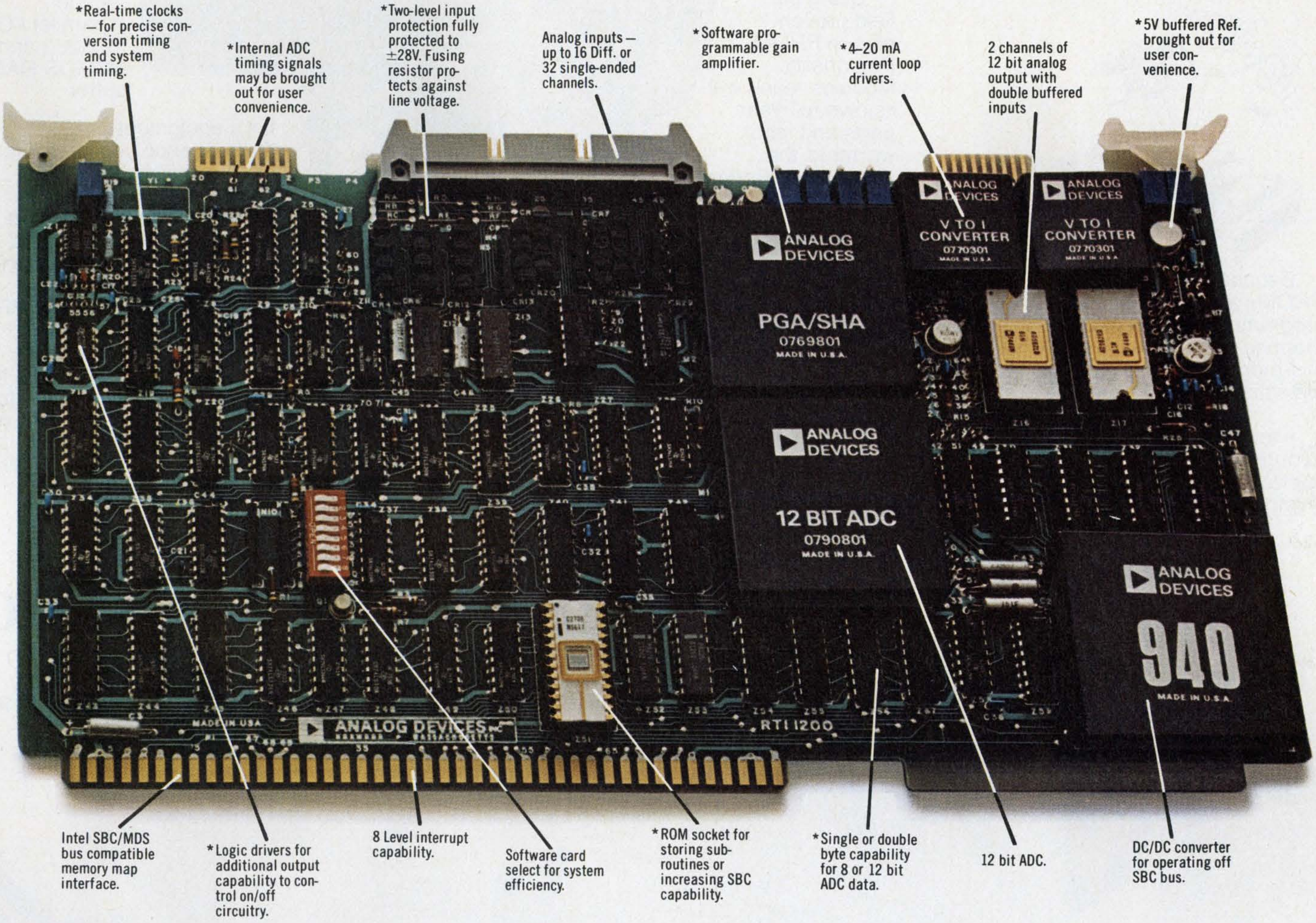
GENERAL ELECTRIC

CIRCLE NUMBER 11

Important news for Intel SBC 80 users:

The RTI-1200 solves your real-time analog I/O subsystem problems.



Now Intel SBC 80 users have the most complete, most versatile and easiest-to-use input card for the acquisition and control of analog signals.

What you don't see here are all the other significant RTI-1200 features that enhance its maximum convenience and versatility. One of the most impressive is our User's Guide. It doesn't just tell you how to hook up jumpers. It does tell you how to write programs that optimize throughput rates, how to use the 8080's instruction set to take advantage of the RTI-1200's capabilities and a whole lot more.

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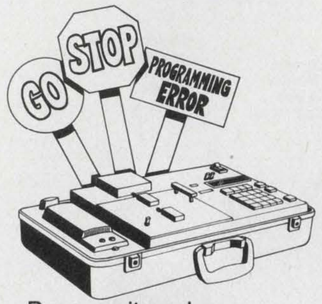

Because it analyzes PROMs as they're being programmed, it minimizes dropped data and mis-programming, and maximizes PROM yield.

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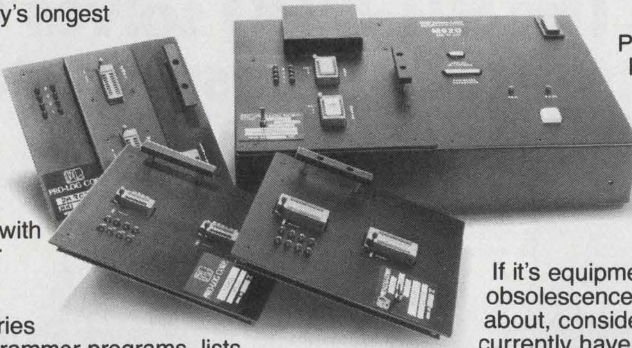

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CIRCLE NUMBER 13

Washington report

Navy lukewarm about British missile seeker

Although the U.S. Navy has agreed to evaluate a new British guidance system for its Sparrow air-to-air missile, chances of acceptance have dimmed considerably since the British decided not to participate in the NATO Airborne Warning and Control System (AWACS). Both the Navy and the Air Force are seeking a more effective guidance system than the current pulsed-doppler seeker, which is susceptible to ground clutter and electronic countermeasures.

The British Sky Flash missile, a short-range version of the Sparrow, solves this problem by using a monopulse seeker developed by Marconi Ltd. In 17 tests conducted to date by the Navy for the British Ministry of Defense at Pt. Mugu, CA, Sky Flash scored eight direct hits against low-flying targets, came within 1 meter seven times, and missed the target twice. Five more tests are planned under the cooperative program, and then the Navy is slated to test the missile about 10 more times for possible American use.

Before pulling out of the AWACS, the British had hoped to sell the monopulse seeker. But now, the U.S. will probably initiate a competition among American firms to develop a whole new monopulse system. General Dynamics and Raytheon are expected to bid on the program.

Air Force pushing avionics reliability in rocket

A "pair-and-spare with cross-strapping" approach to avionics redundancy will be applied by the Air Force to its Interim Upper Stage (IUS), which will launch space payloads from the Space Shuttle. This is expected to improve reliability from 0.81 to 0.983. The new approach will mean "losing one or two spacecraft out of 100 instead of one or two out of 10," explains Lt. Col. Joel M. Rosenzweig, Air Force IUS program manager.

In the past, the Air Force has used "single-string" avionics—essentially one of each subsystem—in its launch vehicles. But this has turned out to be the most expensive approach in terms of losing spacecraft. "Triple-string" systems (three of each) are cheaper, but the pair-and-spare method is the most effective. The Air Force estimates IUS avionics costs (including development and 10 years of operation) would be $1.1-billion for single-string and $348-million for triple-string. Pair-and-spare should cost $254-million.

NASA, GAO quarrel over space-telescope costs

The National Aeronautics and Space Administration is at logger-heads with the General Accounting Office over the proposed 2.4-m Space Telescope, which is now due to be launched in late 1983 by the Space Shuttle.

The GAO, which studied the program at the request of Congress, says that it would cost nearly $1.4-billion to develop and operate for 15 years. NASA says that this estimate "is based on incomplete program definition and erroneous costing and could result in providing misinformation to the Congress."

Both organizations agree that the development will cost at least \$435-million. The disagreement is over the operating costs. GAO estimates these at \$470-million over 15 years plus \$210-million for the nine Space Shuttle flights needed to service the telescope and more than \$200-million in such hidden costs as inflation, government workers' salaries and tracking. NASA maintains that annual operating costs would only be \$10-million to \$15-million, so operating costs for 15 years would total no more than \$225-million.

Air Force optimistic about digital phase-lock loop

As a result of favorable acceptance by systems manufacturers, the Air Force reports, a digital phase-lock loop designed by the Air Force's Avionics Laboratory in Dayton, OH, may be available within a year as a standard catalog item, cost less than \$4, and still satisfy military specifications. Under Air Force contract, 150 chips were produced by RCA, then sent in February to 45 qualified systems manufacturers for evaluation.

The digital PLL, which has a complexity of 270 equivalent gates, contains transistors and resistors that can be connected to create such diverse circuits as radar-signal processors and encrypted speech coders.

The advantage of the digital design over analog PLLs is its ability to change frequency and bandwidth instantaneously, according to designer Gary Gangler of the Laboratory's Electronic Technology Div.

The new loop is being considered for frequency tracking, bit timing and data recovery in 5 navigation systems, and as a synchro/resolver to digital conversion in aircraft flight controls.

Capital capsules:

Raytheon and Ford Aerospace are expected to compete for the \$119-million worth of AIM-9L Sidewinder missiles to be sold to Britain under a letter of offer submitted to congress by the Defense Department. Britain will receive 1709 of the missiles for its F-4, Multirole Combat Aircraft (MRCA) and Sea Harrier fighters....**A \$56-billion market for commercial aircraft** is projected by industry executives over the next decade with the largest market segment, \$36-billion, earmarked for replacing current short and medium-range transports. Boeing, Lockheed and McDonnell Douglas all have begun working on new aircraft that will carry less than 200 passengers in the range of 2000 miles....**The Air Force has begun flight testing of the No. 2 development aircraft in the EF-111A electronic warfare program** following rollout ceremonies May 20 at the Calverton, NY, plant of prime contractor Grumman Aerospace Corp. The aircraft carries internal electronic countermeasures to jam enemy radars, and the No. 2 vehicle is the first with a full avionics suite....Due to Congressional budget cuts, **a delay of at least five months is anticipated in the development of a new forward-looking infrared (FLIR) system** to permit night operations of the Army's Advanced Attack Helicopter. The two competing contractors, Martin Marietta and Northrop, are due to deliver their prototype systems in 1978 for a fly-off scheduled for late 1979....

The Defense Dept. estimates that **an unusual energy monitoring instrument now being tested at the Naval Construction Battalion Center, Port Hueneme, CA** could save \$ 1 million annually in energy consumption costs per military installation. Developed by Franklin Electric Co., Bluffton, IN, the Model 30 Energy monitor keeps track of electrical energy consumption at any branch or load circuit rather than only at the main feeder. As a result, data can be collected and analyzed relative to specific loads, as opposed to watt-hour meters which are connected to a whole plant or installation....Northrop Corp. will present **a panel discussion on the future of wideband data transmission** at this year's convention of the Armed Forces Communications and Electronics Association (AFCEA) to be held June 21-23 at the Sheraton Park Hotel in Washington, DC.

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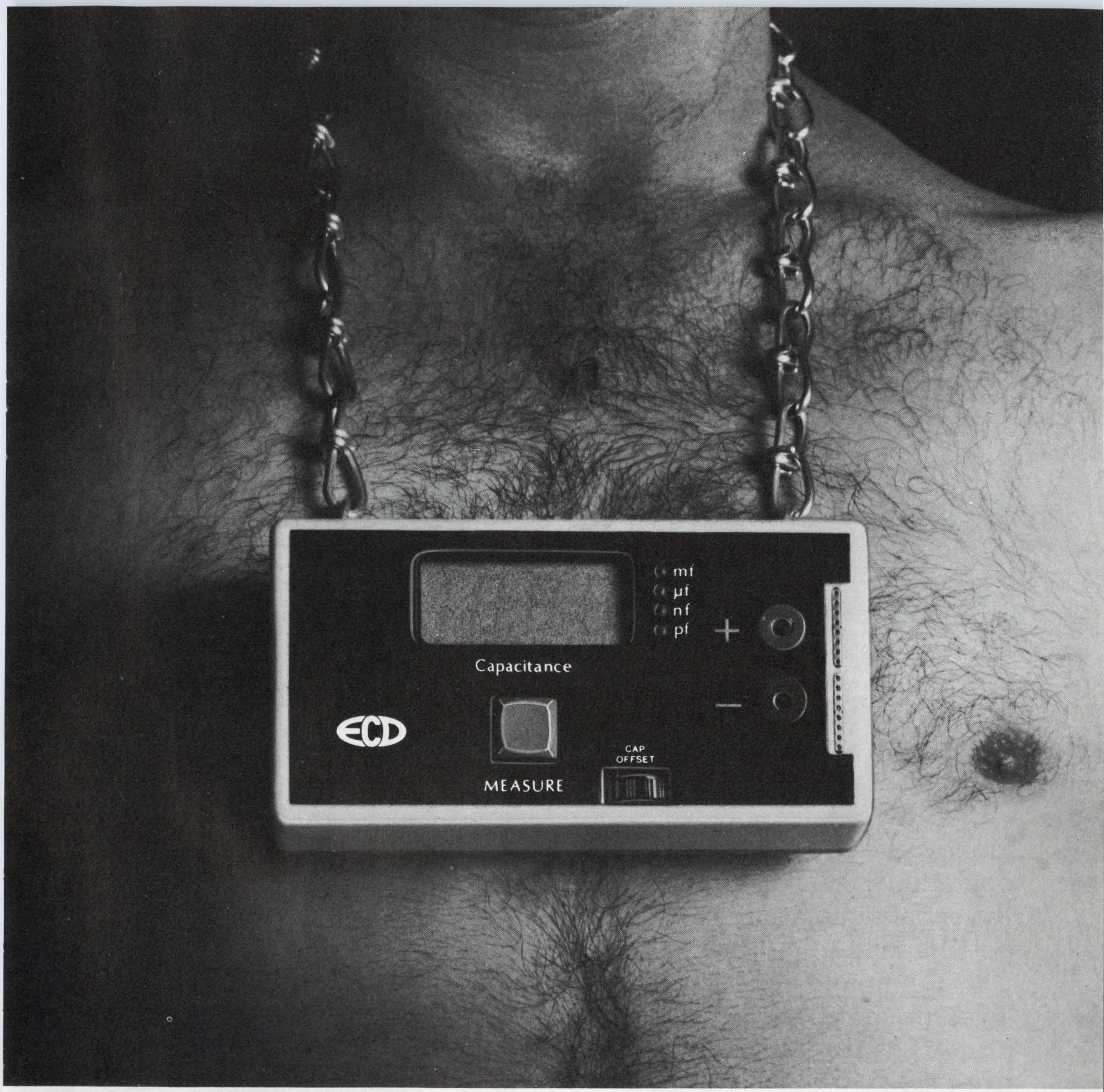

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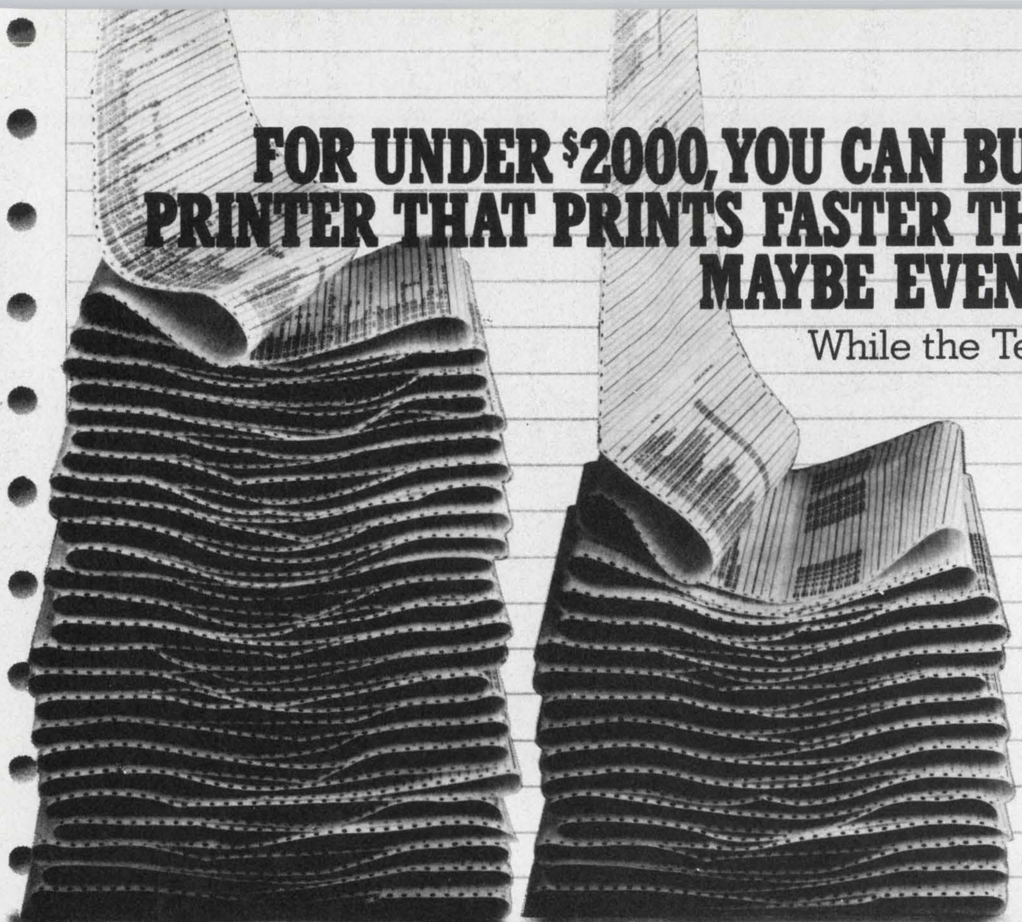

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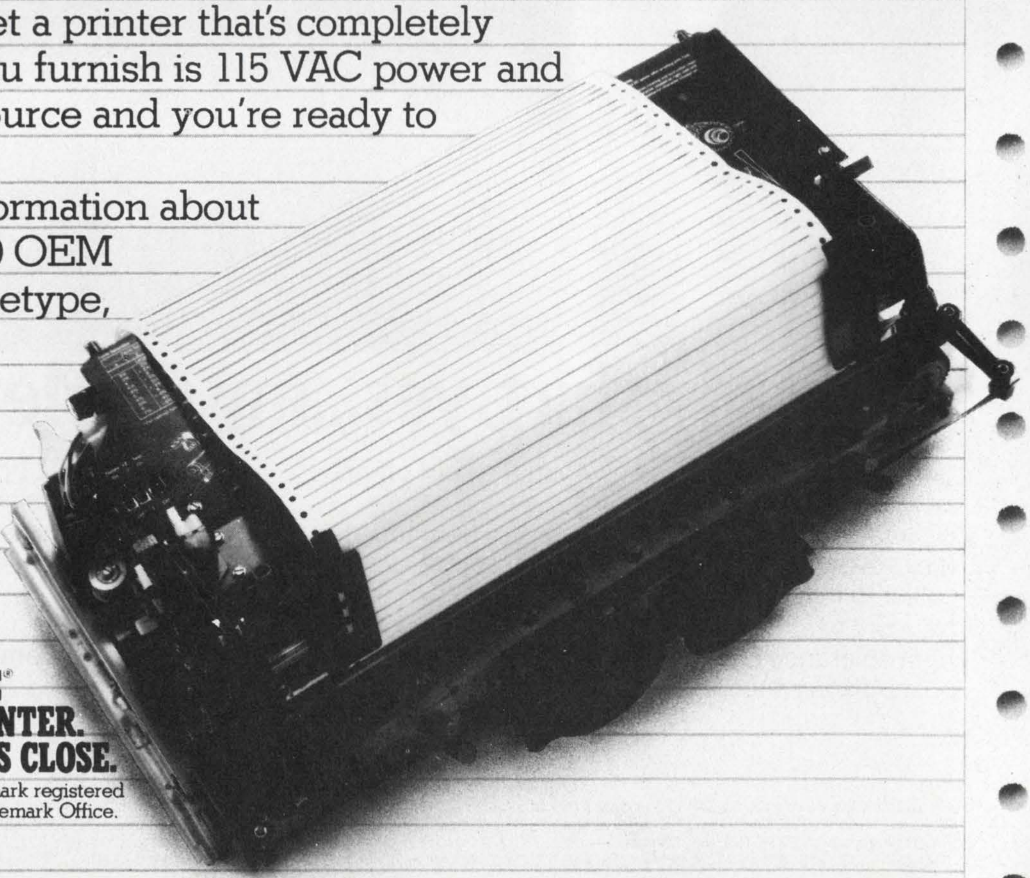

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Four value-packed true line printers with real 90-340 lines per minute throughput at practical, low prices

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GENERAL ELECTRIC

CIRCLE NUMBER 221

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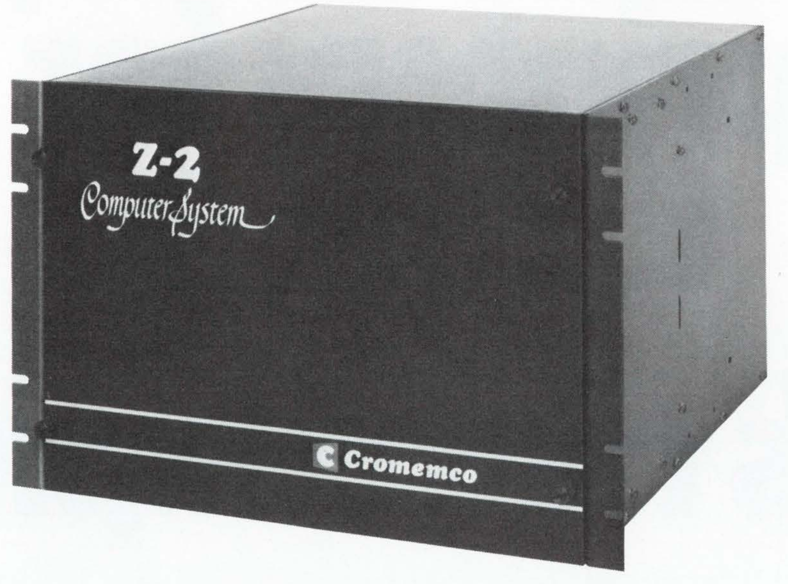

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Its power comes from using the Z-80 μP with its powerful 158-instruction set.

Its speed comes from using a special version of the Z-80 that operates at a 4 MHz clock rate.

So with our Z-2 you not only can do more, you can do it faster. You get extra flexibility, too, because of the Z-2's S-100 bus.

ADAPTABLE TO YOUR JOB

Further, the Z-2 is arranged so you can tailor it to your job. It has a 21-slot motherboard accessible from the front. You can quickly and easily plug in an almost endless variety of additional memory, I/O, or whatever you need for your project.

BROAD SUPPORT

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INDUSTRY-STANDARD BUS

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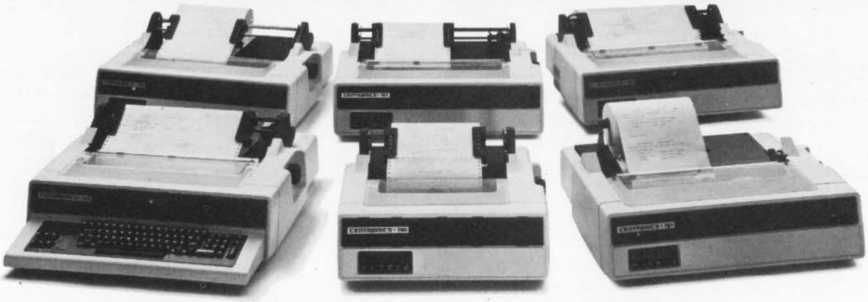

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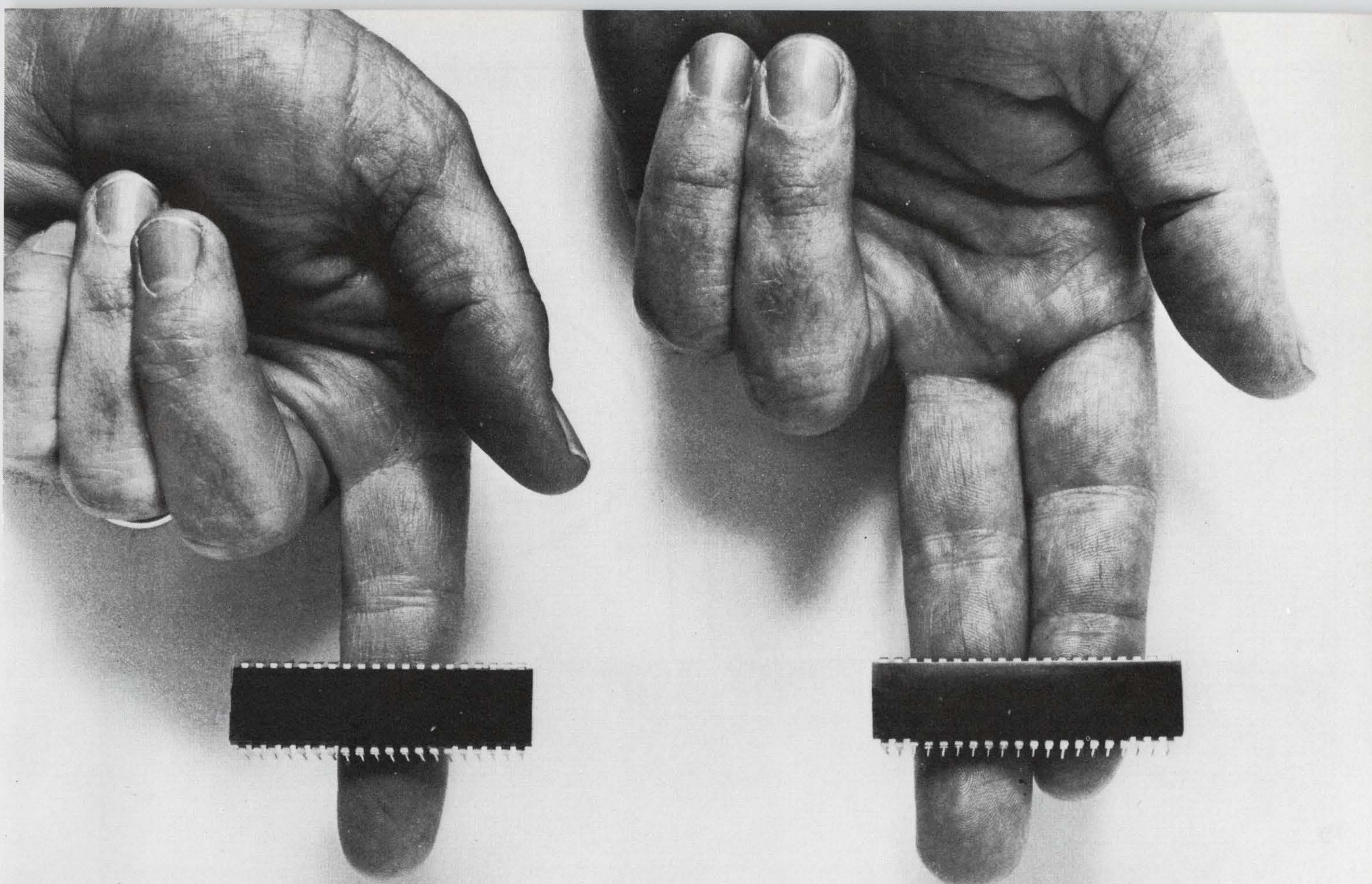

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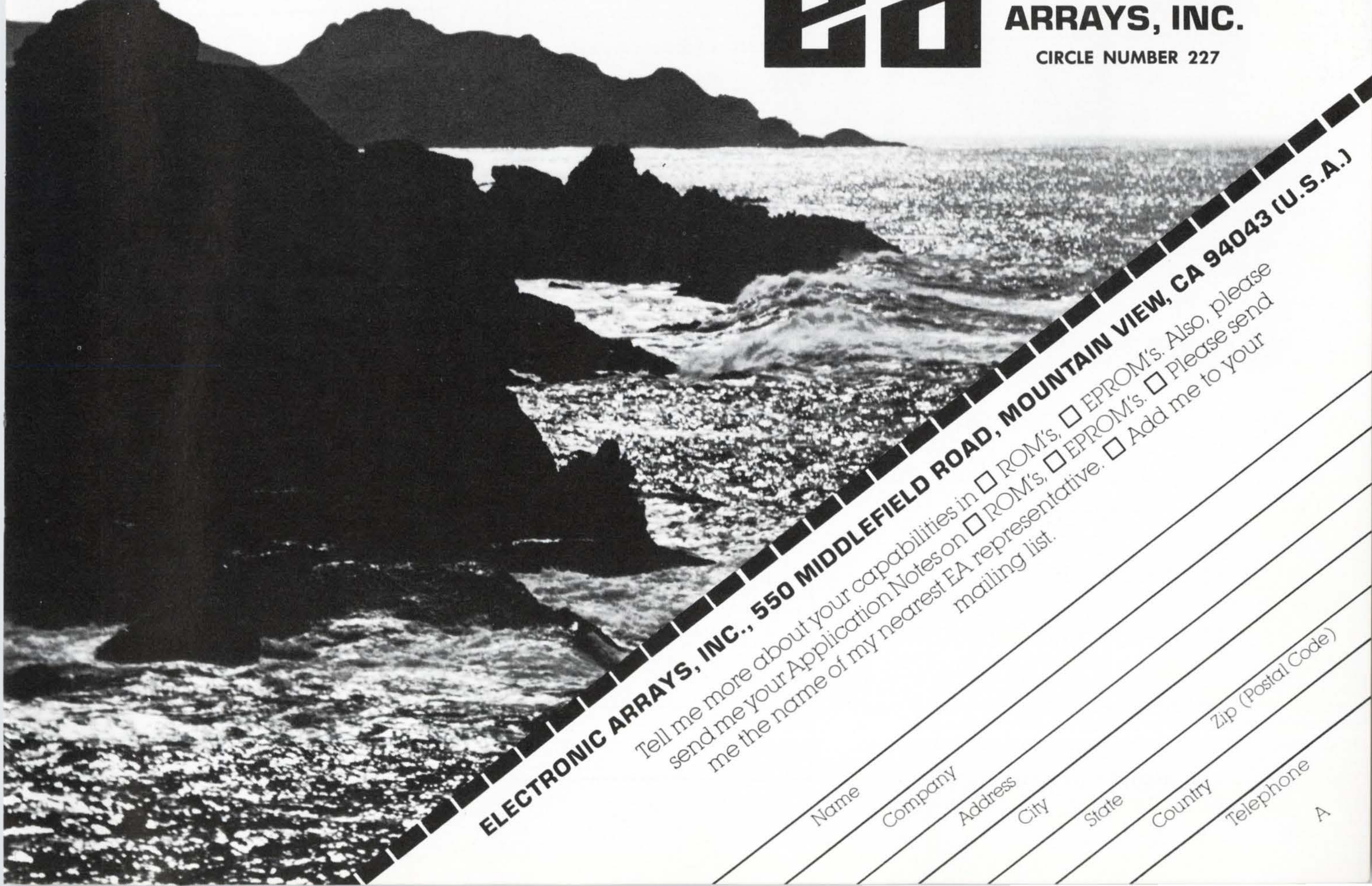

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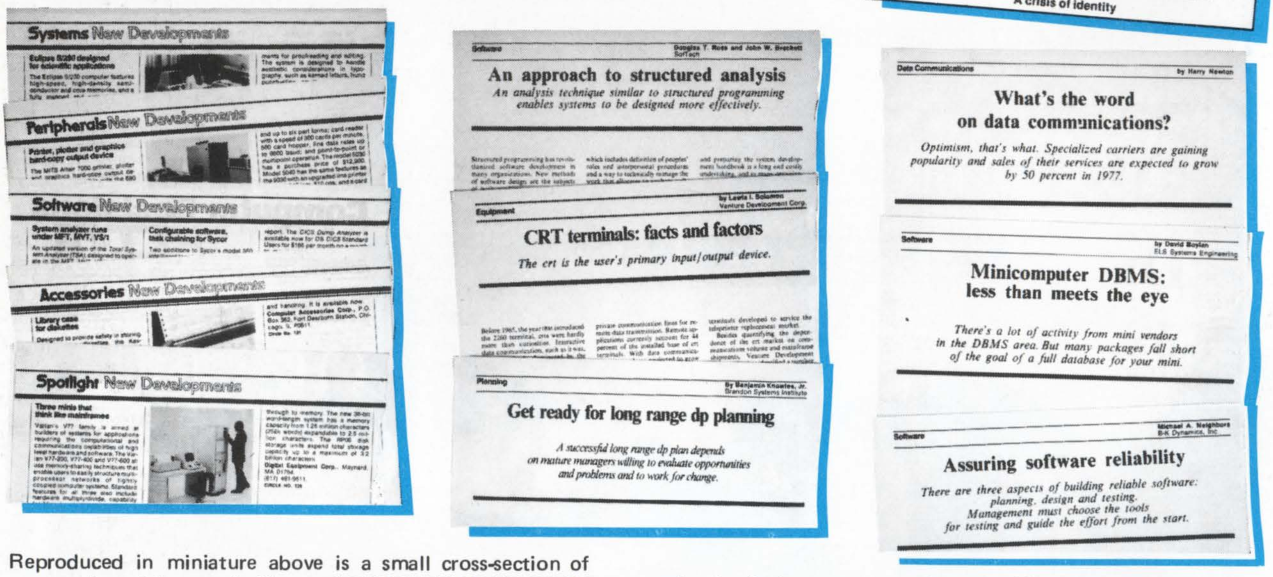

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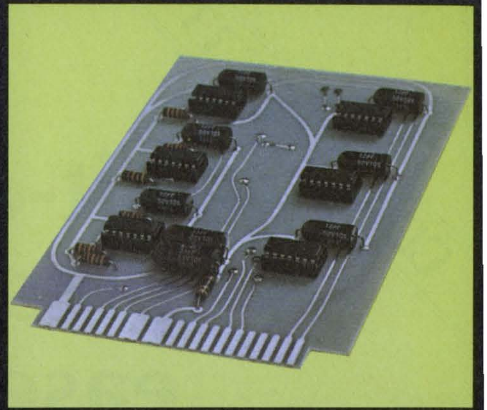

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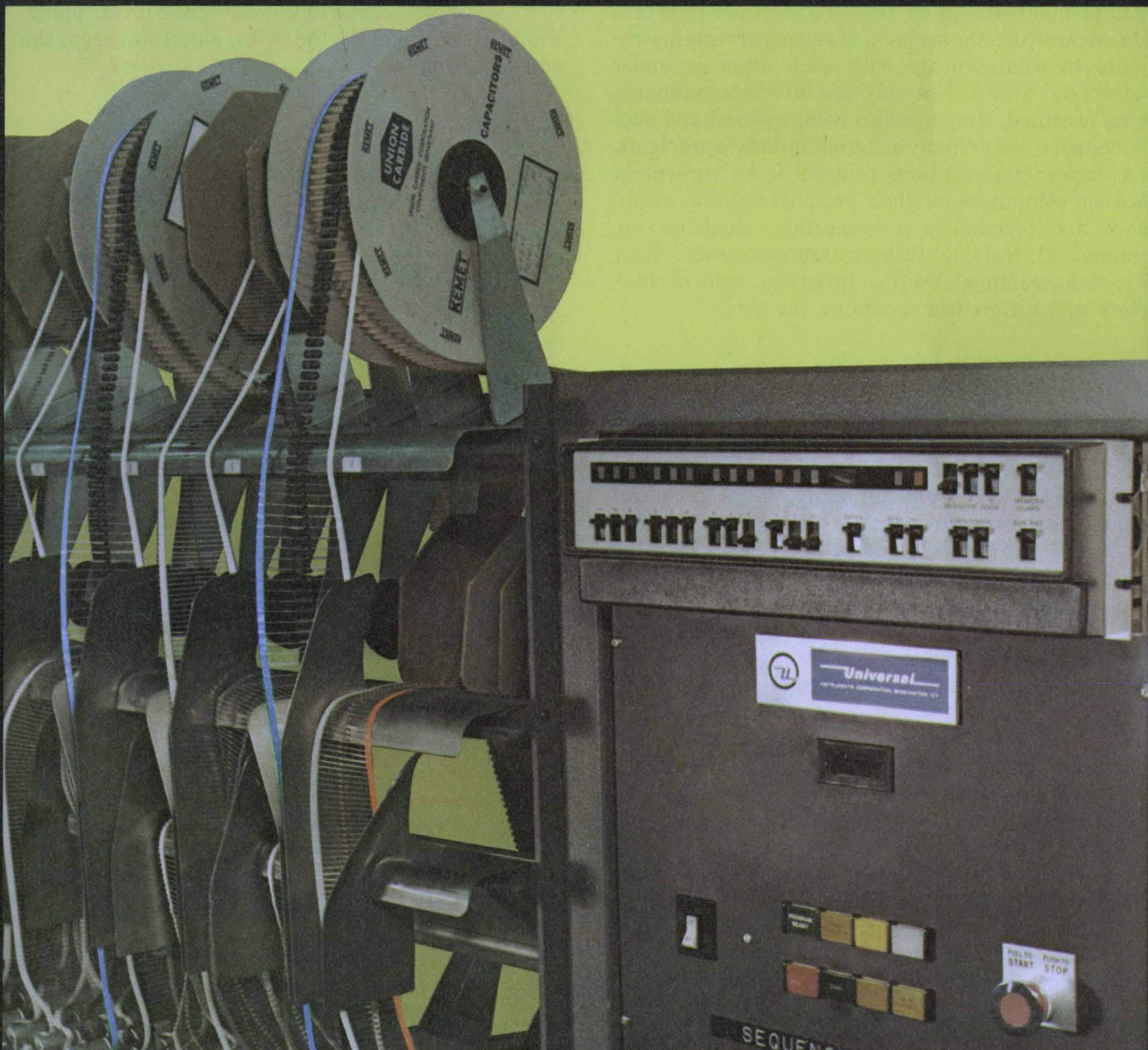

CIRCLE NUMBER 19

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COMPUTER '77

Bit-oriented protocols plus standard interfaces ease data communication

A fundamental shift is gradually taking hold in data communications—software-intensive byte-oriented protocols are destined to give way to simpler, more efficient synchronous data-link control protocols. SDLC protocols are bit-oriented and can be implemented with virtually no software intervention. Meanwhile, the problem of getting diverse instruments to communicate with each other is under widespread attack. Not only are interface standards being accepted, they are also being revised and supplemented to cover many different interface problems.

A data-communications protocol is an agreement between computers (or their peripherals) that establishes and terminates a connection; identifies the sending and receiving stations; assures message integrity; and accommodates text, programs, control characters and differentiates among the three.

Software is a problem

The byte-oriented protocols used today, including IBM's de facto-standard Bisync, Burroughs' Basic and DEC's DDCMP, need complex software to differentiate message text from the many overhead control characters these protocols need. In addition, they are severely limited to half-duplex operation.

Bit-oriented protocols, on the other hand, need recognize only two special characters—the flag pattern 0111 1110 ($7E_x$), which identifies the beginning and the end of a transmission frame, and an abort signal which is simply a sequence of seven or more consecutive ones. Other advantages include

- Full-duplex operation.
- LSI implementation.
- Fewer line turnarounds.
- Error checking over the entire transmission frame.

"Synchronous data link control" is another de facto IBM standard protocol. However, SDLC is also a type name for two similar, bit-oriented protocols that are destined to become standards. "Advanced data communications control prodecure" (ADCCP) is now in the final stages of development and will become the standard protocol of ANSI (American National Standards Institute). "High-level data-link control (HDLC) will become the ISO (International Standards Organization) protocol. The major features of these three SDLC-type protocols are bit stuffing and bit stripping. For all three protocols, the SDLC algorithm keeps the software simple.

Dick Hackmeister
Western Editor

An eloquent algorithm

In SDLC, the number of consecutive ONEs in the bit stream is never allowed to exceed five. The protocol

Data-communications equipment includes (clockwise from top) General Electric Terminet 30 teleprinter, which gives hard copy; Livermore acoustic coupler, which brings a telephone handset to computers; ADDS CRT terminal, which gives soft copy; Vadic VA3400 full-duplex modem (MOdulator-DEModulator), which operates at 1200 bits/s; and the Terminet 300 and acoustic coupler.

sub-system (either hardware or software) at the transmitting station imbeds an extra ZERO after the fifth ONE—neither the flag pattern (0111 1110) nor the abort pattern (1111 111X) is ever duplicated by data.

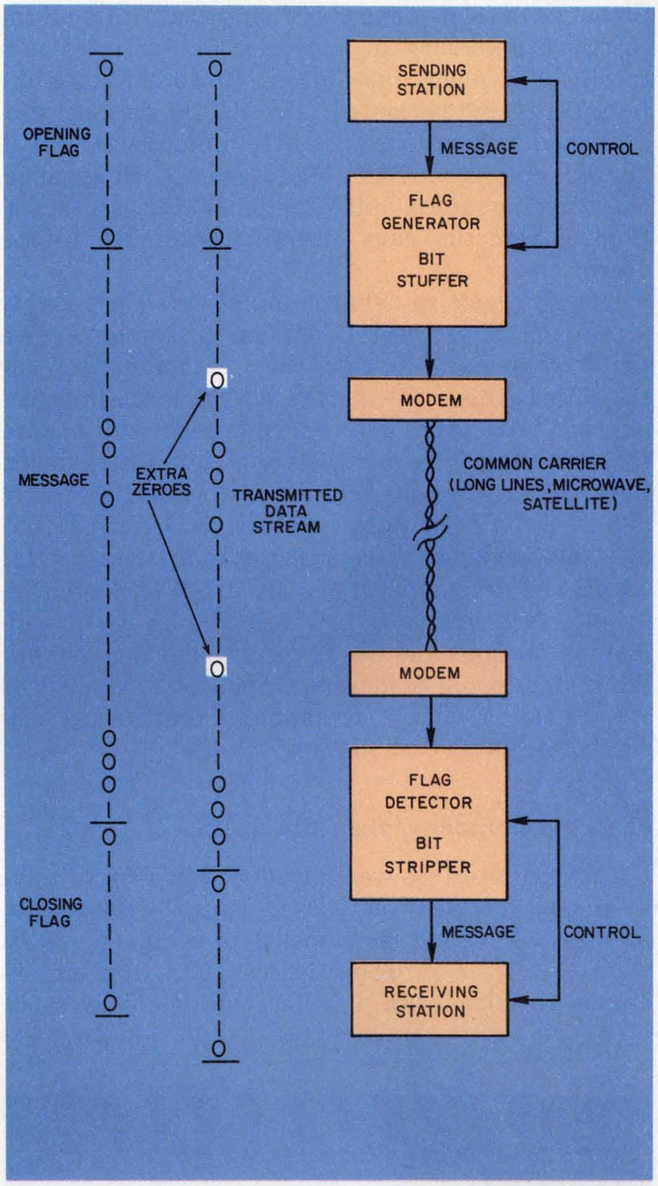
At the receiving station, the protocol sub-system reverses the algorithm, and strips away the first ZERO after a string of five ONEs. The buffered data are then passed on to the receiver. The whole process is transparent to the computers involved.

Transmission in bit-oriented protocol occurs in frames. Each frame has two flags and four fields—address, control, information (which may be empty) and check. The frame is bracketed by identical opening and closing flags. Flags are considered part of the frame. When not actually busy, stations in an SDLC network are kept in an "idle" state. But when an opening flag is detected, the receiving station becomes active.

One of the big differences among mainframe manufacturers' protocols is that the address field can vary in length—larger networks have more sophisticated addressing capability. An 8-bit control field defines how the information field is to be interpreted by the receiver.

The information field is any integral number of bytes long—its only limit is storage capacity. If the control field specifies a "management" or a "supervisory" frame, this field may be empty.

At this point comes a number, a 16-bit check field, constructed from all the data transmitted thus far, including the address and control fields. This check field is generated by the transmitter's protocol sub-system—if the receiver's sub-system constructs the same value, the message is considered error free. After recognizing the closing flag, the receiving station returns to its "idle" state.

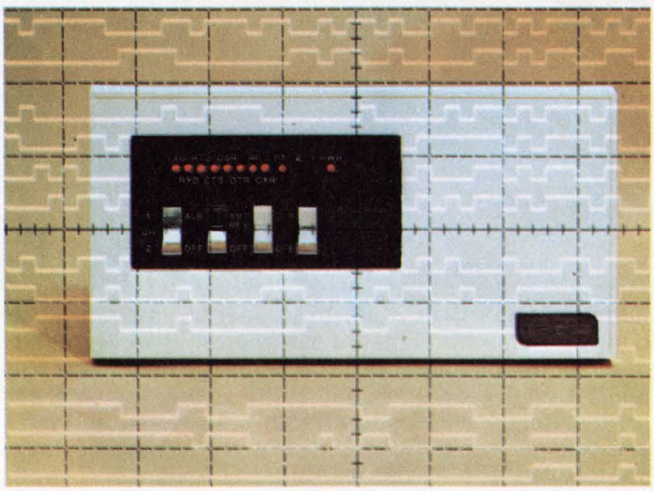


Bit stuffing (and bit stripping) is the key to bit-oriented protocols. A flag generator/bit stuffer is normally part of the computer's software system, but new protocol chips will make this overhead invisible to processors at both ends of the data-communication link.

The future is bit-oriented

Although IBM's SDLC is the current bit-oriented standard protocol, Saroj Kar, an independent communications consultant and ANSI committee member, predicts that HDLC will become the protocol in use after the turn of the century. But the shift from byte to bit will not be complete for quite some time and protocol chip designers are keeping one foot in the present and one in the future.

"Eighty to ninety percent of all the data communications taking place today is in byte-oriented Bisync—it dates from 1968, and it will be a long time before its sphere of application is exceeded," says Al Weissberger, an applications engineer who helped



Vadic VA3400, the first full-duplex, 1200-bps modem operates on dial-up or two-wire leased lines.

Signetics develop a super-LSI chip that shifts all the software necessary to implement bit-oriented protocols into monolithic silicon. However, since the present is byte-oriented, the device can be programmed to handle today's byte protocols as well. A similar chip from SMC Microsystems, Hauppauge, NY, with the same Digital Equipment Corp. specifications as Signetics' chip—also features multi-protocol operation.

However, getting data communicated is not simply a problem of protocol. Dissimilar instruments need an "intermediary" to help them communicate. One response to this problem, Hewlett-Packard's interface bus, has become the most widely recognized standard for communicating data between close instruments. Besides being accepted by the Institute of Electrical and Electronics Engineers and designated IEEE STD 488, the bus is now recognized as standard by ANSI which has designated it the MC 1.1-1975. Moreover, its interface scheme is now accepted by the 62 full-member nations and the 19 correspondent nations of the International Standards Organization and the 44 Western and Eastern-bloc nations of the International Electrotechnical Commission.

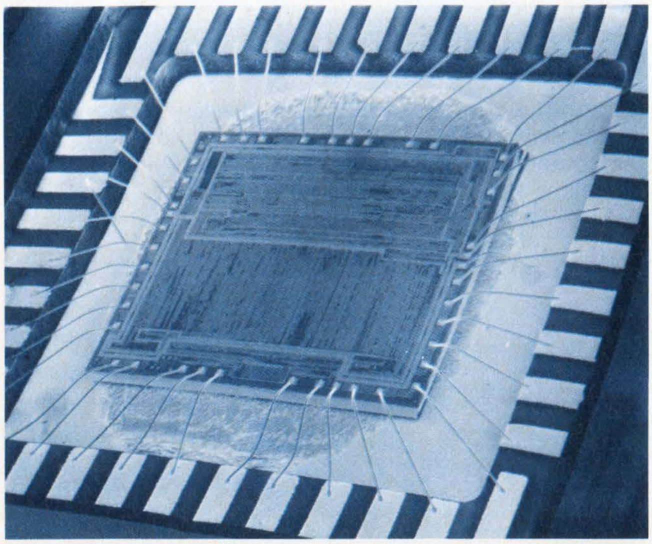
First the company, then the world

The HP interface was introduced in 1973 to solve a company problem that closely parallels the general problem of getting instruments to communicate—a wide variety of differing instruments from autonomous divisions. An interface scheme had to be developed to incorporate all these diverse devices into unique, individual, and functional systems.

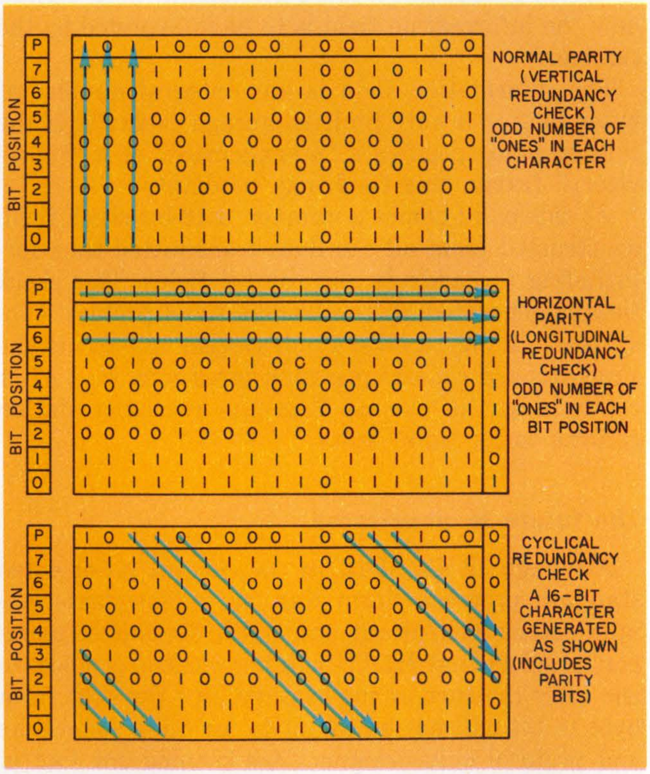
"We wanted an approach that would standardize the mechanical, functional and electrical interface considerations, yet leave the instruments' operational characteristics (programming) free to vary from device to device," recalls Don Loughery, HP's computer interface engineer, who helped develop the interface bus. As a result, not only can each device on the bus retain its particular control commands, but also five broad categories of instruments—stimulus, measurement, storage, display and control—can be connected. In addition, the HP bus can be converted to other interface schemes as well, such as the RS-232 bit-serial interface.

Sixteen active signal lines comprise the bus—8 bidirectional data lines, 5 general interface-management lines and 3 byte-transfer-control lines.

Each station on the bus can work as a "controller," a "talker" or a "listener." Some devices can assume



More complex than a μP, this super-LSI multi-protocol control chip from Signetics assumes all the overhead of data-communications protocol management: Flag and abort signal generation, bit stuffing and stripping and error detection. It supports both bit-oriented and byte-oriented protocols. (Scanning-electron-microscope image courtesy of The Aerospace Corp., El Segundo, CA)



Bit-oriented protocols use three types of error checking to ensure message integrity from transmitting station to receiving station: Vertical parity, horizontal parity and cyclical redundancy checks. The two parity schemes generate an odd (or even) number of ONEs for each byte and for each bit position in the message; cyclical redundancy is an arithmetic operation performed on the data in a wraparound fashion. A 16-bit number is generated from the data and appended to the message. If the data are transmitted correctly, the receiving station duplicates the CRC character and accepts the message. If not, another transmission is requested.

multiple roles, such as a calculator (control, talk and listen) or a digital multimeter (talk and listen). Other instruments like counters and signal generators are not as versatile.

Many stations can listen

The 488 can be configured for as few as two stations (a single talker and a single listener) or as many as 15 (a controller with 14 talker/listeners). Because certain control lines are wire-ORed, many stations can listen at the same time; the bus will accommodate the slowest of them. In addition, the 488 can operate up to 1 Mbyte/s, although most users' data rates lie in the range of a few thousand bytes/s or less.

One byte of data is transferred at a time—completely asynchronously, and without strobes. An "interlocked handshake protocol" between bytes prevents a new transfer from occurring before the current transfer is completed. Two levels of protocol are involved—initial and repetitive.

First, the control station sets the attention line (one of five general interface-management lines) true, and sends out the addresses of all the stations to be involved in the upcoming data transfer. In turn, each station recognizes its address on the data bus and prepares to listen or talk. Only one station, however, may talk at a time. The byte-transfer control lines then support the per-byte handshake protocol.

The 488 operates much like a computer intra-system data bus (except for the absence of a Direct Memory Access function)—in addition to byte oriented, asynchronous data transfer, cables are passive, and the devices they interface are parallel.

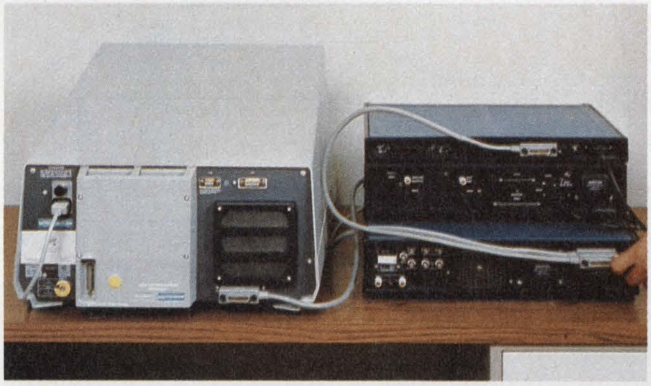
But no single solution can satisfy every interface problem. For example, computer automated measurement and control (CAMAC)—a backplane interconnect system for open-instrumentation modules —is widely recognized in Europe and accepted to a lesser extent in the U.S.

Developed by the Committee of European Laboratories in collaboration with the Energy Research and Development Administration (ERDA) and normally used to implement nuclear instruments, CAMAC is recognized as a standard by the IEEE and designated STD 583. Elements connected into a CAMAC system are called crates, and its 24-bit bus structure is called a highway.

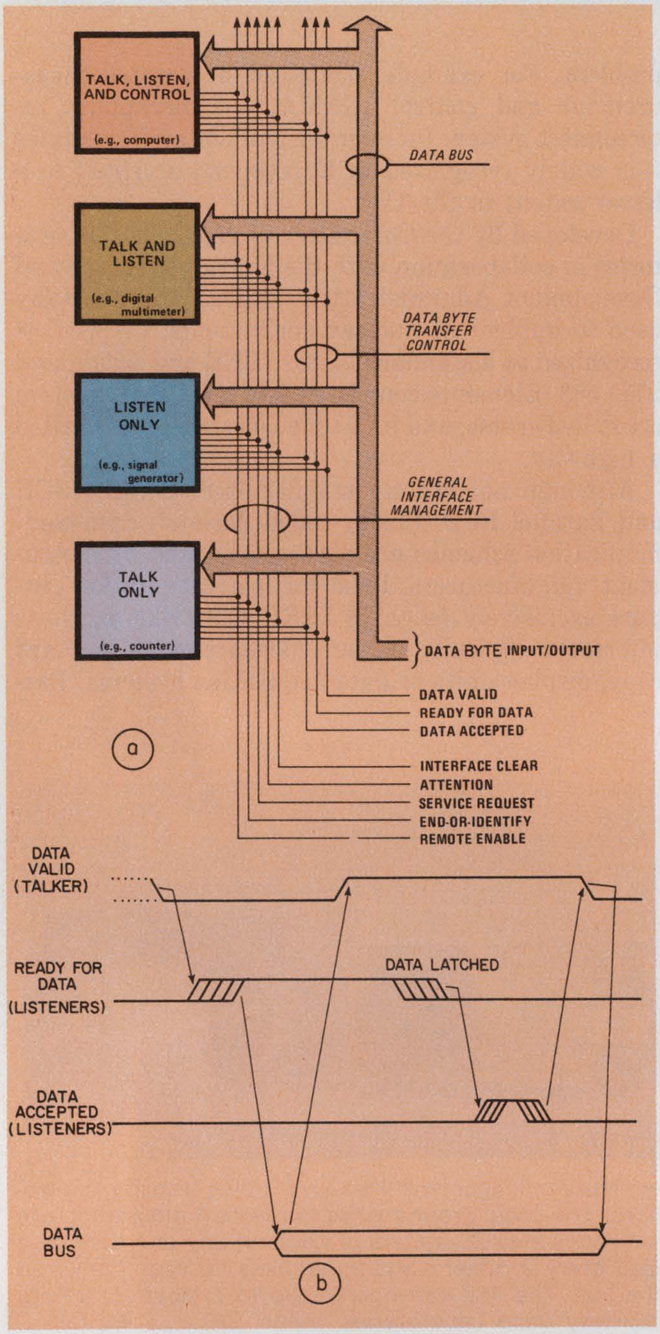
Although not exactly standardized, Serial ASCII and Parallel BCD (binary-coded decimal) data-communication schemes are also widely used by instrument manufacturers. Used for instrumentation outputs exclusively (such as IEEE 488 talkers), these interfaces typically output measurements to hard copy, display units or data acquisition systems. Parallel BCD uses parallel lines to describe a value (measurement result) in a 4-bit scale-of-10. The bus structure typically includes a print-command line and other simple control functions.

Serial ASCII is used for the same purpose, but describes measured values in terms of the standard ASCII character set, and presents them serially to the outside world on a single pair of wires. As a result, instruments can interface directly to a teleprinter, data logger or data-acquisition network.

This kind of bit-serial data communication, which is called RS232C by the Electronics Industries Association, is the latest revision of RS232, EIA's description of an interface between data-terminal equipment and data-communication equipment employing



The Hewlett-Packard Interface Bus, also known as HPIB, GPIB and IEEE Standard 488, is the standard data-communications scheme for instrumentation systems. Here, it interconnects a Tektronix 4051 calculator, a Dana 5900 digital multimeter and a Dana 9000 timer/counter. A single cable carries 8 bidirectional data lines, 5 general-interface-management lines and 3 byte-transfer control lines. The basic ground rules for system integration are not more than 20 meters of cable in any one system, a load every 2 meters, and an address for each "box" on the bus. The 488 can operate up to 1 Mbyte/s. (Photo courtesy Dana Laboratories, Irvine, CA).



The HP interface bus's 16 signal lines interconnect an instrumentation system with as few as two and as many as 15 independent "boxes". Bytewise data communication takes place with the patented, three-wire handshake protocol shown.

serial binary-data interchange. However, this "C" version is just about nine years old (Aug., 1969). Small wonder, then, that EIA has supplemented RS232C with updated interface standards in RS422 and RS423, which apply to integrated circuit implementations of bit-serial interfaces. RS422 describes a balanced line standard that overcomes noise problems; RS423 covers the "unbalanced" version. While RS232C's maximum line length is 50 ft, both RS422 and RS423 are useful up to 4000 ft between devices. And whereas RS232C is slow—it is limited to 20 kbits/s—RS422 operates up to 10 Mbits/s.

A family of devices has been introduced by Motorola Semiconductor, Mesa, AZ, to support the new EIA bit-serial standards. This MC-3480 series provides balanced and unbalanced drivers and receivers in dual and quad packages. In addition, Motorola plans to introduce a monolithic device to support the HP bus's handshake protocol this fall. It will be designated MC-68488.

Datacom: a universal concern

Data communications is an ongoing concern of several organizations, both here and abroad. The father of international technical organizations, the International Electrotechnical Commission, spawned the International Standards Organization. The ISO group most concerned with data communications is Technical Committee 97, Subcommittee 6—ISO TC 97/SC6 for short. The American National Standards Institute is the U.S. representative to ISO.

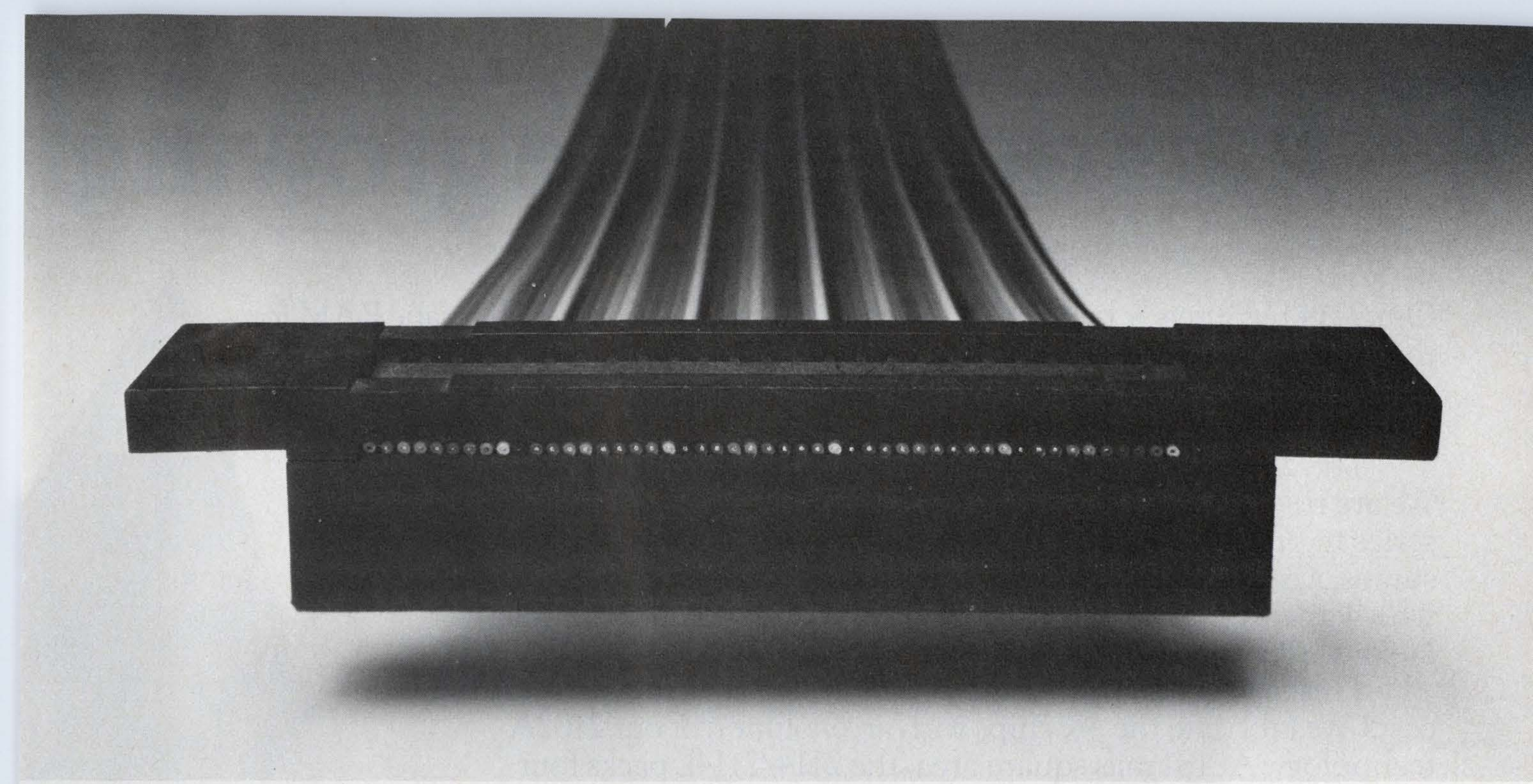
ANSI's standards are widely used by U.S. firms as guides, and often modified. At least nine different standards come from ANSI, ranging from the definition of ASCII to the determination of over-all datacom system performance. Many have been adopted by the Government, are called FIPS (federal information-processing standards), and are mandatory for the Department of Defense.

The Electronics Industries Association publishes standards, too, some of which duplicate ANSI standards. The 14 EIA standards carry an "RS" prefix, and the most popular is probably RS232. These standards are updated periodically. (Designers of any type datacom system should become familiar with EIA's new RS422/423 interface standards—they describe balanced and unbalanced updates for RS232C bit-serial lines.)

The Institute of Electrical and Electronics Engineers publishes standards, but only reluctantly. IEEE publications come in three degrees of importance: mandatory "standards," recommended "preferred procedures" and suggested "guides."

Technical organizations aren't the only standard makers. The Bell System, Data Transmission Co., MCI and American Telephone and Telegraph Co. all have similar "common carrier" standards. These standards have a common prefix, "PUB," and standardize such considerations as a 30-baud private line channel interface (PUB41001) and connector requirements for automatic dialers (PUB41601). Over 30 common-carrier standards are available from AT&T alone.

One government program currently underway is the Federal Communications Standards Program (FCSP), which is developing the National Communications System (NCS). The standards developed by this agency will overlay a number of ANSI standards and will be published by the National Bureau of Standards (NBS). They, too, will be FIPS. ■■



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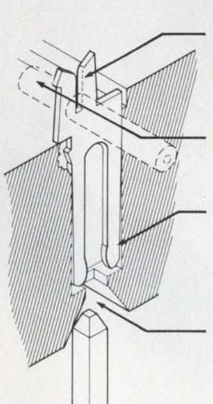

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CIRCLE NUMBER 20

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Our 2114 has already become the most widely second-sourced 4K static RAM for the same reason Intel's 2102A is the industry standard 1K static RAM. The 2114 simplifies system design, like the 2102A, and provides the highest possible density and modularity in static memories.

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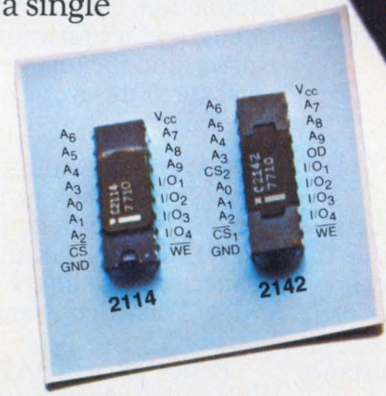
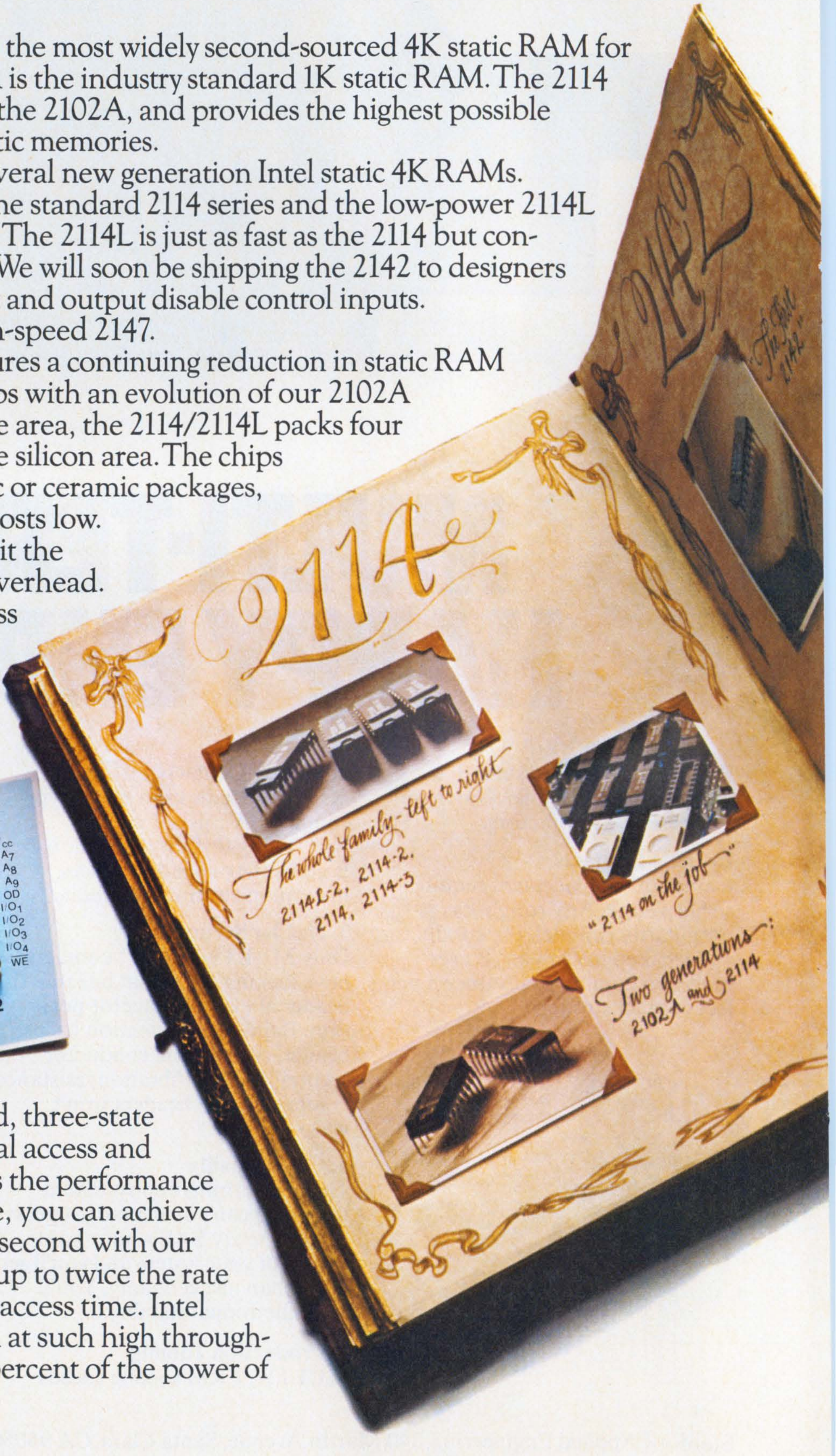
This new generation assures a continuing reduction in static RAM costs. We fabricate the 4K chips with an evolution of our 2102A technology. At 181 mils square area, the 2114/2114L packs four times the bits in only twice the silicon area. The chips fit into standard 18-pin plastic or ceramic packages, keeping volume production costs low.

Our 4K RAMs also inherit the 2102A's ease of use and low overhead. You don't need a clock, address setup timing, or refreshing. You don't even need pullup resistors or output gating. These RAMs operate at TTL levels on a single



+5v supply and have buffered, three-state outputs. We guarantee identical access and cycle times, so you can surpass the performance of clocked RAMs. For instance, you can achieve a data rate of 20 million bits a second with our 200-nanosecond parts. That's up to twice the rate of clocked RAMs with 200-ns access time. Intel specs also guarantee that even at such high throughput you'll need only 25 to 50 percent of the power of first-generation static RAMs.



4K static RAM family.

As for board density, look at the pinouts. The 18-pin 2114/2114L configuration provides the highest density possible in 4K static RAMs.

Our 20-pin 2142 adds a second chip select—so you can go to 4K without external decoders—and an output disable for direct control of the output buffers. And since it is a simple modification of the 2114, it promises similar production economies.

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1K x 4	Access Time (max) Cycle Time (min) 0-70°C	I_{CC} (max) 0-70°C
2114-2 2114L2 2142-2	200 ns	100 mA 70 mA 100 mA
2114-3 2114L3 2142-3	300 ns	100 mA 70 mA 100 mA
2114 2114L 2142	450 ns	100 mA 70 mA 100 mA
4K x 1 with low power standby		
2147	70 ns	160 mA Active 20 mA Deselected

The 2114/2114L series is already as easy to get from stock as the 2102A. The 2142 soon will be. Contact any Intel franchised distributor: Almac Stroum, Component Specialties, Cramer, Elmar, Hamilton/Avnet, Harvey Electronics, Industrial Components, Liberty, Pioneer, Sheridan, L.A. Varah or Zentronics.

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CIRCLE NUMBER 21

COMPUTER '77

Computer-aided design beats trial-and-error —just find the software

Computer-aided design is the most powerful engineering tool today, and is used extensively in many high-technology industries. With CAD, for example, you can optimize the design of a complex filter network in minutes. And yet, many thousands of engineers are hanging on to the wasteful "trial and error" method. Why?

Cost and scanty information about CAD software have restricted the use of CAD. Yet for most applications that would benefit from CAD, hardware cost is no longer an obstacle. Over the past decade, minicomputers have reduced hardware cost by a factor of 10, and now microcomputers are lopping off another order of magnitude. And as more CAD software is being developed, its cost is also coming down.

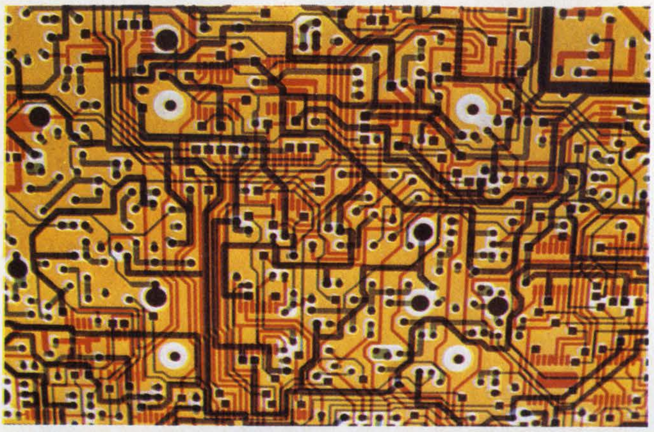
But you still have a rough time finding out what's available and where. Why have repeated efforts to compile CAD libraries failed?

Much of the existing CAD software has been developed in industry for internal use, and is not available to the public. The rest is also proprietary to a large extent, but can be rented or purchased from software houses. There is one notable exception: About 1600 programs, developed under NASA funding, are accessible through Cosmic, a software library in Athens, GA (for full address, see Table 1). Brief program descriptions are sent on request. You can purchase documentation at roughly \$.07 per page, and the program itself for \$.10 to \$.50 per line of code, depending on the length of the program and your selection of a transfer medium.

Computer manufacturers can be a source for applications software, but their programs are mostly math or graphics packages, and tailored for use on their own hardware. There *are* exceptions, such as IBM's circuit-analysis program, ECAP,[1] which is used worldwide on many different computers.

Chances are, you won't find the exact program you need in the "public" sector. Even if you do, you probably will have to modify it for your application, and adapt it to your computer. Since these costs can be very substantial, you may prefer to buy a packaged CAD program from a software house, even though that price may go into five digits. In addition to the program itself, the package contains full documentation, and helps you get started.

Max J. Schindler
Associate Editor



Computers generate the artwork for complex ICs or PC boards. In this composite photo from Markrevel, each color represents a different layer of a PC board for the space shuttle.

$30,000 can be cheap

These expensive programs can save you a bundle. A few years ago, two companies obtained contracts to build 10 prototypes of a very sophisticated traveling-wave tube. One company designed the tube with about \$30,000 worth of CAD programs. It assembled 15 tubes, and qualified 10 prototypes in six months. The other company, staying with the trial and error method, built well over 100 tubes (at about \$3000 each), and after a year was still trying to qualify prototypes.

But before you commit yourself to a \$10,000 program, make doubly sure it's the right one. Get an opinion other than the vendor's. Consult a member of a growing profession—a software consultant who does not offer any programs of his own. You should contact professional societies or universities active in your field, suggests Dr. William van Cleemput of Stanford University, himself a highly reputable consultant in logic simulation and artwork generation.

But even if you have found the best program, and have properly debugged it, you have covered only part of the total expense—possibly even a minor one. Software maintenance is the biggest cost item (70%), according to Barry Boehm of TRW, followed by design and test (12% each), and coding (6%).

And even though some published surveys show that purchased software often saves 90% of the installed cost,[2] make sure you actually receive all the support you are expecting. Software houses form a very volatile industry. Of 2800 companies active during the late Sixties, only 800 survived the 1969-to-1971 pinch. But lately, they have jumped to well over 3000. In fact, the 1974 recession proved somewhat beneficial because many companies pruned their in-house EDP personnel sharply.

Before buying software, consult an EDP information service like Datapro, Delran, NJ, even though not too many technical programs are included in its program list or user ratings.[3] For EDP software in general, a Datapro survey reveals that 63% of the programs purchased in 1976 required no modification, 19% were modified by the vendor, and 23% by the user. For technical software, which is much less standardized than financial programs, the modification rate is bound to be much higher.

There are technical pitfalls, too

But you still aren't home-free. Say you obtain a medium-sized program on paper tape. Though written in "standard" Fortran IV, if developed on Digital Equipment's PDP11, it will probably not run on Data General's Nova, or vice versa. In fact, you may not even be able to feed the tape in. While a short program can always be keyed-in by hand, you don't want to try that with even a moderately complex program. Several typing errors per page are practically guaranteed, and that means hours of troubleshooting.

Large programs are frequently installed from IBM cards, which are accepted by most computers—provided you have a card reader. But even if you do get the program up and running, your troubles are far from over.

Dollars in—garbage out

Costly or not, the program you acquire will probably not run on the first try—or it will output "garbage." A reputable software house certainly will not leave you hanging with a $10,000 inoperative program, but neither will it compensate you for your (and your computer's) time—unless the contract says so. And even if the program runs, debugging can cost you real money.

In fact, one of the most agonizing experiences is to struggle with a program that works well with the vendor's own set of parameters, but gives wrong answers to *your* inputs. Since the canned program you acquire must use your computer's own math library —which often differs from the vendor's—weird things can happen.

In one case, a problem was caused by the host computer's algorithm for a Bessel function, which would not converge beyond a certain value of the argument. The question is, how much time and money will your company expend before it stops "throwing good money after bad," and aborts the whole mission?

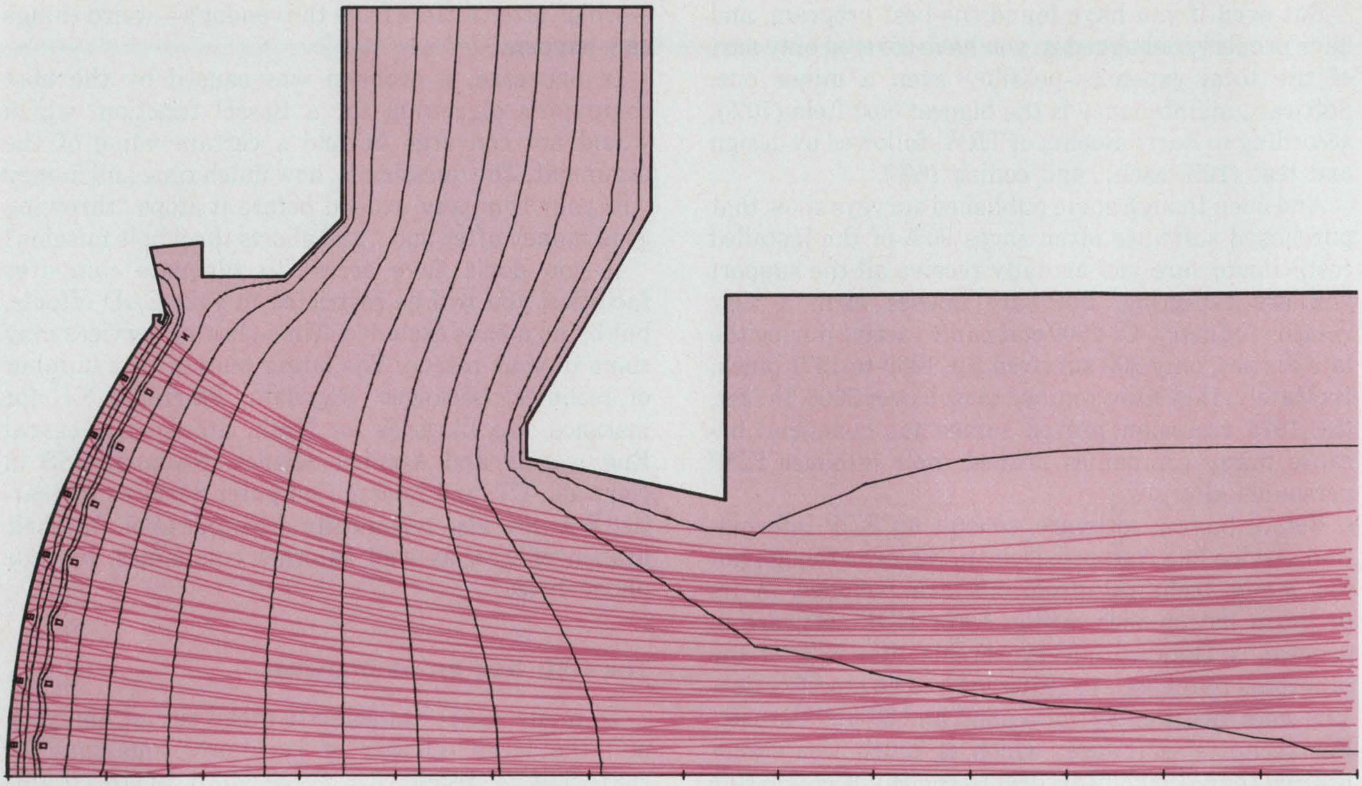
If you don't have access to adequate computer facilities, you will be restricted in your CAD efforts, but by no means excluded. Time-sharing services may come to your rescue. The larger ones offer a number of technical packages. Rapidata, Fairfield, NJ, for instance, has libraries for Math, Statistics, General Engineering and Applied Science. National CSS in Norwalk, CT, and Boeing Computer Services in Seattle, WA, are also technically oriented. Look for their branch offices, as well as other companies, in your phone book.

The CAD tree grows branches

To many, CAD has come to mean circuit analysis, and the large number of such programs may be confusing. A recent Air Force study of 16 circuit-analysis programs can help you choose the right one for your application.[4]

Several types of programs have evolved from circuit-analysis and have established a number of well-defined "branches" on the CAD "tree." One rather straightforward development carries the frequency range up to microwaves, even millimeter waves. Here, distributed components (primarily transmission lines) become very important, while transients are usually of little interest at such high frequencies.

When you design circuits with a computer, you can change the performance with the stroke of a pen, as on this Sanders console. The computer may even display the revised schematic.



After calculating the equipotential lines (black) of a traveling-wave tube gun, a program from Shared Applications plots the electron trajectories (color) accounting for space charge.

As a result, the preferred model for such circuits is no longer a loop/node algorithm. Instead of solving simultaneous equations as a time function, circuit elements are now described by steady-state parameters. These can be scattering (S-) parameters, chain (ABCD-) parameters, or hybrids. Reasonably large networks can be strung together from such elements, but they rarely reach into the hundreds of branches that are typical of ECAP-type circuit-analysis routines.

As soon as computer-aided circuit analysis was established, engineers began to look for ways to have the computer automatically change circuit parameters until the outputs came as close to the design goal as possible. Now, optimization is almost a discipline in its own right, and is often listed as a mathematical routine.

Solid-state technology has stimulated several other major limbs on the CAD tree. For example, since the nonlinear transistor is not easily represented by one equation, or even a few, transistor modeling can be credited with putting solid-state circuitry within the grasp of network analysis.

Next, a logical development

While analog circuits usually require less than a dozen transistors, digital circuits consume transistors now by the thousands—and pretty soon by the millions. No wonder that logic-design programs represent a major CAD branch. Aside from transient analysis, logic CAD is only marginally related to the network-solving algorithms of analog-circuit design.

Another digital branch may even be regarded as a separate tree. As circuit integration has mushroomed from small to medium to large-scale, the routing of interconnections on a chip (or PC board) has surpassed human patience. Only a dumb but dedicated servant like the computer has the perseverance to try thousands, even millions, of combinations to find the best solution.

Once the computer has found the ideal interconnections for 50,000 transistors to fit into a few mm^2, you might as well have it draw the masks. So, automatic artwork generation has become widespread and automatic drafting, another outgrowth of IC technology, is becoming increasingly popular.

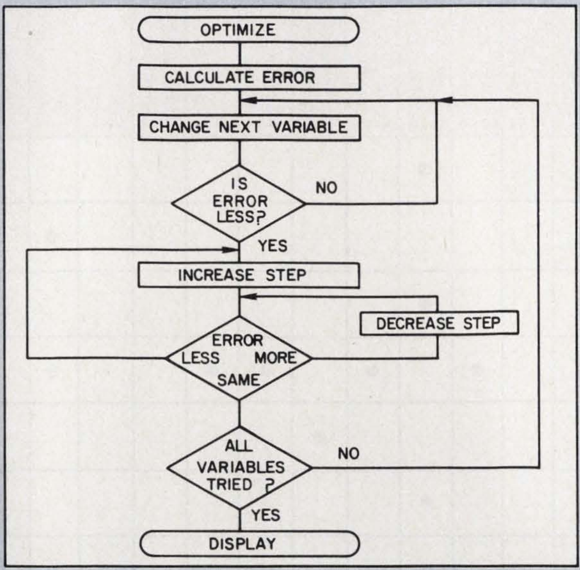
A picture may be worth 1000 dollars

An offshoot of automatic drafting is the entire field of computer graphics. Today, you can feed a rough circuit sketch into a terminal, then modify your computer's interpretation. You can move connecting points, change components, and add elements—all with the stroke of a light pen.

Computer graphics lets you turn a three-dimensional object to any desired view, and even figure out how your prototype can best be assembled, without ever having to build one.

The future development of CAD will be deeply affected by the microprocessor. As more affordable

How computers optimize



Self-optimization routines are sometimes very complex, for example using derivatives and Monte Carlo techniques. But often a simple algorithm like the one roughly flow-charted above will suffice.

In any case, the user must first define an "error function," which contains all important circuit characteristics, like gain, flatness, etc. The computer then varies circuit elements until this error can no longer be reduced.

In a small circuit, the computer can simply change one variable at a time. Starting with a small change, the program increases the step size if the error gets smaller, and then backtracks when the lowest error value has been passed.

If the circuit elements interact with each other, the algorithm shown may not find a global minimum. Rather, the process must be repeated until new iterations yield no further improvement. An element of randomness is usually introduced to avoid retracing the same change sequence.

Choose your favorite model

To work in computer-aided design, you must start with a mathematical model that translates the physical world into equations or tables with which your computer can work. No model—no CAD. Consequently, modeling has become a discipline in its own right.

In electronics, an ideal model would require that you give the computer the location of every electron (and hole) in your device, as well as all boundaries and applied voltages. Then you would feed-in the force equations, and watch the electrons move. However, for any practical device, such a model is still ages away.

But computers *can* solve differential equations (Laplace's or Poisson's) and thus calculate the field in relatively simple geometries, such as electron guns. Once you have the fields, electron trajectories in a vacuum can be determined (and plotted) easily.

Because the "trial and error" approach is terribly expensive for sophisticated electron-beam devices, CAD holds an unchallenged position here. Thermal, stress and hydrodynamic problems can be solved with similar algorithms.

Most engineers, however, work with circuits. Here, too, fields move electrons, but the geometries are far too involved to use electron motion as a model. So you must resort to solving node and loop equations for large networks. For pure dc analysis, that's rather simple. Computers are especially good at solving linear, simultaneous equations that are far too unwieldy to be tackled by hand. Ac and transient analysis add only a time axis to the process.

Keep in mind, also, that nonelectrical problems can often be expressed by electrical analogs. Heat flow, permanent-magnet circuits, and mechanical systems can all be analyzed with network algorithms.

microcomputers with more peripherals get into more engineering labs, CAD programs will become more and more available. And hopefully CAD will benefit as microcomputers proliferate in the home as well as the office—better methods for transferring computer programs will be developed.

At present, paper tape is used widely to transfer small programs. The tape is cheap enough, but readers and punches aren't. And paper tape isn't adequately standardized.

Many "hobby" programs are now available on inexpensive audio cassettes. One manufacturer is rumored to have put his operating system and program library on LP records. But neither of these media can even approach the ultimate bargain in information transfer —printer's ink.

No wonder experiments are already underway to input programs from printed bar code—the lines you find on soup cans and cereal boxes. With a ruler and a light pen, you can read-in small programs in less than a minute, and new programs can be mailed to you by vendors or clubs for pennies. This "paper tiger" may start a new era in computer-aided design. ■■

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(Continued on page 48)

Software vendors for different CAD categories

	Artwork Generation	Beam Tube Simulation	Circuit Design	Graphic Display	Logic Simulation	Mathematics Libraries	Mechanical Thermal	Nonlinear Modelling	Optimization Algorithms	Statistics Programs	Test Automation	Other technical Programs
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Cambridge Computer Associates, Inc., 222 Alewife Brook Parkway, Cambridge, MA 02138. (617) 868-1111.				●								
Cambridge Telecommunications Inc., 41 North Rd., Bedford, MA 01730. (617) 275-1383.										●		
Chi Corp., 11000 Cedar Ave., Cleveland, OH 44106. (216) 229-6400.										●		
Compact Engineering, 1651 Jolly Ct., Los Altos, CA 94022. (415) 968-7025.			●						●			
Computer Aided Design Centre, 25 Kensington Gore, London, SW7 2EP, England (01) 589-7496.				●								
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IBM Corp., Data Processing Div., 1133 Westchester Ave., White Plains, NY 10604. (914) 696-1900.			●	●		●	●	●		●		●
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M & S Computing, Inc., P.O. Box 5183, Huntsville, AL 35805. (205) 772-3411.				●								
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	Artwork Generation	Beam Tube Simulation	Circuit Design	Graphic Display	Logic Simulation	Mathematics Libraries	Mechanical Thermal	Nonlinear Modelling	Optimization Algorithms	Statistics Programs	Test Automation	Other technical Programs
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Optimal Systems Research, Inc., 200 Atlantic Ave., Box 458, Manasquan, NJ 08736. (201) 223-1131.			●						●			
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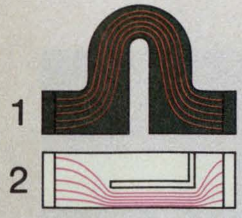

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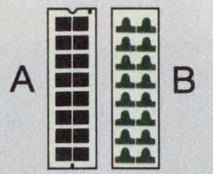

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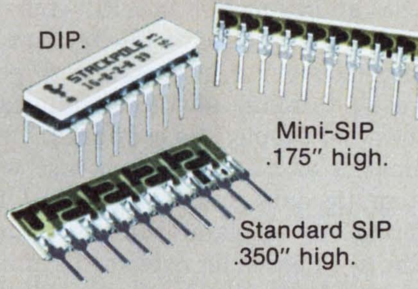

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CIRCLE NUMBER 23

Kenneth Iverson: from a symbolic notation to A Programming Language

"I never really sat down and said 'I'm going to develop a computer language'," Kenneth E. Iverson says, thoughtfully, as he reaches over to a small computer-terminal on his desk and types an instruction in APL—the computer language he invented in 1957 while trying to devise a new system of conveying information to people.

"I wasn't thinking about communication between machines and people," he continues. "While teaching mathematics at Harvard I was also writing a book on automatic data processing. And I found that in attempting to explain things, such as sorting algorithms, I needed an expanded system of notation —a system both simpler and more general than conventional mathematical notation provides."

Iverson turned for help to the computer languages available at the time—Flowmatic, Fortran and others. But he found them useless for his purposes—mainly because they didn't recognize the importance of arrays, or lists (vectors), and tables (matrices).

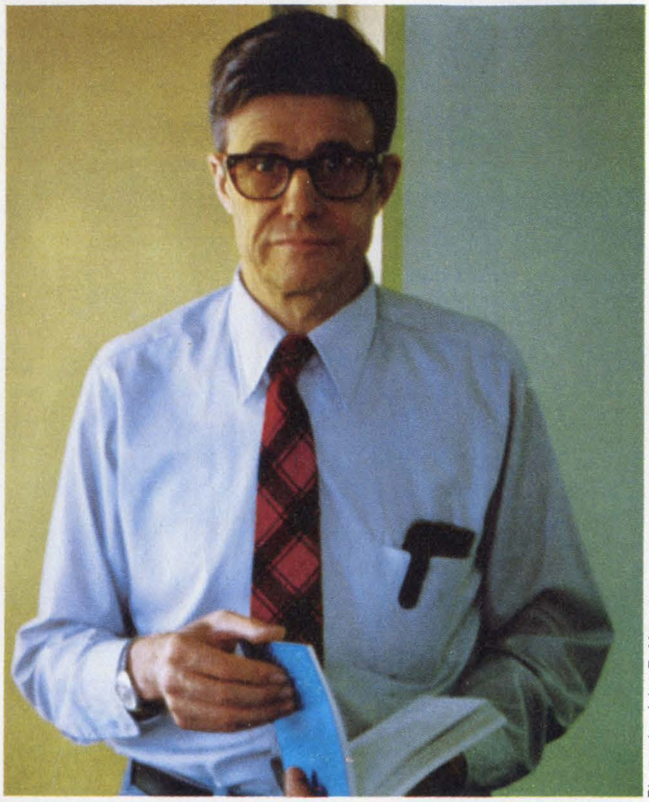
So Iverson decided to develop a system of his own, basing it on conventional mathematical notation and enriching it with symbols he created himself. "When I started I had no intention of creating anything that wasn't needed. I used accepted mathematical notations unchanged. I was perfectly happy with the conventional +, −, ×, and ÷ used in grade school and up." Where no symbols existed, Iverson invented new ones.

Alan Perlis, director of the Computer Science Dept. of Yale University, calls APL (A Programming Language) "a kind of shorthand in which complex data manipulations can be described in single statements." Perlis's students, he says, advance three times faster in programming skills and general understanding of electronic data processing than with more conventional programming languages.

APL is also more concise, Perlis says. "In many cases, there is a 10 to one ratio between the number of Fortran statements and APL statements."

"In another three to five years, APL-based systems will be a major factor in the management of businesses worldwide, and with this as the spearhead, APL will penetrate all aspects of data processing at an accelerated rate," according to Adin Falkoff, who has worked closely with Iverson on the development of APL at the Computer Sciences Dept. of IBM's Research Div. in Yorktown Heights, New York, and later in Philadelphia.

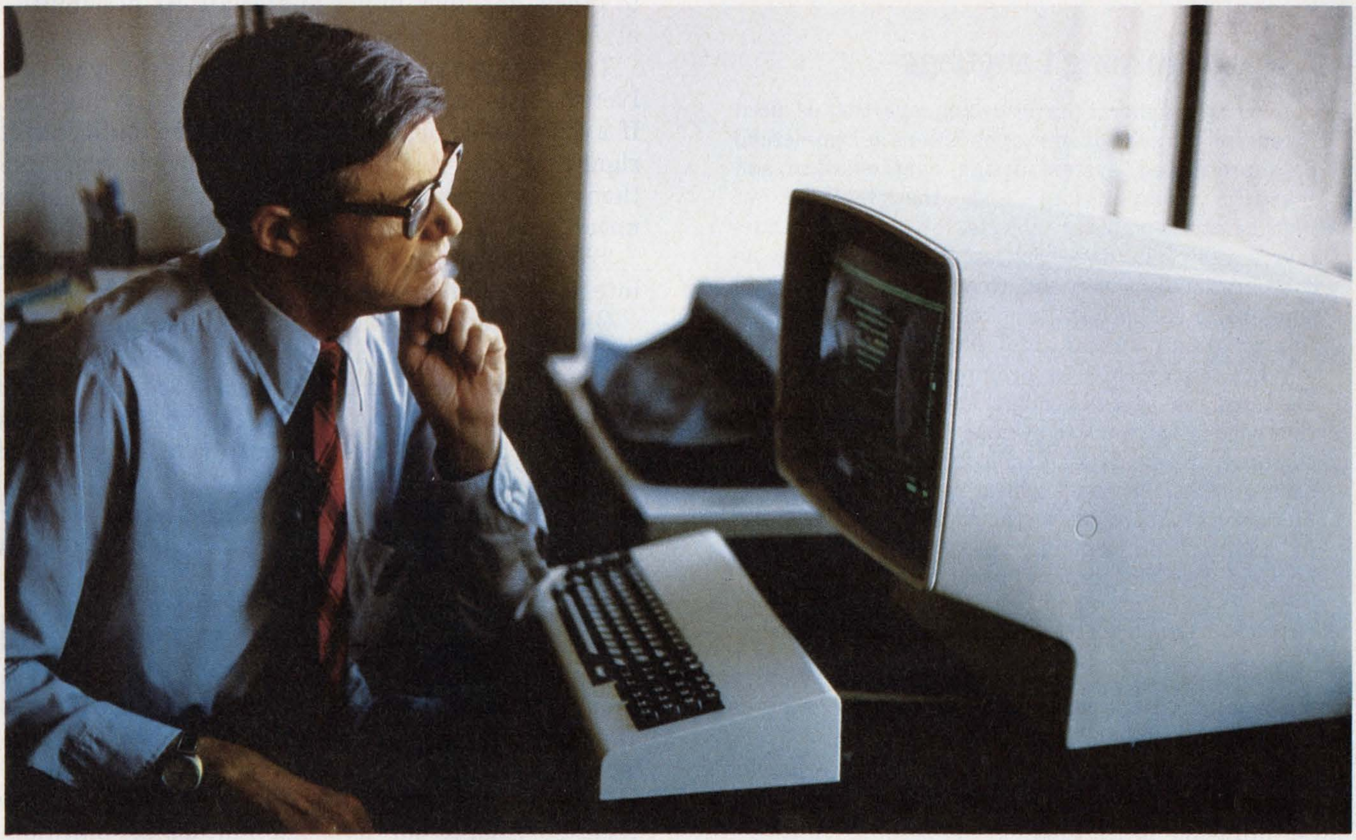
The variety of current APL users, most of whom are not involved in mathematical pursuits, is illustrated by the papers presented at last year's "Proceedings of the Eighth International APL Users Conference." Topics included medical research, hospital administration, a system for evaluating projects in the petroleum industry, investment analysis, text editing



Photos by John F. Mason

"Designers are missing a fantastic opportunity if they don't take a serious look at APL," Kenneth E. Iverson says. "Working with it ushers in a whole different world."

John F. Mason
Associate Editor



Kenneth Iverson invented "a kind of shorthand in which complex data manipulations can be described in single statements. In many cases a 10-line statement in Fortran becomes one statement in APL."

and on-line interactive collection and analysis of scores at gymnastics competitions.

Once a mathematician. . .

Iverson began his career as a mathematician, and in spite of having invented a highly successful computer language and becoming manager of IBM's APL Design Group, he still thinks of himself as such. "Computers," he explains, "are just a mathematical tool."

Iverson's identification with mathematics includes a B.A. in mathematics from Queen's University, Kingston, Canada, in 1950; an M.A. in mathematics from Harvard University in 1951; and a Ph.D. from Harvard in applied mathematics in 1954. He discovered the relatively new world of computers in *Giant Brains*, by Edmund Berkley. Subsequently, he took a course in computer design at Harvard given by Prof. Howard Aiken, the originator (in 1937) of Harvard's famous Mark I built by IBM and completed in 1944.

Iverson became so intrigued by the potential he saw in computers that he transferred out of the mathematics department and into Engineering and Applied Physics. He completed his thesis on computer solutions of an economic model under Professors Aiken and Wassily Leontief (who would win the 1973 Nobel Prize in economics). Then in 1955 Aiken expanded his faculty to develop a curriculum in automatic data processing, and Iverson became one of the newly appointed instructors.

"That's really where I did the early work on APL," Iverson recalls. While teaching, he found, somewhat to his surprise, that many of the notational facilities that he had introduced for the treatment of sorting methods were virtually what he needed for treating things like the simplex method in linear programming.

"As I went from one application to another," Iverson remembers, "I found new needs, and for each one I introduced additional notation. For the first two or three years, each new application called for new symbols. The language was getting much too complicated and I was beginning to despair."

Iverson then made an important observation.

"I realized the value of generalizations: one symbol could be used to express a number of things, depending on how it was used." From then on, the key to developing APL was to recognize generalizations.

First commercial work

Iverson continued to augment and refine his growing system of notation while teaching and writing at Harvard. In 1957 he spent six months with McKinsey and Co., in New York, on a computer model of a transportation problem for one of its clients. This

A Programming Language

APL is a general-purpose language that is used extensively in such diverse applications as commercial data processing, system design, mathematical and scientific computation, and the teaching of mathematics and other subjects. It has proved particularly useful in data-base applications, where its computational power and communication facilities combine to enhance the productivity of both application programmers and end users.

When implemented as a computing system, APL is used from a typewriter-like keyboard. Statements that specify the work to be done are typed in, and the computer responds by displaying the result of the computation. The result appears at a device accompanying the keyboard, such as a printer, or video display. In addition, entries may also invoke the use of printers, disc files, tapes or other remote devices.

work broadened the range of applications being considered in the development of APL.

In 1960, Iverson went to work for IBM. But he didn't start thinking seriously about implementing his computer notation until 1964.

Why did it take so long?

"Benign neglect, I suppose," says Iverson. "If there'd been more interest in the company, we'd have implemented it sooner.

"APL may have lacked backers because it was so different. It was hard for traditional computer people to grasp, and they didn't appreciate its possibilities at first."

The delay was actually beneficial in the long run, Iverson believes. "It's one reason APL is so bug-free. If a language is designed for a machine, built into it right away and sold to hundreds of people who from then on don't want it to change, you will have some uncorrectable weak spots.

"We had years to work on APL before anyone got interested in implementing it on a computer."

Once the decision was made to implement APL, the first step was to design a typing element, like those used on IBM Selectric typewriters, except that this one contained symbols for APL. Iverson and his colleagues then wrote software to run the language on an IBM 360 computer.

"By 1966, we had a time-sharing system, and by 1967, APL on the IBM 1130 was available to users outside IBM."

In 1968, IBM put out an APL program for the 360, and in 1973 produced the APLSV (SV means "shared variables"). "This enabled us to use a larger data base than for previous systems, which opened the door to applications requiring extensive engineering calculations.

"The use of APLSV has grown rapidly," Iverson reports. "Most of our divisions now use the machines in their commercial data processing."

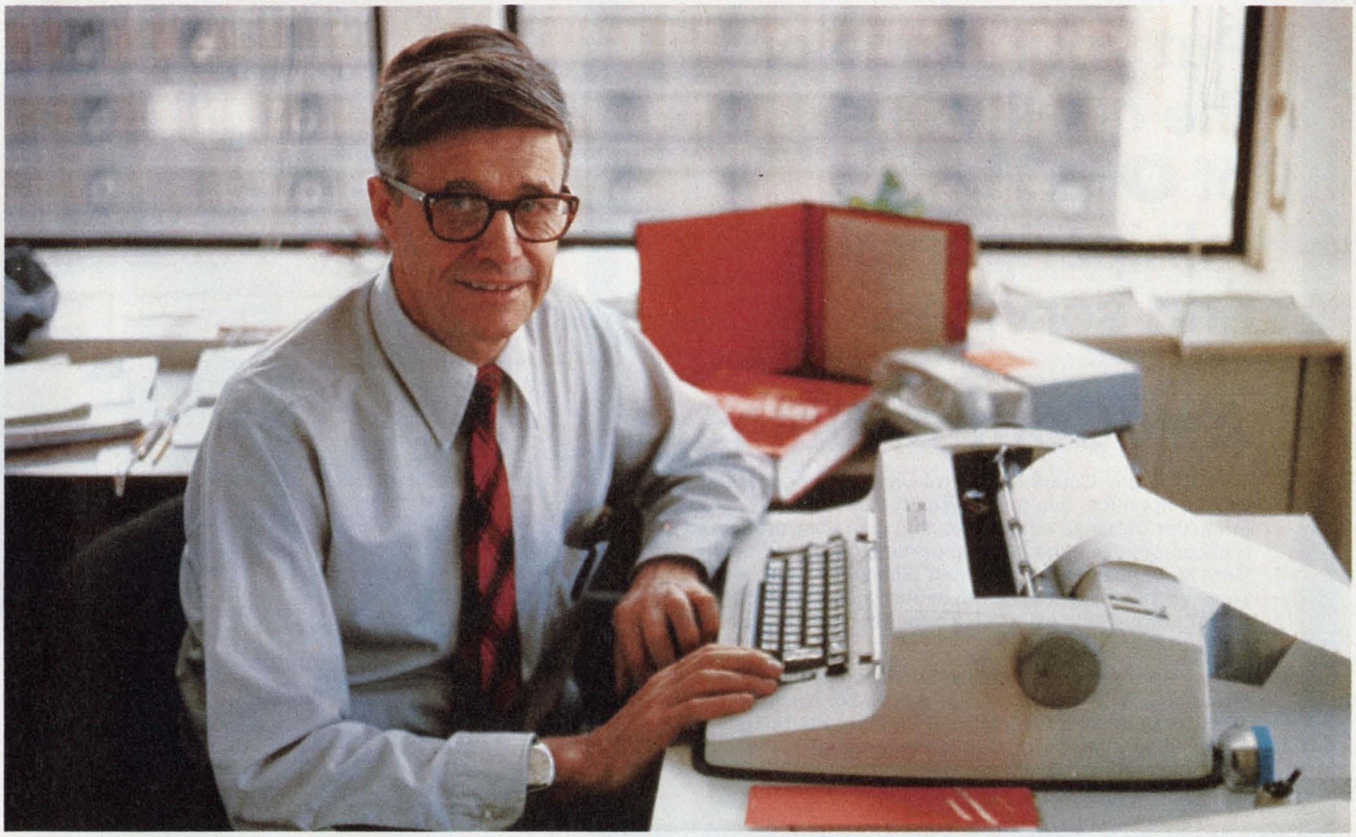
More than mathematical

But somehow, the idea persists that APL is just a mathematical language for mathematical applications

APL: A powerful shorthand

```
      B←26 13 17 28 41
      +/B×B>25
95
      X←1 2 3 4 5
      4⍕B⌹X∘.*0 1 2
  41.0000 ¯20.7857  4.2143
```

In the first example above, the APL expression +/B×B>25 yields the sum of all balances B which exceed 25; the second example yields the four-digit approximation to the coefficients of the polynomial which best fits the function values B for arguments X.



Iverson began his career as a mathematician and in spite of having invented a highly successful computer language and becoming manager of IBM's APL Design Group, he still thinks of himself as a mathematician.

—an erroneous impression, insists mathematician Iverson. "Ninety per cent of APL used, inside and outside IBM, is for commercial data processing. It's also used successfully by design engineers. We use APL to design APL machines."

Indeed, Iverson likes to point out the ease with which anyone can use APL. "You don't need to be a programmer or to know anything about computers. It's like driving a car: You don't need to know anything about the internal combustion engine to drive. You just need to know what language the automobile speaks.

"With APL, every mathematician and every engineer is a programmer." What's more, the language can be easily mastered by non-English-speaking users. Geneticist Dr. Marcos Rico, of the Universidad Politécnica de Valencia (Spain), for example, has used it comfortably and successfully in simulating genetic models.

The absence of natural language is an advantage, Iverson feels. "For example, 'or' is an ambiguous word. Does it mean 'either but not both' or 'either as well as both'? In APL, we have an 'inclusive or' and an 'exclusive or'."

Iverson, who is now an IBM Fellow, is interested in expanding the language with more operators and with further exploitation of shared variables. Currently, APL has five different operators ("one of the most important characteristics of the language," Iverson says), and the plan is to create "a lot more." (An Operator, incidentally, he explains, is *not* something that applies to numbers; it applies to a function that produces a new function. APL's five operators are scan, reduction, axis operator, outer product and inner product.) The next addition could be a derivative operator.

Two interacting programs

"The shared variable is a general notion," Iverson goes on, "which allows us to have two interacting programs—both in APL or one in another language. Essentially, the way they interact is by sharing a name. If we both use "X," for example, then X must mean the same to both of us."

Does he have any plans for leaving APL and starting something else?

"What else is there?" Iverson responds with a look of surprise. "APL is simply *the* language. It's as if I were asked: 'When are you going to drop English and start speaking something else'?"

Designers are missing a fantastic opportunity, Iverson believes, if they don't take a serious look at APL. "Working with this language," Iverson concludes, "ushers in a whole different world." ▪▪

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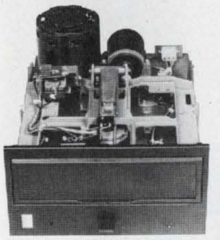

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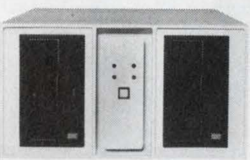

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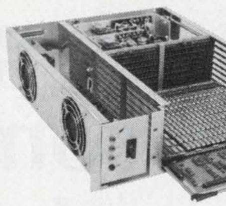

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CIRCLE NUMBER 265

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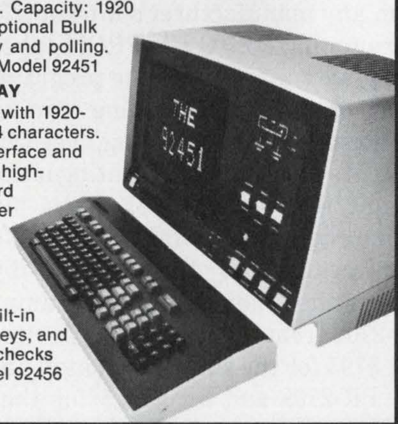

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CONTROL DATA CORPORATION

CIRCLE NUMBER 263

COMPUTER'77

PROM programmers have grown—some have both brains and 'personality'

Originally designed to be a secondary piece of equipment for system development, the PROM programmer is becoming smarter and much more flexible. In fact, recently introduced models employ microprocessor-based controllers to simplify their interfacing with over 200 available PROMs. In addition, selecting the right programmer for any of the many programmable read-only memories, logic arrays and gate arrays has become one big tradeoff of capabilities.

You can select a programmer with varying degrees of flexibility and performance, from over 15 companies. Or you can go to a microprocessor vendor who also offers some form of programmer for use in his program-development system.

Available models now range from simple, dedicated units that can program only one type or generic family of arrays to a "universal" programmer that can handle any array with changeable "personality" cards that control all programming voltages, currents and timing relationships. Prices start as low as $250 for dedicated programmers and can reach $10,000 for a universal model with a full compliment of personality cards.

Whether the programmer is dedicated or universal, many system-like features now come with it. Most vendors, for instance, offer interfaces to terminals so that programs can be written on the terminal and transferred directly to the programmer. Often, the programmer has a RAM storage buffer that holds the data to be programmed into the array and a keyboard that permits you to access the data and alter them before the code is burned into the array.

Dedicated programmers help cut corners

Since the dedicated PROM programmer costs well under $1000, you can purchase several units for the price of one universal programmer. And, some of the more recent dedicated programmers include "smart" interfaces as well as serial communications ports. For example, the Model 2708 programmer from

Able to program any bipolar or MOS PROM, the IM1000 programmer from International Microsystems includes a TTY interface as well as two RS-232 ports as standard.

Shepardson Microsystems, designed specifically for the 2708 and 2704 ultraviolet-erasable PROMs, includes both an RS-232 interface and a 20-mA current-loop port.

Using a built-in microprocessor-based controller and a 1-k×8 RAM buffer, the 2708 programmer can accept BNPF or BHLF-coded paper-tape inputs and program any manufacturer's 2704 or 2708 UV PROM.

Programming a 2708 UV PROM takes 130 s. When operating with a terminal, the programmer offers 17 different operations, including various single key instructions for programming, verifying, inverting the contents of the buffer, printing a checksum of the buffer and reading a PROM into a buffer.

Other programmers for the 2704/08 family of PROMs include the 1007K made by Technitrol, benchtop units from PROM Programmers Inc., and the PR-2708 from Curtis Electro Devices. These units start at $795 for the simple benchtop units, go to $998 for the PR-2708 and hit $1185 for the 1007K.

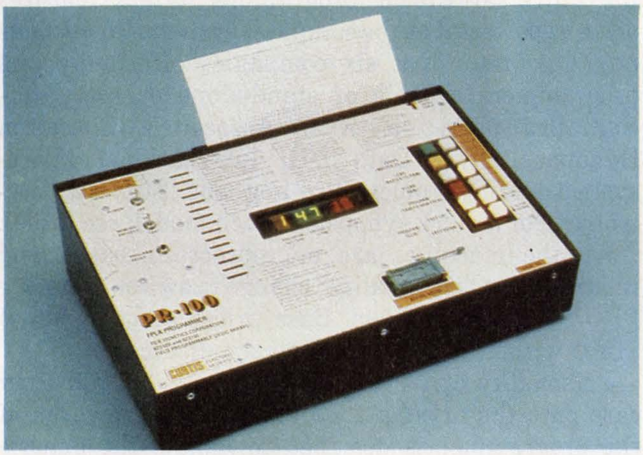
The dedicated units from Curtis are intended for manual programming, but data can be entered either

Dave Bursky
Associate Editor

by 8-bit switches or by a cable connecting a computer to the internal RAM of the programmer/simulator. And with its l-k × 8 RAM, the PR-2708 can simulate the PROM it is designed to program—and provide simple PROM emulation for program development. You can also use it to duplicate PROMs by inserting a master PROM into the test socket and reading its contents into the internal RAM. Then when you plug an unprogrammed unit into the socket, the RAM contents are read out to program the unit.

A similar concept is available in Technitrol's 1007K. Housed in a 5 in. thick attaché case, the programmer includes a keyboard and LED display. For options, you can choose from a hex display ($150), a serial or parallel interface ($250), or a paper-tape reader ($875). Other dedicated models are available for the 1702 PROM or the National Semiconductor 5302/03/04 PROMs.

With an RS-232 interface, the series 90 PROM programmer from Pro-Log lets you enter programs from a CRT terminal directly into the PROM to be programmed or into an optional RAM workspace.



Designed to automatically program the 82S100/101 PLA, the PR-100 made by Curtis Electro Devices provides you with seven different operating modes.

Complete with a portable RAM-pak, DATA I/O's Model IX programmer can program or emulate any type of bipolar PROM array available.

The benchtop units from PROM Programmers come in 2.5 × 6 ×-8 in. cabinets and allow for entering data via the keyboard, copying a master PROM, or parallel-inputting program data with a computer. You can add on a hex keyboard and display for $95 or get a dual serial interface controlled by a μP for both an RS-232 and a 20-mA loop for $350.

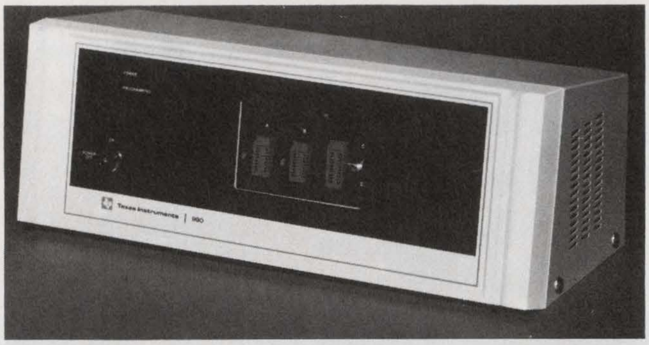
Many of these same companies offer programmers for the bipolar PROMs and include most of the same features. But the lowest-cost programmers come from Curtis Electro Devices—its PM-3000 series units cost just $479.50 plus $75 to $120 for every socket adapter for generic family PROMs. These units are intended for manual operation and have no interfaces for any equipment. For more capability, Technitrol offers bipolar-PROM-programming versions of its 1007K.

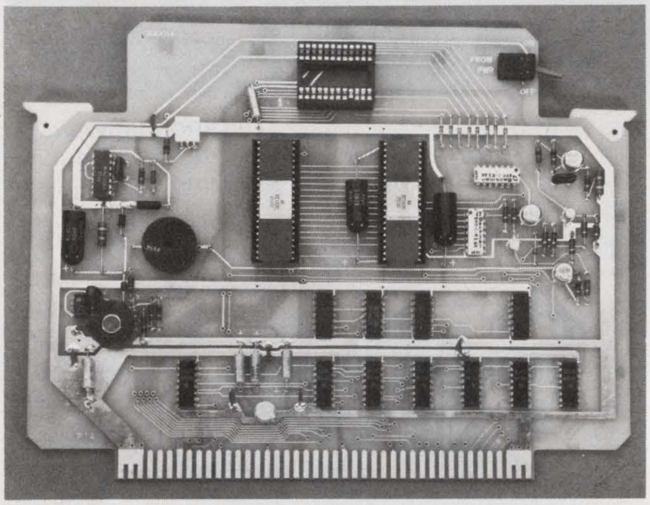
For the not-so-common memory array, Curtis offers the PR-10139, a programmer dedicated for the 10139 ECL PROM; it costs $279.50. And, should you use PLAs, Curtis has the PR-100 an automatic programmer for the 82S100/101 PLA—for a hefty $1299. This unit has seven operating modes: manual data loading into internal RAM, automatic data loading into RAM from master PLA, manual editing of preloaded data, programming from preloaded data into blank PLA, clearing of internal RAM to match blank PLA, program verification of programmed blank vs RAM contents, and PLA blank checking.

Data I/O also offers a universal programmer for PLAs—Model X. The programmer includes a CRT display to simplify formatting, and can accept inputs from paper tape, mark-sense cards or a master PLA. It costs a whopping $8000.

Some dedication is limited

Many of the programmers offered by the microprocessor vendors are also dedicated, but more often than not they're dedicated to the system they can be used in—not to the PROM types they can program. For example, Fairchild's F8 95086001 board mounts in its Formulator development system. Intel offers the UPP-1 and UPP-2 programmers that interface to its Intellec system or the Prompt stand-alone units. Motorola makes a board that plugs into its EXORciser card cage, and Texas Instruments has a PROM-programmer box that connects to its 990 mini.





"Dedicated" programmers, such as the universal unit from Texas Instruments for the 890 minicomputer (top) or the single-card UV PROM programmer board from Motorola for the EXORciser (bottom), are designed specifically for one type of development system.

Many microcomputer companies also offer boards that plug into their own computers—MITS, for example, has a board that programs 2708-type PROMs and is controlled by software from its Altair computer.

To get past the limitations of fixed-hardware programmers, some microcomputer and microprocessor vendors have put all the timing control information into software. As a result, their programming boards can handle almost any PROM—which, of course, has cleared the way for microprocessor-based universal programmers.

Universal units take all comers

Operating in either a stand-alone or system mode, the universal PROM programmer offers features often as powerful as the computer systems the PROMs might go into. Just six companies offer universal programmers capable of stand-alone or computer-controlled operation—Adar Associates (Spectrum Dynamics Div.), Data I/O, International Microsystems, MilerTronics, Pro-Log and Sunrise Electronics (for a quick synopsis of each model, see table).

All the machines are microprocessor-based and require just a "personality" change to switch from one PROM type to another. Base prices start at about $1500 without options and personality cards.

Personality cards can add about $250 to $600 per card onto the price of the programmer. However, if the programmer is designed to handle the generic PROM families, costs can be trimmed since only one

Universal-programmer performance synopsis

Features / Model*	Adar 550	Data I/O Model V	Data I/O Model VII	Data I/O Model IX	Int'l Microsys. IM 1000	Miler-Tronics[1] P-8000	Pro-Log Series 90	Pro-Log Series 92
Keyboard input	Yes	Yes	Opt.	Yes	Yes	Yes	Yes	No
Selectable address field	Yes	No	Opt.	Opt.	Yes	Yes	Yes	Yes
Visual display	Yes	Yes	Opt.	Yes	Yes	Yes	Yes	Yes
Editing capability	Yes	Yes	Opt.	Yes	Yes	Yes	Yes	Yes
Internal RAM size (bytes)	512	1 k	1 k	1 k	4 k	4 k	0	0
TTY interface (20 mA)	No	Yes	Opt.	Opt.	Yes	Opt.	Opt.	Yes
RS-232 interface	No	Yes	Opt.	Opt.	Yes (2)	Opt.	Opt.	Opt.
Baud rates	No	■	■	■	■	■	▲	▲
Parity check	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Papertape reader	Opt.	Yes	No	No	Opt.	Opt.	Opt.	Opt.
Parametric testing	No	Yes	Yes	Yes	Opt.	No	Opt.	No
Operate in terminal mode	Opt.	Yes	Opt.	Opt.	Yes	Opt.	Opt.	Yes
Interface to μP development system	Opt.	No	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.
Programmer base price	$2300	$3750	$1095	$1975	$1495	$1495	$1800	$995
Personality modules	$500 to $750	$400	$400	$400	$250 to $295	$250 to $550	$325 to $450	$325 to $450
Generic adapters	$100	$50	$50	$50	$60	$50	$100	$100

■ = 110 to 9600 baud; ▲ = 110 to 1200 baud.
All units have a duplication capability, can handle MOS & bipolar PROMs, program generic families, have expandable RAM options and operate as stand-alone systems.
1. Will not be available until Fall, 1977.
*Details for the model from Sunrise Electronics not available at press time.

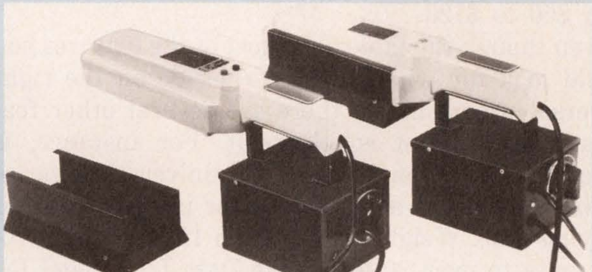
Don't forget the UV light box

With all the discussion about PROMs and their programmers, don't overlook the ultraviolet light box needed to erase the UV PROMs. Typical units are the S-52T and UVS-54T made by Ultra-Violet Products.

The S-52T can erase up to 16 PROMs at once in about seven minutes with an intensity of 6 watt-seconds/cm^2 at a distance of 1 in. It comes with a removable base that can have a built-in timer to shut the lamp off after a preset period. The price with timer is $209.

For less than half the price of the S-52T, the company offers the UVS-54T at only $99. It provides about half the performance too—and takes about twice the time to erase, and holds only half as many PROMs.

Of course, when you use any of the UV light products, make sure to take all the safety precautions recommended by the manufacturers. Never look directly into a lighted lamp, and avoid shining the lamp on reflective surfaces.



For small or large UV-PROM-erasing applications, light boxes such as the 2537 from Technitrol (top) or the UVS-54 and S-52T (bottom) from Ultra-Violet Products are an absolute necessity for fast turnaround.

A primer on PROMs, PLAs and PGAs

Programmable memory products are available in three major forms—the programmable read-only memory, the programmable logic array and the programmable gate array. The PROM is a special form of read-only memory that can be purchased unprogrammed, then programmed in just a minute or two. The PLA and PGA can be user-programmed as well, which cuts out the lengthy turn-around times of two to 12 weeks for custom-programmed circuits.

PROMs are available in three technologies. The two most common are the fused-link bipolar PROM and the ultraviolet-erasable MOS PROM.

Nichrome links (fuses) are commonly used within the bipolar PROM for each memory cell in the array. During programming, a link is either blown open or left intact to indicate a bit's value. Other types of fuses are used—PROMs from Intel have a polycrystal silicon link, while avalanche-induced migrations are used by Intersil to short back-biased junctions.

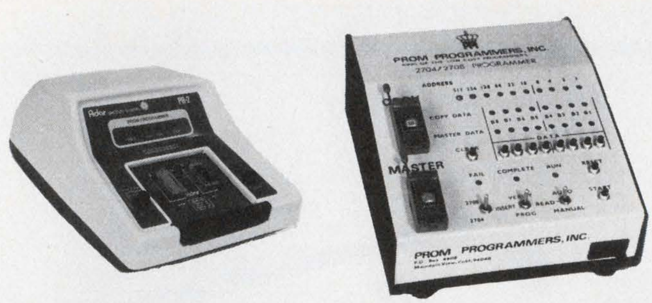
UV PROMs, on the other hand, use MOSFET cells that are programmed by injecting a charge with an avalanche technique. An ultraviolet light source can remove the charge by causing photocurrent to flow between the gate and the silicon substrate. However, when you use a UV light, you cannot erase selectively. The entire array must be wiped out and then totally reprogrammed.

Many PROM manufacturers have developed what they call "generic families" of PROMs. Since units within a family require the same programming voltages, currents and timing relationships, they can usually be programmed by one programmer with a change of socket. Currently, nine manufacturers offer generic PROM families— Fairchild, Harris, Intel, Intersil, Mitsubishi, Monolithic Memories, National Semiconductor, Signetics and Texas Instruments.

Another technology just starting to appear in PROM form is the electrically alterable, metal-nitride MOS array. It can be electrically programmed in much the same way as UV PROMs—but you can erase either the entire array or just one word, then rewrite the word without using any light sources.

Current PLAs and PGAs are available only in the bipolar fused-link technology. A PLA is basically an array of logic gates (ANDs, ORs, NANDs, NORs, etc.) that can be set up to form any combinatorial logic function you desire. The most common array is an AND/OR or NAND/NOR arrangement. For more on PLAs, see ED No. 18, Sept. 1, 1976, p. 24.

The PGA is a bit simpler than the PLA—it has only one level of logic interconnect—such as an all AND or NAND arrangement for multiple input lines and multiple outputs. For more information about PGAs, see ED No. 2, Jan. 18, 1977, p. 101.



Use of dedicated programmers like the PR-2 from Adar (left) and the 2704/2708 from PROM Programmers (right) can help keep capital costs down if only a few types of PROMs are used.

personality card is needed for each family; you still need adapter sockets to route the signals properly for arrays within the family. Adapter-socket prices range from $50 to $120.

Even though the table lists most of the features you should look for when trying to decide on the right universal programmer, there are several other features that are not so clear-cut. For instance, is portability important? Most of the universal units are available in either attache cases or in some form of carrying case. Weights range from 15 lb for the Pro-Log units to over 30 lb for the Data I/O Model IX.

Editing capabilities in the Data I/O Model VII or IX let you alter the contents of any location, and even insert or delete words. The system will automatically make room by shifting the rest of the memory up or down.

Meanwhile, specifications for programming parameters are changed so often by the IC manufacturers that the support provided by the PROM-programmer manufacturers has become an important factor in selecting a programmer. Once you buy a programmer, how well will the vendor keep you informed of hardware updates and changes to the programming algorithm?

And, to guarantee correct performance to the original purchase specifications some self-test and diagnostic capability is another must. Most Data I/O programmers have test circuitry on an optional calibration card. By plugging the card into the unit and using a meter and a scope, you can run a full calibration cycle without returning anything to the manufacturer. Pro-Log, on the other hand, provides a total guarantee that its programmers will remain calibrated. Unlike Data I/O, which uses a programmable power supply, Pro-Log puts all the specialized voltages for a particular PROM on personality cards, to make sure that the voltages remain stable.

In addition, Pro-Log builds some self-checks into the programmer to make sure it doesn't make the entire PROM go up in smoke. Warning indicators alert the operator to a malfunction.

Once a microprocessor is built into a PROM programmer, there are all sorts of wonderful things you can do. For instance, various parametric tests can be performed on unprogrammed or programmed units to make sure they are fully functional before being installed in a system. Almost all programmers include some sort of indicator that lets you know if the PROM has been programmed and if the code matches the code held in the RAM buffer or in the master PROM.

However, there's more to testing—under actual load conditions, some blown fuses in bipolar PROMs can appear to reform and thus cause incorrect bit patterns that are almost impossible to track down. And, with MOS PROMs, charge migration within cells or incomplete erasure of cells can show up as errors in the final assembly.

Both the Data I/O and Pro-Log programmers offer a range of parametric tests that can help spot faulty units before they get put on boards.■■

Need more information?

For further information on PROM programmers, you may wish to consult the manufacturers listed here by circling the appropriate numbers on the reader service card. More vendors and information can be found in ELECTRONIC DESIGN's GOLD BOOK under Lamps, ultraviolet; ICs, central processing unit; ICs, programmable logic array; ICs, programmable read-only memory; and Computers, digital, micro.

Adar Associates, Spectrum Dynamics Div., 11B North Ave., Burlington, MA 01803. (617) 273-1850. (R. O'Leary) **Circle No. 551**

Accutest Corp., 25 Industrial Ave., Chelmsford, MA 01824. (617) 256-8124. (R. Therrian) **Circle No. 552**

Applied Systems Corp., 26401 Harper Ave., St. Clair Shores, MI 48081. (313) 779-8700. (M. Wyrod) **Circle No. 553**

Aquarius Electronics, 32191 Albion Ridge Rd., Albion, CA 95410. (707) 937-0064. (R. Coppeck) **Circle No. 554**

Curtis Electro Devices, Box 4090, Mountain View, CA 94040. (415) 964-3136. (J. Curtis) **Circle No. 555**

DAI, Dreve Des Renards 6, Bte 8, 1180 Brussels, Belgium. Tel. 375 11 14 Telex: 61 067 DAIBRU **Circle No. 556**

Data I/O Corp., P.O. Box 308, Issaquah, WA 98027. (206) 455-3990. (B. Gronquist) **Circle No. 557**

Electro Design Inc., 8141 Engineer Rd., San Diego, CA 92111. (714) 277-2471. (Mr. Davenport) **Circle No. 558**

Fairchild Micro Systems, 1725 Technology Dr., San Jose, CA 95110. (408) 998-0123. (J. Katsaros) **Circle No. 559**

Gulf & Western Co., Eagle Signal Div., 73 Federal St., Davenport, IA 52803. (319) 326-8111. (E. Weaver) **Circle No. 560**

Intel Corp., 3065 Bowers Ave., Santa Clara, CA 95051. (408) 246-7501. (R. Walker) **Circle No. 561**

International Microsystems Inc., 4900 Auburn Ave., Bethesda, MD 20014. (301) 657-3993. (Mr. Sage) **Circle No. 562**

Microkit Inc., 2180 Colorado Ave., Santa Monica, CA 90404. (213) 828-8539. (R. Schaff) **Circle No. 563**

MilerTronics, 525A Airport Rd., Greenville, SC 29607. (803) 242-9232. (T. Brown) **Circle No. 564**

Motorola Semiconductor Products, Box 20912, Phoenix, AZ 85036. (602) 244-6900. (T. Mazur) **Circle No. 565**

Pro-Log Corp., 2411 Garden Rd., Monterey, CA 93940. (408) 372-4593. (S. Noble) **Circle No. 566**

PROM Programmers Inc., P.O. Box 4608, Mountain View, CA 94040. (415) 948-0450. (J. Rampelberg) **Circle No. 567**

Shepardson Microsystems Inc., 20823 Stevens Creek Blvd., Cupertino, CA 95014. (408) 257-9900. (R. Shepardson) **Circle No. 568**

Sunrise Electronics, 228 N. El Molino, Pasadena, CA 91101. (213) 963-8775. (R. Erickson) **Circle No. 499**

Technitrol Inc., 1954 E. Allegheny Ave., Philadelphia, PA 19134. (215) 426-9105. (W. Chamberlin) **Circle No. 569**

Texas Instruments, Digital Systems Div., P.O. Box 1444, M/S 784, Houston, TX 77001. (714) 494-5115. **Circle No. 570**

Ultra-Violet Products, 5100 Walnut Grove Ave., San Gabriel, CA 91778. (213) 285-3123. (L. Wasserkrug) **Circle No. 571**

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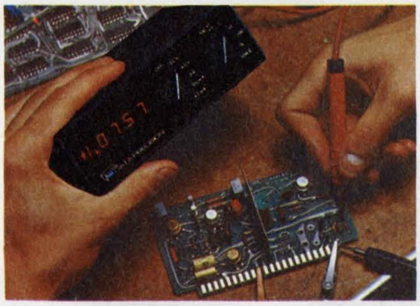

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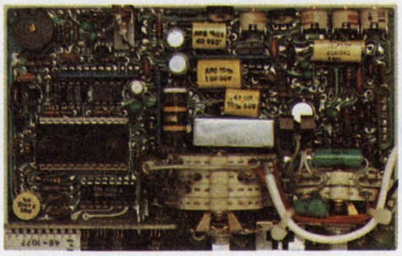

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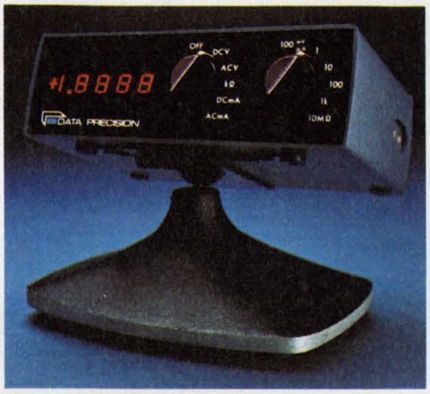

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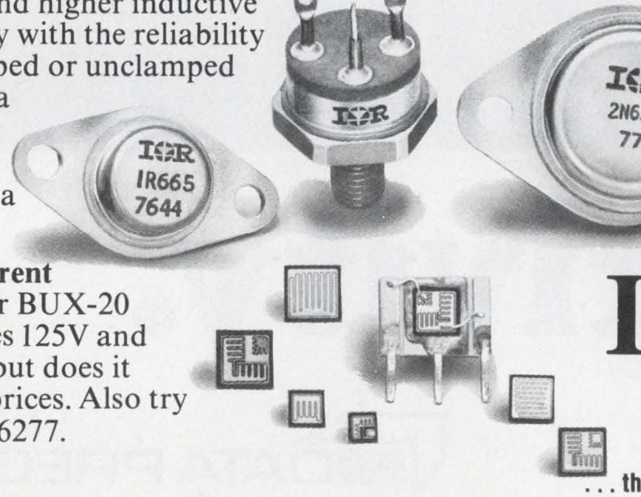

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CIRCLE NUMBER 25

FOCUS on Cassette and Cartridge Recorders

The magazine-loaded, digital tape recorder has matured to the point where you have too many choices. The line-up includes cassettes, cartridges, single-track or multiples, drives of various kinds, and at least 10 encoding schemes. And rather loose specifications for cartridge and cassette recorders cloud the picture even more.

Probably your most important decision in specifying any storage device involves capacity. With cassette and cartridge recorders, the problem of deciding is compounded by the real difference between actual and theoretical capacity.

Don't fall into the capacity trap

Although the theoretical storage capacity (bit density × tape length) for a cartridge or cassette seems adequate at first glance, a large part of the "capacity" can be eaten up by starting and stopping.

Consider, for example, a recorder with a 50-ms start time, a 30-ms stop time, and recording at 400 bits per in. (bpi) with the tape moving at 10 in. per second (ips). Starting takes 0.5 in., writing an 8-bit character takes 0.02 in., and stopping takes 0.15 in. So for a common 300-ft cassette, the number of 8-bit characters you can store is only 3600 ÷ 0.67 (5380). That's a far cry from the theoretical 180,000 characters.

So much space is dedicated to nondata functions that each character can be written five times and affect total storage by only 10%. And increasing the bit density from 400 to 800 bpi changes the character count only from 5380 to 5460—in most cases hardly worth the effort.

Buffering data into blocks helps spread the nondata portions over more characters. Thus, by writing blocks, rather than individual characters, you can make as many as 1000 characters share one start-stop space. Buffering, then, increases actual capacity.

Sid Adlerstein
Associate Editor

Cartridges clearly have more capacity than cassettes. Although the most commonly used media, Philips-type cassettes and 3M-type cartridges, can both accommodate from one to four recorded tracks, the most data a cassette can pack is 1.44×10^6 eight-bit bytes. By contrast, some cartridge systems can cram as much as 11.5×10^6 bytes into one package.

But the high data capacity that multitrack units offer may not fit into your automatic system. Find out: Will you have to remove the media pack and turn it around to access all tracks? Or are the tracks accessible in some predetermined order? The most versatile units let you access any track in either the

The DC-300 cartridge is electromechanically locked into Kennedy Co.'s Model 331 drive, until its release by an Unload command. All four of the serially sequential tracks can be accessed without turning the tape.

forward or reverse motion of the tape.

Be careful when figuring multitrack capacity. Some systems use a track for a prerecorded clock, to either synchronize the data or control tape speed. This is a nondata track and should not be counted in total capacity. However, some systems using a clock track for data synchronization have more actual capacity than systems in which all tracks contain data. The clock validates data recorded on much of the usually wasted start-stop space.

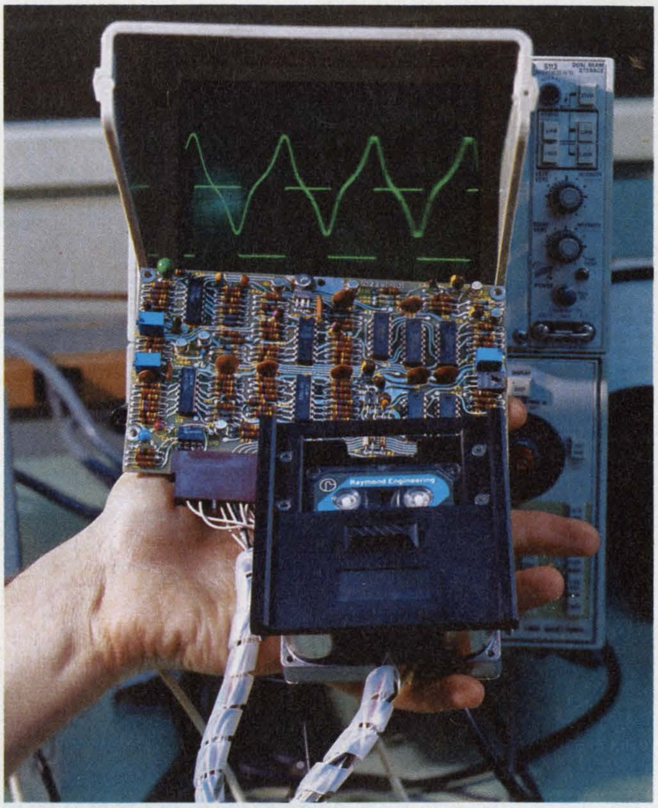
Another pebble that can ripple the already muddy waters of tape capacity is specifying in bits rather than in the standard 8-bit bytes. So keep a sharp lookout and divide by eight.

Need capacity? Look at density

When you are concerned about capacity, you have to be concerned about density. Most cartridge systems use the American National Standards Institute (ANSI) specification for density—1600 bpi, while most cassettes commonly use the ANSI density of 800 bpi. However, with so many cassette units on the market, packing densities of 333, 430, 518, 556, 615, 960, 1000 and even 1600 bpi are available.

Packing density aggravates the sore spot of obsolete standards in packaged-media recording. Shortly after digital data were first recorded on crude audio cassettes, standards became necessary. Data taken on one machine wouldn't play back on others, and finding the right interface was a little too exciting. But by the time the first "standard" for recording digital data on a cassette was ready for publication, it was already obsolete. This was the Kansas City (KC) process that dealt with recording bits as tone bursts.

Data are crammed onto four serial tracks at 6400 bpi in Microdata's Lodestar cartridge recorder. To ensure compatibility between the recorder and the medium, cartridges are certified for this high density.



The Model 6409 Mini-Raycorder fits into your hand. This 17-in.^{3} unit from Raymond Engineering draws 1.5 W at 5 V. All its electronics come on just one PC board, and the tiny device uses ANSI-proposed minicassettes.

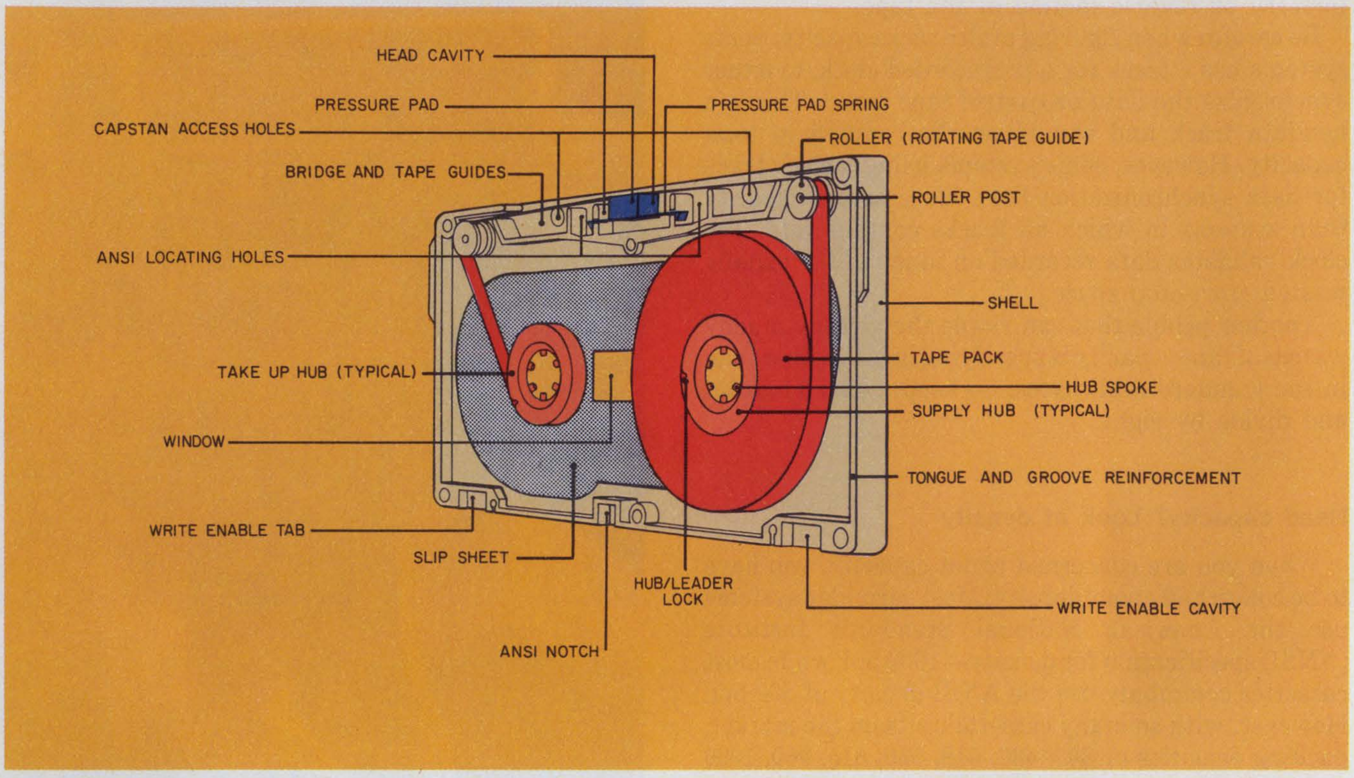
The standards are lagging again. ANSI and the European Computer Manufacturers' Association (ECMA) have instituted cassette-tape standards that specify a width of 0.15 in. and a length of at least 282 ft. These standards are almost universally adhered to. So watch out when a manufacturer boasts that his system produces up to 150,000 characters. He may mean for 450 ft, when the usual capacity specification uses 300 ft.

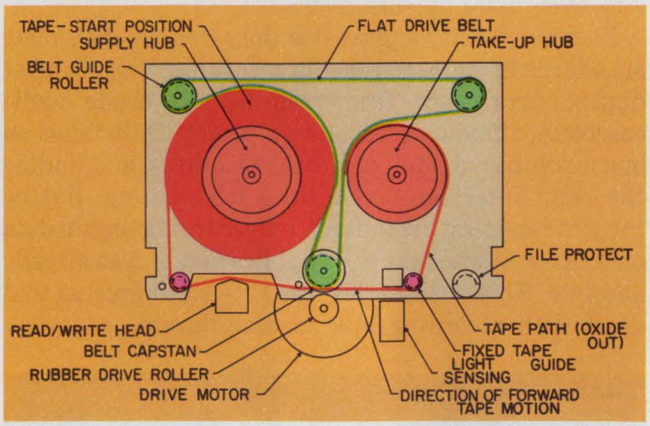
For cartridge tape, ANSI has proposed that 282 ft be the minimum length, and 0.25 in. the standard width.

One problem with yet another standard—recording density—is the rapid change in performance. The approved cassette standard requires phase-encoded data at 800 bpi. The proposed standards for cartridge drives ANSI X3B5/75-44 and -53 for serial and parallel data, respectively, require 1600-bpi density. But some units have already surpassed this level of performance. Commercially available systems pack data into cassettes at 1600 bpi, and at least two units can operate a standard 3M cartridge at 6400 bpi—four times the standard. And the cartridge-recording standard isn't even approved yet.

Try specials when standards won't do

Standards, even if scrupulously updated, can't cover all situations. Therefore, don't be surprised to find a variety of nonstandard media and special systems.





The digital cassette (top) holds at least 282 ft of 0.15-in. tape. Differences between digital and most audio cassettes include an ANSI locating notch, reusable write-enable tabs, pullout-proof leaders, and holes at the tape's beginning and end. The recording qualities of the two types also differ. A flat belt provides built-in direct drive and tensioning for the 0.25-in.-wide recording tape in a 3M-type cartridge (bottom). Internal guides align the tape.

Tape packs made for special drives offer up to 17×10^6 byte capacities, up to nine tracks, 1600 bpi and speeds varying from a barely visible crawl to a zippy 60 ips.

While nonstandard media offer large capacities, the standard units have the edge in speed, with ranges from 0.08 to 90 ips. However, the variety of speeds is rivaled by the variety of drives and guiding systems that move and tension tape.

Guiding and tensioning the tape is more of a problem in cassette drives than in cartridge units. Whereas in a cartridge, tape guiding and tensioning are already built in, each cassette drive must supply its own. Some of the common methods by which cassette drives align the tape across a head are

- A finger guide on one side of the head.
- Rails across the head surface.
- Grooves near the head.
- Spring-loaded guides near both sides of the head.

Any of these methods can skew a tape.

Generally, the more moving parts a system has, the better the guiding. But moving parts are failure-prone, and every additional moving part decreases reliability. And reliability figures, usually expressed as mean time between failures (MTBF), are the most elusive specifications. MTBFs for recorders are usually quoted anywhere from 1000 to 20,000 hours. But these figures are usually based on calculations rather than actual field reports. And some manufacturers can't supply the calculations.

But one thing that every manufacturer will supply is a justification for his tape-moving scheme—particularly for cassettes. The basic methods are reel-to-reel and capstan-drive.

In cassettes, the drive's the thing

The capstan and pinch-roller drives that are so useful for audio recorders, where speed tolerances of 1% may be unacceptable, have stirred a hornet's nest in the digital cassette world, where speed tolerances of 20% are sometimes adequate.

The trouble is that with the start-stop operation common in digital recording, pinch rollers can jam dirt into the tape. While this isn't the end of the world in audio use, it can result in intolerable dropouts in digital recording. Then again, capstans and pinch rollers are a pretty good way to move tape accurately. So the pro and con discussions go on.

Meanwhile, alternatives to capstans emerge. For example, you can move and tension cassette tape via the supply and take-up reels by connecting motors to the hubs. But while these reel-to-reel drives may increase tape life up to five times, at a constant motor speed, tape speed past the head (where it counts) will vary by 2.3:1 over 282 ft of tape. Consequently, you won't be able to record 800 bpi. Controlling the motor speed—thereby the tape speed—is costly and a source of errors.

Controlling tape speed by servo motors, steppers, tachometers and prerecorded clock tracks—all have their champions and their places in digital recording. Their defenders are usually hair-trigger fast in quoting the 1 to 2% short-term speed tolerances you can expect with their particular controls. Data on long-term speed variation sometimes take a little longer to get at—like never.

Also, you will have to prod cassette and cartridge-recorder manufacturers to determine if you need external equipment and what kind. Is the speed control contained entirely in the unit? What is standard equipment? What is optional? When considering any drive, ask what comes with it to move the tape as accurately as you need.

Cherchez le format

Other useful questions: What format capabilities does a given recording unit provide? Do you need any external circuitry to format the data usefully?

As an example of the capability you might look for consider the ANSI standard for cartridge recorders. This specifies that blocks of data be bracketed by known bit patterns.

First comes a 16-bit preamble, followed by a data block of up to 2048 eight-bit bytes. A 16-bit cyclic-redundancy check and a 16-bit postamble follow the data block.

The preamble has 15 ZEROs followed by a ONE. Preambles establish timing for reading data when the tape moves forward. The postamble, a ONE followed by 15 ZEROs, sets the timing for reading data in reverse.

Note that for both directions of tape travel, data are preceded by a string of 15 ZEROs and a ONE. This pattern can be used to locate data in a de-skewing register.

No matter what the format, arranged data must be encoded magnetically onto the tape. Check that the system you buy can encode data. Some systems require optional boards to give you common data-encoding schemes. Others require an external oscillator. And many do not provide common encoding methods—even as options. Then you must design your own encoder.

All data encoding is either clocked or self-clocking.

Data-Logger-2 can record 64 analog channels as a string of 14-bit words. This battery-powered, cassette, weatherproof data-acquisition and recording system, from Datel, can run for up to a year on one charge.

Return-to-ZERO (RZ) and nonreturn-to-ZERO (NRZ) are primary examples of encoding that require a separate but synchronized clock to recover data.

In RZ coding, a half-bit-wide pulse represents a ONE. No pulse is a ZERO. NRZ-coding schemes, on the other hand, have three common variations: level, mark or IBM, and space.

Complementary-NRZ coding uses two tracks. ONEs are recorded as a flux change on one of the tracks and ZEROs by flux changes on the other—obviously a redundant coding technique.

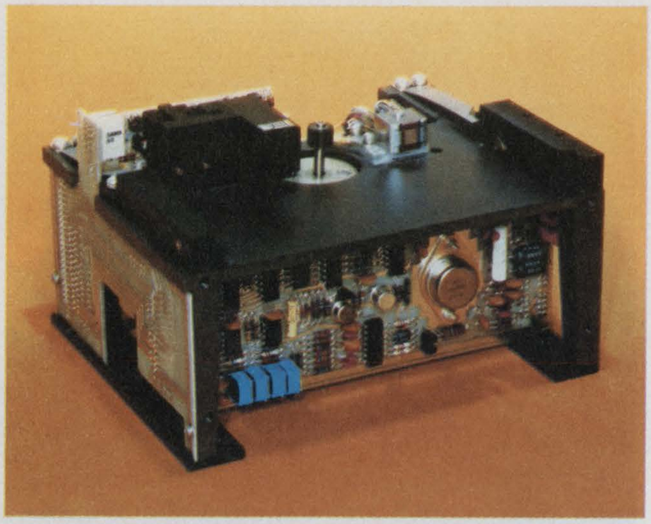
In NRZ-level coding, the high level represents ONE, the low level ZERO. One problem with NRZ-level coding is that a missing bit ruins all subsequent data.

The problem is cured in NRZ-mark or IBM coding. A change in level is a ONE, while no change is a ZERO. NRZ-space coding is the inverse of mark; that is, a change denotes ZERO and no change denotes ONE.

With level-type encoding, bit density is equal to flux changes per inch (fci). So NRZ has the capacity for dense recording.

But this quality doesn't come free. Level (clocked) recording requires that the data-recovery amplifiers respond to dc and show phase linearity. The result is a high signal-to-noise ratio (s/n). Also, pulse-to-pulse jitter and timing errors must be held to half a bit cell. Furthermore, data synchronization is difficult because two tracks are required—one for data, the other for clock. Beware of skewing between tracks.

Self-clocking encoding, on the other hand, uses flux change in every bit time. Therefore, a data-



The 3000-S2 drive meets ANSI standards for processing data on X3B5/75-43 type cartridges. The Data Electronics unit reads and records per standards X3B5/75-44 (serial) and X3B5/75-53 (parallel).

synchronized clock is inherent in the record on the data track. Skewing between tracks isn't a factor.

Since information is put down at precise intervals, just two frequencies matter for data recovery: either fci or fci/2 × the tape speed. The data can thus be bandpassed with a resulting increase in s/n. Phase-encoded data are particularly suitable to detection because phase errors are minimized in a differentiator (slope detector) operating in a narrow-frequency band.

The simplest self-clocking code is Bi-phase-mark (Bi-Φ-M), or Manchester I. The mark version uses a flux change (fc) at the start of each bit space. For a ONE, there is another fc at the middle of the bit space; a ZERO gets no fc.

Either Bi-phase-level (Bi-Φ-L) or Split-Φ (also called Manchester-II +180°) recording has an fc at the middle of every bit. The fc is toward north for a ONE and away from north for a ZERO. Of course, the appropriate fc must be made at the start of each bit to establish the proper polarity state for the bit to come. A peculiar requirement of Bi-Φ-L is that a ZERO must precede data whose first bit is ONE.

Although more complex than Bi-Φ-M, level recording is often recommended because of the following advantages:

- Writing always begins and ends at the same flux level, north, because no matter what the bit pattern is, there is always an even number of fc's in Bi-Φ-L recording.
- The noise sensitivity of Bi-Φ-L is one-third that of the mark method.
- It is the ANSI-ECMA standard (ANSI Std BSR X 3.48).

At a maximum density of 500 bpi, however, Bi-Φ-L recording is usually recommended for high data reliability.

The Bi-Phase-clock technique is similar to the Bi-Φ-M except that it requires two tracks, one for data recorded like Bi-Φ-M and the other for a prerecorded clock. The obvious disadvantage is loss of a complete track to the nondata clock, but this can be overshadowed by the ability to read and write without the tape attaining constant speed.

This capability can be valuable in incremental operation, especially when the records are short. Data can be transferred almost instantly at start, which saves the tape space ordinarily allotted for start time.

Usually, at block sizes larger than 32 characters, a cassette provides more actual storage capacity with Level or Mark recording than with Clock. The starting-stopping time space is then just wasted.

Recording with the Bi-Φ-C method does carry the burden of a high error rate. The number of clock pulses that can be missed without affecting data recovery is $n/3-1$, where n is the number of clock pulses used to write a single data bit.

Divide a bit cell for ratio recording

Another phase-encoding scheme, the three-clock bit-cell method, or ratio recording, divides each bit space into three sections, dedicated to synchronization, data, and reset.

The first transition establishes the beginning of the cell and alerts the system that a bit is about to come. The second transition, timed with the next clock after the synchronization pulse, indicates a ONE; no transition in this slot indicates a ZERO. The third transition space in the cell establishes the reset time and, like the first transition, has no data content.

The most complex phase-encoding method for

Forms are retrieved selectively in seconds from the mini-cartridge storage in Hewlett-Packard's 2644A Mini Data Station. The terminal uses HP's own drive, which is not yet available by itself.

A 32-Mbyte capacity is featured in the 5200 carousel-handling and drive system, in which 16 cartridges can be accessed four at a time. The National Computer Systems unit meets ANSI X3.56-1976.

digital recorders is Miller coding. In this scheme, a ONE is represented by an fc in either direction at the middle of the bit cell. Two adjacent ZEROs are coded as one fc in either direction at the end of the cell containing the first ZERO. Since Miller coding is self-clocking and requires only narrowband recovery amplifiers, the s/n is high.

The main disadvantage is that phasing the clock for data recovery in the decoder requires that either the frame or word-synchronizing fields contain a 101 sequence. In addition, because there is a transition for each clock, you must consider pulse-to-pulse jitter.

Another encoding method, modified frequency modulation, is often used in disc recording and is now being applied to tapes. This method provides two times more density per fc than other recording methods.

The medium is crucial

But no matter how carefully you select your drive, encoding scheme or data format, your system is going to have strange outputs unless the recording medium itself performs properly. Although they look similar, audio and digital cassettes are totally different.

Don't try to capture digital data on your old audio cassettes. Originally, digital recording was done on audio cassettes because the convenience and price of cassette recording were irresistible—and digital cassettes weren't available.

The most pronounced difference between audio and digital tape is the frequency range. But, you say, "the wider the frequency response of anything, the better." Untrue. While audio-tape manufacturers do strive for bandwidths exceeding 20 kHz, one measure of digital-tape quality is that its bandpass be just wide enough to pass the data and cut off sharply to eliminate noise.

Next to bandwidth, the most important difference between tapes meant for pulse recording and those for storing continuous signals is the curve of magnetization vs write current. Whereas an ideal audio tape boasts unbounded magnetization linearity, in the ideal digital tape relatively small currents can switch the magnetization between two saturated states with no stopovers along the way. In other words, audio recording requires linear tape, while digital tape should be nonlinear.

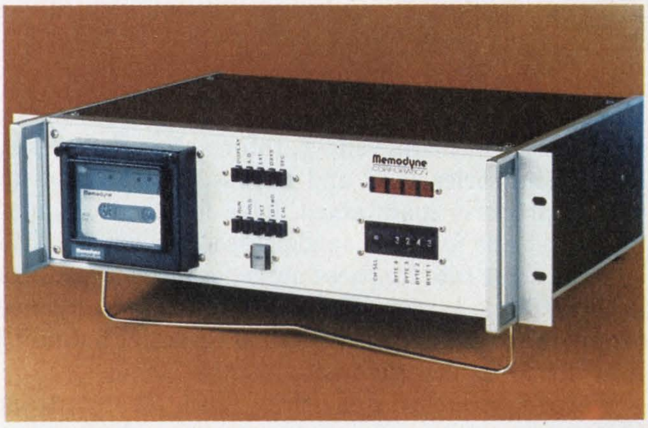
Moreover, in high-quality digital tapes, electrical conductivity is controlled so that static charge doesn't build up, especially at high speed. The uncoated portion's transparency to light is controlled so that clear tape leaders can be detected by beginning and end-of-tape photo-electric sensors.

Furthermore, the tape surface must be uniform and tough enough to stand up to thousands of passes at up to 120 ips. And that's not the worst of it. Many systems require that a small length of tape "shoe-shine," or read/rewind/read, for many passes. Low-quality tapes can be deformed by the rapid tension changes and tape heating that are inherent in this demanding mode of operation.

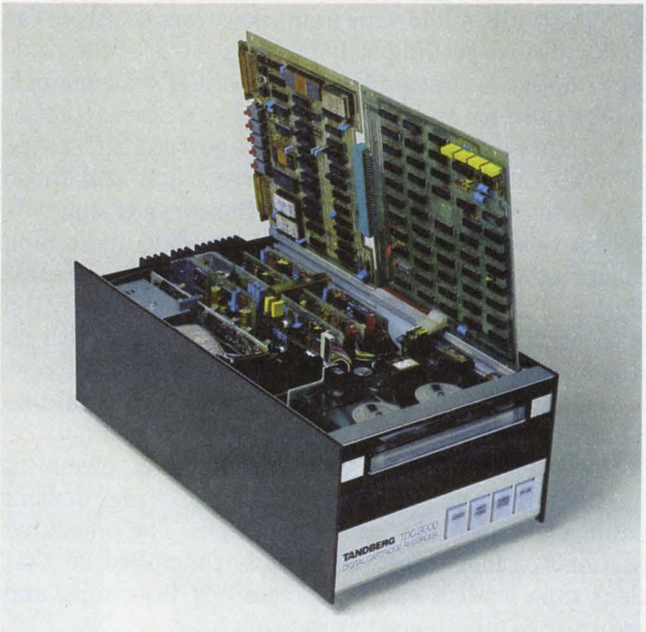
Digital media: the better choice

What's more, tape isn't the only difference between audio and digital cassettes—the housings are usually different. Often, audio cassettes don't have such features as an ANSI locating notch, reusable write-enable devices, a pressure pad for read-after-write heads, pullout-proof leader attachment, and end-of-tape and beginning-of-tape holes. Even the storage box for a digital cassette is different—with dust flanges so the cassette can't get dusty in its box.

Once you know you should use digital, not audio, media, how do you know how good it is? After all,



Drawing only 50 μW in standby, Memodyne's Model 3243 data-logging system uses the company's Model 208 cassette drive and real-time clock. Separate readers mate the write-only machine with popular computers.



Spring-loaded arms hold the cartridge with high retention force in the rugged TDC-3000 recorder, a Tandberg Data product. The replaceable head doesn't require shimming, azimuth or tilt adjustment. An optical encoder on the capstan-motor shaft measures velocity, direction and displacement of the drive tape.

everything is subject to quality variations. So you go all the way with a manufacturer-certified unit. But it's never that easy! There are also statistical, bulk and post-assembly certifications to choose from.

Statistical certification is performed by testing a sample of the media used in a production run. Some lots of statistically certified tapes have as many as 8% defective units. In bulk certification, the tape is tested before it is loaded into the cartridge or cassette. Defect rates of 4% are common. Obviously, you've got the best shot at an error-free medium when it is 100% post-assembly certified.

To get the best results from your tape, be sure the drive is doing a proper job. Dirt, worn or badly adjusted guides or head, improper tensioning and poor speed control all contribute to the early demise of your recording medium.

How long will the tape live?

At least one media vendor, Information Terminals, expects its series R, T and H cassettes to stand up with a properly maintained drive for an average of two, three and four thousand passes, respectively. The average error rate for these units per million readings is 0.1, 0.01 and 0.005. But this level of performance is only for room temperature at 50% relative humidity in a dust-free environment.

Warped, stretched and sticky tapes all stem from high temperatures. So make sure you don't leave cassettes in a car parked in direct sunlight. The car's interior temperature can hit 60 C, and that's enough to damage most tape.

Low-humidity operation can also cause trouble. As tape travels in dry operating environments, electrostatic attraction due to charge build-up can pick up dust and fine particles, which can cause dropouts if they become imbedded in the tape. In addition, abrasion from foreign matter on the tape can wear out the head.

A cassette's conductive slip sheet helps repel pickup, which is most pronounced at relative humidities lower than 40%. Also, back-coated tape is often recommended for operation in dry places. At the damp end, 80% humidity combined with 60 C temperature will wear the tape out very quickly.

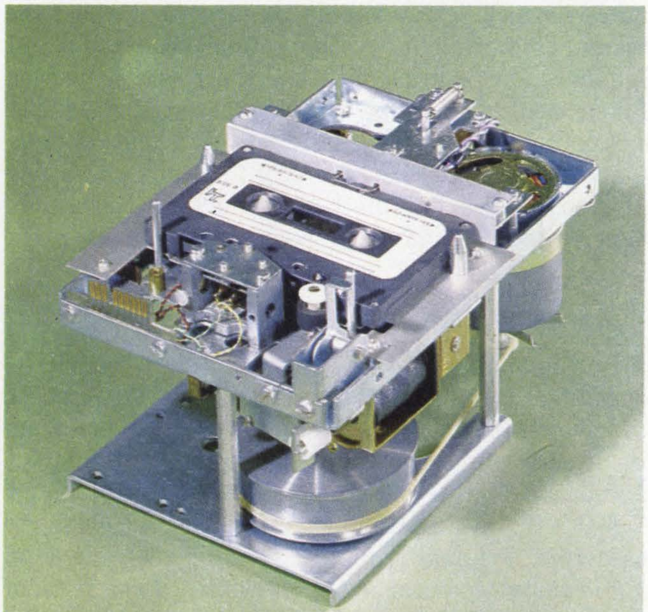
No matter how well tape is treated, its life is limited. Many drives offer heads with read-after-write capability. For the best error detection—reading and checking data while writing—get a read-after-write head.

Cassettes are still the most widely used medium for digital recording. Although many cassette recorders boast various encoding, formatting, buffering and density characteristics, the most distinguishing feature of all these units is the drive.

Cassette drives vary

In one drive, the Model 250B from MFE, two reel motors are servoed to a prerecorded clock track. With only two moving parts, the unit requires no maintenance or adjustments. Just keep the head clean and the tape zips along at up to 120 ips.

The only two moving parts in Datum's Model 4200 are also the reel motors. In this unit, however, circuitry senses speed-related parameters in the mo-



Tape-speed drift is held to within 2% by a synchronous-motor capstan drive in Amilon's Model A7 cassette transport. For high-inertia driving, the unit uses one reel motor and a second capstan motor.

tors so that control needs no tachometers or a clock track.

In another approach, used in the Model 172 transport by Dicom, a tachometer controls dc servo motors driving the capstan and reels. A special feature of this drive, its cam-loaded head actuator, provides precise head-to-tape alignment. The 172 transport is a component of the Model 176 digital cassette subsystem, which includes a servo drive, a μP controller, a data formatter, a character buffer and an interface.

By using simple synchronous ac motors to drive the capstan and only one reel in the Model A7, Amilon maintains almost constant tape speed (within 2%) without external circuitry. This high-inertia drive system holds pulse-to-pulse jitter to 1%. Lower-inertia drives usually hold jitter to 3 to 5%. In addition, the Amilon drive at $102.50 in 1000 qty. is among the least expensive of the ANSI-compatible units.

Wasted space in starting and stopping gaps is greatly reduced by the speed tolerant recording technique used in the STR-150, from Electronic Processors. The self-clocking unit includes an 8-bit interface that easily connects with bus-oriented μPs.

Four ac motors control the fixed-speed Phi-Deck Model 4 μP cassette deck from Tripple i. A separate motor controls takeup, rewind, play or record, and head engagement. Because the capstan motor is dedicated to just moving the capstan, flutter, wow and jitter are kept low.

The established technique of capstan and pinch roller is the heart of the single drive in Anderson-Jacobson's Model AJ 730, a cassette recorder system featuring editing and searching capability. The block-recording unit interfaces directly with terminals specializing in word processing, data collecting and communicating with computers.

Another cassette recorder intended for minicomputer interfacing is used in GE's Terminet terminal. In this desk-top system, block recording increases tape use and eases editing. Block lengths of 88, 144 or 166 characters are strap-selectable. Data-storage capacity ranges from 100,000 to 125,000 characters per cassette with the block format.

Cassette units log data

Cassette recorders are particularly useful for logging data. Datel's LPS-16, a data-logging system for remote locations, operates from a 12-V source and draws a mere 900 mW while recording and "microwatts" during standby. The system accepts up to 16 analog inputs or any number of 16-bit serial bytes. A companion reader transcribes the cassette's data to computer-compatible media.

Another 16-channel data logger, the cassette data acquisition system from Climatronics, can record for up to 240 days. The unit records data and time. The companion reader offers either an RS232 or a parallel-computer interface.

Using a high-resolution stepping motor and eight-phase driver, the Series 1200 all-weather data logger, from Sea Data, samples up to 32 times in one second. On a single battery charge, the unit can record 536,000 12-bit words plus 67,000 36-bit headers, including elapsed time.

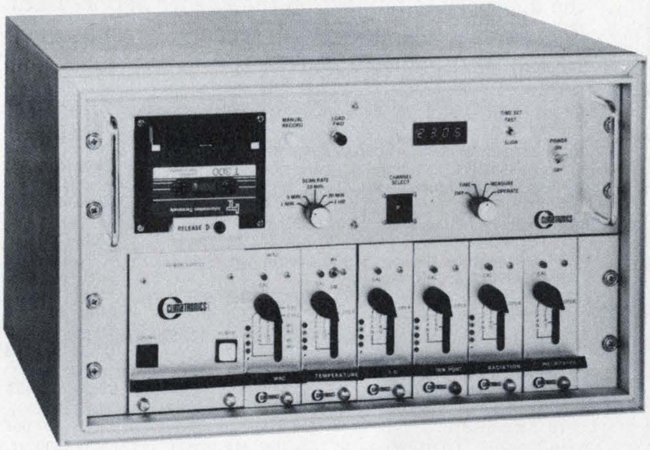
Two independent channels can record the history of events on EDMAC's Model 2043A recorder. In this device, single pulses mark occurrences. The spacing between pulses must be decoded to determine the time at which an event occurred.

Cartridges store more

When cassettes fall short on capacity or recording density, use standard 3M cartridges. The Series 4000, from Kennedy, phase-encodes 1600 bpi, at 5000 bytes/s, into the ANSI format. These recorders use an isoelastic drive that controls tape tension and motion with a single servoed motor. Total storage is 2.875 Mbytes on a cartridge.

In the CMTD-3000S1 ANSI/ECMA tape drive, Data Electronics Inc. uses a servo motor containing an integral tachometer to drive the cartridge's band. Speeds of up to 120 ips for the bidirectional search and rewind are available.

Microdata's Lodestar stores 11.5 unformatted



Scan, record and time 16 channels for 240 days with a cassette data-acquisition system from Climatronics.

Hardware and software control 3M's DCD-100 mini-cartridge drive in Gnat Computers' μP-based MC-200.

Information Terminals 100% certifies Verbatim storage units—cassettes, mini cassettes and cartridges.

Mbytes onto a 3M type cartridge. Data are recorded at 6400 bpi on each of four serial tracks.

Software, in the form of stand-alone dump-restore utilities, operates from either a preestablished command file or a Run command in the 4455 drive, an optional part of SYCOR's 440 system. To get 3200 bpi, the drive uses a double-density encoder and a phase-locked data separator.

Other systems that record on 3M cassettes are offered by Telemetry Systems Engineering (using a transport from Genisco), Epicom (with a Kennedy transport), Tandberg Data, Penny & Giles, and Spectron (in its datascopes).

A carousel-type system that holds 16 cartridges and includes a dual-μP formatter is offered by National Computer Systems. The Model 5200 stores 32 Mbytes.

With a 3M DC100 mini cartridge, Hewlett-Packard's drive is used in its interactive CRT terminals in the 12645A display station and 2641A APL terminal.

Additional drives and systems using plug-in media other than standard cassettes and cartridges are produced by Genisco Technology, Raymond Engineering, Interdyne, Memodyne, Micro Communications, Braemar Computer Devices and Gnat Computers. ■■

Need more information?

The products cited in this report don't represent the manufacturers' full lines. For additional details, circle the appropriate number on the Reader Service Card. For data sheets and more vendors, consult ELECTRONIC DESIGN's Gold Book.

Amilon Corp., 49-12 30 Ave., Woodside, NY 11377. (212) 274-1794. (L. Rosenblatt) **Circle No. 500**

Anderson-Jacobson, 521 Charcot Ave., San Jose, CA 95131. (408) 263-8520. (D. LeVesque) **Circle No. 501**

Applied Data Communications, 1509 E. McFadden, Santa Ana, CA 92705. (714) 547-6954. **Circle No. 502**

Bison Instrument Inc., 5708 W. 36 St., Minneapolis, MN 55416. (612) 926-1846. (F. Schwartz) **Circle No. 503**

Braemer Computer Devices, 11950 Twelfth Ave., South Burnsville, MN 55337. (612) 890-5135. (R. Morris) **Circle No. 504**

Cipher Data Products Inc., 5630 Kerny Mesa Rd., San Diego, CA 92111. (714) 279-6550. (W. Otterson) **Circle No. 505**

Climatronics, 1324 Motor Pkwy., Hauppauge, NY 11787. (516) 234-2772. (T. Schreiber) **Circle No. 506**

Computer Operations, 9700-B George Palmer Hwy., Lanham, MD 20801. (301) 459-2100. (M. Keating) **Circle No. 497**

Data Electronics Inc., 370 N. Halstead St., Pasadena, CA 91107. (213) 351-8991. (S. Thompson) **Circle No. 507**

Datel Systems, 120 Turnpike St., Canton, MA 02021. (617) 828-8000. (L. Copeland) **Circle No. 508**

Datum Inc., 1363 S. State College Blvd., Anaheim, CA 92806. (714) 533-6333. (K. Lowe) **Circle No. 509**

Dicom Industries, 715 N. Pastoria Ave., Sunnyvale, CA 94086. (408) 732-1060. (A. Roberts) **Circle No. 510**

Digital Equipment Corp., 146 Main St., Maynard, MA 01754. (617) 897-5111. **Circle No. 511**

EDMAC Associates Inc., 333 W. Commercial, East Rochester, NY 14445. (716) 385-1440. (R. Reynolds) **Circle No. 512**

Electronic Processors, 1265 W. Dartmouth Ave., Englewood, CO 80110. (303) 761-8540. (J. Voelker) **Circle No. 513**

Emerson Electric Co., Industrial Controls Div., 3300 S. Standard St., Santa Ana, CA 92702. (714) 545-5884. (J. Coolidge) **Circle No. 514**

Epicom, 592 N. Douglas Ave., Mount Laurel, NJ 08057. (609) 234-5700. (B. Adams) **Circle No. 515**

Facit-Addo Inc., 501 Winsor Dr., Secaucus, NJ 07094. (201) 866-5111. (O. Bjerkmann) **Circle No. 516**

General Electric, Data Communications Prods., GE Dr., Waynesboro, VA 22980. (703) 942-8161. (R. Hoffman) **Circle No. 517**

Genisco Technology Corp., Tape Recorders Div., 18435 Susana Rd., Compton, CA 90221. (213) 537-4750. (P. Godinez) **Circle No. 518**

Gnat Computers, 7895 Convoy Ct., Unit 6, San Diego, CA 92111. (714) 560-0433. (F. Adams) **Circle No. 519**

Hewlett-Packard Data Terminals, P.O. Box 1559, 11000 Wolfe Rd., Cupertino, CA 95014. (408) 257-7000. (T. Anderson) **Circle No. 520**

Information Terminals, 323 Soquel Way, Sunnyvale, CA 94086. (408) 245-4400. (G. Newton) **Circle No. 521**

Interdyne Inc., 14761 Califa St., Van Nuys, CA 91411. (213) 787-6800. (B. Geist) **Circle No. 522**

International Computer Products, 2529 Merrell Rd., Dallas, TX 75229. (214) 350-6951. (C. Bishop) **Circle No. 498**

Kennedy Co., 540 W. Woodbury Rd., Altadena, CA 91001. (213) 798-0953. (R. Bartholomew) **Circle No. 523**

Kybe Corp., 132 Calvary St., Waltham, MA 02154. (617) 899-0012. (P. Garland) **Circle No. 524**

Magnetic Information Systems, 25 Dock St., Mount Vernon, NY 10550. (914) 699-7050. (M. Kane) **Circle No. 525**

Memodyne Corp., 375 Elliot St., Newton Upper Falls, MA 02164. (617) 527-6600. (K. Corbett) **Circle No. 526**

MFE Corp., Keewaydin Dr., Salem, NH 03079. (603) 893-1921. (J. Saret) **Circle No. 527**

Micro Communications Corp., 80 Bacon St., Waltham, MA 02154. (617) 899-8111. (I. Johnson) **Circle No. 528**

Microdata Inc., P.O. Box 19501, Irvine, CA 92713. (714) 540-6730. (J. Ramsey) **Circle No. 529**

Mohawk Data Sciences Corp., Administrative Headquarters, Palisade St., Herkimer, NY 13350. (315) 867-6000. (F. Graziano) **Circle No. 530**

3M Co., Mincon Div., 3M Center, St Paul, MN 55101. (612) 733-8863. (R. Swart) **Circle No. 531**

National Computer Syytems, 4401 W. 76th St., Minneapolis, MN 55435. (612) 831-4100. (T. Probst) **Circle No. 532**

NCR Corp., Dayton, OH 45479. (513) 449-4522. (L. Tribby) **Circle No. 533**

Penny & Giles, Mudeford, Christchurch, Dorset BH23 4AT. Phone: Highcliffe (042-52) 71511, Telex: 41266 **Circle No. 534**

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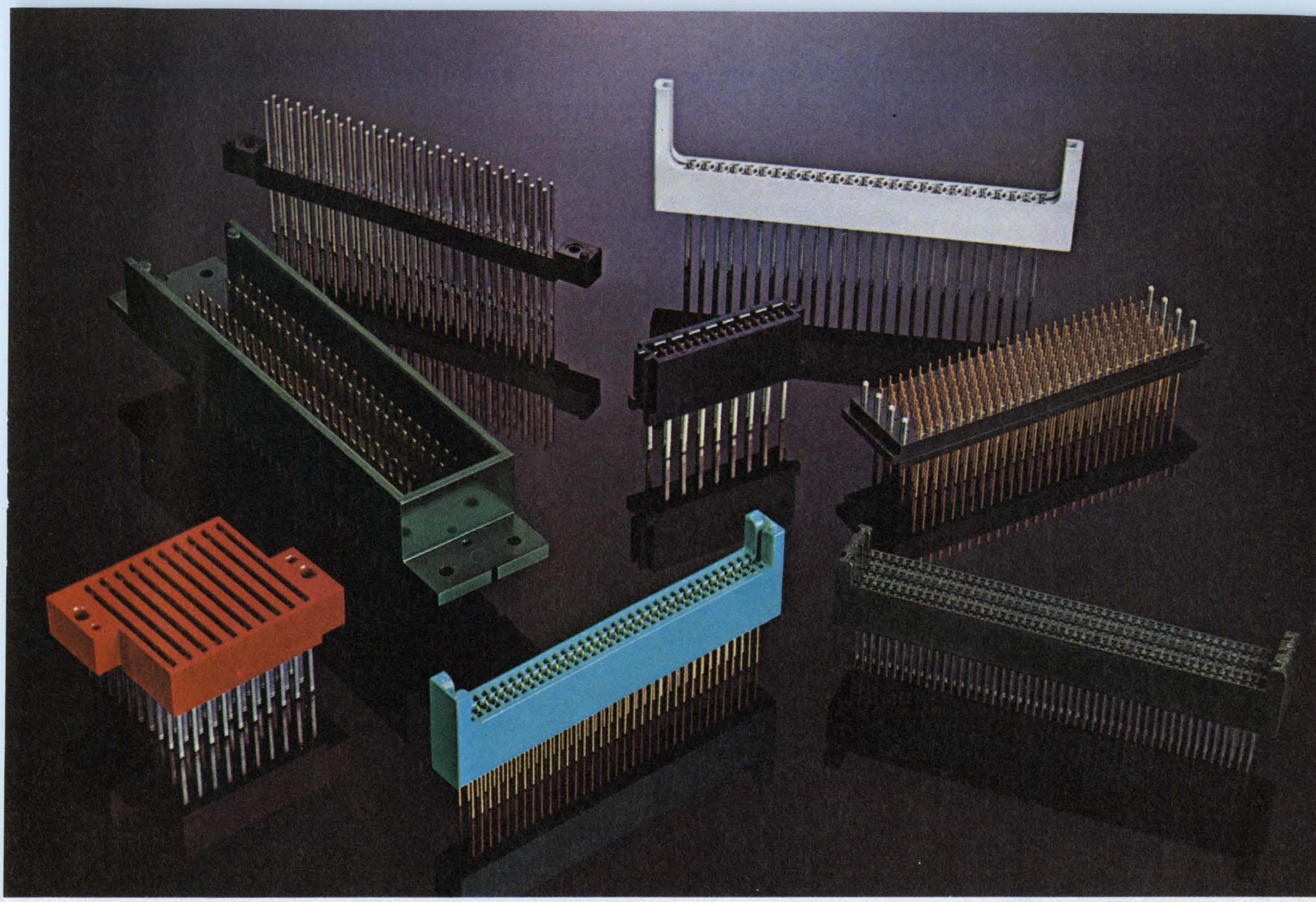

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CIRCLE NUMBER 27

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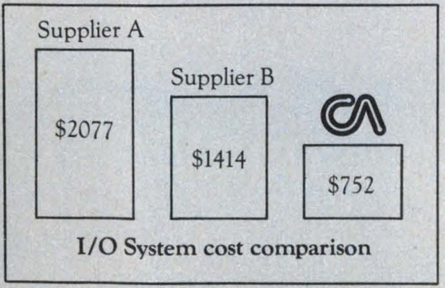

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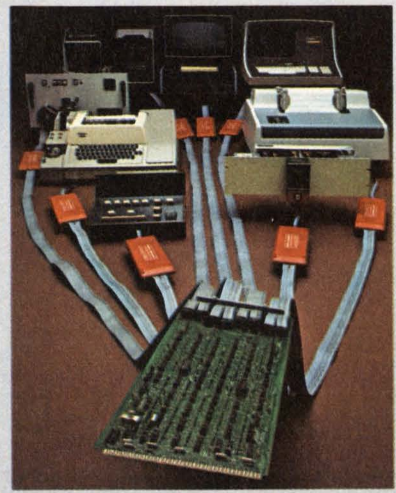

The Distributed I/O System

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CIRCLE NUMBER 29

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CIRCLE NUMBER 31

Editorial

Attacking the problem

Charlie had a problem and he knew it. His counter sales were declining sharply and he knew he would have to make a decision to cope with that problem pretty quickly. Fortunately, he knew the reasons for the problem: his sales people weren't selling properly and his engineers weren't designing imaginatively.

This was particularly irritating because Charlie had already improved the counter with a redesign he had ordered—though his sales and engineering people objected to it and the customers didn't like it either. And because he had improved the counter, Charlie had raised the price—while competitors had lowered theirs.

Cynical Jack, the sales manager, suggested that they redesign the counter to give customers what they wanted rather than what Charlie felt they should have. Charlie's anger was understandable. After all, he reasoned, if the engineers were any good they could refine his redesign so that customers could see that the product merited the price increase. And if the salesmen were any good, they could demonstrate the product's superiority, which should have been obvious anyway.

So Charlie took action. "Straighten out your sales department," he told Jack. "That's where the problem is. Stop looking for excuses." So Jack tried to improve the sales department, which had previously been fine until the counter was redesigned and the price increased. But that didn't help.

So Charlie told the chief engineer to modify the front panel. And that didn't help either.

How could he ever have hired such incompetent managers, Charlie asked himself. And finally he saw the obvious solution to the problem. He fired the chief engineer and sales manager. Any day now, he told himself, those customers should be flocking back.

George Rostky

GEORGE ROSTKY
Editor-in-Chief

Get the best processor performance

by building it from ECL bit slices. The 10800 family offers versatility as well as cycle times of less than 100 ns.

Offering the fastest cycle times of any available bit-slice processor family, the 10800 series of ECL 4-bit processor slices permits you to design high-speed computer systems. Each 10800 circuit is completely expandable, and the major system building blocks are either available or being designed.

The core of any 10800-based system, the arithmetic and logic unit (ALU), operates at system-clock frequencies of 10 to 15 MHz, which represent cycle times of 60 to 100 ns. System word size starts at the ALU width of 4 bits, but can be expanded to n × 4 bits by cascading ALU sections. To support the ALU, Motorola has developed several ECL circuits that take care of most of the housekeeping without restricting the processor design.

Intended to address the instructions stored in the microprogram memory, the 10801 microprogram controller provides a 4-bit address that can be expanded to any size by cascading controllers. A memory interface circuit, the 10803, also has a cascadable 4-bit output bus, but it connects to the address bus of the main memory and supplies all the read and write addresses.

Acting as a register file, stack or I/O buffer, the 10806 dual-port memory provides 32 words × 9 bits of temporary storage and can be accessed through either of its ports. For high-speed mathematical operations, the 10808 multibit shifter can handle up to 16 bits and, under software control, can do left-shift, right-shift or rotate operations. Additional 10808s can be cascaded for larger word lengths.

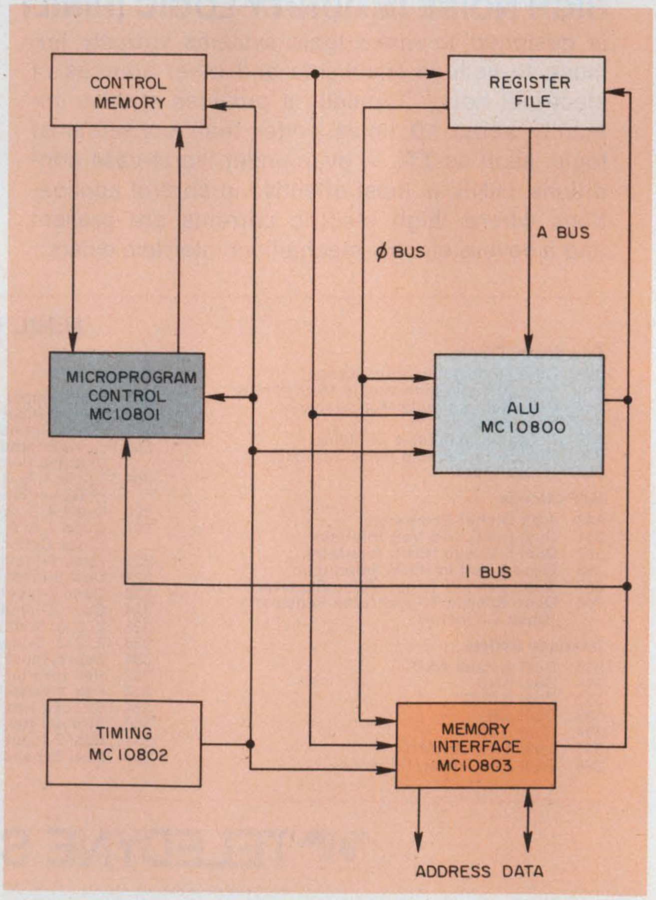
Other support circuits include the 10802 timing generator and clock controller, the 10804 and 10805 bidirectional bus translators (ECL to TTL and vice-versa) and all of the MECL 10,000 series of logic circuits. (All 10800 series circuits and some of the most commonly used 10,000-series units are listed in Table 1.)

A basic processor, built from 10800-series circuits, is outlined in Fig. 1. With a 16-bit word length, the processor would typically consist of four 10800s, two or more 10801s, one 10802, four 10803s, one 10179 (look-ahead carry generator), several 10145s or 10143s for a register file, some microprogram and main memory, and of course some logic glue (SSI and MSI packages). But getting all the parts to work in unison can be quite tricky unless you know how they work.

Tom Balph, Applications Engineer, and **Bill Blood,** Manager, Bipolar LSI System Engineering, Motorola Semiconductor, Inc., 5005 E. McDowell Rd., Phoenix, AZ 85036.

Get to know the ALU

Start with the core. The 10800 4-bit ALU slice can perform both binary and BCD arithmetic and logic operations on combinations of one, two or three variables. All 10800 operations are too numerous to list but some commonly used commands include 28 logic, 23 arithmetic and 16 data-routing combinations



1. **With the 10800 series of bit slices,** you can build a high-performance microprogrammable processor with instruction times of less than 100 ns.

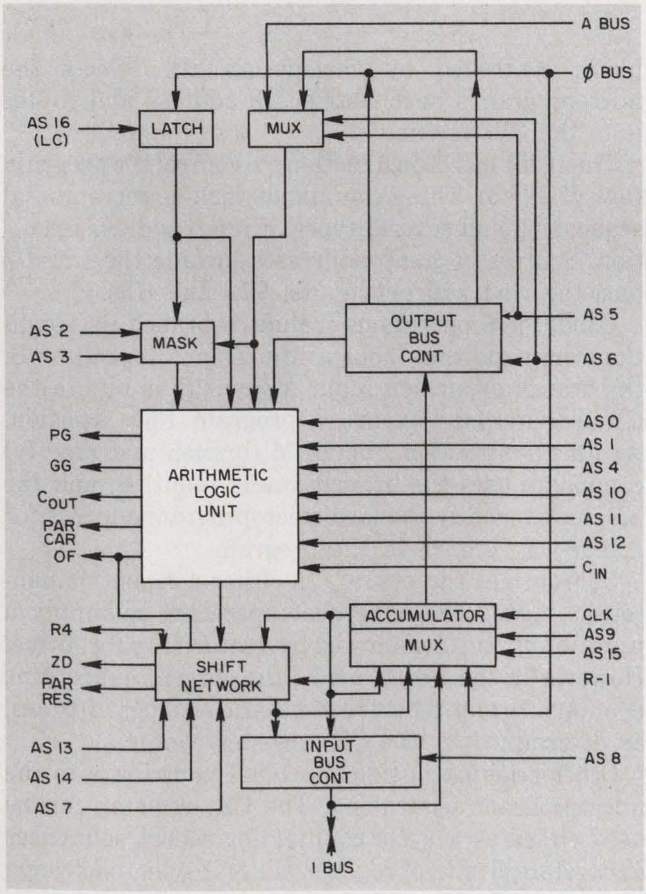
as shown in Tables 2, 3 and 4, respectively. Housed in a 48-pin quad-in-line package (QUIL), the ALU slice offers a flexible organization (Fig. 2).

There are three 4-bit ports on the 10800: an input-only data bus (A bus) and two bidirectional buses (Ø and I buses). The A and Ø buses are the primary data-entry ports, and the I bus is the main output bus. Accepting data from the A bus, Ø bus and/or the internal accumulator, the ALU performs its operations under the direction of 17 selection and control lines.

The three buses and select lines account for 29 pins on the 10800. Another eight pins are required for power (four for grounds, two for −2 V and two for −5.2 V). Five additional lines provide ALU-status outputs, another line is for the clock input, one more for the carry input, and two for parity outputs (one for the carry parity and one for the result parity). And two more control the shift-left/shift-right operation of the ALU's output-shift register. Shifting is possible for the A or Ø bus as well as the accumulator. Also various add or subtract/shift combinations can be performed by using the shift network with the ALU.

Whether the ALU does binary or BCD arithmetic, the speed of the operation remains the same: A 9's-complement circuit is built in and automatically enabled whenever BCD operations are performed. In addition, only one line, AS11, must change state to switch operating modes (see Table 2).

A masking multiplexer on the chip precedes the ALU and performs bit manipulations on incoming data. An on-chip accumulator can hold data for ALU



2. **Capable of 28 logic and 23 arithmetic operations as well as 16-data-routing options,** the M10800 4-bit ALU slice can form the heart of a flexible computer system.

Table 1. M10800 components & support

Part number	Description	100-qty prices
M10800	Arithmetic and logic unit	$30.00
M10801	Microprogram sequencer	50.00
M10802	Timing function and clock controller	15.00
M10803	Memory-interface circuit	40.00
M10804	Bidirectional bus translator (ECL/TTL)	3.75
M10805	Bidirectional bus translator (ECL/TTL)	4.50
M10806	Dual-port address register (32 x 9)	62.00
M10808	Multibit shifter	25.00
MCM10143	Multiport RAM (8 x 2)	9.90
MCM10145	Single-port RAM (16 x 4)	5.90
MCM10146	Single-port RAM (1 k x 1)	15.60
MCM10149	ECL PROM (256 x 4)	22.00
MC10176	Hex, master-slave flip-flop	4.70
MC10179	Look-ahead carry generator	3.30

Table 2. Basic ALU logic commands

Y MUX		X MUX		INV	ACC	Function
AS0	AS1	AS2	AS3	AS10	$\overline{AS5}\cdot AS6$	
0	1	0	1	1	0	Logic 0
0	0	1	0	1	0	A
0	0	0	1	1	0	$\emptyset$
0	0	1	0	0	0	$\overline{A}$
0	0	0	1	0	0	$\overline{\emptyset}$
0	0	1	1	1	0	$A + \emptyset$
0	1	0	0	0	0	$A + \overline{\emptyset}$
1	0	0	0	0	0	$\overline{A} + \emptyset$
0	0	0	0	1	0	$A \cdot \emptyset$
0	1	1	1	1	0	$A \cdot \overline{\emptyset}$
0	1	0	0	1	0	$\overline{A} \cdot \emptyset$
0	1	1	0	1	0	$A \oplus \emptyset$
0	1	1	0	0	0	$\overline{A \oplus \emptyset}$
0	0	0	0	0	0	$\overline{A \cdot \emptyset}$
0	0	1	1	0	0	$\overline{A + \emptyset}$
0	1	0	1	0	0	Logic 1
1	0	1	0	1	1	$ACC \cdot \overline{A}$
0	1	0	1	1	1	$ACC \cdot \overline{\emptyset}$
1	0	1	0	0	1	$\overline{ACC} + A$
0	1	0	1	0	1	$\overline{ACC} + \emptyset$
0	0	1	0	1	1	$ACC \oplus A$
0	0	1	0	0	1	$ACC \oplus \overline{A}$
0	0	0	1	1	1	$ACC \oplus \emptyset$
0	0	0	1	0	1	$ACC \oplus \overline{\emptyset}$
0	0	0	0	1	1	$ACC \oplus A \cdot \emptyset$
0	0	0	0	0	1	$ACC \oplus \overline{A \cdot \emptyset}$
0	0	1	1	1	1	$ACC \oplus A + \emptyset$
0	0	1	1	0	1	$ACC \oplus \overline{A + \emptyset}$

Table 3. ALU arithmetic operations

Y MUX		X MUX		±2	Comple-ment	ACC	Binary function (plus C_{IN})	BCD function (plus C_{IN})
AS0	AS1	AS2	AS3	AS4	AS10	$\overline{AS5}$·AS6	AS11 = 1	AS11 = 0
1	0	0	1	1	1	0	A plus Ø	A plus Ø
1	0	0	1	1	0	0	A plus $\overline{\text{Ø}}$	A plus 9's comp. Ø
0	1	1	0	1	0	0	Ø plus $\overline{A}$	Ø plus 9's comp. A
0	0	1	0	1	1	0	A	A
0	0	0	1	1	1	0	Ø	Ø
0	0	1	0	1	0	0	$\overline{A}$	9's comp. A
0	0	0	1	1	0	0	$\overline{\text{Ø}}$	9's comp. Ø
1	1	1	0	1	1	0	−1 plus A	*
1	1	0	1	1	1	0	−1 plus Ø	*
1	1	1	0	0	1	0	−2 plus A	*
1	1	0	1	0	1	0	−2 plus Ø	*
0	0	1	0	0	1	0	+2 plus A	+2 plus A
0	0	0	1	0	1	0	+2 plus Ø	+2 plus Ø
1	0	1	0	1	1	0	A plus A	A plus A
0	1	0	1	1	1	0	Ø plus Ø	Ø plus Ø
0	0	1	0	1	1	1	ACC plus A	ACC plus A
0	0	0	1	1	1	1	ACC plus Ø	ACC plus Ø
0	0	1	0	1	0	1	ACC plus $\overline{A}$	ACC plus 9's comp. A
0	0	0	1	1	0	1	ACC plus $\overline{\text{Ø}}$	ACC plus 9's comp. Ø
0	0	0	0	1	1	1	ACC plus A·Ø	ACC plus A·Ø
0	0	0	0	1	0	1	ACC plus $\overline{\text{A·Ø}}$	ACC plus 9's Comp. A·Ø
0	0	1	1	1	1	1	ACC plus A+Ø	*
0	0	1	1	1	0	1	ACC plus $\overline{\text{A+Ø}}$	*

*Not defined in BCD

operations. The I and Ø ports are connected to both the ALU and accumulator thus increasing data processing flexibility. With the accumulator, A bus and Ø bus as operands, any of the functions listed in Tables 2, 3 or 4 can be performed in one pass through the circuit.

The status-output lines from the 10800 include the carry-propagate and carry-generate signals for look-ahead carry operations. A carry-output signal is available when slices are cascaded, without carry look ahead. And also available are an overflow output used only for binary operations for indicating when the maximum output from the ALU has been exceeded, and a zero-detect line for indicating when an all-zero condition exists in the output of the ALU shift network. The overflow output can also be used to detect sign changes that stem from a shift operation.

Manipulate the ALU with the microprogram

When a processor is built from 10800 ALU slices, a microprogram selects an ALU operation every clock cycle. The 10801 controller (Fig. 3) determines the next microprogram memory location to be addressed. It performs incremental sequencing, handles jumps, conditional branches, subroutines and repeat loops.

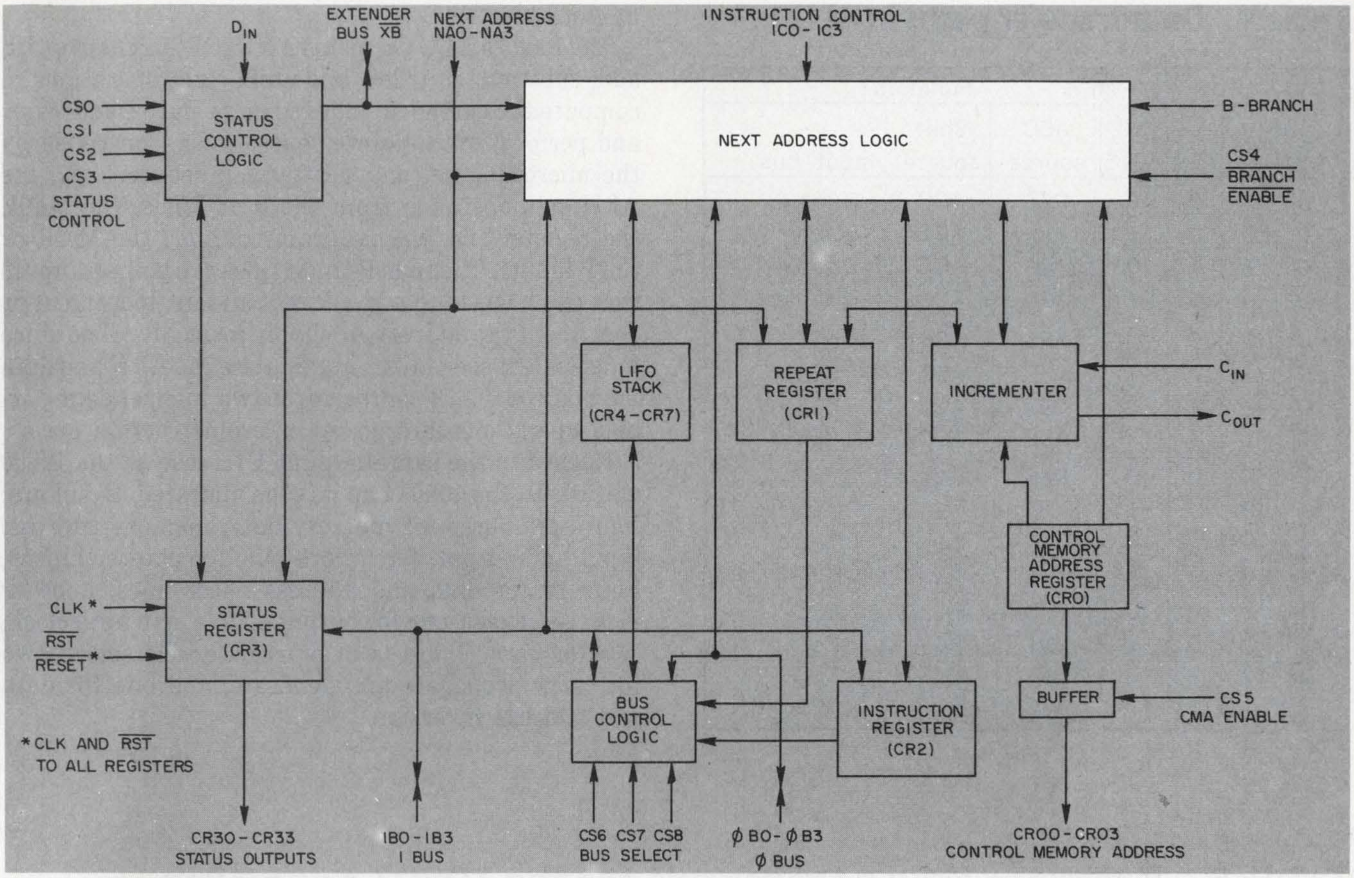
Inside the chip, the control-memory-address register (CR_0) holds the microprogram address that accesses the next instruction. A next-address logic block, controlled by various signals, selects the microprogram's next instruction address and routes it to the CR_0 inputs.

The 10801 has 16 instructions to control the program flow (Table 5). These commands include incremental sequencing and several types of jump address operation. Sources of jump addresses include the I and Ø bus, the next address inputs, CR_1 and CR_2.

Conditional operations include a branch on condition command that looks at the branch input line B, the branch expansion input $\overline{XB}$ or status bits in the CR_3 register and makes a program flow decision. Another instruction, the BRM (branch and modify) command, uses the branch status input, B, and the $\overline{XB}$ line to modify the next microprogram address for a four-way branch in the program.

Subroutines can operate in either a repeat or nonrepeat mode. The nonrepeat operation is simply a jump to subroutine followed by a return to subroutine. However in the repeat mode, the current subroutine is automatically repeated a specific number of times, as determined by the CR_1 register contents.

Other registers inside the 10801 contribute to the microprogram sequencing. The CR_1 register can be used either as a cycle counter for repeat sequences or to store a microprogram address when servicing interrupts. Register CR_2 can hold a machine-instruction starting address or an interrupt vector for microprogram flow jumps.



3. **Controlling the microprogram addressing,** the M10801 microprogram sequencer generates the next address and has a repertoire of 16 program-flow commands. It provides a 4-bit section of the address.

The CR_3 register stores the status bits for conditional program jumps. These bits are most often external signal lines, such as interrupts or test points.

Sometimes, the ALU's condition-code bits are held in CR_3, but usually they are stored in a separate register controlled by the microprogram. Select lines CS_0, CS_1, CS_2 and CS_3 control the CR_3 status register and permit it to store or read individual bits. All status conditions are available as outputs.

Another bank of four registers, CR_4 to CR_7, forms a last-in, first-out (LIFO) stack to next subroutines. Controlled by the next-address logic block, the stack can be extended through the Ø port bus with external memory. Also, should an emergency power-down or priority interrupt be signaled, all the register's contents can be "dumped" through the Ø or I bus ports. The reverse data flow is also possible—all registers can be loaded through the same ports.

The 10801 provides a 4-bit section of the microprogram address, and any number of controllers can be cascaded. For instance, two 10801s can control 16 pages of 256 words. One of the available CR_3 registers makes a handy page-address register while the other available CR_3 register can be used to hold status information. Larger systems might use three 10801s to address up to 4096 words directly or 16 pages of 4096 words each.

The 10801 has five I/O ports—the CR_0, CR_3, I bus, Ø bus and NA inputs—which account for 20 of the 48 pins on the QUIL package. Another nine pins are used for the select lines, four more are the instruction inputs, and eight are needed for power and ground. Two more pins form the carry-in and carry-out lines for cascading, one is for the clock input and four take care of other control functions.

Main memory also needs a controller

To generate main memory addresses for any 10800-based system, the 10803 I/O controller interfaces to the main memory and peripherals via the address and data buses. I and Ø bus ports interface to the other system components. A memory-data register inside the 10803 chip (Fig. 4) holds incoming or outgoing data, and a memory-address register (MAR) holds outgoing information. A 4 × 4 register file can be used as a program counter, a stack pointer, an index register or other related functions. Its output feeds into the simple ALU or into the multiplexer input to the memory-address register.

A data-matrix block controls the transfer of data between various internal registers and I/O ports. Seventeen data-transfer operations are possible (Table 6a and b), and they are controlled by inputs MS_0 to MS_3, MS_5 and MS_{14}. The MS_{14} line permits any combination of positive and negative logic formats by inverting any data on the data and address buses. Once selected, any transfer can be performed within one

Table 4. Data-transfer paths in ALU

AS7	AS8	AS9	AS15	Function		
				ACC source	Shift source	Input bus
0	0	0	0	RES	ACC	Disable
0	0	0	1	ØB	ACC	Disable
0	0	1	0	IB	ACC	Disable
0	0	1	1	ACC	ACC	Disable
0	1	0	0	RES	ACC	ACC
0	1	0	1	ØB	ACC	RES
0	1	1	0	IB	ACC	RES
0	1	1	1	ACC	ACC	RES
1	0	0	0	RES	F_{OUT}	Disable
1	0	0	1	ØB	F_{OUT}	Disable
1	0	1	0	IB	F_{OUT}	Disable
1	0	1	1	ACC	F_{OUT}	Disable
1	1	0	0	RES	F_{OUT}	ACC
1	1	0	1	ØB	F_{OUT}	RES
1	1	1	0	IB	F_{OUT}	RES
1	1	1	1	ACC	F_{OUT}	RES

microinstruction.

The 10803's ALU performs AND, OR, Exclusive-OR, add, subtract, shift-left and shift-right operations to compute the extended, indexed and relative addresses and perform stack-pointer operations. Controlled by the microfunction and destination-decode logic, the ALU gets operands from the Ø or I bus, the MDR, the register file, the program counter, the MAR or the P inputs. The four P-input lines are pointer inputs that can be used to add address offsets, increment or decrement the address, or supply mask bits. And since independent select lines manipulate the ALU and data matrix, the 10803 can perform two independent parallel operations during one microinstruction cycle.

Housed in the same 48-pin QUIL case as the 10800 and 10801, the 10803 has its pins allocated as follows: four 4-pin buses for memory data, memory address, input and output, four more pins for pointer inputs, 11 more for data and address-select lines, another eight for power, one for output enable, one for a clock, two for carry lines, two for register-file select, two for carry propagate and generate, and one for data and address inversion.

Table 5. Program-flow commands for the 10801 controller

Mnem	Code				Description	Reset $\overline{RST}$	Branch or repeat condition	CR0	CR1	CR2	LIFO stack CR4-CR7
	IC3	IC2	IC1	IC0							
X	X	X	X	X	Reset condition	0	X	0	0	0	"Push" CR0 to stack
INC	1	1	0	0	Increment	1	X	CR0 plus C_{in}	—	—	—
JMP	0	0	1	0	Jump to next address	1	X	NA	—	—	—
JIB	1	0	0	0	Jump to I Bus	1	X	IB·NA	—	—	—
JIN	1	0	0	1	Jump to I Bus & Load CR2	1	X	IB·NA	—	IB	—
JPI	1	0	1	0	Jump to primary inst.	1	X	CR2·NA	—	—	—
JEP	1	1	1	0	Jump to external port	1	X	ØB·NA	—	—	—
JL2	0	0	0	1	Jump & load CR2	1	X	NA	—	IB	—
JLA	0	0	1	1	Jump & load address	1	X	NA	CR0 plus C_{in}	—	—
JSR	0	0	0	0	Jump to subroutine	1	Repeat	NA	—	—	"Push" CR0 to stack
						1	Nonrepeat	NA	—	—	"Push" CR0 plus C_{in}
RTN	1	1	1	1	Return from subroutine	1	Repeat	CR4	CR1 plus C_{in}	—	"Pop" stack to CR0
						1	Nonrepeat	CR4	—	—	"Pop" stack to CR0
RSR	1	1	0	1	Repeat subroutine	1	X	CR0 plus C_{in}	NA	—	—
RPI	1	0	1	1	Repeat instruction	1	Repeat	—	CR1 plus C_{in}	—	—
						1	Nonrepeat	CR1·NA	—	—	—
BRC	0	1	0	1	Branch on condition	1	Branch = 1	NA	—	—	—
						1	Branch = 0	CR0 plus C_{in}	—	—	—
BSR	0	1	0	0	Branch to subroutine	1	Branch = 1	NA	—	—	"Push" CR0 plus C_{in}
						1	Branch = 0	CR0 plus C_{in}	—	—	—
ROC	0	1	1	1	Return on condition	1	Branch = 1	CR4	—	—	"Pop" stack to CR0
						1	Branch = 0	NA	—	—	—
BRM	0	1	1	0	Branch & modify	1	CS4=1	NA	—	—	—
						1	CS4=0	CR00=NA0·B CR01=NA1·XB CR02=NA2 CR03=NA3	— —	— —	— —

To get all the blocks to work in unison, the 10802 timing function circuit generates up to four clock phases from a single-phase oscillator input. It also allows for system starts and stops, and has a single-step control for diagnostic purposes. Both the number of clock phases and their duration are programmable through seven select lines.

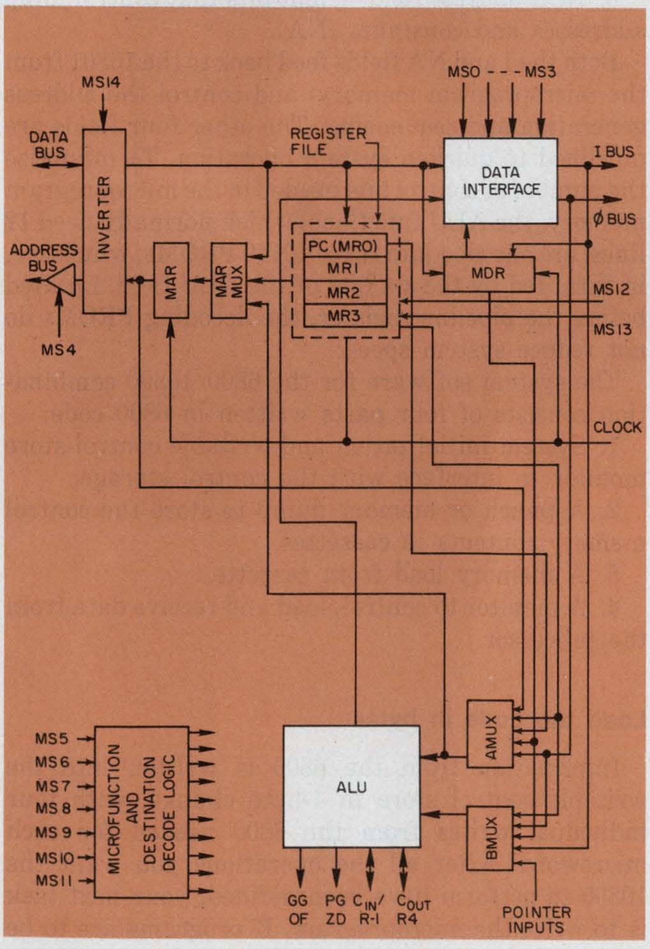
Synchronize all the logic blocks

The 10802 is housed in a 24-pin DIP with seven pins for the select inputs, four for the phase outputs, three for power, one for the clock input and nine for controls. Several timing circuits can be cascaded if more than four clock phases are needed. The 10802 can also be programmed to compensate for one slow path without slowing down the faster sections by doubling the duration of any clock phase.

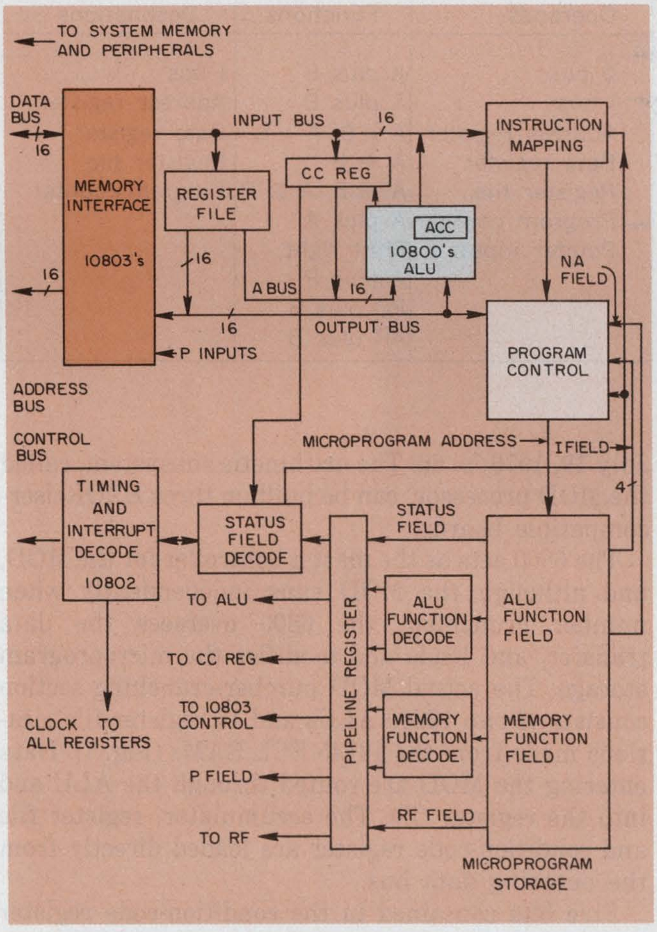
At this point, getting all the parts to work together is a matter deciding on word length, system architecture and microprogramming structure. A generalized 16-bit minicomputer architecture, based on the 10800 series, is shown in Fig. 5 The system uses a pipelined architecture to keep the cycle time as fast as possible. The actual fetch and execution of a microinstruction are accomplished in two clock cycles. The next instruction is being fetched while the current instruction is being executed.

A microprogram control cycle consists of addressing the microprogram memory, setting up a new address (through the I and NA fields) and clocking the new address to the 10801's CR_0 register, which starts the cycle all over again. During the control cycle, new data-processing and memory interface operations are accessed and clocked into the pipeline register. A status-field, also held in the pipeline register, is used to select branch conditions, update interrupt status, and reset the system, among other functions. The number of microprogram memory bits is minimized by decoding the various fields from the microprogram memory.

Before setting up a microcode to control all these operations, a system architecture and instruction set must be defined. Look at a master-slave system that uses a 6800 microprocessor as a controller and an 8-bit, 10800-based processor to rapidly perform complex mathematical operations (Fig. 6). For more about the 6800, see "Microprocessor Basics: Part 5," ED No. 15,



4. **Built with five I/O ports,** the M10803 memory interface circuit offers very flexible operation along with 17 different data-routing instructions.



5. **A generalized 16-bit minicomputer** can be based on the 10800 bit slices. Its pipelined architecture offers the best performance technology can provide.

Table 6. Memory-controller commands

MS 3 2 1 0	MS 5 14	Mne-monic	Operation
0 0 0 0	- -	NOP	No operation
0 0 0 1	- -	AIB	ALU to IB
0 0 1 0	- -	ODR	ØB to data register
0 0 1 1	- -	ADR	ALU to data register
0 1 0 0	0 0	BRF	$\overline{\text{DB}}$ to register file
	0 1		DB to register file
	1 0	BAR	$\overline{\text{DB}}$ to address register
	1 1		DB to address register
0 1 0 1	- 0	BIB	$\overline{\text{DB}}$ to IB
	- 1		DB to IB
0 1 1 0	- 0	BDR	$\overline{\text{DB}}$ to data register
	- 1		DB to data register
0 1 1 1	-	IDR	IB to data register
1 0 0 0	- 0	FDB	$\overline{\text{Register file}}$ to DB
	- 1		Register file to DB
1 0 0 1	- 0	RDB	$\overline{\text{Data register}}$ to DB
	- 1		Data register to DB
1 0 1 0	- 0	ODB	$\overline{\text{ØB}}$ to DB
	- 1		ØB to DB
1 0 1 1	- 0	PTB	$\overline{\text{Data register}}$ to DB; IB to DR
	- 1		Data register to DB; IB to DR
1 1 0 0	- -	FOB	Register file to ØB
1 1 0 1	- -	ROB	Data register to ØB
1 1 1 0	- 0	PFB	Data register to ØB; $\overline{\text{DB}}$ to DR
	- 1		Data register to ØB; DB to DR
1 1 1 1	- -	MOR	Data register to ØB; IB to DR

Operands	Functions	Destinations
Ø bus	A plus B	I bus
I bus	A plus $\overline{\text{B}}$	Address register
Address register	A · B, A · P	Data register
Data register	A + B	Register file
Register file	A ⊕ B, A ⊕ P	Program counter
Program counter	A plus A	
Pointer inputs	Shift right	
	A plus P	
	PC plus B	
	AR plus B	

July 19, 1976, p. 66. The arithmetic subsystem, called the MOD processor, can be built on three EXORciser-compatible boards.

The 6800 acts as the master controller for the MOD, and although the MOD runs independently when number crunching, the 6800 oversees the data transfer, and loads and modifies the microprogram storage. The actual MOD number-crunching section consists of two 10800 ALUs and 16 register-file locations made from the 10145 ECL RAMs (Fig. 7). Data entering the MOD are routed through the ALU and into the register file. The accumulator, register file and condition-code register are loaded directly from the outgoing data bus.

Five bits contained in the condition-code register are used to indicate the following:

1. Carry output from the most-significant bit of the ALU (C).
2. Two's complement arithmetic overflow (V).
3. Zero detect output of the result (Z).
4. Sign of the result (N).
5. Link bit for shifting (L).

Two 10801s are used to sequence through the microprogram storage. When cascaded, they are connected to generate both an 8-bit word address and a 2-bit page address. The memory is thus organized as four pages of 256 words each. The microprogram memory for the MOD consists of 1024 words of RAM, each 32-bits wide.

This writable control store is built from 32 1-k RAMs (10146s) and is loaded with instructions by the 6800 controller. Each 32-bit word is divided into six fields (Fig. 8):

1. ALU field—six bits that control 61 ALU operations (ALU).
2. Condition-code field—three bits that control eight functions (CC).
3. Register-file field—six bits that hold the register-file address, the register-file write enable and the accumulator write enable (RF).
4. Status field—five bits that contain 31 operations to control branch operations for the 10801, the CR_3 register and page addressing (S).
5. Instruction field—four bits that handle microprogram address functions (I).
6. Next-address field—eight bits that control jump addresses and constants (NA).

Both the I and NA fields feed back to the 10801 from the microprogram memory, and control the address generation and sequencing. The other four fields are pipelined to quicken system operation. To minimize the number of control bits needed in the microprogram memory, the ALU functions, which normally need 12 lines, are encoded into three 10149 PROMs, which are, in turn, fed by the six bits of the ALU field. Located before the pipeline register, the decoding PROMs do not reduce system speed.

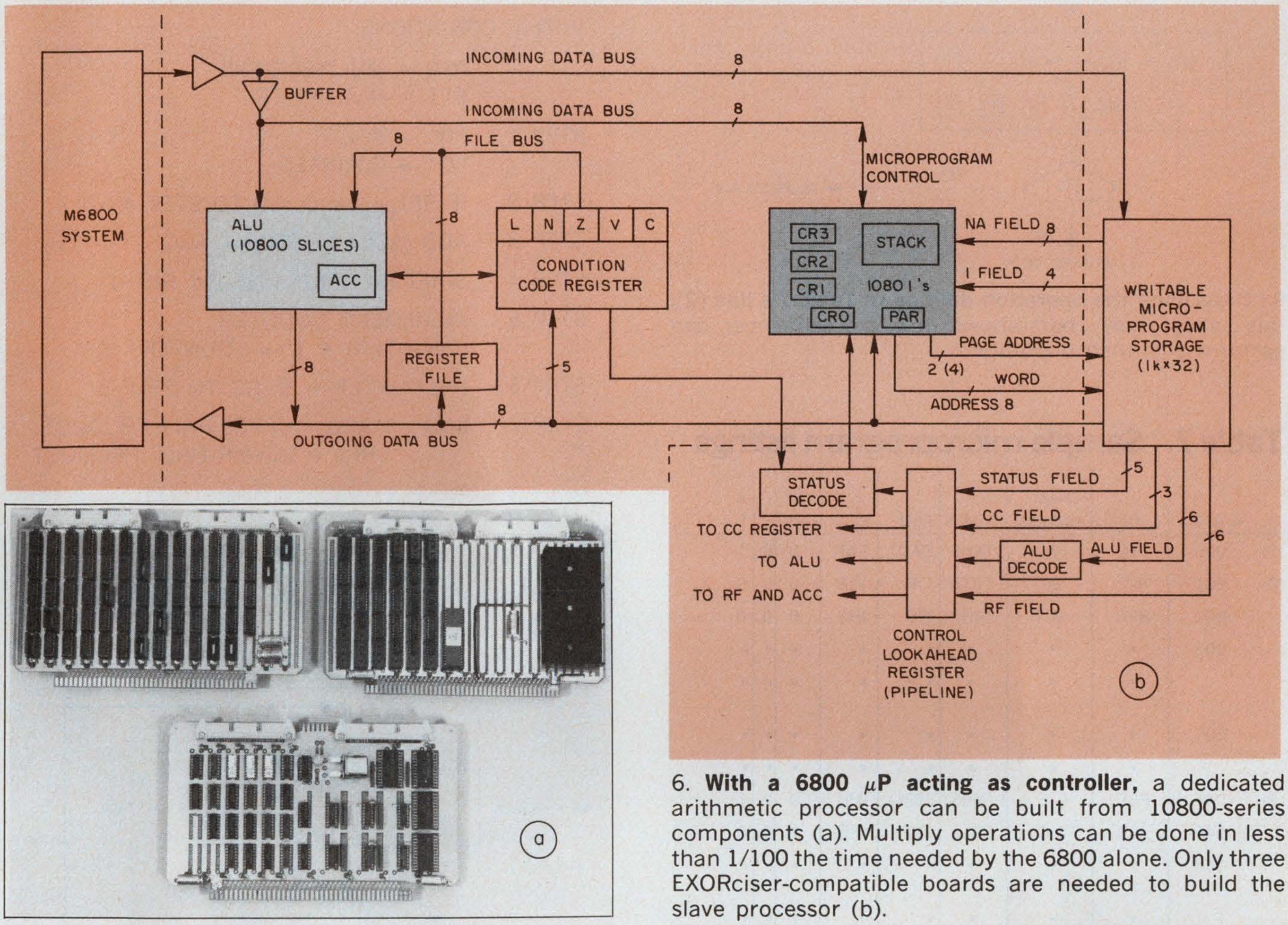
The system software for the 6800/10800 combination consists of four parts written in 6800 code:

1. System initialization and writable control-store monitor to interface with the control storage.
2. A punch or memory dump to store the control memory contents in cassettes.
3. A memory load from cassette.
4. A monitor to control, load and receive data from the processor.

Load the code in bytes

Information from the 6800 is written into the writable control store in 1-byte chunks, with four individual writes from the 6800 needed for each microword. After all the operations you want the 10800 to perform have been defined, your next task is to write the microprogram. If programs are to be written by hand, a tabular listing, as shown in Table 7, can simplify the procedures.

Line (1) represents a complete microinstruction in

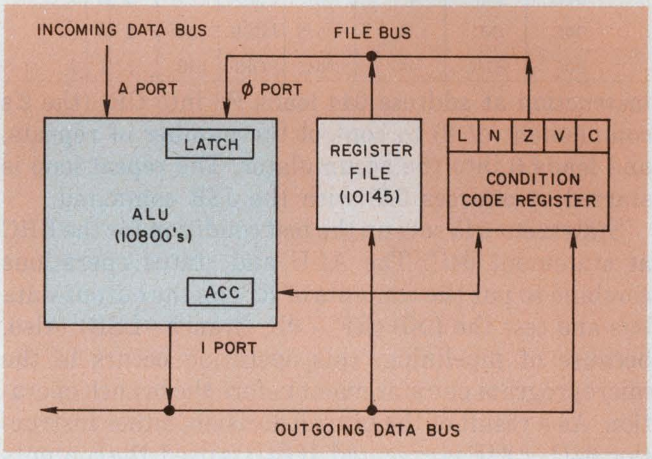


6. **With a 6800 μP acting as controller,** a dedicated arithmetic processor can be built from 10800-series components (a). Multiply operations can be done in less than 1/100 the time needed by the 6800 alone. Only three EXORciser-compatible boards are needed to build the slave processor (b).

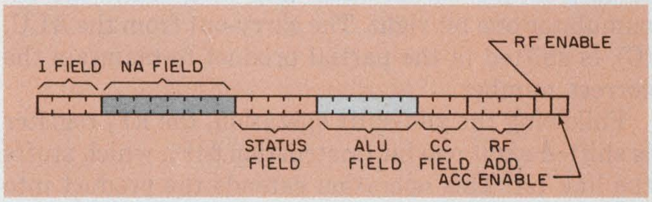
mnemonic form. Each of the field columns defines an operation performed by the microword: INC—increment address; X—don't care for next address; INHS—inhibit status; BADA—binary-add register field and accumulator; LAR—load Z, N, C and V condition-code bits; RFB—register B; FE=0—disable register-file write; and AE=1—enable accumulator write. In "English" the microword tells the machine to increment the address, add register B to the accumulator with the result returned to the accumulator, and load all condition-code bits except the link bit.

The second line of the program, (2), continues the instruction at address 000 to the instructions at addresses 001 and 002. A register-file-add-to-accumulator instruction given in address 000 is followed by a branch operation at address 002 (Fig. 9). The I-field address advances to 002. If N equals 1 the branch occurs, and advances the address to ØØF, as specified by the NA field. If N equals 0, a simple increment instruction is performed.

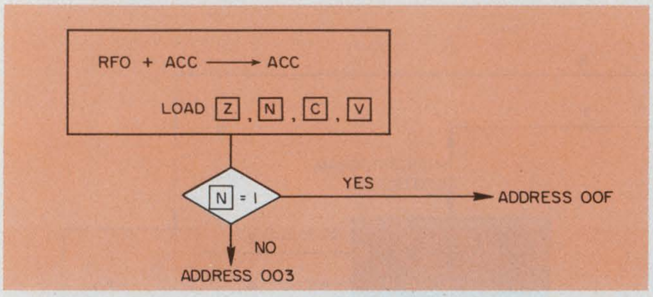
A more complex example is an 8 × 8-bit binary magnitude multiply. For this example let the contents of RF_0 be the multiplicand and RF_1 be the multiplier. The 16-bit product will be stored with the eight MSBs in the accumulator and the lower eight bits in RF_1. To perform the multiplication, use an add-shift algorithm that repeats eight times (Fig. 12). The initial



7. **The data-processing section** of the MOD boards consists of an 8-bit ALU, a 16 × 8 register file and a condition-code register.



8. **The microinstruction that controls MOD operation** is subdivided into six fields that control smaller sections of the processor.



9. **Describing the operation defined in Table 7's line (2),** this simple flow chart shows how the sequencer can perform a branch operation.

Table 7. Sample microprogram listings

	Add_{16}	I. field	Next address	Status	ALU	CC	RF add	F E	A E
(1)	000	INC	X	INHS	BADA	LAR	B	0	1
(2)	001	INC	X	TSTN	TIB	IHB	0	0	0
	002	BRC	Ø F	INHS	TIB	IHB	0	0	0
	003	•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
	00F	•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
(3)	044	RSR	F 8	INHS	ZERO	IHB	0	0	1
	045	JSR	4 C	TSLS	TRF	IHB	1	0	0
	046	•	•	•	•	•	•	•	•
		•	•	•	•	•	•	•	•
	04C	BRC	4 E	INHS	TIB	IHB	0	0	0
	04D	JMP	4 F	INHS	LSRA	LDA	0	0	1
	04E	INC	X	INHS	ACSR	LDA	0	0	1
	04F	RTN	X	INHS	RORF	IHB	1	1	0

instruction at address 044 loads F8 into CR_1 (the 2's complement of 8) to control the number of repeats, and loads 0 into the accumulator. The repeat loop is started at address 045 with the JSR command.

Statement 045 sets up the test condition for the BRC at statement Ø4C. The ALU and status operations combine to put the contents of RF_1 on the output-data bus and test the LSB ($RF_1 \rightarrow$ ØB, Branch=LSB). Also, because of pipelining, this operation occurs in the microprogram one statement before the branch operation. As a result of the branch decision, either instruction Ø4D or Ø4E is executed. If Ø4D is used, the contents of the accumulator are shifted one bit to the right, which is the same as adding zero to the accumulator and then shifting. Instruction Ø4E adds the contents of RFØ to the accumulator and then shifts the accumulator one bit right. The carry-out from the ALU, (C), is shifted in the partial product to maintain the correct number.

Following the add-shift operation, the RF_1 register is shifted right one bit (instruction Ø4F), which stuffs the link bit. This operation extends the product into RF_1 by one bit and moves the next multiplier bit into position for the next iteration. After the final iteration, the program jumps to 046. A more complex

INITIAL CONDITIONS:

RFO = MULTIPLICAND
RF1 = MULTIPLIER

STEP 1 "0" → ACC
"0" → COUNTER

STEP 2 IF $RF1_{LSB}$ = 0, GO TO STEP 4

STEP 3 ADD (ACC) + (RFO) → ACC

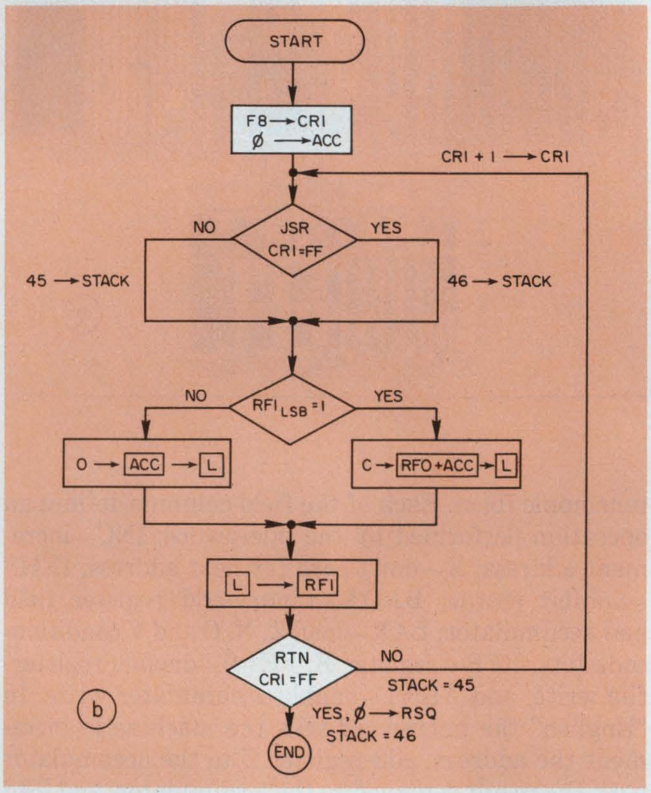
STEP 4 SHIFT (ACCRF1) ONE BIT RIGHT

STEP 5 INCREMENT COUNTER,
(COUNTER) + 1 → COUNTER

STEP 6 IF COUNTER ≠ 8, GO TO STEP 2

STEP 7 END | ACC = UPPER HALF PRODUCT
RF1 = LOWER HALF PRODUCT

(a)



10. **To perform an 8 × 8-bit multiply operation,** a simple add and shift routine can be written and iterated eight times (a). The same routine can be expressed in flow-chart form (b).

example is a full floating-point, single-precision multiply operation with two 32-bit numbers that have an 8-bit sign and exponent and a 24-bit mantissa. With a 10 MHz clock the MOD processor needs 37.6 μs to perform the operation—less than 1/100 the time of an equivalent software multiply in the 6800.■■

Previous articles in this series discussed the 8080, F8, 6800, 2650, 1802, 6100, PACE, SC/MP, Series 3000 and Series 2900. The next article in the series will cover the Z80.

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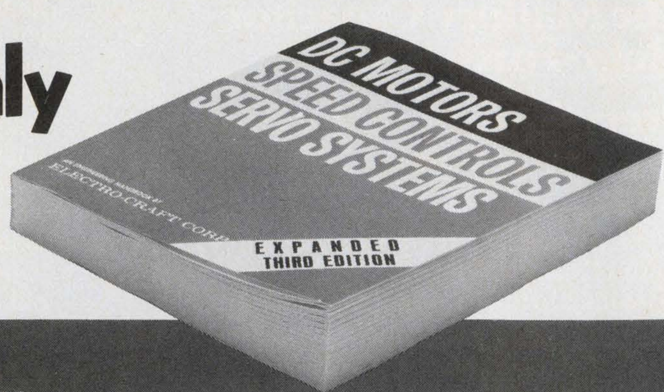

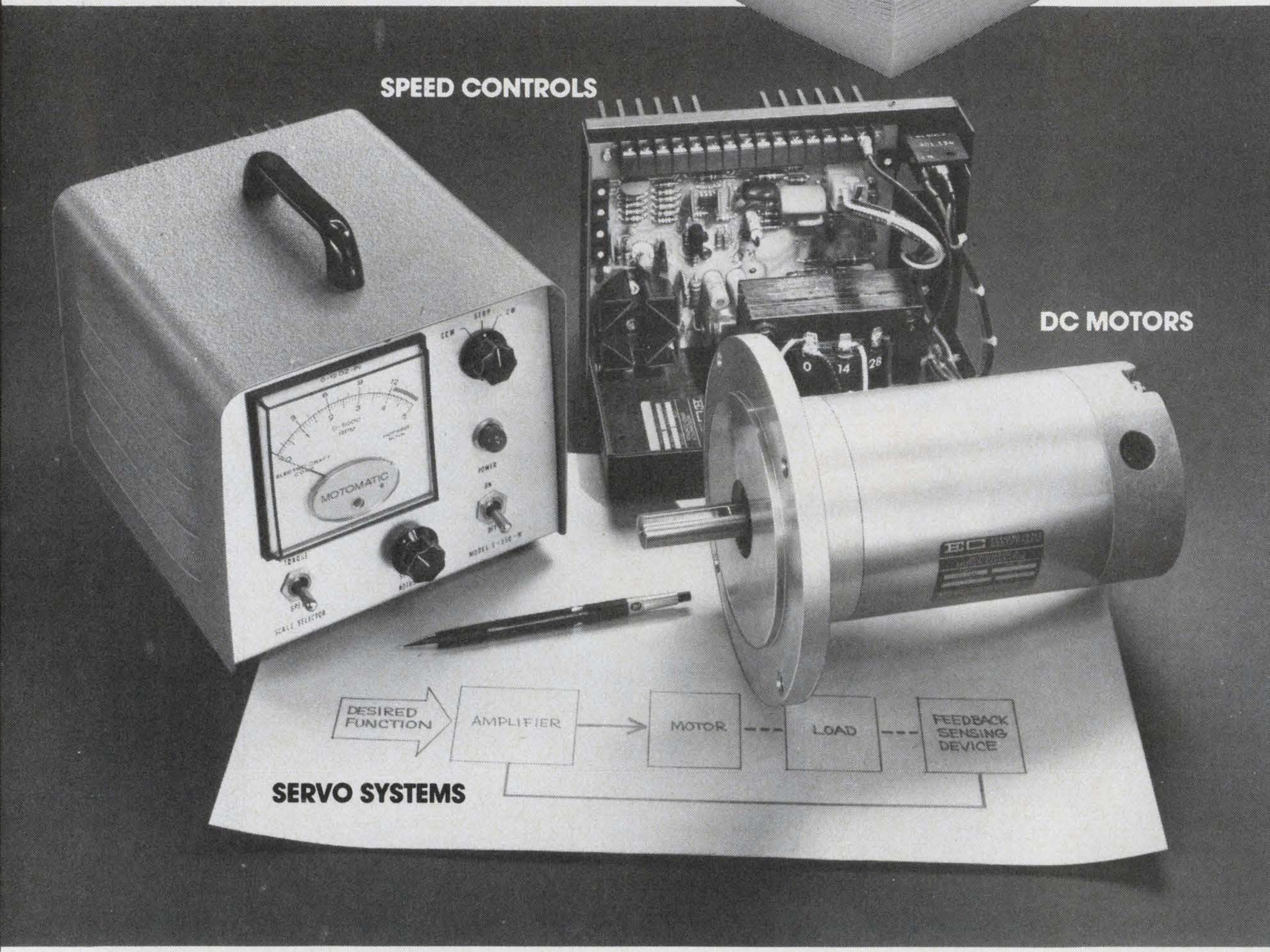

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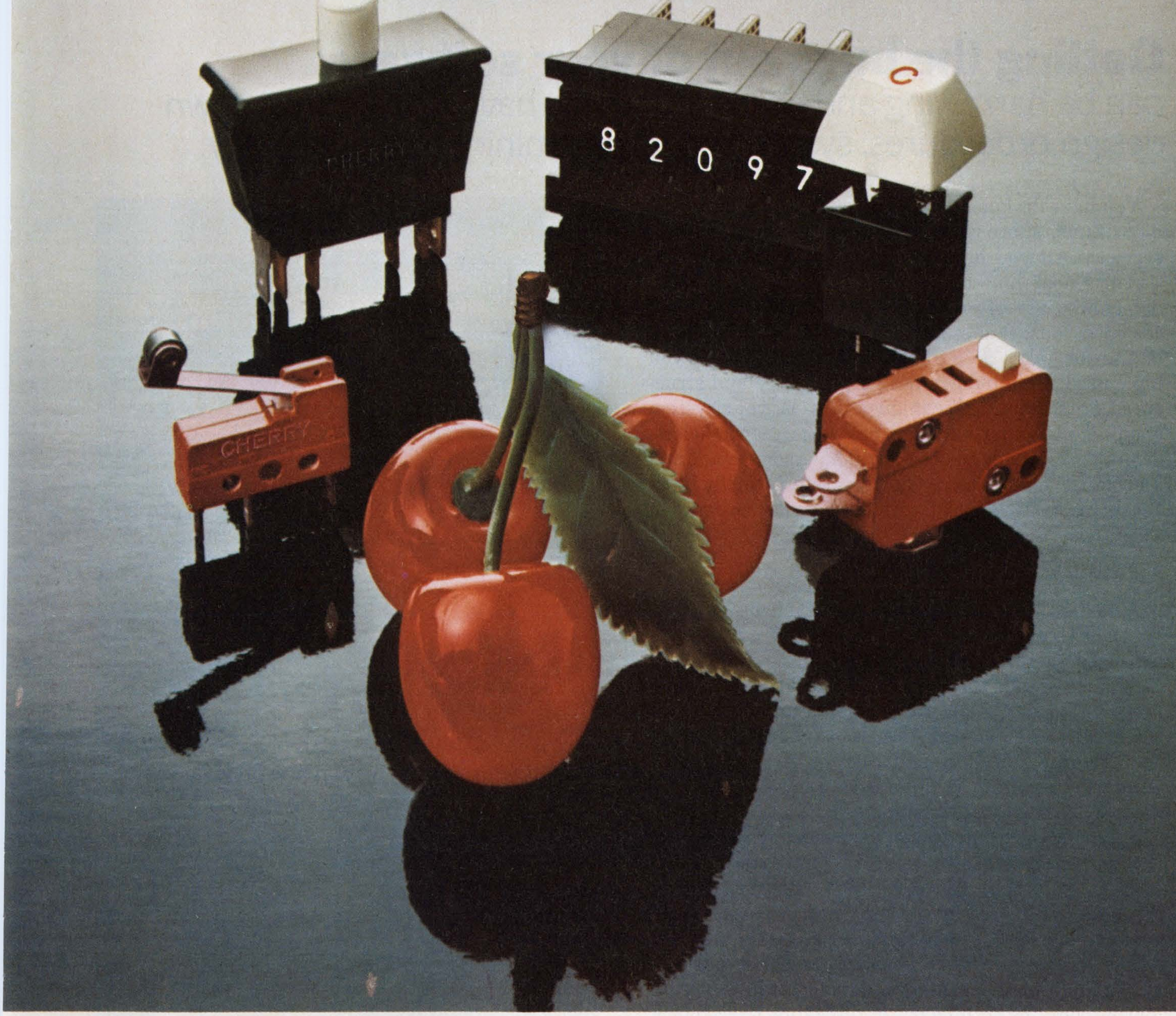

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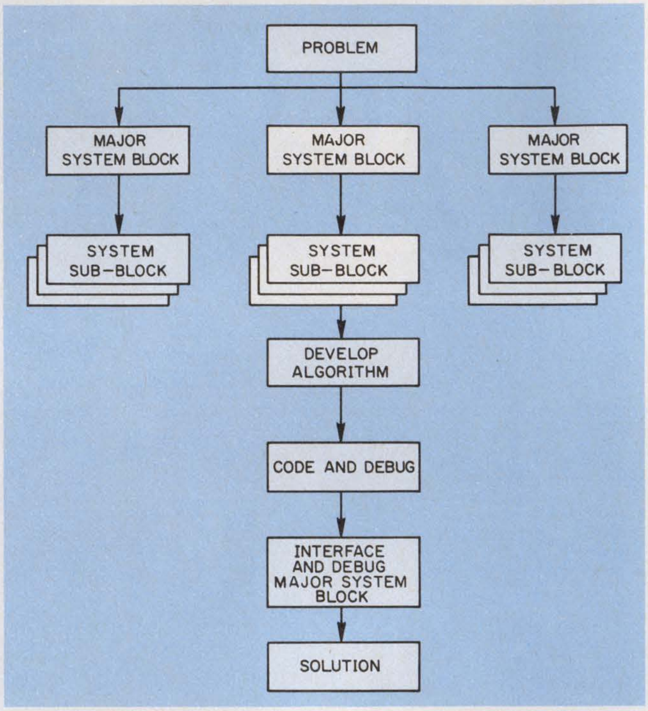


1. **In top-down design** the complete program is broken down into blocks and sub-blocks that can be coded and tested easily.

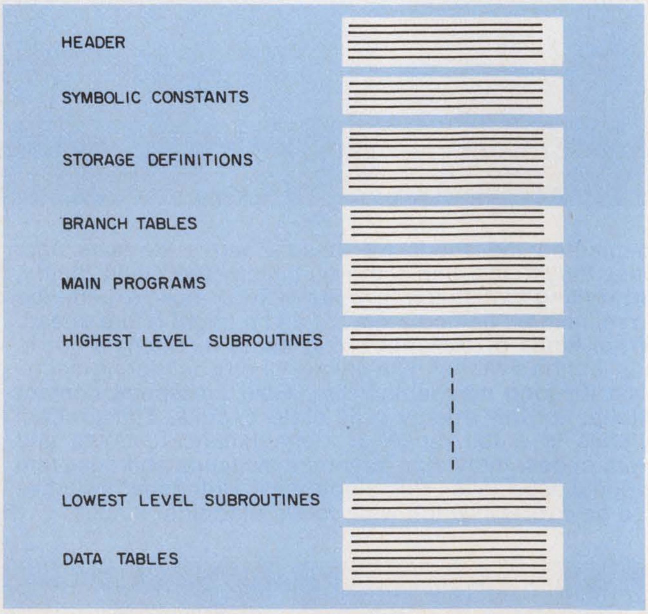
A good layout is half the battle

A well written program is recognizable by its looks. When all the modular blocks and subroutines are arranged in the final program ("source listing"), it should resemble the format shown in Fig. 2. The program header is a comment field that summarizes the program's vital statistics. It includes the name of the program, the date and current revision status, where the program is to be used, and comments on memory and I/O requirements.

Symbolic constants follow the header. They include pseudo-instructions that define immediate data, memory reference addresses, and I/O port names. Next come the storage definitions for reserved program storage, followed by branch isolation tables that define jumps to internal branches and I/O routines.

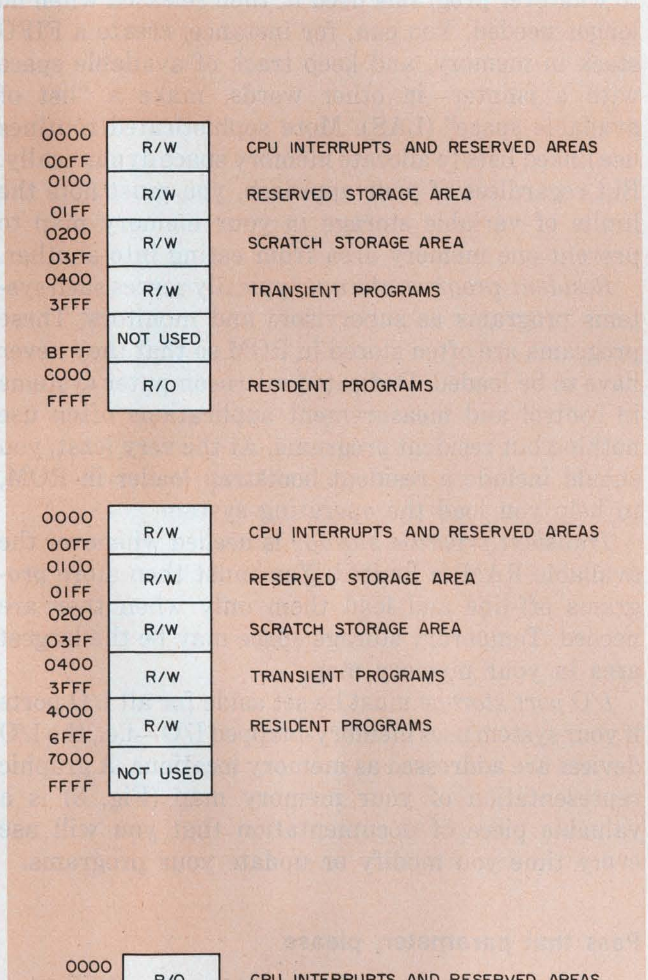
The main program follows, but in modular-design it often contains nothing but initialization and a bunch of subroutine calls. The main program's subroutines are arranged in order of decreasing complexity. Routines called by the main program should come first, then routines called by the first set and so on, down to the most elementary blocks. The organization of the program proper (main program plus subroutines) establishes the order for testing and debugging. After the program, data tables are listed and identified.

When laying out a source program, use comments liberally so that you can instantly identify any pro-



2. **A well written program** follows an established layout, like the courses in a menu.

Robert W. Ulrickson, President, Logical Services Inc., 711 Stierlin Rd., Mountain View, CA 94043.



3. **Memory maps stake out the needs** of various program segments (top). Maps for systems without read-only memory (center), or production-oriented systems (bottom) are two possible variants.

gram area by scanning the source listing. The following skeleton of a source listing in 8080A assembly language is laid out according to the format just described.

```
                HEADER
;SAMPLE PROGRAM STRUCTURE, REV. 0.0
;
;RELEASE DATE:
;PROGRAMMER:
                .
                .
                .
;
;SYMBOLIC CONSTANTS
;
;ASCII CHARACTERS
;
CR          EQU ODH         ;ASCII CARRIAGE RETURN
LF          EQU OAH         ;ASCII LINE FEED
                .
                .
          CONSTANT DEFINITIONS
                .
;
;I/O ASSIGNMENTS
;
DATIN0      EQU 1 OH        ;DATA INPUT PORT
DATOUT      EQU 1 OH        ;DATA OUTPUT PORT
                .
                .
                .
;MEMORY ASSIGNMENTS
;
IOTBL       EQU 60H         ;SYSTEM IOTABLE
;
                .
                .
           STORAGE DEFINITIONS
;
;RESERVED STORAGE AREAS
;
            ORG 100H        ;BUFFER STARTS AT 100H
NAME:       DS 2            ;NAME BUFFER ADDRESS
BUFFIN:     DS 80           ;INPUT BUFFER
BUFOUT:     DS 80           ;OUTPUT BUFFER

              BRANCH TABLES

;BRANCH ISOLATION TABLES
;
;INCOMING—BRANCHES TO INTERNAL ROUTINES
;
            ORG 400H
;
            JMP MAIN        ;BRANCH TO MAIN PROGRAM
            JMP RTE         ;BRANCH TO INT. ROUTINE

;
;OUTGOING—BRANCHES TO EXTERNAL ROUTINES
```

```
;
CI:         JMP IOTBL     ;SYSTEM CONSOLE INPUT
CO:         JMP IOTBL+3   ;SYSTEM CONSOLE OUTPUT
            .
            .
     PROGRAM ORGANIZATION
            .
;
;MAIN PROGRAM
;
MAIN:       -             ;START OF MAIN PROGRAM
            .
            .
;
;HIGH LEVEL SUBROUTINES
;
SUBH:       -             ;FIRST HIGH LEVEL SUBR.
            .
            .
;
;ELEMENTAL SUBROUTINES
;
LOWST:      -             ;LOWEST LEVEL ROUTINES
            .
            .
     PROGRAM DATA AREAS
            .
;
;DATA TABLES
;
            ORG 1000H
;MESSAGES
HELLO:      DB            'HELLO THERE',CR,LF
GOODBYE:    DB            'SEE YOU LATER',CR,LF
            .
            .
;
TABLES
;
;           VTBLE—VOLTAGE TABLE
VTBLE       DB 10
            DW 1000H
            DB 11
            DW 1001H
            .
            .
            END
```

Chart your memory, or else

Each program module must reside somewhere in memory. The plan for locating your program in the available system memory is called a memory map. Its major sections are:

1. CPU-dependent storage
2. Reserved program storage
3. Scratch program storage
4. Resident program storage
5. Transient program storage
6. I/O port storage

CPU-dependent storage for microprocessors is usually a small number of memory locations for interrupt or I/O functions. The 8080A, for example, reserves the first 64 bytes of memory (0 to 3FH) for eight restart blocks. Interrupting devices use these locations to vector control to the appropriate I/O driver routines. When laying out your memory map, mark these locations and avoid using them for anything else.

Reserved and scratch storage occupy one or more small memory areas set aside for branch tables, I/O images, I/O-driver vectors, subroutine-pass parameters, stack pointers, character buffers and operational constants. These areas should be large enough to handle expansion. When using RAM, follow your plan strictly to make sure data are not modified unintentionally in these areas. Record these values by name, size and location in your memory map to make them available to any program segments that need them for temporary storage.

In scratch memory you are not concerned about destroying or restoring the stored values. So don't use scratch memory for passing parameters.

You can manage the use of reserved and scratch storage space with a routine that keeps track of available storage. Space can be dynamically allocated to whatever programs need it, then released when no longer needed. You can, for instance, create a FIFO stack in memory, and keep track of available space with a pointer—in other words, make a "list of available space" (LAS). More sophisticated routines use linked lists to allocate memory space dynamically. But regardless of your approach, you must note the limits of variable storage in your memory map to prevent one memory area from eating into another.

Resident-program storage typically serves such systems programs as supervisors and monitors. These programs are often stored in ROM so that they never have to be loaded. Dedicated microcomputer systems in control and measurement applications often use nothing but resident programs. At the very least, you should include a resident bootstrap loader in ROM, to help you load the operating system.

Transient program storage is needed whenever the available RAM is limited. You must then store programs off-line and load them only when they are needed. Temporary storage space may be the largest area in your memory map.

I/O port storage must be set aside for all I/O ports if your system uses memory-mapped I/O—i.e., the I/O devices are addressed as memory locations. A graphic representation of your memory map (Fig. 3) is a valuable piece of documentation that you will use every time you modify or update your programs.

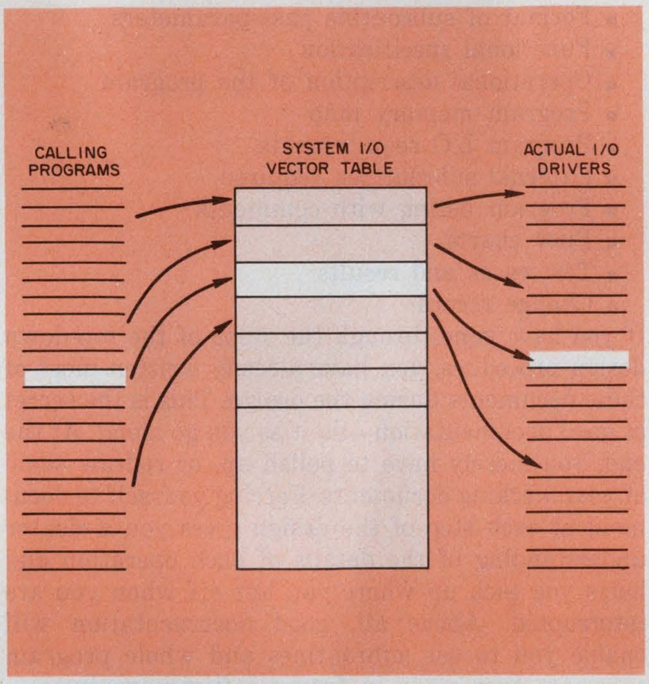
Pass that parameter, please

Two of the most important considerations in putting together your programs are that parameters pass properly to subroutines, and that all working registers be restored when a routine is completed. Parameters can be passed to and returned from subroutines through the working registers, or through memory. Decide on a fixed convention for passing parameters, and stick with it. You can use working registers, and always pass the first parameter in a certain register, the second in the next available register, and so on.

By sticking to a convention, you can design software modules with the confidence that the passed parameters will always match up. One such convention is to use the least versatile registers for passing parameters. For example, the 8080A has seven registers. The B and C registers are the weakest, the D and E registers are slightly more versatile, while H and L are the most versatile after the Accumulator (A register). A good convention, then, is to pass the first parameter in register C and the second in B. Two more 8-bit parameters or one single 16-bit parameter can be passed in DE.

The result of a subroutine operation is often passed back in the accumulator (register A) because it can be treated along with the status or flag register. Be sure that the registers used for passing parameters are restored before being used for other purposes by the calling program, especially if subroutines are to be interruptible and re-entrant.

If your computer does not have enough registers for passing parameters, or if it's inconvenient to use, you can pass parameters in memory. However, fixed memory areas are undesirable for this purpose because nested subroutine calls can easily destroy parameters passed from a previous routine. A software FIFO stack can get you around this problem. The called program pushes pass-parameters onto the stack; the subroutine pops them off the stack, performs its computations, and pushes the results back onto the stack where the calling program can pop them back. But take care to balance the stack: An imbalance between pushes and pops can cause the stack to creep higher or lower in memory until it mysteriously eats another part of the program.



4. **Table-isolated I/O assignments** have the advantage of being easy to modify.

Like memory, the system I/O ports must be assigned in a definite way. It is often useful to isolate the I/O driver routines from the physical I/O ports. You obtain greater design flexibility, and don't have to change all references to a particular I/O driver when it is moved to another location in memory. Fig. 4 shows a "table-isolated" I/O scheme. The memory locations of currently used I/O drivers are stored in the table. Calling programs jump indirectly to the appropriate driver routines via the table. You can then relocate drivers simply by updating the table. I/O isolation prolongs the life of your program, making it much easier to debug and to transfer to other computer systems.

Some bugs are real pests

Debugging is the process of removing mistakes (bugs) from programs. Testing is the means by which these bugs are found. Experience indicates that most programmers spend more time debugging their programs than designing them. Systematic and consistent design techniques help to prevent bugs in the design phase—not exorcize them after the fact. But, in spite of all efforts to prevent them, bugs creep into all but the most trivial programs.

Before you can debug a program, you must test it. But don't load the whole program all at once and "smoke-test" it by throwing the "on" switch. Begin testing with a careful review of the source program. Start with the most elemental routines, those that do not call other routines. Make sure that the coding conforms to the logic of your flow charts and that loops are properly initialized and terminated. Check for correct data values. Look for missing instructions. Cover all the details, and never, never, *assume* that something is right.

Next, devise test cases to check the functioning of each routine. Plug-in worst-case or extreme data values and be sure the routine handles these correctly. Once you have tested and debugged the simplest routines, you can move up to the level of the calling routines. You know now that the elementary routines are correct, so concentrate on testing calling-program operation and parameter passing. Work your way up to the highest-level subroutines, then to the main program itself, repeating the test/debug cycle until each module operates correctly. Then—proceed to the next level (Fig. 5).

Where you have branches, make sure all paths get tested, and check initialization and termination of all operations. Make sure that no routine inadvertently modifies another routine's data. Check structures carefully for both format and contents. Be careful with all pointers, delimiters, and terminators. If you get no output, the computer may be stuck in a loop. Insert print instructions in strategic locations.

But are the answers true?

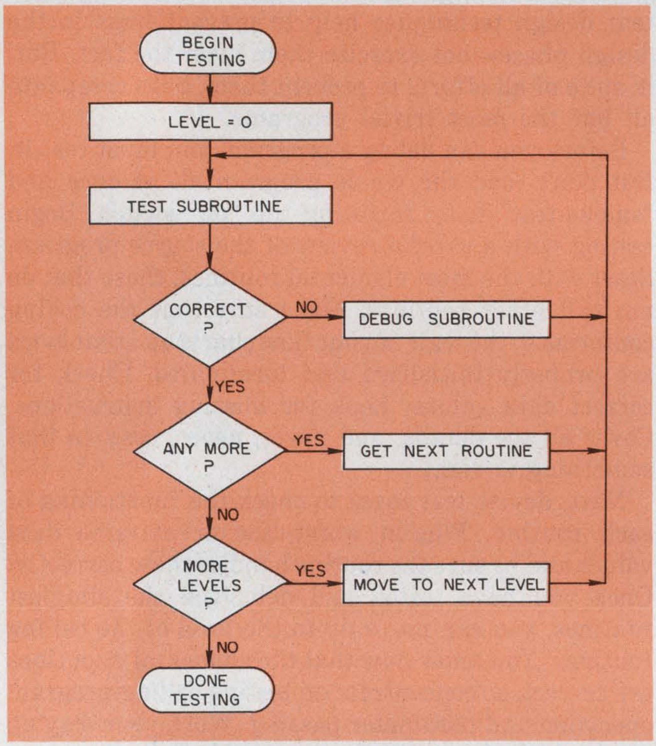
When all parts of the program have been tested, and the bugs you found have been corrected, are you finished? No. When the program appears to be working properly, debugging begins in earnest.

(continued on page 100)

(continued from page 99)

Load the program, and begin assembling or compiling the object code that the computer will execute. Most language processors assist you by flagging syntax errors you overlooked while testing the source program. Syntax errors stem from typing errors, format errors, or transpositions that produce illegal character strings. Correct them before you go on: Syntax errors can cause the language processor to generate erroneous code.

Now attempt to run small portions of the program. If the results don't come out right, look for valid, but



5. **A good debug plan** tests the lowest-level program modules first, then proceeds upward.

incorrect, instructions, transposed variable names, and incorrect data. The machine is a very harsh judge of your work and it will keep sending you back until you fix every detail. After pinpointing a bug to a small section of code, you can single-step through the program and carefully evaluate the results of each step. Debug monitors or similar system programs can be very helpful at this stage.

Once you are convinced that the program operates properly, you can begin looking for the toughest of bugs: faulty algorithms. Algorithm bugs often creep in at parameter extremes. The program may work fine for typical data, but break down for very small, very large, or limiting-data values. If this happens, you may have to change your algorithm or add range tests on the input data before processing it. Be sure that the algorithm you designed provides the speed and accuracy required by the application. You must, of course, know some of the answers beforehand—how else could you be sure your program really works?

Without documentation, you're dead

Documentation consists of all information necessary to understand, modify, or use your program as executed on the computer you selected, such as:

- Computer type and serial number
- Memory size
- Master memory map
- I/O port assignments
- Format of subroutine pass-parameters
- Functional specification
- Operational description of the program
- Program memory map
- Program I/O requirements
- External subroutines required
- Program listing with comments
- Flow charts
- Test cases and results
- Change record

If you have gone through the steps of the top-down design procedure, you have already written most of these documents during the design. This is the secret of good documentation—do it as you go along. At the end, you merely have to polish up, or redraw some of your working documents. Forcing yourself to document at each step of the design gives you a clearer understanding of the details of each operation and helps you pick up where you left off when you are interrupted. Above all, good documentation will enable you to use subroutines and whole program segments over again in future software projects.

By the time your program is debugged and operating, you have probably thought of many ways to improve the job you did. Unless you have some very good reasons, don't. Otherwise, you will produce more bugs, and little else.

On the other hand, if the system doesn't run fast enough, exceeds its production-cost goals, uses more memory than you have available, or is just too difficult to use, you may have to optimize. Usually, this means trading off one feature for another. Memory size can be traded for speed; hardware for software; higher development cost for lower production cost. And don't expect much improvement from more efficient coding. If really significant improvements are needed, find a better algorithm.■■

This article concludes the sequence of articles on the fundamentals of μP programming. Future articles in this series will cover higher-level programming languages.

Acknowledgement

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CIRCLE NUMBER 38

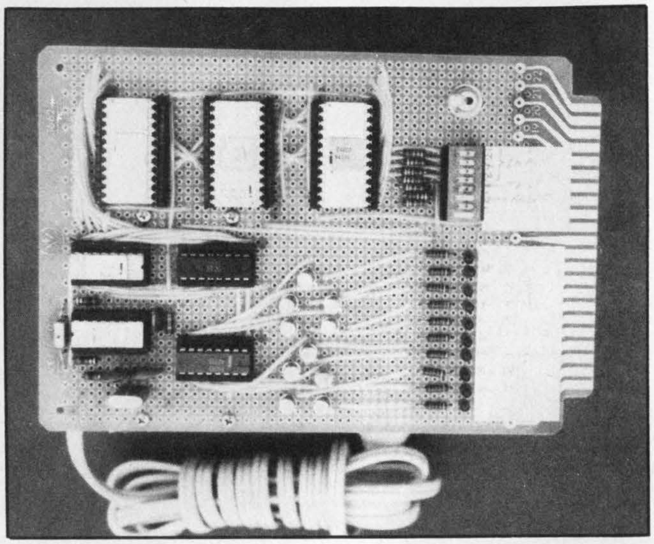
Build a μP-based simulator and learn elementary programming. The unit executes 16 instructions. The parts fit on one punched board and cost under $100.

If you aren't designing with a microprocessor yet, you should be. Microprocessors usually make a system cheaper, easier to modify, and quicker to develop than dedicated-logic circuits. You'll learn quickly with a μP-based simulator, just as you learned by tinkering with your first one-transistor circuit.

With the simulator pictured in Fig. 1 you can become familiar with the hardware and instruction set, both deliberately restricted so that you can focus on the fundamentals. When you outgrow the limited capabilities of this system, you can reprogram it.

You can make the simulator for under $100, plus the power supply cost, with a kit of ICs from Intel and additional parts (Table 1).

You also need access to an EPROM programmer capable of programming the kit's 4702 erasable memory. The EPROM memory chip must be programmed with instructions listed in Table 2. Plugged into the simulator, the programmed EPROM creates an abbreviated instruction set that you use. Fig. 2 shows the schematic of the system.



1. **The simulator fits on one punched board** with integral power supply. To minimize external wiring, board-mounted DIP switches control the simulator.

Table 1. Simulator parts list

Quantity	Type	Description	Manu-facturer
1	MSC-4A	Chip set	Intel
1	4201	Clock	Intel
1	CY3A 4 MHz	Xtal	Crystex
2	33 pF, mica	Capacitors	
1	1 μF, 25 V	Capacitor	
1	15 μF, 25 V	Capacitor	
1	10 μF, 25 V	Capacitor	
10	CM-73A	LED	
3	100 Ω, 1/4 W	Resistors	
10	1.2 k, 1/4 W	Resistors	
5	4.7 k, 1/4 W	Resistors	
1	1 M, 1/4 W	Resistors	
6	spst	Switch	
3	16-pin DIP	Sockets	
3	24-pin DIP	Sockets	
10	2N2907	Transistors	
1	15 V at 150 mA	Power supply	
Miscellaneous: solder, punched board, wire, labels			

Understanding the microprocessor

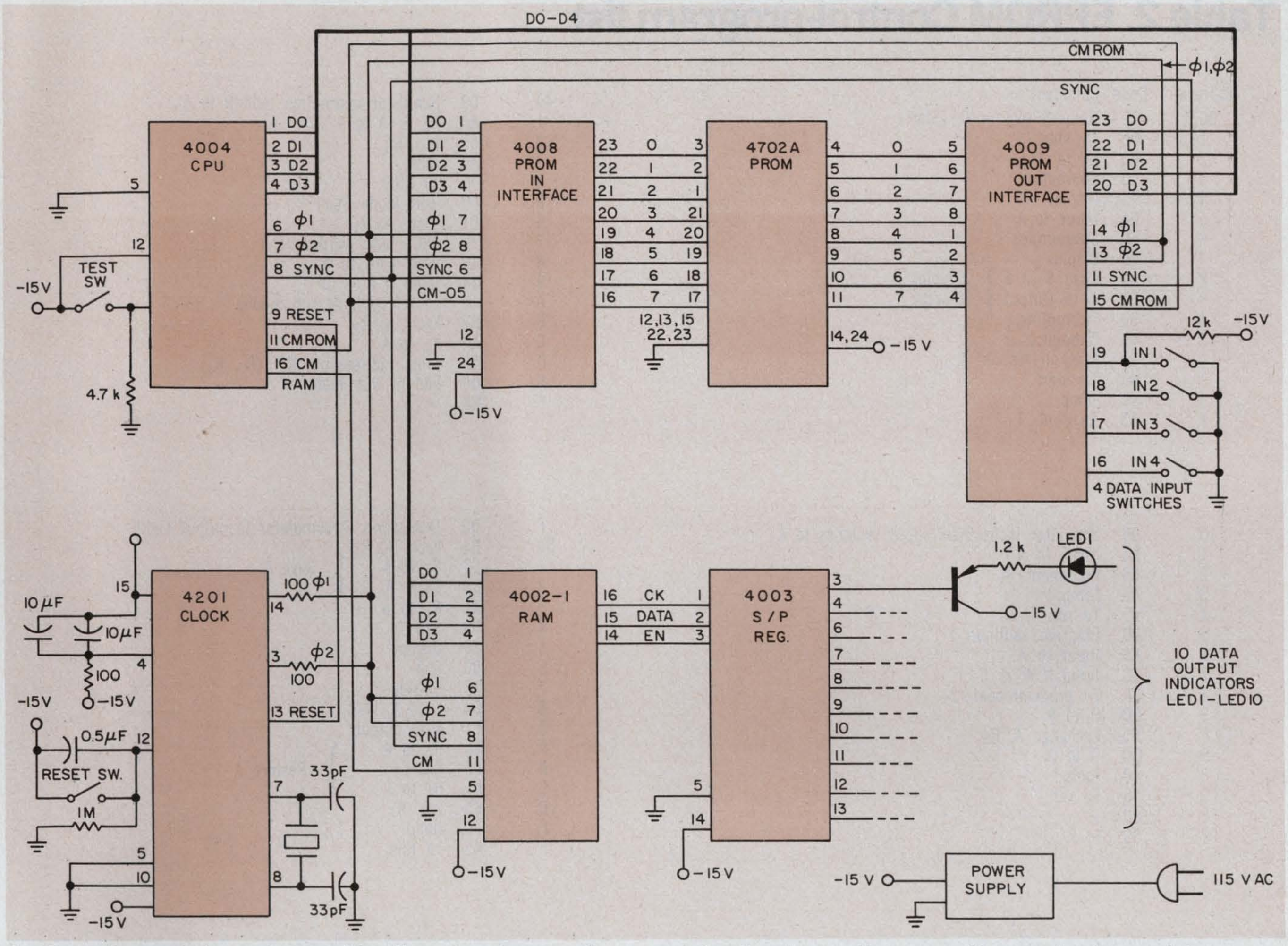
This instructional unit uses the Intel 4004 4-bit μP, chosen because it is the oldest, most popular and most completely debugged of the available chips. Any microprocessor operates in a timed sequence. Instructions entered by the user are first stored in the unit's memory by the programmer. The μP executes these instructions when told to do so.

There is no hidden trick in learning how to use the simulator. First, the hardware has been configured, by the software stored in the EPROM, to look as shown in Fig. 3. It has

- Instruction storage
- Data-input switches
- Data-output lights
- A register (where data are stored)
- An accumulator (where data can be manipulated)
- An instruction-address counter, which tells the address of the next instruction.

Everything else is lumped into the instruction-

W. C. Blanchard, Project Engineer, Bendix Environmental and Process Instrument Div., 1400 Taylor Ave., Baltimore, MD 21204.



2. **The schematic is uncluttered by discrete components,** except for the decoupling capacitors and a few resistors.

interpretation and execution hardware, which is not under your control.

There are two modes of hardware operation: program and run. When the power is turned on and the system reset, the hardware is in the program mode. The system will run after 16 instructions are programmed or a Run instruction is entered.

Second, you should learn what the microprocessor can be instructed to do:

- Look at the input lines and copy their HIGH and LOW states in its accumulator.
- Copy the accumulator's HIGH and LOW states on the output lines.
- Increment, decrement, store or clear the accumulator.
- Jump to a different instruction under certain conditions—for example, when the accumulator bits are all ZERO or when an external condition is satisfied.

The programs that you write can use up to 16 instructions and are stored in memory (Table 3). Most instructions occupy one address location, but some occupy two. Instructions taking up two locations contain either data or another address, which is stored in the second location. The addresses are identified by numbers that start at ZERO for the first address and continue in hexadecimal sequence.

Operating the unit

To load a program into the computer, apply power, turn the Test switch on the input switches off, and push the Reset button. The system acknowledges by extinguishing all address and instruction LEDs—indicating that it is at address 0000. Then, enter the machine code for the first instruction.

For example, set IN4 through IN1, respectively, to 0, 0, 0, 1, or off, off, off, on, to transfer the contents of the input switches to the accumulator when the program is run. The instruction LEDs show what has been entered. Then, set the Test switch off to store the instruction in the simulator's memory.

To enter the next instruction or the second part of an instruction that takes up to two locations, turn on the Test switch again. The address lights show that the computer has incremented the address by 1. Set the IN4-through-IN1 switches for the machine code for the next instruction, then again turn off the Test switch. Repeat the procedure for each instruction you want to enter.

Table 2. EPROM Control-program list

Address	Code	Comment
00	11	Jump if test = 0, (Start)
1	00	To start
2	A5	R_5 to A
3	50	Subroutine,
4	75	Display
5	EA	Input to A
6	50	Subroutine,
7	75	Display
8	D4	Load 4 in A } Enables
9	E1	A to Output } Display
A	50	Subroutine,
B	65	Debounce
C	11	Jump if test = 1,
D	00	To start
E	40	Jump,
F	15	To Cont. 1

10	00	Simulator instruction: Input switches to A
1	EA	Input to A
2	65	Increment R_5
3	40	Jump,
4	45	To run
5	00	Program continue 1
6	EA	Input to A
7	1C	Jump if A = 0
8	2A	To program cont. 2
9	D0	0 to A
A	B5	Exchange A, R_5
B	D0	0 to A
6	40	Jump,
D	45	To run
E	00	—
F	00	—

20	00	Instruction: Subtract from A
1	90	A − R_0 to A
2	65	Inc. R_5
3	40	Jump
4	45	To run
5	00	—
6	00	—
7	00	—
8	00	—
9	00	—
A	00	Program Cont.
B	25	SRC[1] RAM word # (R_5)
C	E0	A to RAM word
D	00	—
E	40	Jump
F	35	To Prog. Cont. 3

30	00	Simulator instruction: Exchange R and A
1	B0	Exchange R_0, A
2	65	Inc. R_5
3	40	Jump
4	45	To run
5	00	Program, Cont. 3
6	50	Subroutine
7	65	Debounce
8	11	Jump if Test = 0
9	36	To −4 addresses
A	75	ISZ[2], R_5,
B	02	To start plus 2
C	00	End of Program Mode
D	0	—
E	40	Jump
F	45	To run

40	00	Simulator instruction: Add R to A
1	80	R_0 + A to A
2	65	Inc. R_5
3	40	Jump,
4	45	To RUN
5	00	RUN Mode Start
6	B1	Exch. A, R_1
7	25	SRC[1] RAM word # (R_5)
8	E9	RAM word to A
9	14	Jump if A = 0
A	49	To self (ending run mode)
B	B2	Exch. A, R_2
C	A1	R_1 to A
D	33	Jump Indirect per RPI (R_2, R_3)
E	00	End of Run Mode
F	00	—

F	00	Instruction: Accumulator to output Light
50	B1	Exch. A, R_1 }
1	F7	Cy to A } Save A
2	BD	Exch. A, R_D }
3	A1	R_1 to A
4	50	Sub
5	75	Display
6	50	Sub
7	75	Display
8	D4	Load A, W/4
9	E1	A to output
A	AD	R_D to A }
B	F6	Rat Cy } Restore A
C	A1	R_1 to A }
D	65	Inc. R_5
E	40	Jump
F	45	To Run

60	00	Simulator instruction: Clear A and Carry Bit
1	F0	0 to A, 0 to Carry Bit
2	65	Inc. R_5
3	40	Jump
4	45	To run
5	00	Sub: Debounce
6	76	ISZ[2], R_6
7	65	To 65
8	77	ISZ[2], R_7
9	65	To 65
A	C0	Return
B	00	—
C	00	—
D	00	—
E	00	—
F	00	—

70	00	Simulator instruction: Set Carry Bit
1	FA	1 to Carry Bit
2	65	Inc. R_5
3	40	Jump
4	45	To run
5	00	Sub Display Start
6	BA	Exch. A, R_A
7	DC	C to A
8	BB	Exch. A, R_B
9	F0	0 to A, Carry Bit
A	BA	Exch. R_A, A
B	F5	Rot L; MSB to Carry Bit
C	BA	Exch A, R_A
0	F7	Carry Bit to A
E	40	Jump
F	87	To Display Cont

80	00	Simulator instruction: Load A with XXXX
1	65	Inc. R_5
2	25	SRC RAM word # (R_5)
3	E9	RAM to A
4	65	Inc. R_5
5	40	Jump,
6	45	To RUN
7	00	Sub: Display, Cont. 1
8	F5	Rot L
9	F2	Inc. A 00 X 1
A	E1	A to out
B	00	0 to A
C	E1	A to out
D	00	—
E	40	Jump
F	95	To Cont. 2

90	00	Simulator instruction; Increment A
1	F2	Inc. A
2	65	Inc. R_5
3	40	Jump,
4	45	To RUN
5	00	Sub: Display Cont. 2
6	7B	ISZ, R_B,
7	79	To Address 79
8	D1	1 to A
9	E1	A to out
A	D0	0 to A
B	E1	A to out
C	C0	Return
D	00	End of Sub: Display
E	00	—
F	00	—

A0	00	Simulator instruction: Decrement A
1	F8	Dec. A
2	65	Inc. R_5
3	40	Jump
4	45	To RUN
5	00	—
6	00	—
7	00	—
8	00	—
9	00	—
A	00	—
B	00	—
C	00	—
D	00	—
E	00	—
F	00	—

B0	00	Simulator instruction: Jump to Inst. XXXX
1	65	Inc. R_5
2	25	SRC RAM word # (R_5)
3	B1	Exch. A, R_1
4	E9	RAM word to A
5	B5	Exch. A, R_5
6	D0	0 to A
7	B1	Exch. A, R_1
8	40	Jump,
9	45	To RUN
A	00	—
B	00	—
C	00	—
D	00	—
E	00	—
F	00	—

C0	00	Instr: Jump if T = 1 to XXXX
1	19	Jump if T = 1
2	B0	To Jump Inst. (B)
3	65	Inc. R_5
4	65	Inc. R_5
5	40	Jump
6	45	To RUN
7	00	—
8	00	—
9	00	—
A	00	—
B	00	—
C	00	—
D	00	—
E	00	—
F	00	—

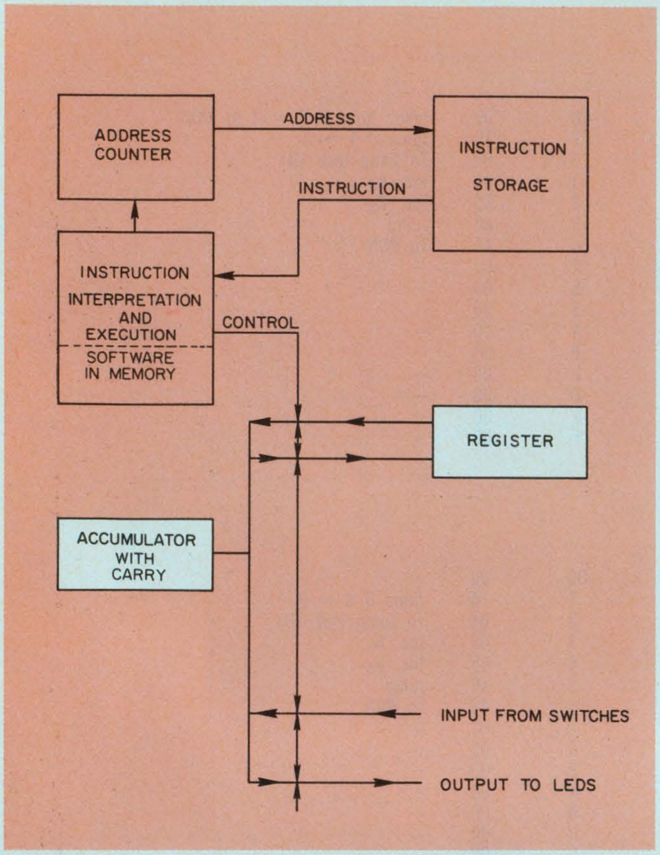
D0	00	—
1	14	Jump if A = 0
2	B0	To Jump Inst. (B)
3	65	Inc. R_5
4	65	Inc. R_5
5	40	Jump
6	46	To RUN
7	00	—
8	00	—
9	00	—
A	00	—
B	00	—
C	00	—
D	00	—
E	00	—
F	00	—

E0	00	Simulator instruction: Carry Bit to out clocked
1	B1	Exch. A, R_1
2	12	Jump if Carry Bit equals 1
3	EB	To EB
4	D1	1 to A
5	E1	A to out
6	D4	4 to A
7	E1	A to out
8	65	Inc. R_5
9	40	Jump,
A	45	To Run
B	D3	3 to A
C	E1	A to out
D	40	Jump,
E	E6	To E6
F	00	—

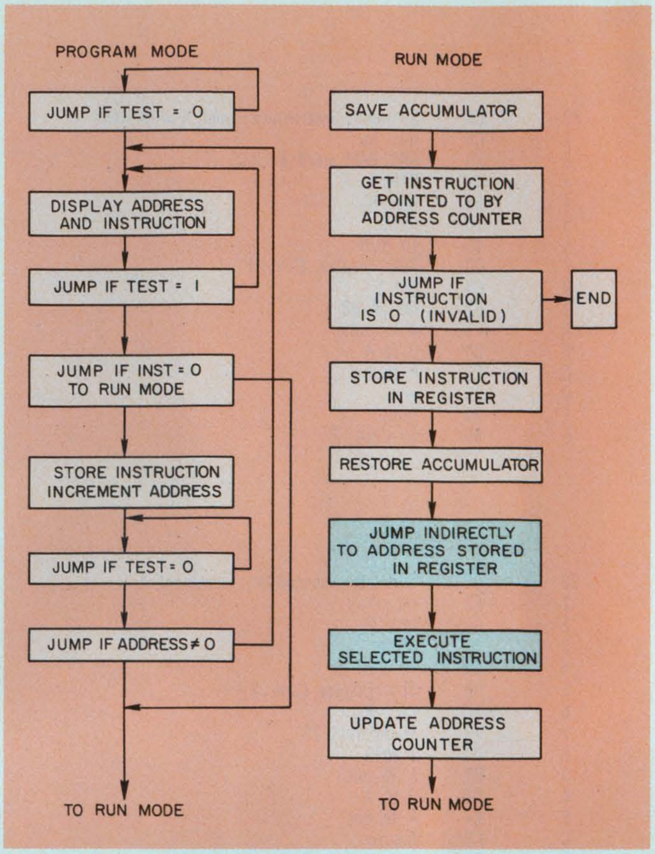
F0	00	Simulator instruction: Delay = 1.5 s
1	76	ISZ, R_6
2	F0	To F_0
3	77	ISZ, R_5,
4	F0	To F_0
5	78	ISZ R_8
6	F0	To F_0
7	79	ISZ r_9,
8	F0	To F_0
9	65	Inc. R_5
A	40	Jump
B	45	To RUN
C	00	—
D	00	—
E	00	—
F	00	—

Note 1: SRC—Send Register Control
Note 2: ISZ—Increment register, if it is then not zero, then jump to address.

(continued on page 108)



3. **The hardware contains an accumulator** to operate on data and a register to hold data temporarily.

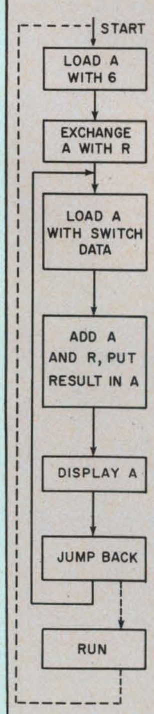


4. **The control program executes** each simulator-program instruction and manipulates the μP's registers.

Table 3. Instruction set for the microcomputer simulator

Instruction Machine Code		Description
Binary value	Hexadecimal value	(A = Accumulator, R = Register)
0000	0	Initiate Run mode from Program mode. In run mode it terminates run
0001	1	Input Switch to A
0010	2	Subtract R from A
0011	3	Exchange A and R
0100	4	Add R to A
0101	5	A to Output Light
0110	6	Clear A and Carry Bit
0111	7	Set Carry Bit to 1
1000	8	Load A with data contained in the next location
1001	9	Increment A by 1
1010	A	Decrement A by 1
1011	B	Jump to the address contained in the next location
1100	C	Jump if test is 1 to the address contained in the next location
1101	D	Jump if A is zero to the address
1110	E	Display Clocked, Carry Bit to output, Light 1
1111	F	Delay ≈ 3 seconds

Table 4. The flow chart for a programming example



Flow chart	Additional remarks	Program listing in hexadecimal	
		Address	Instruction
	Two-location instruction	0 1	8 6
	R contains 6	2	3
	A contains the number on the switches	3	1
	A contains the sum of the switch number and 6	4	4
		5	5
	Two location instruction	6 7	B 3
	The program executes this instruction once to start.	8	0

Table 5. Programming the simulator

Mode	Operating Procedure	Address Lights / Instruction Lights 10987 6 5432 1	Address (Hex)	Instruction (Hex)	Comments
Program Mode	Power on	0000 0 0000 0			Initializing procedure
	Input switches off	Don't know			common
	Test switch on	Don't know			to all programs.
	Reset on then off	0000 0 0000 0	0	0	Ready to input inst. at address 0
	Input switches to 1000	0000 0 1000 0	0	8	Load accumulator instruction
	Test switch off	0000 0 1000 0	0	8	Instruction stored
	Test switch on	0001 0 1000 0	1	8	Ready to input data at address 1
	Input switches to 0110	0001 0 0110 0	1	6	Second word of load inst.; the load value
	Test sw. off then on	0010 0 0110 0	2	6	Inst. loaded & ready for inst. at add. 2
	Input switches to 0011	0010 0 0011 0	2	3	Exchange accum. & register instruction
	Test sw. off then on	0011 0 0011 0	3	3	Inst. loaded & ready for inst. at add. 3
	Input switches to 0001	0011 0 0001 0	3	1	Input switches to accumulator instruction
	Test sw. off then on	0100 0 0001 0	4	1	Inst. loaded & ready for inst. at add. 4
	Input switches to 0100	0100 0 0100 0	4	4	Add register to accumulator instruction
	Test sw. off then on	0101 0 0100 0	5	4	Inst. loaded & ready for inst. at add. 5
	Input switches to 0010	0101 0 0101 0	5	5	Accumulator to output light instruction
	Test sw. off then on	0110 0 0101 0	6	5	Inst. loaded & ready for inst. at add. 6
	Input switches to 1011	0110 0 1011 0	6	B	Jump instruction
	Test sw. off then on	0111 0 1011 0	7	B	Inst. loaded & ready for add. at add. 7
	Input switches to 0011	0111 0 0011 0	7	3	Second word of jump inst.; the address
	Test sw. off then on	1000 0 0011 0	8	3	Inst. loaded & ready for inst. at add. 8
	Input switch to 0000	1000 0 0000 0	8	0	Run instruction
Run Mode	Test switch off	0110 0 0000 0			Inst. loaded & executed, program running & displaying input +6 = 0+6 = 6
	Input switches to 0001	0111 0 0000 0			Display gives input +6 = 1+6 = 7
	Input switches to 1010	0000 0 0000 0			Display gives input +6 = 10+6 = 16 = 0
	Input switches to 0011	1001 0 0000 0			Display gives input +6 = 3+6 = 9
		Data Output Lights			

In the run mode, the instructions are executed sequentially. The instruction starting at address zero is fetched and executed by the instruction-interpretation and execution hardware. The instruction-address counter is incremented, and the machine fetches the next instruction.

The simulator follows a procedure similar to the one for instructions that take up two locations, except that both halves of the simulator's instruction are fetched before it is executed.

If the first half of an instruction is, for example, "Jump to a new address," the second word is loaded into the instruction-address counter so that the next executed instruction will be called from that address. Or, if the first half of a two-location instruction says, "Load the second location into the accumulator," then the hardware will do so.

However, a two-word instruction is restricted two ways. First, the second word cannot be ZERO. If it were, the hardware would immediately run the program, instead of loading the program in memory. Second, jump instructions cannot specify the second half of another instruction location. If they did, that data or address would be interpreted as the first half of an instruction. Then the instruction would be executed improperly.

Solving a problem

The procedure for using the hardware is illustrated by the following problem: All input data from the keyboard must be incremented by 6, then displayed on the output LEDs.

First, make a flow chart—a list of required operations in the order they have to be done. Second, substitute one or more instructions for each operation in the flow chart (Table 4).

When you are satisfied that the flow chart and the instructions are correct, load the program on the simulator and run it. Table 5 shows the sequence of steps for the operate and run mode.

Once you master the instructions that the simulator

Table 6. The control program's use of the μP registers

Register Pair No.	Index Register No.	Use	Index Register No.	Use
0	0	Reserved for user	1	Temporary A storage
1	2	Indirect jump address	3	0, second half of indirect-jump address
2	4	0, first half of Send Register Control (SRC)	5	Counter No., Second Half of SRC
3	6	0, for Delay and Debounce	7	0, for Delay and Debounce
4	8	0, for Delay	9	0, for Delay
5	A	Rotated A for Display	B	C, Counter for Display
6	C	Not used	D	Temporary storage of the Carry Bit
7	E	Not used	F	Not used

is capable of executing, you can learn a program that controls the simulator. This control program is stored in an erasable, programmable, read-only memory (EPROM). The program then controls the execution of each simulator instruction.

The simulator instruction is initially stored in RAM when the simulator is in the program mode, then fetched in the run mode. The simulator instruction becomes an indirect-jump address, the address of a series of instructions in EPROM that executes the simulator instruction.

Display has a separate subroutine

The output display is handled by a subroutine that uses the system's serial/parallel register. This register accepts data via the RAM-output ports from the accumulator. The data have the following format: Bit 1 is the register clock, Bit 2 is the data, Bit 3 is the register enable and Bit 4 is not used. The display is enabled by the calling routine.

The software for the program and run modes is too long for any single place in the programmable memory, so it is stored between the simulator-execution set of instructions.

The control-program flow chart is shown in Fig. 4, along with the hexadecimal program listings. Table 6 is a register map showing the control program's use of the CPU. The instruction set can be changed, of course, by reprogramming the PROM. ■■

References

1. *Intel Memory Design Handbook,* Intel Corp., 1976: Santa Clara, CA.
2. *Intel MCS-40 User's Manual for Logic Designers,* Intel Corp., 1976: Santa Clara, CA.

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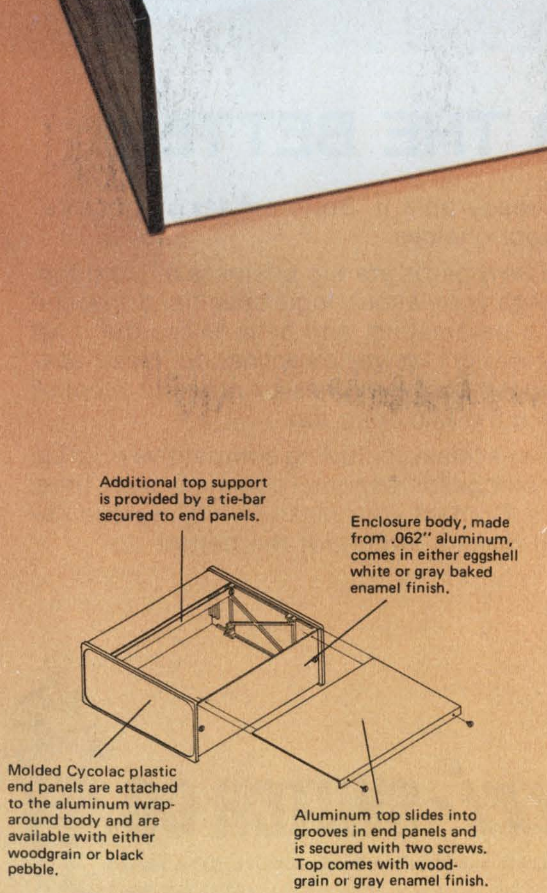

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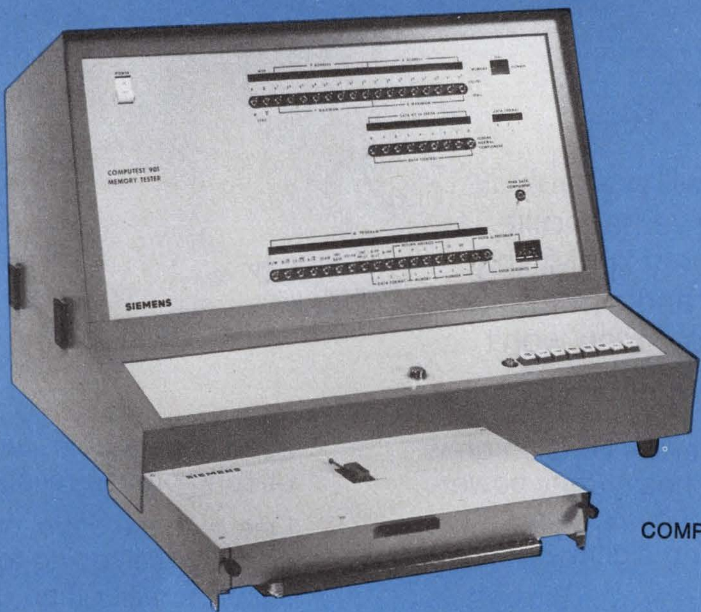

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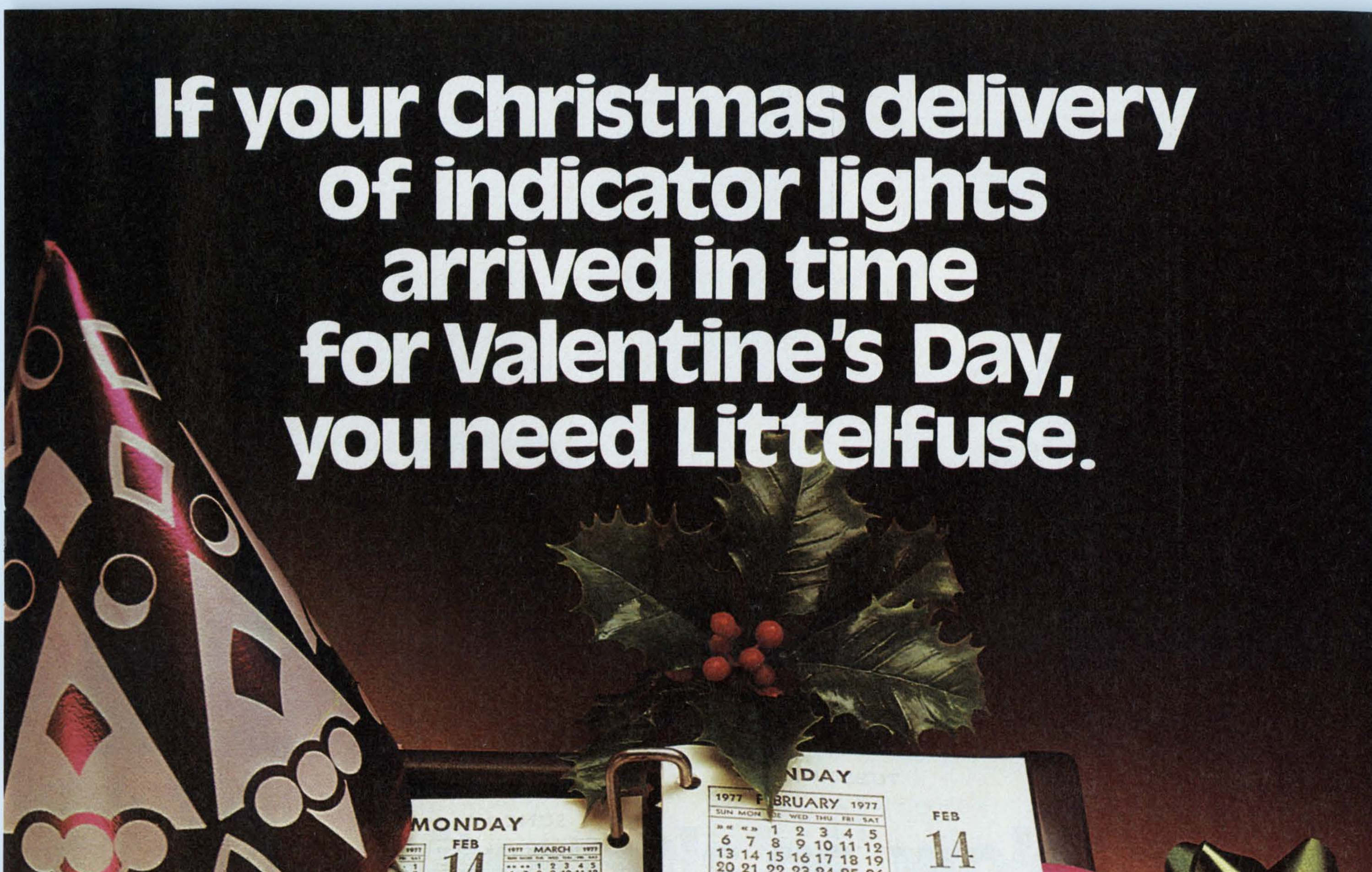

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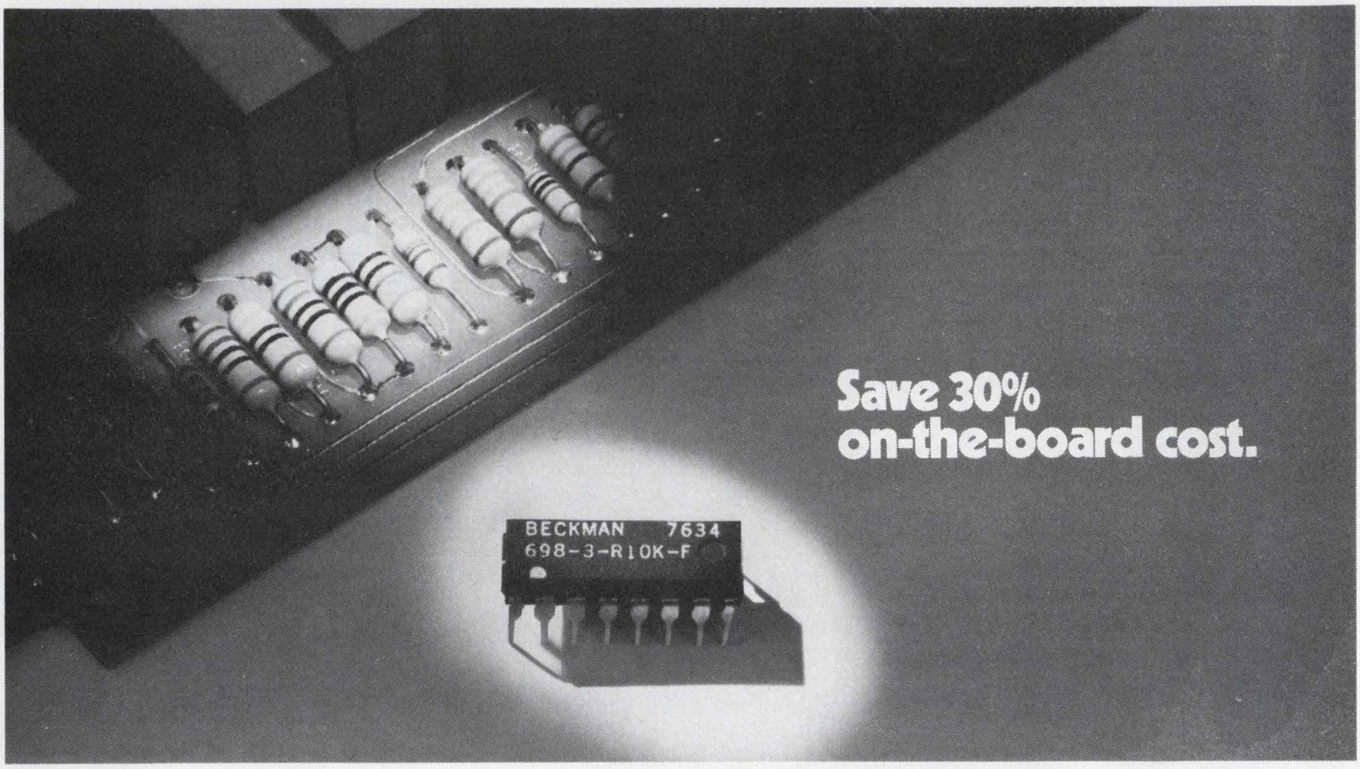

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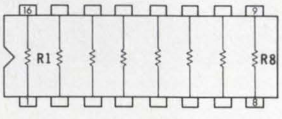

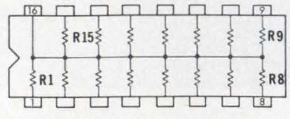

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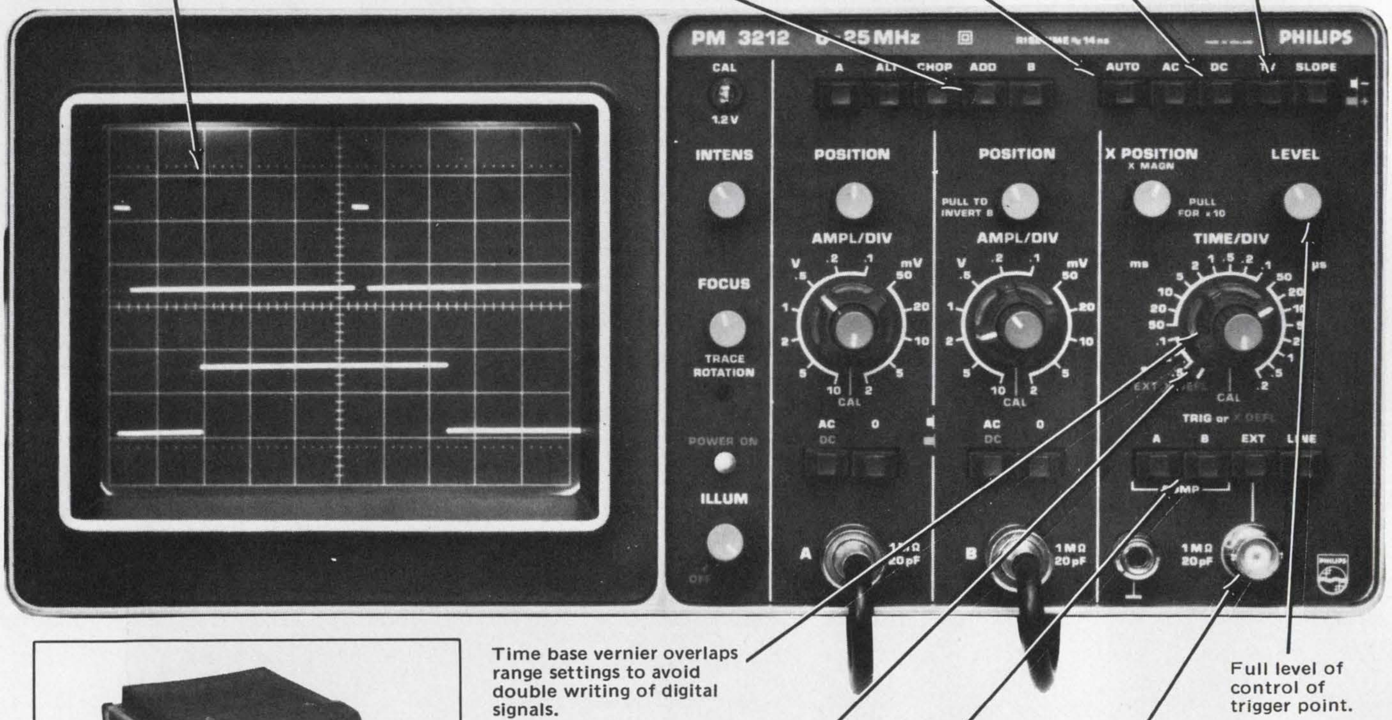

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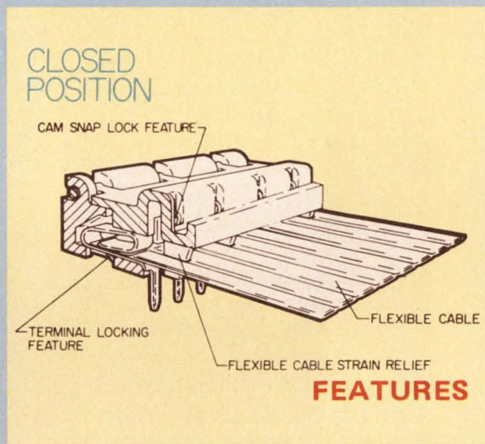

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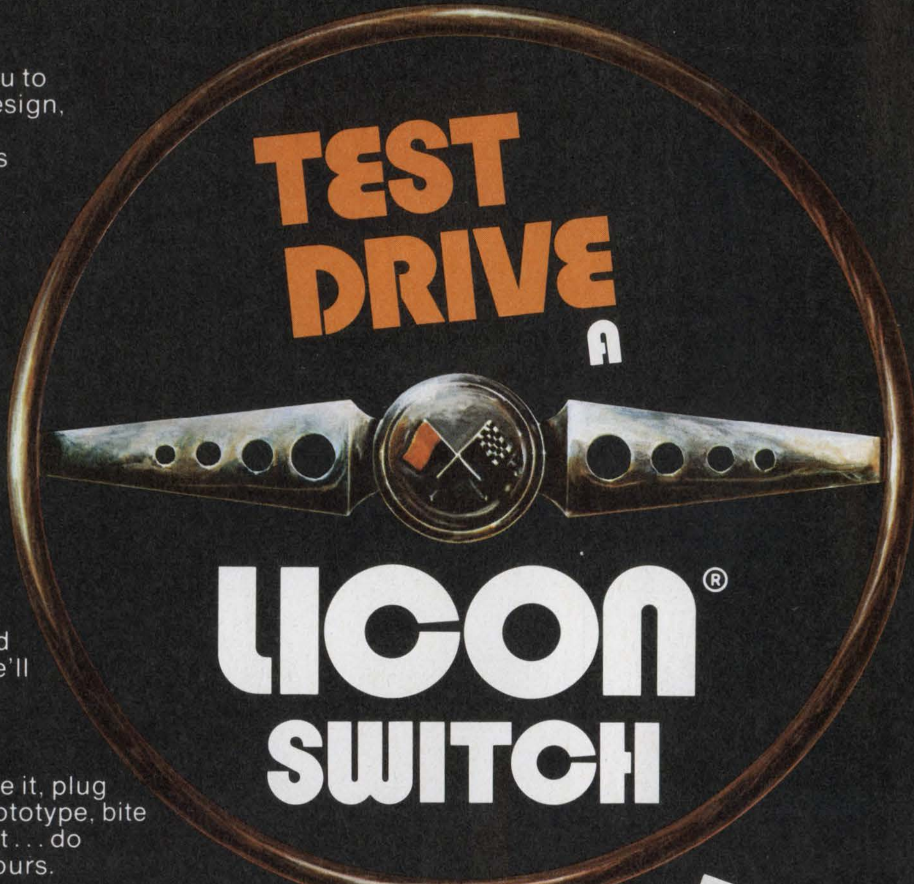

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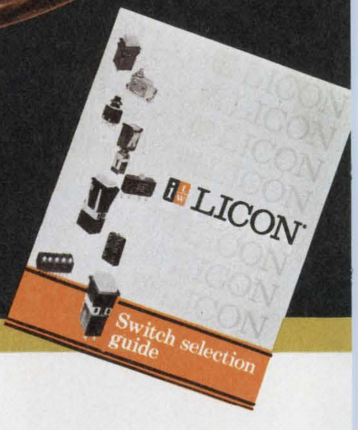

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CIRCLE NUMBER 172

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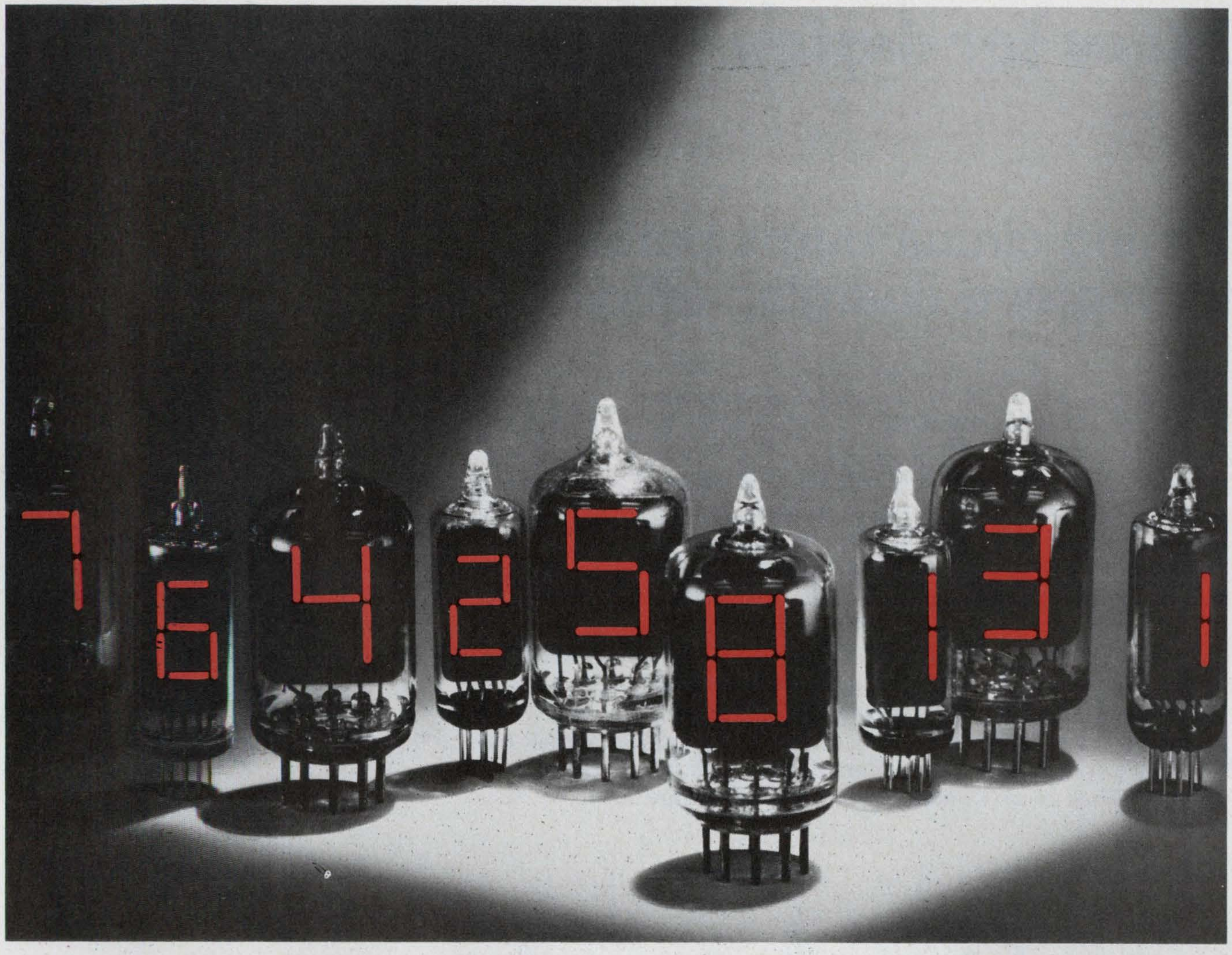

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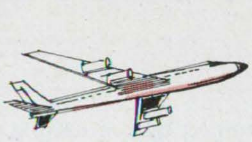
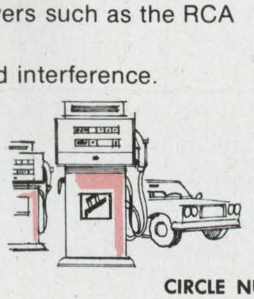
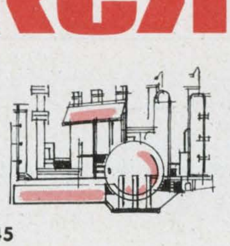
RCA NUMITRON Display Devices







CIRCLE NUMBER 45

Timing circuit burps battery to improve charging efficiency

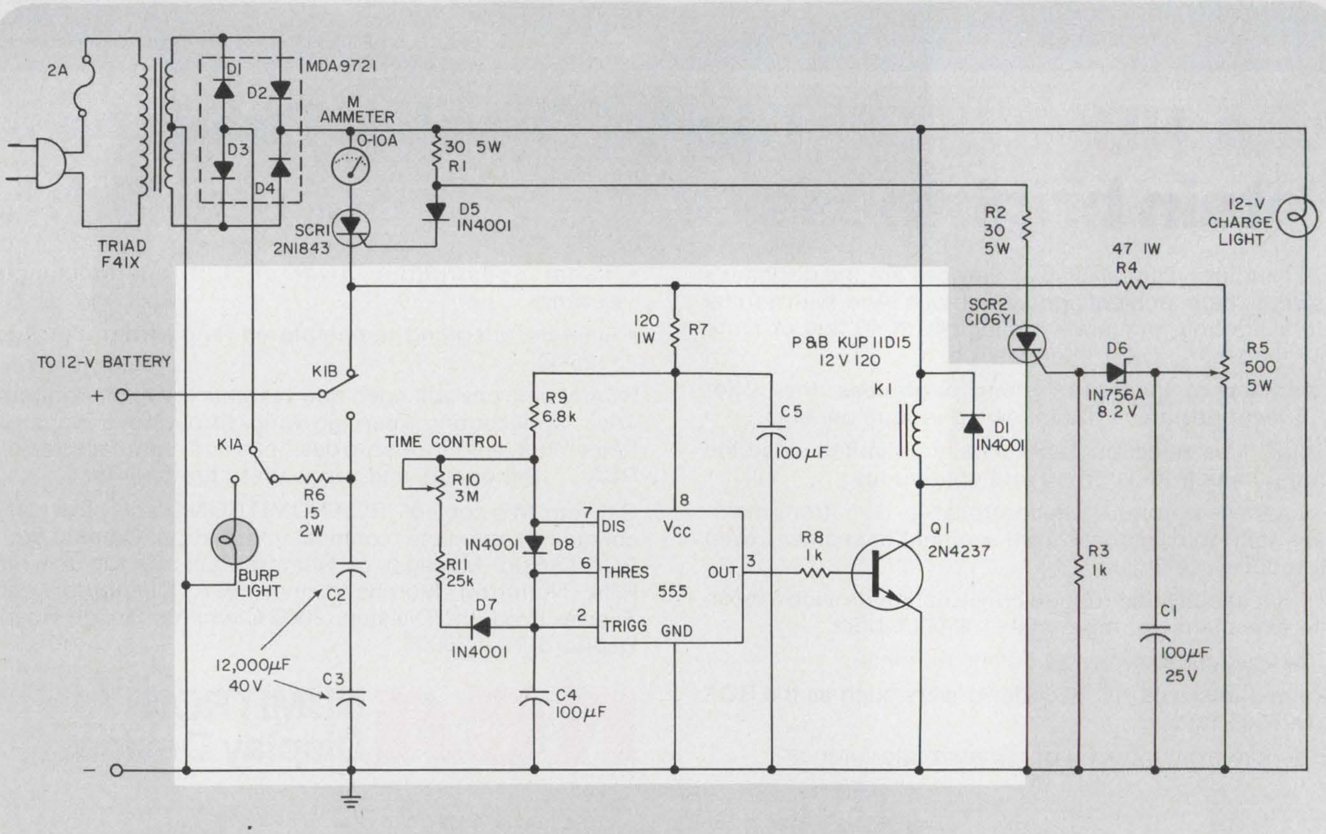
The circuit in the figure is an improved storage-battery charger that uses a 555 timer to "burp" the battery—to apply a 20-V pulse across the battery periodically, while it's being charged. This process tends to shake gas molecules loose from the battery plates. The molecules insulate portions of the battery plates from the electrolyte, which reduces the effective charging current by raising the internal resistance.

This burp-control circuit can be added to just about any existing automobile-battery (12-V) charger. The 555 timer is connected in a free-running mode and has independent on and off times. The time between burps is controlled by the variable pot, R_{10}, from once every 2 s to once every 2½ min. Capacitors C_2 and C_3 charge to 20 V. When relay K_1 activates, a negative charge is dumped into the battery.

Burping continues after the battery is fully charged. But the time between burps should be adjusted to correspond to the chemical activity in the battery—a short time for high activity when the battery charge is low, and long when near full charge. The duration of the negative pulse is short, so it won't harm the battery. But be careful—with the battery mounted in an automobile, the alternator rectifiers can be damaged if the positive cable to the battery isn't removed.

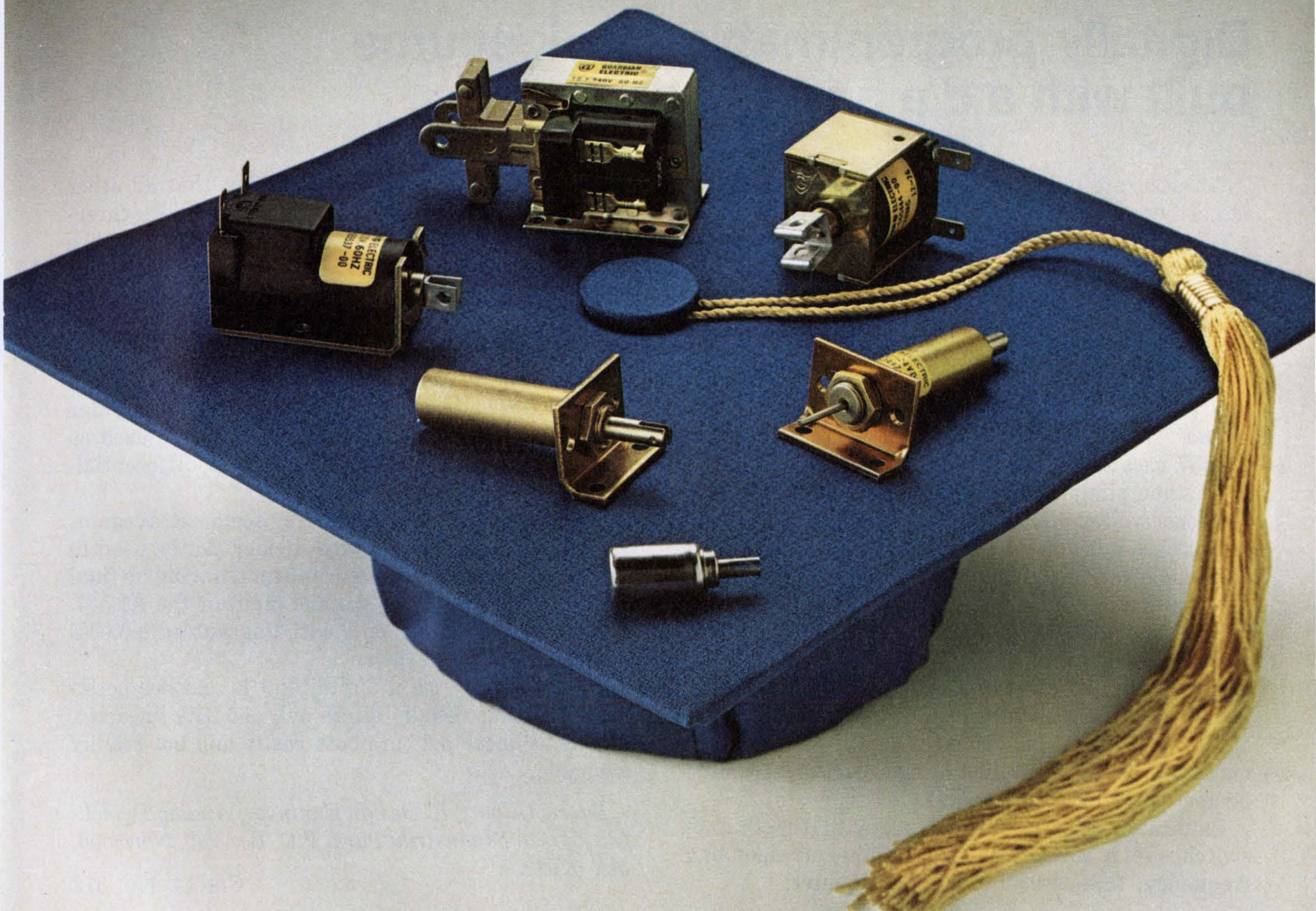
John Okolowicz, Senior Electrical Engineer, Honeywell Inc., 1100 Virginia Dr., Fort Washington, PA 19034.

CIRCLE NO. 311



The burp-control circuit shown within the outline applies a 20-V pulse to a charging battery at intervals of 2 s to 2-1/2 min, determined by the setting of time-control resistor R_{10}.

Group portrait: The Class of '77



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CIRCLE NUMBER 46

Digitally programmable clock source built with a d/a and v/f converter

An accurate programmable frequency source can be easily constructed by using a d/a converter to drive a v/f converter (see figure). The frequency can be set either with thumbswitches or from any source of BCD or straight-binary data. With the components shown, the maximum frequency is about 100 kHz. The AD537 output can easily drive TTL or CMOS logic, or even directly sink a current of 20 mA in the LOW state and put out 36 V in the HIGH state.

The AD562 delivers an output current that the AD537 uses directly without intermediate circuitry. A further simplification results from the +1.00-V reference-voltage output of the AD537. The v/f converter uses this voltage as its reference, so the circuit works in a ratiometric mode that contributes to overall accuracy.

Note that the AD562 exhibits a maximum current-gain from the input at pin 4 to the output at pin 9 of 2.5, so the 160-μA current in the scaling resistors, R_1 and R_2, becomes nearly 400 μA. If a straight binary-coded AD562 is substituted, the full-scale output current is 640 μA, and the timing capacitor, C, should be increased by a factor of 1.6.

Calibration is straightforward: with the thumbswitches set to 999, adjust R_2 to read the corresponding frequency, that is 99.9 kHz, on a counter.

The linearity of the system ensures that all other settings of the frequency are correct within the three-digit window. A fourth decade can be added in the LSD position with an external current feed to pin 4 of the AD537, which is very close to ground potential. This voltage may be trimmed to exactly zero with a pot connected between pins 9 and 10.

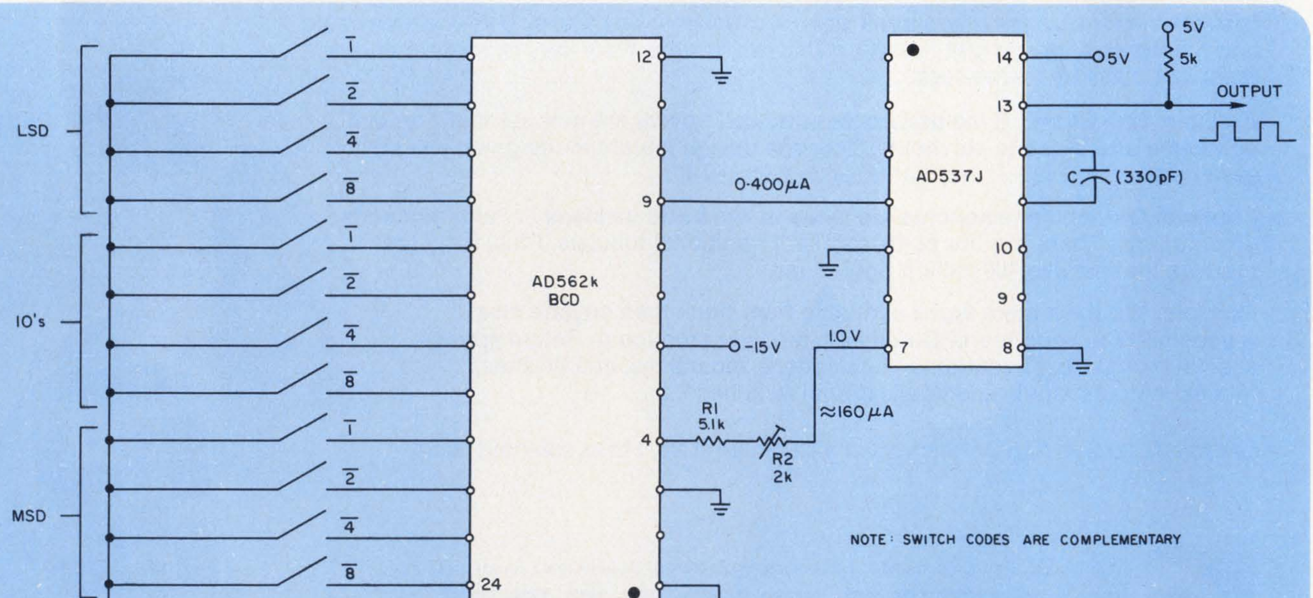
In addition to the square-wave output from its pin 13, the AD537 also generates a symmetrical triangular voltage across the capacitor, which may be used as an alternative output if buffered by a differential-input amplifier.

The use of a d/a converter may seem extravagant, since a Kelvin-Varley voltage divider can be used to energize the +1.00-V reference output, having its final decade connected to the voltage input of the AD537. However, such components with guaranteed ±0.03% accuracy are very expensive.

A helical pot with a digital dial is another possibility, but this usually offers only ±0.25% linearity, and more linear pots are both costly and not readily available.

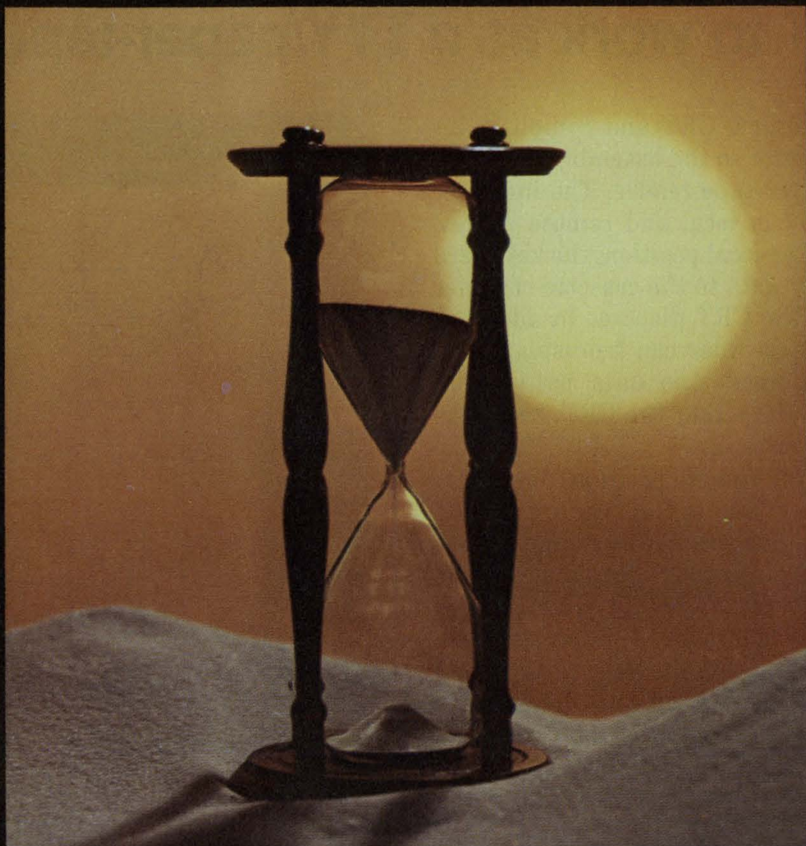
Barrie Gilbert, IC Design Engineer, Analog Devices Inc., Route 1 Industrial Park, P.O. Box 280, Norwood, MA 02062.

CIRCLE NO. 312



A simple, low-parts-count digitally programmable frequency source results because the d/a-converter current output can directly drive the v/f converter without any additional components. Also, the v/f converter provides the reference voltage for the d/a converter, and only R_1 and R_2 to calibrate the output.

Just as you can count on 24 hours in a day,



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Interface circuit teams cassette recorder with a CRT to work as a TTY/paper-tape unit

Use the cassette-recorder, CRT and computer interface circuit in the figure so the assembly can work like a TTY with its paper-tape reader. The interface circuit allows operation in local and remote modes.

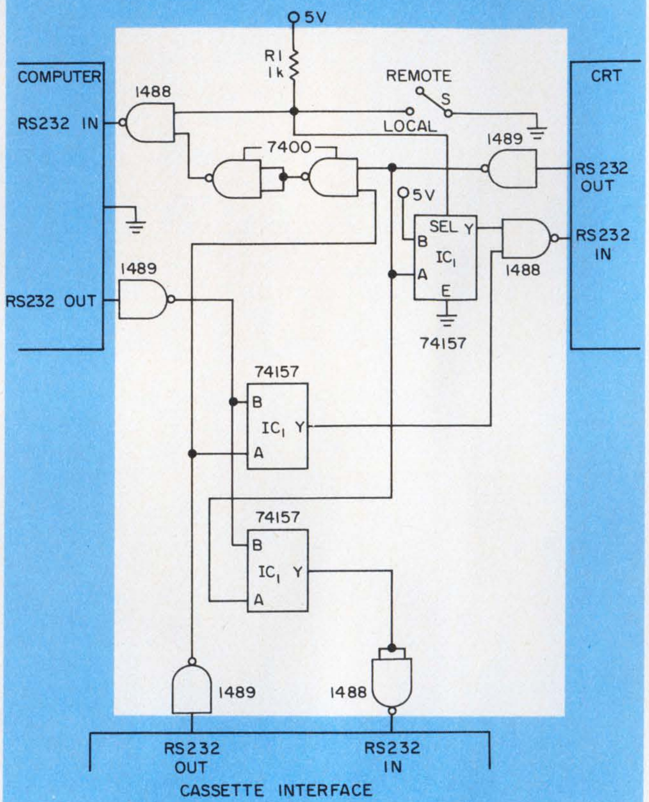
When switch S is in the local position, the keyboard of the CRT can transfer data to the cassette-recorder interface, and also to the CRT display. In addition, data from the cassette recorder can be displayed on the CRT. In the local mode, no data paths exist between the computer and either the CRT, keyboard or cassette-recorder.

When switch S is in the remote position, data from the CRT keyboard or the cassette recorder are applied to the computer, and data from the computer are available to the cassette recorder interface and the CRT display.

Level-changing gates 1488 and 1489 translate between TTL and RS232C levels; the 7400 gates allow data from both the CRT keyboard and the cassette recorder to be ORed into the computer input; and the selector/multiplexer, IC_1, in conjunction with the OR gate acts as a data-transfer switch for the local/remote selection.

Of course, where TTL levels or 20-mA current loops instead of RS232 levels are present, the level-changing gates can be appropriately replaced without sacrifice of circuit performance.

Ban Bong, Senior Technical Staff Engineer, Advanced Technology & Engineering, Collins Government Telecommunications Div., Rockwell International, Cedar Rapids, IA 52406. CIRCLE NO. 313



A cassette recorder/CRT system can be made to do the work of a TTY/paper-tape combination with this simple interfacing circuit.

IFD Winner for February 1, 1977

Peter Ole Jensen, Applied Computer Technology, Lindevangshusene 19, DK-2630 Taastrup, Denmark. His idea "Implement a Lab-scope Data Display with μP Software" has been voted the most valuable of Issue Award.

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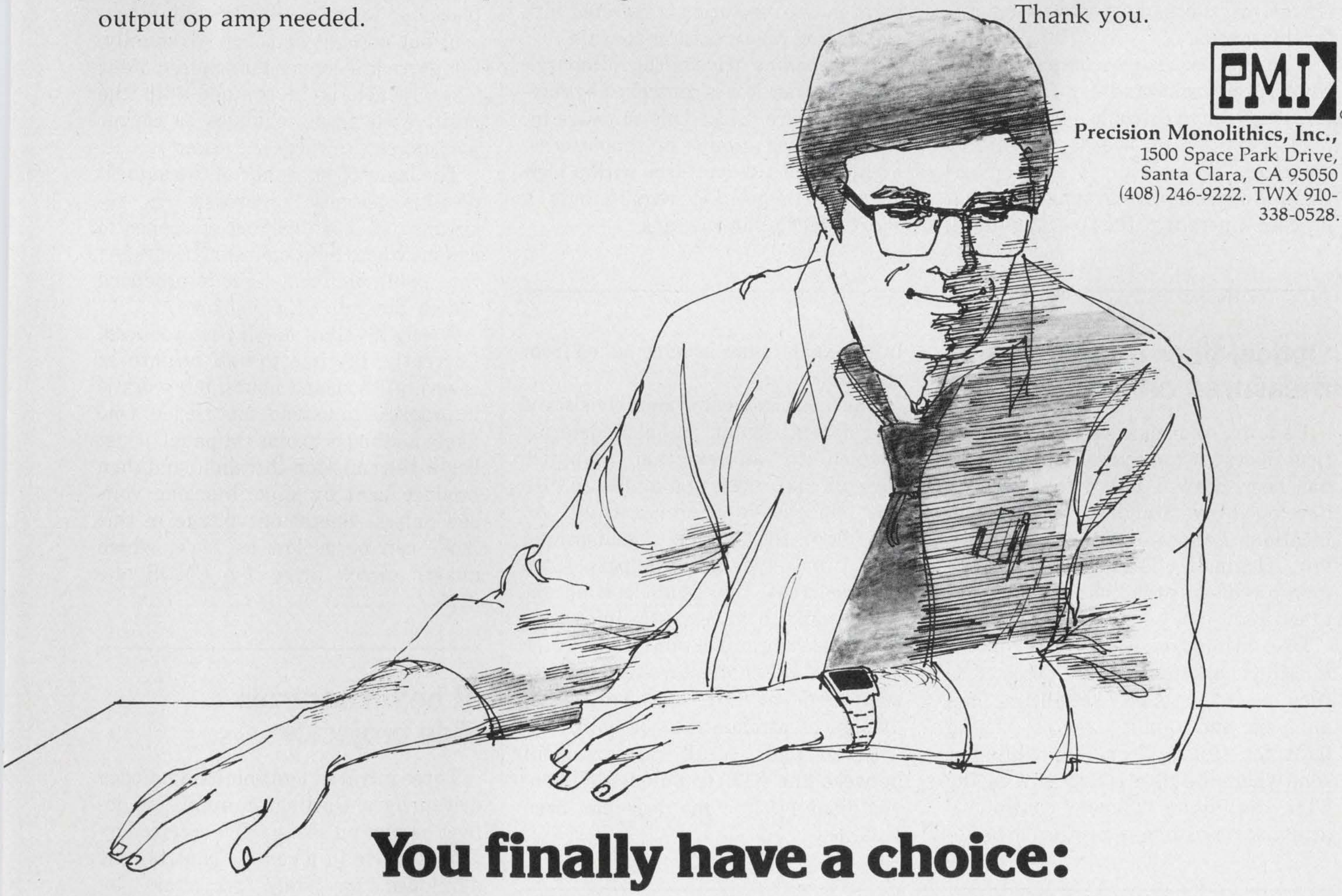

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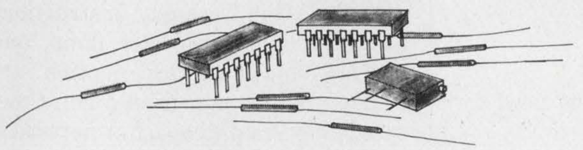

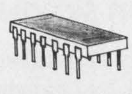

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CIRCLE NUMBER 48

Pattern maker's masks are big and sharp

A computer-controlled pattern generator can produce masks with large-area patterns and fine-line definition. Developed at the University of Edinburgh, Scotland, it can draw patterns over areas as large as 300 × 300 mm (11.8 × 11.8 in.). Image placements are accurate to a few micrometers, with even closer accuracy claimed for repeatability and the ensuing registration of the same patterns on different masks.

Suitable for such components as SAW filters, thick and thin-film hybrid circuits, optoelectronic devices and high-resolution PC boards, the pattern generator is superior to the conventional Rubylith photographic emulsion process. Currently, the largest reduced image available is about 1/2 × 1/2 in. However, the Edinburgh pattern generator can photocompose over a 4 × 4-in. area with half-micro X and Y-axis steps and ±0.2 μm repeatability at any X, Y point.

Line resolutions are restricted to the 2.5 to 3-μm level because of the limiting resolution of the photo-emulsions that have to be used. But further improvement in line resolution is expected with the use of photoresist materials.

The machine drive of the Edinburgh pattern generator is controlled by complex software. Since this software includes nested groups of subpatterns, highly repetitive patterns with a high degree of repetition require only a short description on tape.

Optical-fiber quality measured on-line

Usually, the characteristics of optical fibers are measured after the fiber has been drawn. But with a method developed by Standard Telecommunications Laboratories (STL) of Harlow, England, fiber quality can be monitored while the fiber is being manufactured.

Discontinuities in the fiber-transmission characteristics are detected as they occur, which simplifies loss analysis and quality control. Using light for testing from the white-hot zone where the glass is first melted, the STL technique allows continuous attenuation-vs-length profiles to be obtained as the fiber is being pulled from the melt.

The measurement system consists of a rotating drum, a photodetector coupled to an external amplifier through slip rings, and an 890 to 910-nm bandpass-interference filter. As the fiber is formed, it is wound around the drum, and the bandpass filter ensures that the photodetector responds only to wavelengths important to optical communication. The detector output is either displayed on a chart recorder or converted to a direct digital display of attenuation—or both.

Better than ±1-dB/km agreement between the STL technique and conventional off-line methods has been obtained.

Panel production simpler with dc phosphors

Depositing phosphors on large-area, electroluminescent (EL) ac panels requires careful and costly control. But now phosphors can be applied with a much simpler, low-cost dip-coating dc process that eliminates the need for expensive control.

Constant light can be produced over ac panels only if the bulk uniformity of the phosphors is high. The dc-phosphor technology developed by Phosphor Products, Dorset, England, requires no uniformity to produce constant light.

The new phosphor particles consist of an insulating core of zinc sulfide surrounded by a conducting layer of copper manganese. Particle diameter is about 1 μm.

The phosphor is mixed with only 5% of binder, not the conventional 40%, so that when the mixture is coated onto a panel electrode, the phosphor particles are in close electrical contact with each other.

A forming voltage applied across the phosphor layer results in a high current but no light emission. Gradually, the particle's copper-manganese outer layer, which is in contact with the positive electrode, changes as copper ions migrate towards the negative side.

The layer of phosphor at the highest positive potential increases in resistance as it is depleted of copper to a point where light emission occurs. At that point, uniform light is produced across the full EL-panel area.

A bright yellow display is produced. Currently, lifetime to half brightness is several thousand hours, but work is in progress to extend this period. One likely method is to bias the panel to just below the emission threshold and then produce light by superimposing voltage pulses. Operating voltage in this mode can be as low as 15 V, which allows direct drive by CMOS devices.

IR beam controls slide projector

Three infrared light-emitting diodes driven by a Darlington amplifier deliver carrier pulses that are received by a photodiode in a remote control unit developed for slide projectors by Siemens AG in Germany. Instructions for room lights, projector lamp, and forward and backward motion are transmitted in sequential form, time-encoded by simple capacitor networks. The receiver decodes the pulses through a tuning circuit and a low-cost video i-f amplifier IC.

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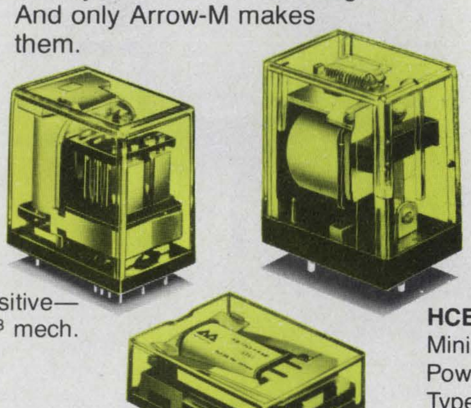

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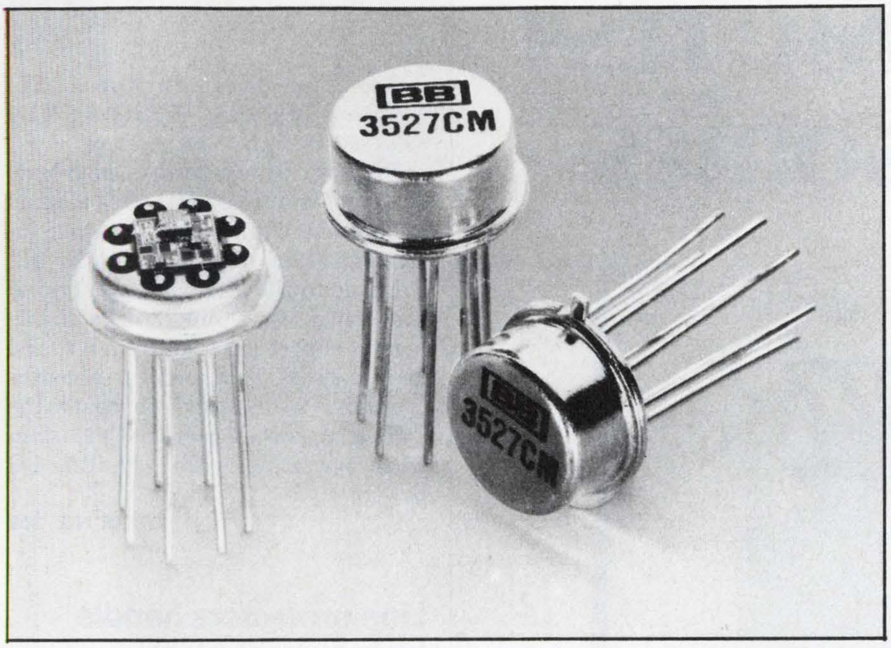
CIRCLE NUMBER 50

Hybrid amplifiers deliver premium specs at low cost



Burr-Brown, International Airport Industrial Park, Tucson, AZ 85734. G. Athey (602) 294-1431. P&A: See text.

The 3527 series of hybrid op amps has input bias currents of 5 pA or less, voltage offsets of under 0.5 mV, and offset drifts no worse than 10 μV/°C. What's more, prices for the series of FET-input op amps start at \$7.95 for the 3527A, rise to \$10.35 for the 3527B and finish at \$19.40 for the 3527C, all in 100-qty lots.

However, to get input specs that are better than those of most other op amps, Burr-Brown had to make a small compromise in amplifier response—the slew rate is just 0.6 V/μs. Each model offers a different combination of bias current, offset and drift. The A version has a 5-pA bias, a 0.5 mV offset and a 10 μV/°C drift. Both the B and C versions have a 0.25-mV offset, but the B has a 2-pA bias and a 5-μV/°C drift. The C has a 5-pA bias and a 2-μV/°C drift.

All 3527s have a 100-dB minimum open-loop gain, a 10-kHz frequency response, minimum, typical input impedances of 10^{12} Ω (differential) and 10^{15} Ω (common-mode), and a typical input noise of 25 nV/$\sqrt{\text{Hz}}$ at 10 kHz and 75 nV/$\sqrt{\text{Hz}}$ at 10 Hz. Each unit is capable of delivering ±10 V at ±10 mA, min, when operated from ±15-V supplies, but can operate over ±5 to ±20 V. When the op amps are powered by ±15-V lines, the quiescent current is 2.6 mA.

Housed in eight-pin TO-99 packages, all versions are specified for operation over −25 to +85 C. As with many FET-input op amps, bias current doubles for every 10 C increase above 25 C.

This 3527 series faces some pretty stiff competition—in both price and performance. Starting at under \$1, the 3130 or 3140 series of monolithic op amps from RCA (Somerville, NJ) come close in performance: Input-bias currents are 50 pA for the inexpensive models and 20 pA for the best (\$12). Voltage-offset span is 2 to 15 mV, and drifts range from 10 to 20 μV/°C.

The LF355 series of monolithic BiFET amplifiers developed by National Semiconductor (Santa Clara, CA) have bias currents of 50 to 200 pA but slew at up to 50 V/μs and cost anywhere from about \$2.50 to \$17. Also from National are the LH0052 and 0022 hybrid amplifiers, which have bias currents of 5 to 25 pA, respectively. The AD506 and 503 series from Analog Devices (Norwood, MA) have better frequency response than the Burr-Brown series, with slew rates from 1 to 50 V/μs. However, their bias currents and drifts are much higher than those of the 3527 series.

Burr-Brown	**CIRCLE NO. 302**
Analog Devices	**CIRCLE NO. 303**
National Semiconductor	**CIRCLE NO. 304**
RCA	**CIRCLE NO. 305**

Multiplex and convert 16 analog channels

Zeltex, 940 Detroit Ave., Concord, CA 94518. R. Terry (415) 686-6660. \$300 (100 qty.); stock to 30 days.

The ZMP-1000 data acquisition system converts 16 analog channels to a multiplexed 12-bit output. The system features monotonicity over 0 to 70 C, max conversion time of 12 μs, adjustable throughput rates of up to 50-k channels/s and differential linearity of ±1 LSB with no missing codes. The unit is 3 × 4.6 × 0.375 in.

CIRCLE NO. 306

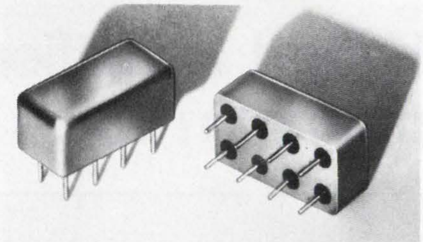
Analog interface plugs into PACE microcomputer

Data Translation, 23 Strathmore Rd., Natick, MA 01760. F. Molinari (617) 655-5300. \$395 (1 qty.); stock.

The DT1723 data-acquisition system is plug-compatible with National Semiconductor's PACE μC application card series. The single-board system fits in a slot of the PACE and requires no additional interfacing. With 16 single-ended or 8 differential channels, the system's front end has an overvoltage-protected multiplexer, a high input-impedance instrumentation amp, a fast sample-and-hold amp, and a 12-bit a/d converter. Standard throughput rate is 35 kHz, with 100 kHz optional. Features include 12-bit resolution, ±0.03% accuracy, ±1/2-LSB linearity, and ±25 ppm/°C tempco. Address selection is fully user selectable at the 72-pin backplane connector. In addition to analog input ranges of ±10, ±5 and 0 to 10 V, the system accepts 4 to 20-mA signals.

CIRCLE NO. 307

Double-balanced mixer dumps distortion

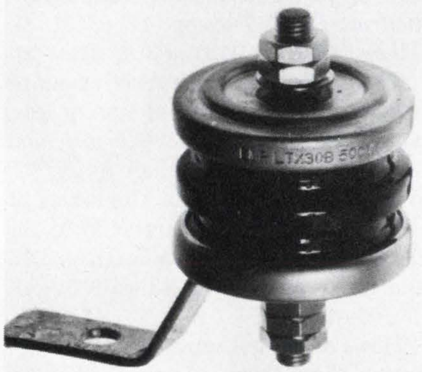


Anzac Electronics, 39 Green St., Waltham, MA 02154. J. Leonard (617) 899-1900. $25 (1-50 qty.); stock.

Even in systems with a high-level local oscillator (LO), MD-151 balanced mixers reject third-order two-tone intermodulation distortion by 15 dB. From dc to 500 MHz (i-f port) typical conversion loss is only 8 dB and LO-port to rf-port isolation from 5 to 200 MHz is 30 dB. Third-order intercept is typically −23 dBm, and rf output to the 1-dB compression point is +13 dBm when operating with +17-dBm LO power.

CIRCLE NO. 308

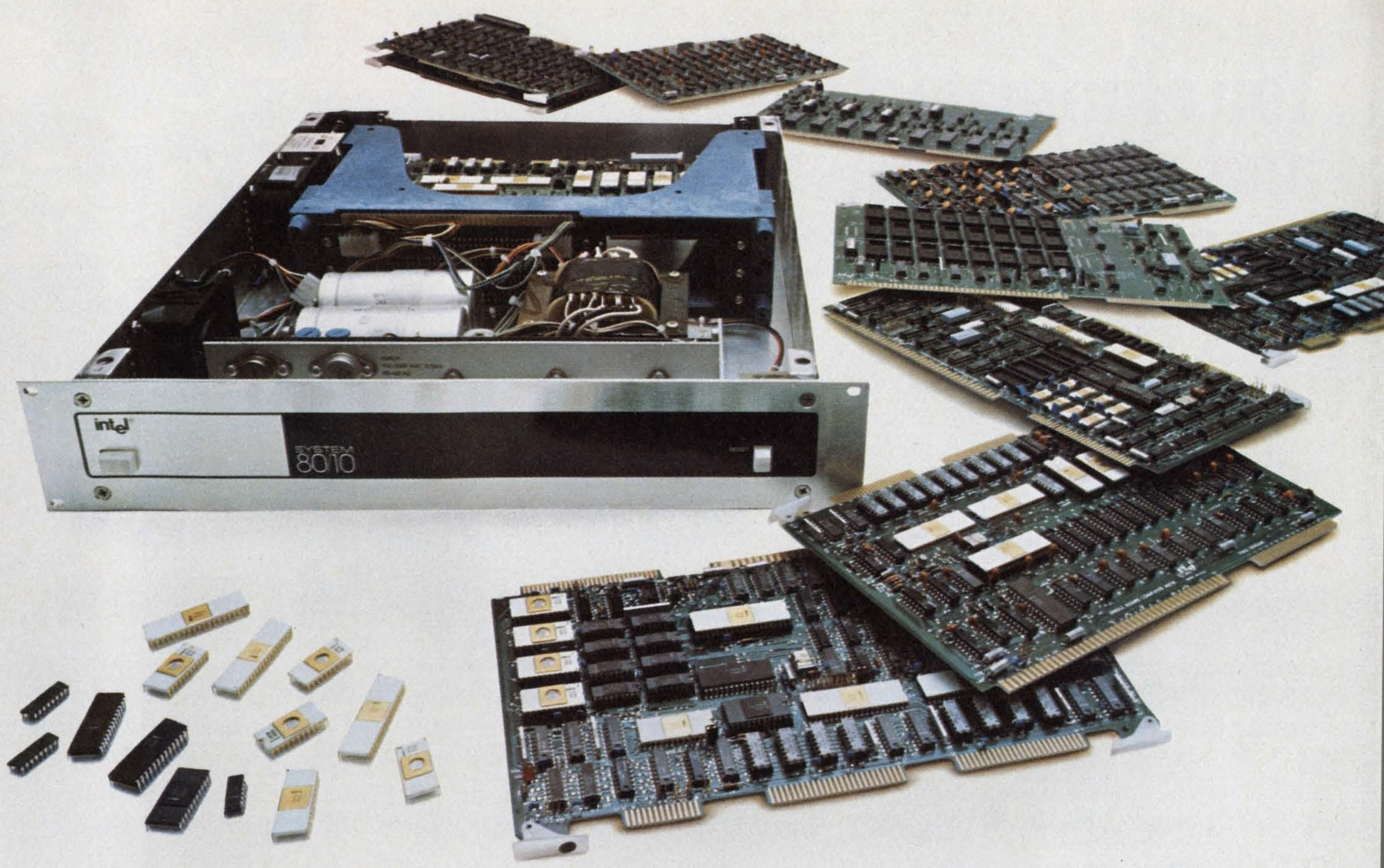
Line protectors handle high-current blasts



TII Corp., 100 N. Strong Ave., Lindenhurst, NY 11757. J. Kent (516) 842-5000. From $30 (13-25 qty.); 60 days.

Surge protectors for 440-V-ac power lines, one to three phase, Models TII-485 and TII-486, ground 65-kA spikes and 1 ms, 75-A surges. Model 485 is a 1-lb axial unit with a terminal at either end; the 2-lb Model 486 includes a mounting strap, ground lug and pigtail. Both units use porcelain gap-spacers, mica separators and heavy-gauge copper electrodes. For three-phase systems connect an arrester from each phase to ground.

CIRCLE NO. 309



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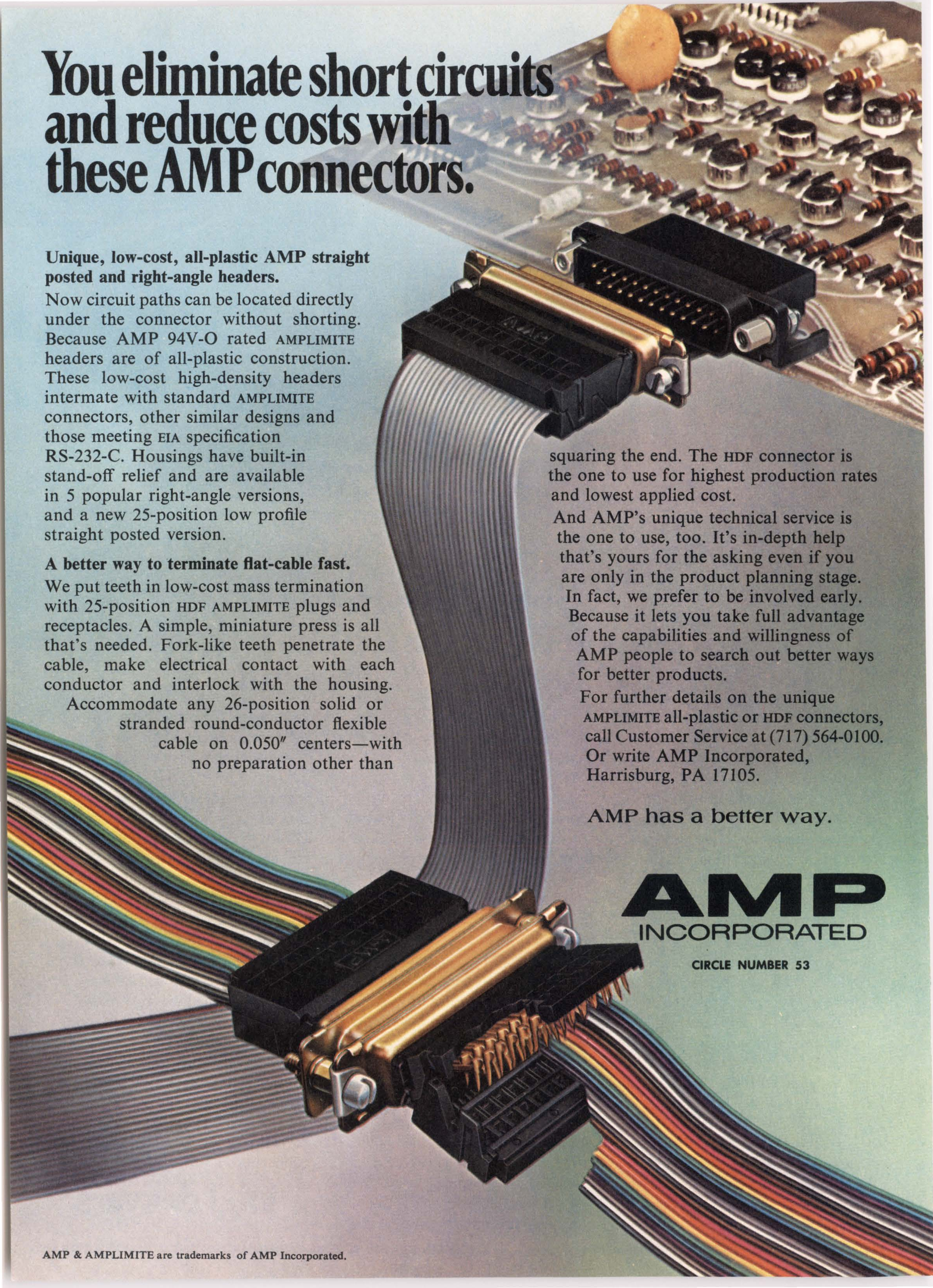
intel® delivers.

CIRCLE NO. 213 FOR TECHNICAL INFORMATION

CIRCLE NO. 214 FOR TECHNICAL INFORMATION AND A DEMONSTRATION



You eliminate short circuits and reduce costs with these AMP connectors.
Unique, low-cost, all-plastic AMP straight posted and right-angle headers.
Now circuit paths can be located directly under the connector without shorting. Because AMP 94V-O rated AMPLIMITE headers are of all-plastic construction. These low-cost high-density headers intermate with standard AMPLIMITE connectors, other similar designs and those meeting EIA specification RS-232-C. Housings have built-in stand-off relief and are available in 5 popular right-angle versions, and a new 25-position low profile straight posted version.
A better way to terminate flat-cable fast.
We put teeth in low-cost mass termination with 25-position HDF AMPLIMITE plugs and receptacles. A simple, miniature press is all that's needed. Fork-like teeth penetrate the cable, make electrical contact with each conductor and interlock with the housing. Accommodate any 26-position solid or stranded round-conductor flexible cable on 0.050″ centers—with no preparation other than squaring the end. The HDF connector is the one to use for highest production rates and lowest applied cost.
And AMP's unique technical service is the one to use, too. It's in-depth help that's yours for the asking even if you are only in the product planning stage. In fact, we prefer to be involved early. Because it lets you take full advantage of the capabilities and willingness of AMP people to search out better ways for better products.
For further details on the unique AMPLIMITE all-plastic or HDF connectors, call Customer Service at (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.
AMP has a better way.
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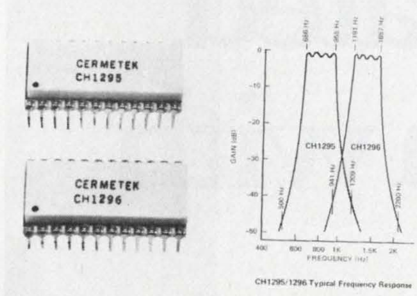
Filters eliminate dual-tone errors

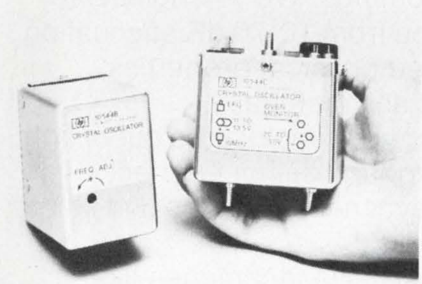


Cermetek Microelectronics, 660 National Ave., Mountain View, CA 94043. (415) 969-9433. $16.50 (1000 qty.); stock to 4 wks.

CH-1295 and 1296 band-splitters eliminate crosstalk, interference and distortion associated with dual-tone multifrequency (DTMF) signaling. The filters can be the front end of a DTMF tone receiver; or with a limiter and digital filter/DTMF IC, the filters complete a DTMF receiver. Model 1295 covers the 686 to 955-Hz low band and the 1296 covers the 1191 to 1657-Hz high band. The units provide 40-dB attenuation, unity gain, and accept inputs up to +10 dBm without clipping.

CIRCLE NO. 310

Fast warm-up modules pour out pure 10 MHz



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1501. From $690; 90 days.

Two crystal oscillators supply 10-MHz outputs featuring an aging rate of 5 parts in 10^{10} per day, spurious phase noise of 150 dB for more than 1-kHz offset, and warm up to within 5×10^{-9} of final value in 20 min. Model 10544B uses a printed-circuit board connector; Model 10544C has filter feed-through terminals, a snap-on rf connector and provision for shock mounting. Both oscillators are rugged enough for field equipment. These 11 oz modules are 2.8 × 2.03 × 2.44 in.

CIRCLE NO. 320

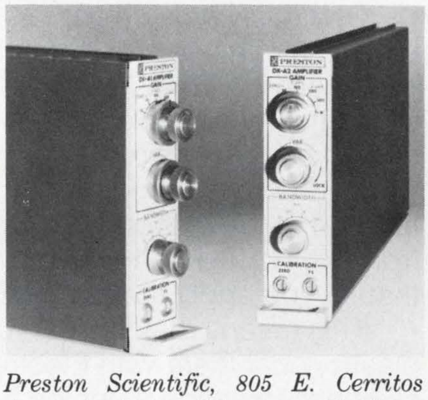
Thermocouple junction compensator acts fast

Hades Manufacturing, 151A Verdi St., Farmingdale, NY 11735. E. Brand (516) 249-4244. $69 (1-24 qty.); stock to 4 wks.

Self-powered thermocouple reference-junction compensators of the NC420 series require no warm-up time. Just connect the external leads and the unit's self-contained battery gives you 5000-h continuous use or 3-yr intermittent use. Standard reference-temperature setting is 0 C with other references available for all thermocouple materials. Compensation accuracies are typically ±1/4°C at 25 C to ±3/4°C from 0 to 50 C. Output impedance is less than 250 Ω. The cylindrical compensator is 3 (L) × 0.625 (D) in.

CIRCLE NO. 321

Instrumentation amp gains CMR & CMV



Preston Scientific, 805 E. Cerritos Ave., Anaheim, CA 92805. B. Spear (714) 776-6400. From $335 (1-10 qty.); stock.

The common-mode rating for the DX-A2 Series of instrumentation amps is 30-V dc or pk ac—a threefold increase over the standard DX-A1 amps. The common-mode rejection ratio has also been increased to 120 dB at 60 Hz for a gain setting of 1000; and 100 dB at a gain setting of 10. Seven switch-selectable gain levels between 10 and 1000 are available on the front panel, and a variable gain control selects any gain between the fixed-gain steps, up to 3000. Additional features include six-month isothermal gain stability of 0.01%, 30-day isothermal and zero stability of ±5 μV (rti) and ±0.1 mV (rto).

CIRCLE NO. 322

MODULES & SUBASSEMBLIES

Accurate attenuator steps with 64 digits

Applied Research, 76 S. Bayles Ave., Port Washington, NY 11050. A. Scandurra (516) 883-5700. From $450; 45 days.

A digital attenuator, Model 7581-004, operates in 0.5-dB steps to 31.5 dB and in 1-dB steps to 63 dB. Accuracy is ±0.25 dB up to 100 MHz. Between 0.5 to 8 dB, accuracy is 0.15 dB. Insertion loss is 1 dB at the zero setting. The phase difference between attenuation settings is ±0.4° from 20 to 90 MHz.

CIRCLE NO. 323

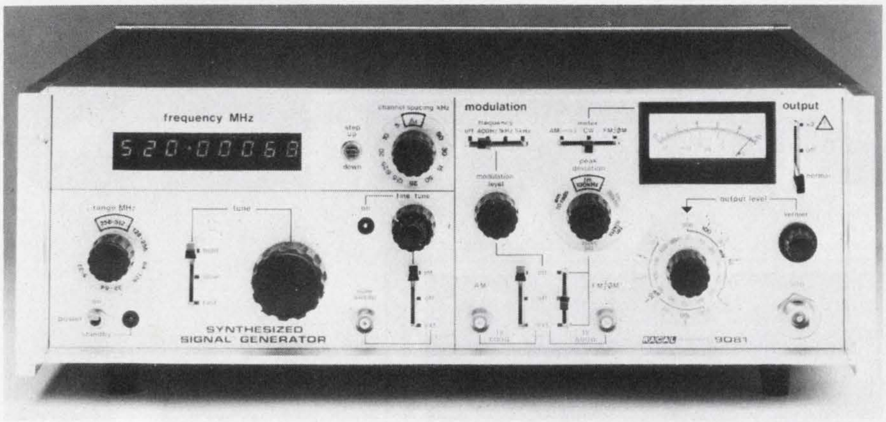
Tiny elapsed timer boasts crystal control

Veeder-Root, 70 Sargeant St., Hartford, CT 06102. A. Patricelli (203) 527-7201. $160; stock.

Using MOS-LSI circuitry, the 7971 Minicounter Indicator measures and displays elapsed time to ±0.01% and ±1 count. A quartz oscillator provides stability. Models are available with 0.01, 0.1 or 1 s resolution for 12 to 15-V-dc operation. The five LED digits are 0.375 in. The crystal is gasketed for splash and dust resistance. The case, only 1 × 1.93 in., clip-mounts without screws into a standard 25 × 50-mm panel cutout. The device displays the measured time between externally applied start and stop signals received from relays, switches or open-collector transistors. It can be reset by an external command after each reading or can accumulate the total time for a number of operations.

CIRCLE NO. 324

Synthesized signal gen tunes with spin wheel



Racal Instruments, Duke St., Windsor, Berkshire, SL4 1SB, England. $4000 to $4500; 4-6 wk.

The Model 9081 520-MHz synthesized signal generator offers spin-wheel electronic tuning instead of decade switches or pushbuttons. You first set a frequency range, then spin the tuning control until the eight-digit display indicates the desired frequency.

The frequency changes in steps, which can be preset to any of 10 channel spacings between 5 and 60 kHz. Or a step switch lets you shift up or down one channel spacing at a time.

To prevent accidental changes, a "hold" switch can disconnect the spin wheel. Two other positions on the hold switch allow fast or slow tuning. Other controls provide either fine-tuning or "continuous" coverage using the smallest increment, plus fine tuning between increments.

Additional features include AM, FM and phase modulation, leveled output (−130 to +3 dBm) and a level meter. Specs include a frequency stability of 1 ppm/10 min. after 30-min. warmup, or 100 Hz/10 min., depending on the band chosen. Harmonics are 30 dB down, and spurious are 70 dB down at 20 kHz from the carrier. Residual FM is 50 Hz rms (300 Hz to 3 kHz bw).

CIRCLE NO. 301

Test station aims at page-mode memories

Teradyne, 183 Essex St., Boston, MA 02111. (617) 482-2700. J387 with H712, $107,000.

H712 is a major station for testing 4-k and 16-k page-mode memories on the company's J387 memory test system. In addition to address multiplexed devices, the H712 station tests page-mode memories with multiplexed input and output terminals. The basic H172 includes nine independently programmable, double-edge clock phases, 16 address drivers, four data drivers, and four dual-limit comparators. These can be expanded. A new Auto-Vector software package is included, which eliminates the need for an external time reference.

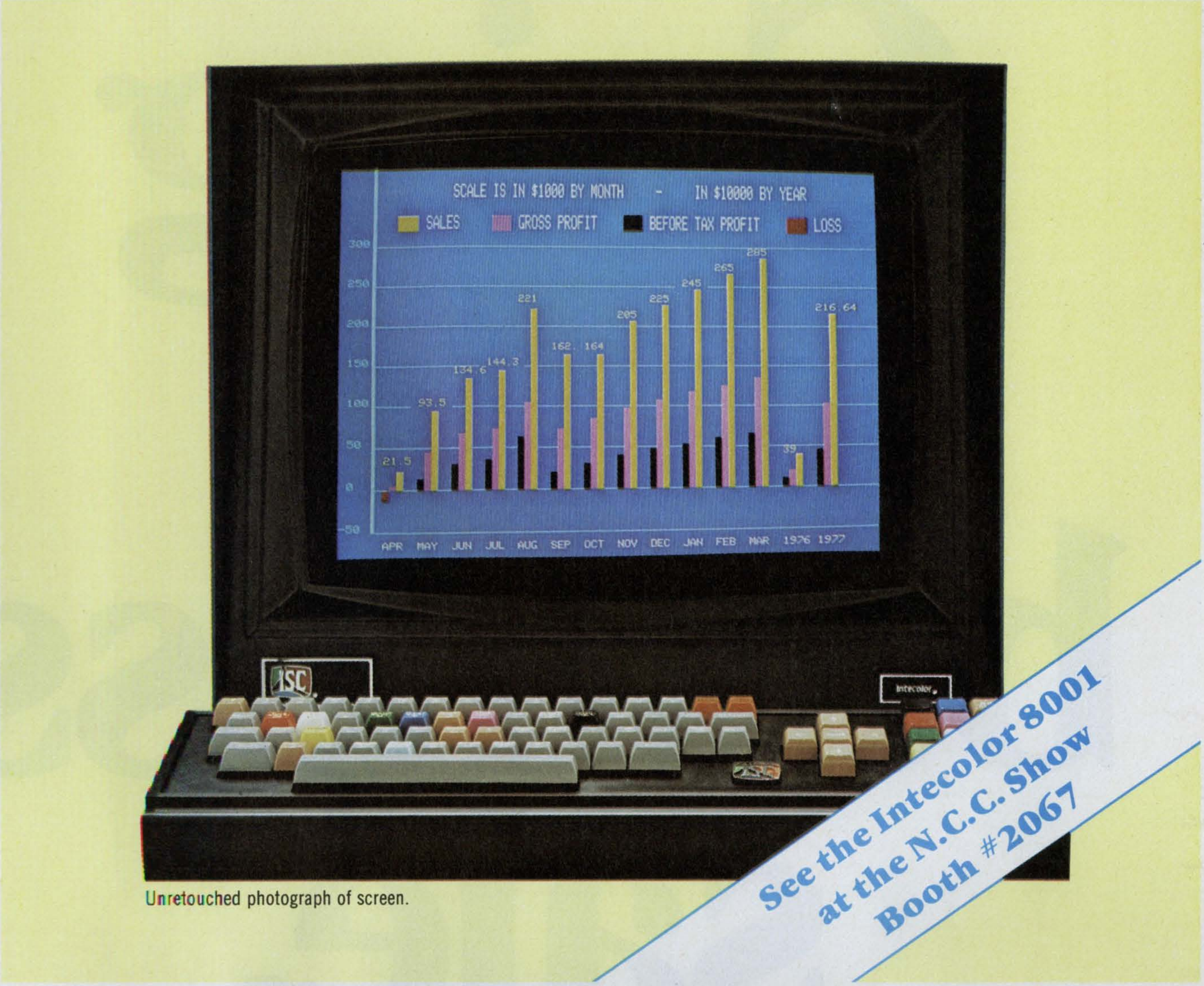
CIRCLE NO. 325

Plug-in performs multichannel averaging

Norland Instruments, Route 4, Norland Dr., Fort Atkins, WI 53538. (414) 563-8456. $3500; June, 1977.

Model 2301 signal averager plug-in expands the capability of the company's 2001A waveform and data analysis system by adding the software and hardware needed for high-speed, multichannel signal averaging. The 2301 can provide up to four channels of simultaneous signal averaging depending on plug-in selection. Both the raw (noisy) input and the averaged waveform can be displayed. The display reads out in user defined units, not counts. Data can be acquired at a 1 μs/s sample rate, with throughput as high as 200,000 sample/second.

CIRCLE NO. 326



Unretouched photograph of screen.

The Intecolor 8001 CRT. Buy One or Buy One Hundred. Just $1495.*

That's the price tag we'll put on the Intecolor 8001 if you place your order right now for 100 or more units. $1495. That's also the price we'll give you on a one-shot cash basis on an Intecolor 8001 CRT evaluation unit. Now, we'll never get rich with a price structure like that, but we look at it this way. That price is an investment in your future. We know that once you get your hands on the Intecolor 8001, once you see what it can do, you'll be back for more.

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Domestic U.S.A. prices

CIRCLE NUMBER 56

Going into business sale.

National Semiconductor is going into the microcomputer business.

And to celebrate, we're having a "sale."

10% off the Intel 80/10.

To get 10% off Intel's 80/10, don't buy Intel's 80/10. Buy National's 80/10.

We're able to sell the 80/10 for less because of our improved board layout which permits automated assembly (such as using axial leaded components)...the fact that we make not only the 8080, but also—unlike Intel—most of the rest of the ICs on the board...and, of course, National's legendary competence in efficient manufacturing doesn't hurt either.

The industry standard.

Our second-sourcing of the 80/10 clears the way for the 80/10 to be the clear-cut standard of the microcomputer industry.

You can't effectively have an industry-standard without a second-source. Having two suppliers is a healthier competitive situation for you, the customer, and you have the security—and abuse-protection—of an alternate source.

What we make and how we make it.

What we're making is this:

Series/80 Cards:

BLC 80/10	BLC 104*
BLC 016	BLC 508*
BLC 406	BLC 416*
BLC 905	

*Available 3rd quarter '77

Series/80 Systems:

BLC 80P BLC 614 BLC 604

Series/80 Firmware:

BLC 910

(With more, much more, to come in the future.)

And how we're making them is this:

We're putting out the finest quality available. A cleaner board—better layout, all axial components, plug selectable options rather than wire wrap.

We "burn in" every board at elevated temperature, and run computer diagnostics during burn-in.

Think we're kidding about quality? We're offering a one year warranty. Which is just about four times longer than Intel's warranty period.

A microcomputer company small enough to do business with.

We're not dummies.

We know that to break into a field that somebody else has a lock on, we've got to offer something extra.

And extra quality for less money ain't a bad start.

But we're offering something else extra, too.

Desire.

As the little guy we can't afford a fat cat attitude.

We'll do our best to meet impossible deadlines.

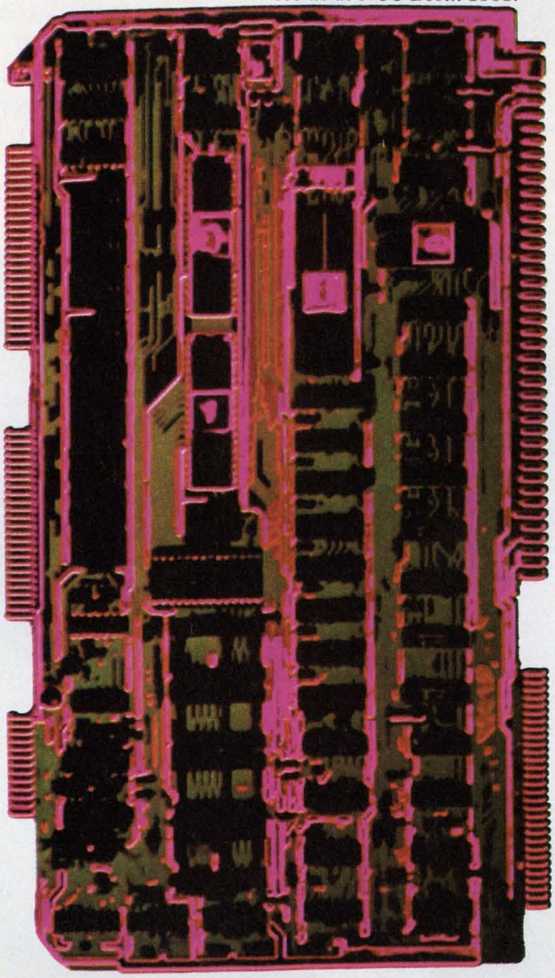
Our phone won't be busy. Etc.

In the microcomputer arena we're young, small, and hungry.

So if you'd like to see what you've been missing in 80/10's, see your local distributor or use this coupon to get our literature.

Help us celebrate our going into business sale by helping us *stay* in business.

See us at NCC Booth 1565.



National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, CA 95051

Gentlemen: ☐ You've got my interest. Please send me more information on National's SERIES/80.
☐ I'm so turned on, I can't wait. Please have a salesman call me immediately.

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Company__________

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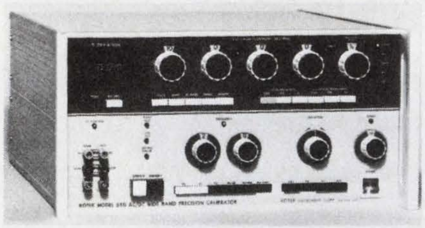
My application is__________

☐ I'm presently using the other guy's 80/10.
☐ I'm not up to the 80/10 yet but I'm using the 8080.
☐ I have an 8080 software development system.
☐ Your BLC 80/10 will be used in house.
☐ I'm an OEM. Your BLC 80/10 will be shipped out as part of my equipment.

National Semiconductor

INSTRUMENTATION

Calibrator extends measurement accuracy



Rotek, 220 Grove St., Waltham, MA 02154. (617) 899-4611. Approx. $9000; July.

Model 610 ac/dc standard provides a dc voltage accuracy of 0.002% setting +0.001% range from 1 to 500 V, and 0.002% setting +0.0015% range +2 μV below 1 V. The ac voltage accuracy is 0.025% setting +0.0025% range +10 μV from 400 to 1000 Hz with reduced accuracies from 40 to 400 and 1000 to 50 kHz. Outputs range from 1 mV to 1000 V, 1 μA to 1 A, and 1 Ω to 10 MΩ.

CIRCLE NO. 327

Personality module analyzes 6502 μPs

Biomation, 10411 Bubb Rd., Cupertino, CA 95014. (408) 255-9500. $300; 60 days.

A plug-in "personality module" to analyze the MOS Technology 6502 extends the capabilities of the company's Model 168-D microprocessor analyzer beyond the previously announced 8080A and 6800 personality modules. The company will also build to order personality modules for specific microprocessors, including RCA COSMAC 1802, Zilog Z80, Signetics 2650, Rockwell PPS-8, Intel 8085, National SC/MP, and Electronic Arrays 9002.

CIRCLE NO. 328

Smart counter/timer tops out at 1 GHz

Ballantine Laboratories, P.O. Box 97, Boonton, NJ 07005. (201) 335-0900. $1050; 30 days.

Model 5500B-Opt. 35 universal counter/timer extends frequency measurement capability to 1 GHz. The 8-digit instrument's ROM-controlled circuitry permits automatic resolution and autoranging in all ten operating modes. Featured on the front panel is a resolution control that guarantees full use of the most significant digit in any measurement, ensuring against overflow or loss of data.

CIRCLE NO. 329

Software package generates test program

Teradyne, 183 Essex St., Boston, MA 02111. (617) 482-2700. Starter package, $8000.

Once a circuit has been described to the P400—a new software system for the company's L100-series of PC-board testers—the software system produces a program that includes the basic input and output test patterns and diagnostic data, as well as the introductory interfacing information and initializing patterns. The program is produced in the symbolic language of the test system on a ready-to-be-loaded tape cartridge.

CIRCLE NO. 330

IF YOU CHANGE TO A NEW TYPE OF PROM TODAY, WILL YOUR PROM PROGRAMMER BE OBSOLETE TOMORROW?

When you program your PROMs on a Data I/O programmer you don't have to worry about obsolescence.

Data I/O programmers are universal. They program all 200 plus commercially available PROMs. This gives you maximum design and production flexibility.

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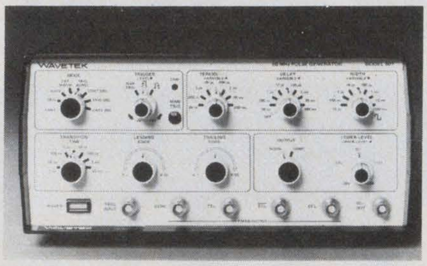
For more information, Circle No. 180

Pulse generator gives varied outputs

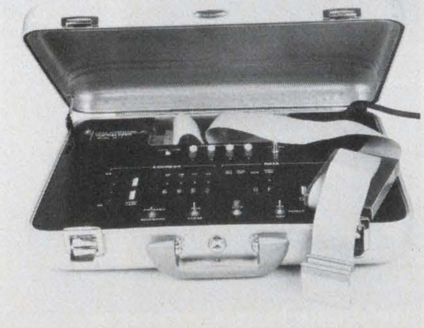


Wavetek, P.O. Box 651, San Diego, CA 92112. (714) 279-2200. $995; 30 days.

Model 801 50-MHz pulse generator provides continuous, triggered, gated or burst pulse outputs with normal, delayed or double pulses. Pulse period, delay and width are independently adjustable with front-panel controls. The primary output pulse is shaped by independent rise and fall controls with a 50:1 range. Fixed ECL and TTL levels and their complements, are available from front-panel outputs, and another output has independently adjustable positive and negative limits from +20 to −20 V.

CIRCLE NO. 331

Logic analyzer comes in a suitcase



Yucca International, 14415 N. Scottsdale Rd., Scottsdale, AZ 85260. (602) 991-1491. $1790 with probe for M6800 or 8080; 30 days.

Model YA-I portable MPU logic analyzer checks 6800 and 8080 μPs in operation. The unit does not take control while monitoring MPU hardware/software. Its speed is controlled by the MPU clock. Special interfacing or additional programming is not required. YA-I traps 128, 32-bit data words at any preselected point in the program, at any address or at any user input. Instructions (32 words back, 96 words forward) are read, a data word at a time, on hexadecimal displays.

CIRCLE NO. 332

'Pocket' thermometer resolves 0.1 C

Extech International, 177 State St., Boston, MA 02109. (617) 227-7090. $174.50.

Series 2400 portable digital thermometer and interchangeable thermistor probes cover −30 to 100 C, reading in 0.1° increments on red LED displays. Accuracy is ±0.4% ±one digit at 23 C ±5 C. The meter is powered by standard AA batteries or works from either the 115 or 230-V line with a plug-in ac adapter. Series 2400 thermometer kits include meter, batteries, ac adapter, stand and carrying case.

CIRCLE NO. 333

Oscillator kit offers pushbutton operation

Heath Co., Dept. 350-20, Benton Harbor, MI 49022. (616) 982-3417. Kit, $129.95; assembled, $190.

Model IG-1272 oscillator kit provides a low-distortion sine-wave output from less than 5 Hz to 100 kHz. Unusual is the ability to offer both pushbutton and variable-frequency operation. Attenuation accuracy is ±0.2 dB. Hum and noise are rated at 0.01% or less. The IG-1272 also comes fully assembled and tested (SG-1272).

CIRCLE NO. 334

Line analyzer memorizes and compares readings

Power-Science, Inc., 8076 Engineer Rd., San Diego, CA 92111. (714) 292-4422. $545.

Line-voltage analyzer, Model LVA-110, offers high-speed ac measurements; the instrument can monitor line voltage with either a 1/2, 1 or 2-cycle time base. Each measurement is analyzed and compared against two memories that store the highest and lowest line voltage readings. An additional power-fail memory lights an indicator when power returns after an interruption. The dynamic input range is 0 to 199 V, and the analyzer can operate continuously over inputs from 50 to 160 V.

CIRCLE NO. 335

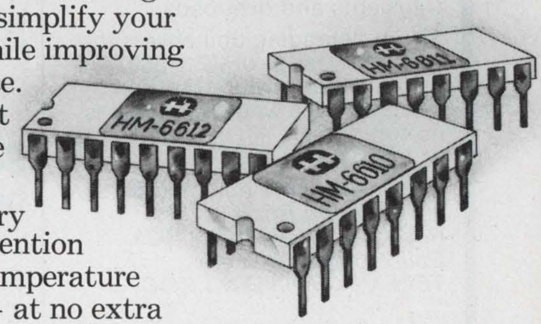
Designers arise!

HARRIS introduces the largest family of CMOS memories in the industry. With the very first CMOS PROMs.

Harris has the answer in CMOS RAMs, ROMs, and PROMs. Count 'em. 10 distinctively different memories, including three exclusive new CMOS PROMs...first in the industry...giving you the widest range of design options ever available. □ Harris CMOS Memories have the kind of high performance features you can design around. Like extremely low power requirements in both active and standby conditions. Fast access times. High noise immunity. TTL compatibility in/out. With temperature ranges for military (-55°C to +125°C), industrial (-40°C to +85°C) and commercial (0°C to +70°C) usage. □ Features that can help you simplify your designs while improving performance. Reduce part count. Save money. And every device is pretested to guarantee data retention down to 2.0 volts over rated temperature range — at no extra cost to you. □ If you want to free yourself from the ordinary, add a new dimension to your designs, check the Harris CMOS Memory family. It's the biggest in the business. The quality is there. And the price is right. For complete specifications call your nearby Harris sales location, or write

Harris Semiconductor,

P.O. Box 883, Melbourne, FL 32901



USE THIS CHART TO HELP YOU SELECT THE CMOS MEMORY BEST SUITED FOR YOUR DESIGNS.

TYPE NO.	ORGANIZATION	PINS	SPEED	FEATURES
HM-6610 PROM	256x4	16	450 ns	Industry's first CMOS PROM. Combines
HM-6611 PROM	256x4	16	450 ns	benefits of low active and standby
HM-6612 PROM	256x4	18	450 ns	power, high noise immunity and fast access time.
HM-6312 ROM	1024x12	18	350 ns	Highest density CMOS ROM available. Ideal for 12 bit microprocessor systems.
HM-6508 RAM	1024x1	16	290 ns	Bipolar RAM pinout
HM-6518 RAM	1024x1	18	290 ns	6100 uP compatible
HM-6501 RAM	256x4	22	285 ns	Popular 5101 pinout
HM-6551 RAM	256x4	22	285 ns	Latched chip select
HM-6561 RAM	256x4	18	285 ns	6100 uP compatible
HM-6562 RAM	256x4	16	285 ns	Smallest 256x4 RAM available.

HARRIS SEMICONDUCTOR

A DIVISION OF HARRIS CORPORATION

CIRCLE NUMBER 60

PACKAGING & MATERIALS

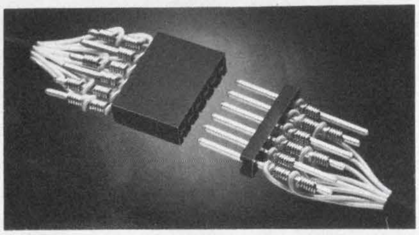
Ground people with a wrist band

Walter G. Legge Co., Inc., 101 Park Ave., New York, NY 10017. (212) 689-3083.

Wristat, an anti-static device worn around the wrist, grounds production, assembly and service employees without restricting arm movement. A flexible double conductor cable connected to an alligator clamp can be grounded to machinery or equipment.

CIRCLE NO. 336

Male and female contacts served by wrapped pin



Methode Electronics, Inc., 1700 Hicks Rd., Rolling Meadows, IL 60008. (312) 392-3500.

The Happy-Wrapper connector is a 0.045-in.-square pin joined to a sturdy female or other male contact. Insulators are injection molded on a nylon base. The Happy-Wrapper method connects leads with hand wire-wrapping terminations. Also a male header element can attach to a bulkhead or circuit board.

CIRCLE NO. 337

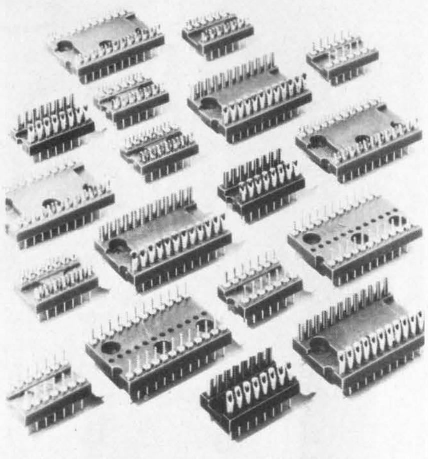
Self-contained torch burns 30 min/refill

Ungar, Div. of Eldon Industries, Inc., 233 E. Manville, P.O. Box 6005, Compton, CA 90220. (213) 774-5950.

The Versa Torch 5001 is a self-contained, pocket-sized torch and soldering iron that provides total freedom and portability for heating and soldering. It refills in seconds from standard propane or MAPP gas cylinders, provides up to 30 min of continuous heating per refill and weighs only 11 oz. A special adapter allows the torch to be fitted with any Ungar ¼-in. tip. And a pinpoint burner tip for conventional flame heating solders copper tubing, welds and bends PVC plastics, and performs an endless list of other jobs. A detachable stand locks the torch into two positions—vertical and horizontal.

CIRCLE NO. 338

Adapter plugs come in many styles and sizes



Samtec Electronic Hardware, 810 Progress Blvd., New Albany, IN 47150. (812) 944-6733. From $0.35 ea.

DIP adapter plugs are available in seven sizes with three terminal styles for interfacing all component leads to DIP pin-out patterns. Terminals are precision-machined brass in either gold or tin finish with a choice of solder-pin, solder-pot, or slotted-head styles. Body is 1/8-in. thick glass-filled polyester U.L. rated 94V-0. All adapters feature pin-1 orientation and counter-bored thru-mounting holes.

CIRCLE NO. 339

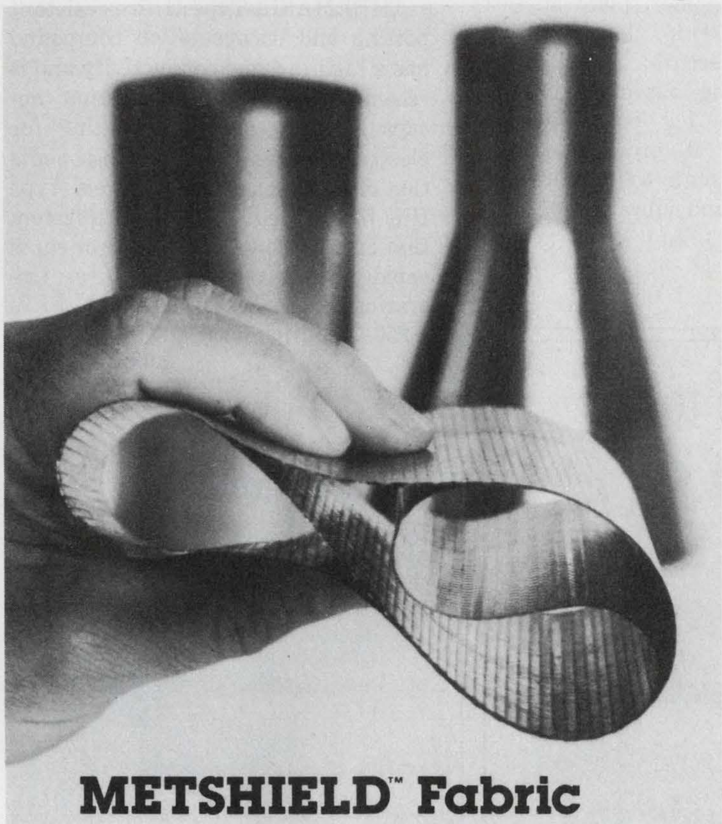
Weary of static? This handy meter helps

Anderson Effects, Inc., P.O. Box 657, Mentone, CA 92359. (714) 794-3792. $250.

A static meter that fits the shirt pocket and weighs only 8 oz is designed for simple one-hand operation. The meter reads the static charge on test surfaces without touching them, showing both polarity and charge in kV. Tote boxes, clothing, and the skin of ungrounded personnel can be checked to prevent electrostatic damage to ICs.

CIRCLE NO. 340

Announcing the first major advance in magnetic shielding in 50 years.



METSHIELD™ Fabric

...the first magnetic shielding product made from METGLAS® alloys. METSHIELD fabric can be handled and shaped without performance degradation.

The time is right for a revolutionary concept in magnetic shielding.

Increased sales of electronic equipment, a trend toward miniaturization, and intensified regulatory considerations have put increased emphasis on electromagnetic compatibility.

Consequently, electronics manufacturers need cost-effective magnetic shielding not plagued by fabrication problems and use limitations associated with conventional nickel alloys.

Now you have such a shielding. It's METSHIELD™ magnetic shielding fabric—a wholly new flexible product made from Allied Chemical's METGLAS® amorphous metal alloys.

Because of its exceptional strength and flexibility, METSHIELD fabric retains its full shielding effectiveness during fabrication and use.

This reliability of performance—plus the ease with which METSHIELD fabric can be handled and shaped—promises you a significant reduction in the overall cost of shielding.

You can use METSHIELD fabric for a variety of applications, including cathode ray, photomultiplier, vidicon, and image tubes.

To find out how METSHIELD fabric can help solve your shielding problems, phone John Dismukes at 201-455-4031 or Jack Thorp at 201-455-3306. Or send in the coupon.

Send me information on METGLAS® alloys and METSHIELD™ fabric.

Name/Title__________

Company__________

City/State/Zip__________

Mail to: Metglas Products, Allied Chemical Corporation
7 Vreeland Road, Florham Park, NJ 07932

Allied Chemical
Metglas Products

CIRCLE NUMBER 62

PACKAGING & MATERIALS

Are you using LCDs? Then mount a Zebra!

Tecknit Corp., 129 Dermody St., Cranford, NJ 07016. R. Ventimiglia (201) 272-5500. $1.20 (5000); 2 wks.

Mounting LCDs at a right angle to PC boards is a snap with a Zebra connector assembly. It consists of a dielectric holder with a metal clip and a Zebra 1010 Elastomeric Connector. The Zebra 1010 is made of alternating layers of conductive and nonconductive silicone rubber and makes 50 electrical contacts per inch. You position it in the holder, place an LCD of up to 2.760 in. length in the holder, and secure it with the metal clip. The assembly is then bolted to the PC board without any soldering; it provides an environmental seal and protection against shock and vibration.

CIRCLE NO. 341

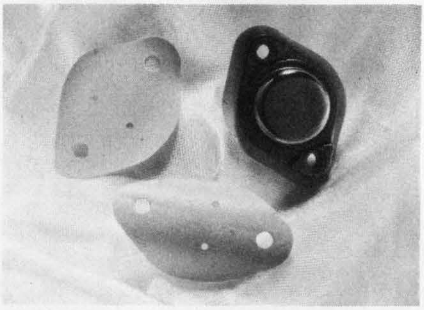
Potting compound resists fires

Transene Co., Route One, Rowley, MA 01969. (617) 948-2501. $5/lb (qty).

THERMASIL-Type II fire-resistant potting and encapsulation compound has a high thermal conductivity and is recommended as a protective encapsulant or conformal coating for electronic circuits and components that operate at high power levels. Type II is formulated as a two-part system that cures at low temperature or cures rapidly at elevated temperatures. Operating temperature range is −50 to +250-C continuous.

CIRCLE NO. 342

Thermal conductor needs no grease



Chomerics, 77 Dragon Court, Woburn, MA 01801. Kevin Dunne (617) 935-4850.

Cho-Therm-R is a family of thermally conductive, electrically isolating silicone materials reinforced with glass cloth to resist tears and punctures. The material is available in three grades to provide thermal-transfer equivalents ranging from that of greased mica to greased beryllium, but Cho-Therm-R does not require grease.

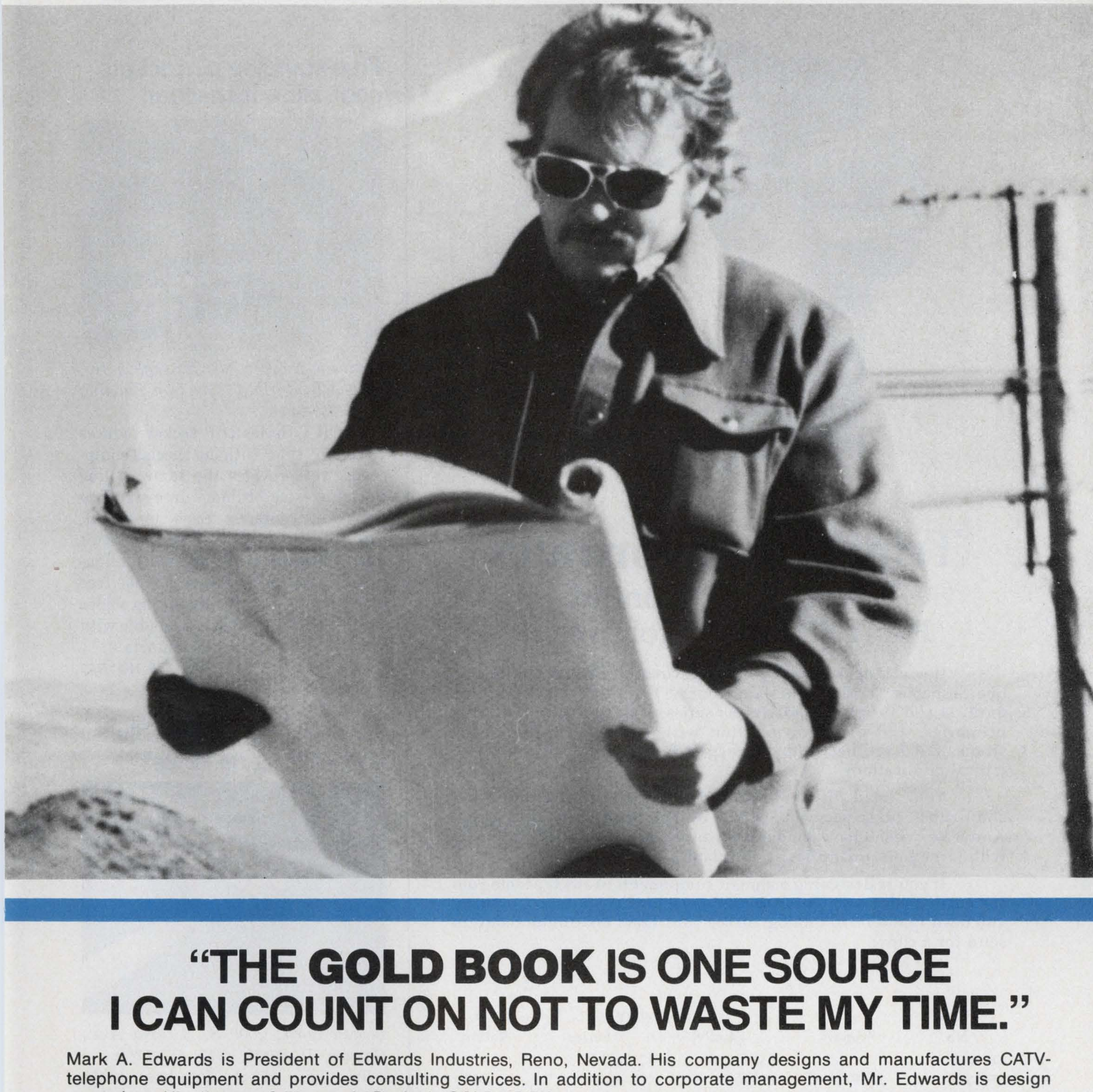
CIRCLE NO. 343

Axial fan helps you save energy

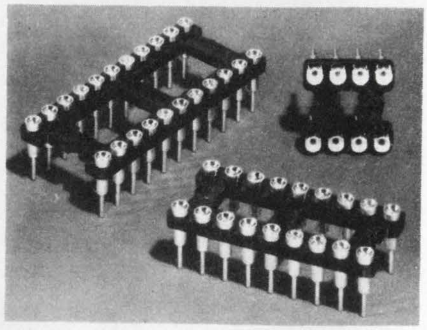
Howard Industries, One North Dixie Highway, Milford, IL 60953. L. Lewis (815) 889-4105. $30 (unit qty); stock-14 wks.

10-in. axial fans of the 5-50-series deliver from 590 ft^3/min at zero static pressure to 55 ft^3/min at 0.35 static pressure and draw approximately 0.35 A—half as much as comparable fans. This ball bearing equipped fan is powered by a permanent split-capacitor motor, rather than the normally used, less efficient, shaded pole motor. Available with solder terminals or cord sets.

CIRCLE NO. 344



Free-standing pinsockets cool, allow inspection

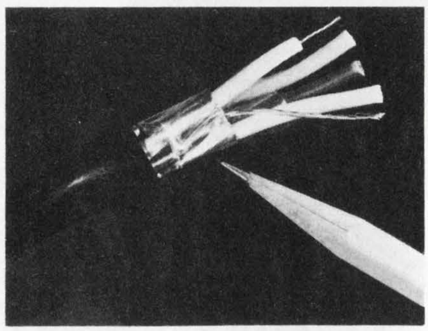


Robinson-Nugent, 800 E. Eighth St., New Albany, IN 47150. Don Fleming (812) 945-0211.

The ICT Series DIP socket reduces assembly time without special equipment, yet provides the same cooling advantages as ordinary free-standing pinsocket contacts. Each pinsocket, precisely set in a carrier, ends difficult and time-consuming assembly alignment. Also, each socket stands free above the PC board, simplifying solder inspection. The socket is available with from 8 to 40 pinsocket contacts.

CIRCLE NO. 345

Two-pair data bus cable carries long distances



Belden Corp., 2000 S. Batavia Ave., Geneva, IL 60134. (312) 565-1200.

Two-pair 150-Ω data-bus cable, YRS-15250, carries data over long distances. The twisted pairs in an overall Duofoil (aluminum-polyester-aluminum laminate) shield are covered with a black polyvinylchloride jacket. Shield termination, a 22-gauge stranded tinned-copper drain wire, is kept in constant contact with the shield. Overall cable diameter is 0.42 in. Capacitance between a conductor pair is 9 pF/ft, and attenuation is 1 dB/100 ft at 10 MHz. The cable complies with UL Style No. 2772.

CIRCLE NO. 346

BIPOLAR MEMORIES

FAIRCHILD INTRODUCES PLASTIC PROMS THAT WILL LIVE TO A RIPE OLD AGE.

While many of our competitors are still trying to figure out how to put PROMs in plastic, we've taken another giant step forward: Plastic packages with silicon nitride protection to make the longest lasting PROMs in the industry about six times longer lasting.

That's because silicon nitride inhibits latent device failure by holding out moisture and ionic contamination. In fact, in accelerated tests such as biased 85/85, MTBF on industry standard plastic PROMs was 2,000 hours, while MTBF on our plastic PROMs was 13,000 hours. And, in the real world of systems applications, they're equivalent to hermetic packages.

WE HOLD ALL THE RECORDS FOR FAST.

For all their reliability, Fairchild PROMs don't sacrifice a nanosecond in speed. They're still the fastest on the market. Up to 30% faster than most.

And the simplest to program. The breadth of our line pretty much speaks for itself, so we'll let it:

PROM Part No.	Organization	Output	0-70°C T_{AA}
93417	256 x 4	OC	45 ns
93427	256 x 4	3S	45 ns
93436	512 x 4	OC	50 ns
93446	512 x 4	3S	50 ns
93438	512 x 8	OC	55 ns
93448	512 x 8	3S	55 ns
93452	1024 x 4	OC	55 ns
93453	1024 x 4	3S	55 ns

STEP RIGHT UP, THERE'S NO WAITING.

If you need fast, reliable, simple-to-program PROMs, and you need them now, you're in luck. Because all ours are available now.

To place an order, or to learn more, write or call your Fairchild sales office, distributor or representative today. Or use the direct line at the bottom of this ad to call our BIPOLAR MEMORY people direct. Fairchild Camera and Instrument Corporation, 464 Ellis St., Mountain View, California 94042. Tel: (415) 962-3951. TWX: 910-373-1227.

FAIRCHILD

CALL US ON IT. (415) 962-3951

CIRCLE NUMBER 66

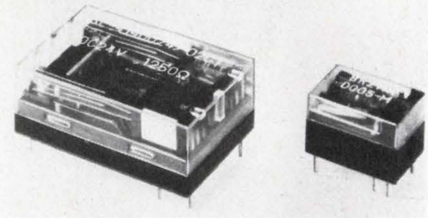
LEDs directly replace phone incandescents

Data Display Products, P.O. Box 91072, Los Angeles, CA 90009. (213) 677-6166. $0.80 (OEM qty.); stock to 6 wks.

The first LEDs that directly replace incandescent lights in standard telephone pushbutton sockets, type 55BS, are mounted in a short No. 5 base. They are produced in red, amber and green. With a drive current of 20 mA, output is typically 50 mcd (red), 35 mcd (amber) and 24 mcd (green) with clear tinted encapsulation. Diffusive encapsulation also is available. A built-in resistor allows operation from 5 to 48 V dc. For ac operation over 12 V, a built-in rectifier is used. The cathode is marked with a green dot; however, units with built-in resistors are not damaged if they are operated momentarily in the wrong direction.

CIRCLE NO. 347

Relays show low profile for PC-board mounting

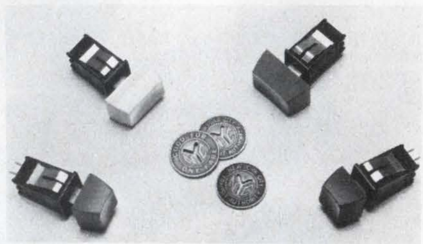


Impact Electrical Products, Inc., 7 Westchester Plaza, Elmsford, NY 10523. Harry Hopper (914) 592-2880. $1.96 (1000 qty.).

Low-profile PC-board relays, less than 0.5-in. high, feature bifurcated contacts, a life of more than 1-million operations at 1 A, 30 V dc and a mechanical life of more than 30-million operations. The relays are available as DPDT and 4PDT and consume low power—approximately 0.45 W for DPDT and 0.6 W for 4PDT.

CIRCLE NO. 348

Modular PB switches employ reed contacts

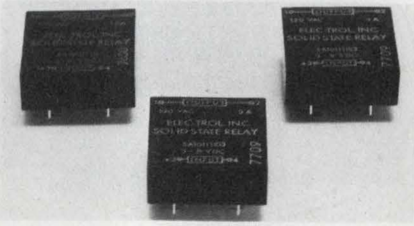


Dialight, 203 Harrison Pl., Brooklyn, NY 11237. (212) 497-7600. $1.10 (1000 up); stock.

Modular pushbutton reed switches, the 541 Series, are designed for reliability and long life with electrical characteristics especially suited to interface semiconductor circuits. A reed element is hermetically sealed in a capsule to isolate contacts from contamination. For impact and vibration resistance, the switches are resiliently mounted in a high-impact glass-reinforced plastic housing, and all internal connections are welded. Electrical specifications include 50-V-dc max. at 20 mA max. of switched current, resistive load; 1000-MΩ min. insulation resistance; and initial contact resistance 0.5 Ω max., rising to no more than 1.25 Ω at the end of switch life. Contact configurations is SPST NO. Terminals are designed for PC boards, wire-wrapping or hand soldering.

CIRCLE NO. 349

PC-mountable SS relay receives UL recognition

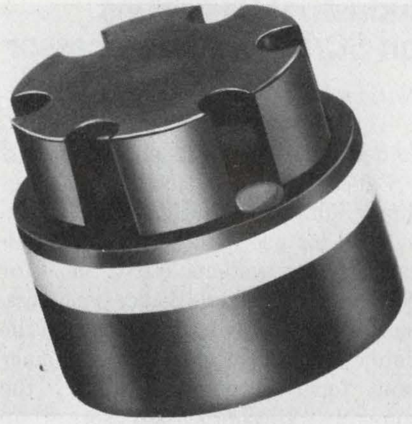


Elec-Trol, Inc., 26477 N. Golden Valley Rd., Saugus, CA 91350. (213) 788-7292. $5.79: 3 A, 120 V (1000 qty); 6 to 8 wks.

Miniature solid-state relays, Model SA 1011 series, have received UL recognition, Bulletin 508 under file E-58275. With a small "footprint"—only 1.27 in.^{2}—they can still switch up to 3 A at 120 or 240 V ac with 3-to-8, 8-to-18 or 18-to-32-V-dc inputs. The units offer zero-crossover switching, photoisolation, total epoxy encapsulation, IC compatibility, long life and immunity to shock and vibration.

CIRCLE NO. 350

Smoke detector senses with two ion chambers



Electrometer Corp., 600 Sonora Ave., Glendale, CA 91201. (213) 240-2010.

Battery-operated type DSID smoke detectors trigger alarms when smoke concentrations as low as 1% aerosols enter the chamber. Two ionization chambers—one sealed, the other open to the atmosphere—provide compensation for changes in barometric pressure, temperature, and humidity without giving false alarms. A minute amount of radioactive material ionizes the air in the chambers setting up a current flow when a voltage potential is applied. Smoke entering the chamber neutralizes the ions before they can be collected, causing the current to drop. A buffer amplifier sets off an alarm.

CIRCLE NO. 356

Interface mates LSI-11s to instrument buses

Digital Components Group, One Iron Way, Marlborough, MA 01752. Robert Brick (617) 481-7400. $750; stock.

Connecting up to 15 instruments to an LSI-11 microcomputer, the IBV11-A interface conforms to the IEEE standard 488-1975. The instrument-bus portion of the interface will support a total cable length of 65.6 ft, and is hardware-compatible with any system using the LSI-11 as a component. Contained on a single printed-circuit board assembly, the IBV11 plugs directly into any LSI-11 bus-structured system backplane.

CIRCLE NO. 357

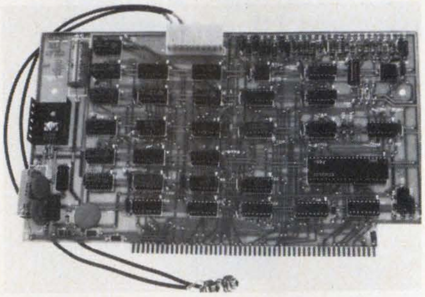
Single-chip μCs come in wide choice of models

Rockwell International, 3310 Miraloma Ave., P.O. Box 3669, Anaheim, CA 92803. (714) 632-3729. Under $10.

Six single-chip microcomputers have become members of the PPS-4/1 family by the Microelectronic Device Division of Rockwell International. Two of the chips, the MM76 and MM78, join the already introduced MM77 single-chip microcomputer. All three are now available. The other four μCs are slated for introduction later this year. On-chip ROM and RAM size is the main differentiating characteristic of the three available microcomputers. The MM76 has a 640 × 8 ROM and a 48 × 4 RAM; the MM77 has a 1344 × 8 ROM and a 96 × 4 RAM; and the MM78 has a 2048 × 8 ROM and a 128 × 4 RAM. Three of the four chips scheduled for volume production later in the year are identical to the MM76 except for minor additions: The MM76C has a high-speed counter (either one 16-bit presettable up/down counter or two 8-bit counters) with 8 control lines; the MM76D features a 12-bit a/d converter and six additional I/O lines; and the MM76E provides an expanded ROM capability of 1024 × 8. An economy single-chip computer, designated the MM75, will be available, too. Identical to the MM76 in ROM and RAM capacity, the MM75 has fewer I/O lines: 22, not 31. And whereas the other five come in 42 or 52-pin quad in-line packages, the MM75 is packaged in a 28-pin DIP.

CIRCLE NO. 358

Cassette interface card mates with 680b bus



MITS, 2450 Alamo S. E., Albuquerque, NM 87106. (505) 243-7821. Contact local distributor; stock.

Designed for use with inexpensive audio-cassette recorders, the 680b KCACR interface board permits mass data storage and retrieval. Using the "Kansas City Standard" for data recording the board fits in the company's 680b microcomputer mainframe (the 680b is a 6800-based machine). Included on the board are a digital demodulator, a motor control circuit and sockets for all ICs.

CIRCLE NO. 359

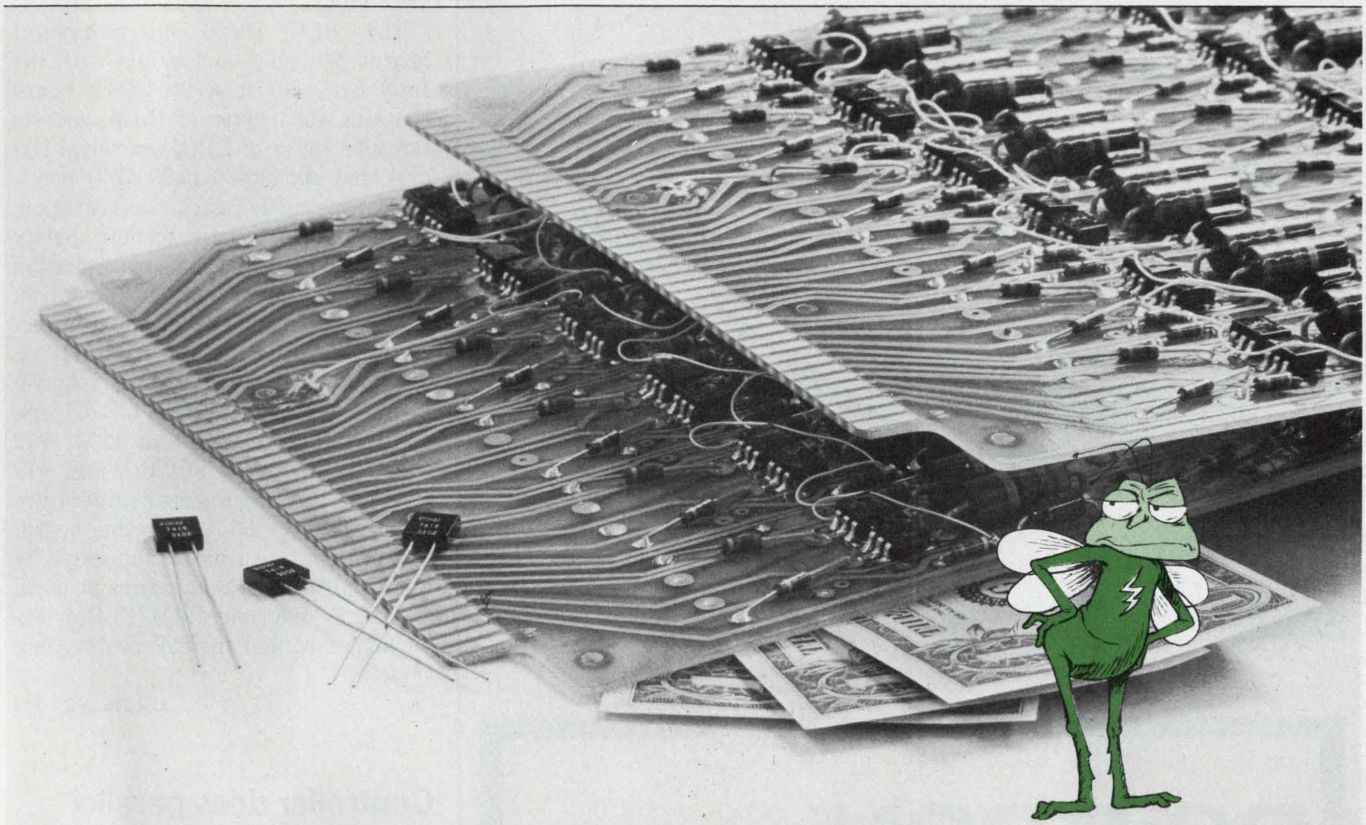
Industrial Basic runs on SC/MP microprocessor

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Phil Roybal (408) 737-5000. See text.

Called NIBL, a microcomputer language similar to Basic, has been developed for use with 8-bit SC/MP microprocessor systems. NIBL, short for National Industrial Basic Language, has been placed, without charge, in the public domain. It is available in paper tape form through Compute, the company's microprocessor users group newsletter. In preparation is a self-teaching manual for NIBL and the SC/MP low-cost development system and a soon-to-be-released NIBL firmware package in ROM. Although NIBL was originally conceived to operate on the SC/MP LCDS, the minimum hardware required to handle NIBL is the SC/MP μP, crystal and support logic; a 110 baud ASCII terminal interface; 4096 × 8 bits of ROM for NIBL; 2048 × 8 bits of RAM user space (allows about 60 average NIBL statements); a teletypewriter or similar terminal and a power supply. Two versions of NIBL are available, one written for the PMOS SC/MP operating with a 2-MHz clock and one for the new NMOS SC/MP II, with a 4-MHz clock.

CIRCLE NO. 360

COULD A $3 RESISTOR SAVE YOU A $300 FIELD SERVICE CALL?



It sure could.

When the equipment you've built fails at the worst possible moment in the field, you may suddenly learn just how expensive a mere resistor can be. You may learn the hard way that the dollar or two you saved at the drawing board has cost you hundreds or even thousands in warranty service. And quite possibly even cost you a customer.

Not every resistance application cries out for Vishay quality. You may often do without this quality and still suffer no dire consequences.

But when you need a precision resistor or trimmer for rock-solid stability and reliability, think of this:

Some precision resistors offer you tight tolerance at the expense of poor frequency response. Others offer low inductance and fast rise at the expense of poor temperature characteristics. Only Vishay Bulk Metal® resistors offer you the *complete set* of top performance characteristics, including TCR as low as 0±1ppm/°C, a combination that will most often free your equipment from that tormenting bug.

And now Vishay offers you the chance to *make your own* custom bulk-metal resistors for breadboard, prototype, or even production use. Call or write for information on the simple calibration and encapsulation of Vishay resistors in your own plant. Vishay Resistive Systems Group, 63 Lincoln Highway, Malvern, PA 19355; phone (215) 644-1300; TWX 510-688-8944.

VISHAY RESISTIVE SYSTEMS GROUP

Only Vishay resistors give you all six top performance specs.

TCR to 0±1ppm/°C	TOLERANCE to .001%	As low as 1-ns RISE TIME— NO INDUCTANCE	TRACKING to ½ ppm/°C	STABILITY to 5 ppm/yr	NO NOISE

©Vishay

6505

CIRCLE NUMBER 70

Microcomputer board fits in SBC 80/10 slots

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Don Schare (408) 737-5000. $265 (100 qty); stock.

The BLC 80/10 microcomputer boards are plug compatible with the Intel SBC 80/10 series. Each board contains 1024 bytes of RAM, sockets for 4096 bytes of PROM, a serial I/O port and six 8-bit parallel I/O ports. Operating mode, data configuration, control characteristic format, parity checks and synchronous transmission rate are all under program control. Easily visible blue jumper plugs select synchronous data rates from 110 to 4800 baud. Maximum supply requirements exclusive of PROM, I/O drivers, and terminators are 5 V at 2.9 A, +12 V at 150 mA, −5 V at 2 mA and −12 V at 150 mA. Operating temperature range is 0 to 55 C for the board. Microcomputer cards are supported by the BLC 016 16-k RAM expansion card, the BLC 406 6-k ROM/PROM expansion card and the 80P prototyping system.

CIRCLE NO. 361

Controller does parallel to serial or vice versa

Fairchild Camera and Instrument, Instrumentation and Systems Group, 1725 Technology Dr., San Jose, CA 95110. Gordon Daggy (408) 998-0123. $595 (one port), $695 (dual port); stock.

The Model 6600 general-purpose interface takes data from a 16-line RS-232C link (eight control lines, nine data lines) and converts them into 8-bit parallel signals. Conversely, the device will take 8-bit parallel data words and convert them to the RS-232C standard. Also operating as a peripheral controller, the 6600 accepts asynchronous commands and generates the required reader or punch on or off, forward or reverse, etc., commands. Front panel controls are used to select the data path to the local terminal or modem, turn on or off the punch or reader, advance or rewind the tape and select a local or remote command mode. Internal switch selection permits speeds up to 9600 bps, parity character, stop bits and character size.

CIRCLE NO. 362

Multibase calculator also has logic functions

Texas Instruments, P.O. Box 5012, Dallas, TX 75222. (214) 238-2011. $49.95; stock.

Called the TI Programmer, the handheld calculator does arithmetic in three different number bases and performs conversions to and from those bases. The number bases include hexadecimal, decimal and octal. The calculator represents negative numbers with a two's-complement code in both the hexadecimal and octal bases. A one's-complement key on the calculator also simplifies working with computers that use one's-complement arithmetic. The calculator can perform bit-by-bit logic operations on numbers in hexadecimal or octal. Included are AND, OR, Exclusive-OR and shift operations.

CIRCLE NO. 363

Development software cuts Z-80 system design

Technical Design Labs, Research Park Bldg. H, 1101 State Rd., Princeton, NJ 08540. Chris Rutkowski (609) 921-0321. $150/program (including manuals), 30 days.

Developed to simplify the writing of Z-80 programs, the Zapple line of μP software is relocatable, and except for the macroassembler, is ROMable (may be placed in ROM and operated from ROM without first being moved into RAM memory). The I/O drivers for all programs are contained only in the monitor program. Thus, once the monitor is configured for any particular hardware I/O configuration, all other programs are immediately compatible with that system. The five software packages are (1) a Zapple Monitor, which occupies 2 k of RAM and offers 27 instructions; (2) a Text Editor, which occupies 3 k of RAM and is both line and character-oriented; (3) a Relocating macroassembler, which occupies 8 k of RAM and can generate fully relocatable object code; (4) Zapple Basic, which occupies 8 k of RAM and, according to the company, packs more command versatility into 8 k than any other Basic ever written; and (5) SCRIPT, a word-processor program that occupies 3 k of RAM or ROM and allows complete word-processing capability, including automatic paging, justification, concatenation, spacing, titling and subtitling.

CIRCLE NO. 364

CIRCLE NUMBER 73

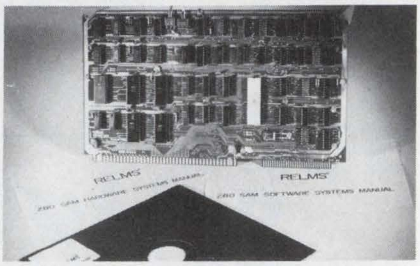
Add-on memory boards support Series 80 micros

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Don Schare (408) 737-5000. Unit qty. prices: $878 (016), $315 (406); stock.

Two plug-compatible memory boards, the BLC 016 and BLC 406, provide memory expansion for any Series/80 microcomputer. The BLC 016 contains 16 k × 8 of RAM with built-in refreshing. Typical read cycle times are 735 ns; write cycle times are 1360 ns. The refresh cycle requires 735 ns. Maximum power requirements for the RAM board are 5 V at 1.5 A, 12 V at 1 A and −5 V at 3.2 mA. The BLC 406 has 24 sockets for up to 6 k × 8 of UV PROM or mask ROM. Switches and plug-programmable jumper terminals set independent base addresses for 2-kbyte blocks and a 4-kbyte block at any 2-kbyte boundary. Other switches enable or disable memory blocks and set access times from 1 μs to 2.5 μs.

CIRCLE NO. 365

Microcomputer adapter upgrades 8080 to Z80

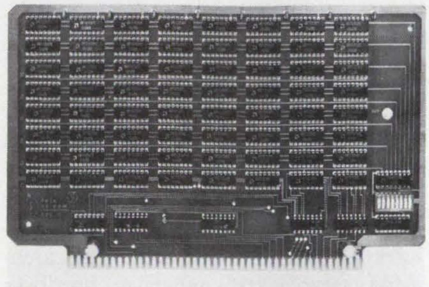


Relational Memory Systems, P. O. Box 6714, Santa Clara, CA 95150. Douglas Kelley (408) 248-6356. $1495; stock.

The Z80-SAM adapter module can update any MDS-800 development system from the 8080 or 8085 to the Z80. Besides the hardware board, a Z80-SAM system monitor in firmware PROM replaces corresponding MDS-800 ROM firmware (on monitor ROM board). Software consists of a 16-k DOS assembler and a 32-k DOS assembler. The Z80 SAM assembler operates four times as fast as the 8080 assembler on the MDS-800. Moreover, the user can patch Z80 code into existing 8080 code.

CIRCLE NO. 366

Static RAM board holds 8 k, accesses in 530 ns



Creative Micro Systems, 6773 Westminster Ave., Westminster, CA 92683. (714) 892-2859. $210 (100 qty); stock.

A fully static RAM board, the 9626, holds 8 kbytes of storage and is compatible with Motorola's EXORciser and Micromodule bus. The RAM card has an access speed of 530 ns, maximum, a power dissipation of 8.5 W, maximum, and a switch selectable operating region. Also compatible with Motorola's MEK6800D1 and D2 systems, the card has full 16-bit address decoding and requires a 5-V supply. The card measures 9.75 × 6.05 × 0.6 in. and operates over 0 to 70 C.

CIRCLE NO. 367

Power supplies.

The HE200 Series Power Supplies offer the design engineer a low-cost, highly efficient alternative to the size, weight and heat generation problems normally associated with series-pass regulated supplies. Using state-of-the-art switching techniques and CMOS logic, the HE200 Series Supplies achieve 75% efficiency at full load.

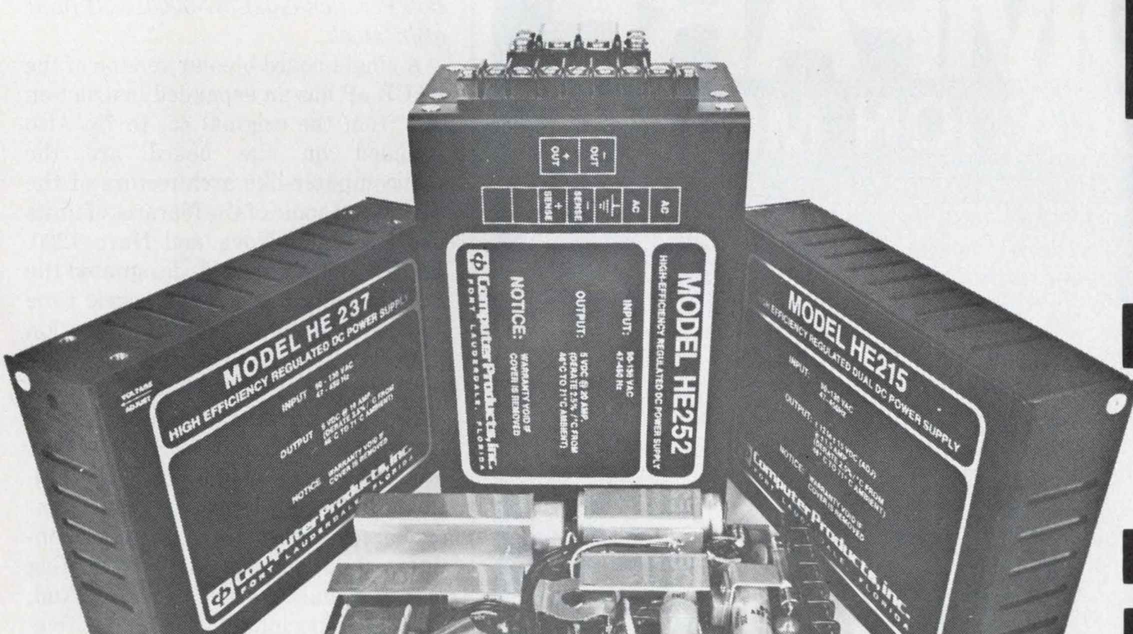
All models in the HE200 Series have the "footprint" and mounting dimensions of the Lambda package size "B" supplies... a feature that allows the engineer to experiment with high-efficiency techniques in existing designs. In new designs, the engineer can take advantage of the small size (1.2 watts per cubic inch) and light weight (½ ounce per watt) of the HE200 Series Supplies.

The highly reliable HE200 Series Supplies are all short-circuit proof, over-voltage protected, available in 115 and 230 VAC input models, and backed by a full two-year warranty.

Finally, the HE200 Series offers the design engineer considerable savings: 5 volts, 10 amps for $195; 5 volts, 20 amps for $295; and ±15 volts, 1.5 amps for $195 in single quantities.

Computer Products, inc.

Distributors: Los Angeles 213-877-5518/ Dallas: 214-341-8311 • Houston: 713-780-2220



High-Efficiency

1400 N.W. 70th Street, Fort Lauderdale, Florida 33309 (305) 974-5500, TWX (510) 956-9895

CIRCLE NUMBER 75

Dual floppy-disc system mates to EXORciser bus

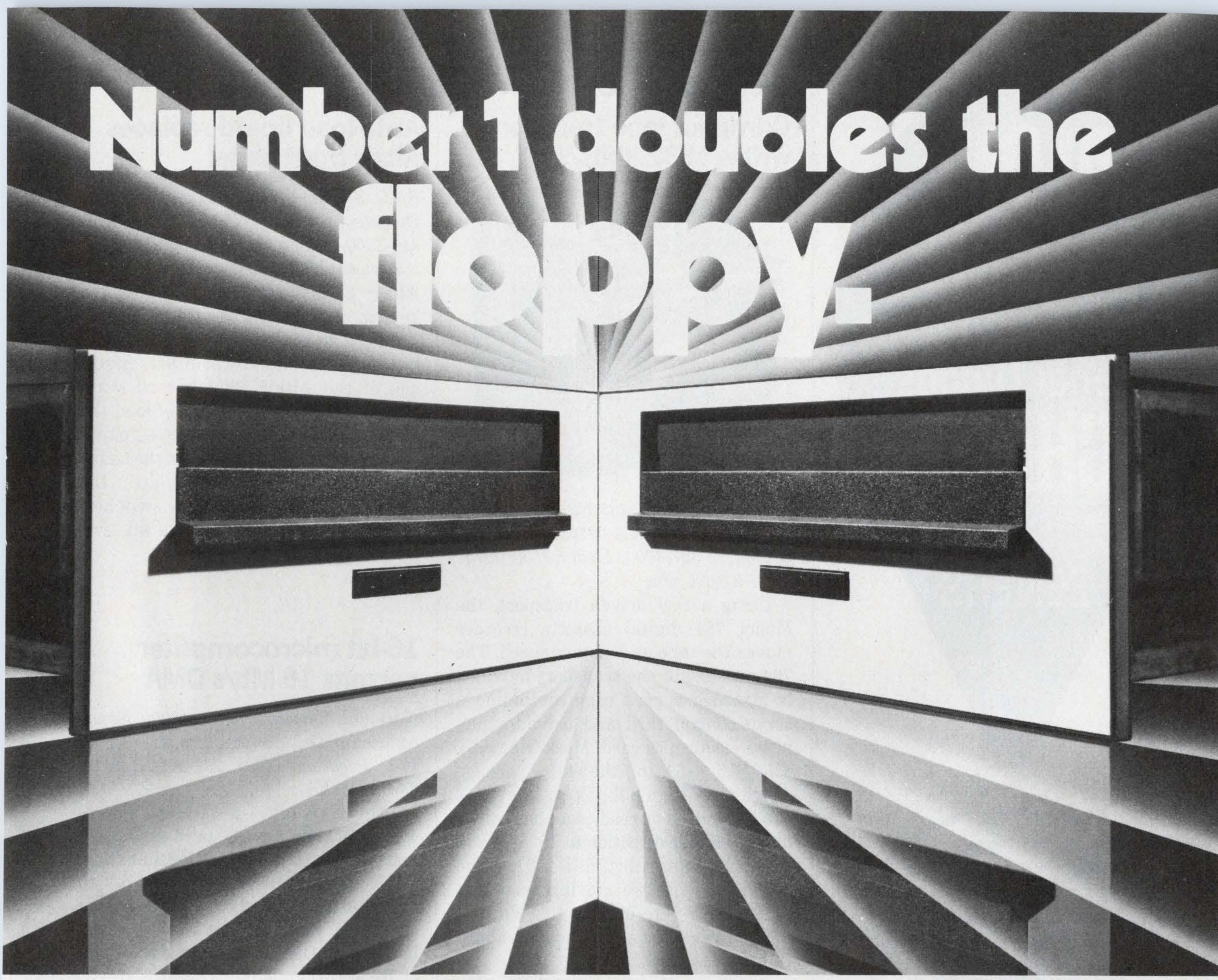
Motorola Microsystems, P.O. Box 2094, Phoenix, AZ 85036. (602) 244-6900. $3300; stock.

A floppy-disc system, the EXORdisk II, consists of a dual side-by-side diskette drive unit. Included with the drive is a controller module, a software package called MDOS (Motorla disc operating system), a cable assembly and support documentation. The controller module is bus-compatible with an EXORciser or a Micromodule-based system. Data recording format is compatible with the IBM 3740 format. Intended for tabletop use, or optionally, for rack-mounted installation, the drive units are available for either 110-V-ac, 60-Hz or 220-V-ac, 50-Hz operation. Random or sequential file organization is permissible with MDOS, as is multiple I/O file activity. Eighteen MDOS commands provide the user with a comprehensive means to rapidly develop or modify software. **CIRCLE NO. 368**

Bipolar PACE equivalent offers 30 extra commands

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Bob Pecotich (408) 737-5000. $831 (unit qty); stock.

A single-board bipolar version of the PACE μP has an expanded instruction set, from the original 45, to 75. Also included on the board are the minicomputer-like architecture of the PACE and some of the features of units like the Micro-Nova and Nova 1200. The 8.5 × 11-in. board, designated the IPS-16C/100, has a 220-ns cycle time and an average instruction execution interval of 1 ns. On the board are a 16-bit address bus and a separate 16-bit bidirectional data bus. Among the new instructions added to the Super-PACE are double word/double precision, multiply, divide, block transfers and memory search. Interface signals, jump condition input signals and control flag output signals are also provided. And, for easier peripheral control, a five-level priority vectored interrupt structure with enable and disable features has also been added. The CPU board comes supported by memory and peripheral boards as well as software and programming aids. **CIRCLE NO. 369**



Doubled data storage capacity. Doubled access speed. Doubled floppy media selection. Get it all with the new Shugart double-sided single/double density floppy disk drive. All this for only 25% more than a single-sided floppy.

Data. Data. The new SA850 double-sided floppy packs twice as much data as a standard unit—up to 1600 Kbytes (unformatted). Yet the SA850 is identical in physical interface, mechanical outline and package size to the industry-standard—our SA800/801. It's plug-compatible, cabinet-compatible.

Faster. Faster. Access time is more than twice as fast. The SA850 moves from track-to-track in 3 milliseconds, with an average access time of less than 100 milliseconds. The secret is a proprietary Fasflex™ actuator that delivers positive, low-friction head movement.

Media. Media. One drive reads and writes them all. Single or double density. Single or double-sided disks. Industry standard diskettes and IBM Diskette 2, too.

Features. Features. The head carriage assembly allows loading of the two read/write heads simultaneously on both sides of the disk. (No more head load pads!) Plus this head can be replaced without an alignment disk, scope, or special tool—and it's totally self-aligning.

Lower heat dissipation and better PCB packaging promise even better reliability. A new I/O controlled programmable door lock strengthens data security.

And there's more, more. So before you look at another floppy, see the SA850 twice. See it in our brochure. Then watch it perform in a demonstration with your own system.

The SA850. The doubled floppy from number 1.

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Eastern Region Sales/Service –
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Phone (408) 252-6860
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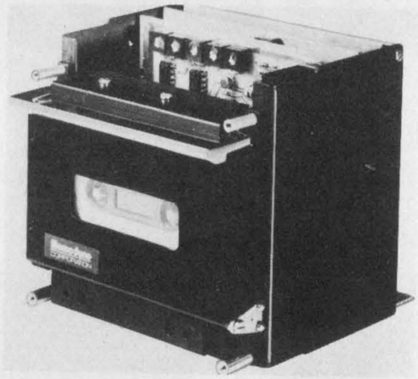
94588 Rungis, France Phone (1) 686-00-85

Number 1 in low cost disk storage.

Shugart Associates

CIRCLE NUMBER 78

Compact tape transport writes at 32 kbits/s



Memodyne Corp., 385 Elliot St., Newton Upper Falls, MA 02164. Kevin Corbett (617) 527-6600. Under $500 (large qty); 2 to 4 wks.

Using a reel driven transport, the Model 764 digital cassette recorder moves the tape at constant speed. The 764 consists of the transport to which is attached a card cage containing a servo control card and a read-while-write electronics card. Measuring only 4.75 × 5 × 5.2 in., the entire package weighs less than 3 lb. Up to 32 kbits/s can be written or read, searches can be done in either direction at 100 ips, and the start-stop-settle time is 200 ms. The drive has only two moving parts and a soft-error rate of 1 in 10^7. Up to 5 × 10^6 bits can be stored on a standard Philips cassette.

CIRCLE NO. 370

PROM/RAM board holds 1 k RAM & 2 k of PROM

Vector Graphic, 717 Lakefield Rd., Suite F, Westlake Village, CA 91361. Carole Ely (805) 497-0733. See text.

Able to hold 1024 bytes of RAM and 2048 bytes of PROM, the PROM/RAM board is compatible with microcomputers using the Altair bus structure. The PROM sockets are laid out for 1702A memories, which can be used to hold monitors, bootstrap loaders and video drivers. A jump-on-reset feature permits a PROM program to be executed at any location in memory without interfering with any other portion of memory. The board has its own regulators, and has optional firmware available for use with Altair, Imsai or Polymorphic I/O boards. Available from stock, the PROM/RAM board costs start at $89 as a kit without the PROMs and goes to $199, maximum (assembled), including PROMs.

CIRCLE NO. 371

Auto-load board replaces Altair front panel

RMQ Systems, 1044 University Ave., Berkeley, CA 94710. Pete Roberts (415) 845-5300. From $165 (kit); stock.

An auto-load board, compatible with Altair 8800 systems, eliminates the keying in of bootstrap programs and the need to reset sense switches. The board, called the Power-Start, fits in one of the Altair 100-pin card slots. Once set it can automatically load the computer from disc, cassette, paper tape, or any other devices. On the board are switches that simulate the computer's front panel sense switches.

CIRCLE NO. 372

16-bit microcomputer permits 16 Mb/s DMA

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Bob Pecotich (408) 737-5000. From $825; stock.

The IMP-16L, a 16-bit microcomputer, has a high-speed asynchronous bus and data controller that allow DMA data transfers at rates to 16 Mb/s. Fully assembled, the microcomputer includes an IMP-16 CPU board with DMA control, 4 k × 16 bits of RAM (expandable to 64 k), a standard TTY interface module and complete program control panel. Optional cards provide interfaces for a Centronics 306 printer, a Documation 300 card reader and a National IMP-16/805 PROM programmer card. The microcomputer has 60 general-purpose instructions which include single-word commands such as multiply, divide, double precision add, double-precision subtract and many bit or byte oriented instructions. With a 1.4-μs microcycle time, the IMP-16L has typical register-to-register addition times of 8.4 μs. A DMA transfer requires 1.05 μs. Software support includes CPU, memory and peripheral diagnostic routines; software Debug, resident assembler; IMP-16 to Pace or SC/MP cross assemblers; absolute and linking loaders; and an IMP/Fortran cross assembler. The 12 × 17 × 24-in. unit has 12 slots for CPU, memory and interface cards and requires 105 to 125 V at 60 Hz. For expansion, additional six-slot card cages may be installed.

CIRCLE NO. 373

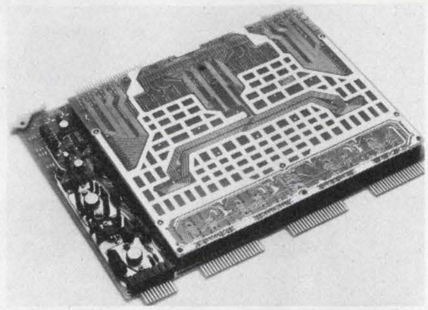
Upgrade SC/MP systems with SC/MP-II μP

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Hashmukh Patel (408) 737-5000. $18.50 (unit qty.); stock.

A retrofit kit for owners of the PMOS SC/MP kit permits an upgrade to the NMOS SC/MP II. The NMOS processor requires only a +5-V supply, and operates at twice the speed. Power dissipation is just 200 mW and because of the +5-V operation, the SC/MP-II can be easily interfaced to other logic families. The retrofit kit includes the SC/MP-II CPU, a 2-MHz crystal, a users manual, an applications handbook and a SC/MP-II data sheet.

CIRCLE NO. 374

Core memory board mates with PACE μP system



Electronic Memories & Magnetics, 12621 Chadron Ave., Hawthorne, CA 90250. Lawrence Treglia (213) 644-9881. $895 (50 to 100 qty); 45 to 60 days.

A core memory system, the Micro 3800, interfaces with National Semiconductor's PACE μP. It is intended for applications where nonvolatile memory is required. Holding 8 k × 16 bits of RAM, the system has all timing, control, decode/drive circuitry, and address/data registers on an 8.5 × 11-in. card designed to mount on 0.75-in. centers. The memory system has a 400-ns access time, and operates from unregulated ±15 and +5-V supplies. Worst-case power consumption is less than 40 W, and standby power is under 10 W. The memory operates over 0 to 50 C without any performance degradation.

CIRCLE NO. 375

Microcomputer system permits modular design

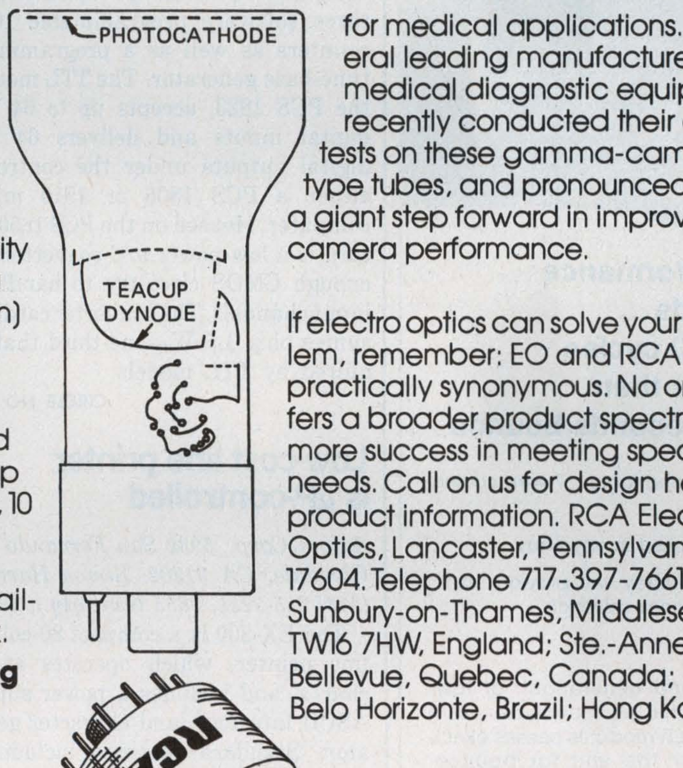
Omnibyte Corp., 900 Jorie Blvd., Suite 192, Oak Brook, IL 60521. (312) 986-1401. From $80 to $595 for cards, $5500 for full system; stock.

Available either as individual cards or housed in a system crate, the Omnibyte series of microcomputer products are based around the 6800 microprocessor. The system crate has 16 card slots and requires an external supply. Cards for the system include the CPU card, the crate controller card, a ROM/RAM card, a PIA card, an ACIA card and a breadboard card. Soon to come are a 16-channel data-acquisition card, a PROM programmer card (for 2708 or 2704 PROMs), an 8-k RAM card and a quad 8-bit d/a converter card. Also available is a dual floppy-disc subsystem and Omnibug—a TTY monitor routine. All cards measure 4.5 × 6.5 in. and the crate size is 5.2 × 10.27 × 8.58 in.

CIRCLE NO. 376

Opening new frontiers with electro optics

PMT with big new "teacup" dynode gives scintillation counters better PHR.



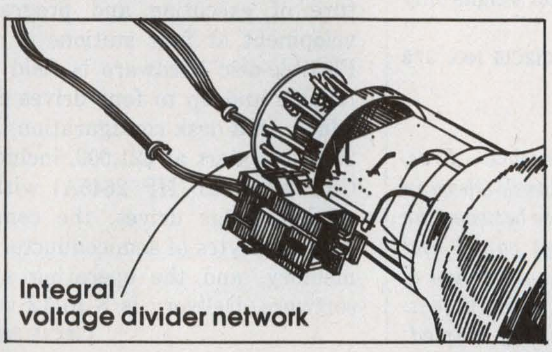
We expect quite a tempest over this teacup. It's a radically different RCA approach to large-diameter PMT's: The teacup is a large, cup-shaped first dynode that is an improvement over conventional venetian-blind types. It has better spatial uniformity and better off-axis uniformity. As a result, PHR (Pulse Height Resolution) is improved by 0.3% for Cs^{137} [NaI (Tl)] and 0.7% for Co^{57} [NaI (Tl)].

RCA 4900 is the first in a whole new family of 2" to 5" circular and hexagonal face PMT's with teacup first dynodes. It has a 3" diameter, 10 stages, and "blue" cathode responsivity of 10 μA/blue lm minimum, 10.5 μA/blue lm typical. Available with voltage divider network.

High performance in exacting applications

Besides scintillation counting, the teacup PMT can also be useful in gamma ray spectroscopy for medical applications. Several leading manufacturers of medical diagnostic equipment recently conducted their own tests on these gamma-camera type tubes, and pronounced them a giant step forward in improving camera performance.

If electro optics can solve your problem, remember: EO and RCA are practically synonymous. No one offers a broader product spectrum. Or more success in meeting special needs. Call on us for design help or product information. RCA Electro Optics, Lancaster, Pennsylvania 17604. Telephone 717-397-7661. Sunbury-on-Thames, Middlesex TW16 7HW, England; Ste.-Anne-de-Bellevue, Quebec, Canada; Belo Horizonte, Brazil; Hong Kong.



RCA

CIRCLE NUMBER 82

Interface cards simplify connections

Process Computer Systems, 5467 Hill 23 Dr., Flint, MI 48507. Gary Johnson (313) 767-8920. From $285; stock.

A line of I/O modules has been developed to simplify interfaces for the 180 microcomputer series. The PCS 1804 ac/dc card accepts up to eight ac inputs and eight high-level digital inputs. It provides optical isolation and delivers eight ac outputs and eight high-level digital outputs. Up to 32 digital inputs are accepted and 16 digital outputs controlled by either a PCS 1806 or 1810 microcomputer are delivered by the PCS 1820 multi-function card. It also accepts up to eight priority-interrupt inputs and has three software programmable 16-bit counters as well as a programmable time-base generator. The TTL module, the PCS 1823, accepts up to 64 TTL digital inputs and delivers 64 TTL digital outputs under the control of either a PCS 1806 or 1810 microcomputer. Housed on the PCS 1850 a/d card is a low-power a/d converter and enough CMOS circuitry to handle 16 input channels. The converter card consumes only 1.5 W—one-third that required by TTL models.

CIRCLE NO. 377

Low-cost line printer is μP-controlled

Axiom Corp., 5932 San Fernando Rd., Glendale, CA 91202. Simon Harrison (213) 245-9244. $655 (unit qty.); 4 wks.

The EX-800 is a compact 80-column line printer, which operates at 160 char/s, and includes a power supply, ASCII interface, and character generator. Standard features include infrared low-paper detector, bell, 96-character ASCII set, programmable character size, built-in μP self-tester and multiline asynchronous input buffer. The EX-800 prints on a 5-in. wide electrosensitive paper, and weighs only 12 lb.

CIRCLE NO. 378

Filler

We learn from Czeslaw Frac, Diploma Engineer of Gdansk-Oliwa in Poland, that the difference between the one-humped (dromedary) camel and the two-humped (Bactrian) version is simply a matter of coupling coefficient. The former is undercritically coupled.

6502 resident assembler package comes in 2 ROMs

Microcomputer Associates, 2589 Scott Blvd., Santa Clara CA 95050. Darrell Crow (408) 247-8940. $200 (ROM), $295 (PROM); 30 days.

Stored in two 2 k × 8 ROMs, the SW101 RAP resident assembler program and a tiny Basic interpretive program are both designed to run on the 6502 μP. Formerly contained in seven 1702A PROMs, the SW200 RAP is claimed to be the only single-pass resident 6502 assembler available. Statements are entered either from paper tape or directly from a terminal keyboard. RAP generates a listing and places object code into RAM for immediate execution. A minimum of 4 k × 8 RAM is needed. Following assembly the programs can be debugged using the debugging facilities of DEMON, the company's DE-bug MONitor program, housed in the 1 k ROM section of an optional ROM/RAM-I/O-interval timer circuit.

CIRCLE NO. 379

Mini with resident OS handles up to 608 kbytes

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1501. See text.

With a new operating system resident in main memory, rather than disc, the HP/1000 Model 20 is compatible with the disc systems but has a starting price of $20,000 instead of $35,000. RTE-M, the operating system for Model 20, uses calls and file structure identical with those of RTE-II and RTE-III, the disc-based systems used in larger models. The Model 20 is available with main semiconductor memory up to 608 kbytes and can support concurrent program execution and program development on four terminals or more. With the addition of the flexible disc, the system will handle any mixture of execution and program-development at four stations or more. Flexible-disc hardware is field retrofittable and up to four drives can be added. In a desk configuration, Model 20 prices start at $21,000, including a CRT terminal (HP 2645A) with two mini-cartridge drives, the computer with 64 kbytes of semiconductor main memory, and the operating system software. Delivery is 8 to 12 weeks.

CIRCLE NO. 380

Same great name. Same great color.

And now a neat new way to definitive display performance.

DOT MATRIX

Consider the new Noritake-Ise dot-matrix line-up—9, 10, 16, 20 and 40-character line displays. Variety aimed at giving you more design potential. Or consider our unique 400-dot graphics display with 17m/m depth and low 35V drive rating. It's aimed at helping you think low voltage, portability and economy all at the same time.

In short, consider Noritake-Ise period for dot matrix (or segmental) displays. Itrons always help you design more competitively.

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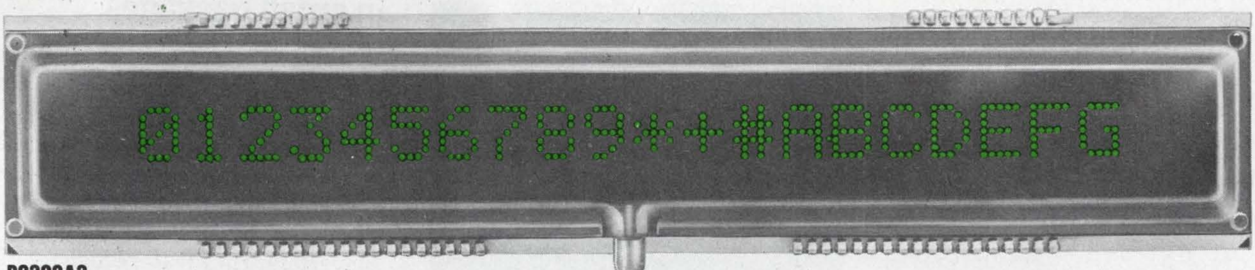
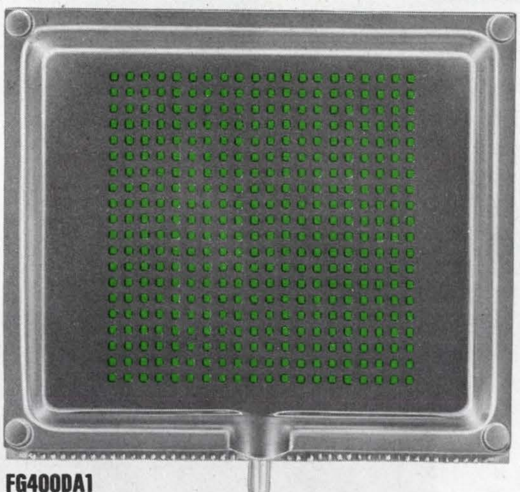
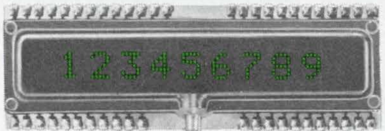


DC209A2
Dimension: 41(H)×208(W)×10.5(D)mm Character Size: 9.0(H)×6.3(W)mm

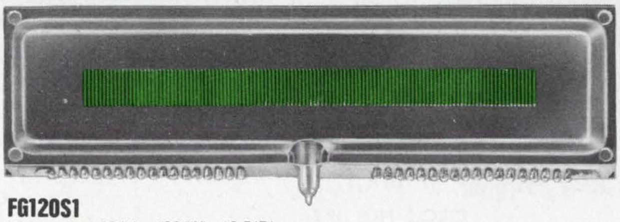


FG400DA1
Dimension: 114(H)×130(W)×17(D)mm

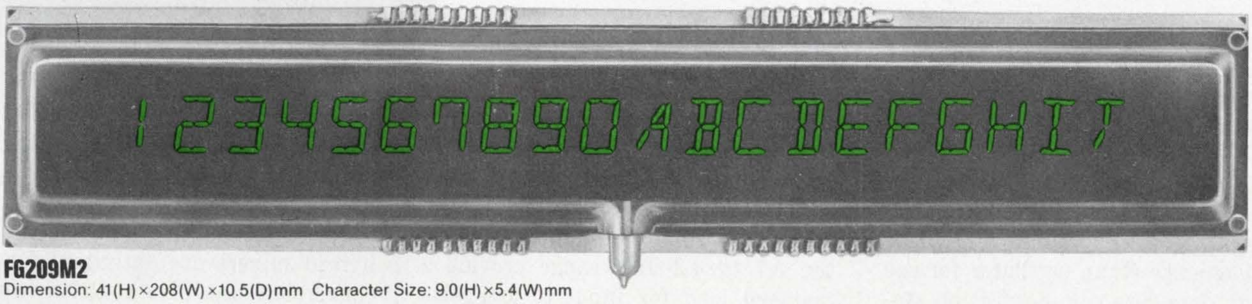


DC95A2
Dimension:
24(H)×75(W)×7.2(D)mm
Character Size:
5.05(H)×3.55(W)mm

FG48D6
Dimension:
25.5(H)×56.5(W)×7(D)mm
Character Size:
8.0(H)×4.2(W)mm



FG120S1
Dimension: 39(H)×138(W)×12.5(D)mm



FG209M2
Dimension: 41(H)×208(W)×10.5(D)mm Character Size: 9.0(H)×5.4(W)mm

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Electronics Division
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Telex: J59738 NORITAKE

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Karlstrasse 55, F.R. Germany
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Telex: 522106

U.K.
ITT Component Service
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Telex: 21637

Hong Kong
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24-26 Stanley Street, Hong Kong
Phone: 5-232420 Telex: HX83151
Taipei
72-9 SEC 2, JEN AI RD., Taipei
Phone: 351-0293 Telex: 11176

Manufacturer:
ISE ELECTRONICS CORP.
P.O. Box 46, Ise-shi, Mie-Pref., Japan
Phone: (05963) 5-2121 to 4
Telex: 4969523

CIRCLE NUMBER 84

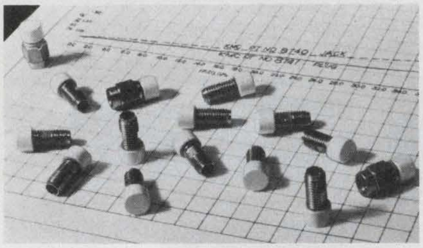
Fiber-optic data link bridges up to 2 km

Meret, Inc., 1815 24th St., Santa Monica, CA 90404. (213) 828-7496.

By combining a high-performance infrared LED with a low-noise receiver, the MDL4577-SF transmitter/receiver communicates digital data over 2 km. The receiver uses a transimpedance amplifier and a voltage comparator for TTL-compatible output, and the transmitter can be driven with a pulsed signal of 0.8/2.5 V. Frequency range is dc to 20 MHz, rise and fall time 15 ns. Connectors are designed for coupling to single fibers.

CIRCLE NO. 381

Coax terminations jacked up to mm-range



Kevlin Manufacturing Co., 26 Conn St., Woburn, MA 01801. Ernest Lattanzi (617) 935-4800. $59 (1-9); stock.

Dc-to-40-GHz subminiature terminations incorporating a new SMA connector design are available in both jack (Model 8740) and plug (Model 8741) configurations. The loads handle 0.1 W; VSWR ranges from 1.05 at 1 GHz to 1.28 (jack) or 1.25 (plug) at 40 GHz.

CIRCLE NO. 382

Gunn oscillators relay fast computer talk

Narda Microwave Corp., Plainview, NY 11803. J. P. Schindler (516) 433-9000.

A low-noise Gunn oscillator for use in high data-rate communication systems is mechanically tunable from 10.7 to 11.7 GHz, with 1-GHz bandwidth. A built-in varactor permits fine-tuning and frequency modulation. Power output is typically 50 mW, and tuning sensitivity 2 to 4 MHz/V.

CIRCLE NO. 383

Low-pass filter hides inside UT-250 coax

Uniform Tubes, Inc., Collegeville, PA 19426. (215) 539-0700.

Low-pass filters packaged inside semi-rigid coaxial cables have several advantages: The monolithically sealed filters are more reliable, and four connectors can be eliminated. In the VT-250A, the cutoff of the 15-section Chebyshev filter is 2 GHz, with a rejection at 2.7 GHz of 60 dB, a VSWR of 1.5, and 0.01-dB ripple.

CIRCLE NO. 384

Small monitor sounds off at low radiation

Cicoil Corp., 70945 Plummer St., Chatsworth, CA 91311. (213) 882-2021. $34.95; 4 wks.

If you work around microwave power sources, the Micro Guard 100 radiation detector offers inexpensive protection. It senses radiation in the 0.5-to-13-GHz range. The trigger level is normally set to 2 mW/cm^2, but Cicoil will adjust it from 0.5 to 10 mW/cm^2. When activated, the 4-oz detector sounds a loud 1300-Hz tone. The Model 100 runs 500 h with a 9-V transistor battery, and is no larger than a pack of cigarettes.

CIRCLE NO. 385

Quiet isolator has low loss

Aercom Industries, Inc., 405 Tasman Dr., Sunnyvale, CA 94086. James E. Mitchell (408) 736-7600. $145 (1-4 qty.); 4 wks.

Low-loss isolators for applications in the 3.7 to 4.2-GHz range provide a matched load for input to low-noise amplifiers, while adding only slightly to the noise level. Typical specs include 23-dB isolation, 0.15-dB loss, and a VSWR of 1.15:1. Operating temperature range is −30 C to +75 C, and size is 1 × 1 × 0.5 in.

CIRCLE NO. 386

Flat Gunn VCOs work up to 40 GHz

Alpha Industries Inc., 20 Sylvan Rd., Woburn, MA 01801. (617) 935-5150.

With a flat 100-mW ±0.5-dB output over a 100-MHz bandwidth, varactor-tuned oscillators in the TRG A9500 series provide relatively high power around 35 GHz. The rugged Gunn-effect devices are available for frequencies from 26.5 to 40 GHz, with a tuning rate of 8 MHz/V, and a temperature range of −10 to 55 C.

CIRCLE NO. 387

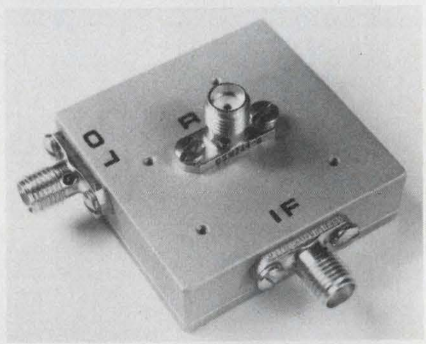
Dual-quad mixers come in small packages

Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, CA 94304. W. A. Green (415) 493-4141. $155 and $199.

Dual-quad, eight-diode, high-level mixers, Models WJ-M1P and M5R, cover frequencies of 40 MUz to 4.5 GHz. They can be used as up or down-converters. They feature high intercept points, a 0.005-to-3-GHz flat i-f response, and good two-tone performance. The M1P is housed in an SMA connector package, while the M5R comes in a 3-pin PC package.

CIRCLE NO. 388

Hybrid mixer loses little in translation



SED Systems Ltd., P.O. Box 1464, Saskatoon, Sask., Canada S7K 3P7. (306) 244-3633.

Series-72525 single-balanced, 90° hybrid mixers are optimized for low conversion loss. Five models cover 3.7 to 15.35 GHz. Conversion loss at 30 MHz i-f is 6-dB max, and local oscillator isolation is 6-dB min at 7-mW drive. While the 3-dB i-f bandwidth normally covers dc to 150 MHz, options go up to 1 GHz.

CIRCLE NO. 389

now there is one... in signal processing

IF and Microwave Components From One Source.

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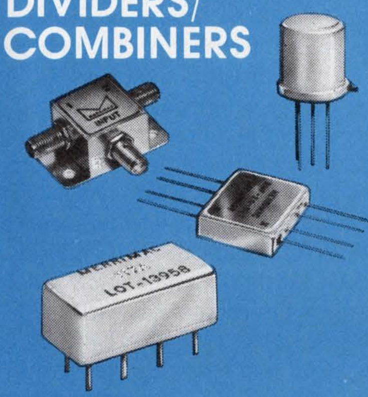
CIRCLE NUMBER 85

AUDIO, VHF AND UHF IN-PHASE, REACTIVE LUMPED ELEMENT POWER DIVIDERS/ COMBINERS



50 kHz to 2 GHz

The winning combination is 83 different standard catalog 2, 3, 4, 6, 8, 12 and 16 way Power Dividers in TO-5, FLAT PACK, RELAY HEADER, LOW PROFILE PC PLUG-IN, SMA, BNC, TNC AND "N" CONNECTOR PACKAGES. Newest models feature ultra-broadband, multi-decade frequency ranges within the range of 50 kHz to over 1 GHz, at low costs.

Following are 4 standard low cost, ultra broadband, 2-way Dividers which demonstrate Merrimac's variety of different packages available off the shelf.
Frequency range (all models) 5 (or 10) to 500 MHz

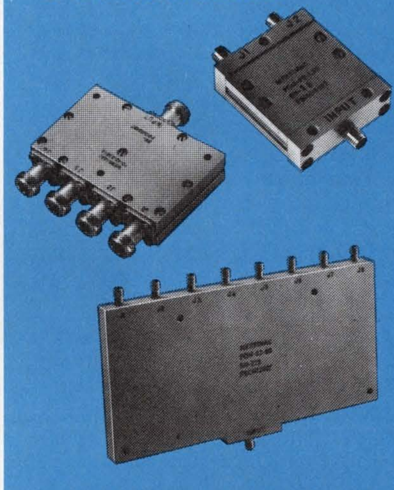
PACKAGE	MODEL NO.	PRICE	ISOLATION dB	PHASE BALANCE
TO-5 (0.3" high)	P-110	$12.00	25 TYP. 20 MIN.	2°
RELAY HEADER	113-C	$ 9.00	30TYP. 25 MIN.	1° TYP. 2° MAX.
FLAT PACK	PDF-2A-250	$17.00	30TYP. 25 MIN.	1°
WITH SMA CONNECTORS	PDM-20-250	$35.00	30 MIN.	1°

For complete detailed specifications on the above 4 models as well as our other 79 standard IF power dividers:

Send for our
NEW '77 CATALOG OF IF SIGNAL PROCESSING COMPONENTS.

CIRCLE NUMBER 86

MICROWAVE IN-PHASE, STRIPLINE BINARY POWER DIVIDERS/ COMBINERS



.5 to 18.0 GHz

The winning combination is 58 different standard catalog 2, 4, and 8 way Power Dividers with SMA and TYPE N, in octave, multi-octave and straddle bands from 500 MHz to 18 GHz with in-line and angled output configurations.

Following are 4 standard models which are typical of the other 54 standard items: prices from $85.00 for 2-ways to $265.00 for-8-ways.

MODEL No.	POWER DIVISION	FREQUENCY RANGE (GHz)	ISOLATION dB(MIN)	INSERTION LOSS dB(MAX)
PDM-22-.75G	2:1	.50-1.0	20	.30
PDM-42-3.95GA	4:1	3.7-4.2	18	.50
PDM-82-6GA	8:1	4.0-8.0	17	1.0
PDM-22-15G	2:1	12.4-18	14	1.0

For complete detailed specifications on the above 4 models as well as our other 54 Standard Microwave Power Dividers:

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NEW '77 MICROWAVE CATALOG

CIRCLE NUMBER 87

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"VISIT US AT MCA REPCO BOOTH #53 AT THE MTT SAN DIEGO SHOW".

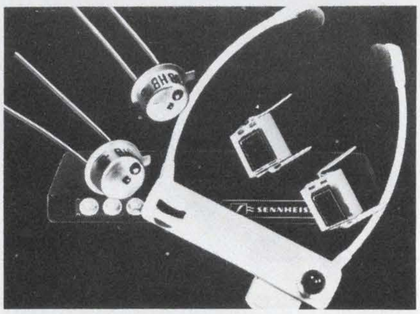
MOS ROM stores 32 kbits and accesses in 450 ns

Texas Instruments, P.O. Box 5012, Dallas, TX 75222. (214) 238-2011. $20 (1000-up).

Designated the TMS 4732, a 32,768-bit MOS ROM organized as 4096 words × 8 bits, is available in a 24-pin DIP. The fully static ROM has a maximum access time of 450 ns, a maximum cycle time of 450 ns and a typical power dissipation of 450 mW. All inputs can be driven directly by series 74 TTL circuits, each output can drive two series 74 TTL circuits and all data outputs are three-state for OR-tieing of multiple devices to a common bus. Two programmable chip select controls are provided for data readout and system decode flexibility. The TMS 4732 is upwards pin-compatible with the TMS 4700 ROM, the TMS 2708 EPROM, and the 8316B and operates over 0 to 70 C.

CIRCLE NO. 390

IR sensor and emitter made for audio & control



AEG Telefunken, Englewood Cliffs, NJ 07632. Manfred Duebner (201) 568-8570. 1000 qty. prices: $0.50 (emitter), $1.95 (detector); 6 to 8 wks.

An infrared emitter and detection pair, the CQY-99 and BPW-34, respectively, are designed for audio and control applications. The CQY-99 IR emitter delivers 14 mW/steradian at a wavelength of 925 nm and has a total radiated power of 15 mW. It requires 100 mA of forward current and dissipates 210 mW in its T-1-3/4 plastic or T0-18 metal package. The BPW-34 p-i-n photodiode detector has a sensitivity of 85 nA/lux up to a maximum of 85 μA of output current. Its open circuit output voltage is 400 mV and the dark current is 30 nA. The detector is housed in a 2-pin clear plastic DIP-like case and has a 120° light angle.

CIRCLE NO. 391

FET power drivers handle loads of up to 2 A

Siliconix, 2201 Laurelwood Rd., Santa Clara, CA 95054. Jim Graham (408) 246-8000. From $3.06 (100 qty); stock.

The S55V01/S75V01 and S55V02/S75V02 series of power peripheral driver transistors offer 12 models to choose from. They provide continuous current ratings up to 2 A, standoff voltages to 90 V and power dissipation ratings of 4 or 25 W in both military and commercial temperature ranges. All S55V/S75V drivers are directly compatible with CMOS. A VMOS input has megohms of impedance and requires only nanoamperes of input current. CMOS fanouts to over 100 drivers are possible. Maximum propagation delays with CMOS inputs are 10 ns for both turn-on and turn-off. With TTL inputs, typical propagation delays are 8 ns for turn-on and 5 ns for turn-off. The S55V01, 11 and 12 handle 2 A, have breakdown voltages of 60, 35 and 90 V, and come in T0-3 packages capable of handling 25 W. The S55V02, 21 and 22 handle 1.5 A, have the same breakdown ratings and are available in TO-39 packages for 4-W applications. All S55V devices operate over −55 to +125 C. The S75V series provides the same six parts specified for 0 to 70-C operation.

CIRCLE NO. 392

Single-chip a/d converts signals to 2-1/2 digits

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Dennis Dauenhauer (408) 737-5000. From $9.85 (100-up); stock.

Known as the DM8700, the single-chip a/d converter forms a 2-1/2-digit panel meter when connected to a LED display. The converter includes autopolarity, overrange indication, a temperature-compensated reference, an internal clock, and digit-select and current-controlled segment drivers for a LED display. Requiring +5 and −15-V supplies the converter needs 1 s for each conversion. Input impedance is 500 kΩ and conversion accuracy is 1%. The DM8700 is specified for operation over a 0-to-70-C range and comes in a 24-pin epoxy or ceramic DIP.

CIRCLE NO. 393

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CIRCLE NUMBER 89

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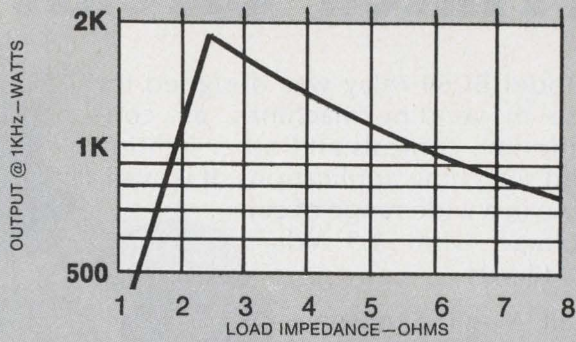
CIRCLE NUMBER 90

The M-600 amp works harder at 2.5 ohms



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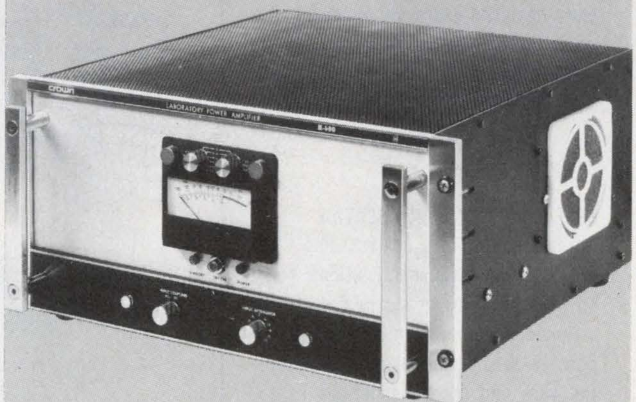

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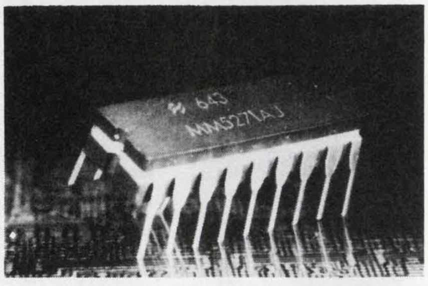
CIRCLE NUMBER 91

4-k dynamic RAMs access as fast as 100 ns



National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051. Ron Livingston (408) 737-5000. $15 (100 qty); stock.

An "A" version of the MM5270, MM5271, MM5280 and MM5281, 4-k dynamic RAMs offers access time selections down to 100 ns. The MM5270A and MM5280A have a cycle time of only 210 ns. The A versions offer a two-to-one speed-power improvement over the original MM5270, 71, 80 and 81s. The 5270A is an 18-pin device that uses a high-level chip enable and has a Trishare common I/O port. The 5280A uses the same clock level, but has 22 pins and a separate input and output, while the 5271A and 5281A both have the TTL-compatible chip enable. All 18-pin devices require +12 and −5 V, while the 22-pin devices need an additional +5-V supply.

CIRCLE NO. 394

Microwave transistors operate at up to 6 GHz

California Eastern Labs, One Edwards Court, Burlingame, CA 94010. Jerry Arden (415) 342-7744. 10 to 99 qty prices: $17 (chip), $54.50 (packaged); 30 days.

Intended for operation over 4 to 6 GHz or 0.5 to 3 GHz, respectively, the NE644 and 645 bipolar transistors use a unique process that reduces collector-to-base and parasitic capacitance to 50% of previously attainable values. The NE644 has a typical noise figure of 2.7 dB at 4 GHz, while the 645 has a 1.6-dB figure at 2 GHz and 7-mA bias. Typical power gain is 11 dB for the NE645 and drops to 9 dB for the 644. Both devices have a V_{CEO} of 12 V, an I_C of 40 mA, a P_T of 300 mW and an f_T of 8.5 GHz. Either transistor comes in chip form or in an 80-mil-square, hermetically sealed Kovar-ceramic package.

CIRCLE NO. 395

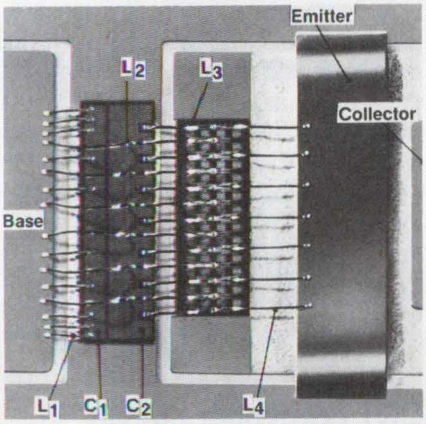
Photo-Darlington couplers provide CTRs of 1000%

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. Inquiries Manager (415) 493-1501. 1000-qty prices: $1.50 (4N45); $1.60 (4N46); stock.

The 4N45 and 4N46 photo-Darlington optocouplers offer a current transfer ratio of typically 1000%. Input current at a 350% CTR for the Model 4N46 can be as low as 0.5 mA and the output voltage can range from −0.5 to 20 V. The 4N45 has a minimum CTR of 250% at 1 mA of input current. Its output voltage spans −0.5 to 7 V. A gain-bandwidth adjustment pin allows an external resistor to be added to adjust gain bandwidth or input current threshold. Performance is guaranteed over a range of 0 to 70 C. Both models are housed in 6-pin mini-DIPs.

CIRCLE NO. 396

Rf power transistors span 100 to 500 MHz



Motorola Semiconductor Products, P.O. Box 20912, Phoenix, AZ 85036. Lothar Stern (602) 244-6900. From $8.95 to $55 (100 qty.); stock.

Capable of delivering up to 80 W of rf, the MRF 321 series of transistors operate at frequencies from 100 to 500 MHz. The rf transistors are designed for class A, AB, B or C use in equipment operating from 12-to-28-V supplies. Units in the series include the MRF 321, 323, 325, 326 and 327 and have outputs of 10, 20, 30, 40 and 80 W, respectively, at 28 V and 400 MHz. Minimum gains at the same bias and frequency are 12, 10, 8.5, 8.5 and 7.3 dB, respectively. All transistors can withstand a 30:1 output load VSWR at rated power and load. The MRF 321 comes in a 0.205 SOE package, the 323 in a 0.28 SOE and the 325, 326 and 327 in 0.5 CQ cases.

CIRCLE NO. 397

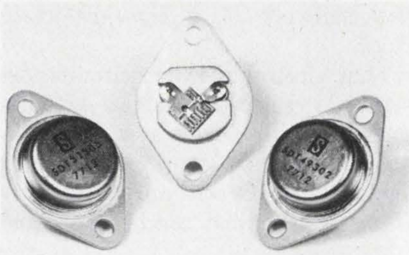
Touch plate sensors scan six or eight channels

Plessey Semiconductors, 1674 McGaw Ave., Irvine, CA 92714. Dennis Chant (714) 540-9945. 100 qty. prices: $4.89 (six channel); $6.52 (eight channel); stock.

Four electronic switch circuits, designed to replace mechanical switches in tuners with touch plates, are available in two six or two eight-channel versions. The ICs can be driven directly from two-terminal touch plates and provide direct neon drive; low impedance drive to tuning Varicaps; remote control stepping; sound muting during channel selection; and operation from 0 to +65 C. Of the two six channel models, the 24-pin ML236 is cascadable and has positive channel selection, while the 16-pin ML237 offers negative channel selection. The eight-channel ML238 and ML239 select channel 1 on power-up, with the 238 providing for positive channel selection, the ML239 for negative channel selection.

CIRCLE NO. 398

Power transistors handle high voltage or current



Solitron Devices, 1177 Blue Heron Blvd., Riviera Beach, FL 33404. (305) 848-4311. From $3.25 (100 qty.); 4 to 6 wks.

Two families of hometaxial single-diffused npn power transistors, one designed for high voltage and one for high current linear applications are both available in TO-3 cases. The high voltage devices, the SDT 31303, 05, 07 have $V_{CEO\ (sus)}$ ratings of 200, 250 and 300 V, h_{fe}s of 10 to 50 at an I_C of 2 A, and V_{CE} sats of 0.5 V min at 2 A. The $I_{s/b}$ for the SDT 31303 at an I_C of 1.25 A, a V_{CE} of 200 V, and a pulse of 1 s is 250 W; $I_{s/b}$ for the SDT 31305 and 07 at an I_C of 1 A, a V_{CE} of 250 V, and a pulse of 1 s is also 250 W. The high current family consists of the SDT 49302 and 04. Typical specifications include $V_{CEO(sus)}$ ranges of 50 and 70 V, and V_{CE} sats of 1.9 V at 60 A (SDT 49302) and 1.4 V at 40 A (SDT 49304). The $I_{s/b}$ for the SDT 49302 at an I_C of 6 A, a V_{CE} of 50 V and a pulse of 1 s is 300 W; and for the SDT 49304 at an I_C of 4.3 A, a V_{CE} of 70 V, and a pulse of 1 s, it is also 300 W.

CIRCLE NO. 399

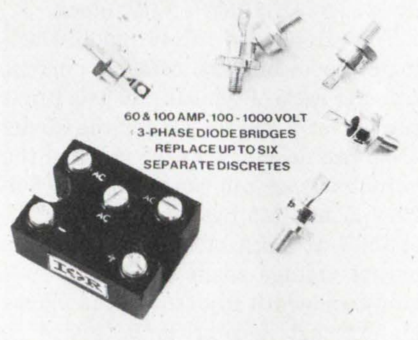
Multiplying d/a settles in 85 ns, delivers 2 mA

Precision Monolithics, 1500 Space Park Dr., Santa Clara, CA 95050. Donn Soderquist (408) 246-9222. From $2.95 (100 qty.); stock.

Capable of multiplying a two-digit BCD input with a reference in just 85 ns, d/a converters in the DAC-20 series have nonlinearities of 1/2 or 1/4 LSB. Models are available with guaranteed performance over 0 to 70 or −55 to 125 C and can deliver 2 mA, maximum. Housed in 16-pin DIPs, the multiplying converters have a compliance voltage swing of −10 to +18 V and can operate with ±4.5 to ±18 V supplies, dissipating 37 mW with ±5-V supplies.

CIRCLE NO. 404

Rectifier assemblies handle up to 100 A



International Rectifier, 233 Kansas St., El Segundo, CA 90245. (213) 322-3331. From $39 (100 qty); stock.

Designated 600HT for 60 A and 1000HT for 100 A, a series of molded bridge assemblies comes in molded packages with screw-on terminals that measure just 2.25 × 1.75 × 1.07 in. Units in each line are available for three-phase operation with peak reverse ratings of 100, 200, 300, 400, 600, 800 and 1000 V. Isolation between the base plate and terminals is 1500 V for units rated up to 600 V and 2000 V for units rated for 800 and 1000 V. All specified ratings are at full rated current and 150 C operating junction temperature. Maximum peak surge current is 500 A for 600HT models and 800 A for 1000HT units. Thermal resistance case-to-heat sink is 0.07 C/W.

CIRCLE NO. 406

CRT controller circuit provides any format

SMC Microsystems, 35 Marcus Blvd., Hauppauge, NY 11787. (516) 273-3100. $32 (100 qty); stock.

Capable of providing programmable display formats, the CRT 5027 video-timer/controller circuit can drive interlaced and noninterlaced CRT monitors. Programming is done by loading seven 8-bit control registers from a bidirectional data bus. Display formats can be modified for the number of characters per row, rows per frame, scans per row, scans per frame, scrolling or nonscrolling, video cursor generation, vertical data positioning and synchronization—horizontal, vertical or composite. The NMOS circuit, housed in a 40-pin DIP, requires +5 and +12 V and operates over 0 to 70 C.

CIRCLE NO. 407

Complete d/a converters deliver 10 bits & sign

Precision Monolithics, 1500 Space Park Dr., Santa Clara, CA 95050. Donn Soderquist (408) 246-9222. From $15 (100 qty); stock.

The DAC-05, a monolithic 10-bit plus sign d/a converter, comes complete with voltage output and internal reference. Settling in 1.5 μs, there are two voltage-output versions, a $\pm$10-V and $\pm$5-V model. Housed in 18-pin hermetic DIPs, the converters come with a monotonicity specification of 8, 9 or 10 bits over 0 to 70 or -55 to 125 C. Versions are also available processed to MIL-STD-883A Class B.

CIRCLE NO. 408

Schottky bit slices cycle in just 100 ns

Texas Instruments, P. O. Box 5012, Dallas, TX 75222. (214) 238-2011. From $2.25 to $29.25 (100 qty); stock.

The S481 chip set is a series of Schottky TTL microprogrammable building blocks that provide up to 10 times the throughput of conventional microprocessors. Available in both commercial and military temperature ranges, the S481 chip set can select and operate on two operands, generate status, and store results in a single 100-ns microcycle. A processor built from S481 chips has complete microprogrammability for emulating existing instruction sets. The S481 chip set can be used to make a processor from 4 to n $\times$ 4 bit system as desired. The set consists of one or more SN54S/74S481 4-bit processors, one or more SN54S/74S482 4-bit controllers, an appropriate number of either the SN54S/74S330 or 331 field programmable logic arrays, and various PROMs, RAMs and logic circuits. Able to recognize, decode and execute any of 24,780 instructions within a single 100-ns clock cycle, the S481 slice has hardwired algorithms for automatically sequenced iterative, signed or unsigned multiplies and divides, as well as for cyclical redundancy character calculations. The S482 control element combines a full adder, four-word push-pop stack, source select multiplexer and address register.

CIRCLE NO. 409

ICs & SEMICONDUCTORS

Tuning diodes offer a 4:1 tuning range

MSI Electronics, 34-32 57 St., Woodside, NY 11377. A. Lederman (212) 672-6500. $10 (100 qty); 2 wks.

With reverse capacitances of 200 pF at a 1-V bias, the HA1850A varactor diode provides a tuning ratio of 4:1. The reverse capacitance drops to 50 pF at a 28 V bias. At 1 V, the Q is greater than 200 and increases with bias voltage. Rated for a 30-V breakdown, the diode comes in a DO-7 glass case.

CIRCLE NO. 410

Power transistors handle 40 A at up to 180 V

Solid State Devices, 14830 Valley View Ave., La Mirada, CA 90638. Arnold Applebaum (213) 921-9660. From $25 to $40 (100 qty.); stock.

The 2N6046, 6047, 6048 and 1748 npn power transistors offer peak collector currents of 40 A. Their V_{CEO}'s are 60, 100, 140 and 180 V, respectively. Maximum dissipation is 200 W at 25 C and the collector-emitter and base-emitter saturation voltages are 2 V. The transistors have maximum rise and fall times of 600 and 350 ns, respectively, and a typical gain bandwidth of 40 MHz. All units come in TO-63 cases and have a linear power derating of 1.13 W/°C above 25 C.

CIRCLE NO. 411

Power transistor handles up to 2 A at 80 V

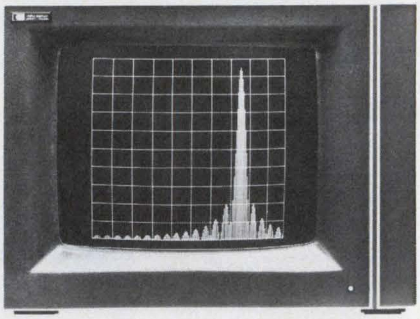
General Transistor Corp., 12591 Crenshaw Blvd., Hawthorne, CA 90250. (213) 679-9721. $0.95 (1000 qty); stock.

Able to handle 2 A of collector current, the GT 200 npn transistor can dissipate up to 12 W. The transistor, housed in a TO-220AB case has a typical f_T of 150 MHz at a V_{CE} of 5 V and an I_C of 500 mA. Reverse collector-emitter voltage is 80 V, as is the reverse collector base voltage. The minimum h_{FE} is 30 at a V_{CE} of 5 V and an I_C of 1 A.

CIRCLE NO. 412

DATA PROCESSING

Large-screen CRT display gives fine resolution



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. (415) 493-1501. $2400; 8-12 wks.

A 20 × 25-cm (nearly 8 × 10 in.) CRT display, Model 1304A, provides the high resolution needed to display 2000 alphanumeric characters in normal room lighting. The electrostatic tube has a spot size of 0.5 mm. A system power consumption of only 60 W enhances reliability. Dynamic focus keeps the spot sharp at all intensity levels. X and Y-axis amplifiers of the 1304A have a settling time of less than 300 ns, and the linear writing speed is better than 25 cm/μs. Z-axis rise time is less than 25 ns, cw bandwidth more than 5 MHz. A range of options tailors the display to special situations. Available mounting hardware includes standard rack-mountings, slide, and slide-and tilt mountings.

CIRCLE NO. 413

Stationary 'bulk core' mimics disc storage

Dataram Corp., Princeton-Hightstown Rd., Cranbury, NJ 08512. John F. Gilligan (609) 799-0071. $9700; 12 wks.

Bulk Core, introduced early last year, is now available with complete interfaces to emulate DEC and Data General fixed-head disc systems. The 15-3/4-in.-high rack-mountable chassis can hold up to eight 128-k word modules, for a maximum capacity of one megaword (two Mbytes). The Models BC-201 and BC-202 emulate DEC's RC-11/RS-64 and RF-11/RS-11, respectively, and the BC-301 mimics Data General's 4019 Controller and Novadisc. Access time for the μP-controlled units is 750 ns to 2.0 μs—5000 times faster than comparable fixed-head discs.

CIRCLE NO. 414

Rugged mini won't mind tortures

Electronic Memories and Magnetics, 20630 Plummer St., Chatsworth, CA 91311. (213) 998-9090. See text.

SECS-11I stands for Severe Environment Controller System-11, Industrial. The rugged minicomputer has been programmed to emulate all functions of the DEC PDP-11/34 or PDP-11/35. The SECS-11I consists of four multilayer board logic modules, power supply, chassis and control panel. Additional board positions provide space for up to 128-k RAM semiconductor or core memory. The chassis can be completely sealed, providing protection against hostile atmospheres. Cards are rigidly mounted and supported to prevent damage from high-level vibration. Prices are slightly higher than for equivalent commercial units.

CIRCLE NO. 415

Modem doubles reach of data transmission

Gandalf Data Inc., 190 Shepard Ave., Wheeling, IL 60090. Alan Melkerson (312) 541-6060. $1500 (unit qty.); 4-8 wks.

The LDM 404 transmits data up to 20 miles at a speed of 4800 bits/s over standard 3002 unconditioned data lines, twice the distance of its predecessor. While the 300 Series required "nonloaded" circuits which cannot always be readily prepared, the 400 Series uses the more easily obtainable "loaded" facility. This is especially valuable in larger cities where "nonloaded" circuits are at a premium.

CIRCLE NO. 416

Line printers get more competition

Centronics Data Computer Corp., Hudson, NH 03051. Chuck Clemente (603) 883-0111. From $4050; October, 1977.

With the 6000 Series, Centronics enters the field of fully formed-character line printers, at prices up to 40% lower than comparable printers. The four models in the series provide speeds of 75, 150, 300, and 600 lines/min, and share 85% common parts. The use of μPs provides simple operator controls and increased flexibility. Each model accommodates 1 to 6-part forms (width 4 to 19 in.) and prints 132 char/line at six lines/in.

CIRCLE NO. 417

Quiet line printer churns out 33 ft/min

Houston Instrument, One Houston Square, Austin, TX 78753. Tom Hall (512) 837-2820. $3450; 4 wks.

The nearly noiseless Model 8210 printer has 80 print columns (10 char/in.) and is capable of speeds up to 2400 lines/min at 6 lines/in. The interface signals allow easy connection to the Intel MDS System. A 132-column version is available at $3785.

CIRCLE NO. 418

Quiet teleprinter has 50 built-in options

Siemens Corp., 186 Wood Ave. S., Iselin, NJ 08830. Martin Weitzner (201) 494-1000.

The T-1000 teleprinter uses MOS and LSI chips to achieve high typing speeds and reliable transmission at low noise levels. The lightweight printer uses a plastic disc, which carries the individual letters and symbols on 56 points. A special feature of the T-1000 is the "variant module" group which permits selection of more than 50 pre-programmed additional functions such as character feed suppression, special symbols, paper monitor, printout stop, etc. A built-in diagnostic unit aids in finding the source of defects.

CIRCLE NO. 419

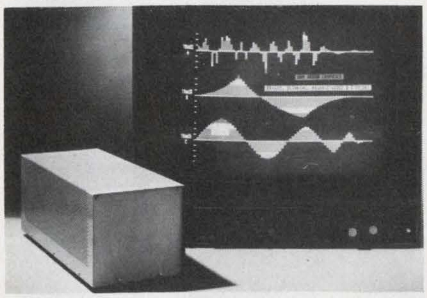
Two-headed printer writes simultaneous translations

Qume Corp., 2323 Industrial Parkway, West Hayward, CA 94545. (415) 783-6100. $2725 (unit qty); 90 days.

The Micro 3 TwinTrack character printer is useful in situations where two heads are better than one. For example, a word-processing system could print a simultaneous translation. The two-headed printer gives 192 on-line characters—twice the number available on a standard 96-character printwheel. Up to 75 char/s can be printed in parallel columns or as solid text. Also the use of two daisy print-wheels eliminates hand insertion of special characters. One print head can type text while the other prints the required symbols in the proper space.

CIRCLE NO. 420

Colorful graphics brighten terminals



Ann Arbor Terminals, 6107 Jackson Rd., Ann Arbor, MI 48103. Sarah J. Freeman (313) 769-0926. $1395; 12 wks.

The 2480 controller displays graphics symbols, 8 dots wide and from 0 to 10 TV-lines high, in any one of seven colors, plus blinking red on RGB-color monitors. It also displays in normal (white), bright or blinking bright on black-and-white monitors. The terminal displays 24 lines of ASCII alphanumerics, as well as the graphics symbols. The characters can be displayed as white, black or blinking on any one of seven background colors. RS232 interface is standard, as are baud rates from 110 to 9600.

CIRCLE NO. 421

Versatile terminal uses plasma display

Applications Group, Div. of Eprad, Inc., Box 4712, Toledo, OH 43620. A. H. Rotsinger (419) 243-8106.

The AG-60 graphics/alphanumerics terminal offers three character sets (5 × 7, 7 × 9, and user-programmable 8 × 16), two graphics sets (incremental and vector) and alphanumeric cursor. Other functional capabilities may be added. The AG-60's 12-in. diagonal plasma panel has a 512 × 512 dot matrix that presents a clear, bright display, free from flicker, jitter and distortion. Input devices include two keyboards, touch panel or sonic pen.

CIRCLE NO. 422

Low-cost disc drive packs up to 70 Mbytes

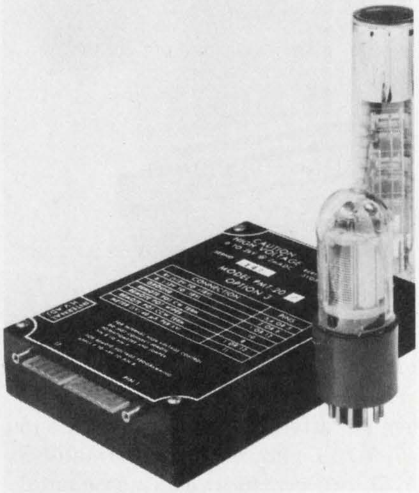
Kennedy Co., 540 W. Woodbury Rd., Altadena, CA 91001. Russell Bartholomew (213) 798-0953. From $2500; 12 wks.

Fixed-cartridge, moving-head disc drives store up to 70 Mbytes of data at rates of 1 Mbyte/s—25 to 50% more than similar units. The Series 5300 drives have unformatted capacities ranging from 14 Mbytes in the single-disc version to 70 Mbytes in the three-disc model. MFM recording technique is used for high-speed, and maximum frame definition. Power supply and all electronics are included in a single, easily serviced assembly. Standard power requirements are 120 V at 60 Hz, with 230 V at 50 Hz optional.

CIRCLE NO. 423

POWER SOURCES

High-voltage dc/dc maintains accuracy



Bertan Associates, 3 Aerial Way, Syosset, NY 11791. L. Bertan (516) 433-3110. $175 (1 qty.); stock.

Model PMT-20, a dc/dc converter module, powers photomultiplier tubes with adjustable or programmable 0 to 2000 V at 0 to 2 mA. Features include line and load regulation of 0.001%, ripple of 2-mV pk-pk and short-term stability of 0.005%. Both positive and negative polarities are available and the module operates from various dc inputs. A low-level output-voltage monitor is included in the short-circuit and arc-protected unit.

CIRCLE NO. 424

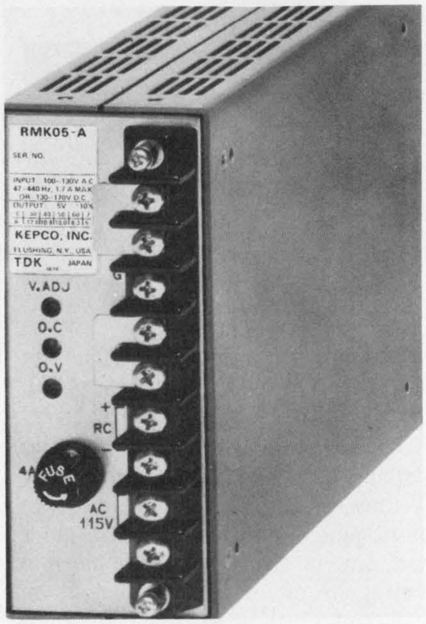
Converters stay cool over wide input dc

Semiconductor Circuits, 306 River St., Haverhill, MA 01830. (617) 373-9104. From 100 (1 qty); 2 to 4 wks.

Models CW12-5S600 and CW24-5S600 encapsulated, modular, ripple-regulator, dc/dc converters feature 60 to 70% operating efficiencies over a 2:1 input-voltage range. Delivering foldback-protected outputs of 5 V dc at 6.5 A, both models differ only in input voltage ratings; the CW12 operates from 9 to 18 V dc, while 18 to 32 V dc powers the CW24. Features of the converters include 0.5% line and load regulation, 13 mV rms of output ripple and noise, and full-rated output from −25 to +71 C. The chassis-mount modules are wired via a top-mounted barrier strip and measure 3.5 × 2.5 × 2 in.

CIRCLE NO. 425

Switcher family spans 5 to 24-V outputs



Kepco, 131-38 Sanford Ave., Flushing, NY 11352. (212) 461-7000. $179 (unit qty).

Series A of the RMK switching mode power supplies contains five models whose outputs are: 5 V at 0 to 12 A, 9 V at 0 to 7.6 A, 12 V at 0 to 6.3 A, 15 V at 0 to 5 A and 24 V at 0 to 3.2 A. All models can be factory-set at −30% to +10% of nominal voltage. Their operating temperature is 0 to +71 C. Features include 25-kHz switching (for a 68% typical efficiency) and a five-year warranty. The units also have remote error sensing, adjustable current limiting, logic-level turn-on and turn-off and both ac and dc power input. The 3-lb modules are 2.19 × 5.1 × 7.5 in.

CIRCLE NO. 426

Smaller transformer holds the line

Power-Controls, 142 Peconic Ave., Medford, NY 11763. (516) 654-2084. $39 (500 qty.); stock to 4 wks.

Smaller by 50% than ferroresonant regulators, Mini-Reg line-regulation transformers are insensitive to line-frequency shifts and unaffected by rectified loads. The units deliver 250-VA of 115-V, 60-Hz output power with 1% voltage regulation from an input line that varies from 105 to 125 V. Standard units operate from either 115 or 230-V nominal input lines. A MIL-T-27 version that operates from −55 to +125 C and weighs 2 lb, comes in a can that is 2.375 × 2.75 × 3.875 in.

CIRCLE NO. 427

TRUE POWER MEASUREMENT

PC5 SERIES OSI WATT TRANSDUCERS

- ☐ Easy installation
- ☐ For power (E-I-Cos Θ) monitoring and control
- ☐ Proven reliability, repeatability, long life
- ☐ Specified by Government Agencies, Industry and Public Utilities

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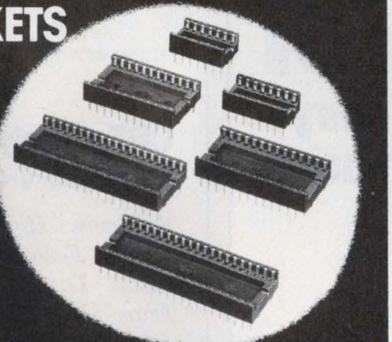
CIRCLE NUMBER 118

NEW LOW PROFILE LSI SOCKETS FROM SMK



The SI-2440 Series complete line of new LSI Sockets, including 14, 16, 24, 28, 40 and 42 pin versions on 0.1″ centers are designed so that they can be flush mounted end-to-end maintaining the 0.1″ center-to-center pin spacing. For example, two 24 pin LSI Sockets can be mounted end-to-end to accommodate the latest 48 pin ROM.

The glass-filled Nylon bodies (66% Nylon) are designed to withstand soldering temperatures to +350°C for 3 seconds and are available with either tin plating, selective gold contact plating or gold flash.

Typical 100 piece price for the fourteen pin unit, tinned plated, is $.311 each.

SMK SMK Electronics Corporation of America
118 East Savarona Way Carson, California 90746
Tel: (213) 770-8915

CIRCLE NUMBER 119

decitrak® decit

OPTICAL INCREMENTAL SHAFT ENCODER

Low, Low Cost... Rugged Industrial Design... Wide Ranges Available Up To 14,400 Counts...

The ideal, low cost incremental encoder to digitize rotary motion for display and control...up to 14,400 counts per turn...ultra reliable LED light source...only 5VDC required for operation...Bi-directional outputs in sine wave, square wave or pulse format...heavy duty industrial design...And...if you need additional electronics or a system, you can rely on Theta. Our application engineers are ready to help.

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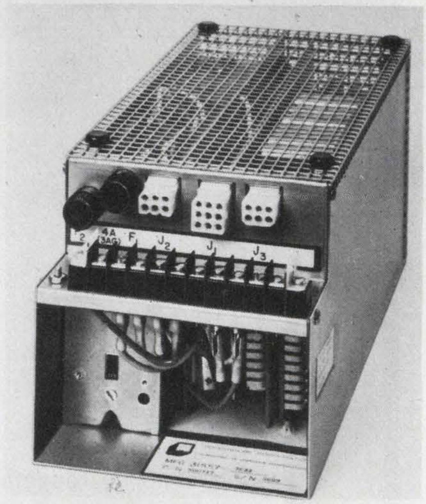
CIRCLE NUMBER 120

Three-output switchers deliver 172 W



Powercube Corp., 214 Calvary Street, Waltham, MA 02154. J. Prestidge (617) 891-1830. $300 (1000 qty.); 8-10 wks.

OLS switching power supplies offer three regulated outputs: +5 V at 24 A and ±12 V at 4 A each up to a 172-W total. Outputs of ±15 V are optionally available at the same power level. Each output has overvoltage and short-circuit protection, and holds up for 50 ms during power failure at full load. The supplies feature plug-in card construction and are designed for high-temperature operation with forced-air cooling. They operate from 115 or 230-V, 47 to 63-Hz, input power. The 9 lb units are 5.5 × 5.5 × 11 in.

CIRCLE NO. 428

CRT supply operates from 28-V-dc input

Spellman High-Voltage Electronics Corp., 7 Fairchild Ave., Plainview, NY 11803. D. Galluzzo (516) 822-2130. From $300; stock to 10 wks.

Operating from a 28-V-dc input and drawing 300 mA max, the RMX810 provides high-voltage dc outputs for a CRT. You get −3 kV for the anode, −1 kV for the cathode and a floating −1 kV for the grid. Load and line regulation of these voltages is 0.01%. You can modulate a CRT either through grid bias or in the Z-axis mode via an input on the supply. The supply is enabled through an energized relay. Ground-referenced, low-level test points provide monitoring for all outputs. The self-restoring unit is arc-over and short-circuit protected. The design complies environmentally with MIL-E-16400.

CIRCLE NO. 429

Evaluation samples

Containers

Containers come in nine standard sizes, each equipped with standard slotting layouts. By adding adjustable inserts, containers allow the positioning of more than one size PC board. Shell Containers Systems.

CIRCLE NO. 430

Soft ferrite beads

A soft ferrite bead pack contains 10 items of approximately a dozen beads each. O.D.s range from 0.073 to 0.375 in.; I.D.s from 0.038 to 0.187 in. and lengths from 0.085 to 0.6 in. Special sizes and materials may be included upon request. Stackpole Carbon Co.

CIRCLE NO. 431

Potentiometers

Conductive-plastic, semi-precision, industrial-grade potentiometers feature 1% linearity, 5-million cycle rotational life and low noise (0.25% output smoothness). For more information, circle the reader service number. New England Instrument

CIRCLE NO. 432

Oxide-free solder cream

Solder creams require low heat, short dwell time and low soldering temperatures, and are virtually oxide-free. The creams come in a variety of tinlead as well as silver bearing alloys with either an active or midly active rosin-base flux. The flux residue is light and clear in color. Multicore Solders.

CIRCLE NO. 433

Reed relays

The RX-1 relay operates at 5, 6 and 12 V dc. When the RX-1 is used at TTL switching levels, it provides 50-million switching operations without discernable deviations in performance. Send a letterhead request for a free sample, stating in minor detail how the relay will be used. Electronic Applications, 4918 Santa Anita Ave., Ei Monte, CA 91734

INQUIRE DIRECT

Application notes

Input noise

How to minimize noise problems in X-Y recorders is shown in a four-page note. Hewlett-Packard, Palo Alto, CA

CIRCLE NO. 434

Alarm sensing circuit

Design and performance of an alarm sensing circuit is described in an application note. All element values, layout and characteristics over the military temperature range are included. Interdesign, Sunnyvale, CA

CIRCLE NO. 435

Instrumentation quarterly

The first issue of an applications engineering quarterly describes use of digital instruments in trip-point testing of protective relays. Dranetz Engineering Laboratories, South Plainfield, NJ

CIRCLE NO. 436

Timing measurements

A better approach to pulse and digital timing measurements based on the Delta Time measurement package (7B80 and 7B85 plug-ins) for 7000-Series Oscilloscopes is described in an application note. Tektronix, Beaverton, OR

CIRCLE NO. 437

Encoders, decoders

How to implement highly noise-immune, remote supervisory control systems using commercially available tone-encoder and decoder modules are described in an eight-page reprint. Frequency Devices, Haverhill, MA

CIRCLE NO. 438

7-digit LED counter

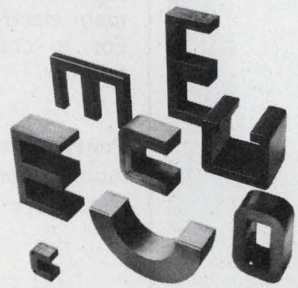
A battery-operated, low-cost counter is described in a six-page bulletin. With frequent references to design drawings, the bulletin discusses circuit design considerations, display requirements, the power-supply requirement, hardware and the basic system accuracy as a function of the oscillator and mode selected. Intersil, Cupertino, CA

CIRCLE NO. 439

WE KNOW A LOT ABOUT A LITTLE.

Nickel cut cores, for instance.

If you need nickel-iron cores with low losses and high efficiency in small sizes, our nickel cut cores will do the job for you. Designed for high saturation flux densities, our Supermendur types make possible a 30% weight reduction over conventional silicon-iron cores. Our Permalloy 80 cores provide a core loss approximately one-tenth that of a silicon-iron core of equal thickness. Our Orthonol® cores have a flux density of 15,000 gausses, with a core loss about one-half that of a silicon-iron C core of the same thickness. For more information, write Magnetics, Components Division, Butler PA 16001.



Very special specialists in nickel cut cores.

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A DIVISION OF SPANG INDUSTRIES INC

CIRCLE NUMBER 131

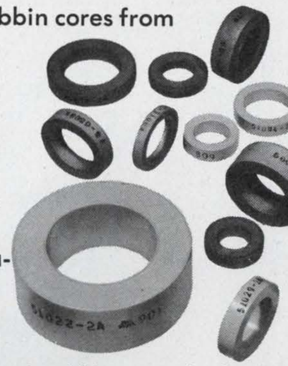
WE KNOW A LOT ABOUT A LITTLE.

Tape cores, for instance.

When it comes to tape wound cores, we offer thousands of choices—900 sizes, eight materials, seven gauges. Our Supermalloy tape cores feature high permeability and low loss for such applications as precision current and ratio transformers, high-perm inductors, bridge lifters, etc.

We also make bobbin cores from Permalloy 80 and Orthonol® ultra-thin tape. These cores are wound on nonmagnetic stainless steel bobbins, with core diameters down to 0.050".

For more information on tape or bobbin cores, write Magnetics, Components Division, Butler PA 16001.



In addition to catalog items, we offer a custom core service.

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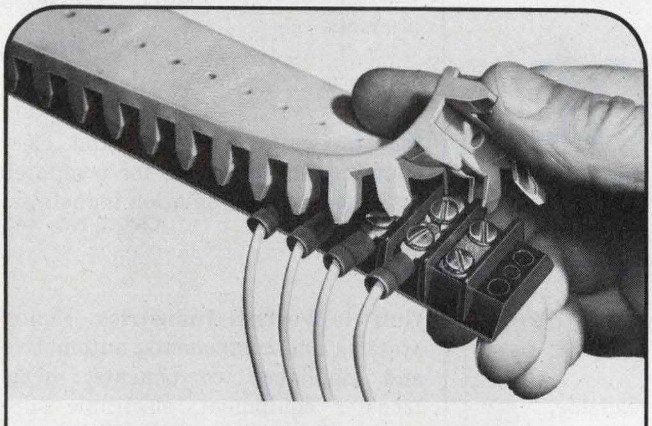

NEW SAFE-TI CAPS™

Protect your terminal board connections by covering them with Kulka's non-flammable, rubber Safe-Ti Caps™. These unique covers guard against spills, dirt and accidental short circuits from dropped tools. Available in all the popular sizes. Be sure to send for Kulka's free catalog.

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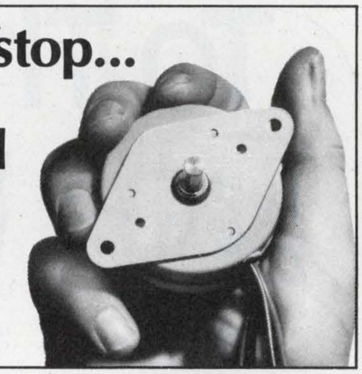
CIRCLE NUMBER 133

Fast start/stop... positive directional stability



It's great on torque and price, too! The compact 81700 synchronous motor.

High torque-to-frame size ratio, superior performance characteristics and attractive low price make the 81700 synchronous motor ideal for computer peripherals, business machines and home entertainment equipment. Included are turntables, remote tuners, credit card readers and facsimile transmission equipment.

The motor's inherent reliability and 6 oz. in. @ 300 rpm are key factors. Instantaneous start/stop eliminates clutching and prestarting. Directional stability and low cost are other important advantages. A permanently lubricated bearing prolongs motor life and minimizes maintenance.

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CIRCLE NUMBER 134

Vendors report

Annual and interim reports can provide much more than financial position information. They often include the first public disclosure of new products, new techniques and new directions of our vendors and customers. Further, they often contain superb analyses of segments of industry that a company serves.

Selected companies with recent reports are listed here with their main electronic products or services. For a copy, circle the indicated number.

Penril Corp. Business, data-communications products and electronic test instruments.
CIRCLE NO. 440

Computer Automation. Computer and computer-related products, software and computerized systems.
CIRCLE NO. 441

Energy Conversion Devices. Imaging products.
CIRCLE NO. 442

Electro-Craft. Electronic and electromechanical products for computer peripheral and automation industries.
CIRCLE NO. 443

Gulf + Western Industries. Piping systems and components; automotive and appliance components; heat-transfer equipment; electronic supplies; wire and cable; traffic-control systems; natural resources and automotive replacement parts.
CIRCLE NO. 444

Polarad Electronics. Commercial and military electronic equipment and systems; microwave signal generators and receivers; spectrum analyzers, and electronic navigation instruments.
CIRCLE NO. 445

Harris Corp. Communication and information-handling systems and equipment; ICs.
CIRCLE NO. 446

Itel. Leasing of data-processing equipment.
CIRCLE NO. 464

EG&G. Instruments; components; environmental and biomedical services; custom services and systems.
CIRCLE NO. 465

Threshold Technology. Automatic voice-recognition systems.
CIRCLE NO. 466

Data 100. Data-processing terminal systems. A separate corporate profile is available.
CIRCLE NO. 467

Computer Communications. Equipment and systems for processing and switching of data transmitted between computers and remote locations.
CIRCLE NO. 468

SGL Industries. Batteries, spark plugs and igniters; magnetic transformer components; PCs and specialty plastics.
CIRCLE NO. 469

Datapoint Corp. Data-processing equipment.
CIRCLE NO. 470

Bio-Medicus. Medical products and devices.
CIRCLE NO. 471

Lafayette Radio Electronics. Consumer electronics.
CIRCLE NO. 472

Tandy Corp. Consumer electronics.
CIRCLE NO. 473

Dataram Corp. Memory systems.
CIRCLE NO. 474

Zero Manufacturing. Cases, cabinets and specialized cabinets.
CIRCLE NO. 475

Scientific-Atlanta. Satellite-communications systems; microwave test equipment.
CIRCLE NO. 476

Pentron Industries. Coils, extruded and molded plastic parts and electronic distance measuring instruments.
CIRCLE NO. 477

CIRCLE NUMBER 136

CIRCLE NUMBER 137

New literature

CMOS

Specifications, functional and pinout information on 98 different SCL-4000B series CMOS devices as well as standard CMOS memory and time-keeping circuits are given in a 12-page catalog. Solid State Scientific, Montgomeryville, PA

CIRCLE NO. 447

Bridge rectifiers

Full specifications and dimensional drawings of bridge rectifiers are shown in a four-page brochure. Electronic Devices, Yonkers, NY

CIRCLE NO. 448

Wire-wrapping

Solderless wire-wrapping production techniques and practices are described in a 34-page manual. Amphenol Connector, Oak Brook, IL

CIRCLE NO. 449

Thick-film hybrids

Custom thick-film hybrid products are covered in a 4-page brochure. Parlex Corp., Methuen, MA

CIRCLE NO. 450

Peripheral driver ICs

A 120-page peripheral-driver IC catalog provides comprehensive information on 46 peripheral-driver ICs. Featured are function tables, schematics, pin configurations and parametric measurement information. Texas Instruments, Dallas, TX

CIRCLE NO. 451

CAMAC equipment

An introduction to IEEE Standard 583, "IEEE Standard Modular Instrumentation and Digital Interface System (CAMAC)" and descriptions of over 90 products conforming to this standard, are included in a 224-page catalog. KineticSystems, Lockport, IL

CIRCLE NO. 452

Spectrum analyzer

A 12-page brochure shows how to apply real-time spectrum analysis to acoustic, vibration and transient problems with the Model 444 FFT computing spectrum analyzer. Nicolet Scientific, Northvale, NJ

CIRCLE NO. 453

Splicing products

Modular-system splicing products are described in a 24-page booklet. 3M TelComm Products, St. Paul, MN

CIRCLE NO. 454

Thyristors

Data sheets describe converter-grade thyristors, types N007, N010, N013 and N023. Rating information, performance curves and characteristics at specified case temperatures are given. Westcode Semiconductors, Chippenham, Wilts, SN15 1JD England

CIRCLE NO. 455

Microwave tubes, diodes

"Microwave Tubes and Diodes" contains data on lighthouse tubes, reflex klystrons, TWTs, magnetrons and microwave silicon diodes. The 500-page book is printed in English and German. AEG-Telefunken, D-7900 Ulm, West Germany

CIRCLE NO. 456

8-bit MOS μP

The 320-page 8080A/9080A Handbook describes the 8-bit MOS microprocessor and major support circuits. The publication includes detailed timing diagrams, memory and interface circuit descriptions and an applications section. For more information regarding the $7.95 book, circle the number. Advanced Micro Devices (Library), Sunnyvale, CA

CIRCLE NO. 457

Switches

Single and double-break, lighted or nonlighted PB, DIP LED-indicator PB, industrial and sealed actuators are covered in a 36-page guide. Engineering and specification data, switch dimensions and electrical ratings are included. Licon, Illinois Tool Works, Chicago, IL

CIRCLE NO. 458

Function circuits

"Function Circuits, Design and Applications" deals with the multifaceted area of analog function circuits. Numerous graphs and formulas are presented in the 300-page book. The book costs $18.50 postpaid. For more information, circle the reader service number. Burr-Brown Research, Tucson, AZ

CIRCLE NO. 459

Engineering encyclopedia

"The Reston Encyclopedia of Biomedical Engineering Terms" is a comprehensive dictionary of medical and electronic terms. The book costs $29.95. For more information, circle the number. Prentice-Hall, Englewood Cliffs, NJ

CIRCLE NO. 460

Power sources

Performance and specifications, ratings, prices, options and accessories for a family of digitally controlled power sources are given in a 12-page catalog. Hewlett-Packard, Palo Alto, CA

CIRCLE NO. 461

Communication components

Over 500 communication components are featured in a 36-page catalog. Schematics, specifications, selection charts, product descriptions and photos are included. ADC Products, Minneapolis, MN

CIRCLE NO. 462

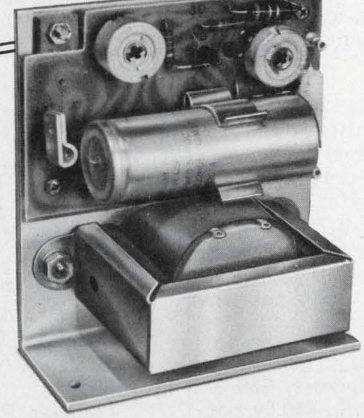
Solid-state relays

Application data, charts and graphs provide specifications and design data on ac and dc-controlled, triac and SCR solid-state relays. Also included in the 20-page catalog is information on heat sinks, solid-state hybrid power relays and sockets. Magnecraft Electric, Chicago, IL

CIRCLE NO. 463

The original economy power supply.

Proven reliable 125,000 times.



More than 125,000 DPS supplies have been sold to OEM's and it's still a best seller. That's your assurance of quality ...reliability ...cost effectiveness.

Models available to supply 5 volts at 3 amps to 24 volts at 0.8 amp. Each is a U.L. listed recognized component.

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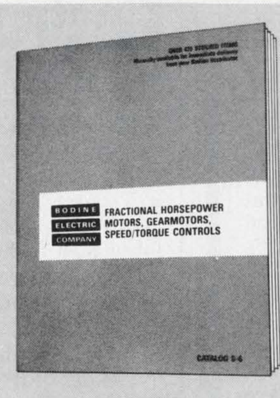
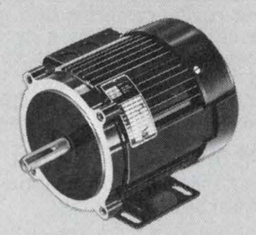


NEW! CATALOG



NEW! MOTORS

Higher Hp. (up to 1/2)

425 STOCK fhp (1/2000 to 1/2 Hp) motors, gearmotors, and speed/torque controls listed. Included are Bodine's new TEFC 48 frame A-C induction motors and gearmotors. Also new 32 and 42 frame PM D-C motors, gearmotors and speed controls.

32 pages packed with over 150 photos, charts, diagrams and graphs. Plus helpful information on proper selection and application, mounting, performance, safety, custom designing... Send for Catalog S-6, or see your Bodine Distributor (your *now* source for all items in Catalog S-6).

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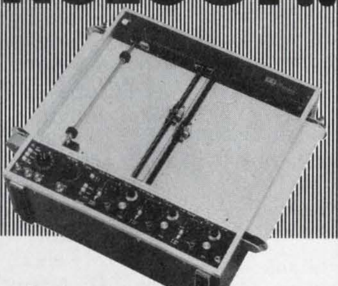
CIRCLE NUMBER 141

CHOCKED FULL OF TECHNOLOGY!!

Model D-72C Two Element X-Y, T Recorder



Features

1. Two element time axis
Model D-72C permits time recording by two systems; mechanical recording chart feed and time axis sweep by time.

2. High performance chart attraction
Troubles due to faulty attraction of the chart due to friction during chart feed has been completely eliminated regardless of the temperature or feed rate.

3. Automatic chart replacement in XY recording
The chart can be automatically fed and stopped at the end of chart replacement with one touch by loading roll chart.

4. Remote control terminals
- Pen up-down
- X-axis electronic time sweep trigger
- Mechanical time feed recording chart start/stop
- XY chart automatic replacement feed trigger

5. Easy-to-install optional chart take-up device (Optional)

6. Felt tip pen (Optional)

7. High input impedance 10MΩ fixed (Optional)

• *For further information, please contact:*

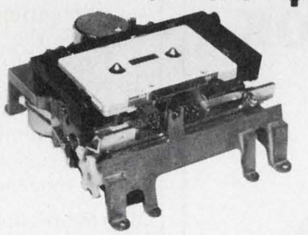
Riken Denshi Co., Ltd.

5-5-2, Yutenji, Meguro-ku, Tokyo, Japan. TELEX: 0246-8107

CIRCLE NUMBER 140

The

fabulous **Phi-Deck**® family of 5 **cassette transports** under **$100** in quantities of 10



Featuring:
- Die-cast frames
- Remote controllable
- Precise, fast head engage/disengage
- Quick braking
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Electronic packages and mag heads for most applications

For application in:

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3. Programming
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ELECTRONIC DESIGN's function is:

- To aid progress in the electronics manufacturing industry by promoting good design.
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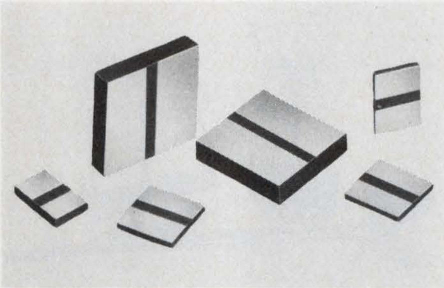

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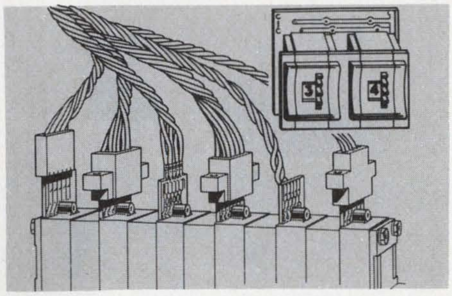

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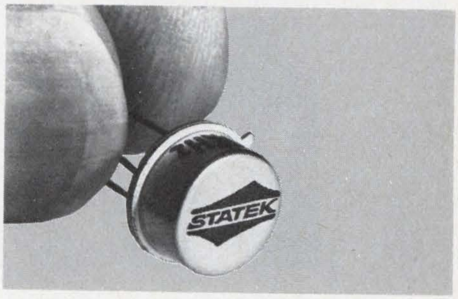

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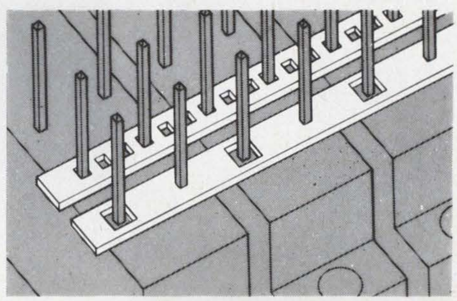

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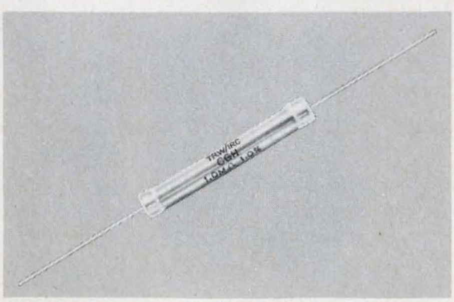
STRIP/BUS **188**



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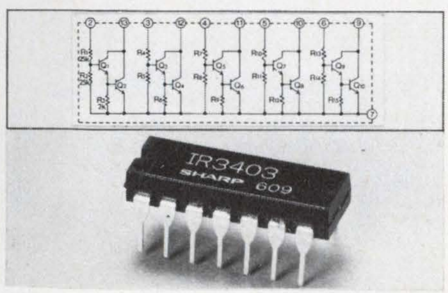

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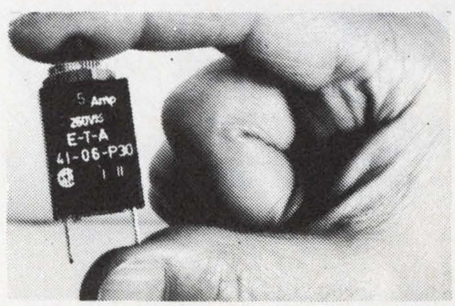

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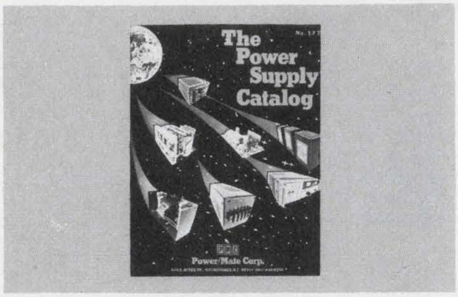

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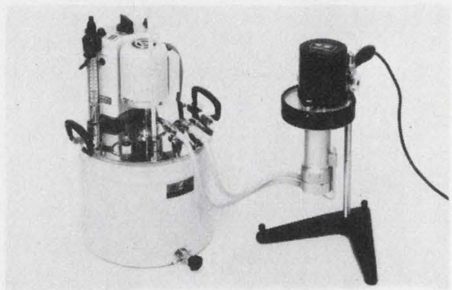

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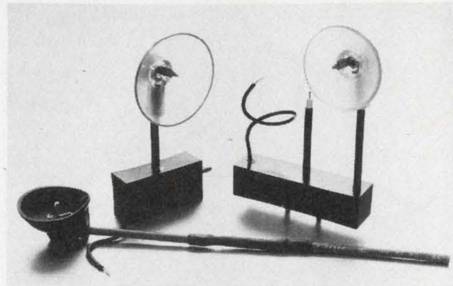

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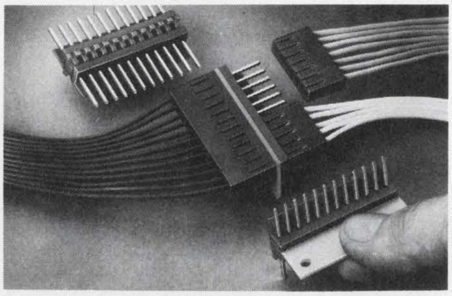

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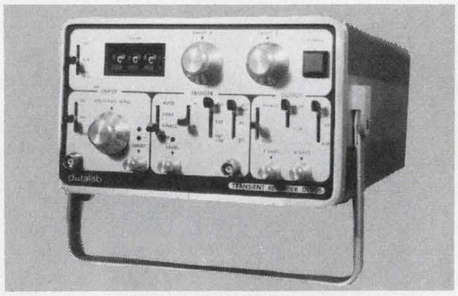

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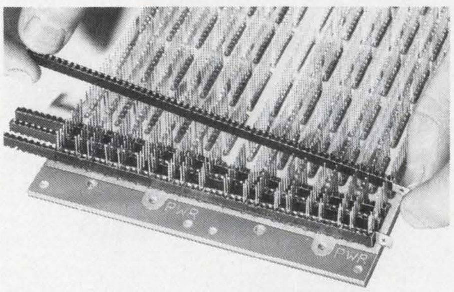

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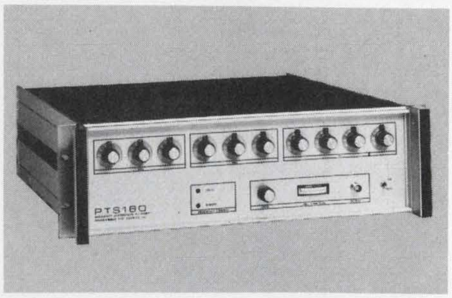

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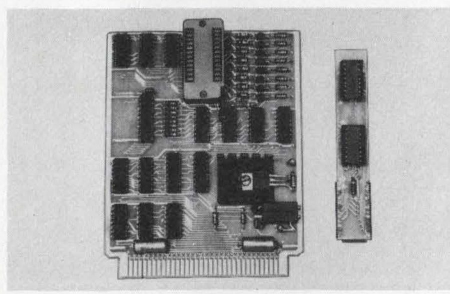

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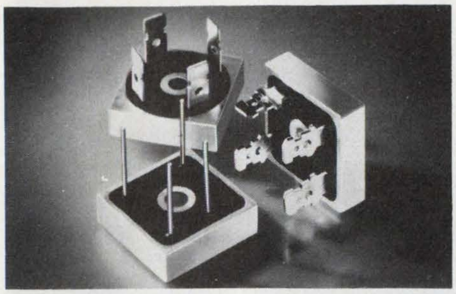
PROM PROGRAMMER **198**



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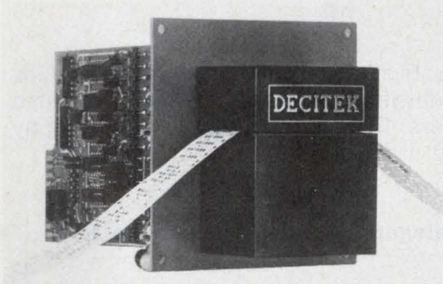

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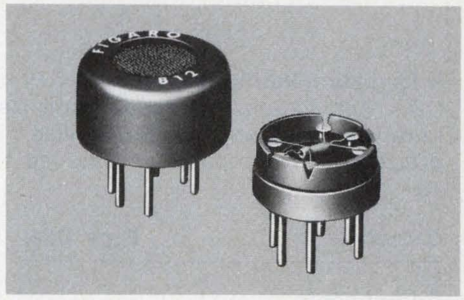

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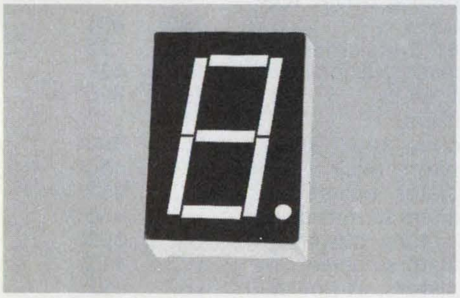

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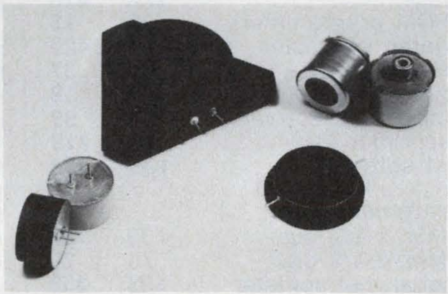

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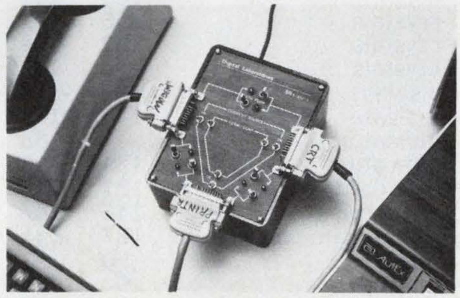

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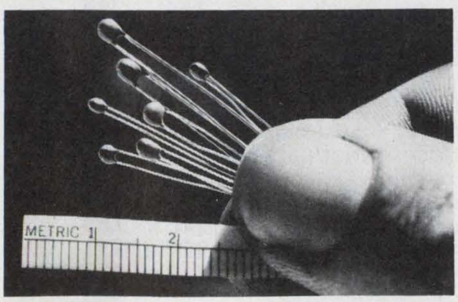

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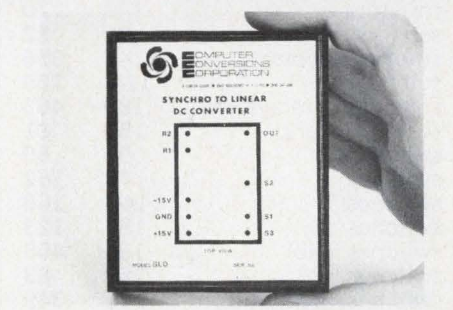

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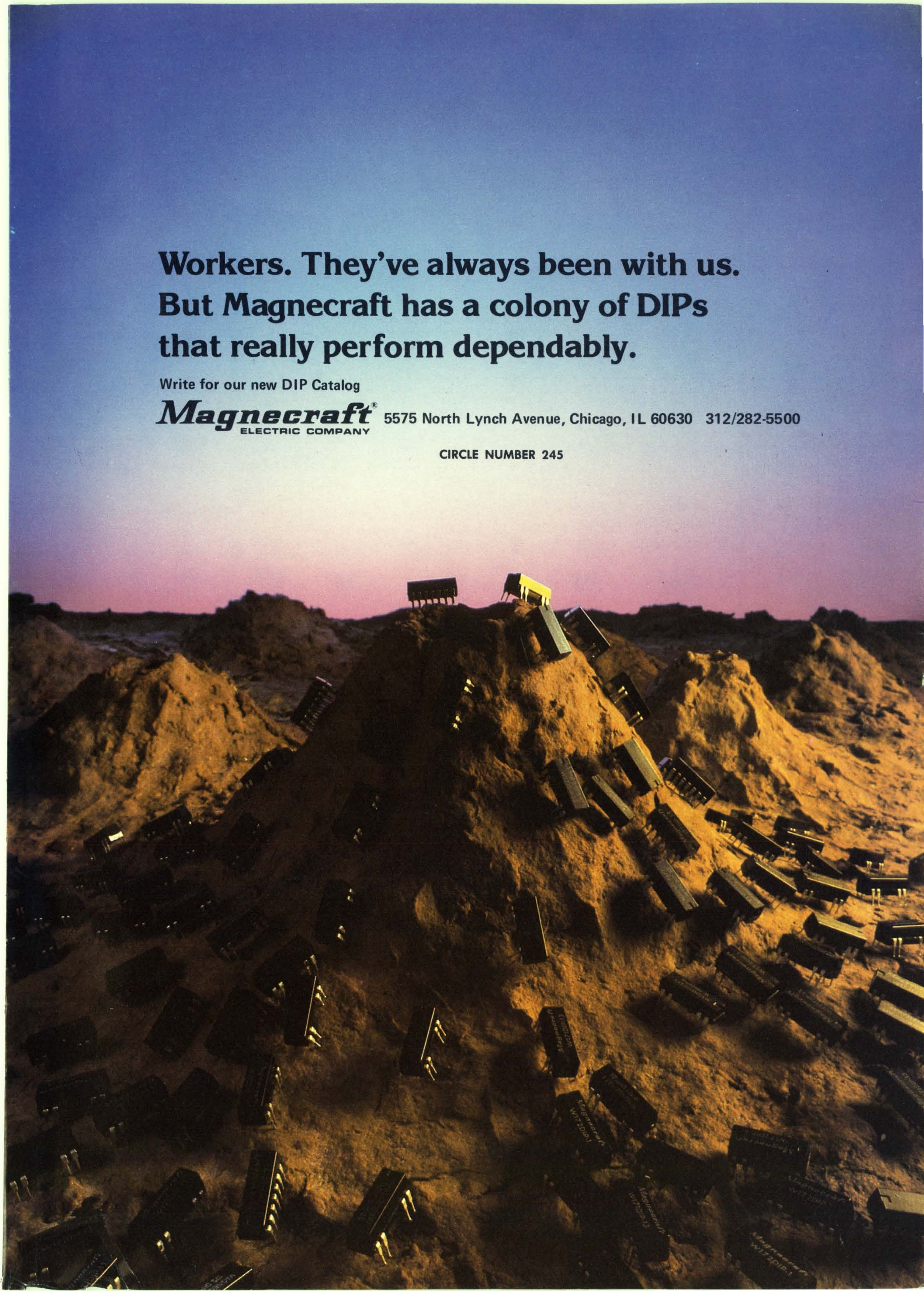

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