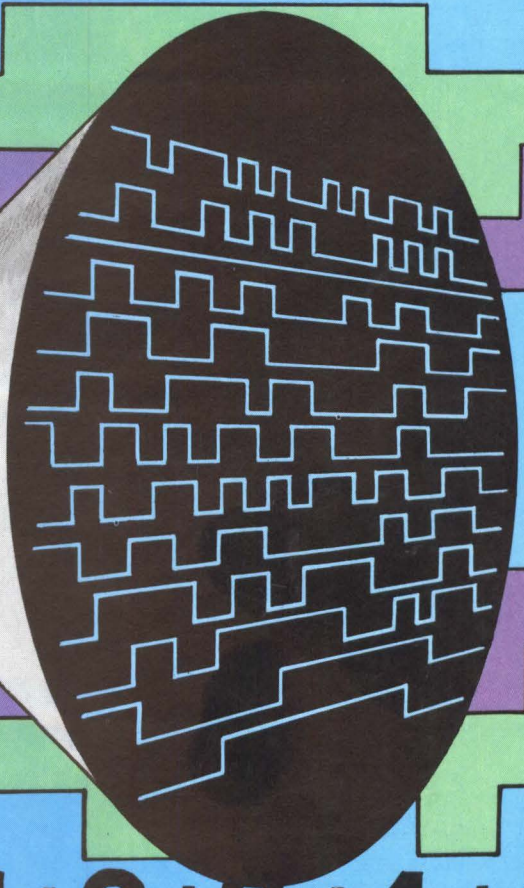
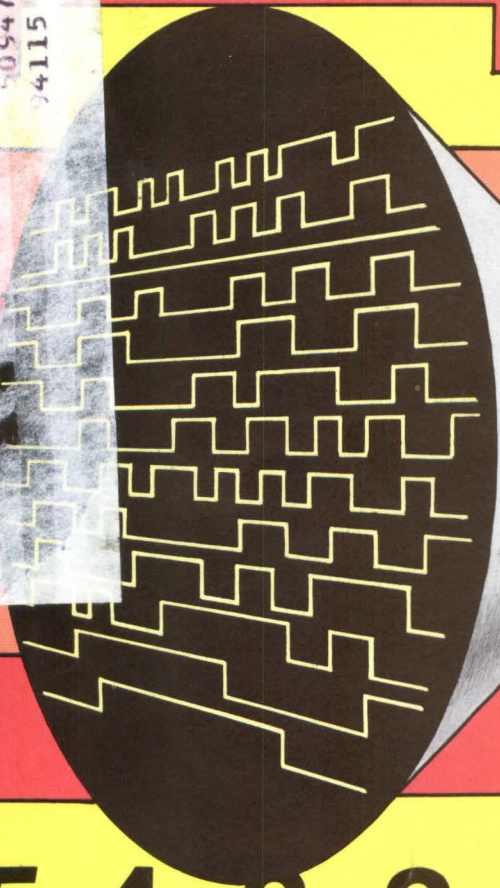


# COMPUTER DESIGN

THE MAGAZINE OF DIGITAL ELECTRONICS

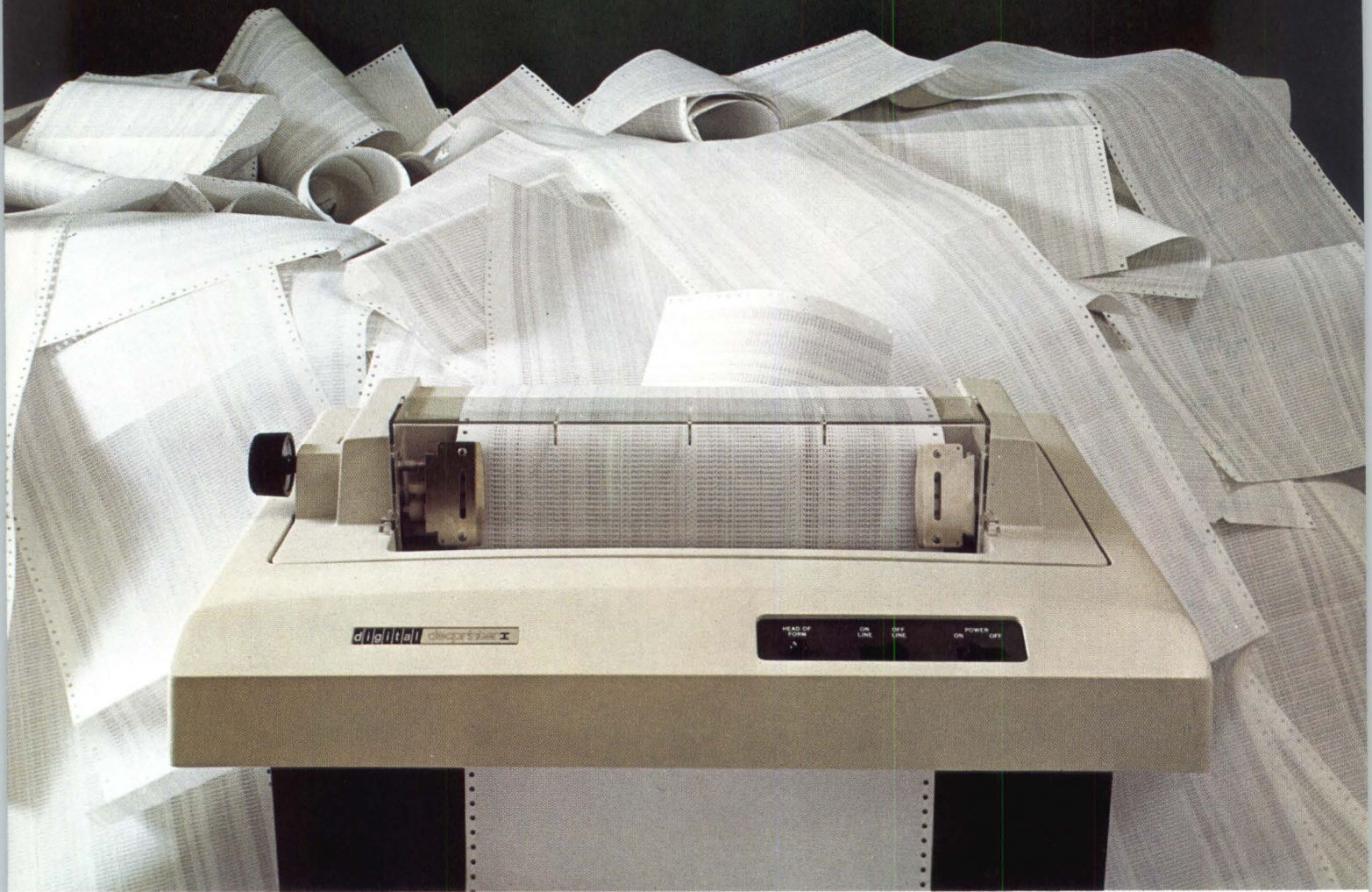
DECEMBER 1975



**-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5**

LOGIC ANALYZERS IN SYSTEM DEBUGGING MAKE TIME RUN BACKWARD  
MICROPROCESSOR TEST TECHNIQUE REVEALS PATTERN SENSITIVITY  
ELECTRO-OPTICAL SCAN CONVERTER SHARES BENEFITS OF CONVENTIONAL UNITS





## Our new LA180. You get more out of it because we put less into it.

Introducing the LA180 180-cps line printer.

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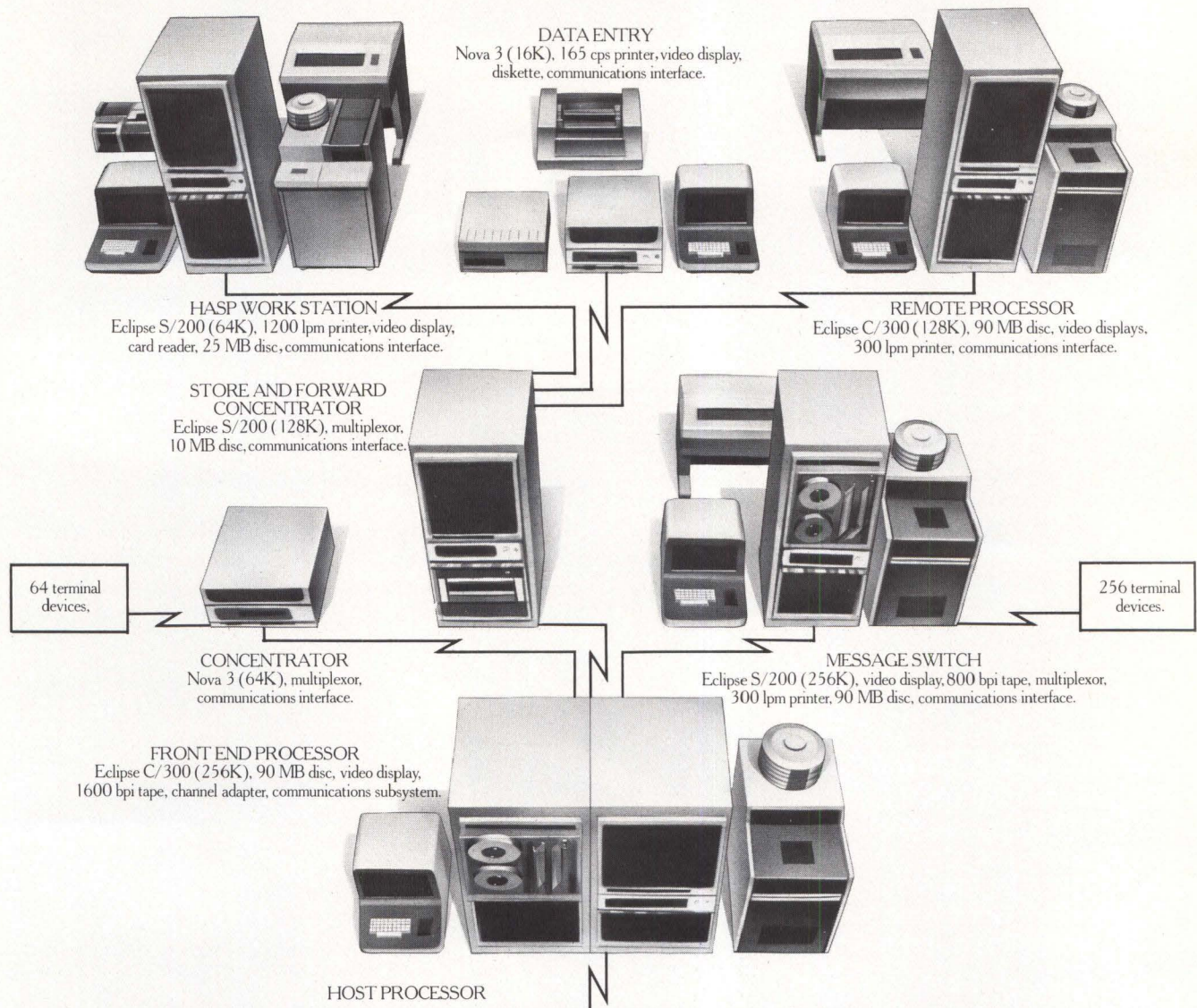
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CIRCLE 2 ON INQUIRY CARD



THE  
MAGAZINE  
OF DIGITAL  
ELECTRONICS  
**COMPUTER  
DESIGN**

DECEMBER 1975 • VOLUME 14 • NUMBER 12

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**FEATURES**

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**67 LOGIC ANALYZERS IN SYSTEM DEBUGGING  
MAKE TIME RUN BACKWARD**

by J. Carver Hill and Cliff Fiedler

Permitting direct observation of malfunctions, by establishing multichannel trigger criteria, obtaining true simultaneity on many channels, and recording pre- and post-trigger events, a logic analyzer can cut 30 to 50% off system debug time

**75 ELECTRO-OPTICAL SCAN CONVERTER  
SHARES BENEFITS OF CONVENTIONAL UNITS**

by Neil M. Poley

Adding a transmission scan converter grid to a storage vidicon tube results in a data conversion device with greatly increased functional capability at minimal cost

**81 MICROPROCESSOR TEST TECHNIQUE  
REVEALS INSTRUCTION PATTERN SENSITIVITY**

by Dick Hackmeister and Albert C. L. Chiang

Diagnostic emulation—a combination of pattern generation and pattern recognition testing techniques—provides the flexibility necessary to characterize today's microprocessors with their complex software

**97 CHOOSING THE CORRECT FLAT CABLE  
FOR HIGH SPEED LOGIC CIRCUITS**

by Stanley Sullwold

A comparison of crosstalk, attenuation, and impedance characteristics of three common flat cable configurations gives designers the information they need to make tradeoffs for their circuit design needs

**108 ELECTROSTATIC PLOTTER OFFERS HIGH VERTICAL ACCURACY  
ON NEARLY 72-INCH WIDE PLOT**

A printer and printer/plotter feature 0.3-mil vertical plotting accuracy and plot area of over 36 sq ft (nearly 72" wide). A dual microprocessor option provides system control and choice of programmable functions

**126 1975 COMPUTER DESIGN INDEX**

Here is a listing of all feature articles published this year

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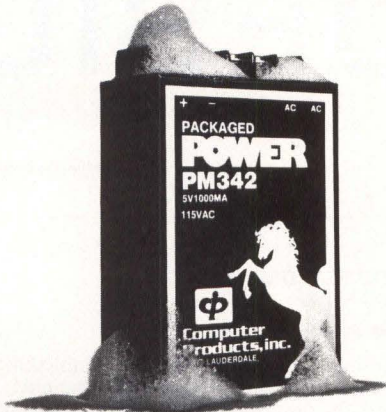
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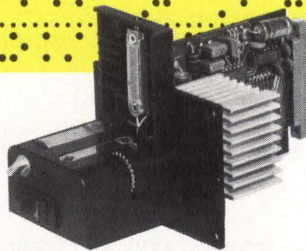
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CIRCLE 3 ON INQUIRY CARD

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CIRCLE 4 ON INQUIRY CARD

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COMPUTER DESIGN/DECEMBER 1975



# Dialight sees a need:

Need: A new computer-grade switch at a price you can afford.

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Dialight's low cost 554 series switches are available in a wide selection of rear panel and front bezel mounting types. Switches are available with silver or gold contacts for wide range of applications; operating life is 250,000 operations.

Fingertip grips permit easy cap removal . . . lamp replacement is from front of panel . . . no special tools needed.

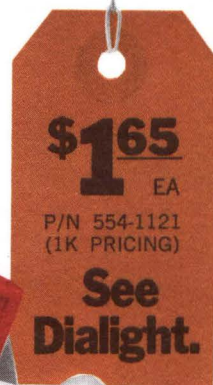
Caps are available with or without underlying color filter in

5/8" and 3/4" square, 5/8" x 3/4" and 3/4" x 1" rectangles. At Dialight it's your choice because we see your need.

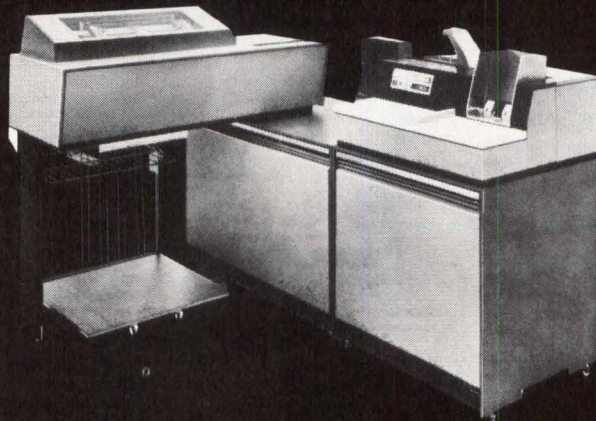
## DIALIGHT

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CIRCLE 5 ON INQUIRY CARD





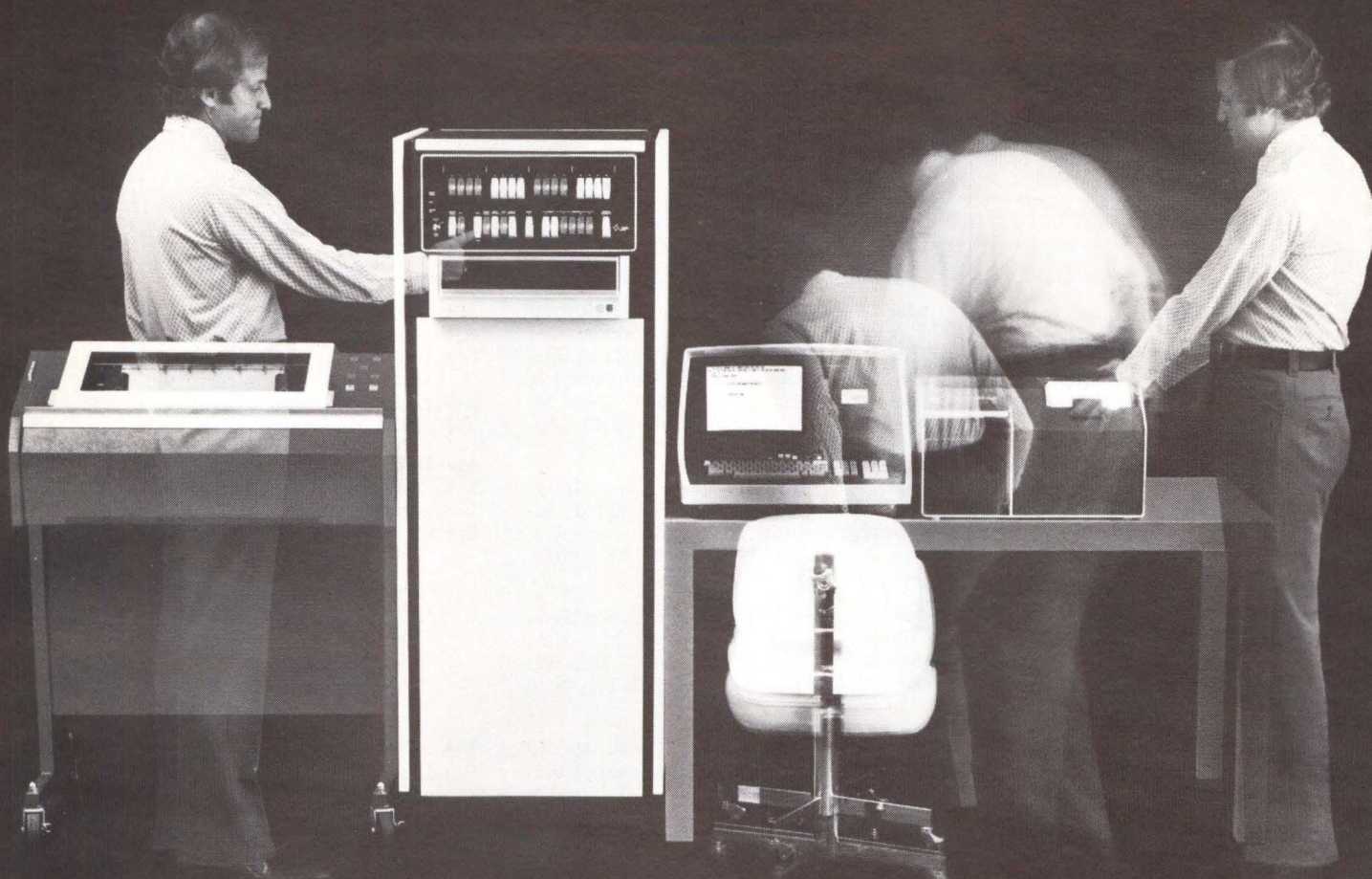


# THIS IS A REMOTE BATCH TERMINAL.

About all it can do is shuffle cards and do a little printing.

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# THIS IS MODCOMP'S REMOTE TERMINAL SYSTEM.

So much more. For so little more. The MODCOMP 3-in-1 Remote Terminal System.

It's an intelligent Remote Batch Terminal. It's a satellite computer. It's a stand-alone processor. All in one.

With it, remote offices or plants can handle a lot of their local computing. Locally. Without heavy charges for long distance dial-up lines to the central processor. And without ever sitting around drumming their fingers waiting for an answer.

MODCOMP RTS comes in three versions. So you can pick the one you need. Depending on what you need. All three systems will communicate with your IBM, Control Data or Univac central computer. Because with all three we throw in emulator software for IBM 2780/3780 and CDC 200UT terminals. Univac 1004 terminal and HASP work station emulators are also available.

One of these standard RTS packages will probably fit your needs just the way it is, right now. But the beauty of them all is that they can be added on to or changed at any time, to suit your own changing needs (add-on options include mag tape and other alternative peripherals).

And one thing you can be sure of. When you buy a MODCOMP Remote Terminal System, it's going to cost you a lot less than trying to get anywhere near the same performance anywhere else.

**MODCOMP RTS-1** As an intelligent RJE terminal, it is used to enter, transmit and receive data between the remote location and your central processor. When it's not doing that, its MODCOMP II computer with 64K bytes of core memory and dual floppy disc can take on a number of local computing tasks.

**MODCOMP RTS-2** (illustrated) The next step up, it can handle both remote batch and local processing simultaneously. And its moving head disc unit gives you a lot more storage capacity and computing speed.

**MODCOMP RTS-3** The block buster. With 128K bytes of memory, floating point hardware, plus a dual disc unit with 5-million bytes of storage. Running both remote and local processing concurrently, it can handle just about anything you throw its way.

For more information about Remote Terminal Systems, call your nearest MODCOMP sales office. Or write Modular Computer Systems, 1650 West McNab Road, Ft. Lauderdale, FL 33309. Phone (305) 974-1380  
European Headquarters: 103 Mytchett Road Mytchett, Surrey, England. Phone (0252) 514251

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# CALENDAR

## CONFERENCES

**Jan 19-21**—2nd Annual Sym on Computer Architecture, Fort Harrison Jack Tar Hotel, Clearwater, Fla. **Information:** Oscar N. Garcia, U of South Florida, College of Eng, Tampa, FL 33620. Tel: (813) 974-2581

**Feb 9**—FORTRAN Forum (immediately preceding ACM Computer Science Conf), Disneyland Hotel, Anaheim. **Information:** Donald Reifer, The Aerospace Corp, PO Box 92957, Los Angeles, CA 90009

**Feb 10-12**—4th Annual ACM Computer Science Conf, Disneyland Hotel, Anaheim, Calif. **Information:** Assoc for Computing Machinery, 1133 Ave of the Americas, New York, NY 10036. Tel: (212) 265-6300

**Feb 11-13**—Workshop on Data Structures & Pattern Recognition, Albuquerque, NM. **Information:** IEEE Computer Soc, PO Box 639, Silver Spring, MD 20901. Tel: (301) 439-7007

**Feb 18-20**—IEEE Internat'l Solid State Circuits Conf, Sheraton Hotel, Philadelphia, Pa. **Information:** Institute of Electrical & Electronics Engineers, 345 E 47th St, New York, NY 10017. Tel: (212) 752-6800

**Feb 18-20**—Winter Convention on Aerospace & Electronic Systems (WINCON), Sheraton-Universal Hotel, North Hollywood. **Information:** Richard L. Harmon or Russ Blaesing, 666 E Dyer Rd, Santa Ana, CA 92707. Tel: (714) 557-4700

**Feb 18-21**—IEEE 2nd Internat'l Conf on Telecommunication Switching Systems, Kongresshaus, Salzburg, Austria. **Information:** Annemarie Cunningham-Swendell, Institution of Electrical Engineers, Savoy Pl, London WC2R 0BL, England

**Feb 24-26**—COMPCON 76 Spring, Jack Tar Hotel, San Francisco, Calif. **Information:** IEEE Computer Soc, PO Box 639, Silver Spring, MD 20901. Tel: (301) 439-7007

**Mar 2-4** (Boston), **Mar 9-11** (New York City), **Apr 13-15** (Chicago), **May 4-6** (Los Angeles), **May 11-13** (San Francisco)—CompDesign/76 Tour. **Information:** Jack Edmonston, The Conference Co, 797 Washington St, Newton, MA 02160. Tel: (617) 965-5800

**Mar 4-6**—ACM Conf on Programming Micro/Minicomputers, Delta Towers Hotel, New Orleans, La. **Information:** Assoc for Computing Machinery, 1133 Ave of the Americas, New York, NY 10036. Tel: (212) 265-6300

**Mar 8-10**—IEEE Conf on Industrial Electronics & Control Instrumentation (IECI '76), Sheraton Hotel, Philadelphia, Pa. **Information:** Institute of Electrical & Electronics Engineers, 345 E 47th St, New York, NY 10017. Tel: (212) 752-6800

**Mar 9-11**—Electro-Optics/Laser Internat'l Exhibition, Brighton, England. **Information:** British Information Services, 845 Third Ave, New York, NY 10022. Tel: (212) 752-8400

**Mar 17-19**—9th Annual Simulation Sym, Tampa. **Information:** Ira M. Kay, Southern Simulation Service, Inc, PO Box 22573, Tampa, FL 33622. Tel: (813) 839-5201

**Mar 25** (Orange County, Calif), **Apr 13** (Cleveland, Ohio)—Invitational Computer Conf. **Information:** B. J. Johnson & Assoc, 300 Otero, Newport Beach, CA 92660. Tel: (714) 644-6037

**Apr 5-7**—IEEE Region 3 Conf & Exhibit (SOUTHEASTCON), Clemson House, Clemson U, Clemson, SC. **Information:** Dr J. T. Long, Gen'l Chm, E&CE Dept, Clemson U, Clemson, SC 29631. Tel: (803) 656-3376

**Apr 5-8**—Design Engineering Show/Amer Soc of Mechanical Engineers Conf, McCormick Place, Chicago, Ill. **Information:** Clapp & Poliak, Inc, Management, 245 Park Ave, New York, NY 10017. Tel: (212) 661-8410

**Apr 7-9**—IEEE Region 6 Conf on Energy for the Future, Braniff Place Hotel, Tucson, Ariz. **Information:** Institute of Electrical & Electronics Engineers, 345 E 47th St, New York, NY 10017. Tel: (212) 752-6800

**Apr 12-14**—IEEE Internat'l Conf on Acoustics, Speech, & Signal Processing, Marriott Hotel, Philadelphia, Pa. **Information:** Institute of Electrical & Electronics Engineers, 345 E 47th St, New York, NY 10017. Tel: (212) 752-6800

**Apr 20-22**—Sym on Computer Software Engineering, Barbizon Plaza Hotel, New York City. **Information:** Jerome Fox, Exec Sec'y, MRI Sym Comm, Polytechnic Institute of New York, 333 Jay St, Brooklyn, NY 11201. Tel: (212) 643-2393

**Apr 20-22**—Internat'l Reliability Physics Sym, Caesar's Palace, Las Vegas, Nev. **Information:** C. H. Zierdt, Jr, IRPS Publ Chm, Bell Laboratories, 555 Union Blvd, Allentown, PA 18103. Tel: (215) 439-7500

**Apr 27-29**—Internat'l Sym on Circuits & Systems, Technical U of Munich, Fed Rep of Germany. **Information:** Institute of Electrical & Electronics Engineers, 345 E 47th St, New York, NY 10017. Tel: (212) 752-6800

**Apr 27-29**—Internat'l Optical Computing Conf, Capri, Italy. **Information:** IEEE Computer Soc, PO Box 639, Silver Spring, MD 20901. Tel: (301) 439-7007

## SEMINARS

**Feb 2-4**—Digital Communications & Signal Processing Techniques, Concordia U. **Information:** Dr K. Feher, EE, Concordia U, 1455 de Maisoneuve West, Montreal, H3G 1M8, Canada. Tel: (514) 879-8049

**Mar 12-13**—Microcomputer Interfacing Workshop, Virginia Polytechnic Institute & State U, Blacksburg. **Information:** Dr Norris Bell, VPI&SU, Cont Ed Ctr, Blacksburg, VA 24061. Tel: (703) 951-6328

**Mar 21-26**—Digital Electronics for Automation & Instrumentation, Virginia Polytechnic Institute & State U, Blacksburg. **Information:** American Chemical Soc, Education Div, 1155 16th St, NW, Washington, DC 20036. Tel: (202) 872-4528

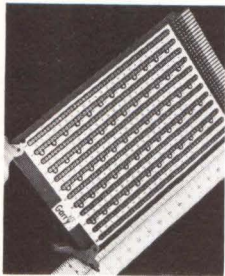
## SHORT COURSES

**Jan 5-9**—Minicomputers & Microprocessors in Instrumentation & Control; **Jan 19-23**—Operational Amplifiers; **Jan 22-23**—Minimizing Electrical Connector Costs; **Feb 2-3**—Uninterruptible Power Supply Design; **Feb 23-27**—Design of Optoelectronic Systems, U of Wisconsin, Madison/Milwaukee. **Information:** U of Wisconsin-Ext, Dept of Eng, 432 N Lake St, Madison, WI 53706. Tel: (608) 262-2061

**Feb 9-13**—Coding Techniques for Digital Communications, George Washington U. **Information:** Dir, Cont Ed, George Washington U, Washington, DC 20052. Tel: (202) 676-6106



## IC PLUGGABLE PACKAGING ASSEMBLIES NOW AVAILABLE IN METRIC SIZES



Metric-sized IC pluggable packaging assemblies are now available from Garry Manufacturing Co., of New Brunswick, N.J. These meet the needs of European electronic manufacturers and of the machine tool industry.

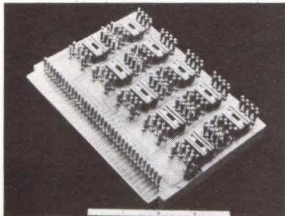
The new packaging assemblies can be obtained in many metric sizes, including: 100 mm x 160 mm.

The new metric boards offer large solder-plated ground and voltage plane area, and are offered with or without decoupling capacitors. Board is fabricated from glass epoxy 94V2.

Options include committed or non-committed power and ground planes. Contact pins in a variety of lengths permit one-, two-, or three-level wire wrapping. Pins are available in various thicknesses of gold over ductile nickel.

For complete information, use the Reader Service Card or contact Garry Manufacturing Co., 1010 Jersey Avenue, New Brunswick, N.J. Telephone 201-545-2424.

## NEW SOLDERLESS BREADBOARDS FOR EXPERIMENT AND TEST



NEW BRUNSWICK, N.J.

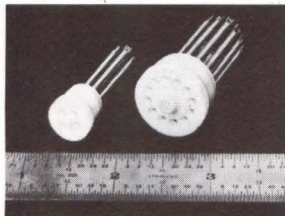
— A new series of plug-in breadboards is now available from Garry Manufacturing Company, of New Brunswick, N.J. Created to facilitate prototype design, experimentation, and testing of circuitry without the need for

hardwiring, the new boards accommodate 14- or 16-pin DIPs and other packages, and are made in various sizes to accept from one up to as many as 50 integrated circuits.

Principal feature of the new boards is that they employ plug-in socket pins instead of the usual wire-wrappable or solderable connections. Thus, reliable yet temporary circuit interconnections can be quickly made and quickly changed during the course of design or test.

For complete information, use the Reader Service Card or contact Garry Manufacturing Co., 1010 Jersey Avenue, New Brunswick, N.J. Telephone 201-545-2424.

## NEW TEST SOCKETS FOR TRANSISTORS



NEW BRUNSWICK, N.J.

— A new line of test sockets, which accept the uncut leads of transistors, is now available from Garry Manufacturing Co., of New Brunswick, N.J. The new sockets have smoothly chamfered entry holes for fast insertion,

and long, gold-over-nickel-plated beryllium copper elements that make reliable contact with the leads of the inserted components.

The sockets are available for three- to twelve-lead components, with pin circle diameters ranging from 0.200 inch to 0.510 inch. They are made in two basic versions: one to accept leads of 0.187 inch minimum length, the other for leads of 0.500 inch minimum length. Both accept leads ranging from 0.015 to 0.032 inch diameter. Contact resistance is 0.015 Ohm, maximum.

For complete information, use the Reader Service Card or contact Garry Manufacturing Co., 1010 Jersey Avenue, New Brunswick, N.J. Telephone 201-545-2424.

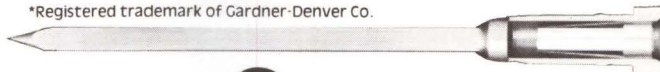
# Joan Borst is doing 5 to 10 on a bum wrap.

Joan should've talked to Garry. Instead of condemning her to a faulty Wire Wrap\*, we would've given her a wrap that worked. With pin squareness that's exactly .025 inch. A precision beryllium spring clip that has the most consistent IC insertion/withdrawal rate in the industry. And the widest line in the industry.

In short, we would've given her a good wrap. Backed up by a complete IC packaging facility (boards, headers, wrapping, racks), as well as dependable service, good prices and fast delivery.

Ask us about it. We won't pin a bum wrap on you. Garry Manufacturing, 1010 Jersey Avenue, New Brunswick, New Jersey 08902. (201) 545-2424.

\*Registered trademark of Gardner-Denver Co.



# Garry

Manufacturing Co.

**We won't pin a bum wrap on you.**





by **John E. Buckley**  
Telecommunications Management Corp  
Cornwells Heights, Pa.

## Network Node Criteria

Recently, interest has been increasing in packet switching, intelligent networks, and distributive networks—terms which describe the concept of providing intelligibility to a communications network. Such a network comprises a number of geographically dispersed nodes or remote processors. The nodes are interconnected by one or more communication channels, enabling multiple routing between remote input/output (I/O) devices and the centralized processing site. The data processing industry has long been aware of the concept of centralized data processing, yet each application must justify its own direct access from remote terminals directly to the centralized processing site. The intelligent network concept considers the information processing site to be essentially surrounded by a centralized access network. Remote terminals are required merely to achieve access to their nearest node. Long-distance transmission to the processing site is then accomplished and controlled by the network itself.

The focal point for a centralized data access network is the structure and design of the processing elements at each network node. These processors interface to the remote terminals and network channels. In addition, one or more of these nodes would be connected with the processing site. The interface to the centralized site is considered another I/O port, even though the data transmission rate and associated data volume for that port may be significantly higher than at any other port.

Seven major functions must be resolved to insure proper design of a

network node, and the range of choices for each can be extensive. Proper selection of specific functional characteristics in each of these criteria is directly influenced by the nature of the application intended to use the resulting centralized data access network. The network can be developed and implemented either on a limited functional basis, restricting the scope of its applicability, or with increased node complexity, for unlimited application flexibility.

System designers considering the centralized data access network concept should review and resolve these seven items with respect to the particular applications defined or projected for the network: data code sensitivity, protocol sensitivity, timing sensitivity, data rates, packet formation, packet routing, and data storage. There is an equation of reality that must be constantly balanced; that is, the more application flexibility desired, the more network complexity and, hence, costs increase. Furthermore, cost in this instance does not merely include that of developing and implementing the network but also, more importantly, of operating and maintaining a viable network.

### Data Code Sensitivity

One of three levels of data code sensitivity can be selected. In its simplest form, the node need only define a particular byte length. The node is essentially transparent to the data flow and requires only that information exchanged through the network exhibit consistent character or byte length. The next level requires the node to recognize only

the control codes in the data flow—necessary if the node were to be transparent to the information content in the data flow but required to respond to the data protocol.

The third level permits the node to be totally aware of both the control and information data codes. This degree of sensitivity is necessary if the node is expected to respond to the data content, such as performing code translation between the native code of the remote terminal and the data code environment of the centralized processing system.

### Protocol Sensitivity

This also offers three levels of sophistication. In its basic form, the node can be defined as having no protocol awareness, which also implies that only unsophisticated remote terminal devices will be utilized. The second level permits limited protocol interaction between the node and remote terminal. Such interaction would be limited to controlled responses by the node. Remote terminals having a data flow timing constraint, such as a block response, require that the node at least be able to detect the control codes and respond to the generalized flow of information being exchanged with the terminal.

Full protocol sensitivity implies that the node is capable of both control and information response. Not only is the protocol participated in by the node but the information content is also tested and verified. Full protocol sensitivity adds significant complexity to each node as well as limiting the types of associated terminal devices. Sensitivity to different protocol procedures may also



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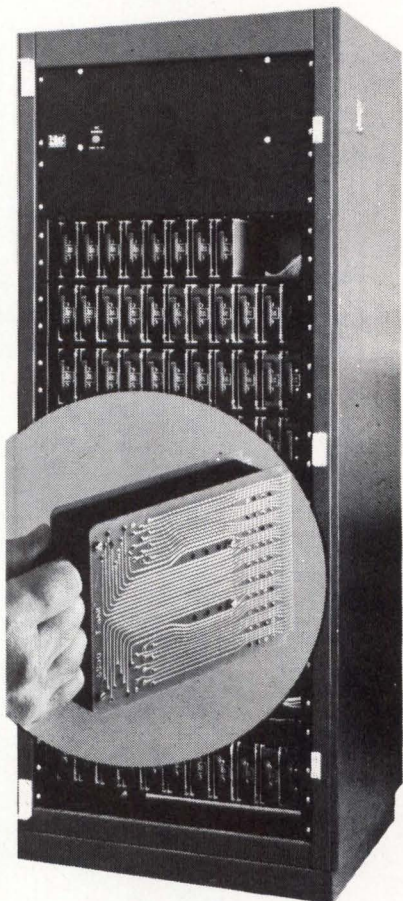


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be required if different terminals are expected to utilize the network; node complexity then increases dramatically. Functions such as node/transmission error control procedures, data format checking, and data entry verification require full protocol sensitivity.

## Timing Sensitivity

The basic timing method for accessing the network node is asynchronous timing only, which limits the transmission rate to under 1800 bits/s, and significantly constrains the choice of compatible terminal devices. Synchronous timing means operation only at rates of 2000 bits/s and higher. In addition, synchronously timed data exchange requires that both the terminals and node recognize a specific synchronization character and synchronization pattern. Maximum flexibility with respect to timing sensitivity at a network node would permit both synchronous and asynchronous timing to be used by the remote terminal devices. Due to the totally different functional requirements necessary to operate with these timing methods, specific ports must be equipped for each. Maximum efficiency for inter-node communication would typically be achieved on a synchronously timed basis.

## Data Rates

Design with respect to data rates also provides three alternatives. A basic design for a simplified node is a common data rate for all I/O transfers, although permitting a port to operate at different rates within a reasonable range is more common. Variable rates over a common port is limited to asynchronous timing.

For ports using synchronous timing, a specific data rate must be established. Due to the nature of higher speed modems, the digital data and timing clock relationships must be clearly established and maintained by both port and modem.

## Packet Formation

Once the information is gathered within the node, packet formation must be determined. If the node is control-code sensitive, the information data may be extracted from the data flow and put into packets

or blocks to be transported to the node associated with the data destination. For a node having limited or no protocol sensitivity, the packet formation must be constructed to include both control and information characters. In addition, in order to maintain data flow synchronization, the relationship between these characters must be maintained upon delivery of the packets to the destination device.

## Packet Routing

To properly route the packets over the trunks available within the network, a common addressing convention must be established. The data destination address may be provided by the remote device, which requires at least control code sensitivity. If a predetermined data destination address for a specific port is established, the designer will have decided that all information received over that port will always be delivered to the same destination device.

The most basic of the three packet routing methods is to have only one possible route to the data destination node. If that route is busy or inoperative, the originating node must either store the packets of information or reject any data input from the remote device until the channel becomes available. The second level is limited alternate routing, with the most direct channel being the primary route; however, in the event of a malfunction or congestion, the packets could be transmitted to another node and retransmitted to the desired destination over a different path.

If alternate routing is selected, significant queuing and traffic engineering statistical studies must be conducted to insure that it does not create adverse traffic constraints within other portions of the network. Alternate routing carried to an extreme is called universal routing; that is, a packet can be routed over any possible alternate route. Any combination of nodes and trunks may be utilized to transport the packet to the desired data destination node. With alternate routing, other functions must be added to the network to insure that the packets are delivered by the destination node in the same sequence as received by the originating node. Techniques for using transmission or node serial



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numbers and the corresponding recognition and processing of these serial numbers, including procedures to correct packets that are out of sequence, must be established. Because alternate routing also introduces the possibility that a packet could continuously travel throughout the network without ever reaching the desired data destination node, a time limitation must be established for each packet in transit within the network. If a node recognizes that a particular packet is beyond its allowance in network time, recovery procedures must be implemented.

## Data Storage

Actual storage information within the network can be provided in three levels. The most basic is that no data storage is permitted in any of the nodes. If a channel constraint occurs, all input data from the remote devices are halted, and data storage capacity at the various nodes is limited to the maximum volume of packets expected to be transmitted at any point in time. Limited packet storage within the various nodes requires more storage than the non-queued node; its capacity is dictated by the necessity for any transmission delays. The third level is unlimited node storage, which provides for the node to store an unlimited number of packets in the event of a constraint within the network. The remote devices are always able to off-load their data to the associated node, which can store an unlimited quantity of data packets until transmission to the desired data destination node is accomplished.

The growing requirement for centralized data access networks is encouraged by lower cost processing developments. These can provide the data information system user with opportunities for more efficient and reliable transmission networks. The ultimate value of these new network concepts, however, is directly dependent upon the insight that has been applied by development personnel during initial network planning and specification phases. Although further opportunities to optimize information data systems are being provided, if left in the hands of inexperienced system design personnel, they could introduce greater opportunities for system disaster. □

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Using a noncontact clamp-on probe, dynamically stabilized to automatically correct for different magnetic conditions, the instrument introduces virtually no load on dc readings and extremely low inductance on ac readings, and provides direct indication of current on a 3½-digit LED readout. A peak, read-and-hold feature permits peak currents of a time-varying waveform to be read and held, allowing measurements of difficult transient currents. High resolution and wide dynamic range are enhanced through a special circuit design coupled with the digital readout. Internal rechargeable batteries permit completely portable operation.

Operating on the principle of Ampere's Law, the probe consists of a magnetic core and Hall generator. The core serves to concentrate the magnetic field and to approximate the line integral; the generator senses the magnetic field and provides a current proportional voltage to the digital current instrument.

In ac mode, the current's ac component is measured; in dc mode, the dc total. Knowing this permits the user to make measurements for circuit design, such as in power supplies, or in troubleshooting operations. The meter can also be used to measure percentage ripple current.

Basis of the unit's performance is circuitry that provides for a stabilizing pulse to be fed back to the current probe, thus modifying the performance of the material used. One problem in using magnetic materials to measure currents lies in the inherent property of the material to maintain some level of magnetization after having been exposed to a magnetizing force.

Silicon steel offers a high saturation flux density, but has large remanent field; when used alone a large error, in terms of magnetic bias at low levels, would result from past high level operation. On the other hand, molypermalloy has a low saturating flux density, which limits the dynamic range, but its low remanent field increases the accuracy. A stabilizing circuit within the current meter allows the accuracy of molypermalloy to be obtained with the high saturation density of steel through modification of the performance characteristics of silicon steel.

Current probes are available for each current range with digital meter autoranging; each is dynamically stabilized to automatically correct for different magnetic conditions. The signal is amplified and conditioned to provide features and outputs of the digital current meter. Conductors external to the current probe code normally will not affect the reading.

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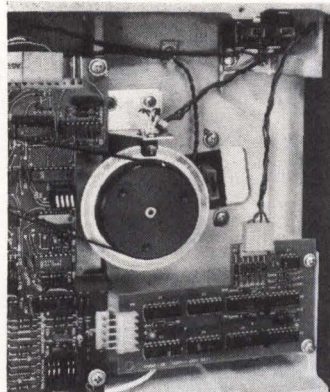
Increasing total capability of flexible disc technology while reducing the logic requirement in the host system, the RFD 7400E, a universal drive, incorporates standard features that enable users to expand from basic IBM compatibility to enhanced performance. IBM-formatted soft-sectored diskettes and 32-hole hard-sectored discs are accepted in the same unit. Four drives can be con-

trolled by one set of drivers and receivers; and up to four drives can seek new tracks simultaneously. In addition, a self-contained dc-dc converter eliminates the need for a negative voltage to be supplied by the host system.

Developed by Remex, a unit of Ex-Cell-O Corp., 1733 Alton St, Santa Ana, CA 92705, the portable diskette drive mechanism consists of belt-driven spindle, spindle motor, read/write head mounted on a stepping motor drive mechanism for track accessing, indexing LED and photo-transistor, and a printed circuit board that provides all required internal electronic functions. The unit is media and format compatible with the IBM 3740 data entry system and 3540 diskette I/O drive; IBM-equivalent recording levels and compatible bit-packing densities in all tracks are used. In addition, the drive will operate in non-IBM soft-sectored mode, providing a choice of 2, 4, 8, 16, or 32 sectors/track. It may be used with a 32-hole sectored disc, or with the hard-sector option, which furnishes an internally generated sync signal.

Providing index signals to the host equipment for either hard- or soft-sector operation, the device's sector option circuitry functions by sensing sector holes in a 32-hole media for hard-sector format and transmitting sector pulses to the host system. To hard sector a single-hole media, the sector generator option is used to provide 32 sector signals per revolution to the host, allowing the disc to be divided into the desired number of sectors per track.

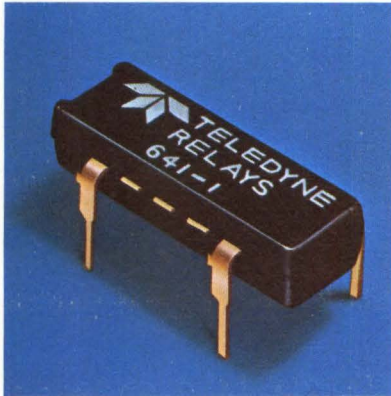
When this option is used, the driver generates the signals by sensing slots in a code wheel attached to the disc



Remex' RFD7400E floppy-disc drive accepts soft-sectored diskettes and 32-hole hard-sectored discs. A single-hole diskette may be divided into 2, 4, 8, 16, or 32 sectors using the sector generator option, which attaches a code wheel (center photo) to the drive spindle and associated electronics to provide the host system with 32 pulses per revolution

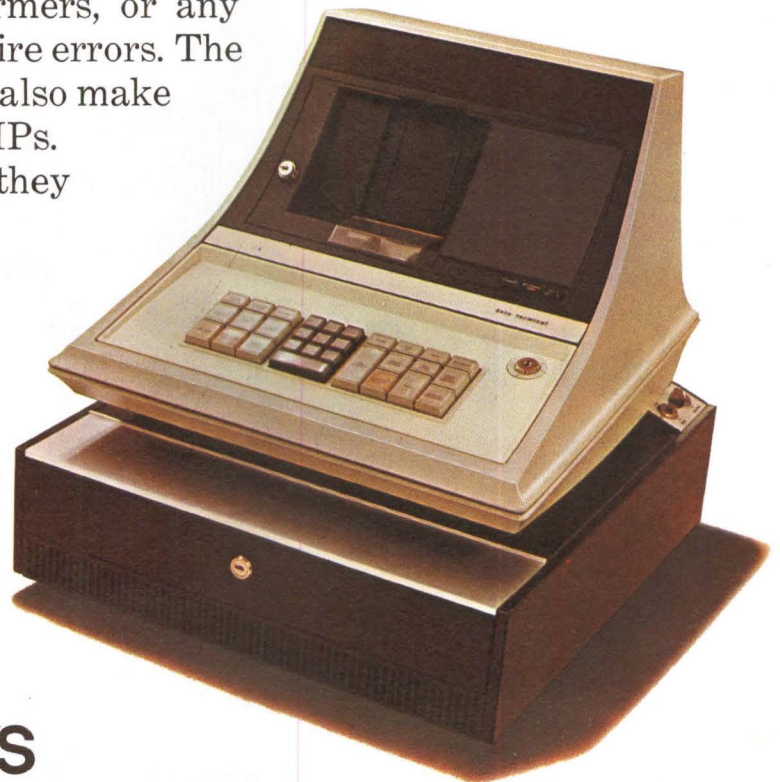
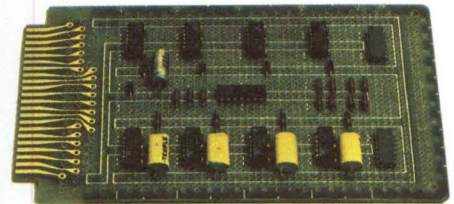


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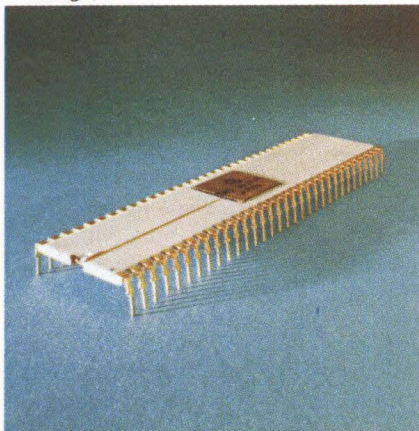
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drive spindle. Sector pulses are accurately related in time/position to the index hole in the diskette. The code wheel consists of a stainless-steel disc with 256 slots around its circumference. An LED/photocell combination senses the slots as the wheel rotates. Sector generator circuits are located on an optional printed circuit board which plugs into a connector on the main drive printed circuit card.

By including its own drive-select code decoding circuitry and permitting the address code of an individual drive to be changed by user manipulation of a simple set of switches, the unit eliminates the necessity for the host system to provide drive-select decode circuitry and permits users to swap drives without physically interchanging them. Overlap seek capability allows up to four drives to simultaneously seek new tracks while the CPU communicates with another peripheral or performs other operations. After receiving a seek signal, the drive will perform the 6-ms step and return an interrupt to the host system. The self-contained dc-dc power converter releases the host from the necessity of providing regulated  $\pm 15$ -V power; it need supply only 5 and 24 V. This serves to improve noise immunity, and eliminate ground loops and decoupling problems inherent in many single-source power distribution systems.

The standard unit is specified to provide  $1.94 \times 10^6$ -bits capacity on an IBM-initialized diskette; unformatted capacity is  $401 \times 10^3$  bytes using 2-frequency encoding techniques. Transfer rate is  $31.25 \times 10^3$  bytes/s at 360 rpm.

Circle 141 on Inquiry Card

## BASIC Language Desktop Computing System Provides Graphics Display

A compact data system that combines high level BASIC language interaction, built-in computing, local tape memory, and graphics capabilities, the 4051 BASIC Graphic Computing System puts problem-solving power on a desktop. Consisting of 11"-diagonal CRT, alphanumeric keyboard plus control keys and numeric keypad, and built-in 3M cartridge tape drive capable of storing 300



Incorporating up to 32K of random-access memory plus a magnetic tape unit, Tektronix' 4051 computing system uses an extended BASIC language for easy access and to provide graphics capability. The unit operates on or offline, and readily interfaces with peripherals such as the 4631 hardcopy unit shown with it

kilobytes of data, the 4051, from Tektronix, Inc, Information Display Group, PO Box 500, Beaverton, OR 97005, includes a firmware implementation of BASIC with 8 kilobytes of workspace. Memory options include 8K, 16K, and 24K add-ons.

Processing power comes from the Motorola 6800 microprocessor. The operating system is housed in a 32K ROM. A ROM backpack is capable of accepting two 8-kilobyte extended-function ROM packs, providing storage for heavily used subprograms without using available memory space. While the BASIC language allows easy English-like access to the computer, extensions provide special graphic primitives, file system data access, matrices for graphic manipulation, string functions for text handling, and high level interrupts to access the processor.

System capabilities are multiplied with the RS-232-C communications option, complete with built-in firmware for interactive data communications mode selection. In terminal mode, keyboard input goes direct to the mainframe, returning data or graphics to the CRT screen; in communications mode, the internal tape unit appears to the mainframe like a paper tape unit, allowing data to be sent/received via tape at asynchronous speeds up to 2400 baud.

Also optional for use with the 4051 are the 4631 hardcopy unit, which produces a high resolution copy of the display; the 4924 magnetic tape unit, designed as an extension of the internal tape file system, provides data I/O and tape

copying, reading and writing at 30 in./s, searching at 90 in./s. Also available are the 4662 digital plotter with hardware page scaling and alphanumeric capability for offline plotting, and the 4952 Option 2 Joystick for use in positioning the graphic cursor.

An I/O connector at the back of the unit guarantees compatibility with state-of-the-art peripherals. It meets the IEEE standard (488-1975) requirements for programmable instruments, and can handle multiple devices simultaneously in a daisy chain. The RS-232-C connector provides a printer interface, outputting the proper format to drive printer, printing terminal, or other compatible peripheral.

Included in the machine's \$6995 base price are a tutorial program covering keyboard operation, use of tape, and graphics commands; operator's manual; and PLOT-50 graphics software. Also available are statistics, mathematics, and electrical engineering applications-oriented software packages.

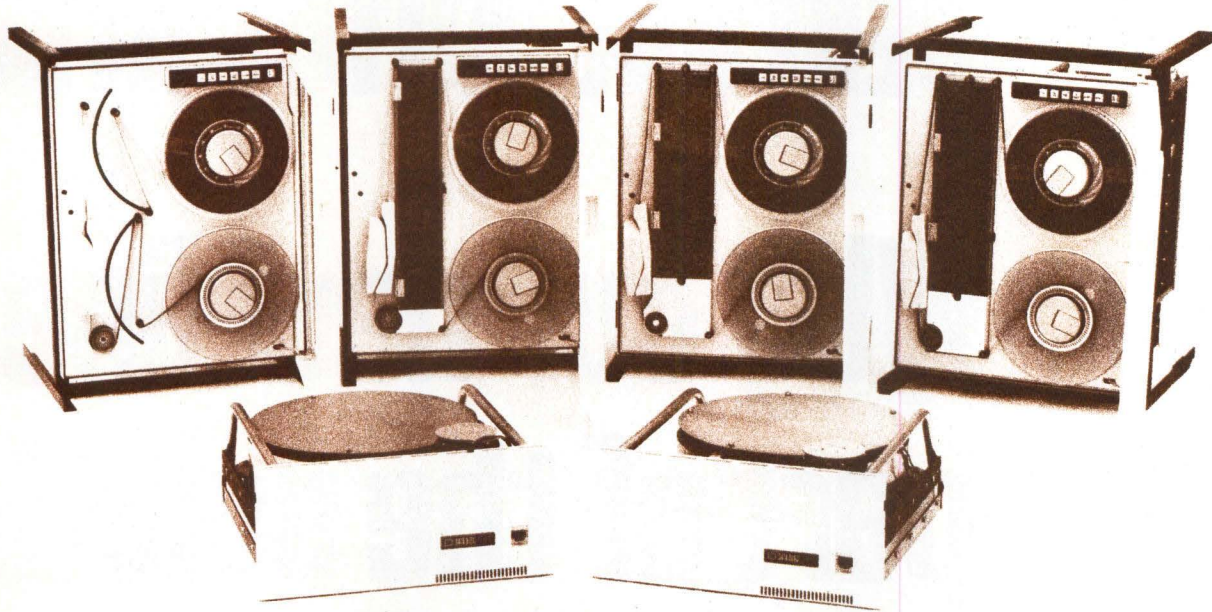
Circle 142 on Inquiry Card

## Commercially Available CCD Memory System Stores 1 Megabit/Card

Storing more than 1 million bits of data per plug-in card, the in-65 CCD semiconductor memory is designed to replace magnetic drum memories or small- to medium-capacity disc mem-



# What do you get when you merge the speed of Bright with the technology of Data Disc?



## You get better.

You get better disc and tape drive capability—and from one vendor. The company whose disc dependability has been proven for well over a decade is the same company you can rely on for state-of-the-art tape drives.

Through the years you've learned both the name and the dependability of Data Disc and our head-per-track disc drives. Choose from the 8400 Series, with storage capabilities from 2.4 to 19.2 million bits, or the new ruggedized 8500 Series, with its storage of up to 38.4 million bits. Both have 8.6 milliseconds (3600 rpm) or 17.2 milliseconds (1800 rpm) average access time.

The Bright line of tape drives are of equal quality. Three speeds—45, 75, and the new 125 ips—and two drive types (tension arm or vacuum column). Four compatible models give you a varied and necessary breadth of line. Add that to 80% parts commonality and you've eliminated costly inventory and training requirements.

**DATA DISC** tape and disc drives:  
Leading-edge-of-the-technology equipment designed for the user who wants the engineering support of a high-technology company along with the dependability of field-tested and proven systems.



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(408) 732-7330



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Mr. Sam Lane, General Automation, Inc.,  
1055 South East Street, Anaheim, California 92805; (714) 778-4800

CIRCLE 16 ON INQUIRY CARD



ory peripherals, or to function in high resolution or multiterminal CRT systems. Developed by Intel Corp, Memory Systems Div, 1302 N Mathilda Ave, Sunnyvale, CA 94086, the memory system is built around the 2416 CCD serial memory (see *Computer Design*, May 1975, p 26), and has a data density that is four to 16 times greater than previous semiconductor memory systems.

High density is accompanied by a corresponding reduction in the number of memory circuits per system, resulting in reduced system size, weight, power, assembly cost, and cooling and maintenance requirements. In addition, high density and solid-state design make the memories more compatible with mainframe logic and other forms of semiconductor memory.

Seen as major advantages over drum and disc memories are shorter latency times, faster data transfer, and improved reliability and maintainability. By using various combinations of random access and serial shift operations, a variety of data storage formats are possible with the same basic plug-in cards. The system can be used as a peripheral or as a memory plugged directly into the mainframe.

Basic module is the MU-65-8 memory card, which stores 128 kilobytes, accessible in single-bit serial or parallel word modes. The two support cards consist of control unit, a general-purpose system control and buffering card, which handles up to 1 megabyte; and the BU-65 buffer unit, which is used with a control unit to implement word lengths of two or more bytes, providing supplemental data registers and control signal buffers for each additional byte.

Basic 128-kilobyte cards, measuring 12 x 15", are organized as two interleaved 64K banks. They accommodate 8-bit byte-lengths by forming each bank of 32 CCD devices; for 9-bit bytes, there are 36 devices in each bank. Each card emulates a high speed drum with eight read/write heads, or a serial disc track if serial transfers are preferred. Memory expands to any word length by chaining card modules; any capacity is attained by paralleling cards. Block lengths can range from a single bit to the full capacity of the system.

Use of interleaved banks reduces the effective minimum shift cycle to 550 ns during data transfers, pro-

viding a range from tens of kilobits up to 1.8 megabits/s per card. Since registers are only 256 bits long, average serial access time is as little as 96  $\mu$ s. As a result, the system can access data 10 to 100 times faster than rotating magnetic media, and virtually eliminates peripheral latency. Chaining cards multiplies the rate—to more than 15 megabits, for example, with 36-bit word lengths.

The in-65 uses the ability to randomly access registers and serially access bit locations by operating as a block-oriented random access memory. Blocks are accessed randomly, then data within the blocks are accessed serially. Block lengths are variable since they are governed by the access codes of the system using the memory. In addition, read and write cycles can be mixed between individual random accesses, and data can be transferred in word-parallel or bit-serial mode.

Because the control unit implements these operating features and allows the using system to govern storage formats with normal drum- or disc-addressing codes and govern shift and transfer rates over a wide range, as well as select parallel or serial transfer, the system readily emulates many types of discs or drums or can create formats for specific applications.

Circle 143 on Inquiry Card

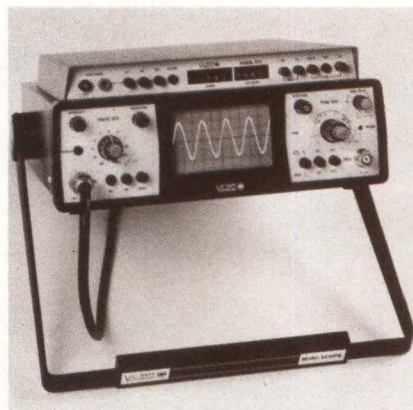
### Test Instrument Puts DMM, Counter, and Scope Into Tool-Kit-Size Unit

Providing the coordinated measurements necessary to troubleshoot today's increasingly complex electronic equipment, the PS915/975 is claimed

to be the only instrument that provides digital multimeter (DMM), frequency counter, and oscilloscope in one convenient package. Each sub-instrument with its own dedicated display can be used simultaneously with the others or as a complement, or they may be used independently at the same time. Package size is 3½ x 8½ x 12½", and weight is 10 lb.

Made by Vu-data Corp, 7170 Convoy Court, San Diego, CA 92111, the PS915 Mini-Scope is a 20-MHz bandwidth, triggered sweep, single-trace oscilloscope, with 10-mV/div vertical sensitivity and a 100-ns/div sweep rate which can be increased to 20 ns/div using a 5X magnifier. CRT viewing area is 6 x 10 major divisions with each division equal to ¼". The 975 DMM-Counter includes a 3½-digit, autoranging digital multimeter (ac volts, dc volts, and kilohms) as well as a 4-digit, 20-MHz frequency counter. The counter solves a long-standing problem associated with oscilloscopes by eliminating the need to make tedious calculations to determine the rms value of a sine wave presentation. Since the ac converter within the DMM is calibrated in terms of rms, the rms value of a displayed sine wave can be automatically measured and displayed directly in the form of a digital readout. Similarly, frequency of a displayed signal can be read out directly by the counter instead of requiring that the operator calculate it. Convenience is enhanced by the built-in verification tools provided for scope attenuator and sweep rate calibration by DMM and counter, respectively.

Operational features include three separate measurement displays: a 3½-digit display for the DMM; a 4-digit display for the frequency counter; and 6 x 10-div CRT display for



Vu-data's PS915/975 packs digital multimeter, frequency counter, and oscilloscope, each with its own measurement display, into a compact unit, providing a convenient troubleshooting tool that will fit into a briefcase



# HEWLETT-PACKARD

## COMPUTER ADVANCES

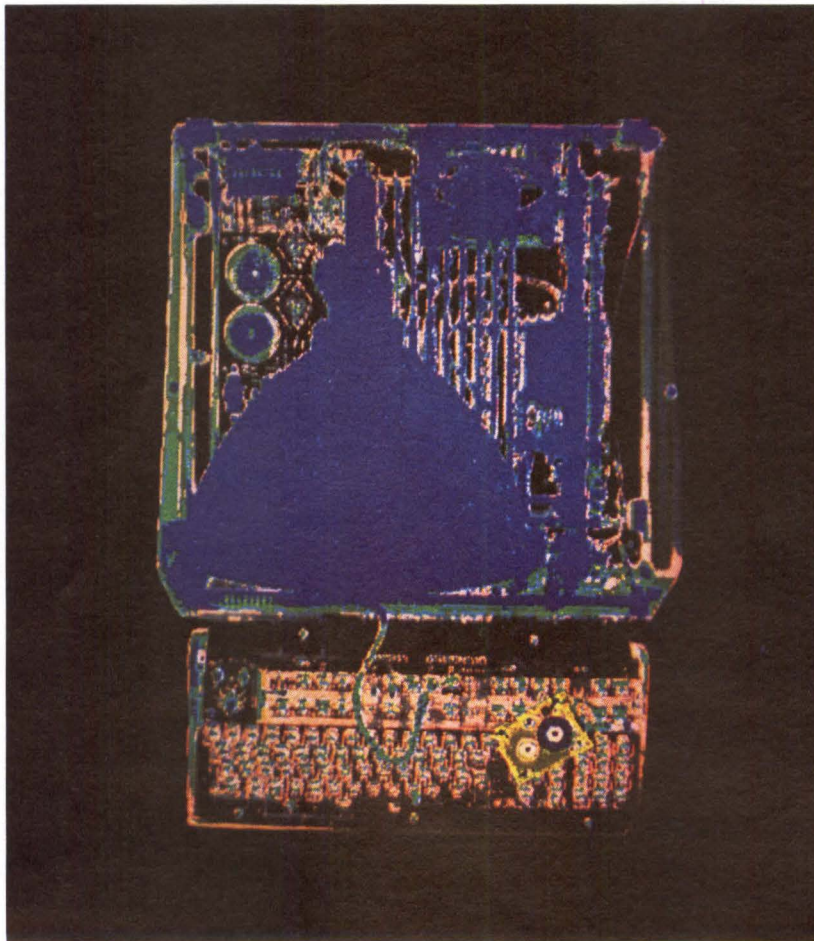
The HP 2644 Mini DataStation may well help change the character of data entry, programming, inventory, point-of-sale and other disciplines dependent on real-time editing, formatting and filing of data. This unique microprogrammed display terminal combines powerful interactive editing with dual cartridge, integrated local storage and peripheral capabilities—

### THIS ADVANCED TERMINAL MINIMIZES YOUR DEPENDENCE ON A COMPUTER

all in one compact, economical, easy-to-use unit. No longer must you take up expensive computer time with routine editing and error correction.

Instead, at the end of the day, the fully formatted and corrected data can be dumped to the CPU from a magnetic cartridge, rather than at operator speeds. And, your ability to keep work flowing is protected by the Mini DataStation's ability to continue operation even when its host computer is down.

The Mini DataStation's own peripheral capability provides you further



Color derivation from X-Ray courtesy Stanford Technology Corp.



### Terminal Cont.

independence from the computer. Up to five option slots are available with multiple data paths allowing data to be transferred between display, cartridges, keyboard, an optional printer, or RS-232C serial output interface. This is accomplished at rates up to 2400 baud for ASCII, or 9600 baud for binary data.

One of the breakthroughs that made the Mini DataStation's stand-alone capability possible is an unusually precise, shirt-pocket-size cartridge capable of storing up to 110,000 bytes. Engineered to strict specifications, these cartridges incorporate full-width data recording, to bring the bit loss rate down to a remarkable 1 in every  $10^8$  bits. This same precision also minimizes problems with cartridge interchangeability.


Each Mini DataStation can use two cartridges and can operate in either character or block mode. Data is stored in variable lengths at a density of 800 bpi formatted in either ASCII or binary.

You can conveniently insert and delete characters and keep track of data fields on the display with a built-in cursor sensing and positioning control. Programmable field protection helps the operator avoid misplaced data entries by allowing you to prohibit access to certain fields. And, you don't lose information the minute it goes off the screen. Off-screen character storage with scrolling or page select controls lets you bring the data back. Other keyboard controls can establish a positional memory lock to retain operator instructions or headings, while data is entered below, or display control codes for convenient error tracing. And, you can call up any form your company uses in seconds.

Users of the Mini DataStation will enjoy the high resolution screen. The clarity of the 9x7 dot matrix screen has to be seen to be appreciated. Not only is a sharp, readable Roman Alphabet displayed, but up to four 64-character sets of type and symbols are available, eliminating the need for awkward graphic approxima-

tions. Other useful features, such as inverse video (black on white), blinking, half-bright and underlining are available in any combination needed.

And the Mini DataStation is as easy to maintain as it is to use. Flip open two latches and inside you will see that we have chosen modular single-bus architecture. Maintenance is as fast as popping out the old module and plugging in the new, with hardly a pause in your operations. A built-in go/no-go test feature allows the operator to quickly verify the operating condition of the terminal.

We know that the Mini DataStation will meet many of your needs. Not simply because of its capabilities, but because these capabilities are available at a realistic, affordable price. If you would like to know more about how you can break free of the computer-dependent terminal, circle "A" on the attached reply card. 



HP's new 2644A terminal uses a pocket-size cartridge to provide stand-alone capability.

HEWLETT-PACKARD COMPUTER ADVANCES



## INNOVATIONS IN DISC TECHNOLOGY

# A DISC FOR DEMANDING OEM'S

The fact that HP's compact 7905A disc drive has both the fastest access and the widest operating range of any interchangeable drive available is no coincidence. Both features are unique contributions to the need for quickly accessed, yet reliable data in the less than ideal operating environments OEMs encounter in scientific and industrial applications.

Consider the problems faced at field or remote sites. Typically in this situation, equipment is being driven by mobile motor-generators with power frequency tending to wan-


der and high RFI being generated. In such an environment, the 7905A will operate anywhere between 47Hz and 66Hz to compensate for power variances. At the same time, an electronically commutated DC motor eliminates all belts and pulleys, reducing parts failure and RFI. And cartridge interchangeability is guaranteed from 50° to 104°F at altitudes up to 10,000 feet.

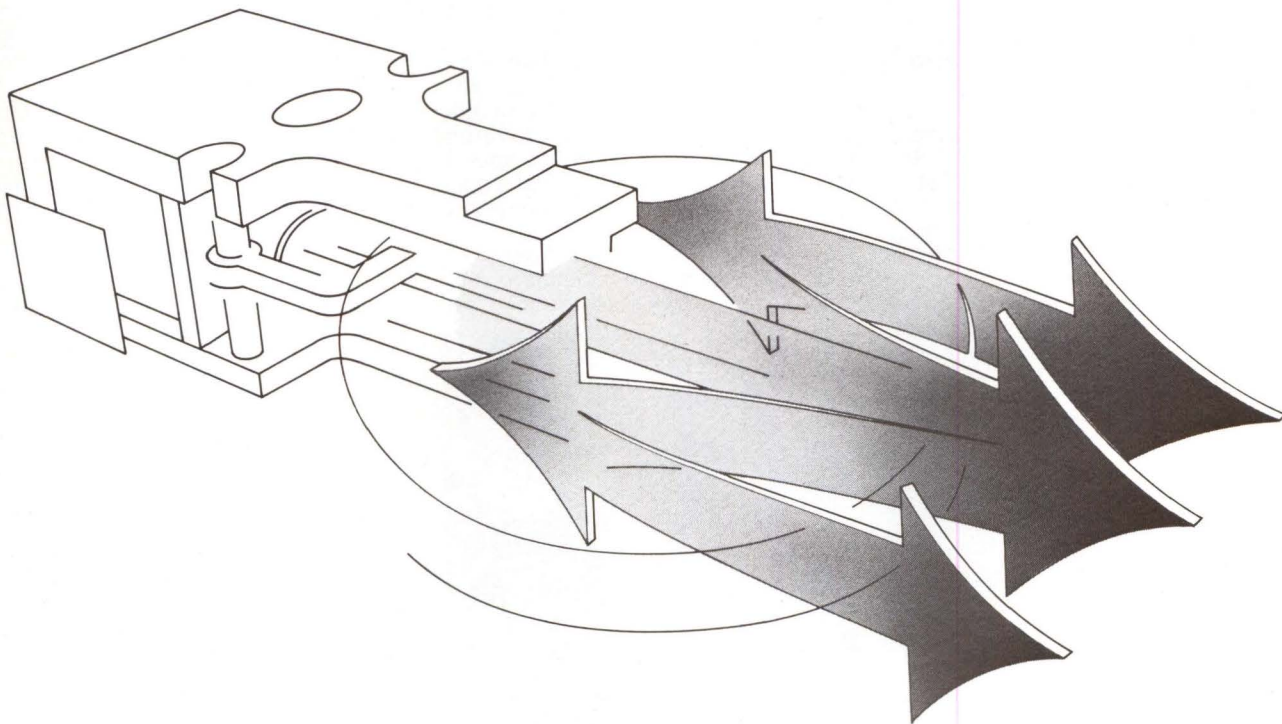
The 7905A can store 15 million bytes on each drive. Average access is a remarkable 25ms, and you can use up to eight drives per control unit, making it ideal for any system requiring fast access to large amounts of data.

In remote locations, or anyplace where accurate on-line data is critical, the 7905A incorporates Error Correction Code (ECC) hardware. This

feature allows the user to correct up to 32 contiguous bits of error per sector, or 48 times per track. Plus, automatic track and cylinder switching allows more throughput by cutting down interrupts to the CPU.

And, helpful to keeping servicing costs at a minimum, there is a plug-in Disc Service Unit which permits head alignment without an oscilloscope.

To find out how our disc can help you build more reliability and speed into your product, just circle "B" on the attached card. 



The precise engineering of the 7905A's moving heads provides a remarkable 25 ms access time to 15 million bytes of data.



# GETTING MORE WORK OUT OF REAL-TIME

More. More. More. Whether you're in production, research or new product development, the pressure is inevitably for "more." For many of you, getting more work out was the major reason for bringing in a computer in the first place.

Times change. If your computer is now the bottleneck, the problem could lie in an inadequate operating system. If you've been thinking that this is the price you have to pay for the economy of using a mini-computer, we have some good news for you.

## RTE-III.

RTE-III is HP's Real Time Executive III, the latest and most powerful addition to a large family of graded HP operating systems. You might call it the multi-solution operating system.

It's multi-programming. In a real-time environment, more of your

people can get more work done. Editing, compiling, testing and debugging can go on concurrently without interrupting the execution of real-time programs.

It's multi-terminal. More people can use the computer from more locations. Waiting in line is minimized, if not eliminated.

It's multi-batch. The ability to handle multi-stream batch lets you get full benefit out of your processor around the clock. You get not just output spooling, but input spooling as well, a boost to efficiency that's never been available for a minicomputer before.

It's multi-language. You can use the language you want to use—or use several languages at the same time; even call a program in one language with a program in another. Choose from FORTRAN IV, ALGOL, Assembly language and HP's unique Multi-user Real-Time BASIC, the interactive programming language that lets anyone write useful, powerful programs with only a few days training.

Obviously, RTE-III is more than just another foreground/background operating system. At its heart is a memory expandable to 256K words

that provides space for as many as 64 32K word partitions. This ability to house as many as 64 programs in active memory drastically reduces the need for swapping, making response as much as a hundred times faster.

It puts you in control. You assign programs to specific partitions during system generation. Or, if you prefer, you assign priorities matched to the relative urgencies of your programs and let RTE-III's Dynamic Memory Management allocate memory automatically.

In the end, it means faster throughput, more work accomplished, a cost-effective answer to the continuing demand for "more" from you and your staff.

We have some very comprehensive literature on RTE-III. It should be in your file. Circle "E" on the attached card for your copy. 

## HOW TO RUN LARGE SUBROUTINES AT MICROPROCESSOR SPEEDS

Microprogramming is the time short-cut that works. It can speed up execution of repetitive calculations by as much as 95 percent and allows you to customize your processor hardware to a specific application for the duration of the microprogram.

Now HP opens new horizons for microprogramming with a 1024 word Writeable Control Store (WCS), four times the user-microprogrammability previously offered. Now, even large subroutines can run at microprocessor speeds.

Since WCS is dynamically


alterable, it offers you the flexibility of storing microprograms on disc or in main memory and transferring them to the WCS card as needed.

Each WCS board contains 1024, 24-bit words of semiconductor RAM memory with a cycle time of 325 nanoseconds. WCS also provides access to 12 additional high-speed scratch registers for data manipulation and status to increase programming efficiency.

You can also burn frequently used routines into PROM chips which, in turn, are attached to an HP User

Control Store Board (UCS) installed in the microprocessor section of the computer as a permanent part of its processor instructions. Up to 2,056 words of RAM can be stored on a single UCS board.

Both WCS and UCS come documented with driver and I/O utility programs. Microprograms are callable from FORTRAN II, FORTRAN IV, HP Assembly language, ALGOL and HP extended BASIC.

If the idea of speeding up critical routines appeals to you, circle "C" on the reply card for more information. 





# ACCURATE SOURCE DATA ENTRY, THE EASY WAY

Getting data into a computer is easy enough these days. The problem and the expense is getting it right—the first time.

Hewlett-Packard has a novel solution. It's HP's new Source Data Entry package (SDE) which operates on HP's 2000 Access System, servicing 16 to 32 terminals. SDE significantly reduces the common sources of operator data entry error. It allows you to generate single- or multi-screen forms, check errors and edit without using complex programming languages.


The difficult and costly effort of writing programs to do these jobs has been done for you. SDE includes four built-in program modules for range checking and data type checking. There's even a feature that allows highly repetitive data to be directly supplied from tables with a single key-stroke, increasing both the speed and accuracy of data entry procedures.

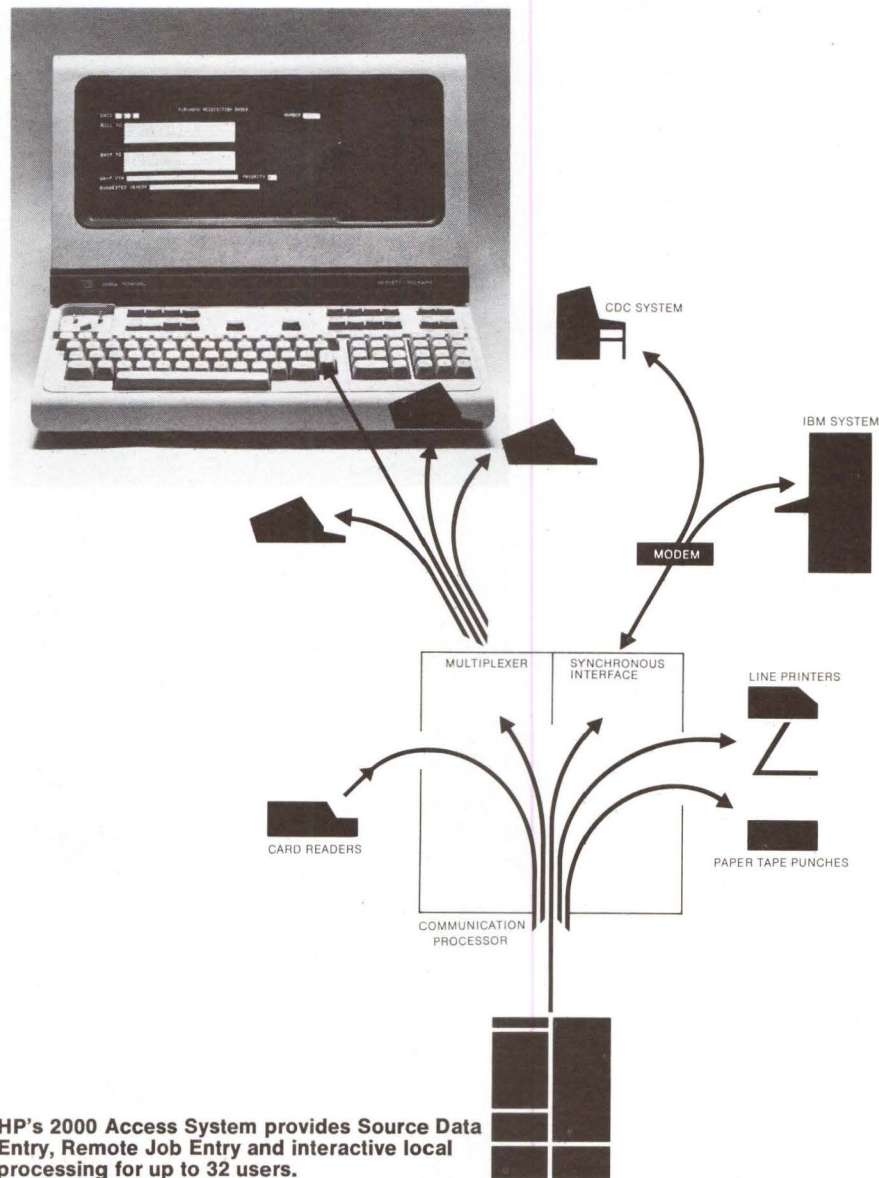
You design the forms. You establish the error-checking parameters. Simply. Quickly. For the more sophisticated user, SDE/2000 can be linked to user-written application programs to function as an efficient front-end module to reduce the cost and time for implementation of data entry applications.

Imagine the savings, the increased flexibility, the greater throughput that SDE might make possible in your application.

It saves money in another way, too. Each terminal can share an extensive family of local peripherals, thus avoiding the expense of redundant hardware.

SDE is the newest enhancement to the 2000 Access System. It operates concurrently with the system's "transparent" multi-terminal RJE capability, servicing IBM 360/370 or CDC computers. Or, it can use the 2000 Access System's 128k byte, dual-processor capacity as the basis for a stand alone interactive processing system serving up to 32 users.

To find out more about SDE and 2000 Access, take the easy way yourself and circle "D" on the reply card. 



HP's 2000 Access System provides Source Data Entry, Remote Job Entry and interactive local processing for up to 32 users.



# SOLVING THE PROBLEMS OF SUCCESS

Malkin and Pinton Industrial Supplies  
Accelerates Customer Orders

Malkin and Pinton are running a successful business in Vancouver, Canada. Their customers are getting good service and they are growing 20 percent a year. That is precisely the problem.

By the end of 1974, they had 6,000 customers for a complex line of fasteners, abrasives, power tools, shop and forestry products. They were managing an inventory of 25,000 items. Like many distributor environments, order clerks must check availability, price, discounts and updates to quantities on hand. Doing business called for five sets of customer files, kept in four separate departments. A single order involving one back order generated 21 separate pieces of paper—a river of 2.5 million copies in a year.

It was a manual system; a complex system; but a good system. The problem was they had simply outgrown it. Their analysis showed that it was extremely labor-intensive and involved considerable duplicate information—all necessary to maintain accuracy, but all operating to multiply the opportunity for error and impede fast customer service.

Success had brought them to capacity operation. A new solution was called for, one that would improve service without adding (or eliminating) people.

First they considered electronic accounting machines, but they could only do part of the job and would create queuing problems.

Some kind of computerization seemed the only viable alternative. Outside service bureaus and time-sharing approaches carried built-in delay factors and the certainty that as business grew, so would their expense.

In the end, an in-house computer system seemed to be the only practical solution. Batch? No. Its inherent time lag would actually make service worse and input errors would still be able to multiply before the system caught them.

A terminal-oriented data base management system seemed to be the



**When you have 6,000 customers and 25,000 products, good service is essential.**

only approach that would retain the best of their manual system, eliminate its problems and improve service.

Such a system would have to meet a number of objectives if it was to take over smoothly from their existing manual system. It would need: on-line multi-terminal capability for fast response, data base management to eliminate redundancy, multi-language capacity for efficient program-writing, the ability to operate in real-time to avoid processing delays, flexibility for short- and long-term changes in the company's requirements, a reasonable price and the availability of local service.

This was the list of qualifications met by the HP 3000CX they purchased. As Gary Nordman, their Systems Development Manager put it, "The (HP 3000's) combination of hardware and software and relatively low cost simply met all our requirements."

The HP 3000CX has been installed and is well into its first year of operation. The 11 terminals Malkin and Pinton purchased with the system are distributed throughout the company in operating departments such as sales, pricing and purchasing. Twenty-one more can be accommodated, some slated for their five branch offices. No changes will have to be made to the system to accommodate them.

HP's IMAGE 3000 data base management system has proven to be


an optimum solution to the problem of duplicate files. Unlike traditional file management, data is entered only once by the department responsible for it. For example, a clerk in the credit department enters credit data to a customer data base accessed by an order-entry clerk. Since only the responsible department can change its own information, errors are minimized and strict accountability is maintained.

Most programming is being done in HP's System Programming Language (SPL), the high level language in which the operating system is written, which makes custom-tailoring it to Malkin and Pinton's particular needs a relatively simple process. At the same time, the multiprogramming capability of the 3000CX allows other programs to be written in the most appropriate language for each problem whether it is SPL, COBOL, FORTRAN, BASIC or RPG.

As an on-line system, data is checked as it is entered. If errors show up, the individual who originated the information is still there to correct the data. Added to the single entry benefits of IMAGE and the restricted access that is possible through IMAGE's protected data items, maintaining correct records is dramatically simplified.

By choosing the HP 3000CX, a system whose flexibility, sophistication and features could readily be tailored to their needs, the goals of better service and increased work output from the same staff have been handily met.

But what about the future? There will be changes. New programs will be added. Management is just beginning to make use of the system's extensive capability to generate a wide variety of management reports for increased control and profitability.

Should you be considering the benefits of a terminal-oriented data base management system? Circle "F" on the attached card and we'll send you detailed literature on HP's powerful 3000CX series computers. 

**HEWLETT  PACKARD**

Sales and service from 172 offices in 65 countries.  
1501 Page Mill Road, Palo Alto, California 94304

22652



the oscilloscope. Originally intended only to provide digital information such as amplitude and frequency parameters of the displayed waveform, DMM and counter displays work independently as well. The scope provides the circuitry necessary to furnish information to the DMM-counter for digital display of dc or ac voltage and frequency of the displayed waveform. The DMM measures ac and dc voltage; scope input impedance of 1-M $\Omega$  allows either X1 or X10 probe to be used.

Trigger pulses provided from the scope's horizontal circuit trigger generator enable the counter to display the frequency of any signal that is synchronized on the CRT in internal trigger mode. In external trigger mode, the scope trigger generator pulses represent the external trigger signal's frequency.

An extreme example of the convenience provided to the operator by the unit's coordinated measurement capability is a power supply circuit under test. The auxiliary input connector of the DMM can be used to measure and display the dc level, while the ac ripple amplitude is displayed on the mini-scope, and the ripple frequency is monitored by the counter.

Circle 144 on Inquiry Card

### LSI I/O Circuit Cuts 80% Off Costs of Floppy Disc Controller

An LSI floppy disc controller (FDC) I/O circuit is claimed to cut the cost of IBM-compatible disc controllers by as much as 80%. Introduced by Rockwell International Corp, Microelectronics Device Div, 3310 Miraloma Ave, PO Box 3669, Anaheim, CA 92803 as part of its PPS-8 microprocessor system, the chip will allow a control unit to be formed from only eight PPS-8 LSI circuits, including one FDC I/O, with about ten additional SSI and discrete devices, rather than the more than 200 ICs required to form conventional units.

Inherent data transfer capabilities of the microprocessor and I/O devices permit the disc controller to operate at either single or double density. Servicing a floppy disc operation requires less than 20% of system resources during sector transfers.

MOS/LSI chips necessary to make the controller are available as a chip set, or assembled on a PC board; the company will also put together specially designed PCB disc controllers for computer users. Designers can connect one or more floppy discs to existing PPS-8 microprocessor systems by using the FDC circuit. This will allow manufacturers to feature floppy disc add-ons with only a proportion of their total product run, with cost estimates including the necessary extra circuits and discrettes.

Prices for the chip are \$125 each in 1 to 24 quantities; \$100 (2-99), and \$80 (100-199). It is estimated that an IBM-compatible floppy disc control system can be made for about \$200 (each in 1000 quantities) using the company's components. Projected cost of adding one or more floppy discs to an existing system is less than \$75 in 1000 quantities.

Circle 145 on Inquiry Card

### Memory Matrix Provides PCB or Cable Plug-Ins for Flexibility

Built around self-latching, dry reed switch capsules, the 969 series Mini Memory Matrix, a 64-crosspoint switching module, is available with PCB plug-in or cable plug-in terminations. Designed to provide flexibility in creating large multi-pole switching arrays, PCB plug-in units make the matrix compatible with conventional pre-wired card-cage assembly techniques; cable plug-in units mate with standard 9-pin in-line socket terminations and 16-pin DIP jack terminations found on flexible flat cables, allowing the matrix to be easily incorporated into motherboard assemblies.

Matrices are configured as standard 8 x 8 modules with either two or four poles per crosspoint, and wirewrap or plug-in terminations. An 8 x 16, 2-pole plug-in model is also available. Standoff voltage rating of the crosspoint poles is 600 Vdc standard (800 Vdc is available); square-loop magnetic characteristics of the reed switches ensure reliable latching forces throughout life.

The multiple coils around the crosspoints are interconnected so as to provide coincident selection paths. Crosspoints are addressed by simul-

taneously applied current pulses on both X and Y areas. Previously selected crosspoints are automatically erased when a new crosspoint is selected. Signal paths are provided with sufficient dielectric spacing to enhance crosstalk isolation. Signal crosstalk levels between pairs in a 4-pole wirewrap module are 55 dB max at 4.5 MHz; between adjacent crosspoints they are 70 dB max at 4.5 MHz.

Developed by C. P. Clare & Co, 3101 Pratt Ave, Chicago, IL 60645, the self-latching matrix provides magnetic memory crosspoint coupling without external biasing magnets or coils. By omitting these components, the matrix requires less than half the space needed for a comparable matrix of conventional dry reed switches, and cuts power consumption by eliminating the need for holding power.

Heart of the self-latching matrix is a memory switch in which reed blades accept like or unlike magnetic polarities induced by applied drive pulses. In unlike state, the blades attract each other, closing the contact firmly and greatly reducing contact bounce; in like state, they repel each other and break contact. Once pulsed into a set (closed) or reset (open) state, the blades automatically remain in that state until the opposite mode is selected. Switching is triggered by a 500- $\mu$ s, 1-A pulse, and is approximately 10% faster than the dry reed switch used in conventional reed matrices.

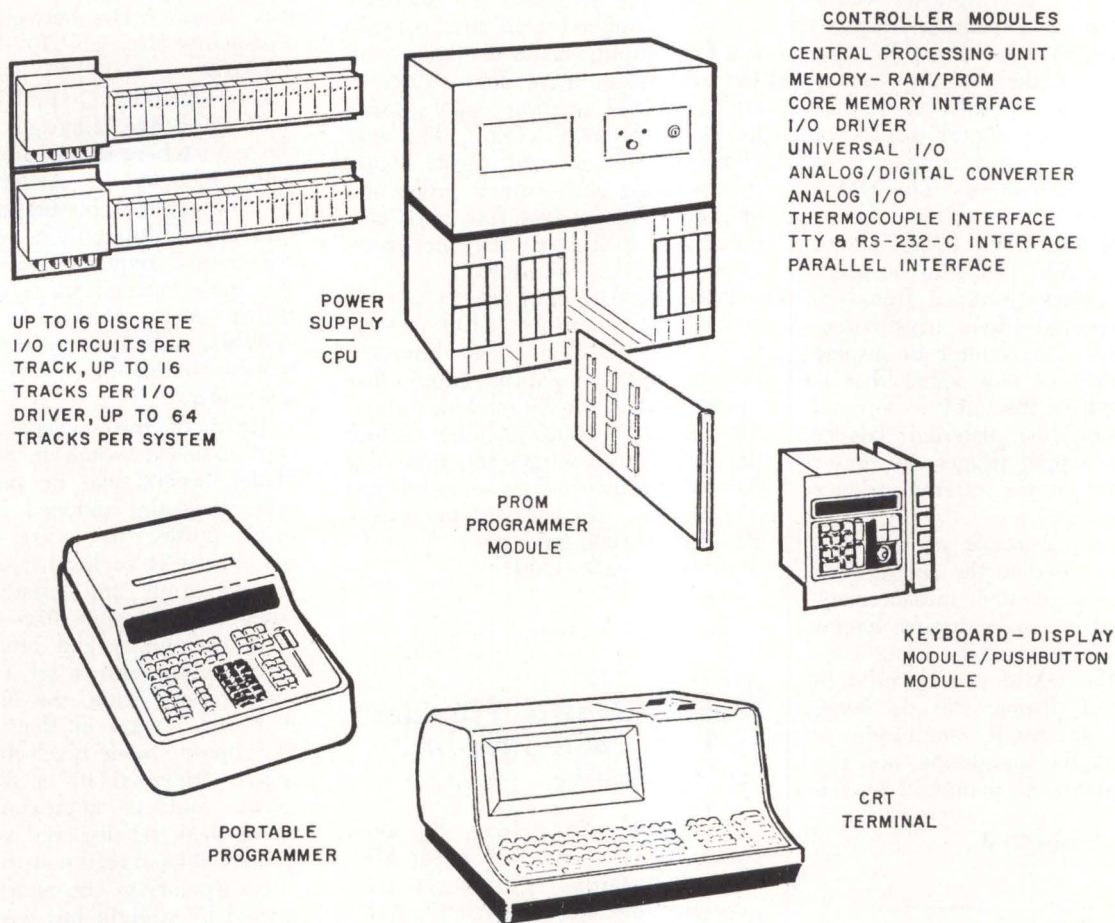
Crosspoints in the matrix are connected by straight bus wiring, which offers lower capacitance than PCB connections and permits up to 4.5-MHz frequency switching. Signal handling capabilities range from dc through video frequencies.

Circle 146 on Inquiry Card

### Microprocessor Controllers Adapt to Application Through Module Selection

Combining sophistication of minicomputers with simple programming and operation of programmable controllers, the EPTAK™ Microprocessor System family spans applications ranging from single machine control to supervision of a complex process. Introduced by Eagle Signal Industrial Controls Div, a Gulf + Western Manufacturing Co, 736 Federal St, Davenport, IA 52803, the family comprises three controllers, each based on the Intel 8080A microprocessor chip





Programmable logic controller is first of Eagle Signal's family of controllers to be based on the same microprocessor chip and constructed from one array of hardware. Software and module selection define type and function of the controller

and constructed from one array of hardware modules. Application-oriented software and selection of modules determines the function and type of each.

Advanced programmable logic controllers (PLCs) can be formed for metal-working and machining; material handling; measuring; and gauging. A process controller is intended for chemical, petrochemical, food, pulp and paper, and similar industries; and a dedicated machine controller performs such specific tasks as plastics injection-molding, or load-level demand. The units are claimed to be the first to combine arithmetic

computation, analog interface, simple control language, three types of memory, data entry and display, peripheral interfacing, and ruggedized construction in one system.

The central processor houses an Intel 8080-based processing unit, memory, I/O interface modules, peripheral interface modules, data entry and display modules, and power supply (can also be mounted separately). The processor provides up to 64, 999.9-s timers with resolution to 0.1 s or up to 64, 9999-count BCD or binary counters or any combination of up to 64 of either; eight 256-bit and four 256-byte left/right

shift registers; and a 12-bit A-D converter with  $\pm 0.0125\%$  resolution. Also incorporated are a function-select pushbutton module, numeric keyboard module for setpoint modification, and 5-digit numerical display for function setpoint and monitor. Memory is available as core, semiconductor RAM, UV-p/ROM, or RAM with UV-p/ROM combination on a single board. Standard memory size is 4K x 8 bits, 16K x 8 bits is maximum.

I/O is provided by up to four I/O driver modules driving up to 64 I/O tracks, with 16 discrete I/O modules/track. A maximum of 1024 on/off



# A new low for on-board programming.

AMP introduced the DIP switch to solid-state electronics. Now we've gone still further. AMP's new *low-profile* DIP switches are as low as you can get. You can use them to program ICs right-on-the-board without remote wiring. And sandwich boards in less space, to cut packaging costs.

With our new, low-profile DIP switches, cleaning boards is easier than ever. Simply place our protective covers or pieces of tape on the switches and you can clean complete boards without damage.

We're the people who developed and perfected DIP switches—a whole family of them—including our innovative, pluggable Hexadecimal Rotary Switch. Our experience is broader and deeper than anyone's. At AMP we'll have the right answers for your applications.

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Unique LED DIP switches are available in SPST "on" or "off" as well as momentary-contact types. They permit rapid, visual circuit test, fault indication and programming verification. Plus, for the first time, they permit DIP packaging of LEDs.

Rockers are detented to avoid accidental actuation. Switch leads and LED leads are terminated independently for circuit connection versatility.

There's nothing quite like new AMP LED DIP switches. For more details on them, or the new AMP low-profile DIP switches, call (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

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# AMP

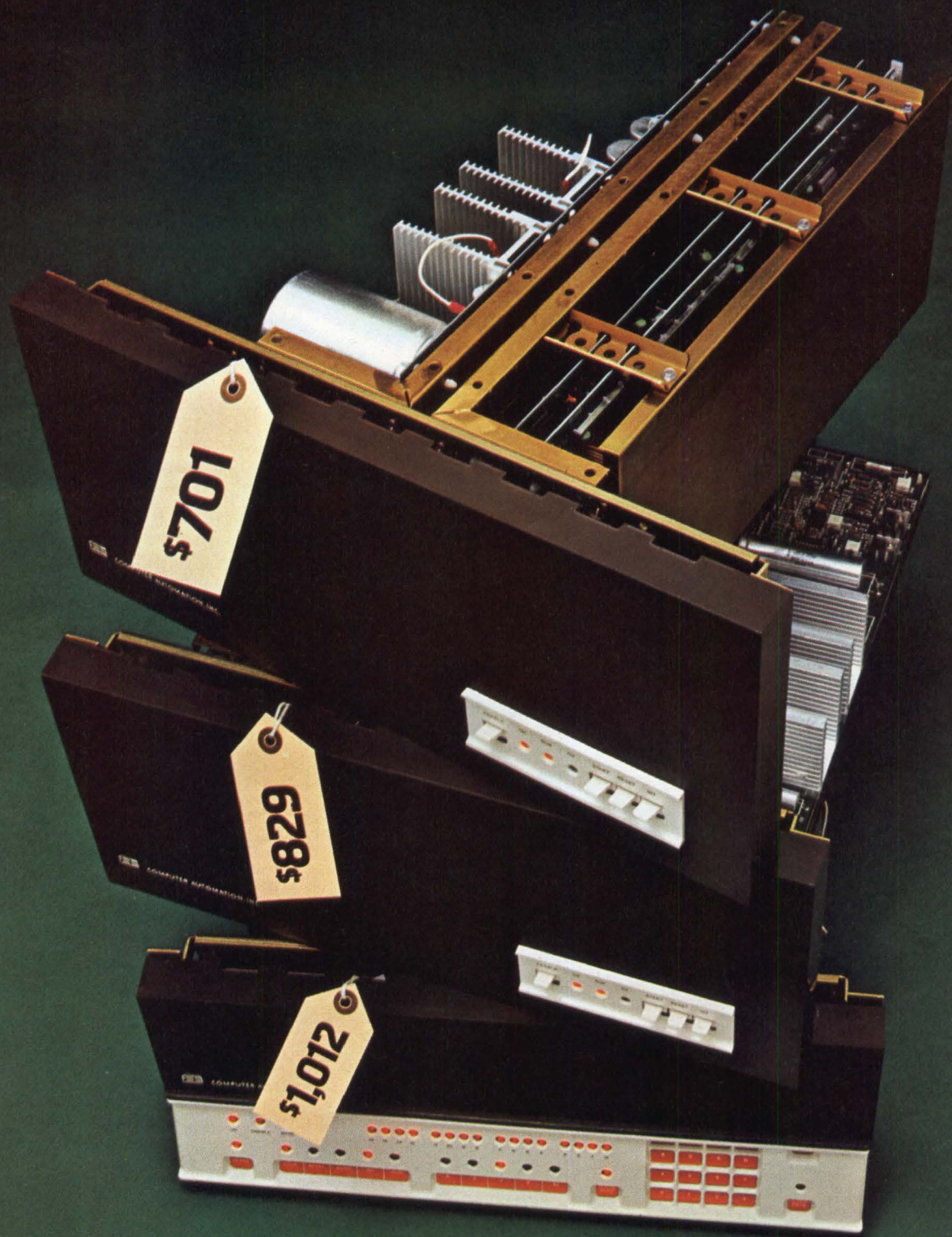
INCORPORATED

CIRCLE 17 ON INQUIRY CARD





# What our bottom-of-the-line



## The New ALPHA™ LSI-3/05

Introducing the lowest priced, 16-bit, full-scale, fully compatible, packaged computers in the world.



# can do for your bottom line.

Stack the new ALPHA LSI-3/05 millicomputer up against any other low-end computer.

Preferably while you're sitting down, because on price alone, you're bound to be astounded.

Ready? \$701 total packaged price. And that's complete with 256 words of MOS RAM, and a CPU that offers a really powerful instruction set, Power Fail Restart, Real-Time Clock and Autoload capability.

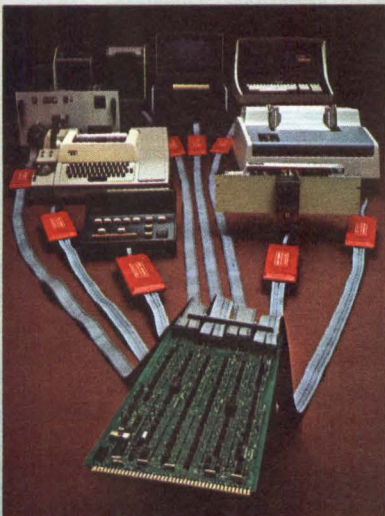
Try to buy an equivalent computer at twice the price.

## Have it your way.

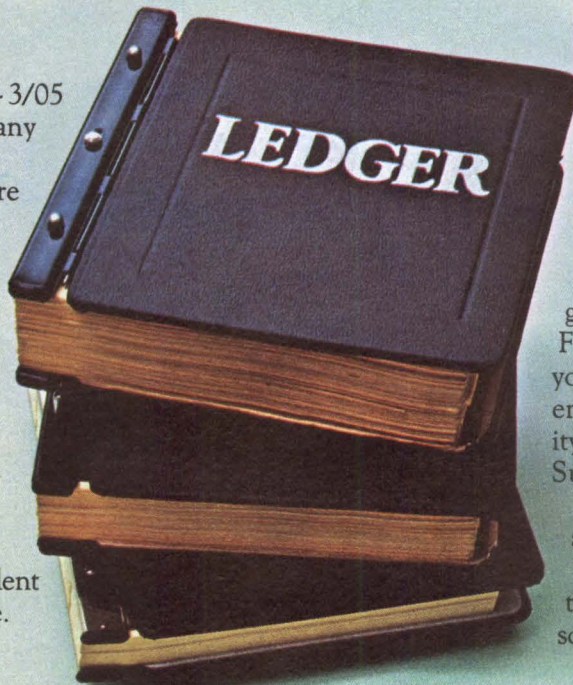
You also get the capability to configure your computer pretty well the way you want it. A choice of packaging, of course, that includes either the Operator's or the Programmer's Console, power supplies and so on.

A choice of two standard I/O options.

And a choice of optional memory configurations that



Maxi-Bus compatible ALPHA LSI-3/05 achieves unprecedented cost-effectiveness with ComputerAutomation's new Distributed I/O System.



include RAM/ROM, RAM/EPROM and RAM-only in sizes from 256 words all the way up to 32K words. Totally addressable.

## Family connections save you still more money.

So far, what we've been talking about could easily add another five or six figures to the bottom line of your ledger.

But there's more. Really big savings on off-the-shelf software, peripheral controllers and I/O interfaces.

The reason is that the ALPHA LSI-3/05 millicomputer is a full-fledged member of ComputerAutomation's LSI Family... Maxi-Bus compatibility and the whole works. So, every piece of Family hardware we've ever developed will work like it was made for the ALPHA LSI-3/05. Including ComputerAutomation's exclusive new Distributed I/O System... just like you see it in the picture.

With this versatile interface system, you can interface virtually any kind or combination of peripherals. Parallel or serial. Just by plugging them in.

Your cost? Probably less than \$200 per interface.

## The pros know.

Computer-wise OEM's will tell you that product requirements sooner or later get ahead of the hardware. For instance, the computer you buy today may not have enough I/O or memory capacity for tomorrow's Mark II Super Widget.

Then you'll have to scrap all your software and your interface designs, because they're not about to work on some other machine.

You lose.

Of course, with our LSI Family of compatible computers you don't.

You can switch to a different CPU or a different memory anytime. Faster, slower, bigger, smaller. The electrical interface will still be the same; the original programming will still work.

You win.

## From the people who brought you the NAKED MINI®

And the NAKED™ MILLI. And the Distributed I/O System. And the PICOPROCESSOR.

And now the ALPHA LSI-3/05 millicomputer.

One cost breakthrough after another. Breakthroughs that didn't just happen... a lot of profits got plowed back into R&D.

But then, that's the price of leadership.

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**CIRCLE 18 ON INQUIRY CARD**



# Fast talk

Here they are at last—high-speed communications interfaces on a single chip.

Our new S2350 Universal Synchronous Receiver/Transmitter and S6850 Asynchronous Communications Interface Adapter make it easy to link your word-oriented controller or microprocessor with a serial transmission line. They're both N-Channel, use single 5-volt power supplies, need no TTL, and are bus compatible.

And they're fast. The USRT transmits and receives at a rate of 500 KHz. The ACIA at 800 KHz (making it the fastest Asynchronous R/T going).

Both circuits will fit right into most synchronous or asynchronous communications systems. But they're especially valuable as part of a system using the AMI S6800 microprocessor family.

They both have interrupt logic and they're both double buffered. This lets the MPU operate much more efficiently, because it's not a slave to its family.

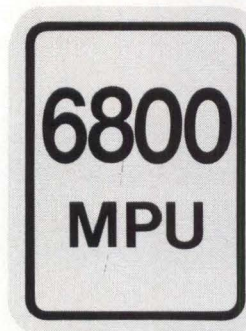
These two chips are the latest additions to our growing list of communications circuits. It now includes the S1757 UART (CMOS compatible), the S1883 UART, the S9544 CRC and the S6860 Modem.

## Features of the S2350 USRT

- 500 KHz data rates.
- Internal sync detection.
- Fill character register.
- Double buffered input/output.
- Bus oriented outputs.
- 5-8 bit characters.
- Odd/even or no parity.
- Error status flags.
- Single power supply (+5v).
- Input/output TTL compatible.

## Features of the S6850 ACIA

- 8 bit bidirectional data bus for communication with MPU.
- False start bit deletion.
- Peripheral/modem control functions.
- Double buffered receiver and transmitter.
- One or two stop bit operation.
- 7 or 8 bit characters with odd, even or no parity.
- Parity, overrun and framing error checking.
- Programmable control register.
- Optional +1, +16, and +64 clock modes.
- Up to 800,000 bps transmission.



So make communicating a lot easier. Talk to your nearest AMI sales office. Or call our distributor.

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## DIGITAL TECHNOLOGY REVIEW

discrete circuits is standard; this can be expandable to 2048. There are eight multiplexed 4- to 20-mA analog inputs for each module and four 4- to 20-mA analog outputs. Two universal I/O ports operated by the CPU in parallel mode handle 8-bit words of input or output.

Programming for the unit is done using a portable programming terminal, p/ROM programming module, CRT with keyboard, or teleprinter. Although not a programming device, the data display with pushbutton modules can be used to enter data such as temperature setpoints and time ranges. Applications programs can be generated using EPTAK process control language, which is BASIC

and FORTRAN based; assembly language, using the 8080 chip instructions; EPTAK control language, which is based on solid-state logic expressions; or relay diagram language.

A typical system, including processor and power supply with 80 120-Vac inputs and 40 120-Vac outputs; eight 4- to 20-mA analog inputs; 64 internal timer or counter functions; twelve 256-step shift registers; add, subtract, and compare functions; and 2048 words of RAM or UV-p/ROM, is priced at \$6500. A more complete system with these plus 256 Vac inputs and outputs and 16K words of read/write core memory has a price of \$19,000.

Circle 147 on Inquiry Card

## Terminal Line Controller Opens VTAM Benefits To Non-Virtual Systems

Incorporating virtual terminal addressing and virtual memory, the 2761 Virtual Terminal Line Controller (VTLC), developed by Courier Terminal Systems, Inc, 2202 E University Dr, Phoenix, AZ 85034, permits IBM System/360 users to benefit from the Virtual Telecommunications Access Method (VTAM) with a non-virtual system, and allows /370 users to have a VTAM-type network without associated memory constraints. If used with VTAM, the controller establishes a dual-dimensional virtual network, eliminating remote communications software and such mainframe functions as error recovery. By sharing system resources and establishing effective communications paths, the system provides users with a virtual communication facility at minimum cost.

Implementation of the concept involves attaching remote terminals, via the controller, to a /360 or /370 that operates in a local environment using local software. This relieves the mainframe from remote-line activities such as polling, selection, scheduling, and insertion-deletion of line control characters. The unit supports up to four remote lines operating at speeds of up to 9600 bits/s using asynchronous, bisynchronous, and synchronous data link control (SDLC) line disciplines. A line may have numerous terminals with only

a subset being used at the discretion of terminal operators and the network supervisor. Up to 32 intermixed remote, local, or standalone terminals are connected by "log-on" procedures that associate a terminal with a channel address.

VTLC intelligence supplements network control with diagnostic capabilities for testing remote lines, capturing data streams at either mainframe or terminal, analyzing software tables, and collecting error statistics. Other capabilities included in the concept are dynamic network reconfiguration, message switching using logical terminal names, and broadcasting to logical groups of terminals throughout the network.

In the system environment, applications programs communicate with terminals without concern for intermediate connections such as front-ends, control units, or communication lines. By sharing resources, several programs using individual disciplines can communicate with different terminals on the same multipoint lines. Any terminal can communicate with any mainframe applications programs. Communication line use is also shared among application programs and terminals.

A minimum VTLC configuration, supporting eight terminals, can be purchased for \$12,675, or leased for \$345 per month on a 3-year term. A full capability system, capable of supporting 32 terminals, is priced at \$19,650, and can be rented for \$570 per month on a 3-year term.

Circle 148 on Inquiry Card

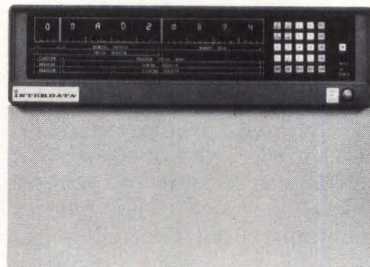


# Interdata announces minicomputer EASYWARE.

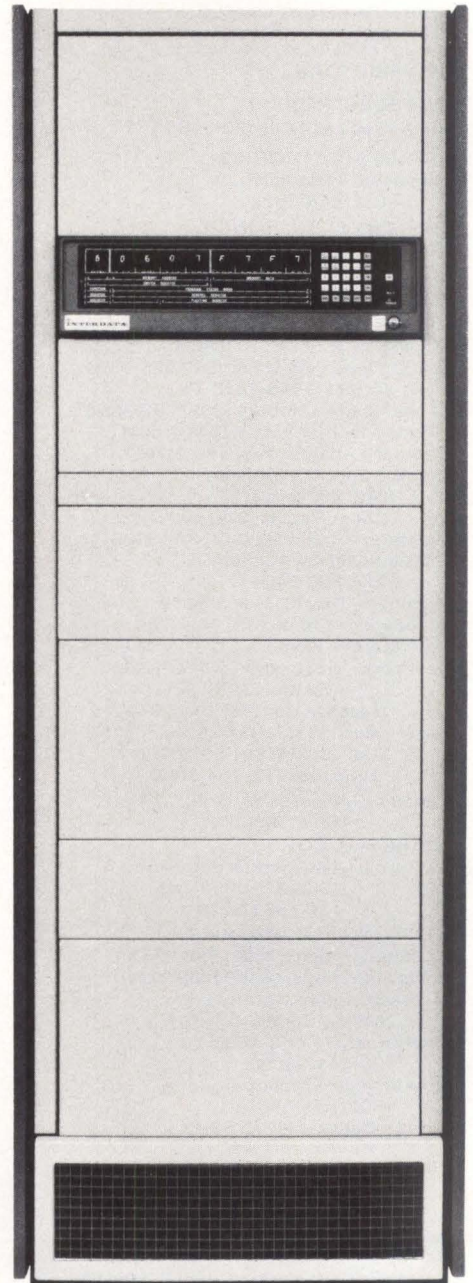
Interdata and Megamini are trademarks of Interdata, Inc.



**Interdata's 7/16 minicomputer** is a 16-bit machine that combines high-performance with low cost. Its architecture, packaging and programmability make it a proven, cost-effective solution for the OEM buyer.



**Interdata's 7/32 minicomputer** is an economical 32-bit machine with a main memory expandable up to a directly-addressable million bytes of 750 ns core.



**Interdata's 8/32 Megamini** is the industry's most powerful 32-bit minicomputer. It is an unequalled combination of power, flexibility and reliability compactly packaged.



# A family of hardware and software that's easy to work with.

Interdata offers a family of 16- and 32-bit hardware and software designed to be compatible throughout—from the low to the high end of the product line. Our Common Assembly Language enables you to go up or down in performance ranges always knowing your Interdata software will work.

## **Hardware.**

From the beginning, Interdata built its minicomputers with a microprogrammed architecture, using the same architectural principles as the companies who build large-scale machines. As a result, our big machine architecture offers you 360/370-like instruction sets. Multiple registers. And the ability to scale-up from our 16-bit minicomputer to our one-megabyte, 32-bit Megamini.

With Interdata comes component compatibility which minimizes your inventory and guarantees interchangeability. Whether you use a 7/16, 7/32 or 8/32, you get the same front panel, power supply, memory, and same family of peripherals. Also, when you choose Interdata hardware, you can be sure anything you buy from us today is compatible with what you bought from us yesterday—or will buy from us tomorrow.

## **Plus software.**

Interdata makes operating systems for the systems builder. Not only do they take advantage of the hardware, but they optimize the use of systems software and the human user. In addition, both the 16-bit OS and the 32-bit OS are completely compatible at all user interfaces—namely, file structure, supervisor calls, operator commands, etc.

To help the user build his system, Interdata offers a variety of higher level languages. These include: FORTRAN V—a very well-known version of FORTRAN extended for system construction. MACRO CAL (Common Assembly Language)—a macro-assembler which guarantees application program compatibility across the family. And BASIC—a simple, easy-to-use language.

## **Equals EASYWARE.**

Interdata's philosophy has always been to make the hardware—the least expensive part of a minicomputer system—work the hardest. Our software then provides the tools which make it easier for you, and your people, to use our systems to solve your automation problems.

That's why we call it EASYWARE.



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## VMOS LSI Technology Promises Competition for TTL in Speed

V-groove isolation has been applied in a number of second-generation bipolar IC processes such as Harris' Poly-Planar, Motorola's VIP, and Raytheon's V-8 technologies. Recently, Siliconix has used V-grooves to increase the performance of MOS discrete power transistors to the 60-W level. The process is based on properties of certain silicon etchants, such as hydrazine, which have different etch rates on different crystal planes. This differential etch rate allows for precise definition of "V"-shaped grooves and/or square pyramidal holes in silicon wafers of the proper crystal orientation.

In the LSI area, Dr T. J. Rodgers, a research engineer at American Microsystems, Inc, Santa Clara, Calif, is presently testing the feasibility of VMOS, a high speed, high density, V-groove MOS process.<sup>1</sup> A VMOS transistor (Fig. 1) is a vertical n-channel MOS transistor with its chan-

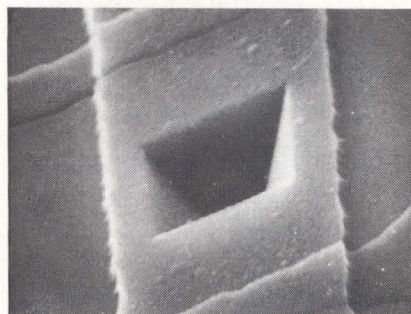


Fig. 1 Scanning electron photomicrograph of an aluminum gate VMOS transistor. Surface size of the V-groove is  $10\ \mu \times 10\ \mu$  (0.4 mil  $\times$  0.4 mil). The  $\langle 111 \rangle$  walls on which the device is fabricated are microscopically smooth, and have the same properties as ordinary  $\langle 111 \rangle$ -oriented silicon wafers

nel on the  $\langle 111 \rangle$  face of a V-groove. The heavily doped  $n^+$  substrate is the source and common ground for all VMOS transistors. A p-layer which is analogous to the base of an npn bipolar transistor is the effective MOS substrate. The effective channel length of the VMOS is the thickness of the p-layer, which is controlled accurately by diffusion techniques to  $8000 \pm 1000\ \text{\AA}$ . A lightly

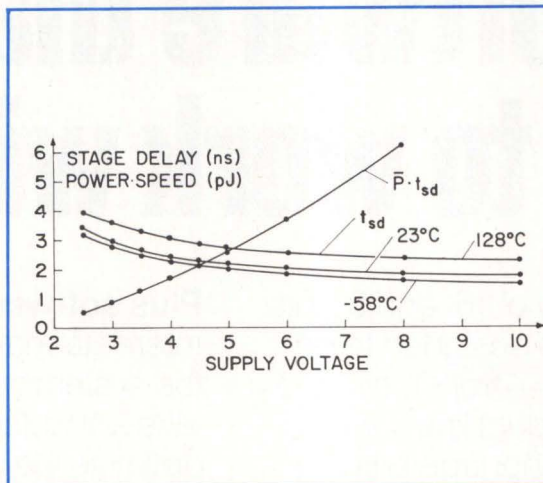


Fig. 2 Stage delay supply voltage for a VMOS resistor-loaded (RTL type) inverter chain. Delays are in the 2- to 4-ns range, and are insensitive to temperature and the supply voltage. Product of the average power per inverter stage times the delay ranges from 0.5 to 6 pJ. Typical 7400 TTL power-speed products range from 20 to 40 pJ

doped p-type or " $\pi$ " epitaxial layer is used to separate the  $n^+$  drain from the p-layer substrate. The  $\pi$  layer raises VMOS breakdowns to 20 V and decreases drain capacitance for higher speed.

By using the vertical V-groove structure, Rodgers claims to be able to achieve both higher density and higher speed than with conventional MOS structures. The circuit advantages come from fundamental VMOS properties. If the surface opening of a VMOS is assumed to be  $10\ \mu \times 10\ \mu$  (0.4 mil  $\times$  0.4 mil), the channel width is  $25\ \mu$ , and the width-to-length ratio of the device is  $W/L = 25/1$ .

An ordinary n-channel device having the same  $10\text{-}\mu \times 10\text{-}\mu$  gate area has, at best, an aspect ratio of  $W/L = 2/1$ . Consequently the use of a V-groove allows a much higher capability device to be put in the same area (or, conversely, a much smaller device to perform the same function). VMOS density is further increased by the use of a substrate ground which eliminates the need for ground wiring on the chip. This is the technique employed in bipolar integrated injection logic (IIL) to achieve high density.

Because of the combination of both small size and high gain, VMOS promises to make MOS LSI that com-

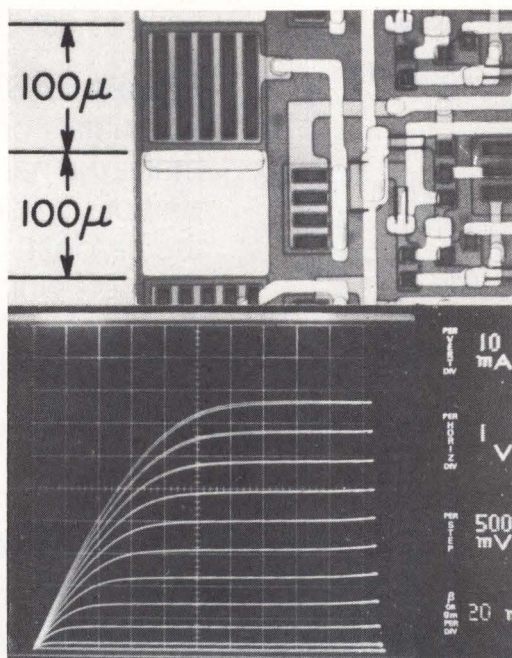


Fig. 3 VMOS output drivers offer bipolar drive capability. The photomicrograph at the top shows a VMOS output device. The transistor is only  $100\ \mu \times 100\ \mu$  (4 mils  $\times$  4 mils)—the size of a typical bonding pad. Nevertheless, it can sink 10 mA of current to the 0.4-V TTL low level, as shown by its drain characteristics below



# We were told it cut installation time 13%... it's UNREEL™

## Here's how it happened on the following job...

Requirements: Installation of 33 speakers and a terminal console requiring 4 home runs of up to 12 cables each.

The cable: 9000 feet of Belden 8761, two-conductor with Beldfoil® shielding supplied in Belden's new UNREEL dispenser.

The results: According to the contractor, UNREEL saved 45 minutes per home run.

Permitted one man to pull cable unassisted, freeing a helper to make speaker hookups.

Produced a 13% saving in installation time.

UNREEL made the big difference:

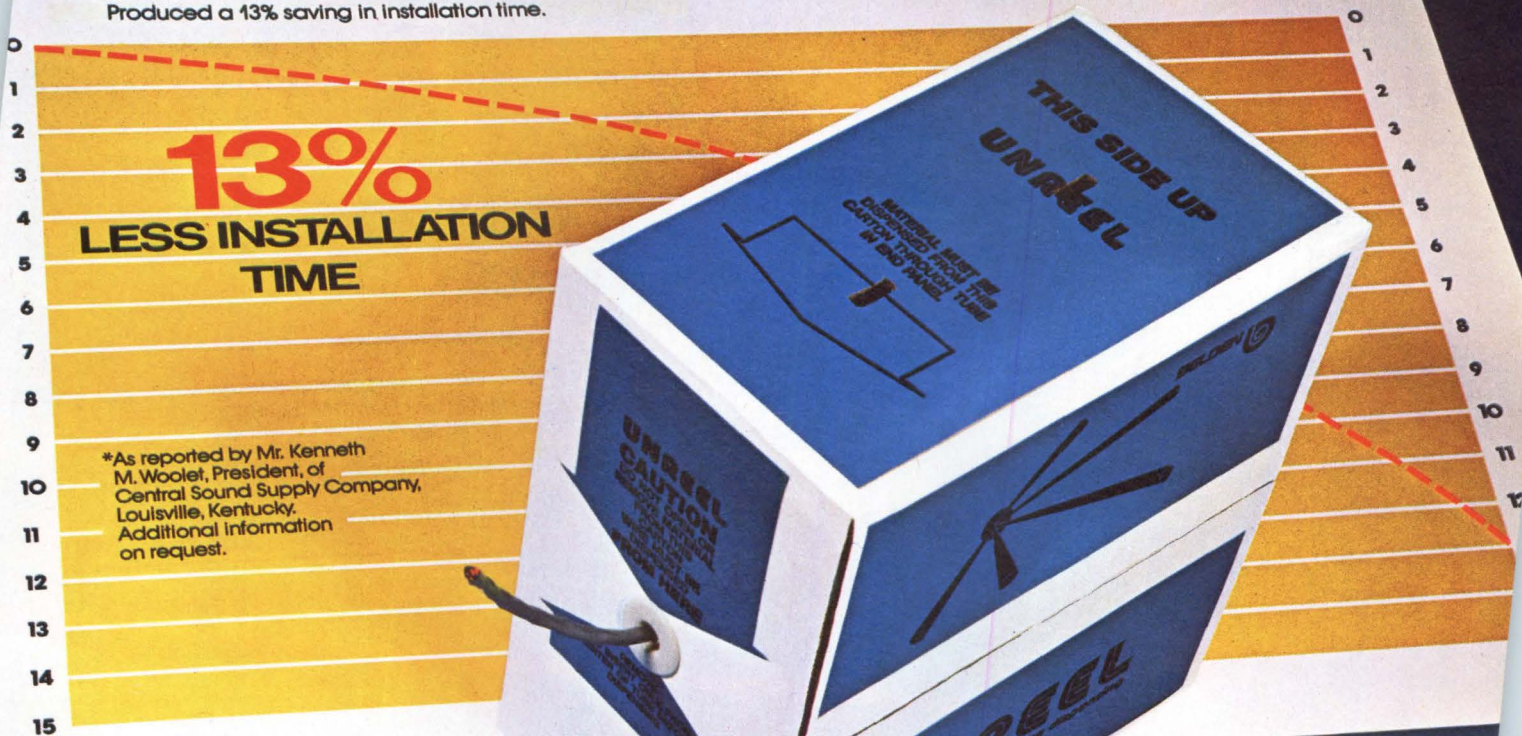
Faster setup. Tensioning devices are not needed.

Package stands free.

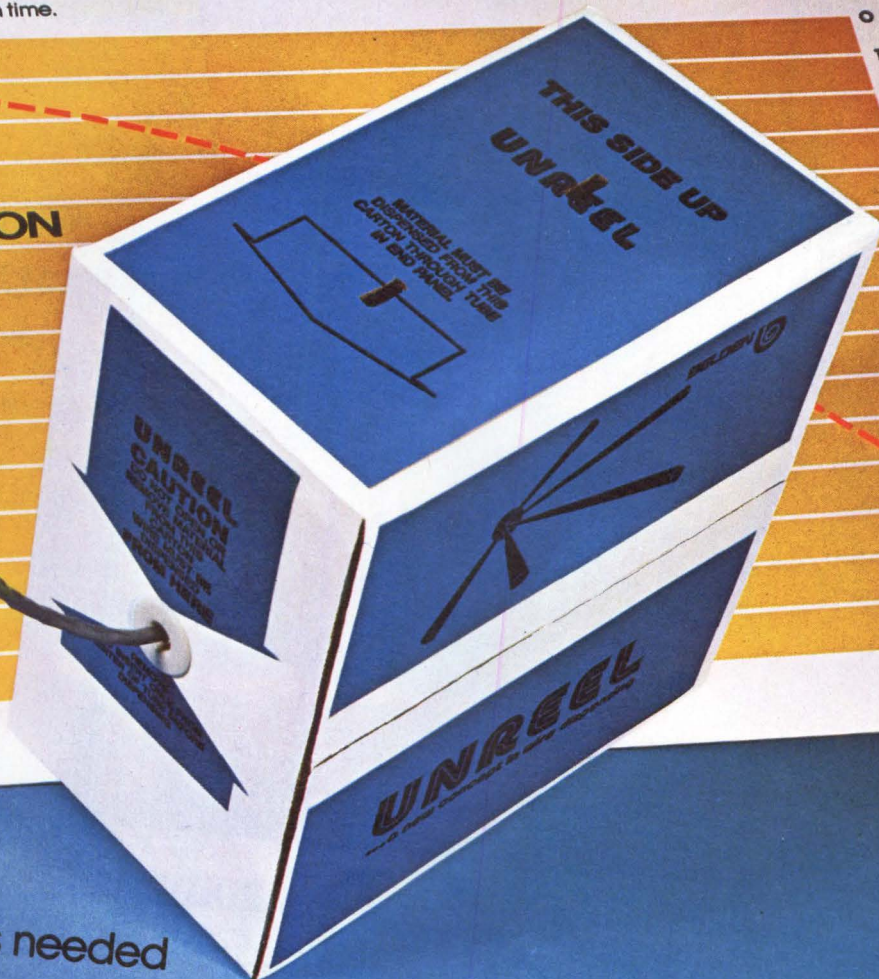
Cable pulls easily. Stops instantly when pulling stops.

No tangles, backlash or kinking problems to contend with.

One man can pull cable. Frees helper for other work.



\*As reported by Mr. Kenneth M. Woolf, President, of Central Sound Supply Company, Louisville, Kentucky. Additional information on request.



- No tensioning devices needed
- No backlash, tangles or kinking
- No reels to dispose of
- Easy to pull
- Doesn't run wild when pulling stops

Belden now offers 80 types of cable in UNREEL packaging for sound communications, security, CATV/CCTV/MATV applications. For details write Belden Corporation, Electronic Division, P.O. Box 1327, Richmond, Indiana 47374. Phone 317-966-6661.

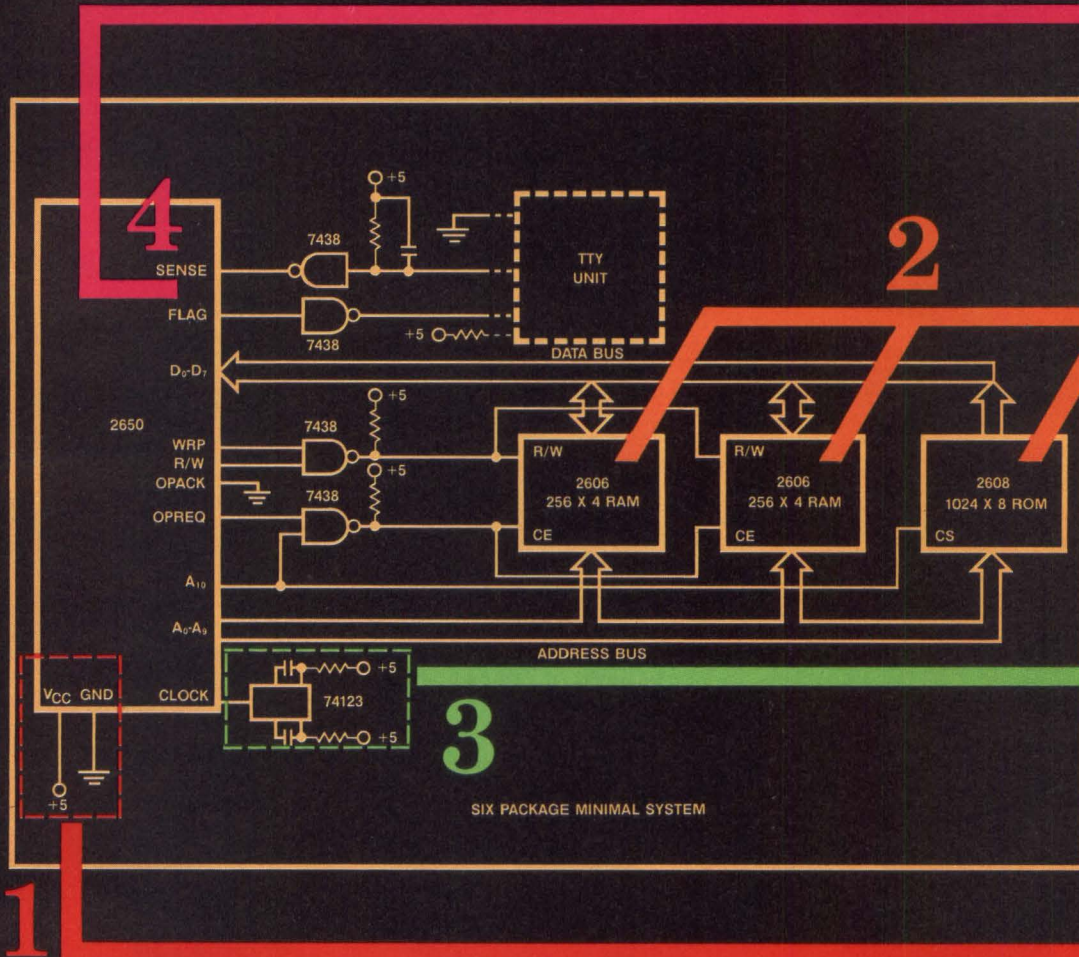


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CIRCLE 21 ON INQUIRY CARD



# EASIEST-TO-USE



## The 2650—static, 5V, TTL compatible, 8-bit $\mu$ P.

Conceptual simplicity is the key to the 2650's ease of design. This  $\mu$ P is static, not dynamic. Its multiple addressing modes mean fewer instructions. Even the instruction set is extra powerful, to increase coding efficiency. Features that add up to less memory required, less design time. Less parts cost and assembly time. More value.

**Illustrated: Parts for 6-package system. Can be purchased for under \$100 in quantities of 1.**

How much less than \$100? In large quantities, the parts could go below \$50. But what's most important is that if you build a larger system—perhaps with 5 or 10 times the memory, plus more I/O—you'll do it with the greatest of ease, and increase your savings still further. Because the 2650 won't need the special (and expensive) memory and LSI I/O chips required in other microcomputer systems. What's an outstanding value in small systems becomes an unbeatable value as the systems get

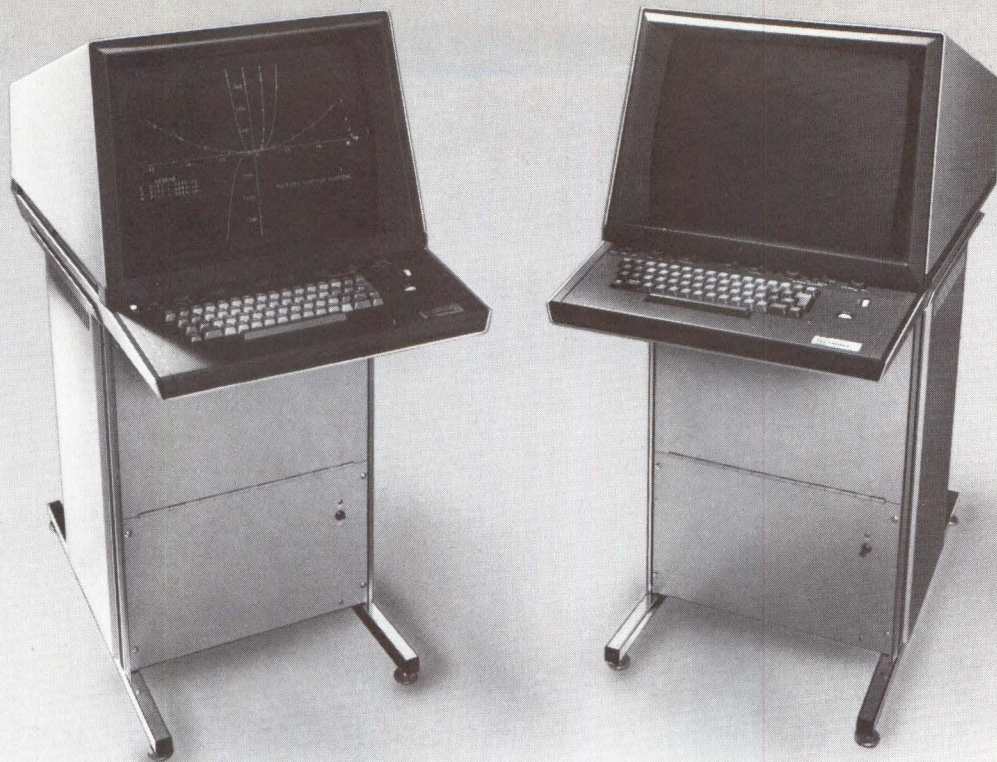
larger. Convince yourself by looking at this beautifully simple Teletype system, a typical example.

**1** Only one +5V power supply drives everything in the system; and this microprocessor is really low power: just 525mW max.

**2** Standard, low-cost memories—your choice. This 6-package system with TTY interface uses only 3 ICs to give you 1024 bytes of standard ROM, 256 bytes of standard RAM. ROM can contain bootstrap loader and I/O driver programs for the TTY, plus operating programs for the system. Other programs plus data can also be in the ROM or written into the RAM by the TTY. Or use a PROM instead of a ROM for maximum flexibility.

**3** Single-phase, TTL-compatible clock input eliminates the nest of transistors, crystal and extra ICs some other microprocessors require. Simple. Cheap. Works better.





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A CRT image is like puppy love. Nice while it lasts, but over before you can enjoy it.

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mation. And the copy is truly permanent. No fade or deterioration like silver paper.

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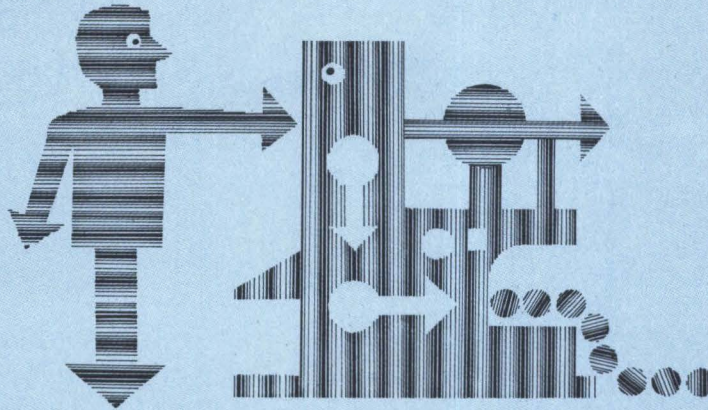
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# DIGITAL CONTROL AND AUTOMATION SYSTEMS



## Social/Economic/Governmental Considerations of Automation

**Sydney F. Shapiro**  
Managing Editor

Any review of automation, whether or not the automation is computerized, must take account of man/machine interface aspects. No matter how sophisticated the level of automation, the human factor exists. Someone has to push a button to start the process and someone has to make decisions or assume control when mechanical or electronic components malfunction.

Infinite mean-time-between-failures has not yet been attained for all components in the control loop—even for the human element. Therefore, back-up systems must be available to assume control, either automatically or on human command. Also, there must be people somewhere in the loop to diagnose the cause of malfunctions and to substitute good components for those that go bad.

Even more important, the people involved with the systems must feel that they are needed, that they are not merely human robots who push buttons on command from the computer. They must feel that their expertise on how the process should operate is necessary in order for the system to function properly.

As discussed in "Computer Process Control Around the World" (*Computer Design*, Nov 1975, pp 58-77), speakers at IFAC 75 (the 6th Triennial World Congress of the International Federation of Automatic Control) represented nearly all countries using automatic process control. Although the systems described then differed widely in both purpose and level of

engineering sophistication, there seemed to be almost universal agreement among speakers involved with the human element in automation that engineering was far ahead of sociology. System designers in the past had been so intent on developing equipment configurations that could minimize the need for man that they ignored social and economic considerations. Fortunately, the trend has very drastically changed direction.

### Social/Economic Aspects

An entire IFAC 75 session as well as several Plenary papers were dedicated to the social effects of automation, with speakers from both the U.S. and Europe—and from both capitalist and communist countries. With only one exception, science overcame political philosophy; however, the lone biased paper<sup>1</sup> was so heavily weighted with political digressions and repeated references to Karl Marx' *Capital* that the author seemingly missed whatever point he promised to make.

Despite the dream of many control engineers for complete automation—eliminating man's role except as a consumer of the products being made, even highly automated systems need human beings.<sup>2</sup> In effect, automated systems are still man/machine systems. The machine may function automatically, but the man must supervise, maintain, and improve. However, consideration should be given to the well being of the human



# MICROPROCESSOR.

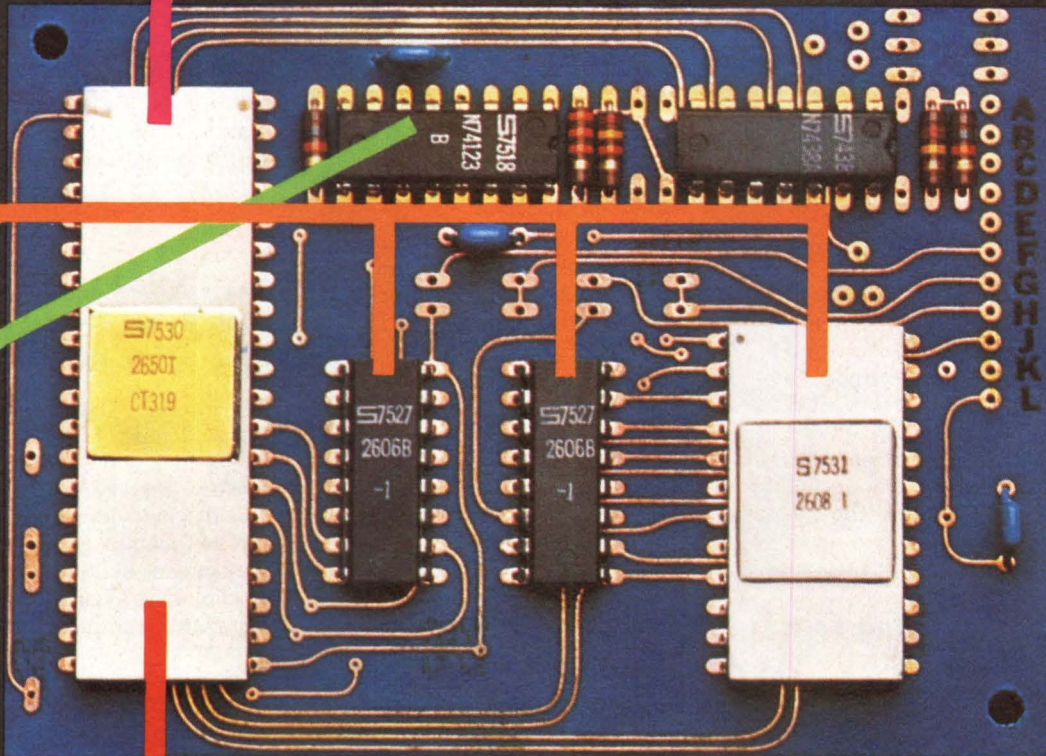


Photo approximately twice actual size.

**4** On-chip serial interface eliminates a 24-pin IC. And its cost. And its space. And its connections.

**5** Where are the special interface chips? There aren't any in this sample system. And not much in any other system you might design with the 2650. With much of the I/O built into the 2650, you can interface the I/O devices with simple, low-cost, industry-standard 74LS, 7400 and 8T circuits.

For instance, get both input and output with the 8T31 Bidirectional I/O Port. Or take the 8T26 Quad Bus Driver as another example. Signetics offers fifty 8T types and nearly everything in 74LS and 7400—all low cost, all industry standards. Lower parts cost means much greater value.

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- Send me full specs & abridged manual, free.
- Send me the complete 2650 manual with update service (additions, corrections, application notes, etc.). Bill me \$40.
- Call me to answer questions I have.
- Have a Field Applications Engineer make an appointment with me soon.

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CIRCLE 22 ON INQUIRY CARD



petes with TTL in speed. The stage delay of a resistor-loaded on-chip VMOS inverter chain (Fig. 2) varies from 1.8 to 3.9 ns over a supply voltage range of 3 to 10 V, and a temperature range of -58 to 128°C when the average power dissipation is 1 mW/inverter. A figure of merit for the inverter chain—the product of the average power per gate and the stage delay—is 2 pJ for a 5-V supply. Present 7400 TTL logic has a stage delay of 4 to 10 ns with a 20- to 40-pJ figure of merit. The power-speed product of a logic structure relates directly to its power dissipation in a system with a given size and clock rate.

A second advantage of VMOS over MOS is bipolar drive capability in the output devices. Because no area-consuming ground electrode is needed in the grounded-source VMOS structure and because each V-groove stripe has an active channel on each side, a very compact VMOS output device (Fig. 3) can provide the 10-

mA at 0.4-V sink capability of most bipolar LSI parts. Typical n-channel MOS output devices are much larger than the 16-sq-mil VMOS buffer in Fig. 2, yet offer only a 1.6-mA at 0.5-V sink capability. This lack of output drive often forces the use of one or more TTL interface devices between MOS LSI parts and heavily loaded bus lines. The extra buffers may double the board area and power required by the MOS parts.

"The major hurdle which VMOS faces," says Rodgers, "is the test of LSI yield feasibility. If it passes that test, there will be high density, high speed VMOS LSI parts becoming available which have smaller die sizes than current MOS parts, and speeds in the TTL range."

## Reference

1. T. I. Rodgers and J. D. Meindl, "Short-Channel V-Groove MOS (VMOS) Logic," *1974 IEEE International Solid State Circuits Conference Digest of Technical Papers*, pp 112-113

In addition, Dr Robert Lawton has developed a simple, independent method, based on the pulse waveform autocorrelation, for measuring fast pulses. The pulse waveform to be evaluated and its delayed version are multiplied together in a pyroelectric device and the results summed over time. Using equipment he developed, Lawton says he can observe electrical pulses to 10-ps resolution.

Andrews and Lawton have also designed another system—an optically strobed sampling oscilloscope for electrical pulse information. Because a picosecond laser pulse lengthens when converted to an electrical pulse, the researchers are trying to narrow the picosecond pulse generation gap to match the original laser pulse by using fast-responding photoelectric devices. In the process, they have developed an electrically strobed sampling oscilloscope for optical pulse information.

For reliable picosecond transition-time pulses, Andrews has developed solid-state pulse generators which can help evaluate short events, oscilloscopes, and receivers measuring radio interference. To retain their useful shape, pulses from the solid-state devices are sent through a nearly lossless NBS superconducting

line, arriving at their destination in their original form, and delayed in time because of the path traveled.

A compact, 100-ps risetime waveform generator has also been designed that will convert short pulses of unknown risetime into somewhat longer pulses of known risetime. This waveform generator—a special lossy coaxial cable—provides well defined pulse waveforms for measuring events. By using different lossy liquids inside the coaxial cable, a variety of pulses are available.

## Encapsulated Aluminum Foil Tape Provides Shield for PCM Cable

An internal shielding tape consisting of 4 mils of aluminum foil totally encapsulated by 6 mils of copolymer plastic has been developed as a shield for pulse-code modulation (PCM) cable. Lamiglas™ 704 tape, announced by Sun Chemical Corp's Facile Div, Paterson, NJ, provides complete conductor isolation plus complete insulation of the shield. It is claimed to be the "most cost-effective shielding material now on the market," offering a cost savings of 5% or more.

The ethylene-acrylic acid copolymer plastic encapsulation material has been used for many years to provide corrosion resistance. By edge-sealing the insulation layers under pressure, entrapped air channels are eliminated. This precludes wicking of moisture along edges of the shield as well as corrosion and potential delamination.

Dead-fold characteristics are such that the tape can be formed into any PCB cable configuration. In addition, industry specifications have been met for accelerated thermal aging for both water and filling compounds.

No adhesive is used when joining foil and plastic. The copolymer plastic is placed directly over the aluminum foil under specific, regulated conditions of heat and pressure that ensure a virtually inseparable bond. Top and bottom layers of plastic overlap the aluminum and are sealed together under the same heat and pressure conditions to totally encapsulate the shield. □

## NBS Research Leading to Improved Picosecond Pulse Measurements

Because of the increasing requirements for controlling and interpreting picosecond events or pulses, scientists and engineers require reliable pulse waveform data on single, repetitive, and step pulses that may have varied rise, fall, and delay times as well as variations in amplitude, shape, and duration. Research at the National Bureau of Standards' (NBS) Boulder, Colo Laboratories, Electromagnetics Div is leading toward development of measurement methods for electrical and optical pulse waveforms that will provide the necessary improvements in accuracy.

Dr James Andrews recently completed an Automatic Pulse Measurement System (APMS) covering frequencies up to 18 GHz and time intervals down to 20 ps. This system takes digital data from a sampling oscilloscope for processing by a mini-computer, and automatically measures the pulse-handling performance of broad frequency range antennas and microwave networks. NBS is considering an APMS service for picosecond pulses.





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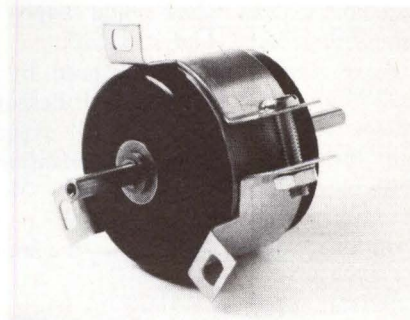
Its many attractive features include:

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The Econo-Line also fits in a smaller space than that variable motor drive you may be paying more for right now. And, in keeping with its thrifty price, it is easily mounted in your product with a standard 27¢ capacitor clamp.

In these inflationary times, it takes more than good luck to get a good product from a good source at a good price. So, why not get all the details?

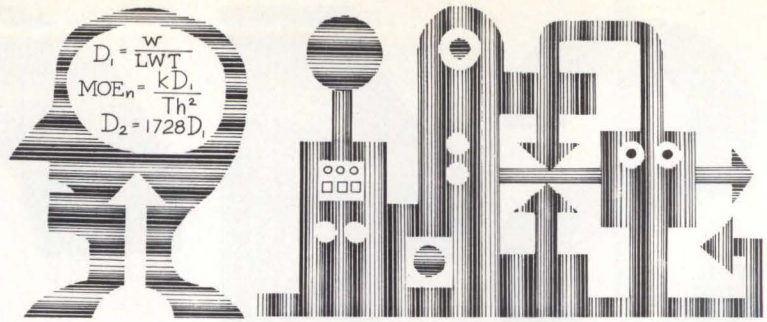
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AEROSPACE & MARINE SYSTEMS

CIRCLE 24 ON INQUIRY CARD





element; he should not be used simply to optimize operational efficiency. Physical tasks can be left to the machine, allowing man to have more time to use his mental capacity to greater advantage such as in devising ways to improve the systems.

Satisfactory man/machine relationships must be a part of the original system design. Some processing decisions—at least with today's level of technology—can be made only by man because only man can "think." However, thorough evaluation must be made during system design to minimize such areas of the process where human errors could result in extremely high cost-penalties. In addition, although a high degree of automation may reduce supervisory work to near boredom, it also eliminates most of the monotonous tasks that today's workers find so objectionable.

Frederick W. Taylor, author of a 1911 book on "The Principles of Scientific Management," is said to have believed that a worker will have the incentive to give optimum performance only if his work is simplified, if his output is measurable, and if he is paid by piece rates. Although the educational level of workers has increased since 1911, and much more consideration should be given to using more of the worker's mental capacity, there still is a strong tendency by employers to maintain sophisticated production incentive programs which ignore mental motivation.<sup>3</sup>

With the advent of automation, whereby machines perform the physical tasks in prearranged sequences, the need to develop satisfactory man/machine systems that provide job satisfaction becomes even more important. As an example, with the introduction of numerically-controlled (NC) machines, it was found that skilled workers were still necessary to supervise those machines in order to maintain the offered production potential. However, the skilled workers were unhappy because they could apply only a small portion of their knowledge and skill.

A research project sponsored by the Austrian Federal Ministry of Science and Research combines theoretical models with practical experiments to investigate the impact of job organization and qualification patterns on NC machine systems. Main factors involved are job satisfaction of skilled personnel, quality of programs and production, machine utilization, and social costs.

Skilled workers, trained to work with NC machines, will organize their work patterns such that each member of a team will assume responsibility for all steps in the production of a particular group of parts. Each team member will select tools to be used, set up the

NC program, prepare and adjust tools, make test runs on the machine, operate the machine during the production period, and make adjustments or corrections necessary to produce satisfactory parts.

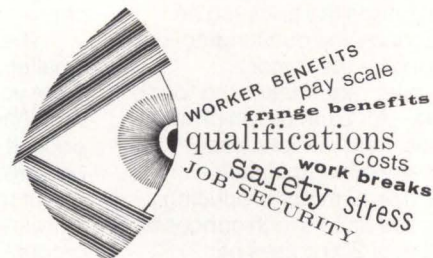
It is expected that the experiment will increase workers' interest in the work by allowing them to use their knowledge and experience, and will provide incentives for improvement in design, programming, and production. High levels of worker qualification should permit mistakes and breakdowns to be avoided or quickly corrected without outside assistance. The most important results, however, are expected to be better machine utilization plus greater job satisfaction.

Comparable studies to determine the likely effects of numerical control on social and economic costs and benefits are being conducted by the Austrian Academy of Sciences, Institute of Research for Socio-Economic Development.<sup>4</sup> Both upper management desire for profit and workers' needs for proper working conditions are being considered in an attempt to determine a satisfactory ratio.

These studies are based on a unit of machining production. They involve shifting from conventional to NC machines as well as switching from a conventional work organization involving operators and programmers to one that uses all-round workers.

Main decision points included are capital investment, production, manpower, and working conditions. Only two types of machines will be involved—conventional and NC—thereby reducing initial capital investment. The production target will be to use the machines at the best ratio of labor and output. Periodic decisions will be made as necessary on hiring, firing, and training workers.

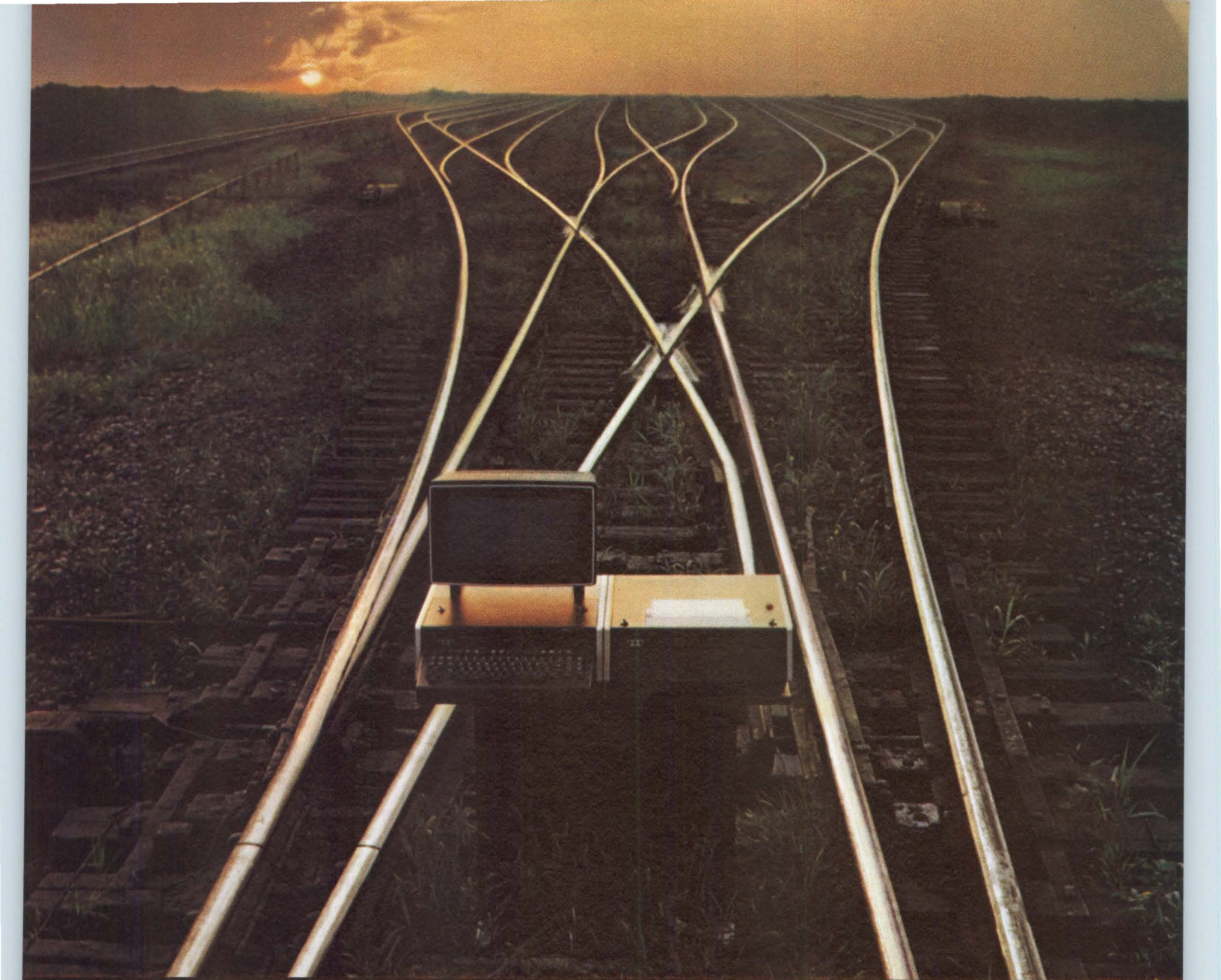
Evaluation of working conditions will consider both worker benefits and associated costs. Psychological fac-



tors such as pay scale, work breaks, fringe benefits, level of qualification, worker safety, stress, and job security will be thoroughly investigated.

(Continued on p 56)





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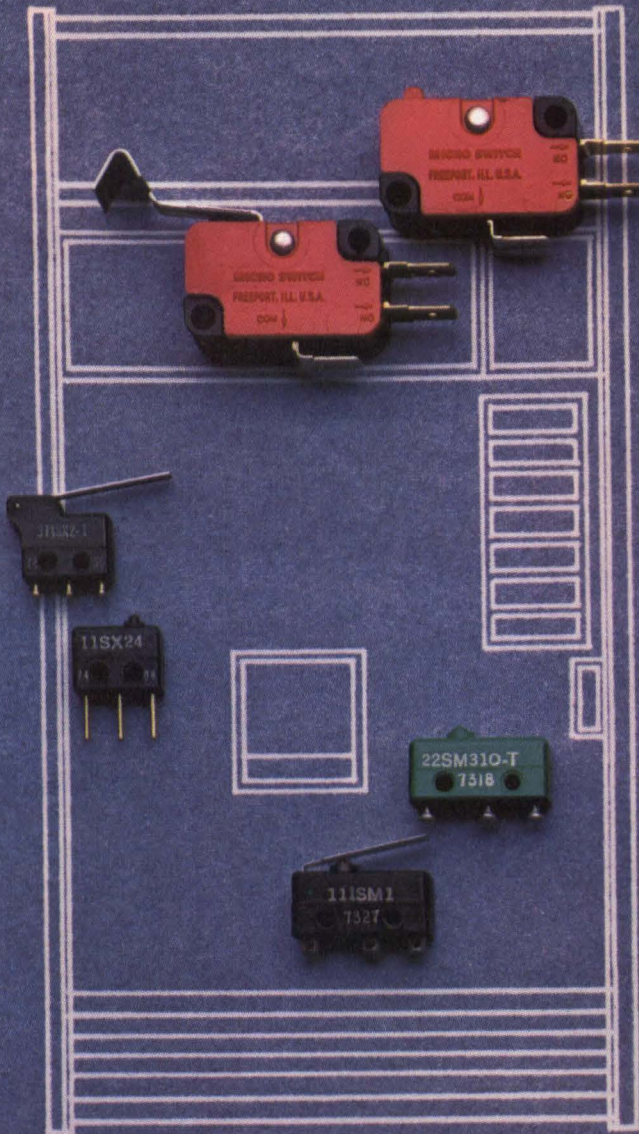
**The Teletype model 40 system.  
Nothing even comes close.**

CIRCLE 25 ON INQUIRY CARD



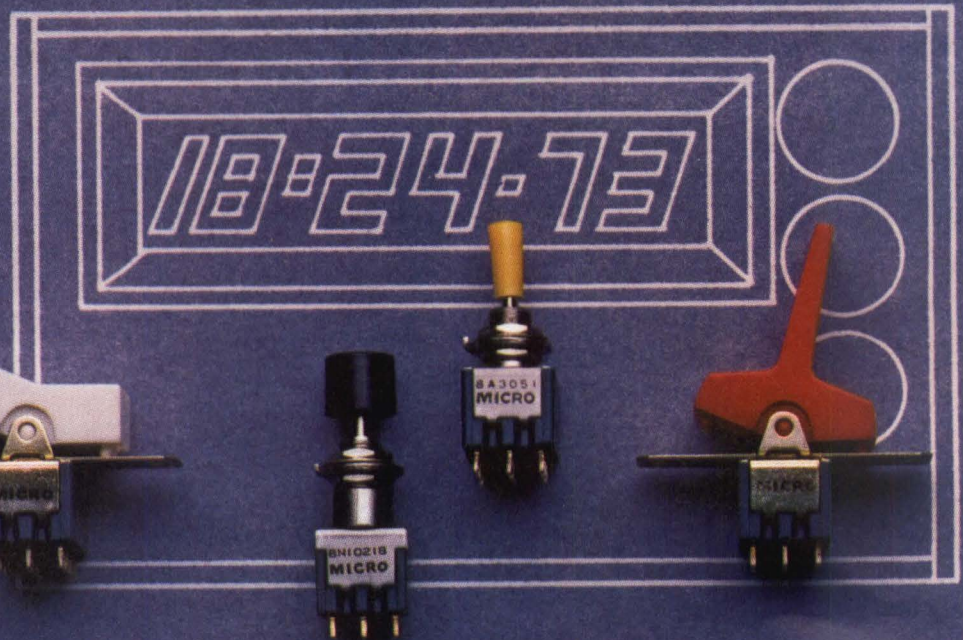
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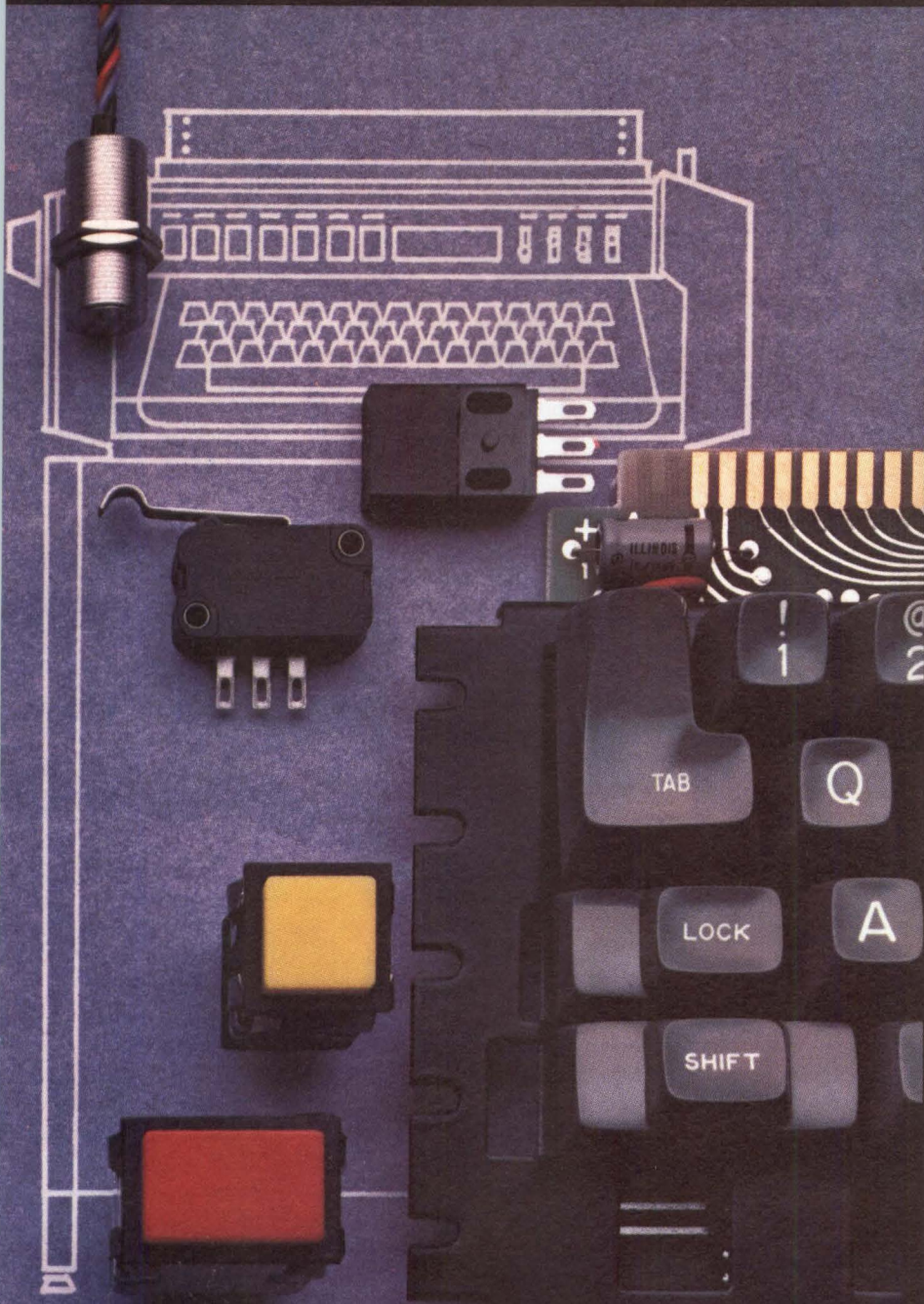
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Theory put into practice is illustrated at the Volvo automobile assembly plant in Kalmar, Sweden.<sup>5</sup> The primary intent was to arrange production procedures such that employees would "find meaning and satisfaction in their work." Reportedly with no sacrifice in efficiency or economic results, the system permits employees to work in groups, communicate freely, rotate jobs, vary work rate, identify with the products, be aware of responsibility for maintaining quality, and influence work environment. Assembly is subdivided into 28 separate teams which work in an atmosphere of small workshops within the overall factory. Each group influences its work plan, organizes internal job allocation, and varies work rate.

Five Digital Equipment Corp PDP-11 minicomputers supervise and control the plant. They perform routine functions, provide information to assist workers in making decisions, and carry out the instructions requested as a result of those decisions. Communication between information systems and people is maintained through 35 displays, 24 printers, 60 keyboard input devices, and 40 links to Robocarriers under the control of a dedicated computer. In essence, the computers work for, rather than control, the people.

Language problems have been minimized. Each employee can "talk" to the system in his own language. (In addition to Swedish employees, many workers are Finnish, Yugoslav, or Turkish.) Plans for the future also include use of audio-visual techniques.

A process and production control system supervises and controls all process functions. These include movement of 250 Robocarriers throughout the plant; supervision of charging batteries on the Robocarriers; starting, stopping, and supervising related conveyor systems, hoists, lifts, and automatic equipment; and status of workshop groups. This is accomplished through a 2000-line network with 32 interrupts and over 1800 digital input and output lines, all maintained by a universal digital controller.

Quality information is maintained by tests made on each car at 20 checkpoints chosen by the computer from a possible 3000, in accordance with the laws of probability. Faults are identified to the works on display screens so that corrective reactions can be implemented immediately. Expectation is that over 85% of assembly or production faults can be detected by this procedure.

Theoretically, the increased cost for building the Kalmar plant will be repaid by reduced absenteeism and labor turnover, although true figures are not yet available. However, in a related system at a truck assembly plant in Gothenburg (under different conditions because labor there is in higher demand), labor turnover is currently 10 to 12%, opposed to more than 50% in 1968-69, and absenteeism is much lower than during the earlier period.

#### **Government Support for Research**

Sources of financial backing for studies of improved

methods and application of industrial automation vary from country to country. Although federal government support plays some role in each country, the degree of financial backing ranges from nearly minimal for projects other than defense- or aerospace-related ones in the U.S. to effectively 100% for some projects in Japan. What influences the different policies will have on the future ability of each country to compete with the others is beyond the scope of this review. Readers may make their own evaluations and decisions from the speakers' reports.

Although industrial research in the U.S. is supported by a multitude of federal agencies, the backing tends to be generally small and quite diverse, except for certain defense-related projects.<sup>6</sup> This, of course, has not gone unnoticed or unchallenged by trade and professional organizations and some government offices. The main themes generally universal among their statements are that the U.S. government could play a key role in promoting manufacturing and service industry productivity and that the major problems facing the government and industry are political rather than technological.

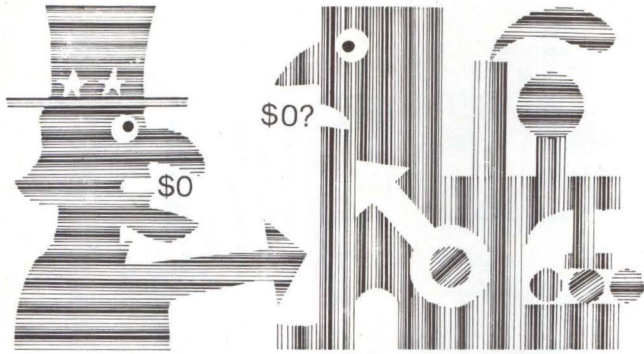
Several agencies—the Department of Defense (DoD), the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the former Atomic Energy Commission (AEC), and the National Bureau of Standards (NBS)—invest in research and development relative to manufacturing process technology. The great bulk of government research spending is through DoD—\$50 to \$60 million by the Army, \$25 to \$30 million by the Air Force, and smaller amounts by the Navy. Efforts that directly relate to automation include a recent major contract to produce a master plan for an Air Force computer-aided manufacturing program, and a 1950s project to develop the original numerically-controlled machine tools and the APT language for programming NC tools.

NSF has sponsored a program for the enhancement of productivity that is based on industry/university cooperative efforts. For instance, Case Western Reserve University is developing NC systems for a large machine to bend metal plates for the hulls of ships; at Stanford University research is being conducted in the use of computer-controlled manipulators and visual pattern recognition systems for automatic assembly; the University of Rochester is studying discrete part manufacturing and interactive programming concepts for mini-computer systems in total manufacturing plans; and at the Charles Stark Draper Laboratory, further research is being carried out on the programmable assembly problem.

Still other government-sponsored projects involve one for NASA for a large scale integrated design system that would operate on large computers, and two Dept of Commerce programs to aid shipbuilders. In addition, NBS has several relevant projects, including research on sensors and computer control systems for robots and machine tools.



In general, the U.S. government believes that industry must take the responsibility for developing automation systems and that the need to compete will force development of whatever technology is required. The noted exception is NSF, which is studying basic research.



A drastically different policy is illustrated by the government of Japan, which fully funded one project alone for \$100 million.<sup>7</sup> This project, for a pattern information processing system, will cover an 8-year period. Its target is to develop a practical system which will directly accept pattern information such as characters, pictures, 3-dimensional objects, and speech. Built-in functions provided will include parallel operation, associative information retrieval, and learning capability.

More balance in funding responsibility is maintained in the Federal Republic of Germany.<sup>8</sup> There, industrial firms are usually required to supply 50 to 75% of the funds budgeted for a project. To date, two long-range programs have been set up to support the overall data processing industry—the first from 1966 to 1968 and the second from 1971 to 1975. However, only a portion of the funding has been allocated for developing automated processes; because of the overlapping coverage of various projects, exact figures are difficult to determine.

To find ways of broadening the application of computers to process control, several projects have been initiated. One of these is under the direction of the Karlsruhe Nuclear Research Center, which uses process control computers in its own nuclear physics experi-

ments. A separate institute at the Center works on process control problems.

Although tiny in relation to the giant industrial countries of the world, Norway has relegated a disproportionate amount of money to studies in automation and data processing—approximately \$7 million.<sup>9</sup> This amounts to \$1.75 for each of the 4 million people in the country. (Norway spent \$30 million on all research and development in 1972, or \$7.50 per person.)

One of four councils set up to advise the government ministries, the Royal Norwegian Council for Scientific and Industrial Research (NTNF) is involved in research on automation. Funding is from direct government grants and from industrial contracts. Five of NTNF's 16 research institutes work in automation and data processing; one of the five concentrates on this field alone. With only 9000 degree-holders in the country—10% involved in automation and data processing—the government feels that the stress on process automation is necessary in order for it to compete in its major export markets with the large, technologically advanced countries.

#### Tomorrow's Process Control

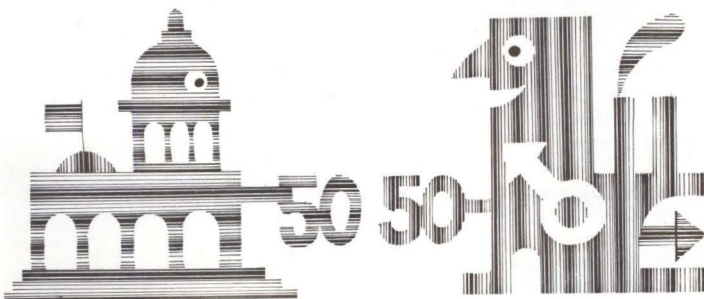
What effect will digital control have on the future? Will extensive automation result in increased unemployment? Will it instead cause a readjustment of labor practices, with more jobs of improved levels of responsibility?

There is little question that the technology is available to institute full plant control by computers. Microprocessors and their low hardware costs promise the possibility of control in finite areas that previously did not warrant automation. Yet, expensive software may drastically hinder application of process control where it might otherwise be used.

Historically, the development of process control can be divided into two periods: 1945 to 1960 with single-loop, industrial systems, and 1960 to the present in the era of "modern" control.<sup>10</sup> Much of the credit for drastic advancements in the latter period can be given to the aerospace government/industry complex. Rocket guidance required sophisticated control that was unavailable until developed through intensive research programs.

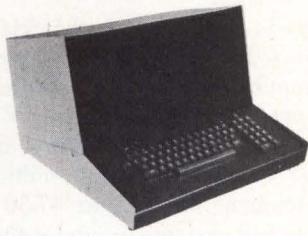
Yet, this resulted in a gap between theory developed in the aerospace research studies and practice for industrial applications. Concentration had been on producing dedicated control systems, often without consideration of operating costs. This "tunnel vision" attitude put man on the moon, but it did little to immediately solve general industrial control problems. Full blame, however, cannot be placed on the "theorists;" industry, for the most part, failed to take advantage of the knowledge that was available.

Large scale integration and other forms of micro-miniaturization, resulting in large part from technology developed for aerospace projects, have already given a tremendous impetus to solving control-related prob-





# Sphere. The Component Packager.

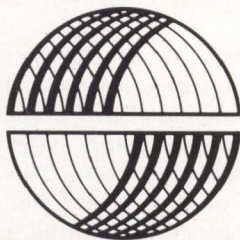


## BUY ONLY WHAT YOU NEED!

- \$622.00 CPU Board: 8 bit parallel microprocessor with 4K dynamic memory. 1K EPROM containing program development system or Basic language subset or your specific application software. Real-Time Clock, bus cable structure and 16 lines of digital I/O optional.
- \$207.00 CRT Board: generates 64 character ASCII character set which is displayed on 16 lines by 32 characters (5 x 7 matrix). Electronics will display on television set or video monitor.
- \$160.00 Keyboard: ASCII type alpha/numeric keyboard with numeric and cursor keypad.
- \$219.00 Communications Board: includes FSK Modem (110 to 600 baud) originate/answer with cassette or telephone interface includes serial I/O capabilities (110 to 9600 baud) it is EIA, TTL, TTY, current loop I/O and RS 232 compatible.
- \$160.00 PIM: Peripheral Interface module, 64 digital I/O board allowing complete interfacing with printer and Floppy Disks Systems.
- \$96.00 Power Supply: produces 5 volts at 5 amps, 12 volts at 3 amps, -5 volts at 400ma, -12 volts at 400ma.

Or...you can buy the combination of the above assembled in an attractive chassis with line printer and/or Floppy Disks from \$1400 to \$11,300 (kit price available upon request).

Also consider our options: Light pens, line printers, Floppy Disks and more to come with low-cost disk systems, megabyte storage, and the new color and B/W graphics terminal.



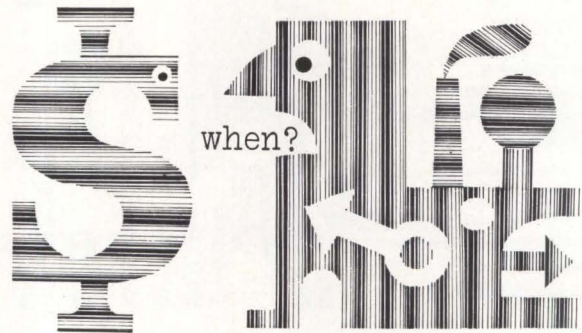
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## DIGITAL CONTROL AND AUTOMATION SYSTEMS

lems. Prime examples are the microprocessor and related semiconductor memories.

Whether or not the theory-practice gap can or will be immediately closed will depend on future economic trends that may or may not permit the capital investments that will be required. The shift from today's semi-automation status to future full automation could



occur very soon—or it could be years away. Perhaps by IFAC's 7th Triennial World Congress in 1979, the trend will be more defined than it is at present.

### References

All references are to papers presented at IFAC 75, to be published in four volumes: I—Theory, II—Applications, III—Systems, Economics, Management, and Social Effects (also includes Plenary Session papers), and IV—Computers, Space Components, and Education. (Copies may be ordered from Instrument Society of America, 400 Stanwix St, Pittsburgh, PA 15222, USA, or John Wiley & Sons, Ltd, Baffins Lane, Sussex PO191UD, England. Payment of \$35 per volume or \$125 for the complete set of four volumes should accompany order.)

1. H. Maier (German Democratic Republic), "The Social Consequences of Automation for the Qualification and Training of Workers," Vol III, Paper 33.5
2. K. S. Bibby (UK) et al (Austria, Netherlands, USSR), "Man's Role in Control Systems," Vol III, Plenary Session Paper 4
3. H. Weseslindtner and F. Margulies (Austria), "Numerically Controlled Machine Tools: Different Systems of Organization and Their Impact on Output and Job Satisfaction," Vol III, Paper 33.3
4. P. Fleissner and P. P. Sint (Austria), "An Integrated Model of Social and Economic Costs and Benefits in the Use of Numerical Control Machines (A Progress Report)," Vol III, Paper 33.4
5. W. Krieg (Switzerland), "Social Effects on Automation—Based on Volvo-Kalmar Example," Vol III, Paper 33.2
6. J. M. Evans, Jr and T. J. Williams (USA), "National Support of Advanced Industrial Automation Research in the United States," Vol II, Paper 32.1
7. R. Mori (Japan), "Pattern Information Processing System (PIPS) Project in Japan," Vol II, Paper 32.4
8. H. E. Bertuleit (Federal Republic of Germany), "Computer Applications to Process Control—Promotion Measures in the Federal Republic of Germany," Vol II, Paper 32.2
9. H.-P. Klemmetsen (Norway), "Organization and Promotion of Government Sponsored Research in Automation and Data Processing in a Small Country," Vol II, Paper 32.3
10. H. H. Rosenbrock (UK), "The Future of Control," Vol III, Plenary Session Paper 2



**Design Problems...**  
**Systems Problems...**  
**Application Problems...**  
**Business Problems...**

CompDesign/76 provides digital electronics engineers the most comprehensive forum for understanding their problems and the state-of-the-art capability for solving them.

Workshop forums, product seminars and exhibits are all part of one event, and are all aimed at bringing these problems into focus . . . how they inter-relate . . . how to solve them.

Computer Design Magazine has assembled a group of professionals in each of these areas to present the most current information, listen to your problems and ideas and work out the best avenues to solutions.



**COMPDESIGN/76**

**Three days of Forums, Seminars and Exhibits directed at you,  
the Computer Design reader**

BOSTON NEW YORK CHICAGO LOS ANGELES SAN FRANCISCO



The most complete concentration of technical sessions and product exhibits in the computer industry is scheduled for three days each in Boston, New York, Chicago, Los Angeles and San Francisco in 1976.

Tailored for multiple-unit buyers, including traditional OEM's, systems houses and in-house systems people, CompDesign/76 will provide the most-up-to-date practical information on microprocessors, peripheral devices and business topics relating to the design and implementation of computer systems.

The touring conference is sponsored by Computer Design Magazine and the three days of sessions will be geared to all levels of digital electronics engineers with special emphasis for computer-based systems designers and technical management. The meetings will be held in conjunction with the Computer Caravan in these cities and in addition to forums on the above topics, attendees will be eligible to attend exhibitor seminars and the Computer Caravan exhibits with no additional charge.

The co-appearance of CompDesign/76 and the Computer Caravan in the above cities, comprised of forums, product seminars and exhibits, will provide attendees with the most complete and integrated overview of the computer industry to date.

Forum sessions will be set up and administered by personnel with years of experience in presenting technical information, and the material will be presented by established, knowledgeable people in the engineering and technical management fields.

During each of the three days in each city, forum sessions will take place during the morning, exhibitor seminars during the afternoon, and the exhibits will be open from 10 a.m. to 5 p.m.

The forum sessions will be keyed to practical, state-of-the-art information to help OEM suppliers and designer-users put together more efficient and reliable products and systems. These will not be tutorial sessions but give and take meetings that will put the problems on the table for thorough discussions.

## Tuesday (Day 1)

### CONCURRENT WORKSHOPS UNDER THE THEME OF BUSINESS TOPICS FOR THE COMPUTER PRODUCT MANAGER.

#### a) "Specmanship": How to cope with it.

Specmanship is the art of distorting a specification without actually making a false statement. This session covers subtle variations in parameter definition and test methods, omission of qualifying statements, use of "typical" rather than properly tolerated values, and many other misleading techniques which add to the difficulty and cost of choosing the right components and equipment.

The session will cover the many forms which "specmanship" can take, with topical examples, how to cope with it, and inter-action between users and vendors on the more controversial aspects.

#### b) Standardization — status, future directions.

Standardization, a valuable tool in dealing with "specmanship", is also a means for simplifying the application and interfacing of electronic equipment. However, standardization is especially difficult to implement in the rapidly growing and highly competitive computer industry. The workshop will review the nature and role of standardization procedures, with pertinent illustrative examples. It will explore possibilities for accelerating the standardization process while still encouraging creativity in product development and application. Vendor-user interaction will be a prime element of this forum.

#### c) Buying from new or very small companies.

New small companies are frequently structured (at least initially) around technologically advanced products which extend the state-of-the-art. However, there is an element of risk to the user who must be assured that the advanced product supplier will remain in business and continue to provide necessary customer support for the life of the application.

The session will consider appropriate criteria for small company evaluation, including decision-making trade-offs. Specific experiences will be used as illustrations.

#### d) Testing and quality of purchased products, economic factors.

As part of the effort to cut costs in the highly competitive digital electronics industry, many companies are spending less on quality control. The consequences are costly production line rejections as well as field failures. Frequently, the only practical user alternative is to set up a comprehensive incoming inspection system.

The workshop will consider the problems of testing and quality, with emphasis on economic trade-offs. Strong interaction between vendors and users will assure airing of all pertinent factors.



# Wednesday (Day 2)

## CONCURRENT WORKSHOPS UNDER THE THEME OF PERIPHERALS FOR MINI- AND MICRO-COMPUTERS.

### a) Defining characteristics of mini- and micro-peripherals.

The development of mini- and micro-computers has made substantial computing power available at low cost, with a forecast for more of the same. As a result, computer applications are expanding phenomenally. However, since the cost of peripherals can easily exceed the computer cost, the development of mini- and micro-peripherals with computer-compatible performance and price, is a major requisite for continued growth.

The sessions will estimate the desired nature, performance and price of peripherals for micro-computer applications. Some guidance will be provided by comparison with the evolution of peripherals for mini-computers.

### b) Interfacing and standards.

Important simplifications in system design and application may be achieved by the establishment of comprehensive interface standards for mini- and micro-peripherals.

The workshop will review the status of current standards and standardization programs, and will emphasize desirable future trends. The role of the microprocessor and associated LSI devices in the interface function will be illustrated by specific examples.

### c) Micro-peripherals — current status vs. users' needs.

The defining characteristics of micro-peripherals are examined in another forum session. This session reviews the state-of-the-art of micro-peripherals with regard to type, availability, general characteristics, and price. Special attention will be given to specific user needs, including performance and price goals. Vendors are expected to comment on the practicality of user expectations.

### d) Future trends.

In view of the emphasis on new peripheral development, some effort will be made to anticipate future trends. For example, the impact of solid-state alternatives (such as CCDs, bubble memories) to electromechanical mass storage means. The session will seek out the latest vendor opinions on the impact and timing of new products arising from today's laboratory models.

# Thursday (Day 3)

## CONCURRENT WORKSHOPS UNDER THE THEME OF MICROPROCESSORS

### a) The State of the art; availability.

The state-of-the-art in the microprocessor design is changing so rapidly, that "keeping up" is a continuing and time-consuming process. This session will examine the current state-of-the-art, with particular attention to performance and availability of the newer types.

### b) Application factors; user needs.

The typical system design engineer using microprocessors for the first time, will usually require considerable application assistance. The nature and adequacy of this assistance, as provided by microprocessor suppliers, will be explored. Users will be given ample opportunity to discuss their experiences, both good and bad, in getting started with microprocessors, and to describe the kinds of support they would like to have. Interaction between users and vendors should be particularly illuminating.

### c) Applications — variety of examples.

The versatility and benefits of the microprocessor will be illustrated by a variety of application examples presented by users. The principal areas of microprocessor usage will be covered. Discussion will be moderately technical, emphasizing application requirements, the benefits expected from the microprocessor, microprocessor performance requirements, reasons for the specific microprocessor choice, and problems encountered in application. Users at this session will have ample opportunity to ask questions and to describe their own application needs.

### d) Future trends.

Because of the impact of the microprocessor on the entire digital electronics industry, estimating future trends is critically important for long-term product development and marketing planning. Estimates must consider the timing of new products, improvements as well as breakthroughs in technology, ultimate technological limits, and price trends. The forum session will cover these topics, as well as their impact on microprocessor usage and on new applications.



# Three reasons why you should attend **COMPDESIGN/76**

## 1. Keep Abreast of Your Industry.

Techniques, technology and applications in the computer industry change faster than in any other industry.

Basic technology developments have given us new products — especially in the mini and microcomputer areas. These have led to new applications which means new interfaces, new customers, new business problems, specification changes, re-design, and testing problems. The impact can be seen by looking at the growing market for microprocessors and microprocessor-based equipment, just as one example.

The forums and seminars at CompDesign/76 will bring together knowledgeable people in problem areas such as those cited above to give you an update on developments and how to deal with them.

You will attend shirt-sleeve sessions with plenty of opportunity for two-way communication. You will be exposed to problems concerned with your particular discipline or function. And you will better understand how you affect and are affected by other areas of the industry.

*"The Computer Designers' Forum, the name given to the technical program of CompDesign/76, is an extension of the editorial objective of Computer Design Magazine. You can expect the same approach as we follow in our pages: no vendor pitches, but an important dialogue on digital equipment and systems technology by designers who have solved very specific problems.*

**John Camuso**  
Editor, Computer Design Magazine

**When returning the registration form make sure you designate which days you would like to attend and check the city.**

<b>Boston, March 2-4</b>	Showcase 1-2-3 & 4 Movie Theater, Woburn, Mass.
<b>New York, March 9-11</b>	Mariott's Essex House
<b>Chicago, April 13-15</b>	McCormick Place On-The-Lake
<b>Los Angeles, May 4-6</b>	Los Angeles Convention Center
<b>San Francisco, May 11-13</b>	Civic Auditorium

## 2. Exchange Ideas With People Responsible for Progress in the Industry

You will be meeting and exchanging ideas with people from all levels and all areas of the industry who are responsible for making things happen. OEM suppliers and designer-users will be interacting in all aspects of the forums and exhibitor seminars. You will get first hand knowledge of problems from people who have experienced them, and who will describe their solutions. You will have an opportunity in a face-to-face environment to state your views, question speakers and generally work out problems that affect your job and your industry.

## 3. "Backyard" Availability

These forums and seminars will be held in five regional cities. The cities were selected because they are centrally located in the largest "computer markets" in the U.S. and have the accommodations required to make the meetings a success.

For most industry people it will be a relatively short trip to one of the sites, which is a positive cost factor in a cost-conscious economy.

In addition to the morning forums you will have the advantage of attending, free-of-charge, the Computer Caravan exhibits (which will be held in conjunction with CompDesign/76) and exhibitor seminars for either conference.

### DAILY SCHEDULE OF EVENTS

**9 am to 1 pm** — COMPDESIGN FORUM

**9:00-9:40**—Welcome, Orientation and Introduction to theme of the day presented by Sid Davis, Associate Editor, *Computer Design Magazine*.

**9:45-11:00**—Four Concurrent Workshops (First presentation)

**11:00-11:10**—Coffee Break

**11:10-12:25**—Workshops (Repeated)

**12:30-1:00**—Wrap-up Panel

**1:00 to 2:00**—Dutch Treat Lunch

**2:00 to 5:00**—Product Seminars

**Exhibits:** Open 10:00 to 5:00 each day



**WHAT IS YOUR PRINCIPLE ENGINEERING FUNCTION OR MANAGEMENT RESPONSIBILITY?**

- E1 Computer-Based Systems Design
- E2 Digital Systems Design
- E3 Digital Equipment Design
- E4 Digital Circuit Design
- E5 Interface Engineering
- E6 Data Communications Engineering
- E7 Test/Inspection/Reliability Engineering of Digital Equipment
- E8 Consulting/Educating on Digital Electronics

**WHAT IS YOUR ORGANIZATIONAL CLASSIFICATION:**

- C1 Executive Management
- C2 Engineering Management
- C3 Senior Personnel
- C4 Staff Personnel
- C5 Consultant/Educator

**WHAT IS THE NATURE OF YOUR ORGANIZATION?**

*Use code for best description.*

Manufacturer of:

- 02 Large Computers
- 04 Minis/Medium Computers
- 06 Micros (excl. ICs)
- 08 Memory/Storage Equip (excl. ICs)
- 10 I/O Equip (incl. Data Terminals)
- 12 Data Comm Equipment
- 14 Computer-Based Systems
- 16 Office/Business Machines
- 18 Industrial Control Equip
- 20 Test/Masurement Equip; Instruments
- 22 Comm Equip (other than Data Comm)
- 24 Navigation/Guidance Equip
- 26 Undersea/Aircraft/Missile/Space/Ground Support Equip
- 28 ICs/Circuit Modules
- 30 Consumer Electronic Products
- 32 Medical Electronic Products
- 34 Other Products Incorporating Digital Electronics:

**Other organizations:**

- 36 Systems House
- 38 Industrial Company Using/Incorporating Digital Electronic Equipment (incl. Computers) in Manufacturing/ Research/ Development Activities
- 40 Commercial User of Digital Electronic Equipment
- 42 Government/Military Agency or Installation
- 44 Independent Research/Test/Design Laboratory (i.e., one not connected with a manufacturing company)
- 46 Independent Consulting Company
- 48 Educational Institution
- 50 Other



**COMPDESIGN/76**

# COMPDESIGN/76

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**Registration Fees**

Figuring total fees is simple. Add up total days registered for all people on this form (plus any additional people on copies of this form which you have enclosed) and enter below:  
TOTAL NUMBER OF DAYS FOR ALL PEOPLE BEING REGISTERED WITH THIS ORDER

First Day is \$50, additional days are \$35 each (for example, if you have three people registering for a total of eight days, fee will be \$50 plus 7 times \$35 (\$245), or \$295 for all people).

Calculate *total fee due* and enter here

*Remember that any single-day Forum registration also entitles you to attend all three days of exhibits.*

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## REGISTRATION FORM

Use this form to register up to two different people for any number of days. Please fill out completely and mail to:

**THE CONFERENCE COMPANY**  
**COMPDESIGN 76 Registration**  
797 Washington Street  
Newton MA 02160

**(If form below has been removed fill out reverse side.)**

*You may charge registration to your American Express Credit Card. See Check Box below.*

Register me for:  All three days, or:  1st Day  2nd Day  3rd Day

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*Please enter proper codes from box with listing:*

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**CHECK CITY IN WHICH YOU PLAN TO ATTEND**

- Boston March 2-4
- Los Angeles May 4-6
- New York March 9-11
- San Francisco May 11-14
- Chicago April 13-15
- Charge my American Express Card

Your Card number \_\_\_\_\_ Expiration Date \_\_\_\_\_

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- 22 Comm Equip (other than Data Comm)
- 24 Navigation/Guidance Equip
- 26 Undersea/Aircraft/Missile/Space/Ground Support Equip
- 28 ICs/Circuit Modules
- 30 Consumer Electronic Products
- 32 Medical Electronic Products
- 34 Other Products Incorporating Digital Electronics:

#### Other organizations:

- 36 Systems House
- 38 Industrial Company Using/Incorporating Digital Electronic Equipment (incl. Computers) in Manufacturing/ Research/ Development Activities
- 40 Commercial User of Digital Electronic Equipment
- 42 Government/Military Agency or Installation
- 44 Independent Research/Test/Design Laboratory (i.e., one not connected with a manufacturing company)
- 46 Independent Consulting Company
- 48 Educational Institution
- 50 Other



## COMPDESIGN/76



You'll find our Series 700 is the *most significant* head per track disk memory introduced in years.

**The reason.** It's small. Low-cost. Lightweight. Reliable. And designed for easy servicing. Of course we're using our most proven technology in the Series 700. Technology that made General Instrument the world's leading independent supplier of rotating memories. But we're also using innovative design techniques that allow high performance and reliability...while keeping costs low.

The Series 700 offers up to 19.2 million bits. Up to 128 tracks in 32-track increments. A *fast* average access time of 8.5 milliseconds. 3600 rpm. And a data rate up to 4.5 megahertz. You'll get a new head assembly that's been proven in current military programs. Modular construction so one unit can meet all requirements. Minicomputer compatibility. A completely self-contained system. Standard recording disk. And other important features all packaged in a 7-inch high unit. All at \$3985.

**Serviceability.** The Series 700 was designed for *service simplicity*. It's essential in many applications. Like point of sale, data entry and small business processing. Anywhere you'll need *maximum access* to service and inspection areas.

Our goals are still simple. Provide quality rotating memories. Be responsive. And maximize customer convenience.

We're in most major U.S. Cities and Europe. Call (213) 973-1741. Or write for our new Series 700 brochure. General Instrument Corporation, Rotating Memory Products, 13040 South Cerise Avenue, Hawthorne, Ca. 90250.

\*OEM price @ 100 units per year.

**\$3985 a megabyte**

**small... light... low cost**

**new head-per-track disk memory**

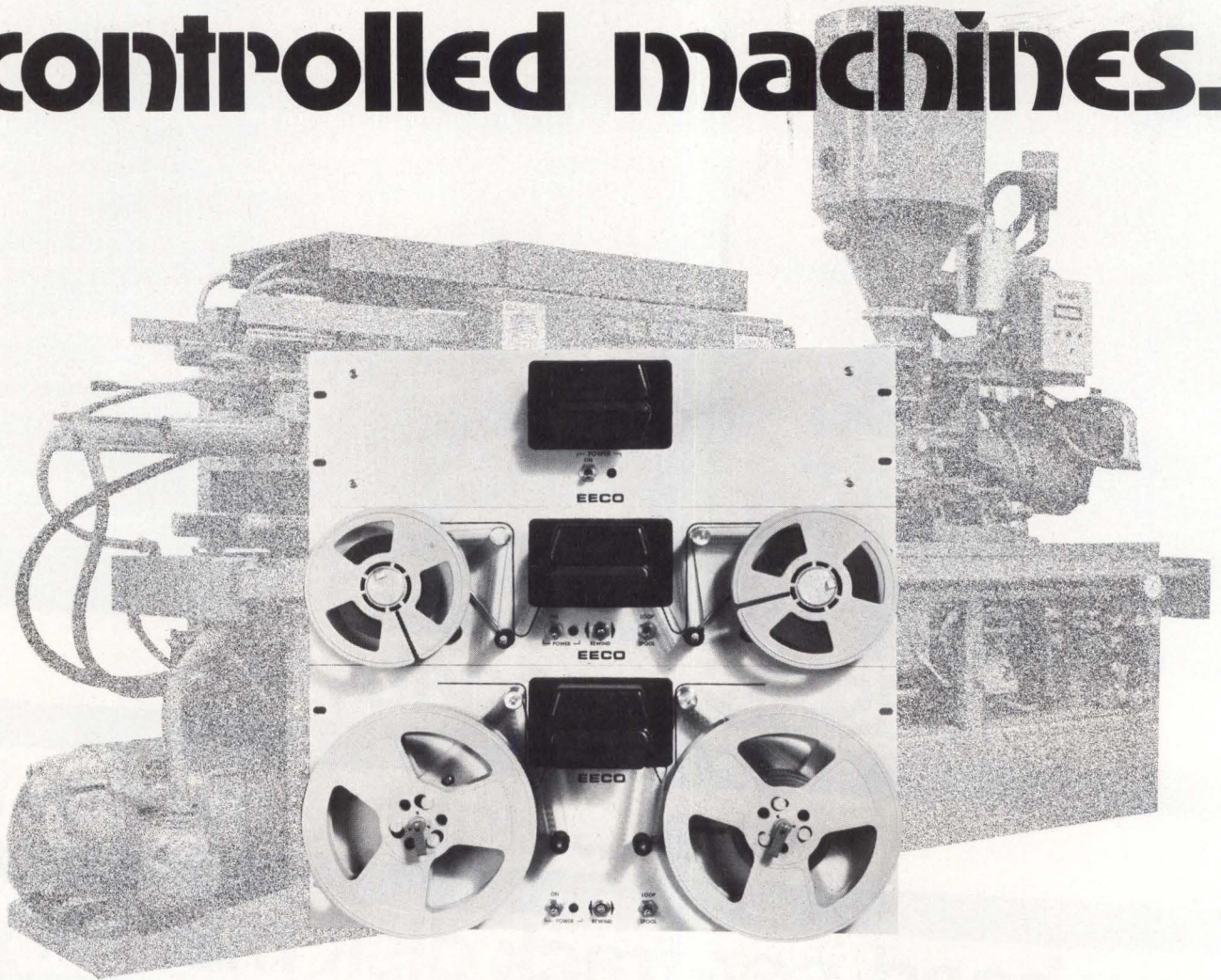


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**CIRCLE 29 ON INQUIRY CARD**



# New tape readers for numerically controlled machines.



We are pleased to announce our new Series 9200 Tape Readers, an event that will be of little interest to everyone outside the numerical control field. That suits us, because these readers have been designed specifically for NC people.

By specifically we mean that they combine performance, simplicity, ruggedness, availability, service, and low price all at the same time.

*The basic reader operates at a fixed 200 characters per second, includes its own power supply (115 vac) and sells for \$640.*

*That reader equipped with 5 1/4-inch reels (for 500 feet of tape) sells for \$945.*

*Make those reels 7 1/2 inches (for 1000 feet of tape) and it goes for \$1045.*

**CIRCLE 30 ON INQUIRY CARD**



Now, they may be cheap, but they're not *cheap*. They are driven by a genuine stepping motor (no solenoid). The tape is firmly and gently handled by a full-width barrel sprocket. The light sources are LEDs (not filament bulbs). The read sensors are phototransistors (no errors). The read head is self-cleaning and opens for easy loading. And it handles all standard tapes.

They are made to be compatible with most major types of NC machines. And we can deliver units to your door within 30 days.

So don't just sit there, write a P.O. Or... well, write. Either way, we'll answer. Fast.

## **EECO**

**FOR READERS**

1441 East Chestnut Avenue, Santa Ana, California 92701  
Phone 714/825-6000



*While an oscilloscope displays events that follow a trigger, a logic analyzer displays those that precede it—even if the trigger event is a one-in-a-million rarity. Result: quicker troubleshooting and repair of difficulties that might otherwise require months of guesswork*

## Logic Analyzers in System Debugging Make Time Run Backward

**J. Carver Hill and Cliff Fiedler\***

**E-H Research Laboratories, Incorporated  
Oakland, California**

For years digital engineers have grappled with subtle problems beyond the capabilities of the ubiquitous oscilloscope. They know that digital systems depend upon simultaneous interactions of data on several channels, but the oscilloscope cannot record events on more than two channels with true simultaneity. They also know that, because of the many channeled nature of the digital interaction, the oscilloscope will often not be able to trigger on the event of interest—that it can not even find the right ball park. But worst of all, they know that when a system malfunctions, clues to why all lie *before* the trigger event (ie, some consequence of the malfunction). The oscilloscope can only depict events that occur after the trigger event.

Some traditional responses to these frustrations are inclusion of stacked status registers in the system console, use of a stop-on-address-n mode, and the excruciating “stepping through” procedure. These methods, however, are woefully inadequate, costly, and time consuming, leaving engineers with weeks and often months of intelligent guessing to find the cause of a single malfunction—while the actual adjustment necessary to correct it is often a 5-minute job.

This wasteful frustration can be relieved by a suitable piece of instrumentation, which permits these

malfunctions to be observed directly, by establishing multichannel trigger criteria, obtaining true simultaneity on many channels, catching one-shot phenomena, and recording events both before and after the trigger, so that a large part of a system's debugging time is eliminated. Systems managers conservatively estimate a 30 to 50% time savings, but even that can mean savings of tens of thousands of dollars on a single system.

That suitable instrumentation, generically, is called a logic analyzer. One analyzer can present up to 16 channels of simultaneous data, trigger on Boolean logic combinations of any or all of those channels, and capture system glitches.

How does the logic analyzer do it? Simple; it divorces data acquisition from data display. In an oscilloscope, a signal input passes through the analog circuitry directly onto the CRT phosphor; in a logic analyzer, that analog signal is first converted to binary, and is then shifted into a memory at the analyzer's clock rate. When the trigger occurs, the memory is

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\*Mr. Fiedler is currently employed by Tennessee Musical Instrumentation, Nashville, Tenn.



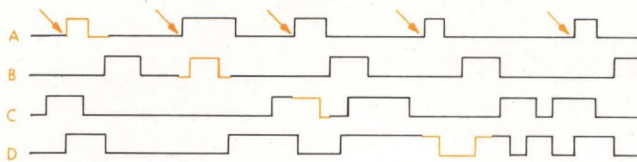
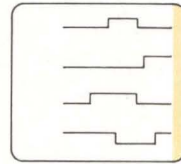
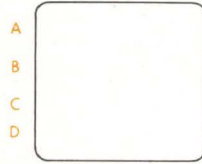


Fig. 1 Alternating sweep. Because timing relationships may not be the same for successive trigger events, this kind of sweep sometimes shows events that are actually well separated in time as if they were simultaneous. Colored arrows are trigger events; color in the traces shows what successive sweeps display as well as their true time relationship



frozen, either immediately or a specified length of time after the trigger. Information in the frozen acquisition memory is then transferred to a display memory, one for each channel, where it can be leisurely displayed.

### Multichannel Simultaneity

Because each channel has its own acquisition memory and display memory, and because the analog-to-binary conversions fed into them are all strobed simultaneously by either the instrument's clock or an external clock, data recorded on the channels of a logic analyzer are simultaneous. The display section aligns recorded data bits on the screen, to present an accurate picture of events on all channels.

An oscilloscope, on the other hand, cannot show true simultaneity on more than two channels. A scope can show more than two channels, of course, by time-sharing a single electron gun, but that process takes data from different channels at different times, and presents them as if they were simultaneous (Fig. 1). This display, called alternating sweep, always triggers on the same event (positive-going edge of variable A in the diagram), but displays different signals in rotation on successive sweeps. These signals may have different timing relationships that are not evident in the alternating sweep, leading to a composite display that can be misleading. For example, in the diagram, the CRT display at the lower left shows variables A, B, and C simultaneously high, when in fact they never are, as illustrated by the color in the real-time traces at the top of the diagram. It also fails to show that variables B, C, and D are sometimes simultaneously high. If a logic analyzer with combinatorial triggering is programmed to trigger when A, B, and C are all high, it will not trigger at all during thousands of complete system cycles (lower middle), indicating that the specified state did not really occur during the measured interval. Similarly, if this logic analyzer is programmed to trigger when B, C, and D are all high, it will display this state together with immediately preceding events (lower right).

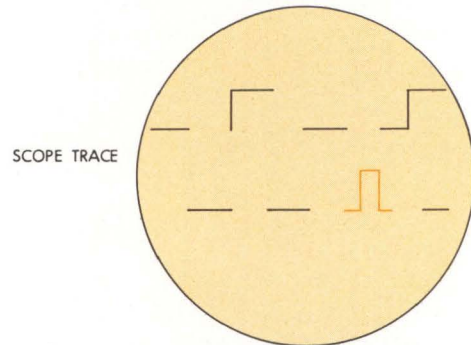
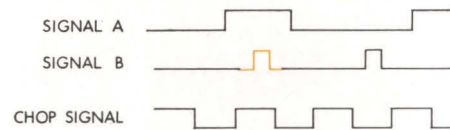


Fig. 2 Chopped sweep. When the digital interaction time approaches the chopping interval, a narrow pulse (color) can be completely lost from the display

Although an oscilloscope with a chopped sweep can sometimes be useful, its practical value is lost when the digital interaction time is about the same as the chopping period (as shown in Fig. 2).

### Looking Back in Time

The logic analyzer is most superior to the oscilloscope in its negative trigger delay capability. With this feature, an engineer can look back in time at events on the lines before the trigger—a capability that is beyond the realm of the oscilloscope. While there are some logic triggers for scopes and some logic analyzers



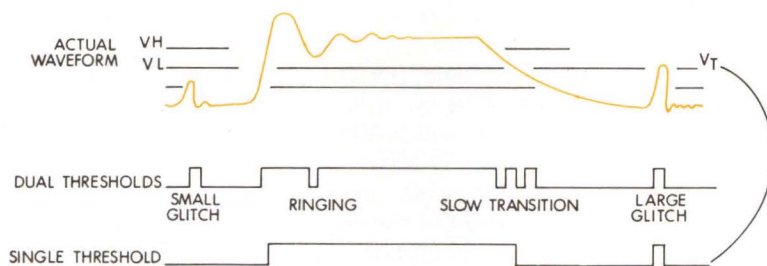


Fig. 3 Dual thresholds. Glitches are much more likely to be detected by a double threshold, which can also retain critical information such as slow rise times, ringing, low 1 levels, and high 0 levels

that generate trigger-out signals, even with these oscilloscopes can depict only post-trigger information. However, the digital engineer is much more interested in pre-trigger information. By triggering on a malfunction and observing events that took place immediately before it, he can nearly always spot either the cause of the problem, or some anomaly directly related to the cause.

Why not always? Because first he must make sure that he is monitoring the appropriate lines. Even a logic analyzer cannot detect a fault if a major implicating line is missing. Second, the logic analyzer used must be sensitive enough and fast enough to detect the fault.

Determining a system's operating sequence is obviously the chore at hand, but even a logic analyzer can lie, if the user is not careful—because displayed 1's and 0's (or high and low logic levels) are only the binary end of an analog-to-binary conversion. Two logic analyzers can monitor the same points on the same lines and, using the same trigger information, present totally different pictures of what is happening in the system. This may occur when one logic analyzer is too slow to see what is really happening, or when it has a single instead of a dual threshold, or if one analyzer can detect glitches that the other cannot (Fig. 3).

### Dual Thresholds Increase Sensitivity

The difference between a single and a dual threshold is slightly less than that between night and day from the troubleshooting point of view. If all signals in a system are clean and have a full logic swing, then a single-threshold comparator logic analyzer can tell you whether or not a given pulse that is supposed to be on a line is really there; but it has a much harder time determining whether or not other pulses are between the desired pulses. These other pulses are transient responses, or glitches.

A glitch is detectable only by the amount of energy it expends above the comparator threshold. As Fig. 3 shows, this makes dual thresholds a great deal

more sensitive to glitches than single thresholds. One line of thought says that a single comparator simulates actual system sensitivity, and that a glitch which does not register on a single-threshold logic analyzer will not disturb the system. This is wishful thinking.

Perhaps it disturbs the system only once in every 10 billion cycles; however, that is once every 2 hours and 47 minutes in a system with a 1- $\mu$ s cycle. Because of the system's speed, single-threshold logic analyzers are not much more effective than traditional design aids in determining the existence or non-existence of pulses by the nominal gate-threshold criterion.

Dual-threshold conversion adds the capability to determine the relevant conditions preceding an intermittent failure, ie, fast ringing pulses, glitches, low 1 levels, high 0 levels, or slow switching times. Finding the cause of intermittent, often asynchronous, failures is the logic analyzer's true domain of usefulness. Since the cause is in the pre-trigger portion of the recording, the analyzer itself must record sufficient information to identify the cause—it is already too late to obtain causal information by triggering even the fastest oscilloscope.

### Fast Pulses Require Faster Instruments

The other major distinction among logic analyzers is speed. Even if the circuitry in a system runs at 10 MHz, or with a 100-ns period, its operation can be affected by incomplete pulses and glitches of much shorter duration. These pulses are the usual cause of intermittent failures. Therefore, the instrument must run faster than the logic it is measuring. How much faster is determined by the presence of a capture circuit in the logic analyzer, and by its ability to operate in a burst mode.

First logic analyzers on the market operated at 10 MHz and did not have a latching circuit to capture glitches. This limited their ability to resolve the three successive edges of the classic digital cycle (Fig. 4). When sampling asynchronous logic—the most general case, particularly since systems cannot be constrained



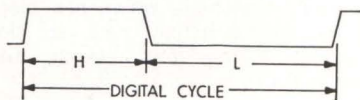


Fig. 4 Digital cycle. Simple logic analyzers must have clock periods shorter than either of the two parts of a digital cycle in order to guarantee that they will obtain at least one unambiguous sample of each cycle part

to have only synchronous failures—the clock period of the analyzer ( $P$ ) must be shorter than the shortest edge-to-edge time within the cycle. If  $D$  represents the effective duty cycle (the ratio of the shorter of the two edge-to-edge intervals in the cycle to the cycle itself), then  $P < D \times \text{minimum digital cycle time}$

$$P < D \times \frac{1}{f}$$

where  $f$  is the maximum frequency of operation.

Adding system noise, differential propagation delays, and other effects as clock jitter ( $J$ ) reduces the speed of the logic further:

$$P + J < \frac{D}{f} \quad \text{or}$$

$$f < \frac{D}{P + J}$$

Thus, even in the best case, where duty cycle is 50% and there is no jitter,

$$f = \frac{0.50}{P} = \frac{1}{2P}$$

That is, the system's maximum frequency is 5 MHz if a 10-MHz analyzer is used. Ordinary systems often have 25% average duty cycle and 10% jitter, so that the observable frequency with a 10-MHz logic analyzer drops to

$$f = \frac{0.25}{P + 0.1P} = \frac{1}{4.4P}$$

or 2.27 MHz.

Troubleshooting is greatly improved if the analyzer has a glitch capture circuit, which removes the dependence on the duty cycle:

$$f < \frac{1}{2P + J}$$

$$\lim_{J \rightarrow 0} f = \frac{1}{2P}$$

provided no signal is shorter than the briefest glitch the instrument can capture. Thus, the fastest asynchronous logic (or asynchronous fault sequence) that can be observed with a 10-MHz analyzer with capture circuitry is still 5 MHz, if there is no jitter. With 10% jitter, it is 4.76 MHz.

Another subtle improvement is that the logic provides one bit of elasticity in the latching circuitry, which allows it to operate in a burst mode in the presence of a glitch. Operating in a burst mode means that the circuitry can use four edges instead of three as the effective clock cycle, yielding about 50% improvement in maximum observable digital frequency over the burst period (see Table).

Conversion Rates and Glitch Sensitivity for Current Logic Analyzers

Unit	Instrument Speed (MHz)	Capture Circuitry
HP 5000A	10	No
HP 1601L	10	No
HP 1600	20	No
HP 1607	20	No
Biomation 810D	10	Yes (10 ns)
Biomation 8100	100	Yes
Biomation 8200	200	Yes (1 ns)
E-H 1320	50	Yes (5 ns)
Tektronix LA501	100	No
BP Instruments 20D	20	Yes (10 or 100 ns)

## The Logic Analyzer at Work

With the proper speed to catch system glitches as well as combinatorial triggering, negative trigger delay, and dual thresholds in its kit, the logic analyzer can detect and spotlight even the most subtle problems found in digital systems, as the following story illustrates.

Delivery of a computer-based system was slipping further and further behind schedule because one intermittent, but persistent, error could not be eliminated. A parity error would halt the processor every 10 to 20 minutes. Even though all logic cards associated with parity and memory control were replaced several times, in both the processor and in the memory modules, and all waveforms on the bus linking the processor and memory were checked and rechecked, test programs were unable to correlate the failure with either address or data patterns. No other ordinary measures helped at all. Finally, the group acquired a logic analyzer to use in tracking down the problem.



First, they attached a probe to the "parity-error-detected" flip-flop and triggered the instrument on that channel. The instrument was set to display the maximum amount of pre-trigger information, since clues to the parity error obviously came before the trigger. Places to attach the other probes were considerably less obvious. As a first try, one probe was attached to the "read-data-ready" signal from memory, while the remaining six were attached to various points in the parity checking logic.

After about 12 minutes, a parity error triggered the logic analyzer. There was no "read-data-ready" signal present in the time-slot immediately preceding the "parity-error-detected" signal. Ordinarily, "parity-error-detected" is set only when "read-data-ready" turns on and a parity error is present. (Occasionally, if the memory is inoperative, "read-data-ready" never turns on, in which case a memory time-out pulse sets "parity-error-detected.") Since "read-data-ready" was not on, the engineers concluded that there must have been some operator error or misconception in the measurement.

To make the second measurement, probes were attached as before to the "parity-error-detected" signal

(still used as the trigger) and the "read-data-ready" signal; an additional probe was attached to the "read-request" signal of the processor.

After a wait of some minutes, the analyzer triggered, and again revealed no "read-data-ready" signal to correspond to the "parity-error-detected" signal; moreover, the "parity-error-detected" signal was occurring much too soon after "read-request." One technician concluded that something was wrong with the "memory-time-out" logic. A second technician objected, saying that if the "memory-time-out" pulse had been generated, it would have set the "no-response-from-memory" flip-flop. The first agreed, but suggested that the five probes be moved from the parity checking logic to the "memory-time-out" logic.

In this logic (Fig. 5), a retriggerable one-shot is started at the time of every request to memory. This one-shot times out after the maximum allowable access time of the memory has passed, and triggers a second one-shot. The output of the second one-shot feeds an OR gate, also driven by the "read-data-ready" signal from memory; the gate's output is a "read-strobe" signal. If "read-request," reset by "read-data-ready," is still true at the time "read-strobe-delayed"

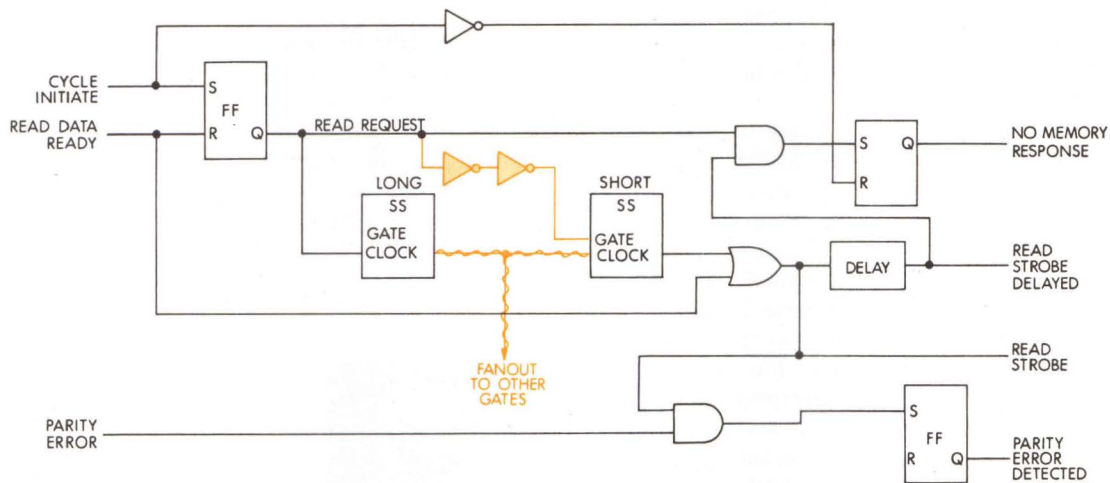


Fig. 5 Memory time-out logic. In one real case, a serious bug in this logic shut down a system several times every hour. A logic analyzer identified the problem as a premature turning on of the second one-shot. It was cured by replacing a straight wire with a twisted pair (color) and by gating the previously un-gated turn-on with a signal guaranteed to be slightly later than the turn-on of the "read-request" flip-flop



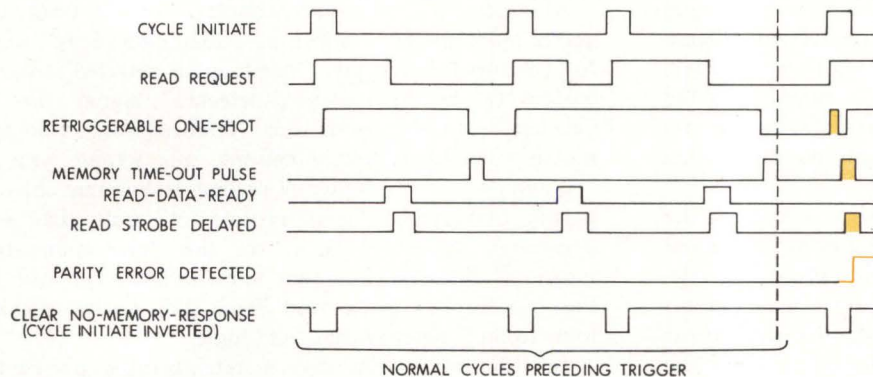


Fig. 6 What the analyzer found. When triggered by the rise of the parity error detected signal, preceding events were found to be normal, with the exception of a glitch (color) at the output of the first one-shot, which was retriggerable. This glitch prematurely started the second one-shot, which signaled a parity error but not memory time-out, held off by cycle initiate

occurs, then it may be presumed that the memory did not respond within the allowable access time and "no-memory-response" is set.

While waiting for the analyzer to trigger again, an oscilloscope was connected to the "memory-time-out" logic; all signals appeared clean and strong.

When the analyzer did trigger, it revealed that the second one-shot, which generated the "memory-time-out" pulse, had triggered on the leading rather than the trailing edge of the output of the retriggerable one-shot. The consequent premature "read-strobe" pulse explained the parity error but did not explain why "no-memory-response" had not been set.

Subsequent measurements (Fig. 6) still using "parity-error-detected" as the trigger while observing pre-trigger information, revealed that there was a "glitch" higher than 0.8 V (value of the low threshold) on the output of the retriggerable one-shot; causing the second one-shot to fire. This "glitch" occurred at the leading edge of the "cycle-initiate" pulse, causing the leading edge of the false "memory-time-out" pulse to occur before the trailing edge of "cycle initiate." However, since "cycle-initiate inverted" was the direct clear input to the "no-memory-response" flip-flop, the premature "read-strobe" falsely precipitated by the "memory-time-out" logic could not set "no-memory-response," because "cycle-initiate inverted" held it off.

Exact amplitude and duration of the glitch was never determined, since no implicating, preceding event could be discovered on which to trigger an oscilloscope. However, repeated measurements with the analyzer showed the glitch to have a peak amplitude of more than 1.4 V and to be less than 20 ns wide.

The pragmatic solution was to replace the single wire connecting the output of the retriggerable one-shot to various points in the backplane with a twisted pair, and, to be on the safe side, to make the firing of the one-shot conditional upon "memory-read-request" having been set for at least two gate delays. With

these changes installed, the persistent parity error problem disappeared, and the system passed its preliminary acceptance test.

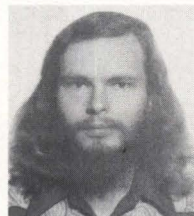
## Summary

A logic analyzer that can simultaneously record timing and amplitude details of several variables in a system immediately *prior to* the malfunction can change a seemingly unapproachable problem to a readily solvable one.

Cases like the one described are only the beginning. As the field matures, a diversity of plug-ins and plug-ons will give logic analyzers even greater power. However, even now digital systems engineers can use equipment that is currently available to track down subtle and frustrating faults in digital systems with unprecedented ease and efficiency.



J. Carver Hill is responsible for logic-analyzer design and development at E-H Research Laboratories. He holds a BSEE degree from Clemson University, and MS and PhD degrees from Oregon State University.



At E-H Laboratories, Cliff Fiedler was involved in converting pilot production of the logic analyzer into full scale production. He is currently engaged in the design of automated sound synthesis systems at Tennessee Musical Instrumentation.



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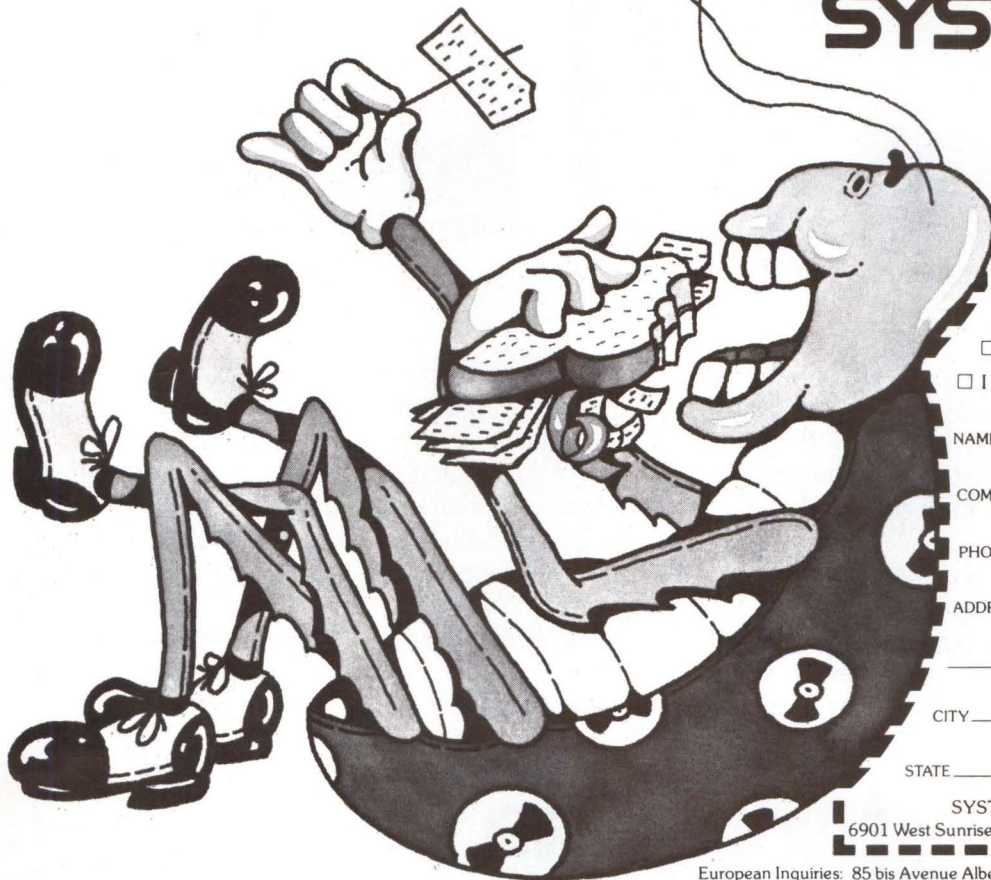
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*This scan converter permits easy, low cost conversion between relatively low speed transmission channels and high speed data display devices*

# Electro-Optical Scan Converter Shares Benefits of Conventional Units

**Neil M. Poley**

**International Business Machines Corporation  
System Communications Division  
Kingston, New York**

As society becomes more highly dependent on information processing, efficient conversion between different data rates becomes vital. In particular, computer terminals are increasingly using displays to communicate information to the user. However, when this information is transmitted over a narrowband channel, the signal must be converted from a low data rate to a high one for driving the display, and the information must be stored for displays that require continuous refreshing. A recently patented electro-optical scan converter\* combines most of the advantages of conventional devices, but has few if any of their disadvantages.

Data rate conversion can be either from a fast rate to a slow one, or vice versa, in either of two conventional types of scan converter tubes; for simplicity, the following discussion mentions only the slow-to-fast conversion. The most straightforward design has two electron beams—one for writing and one for reading (Fig. 1). The writing beam, scanning slowly, is modulated by the received data, storing them in the form of a pattern of charge in a dielectric material inside the tube. This stored charge is scanned more quickly by the other electron beam, creating variations that are picked up by an output grid.

The other type of scan converter tube has only one beam, which scans a storage medium at two different speeds—slowly when writing and, later, quickly for reading. Transmission grid scan (TGS) converters (Fig. 2) have a dielectric layer supported by a metal mesh;

a variation similarly uses a silicon wafer with coplanar discrete silicon-oxide islands. Storage photoconductor scan (SPS) converters (Fig. 3) write information on a storage photoconductor while the photoconductor is illuminated. Information can also be entered optically through a lens and shutter located in front of the photoconductor, similar to a TV camera operated in "snapshot" mode. Then the light is turned off; to retain the stored data, the unmodulated beam continuously sweeps across the photoconductor. Information is read at the faster data rate while amplifying the current discharging the photoconductor during this sweeping action. Variations in the current, created by variations in the photoconductor's conductivity, represent the data.

All of these converters have disadvantages. The 2-gun tube is complex, performs only a single function, and is expensive on a cost-per-function basis. The TGS converter suffers a 50% resolution loss after about 5 min. when data are continuously read out. Finally, the SPS converter must be continuously scanned to retain the data, which nevertheless can be stored for only about an hour. Furthermore, the data must be written completely within the relaxation time of the tube (generally 1 s), so that the unmodulated beam returns to scan the first information written before it decays. This drastically limits the conversion applications of this tube.

\*Neil M. Poley, "Multiple Function Vidicon Tube Including a Transmission Grid," U. S. Patent 3,809,946; May 7, 1974



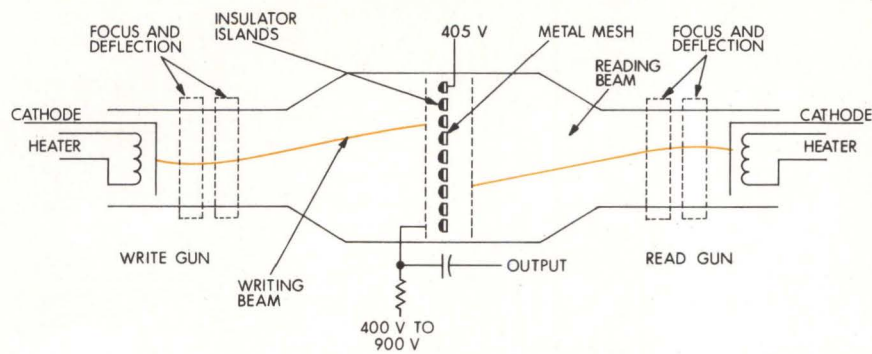


Fig. 1 Two-gun scan converter. Electron beams are independent, writing and reading at different speeds and, if necessary, at the same time

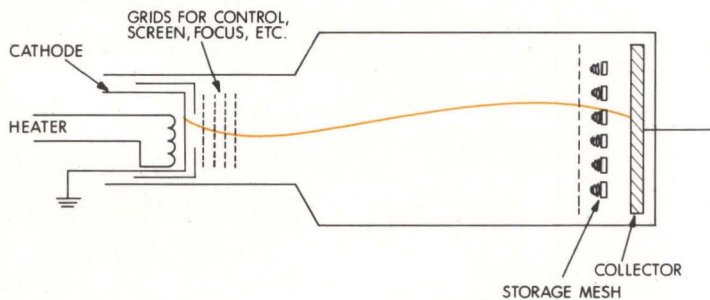


Fig. 2 Transmission grid scan converter. Single-gun device writes and reads with the same electron beam and at different times, at different speeds, if necessary. Storage is long-term, but continuous reading degrades resolution quickly

## An Alternative Method

The electro-optical scan converter includes a transmission grid between the electron gun and the photoconductive target of the basic SPS tube (Fig. 4). The

grid is biased and a pattern of localized charges distributed on it, so that it controls an electron beam passing through it. The result is less expensive than the 2-beam tube, can store data almost indefinitely (weeks or months) as can the TGS tube, and can be

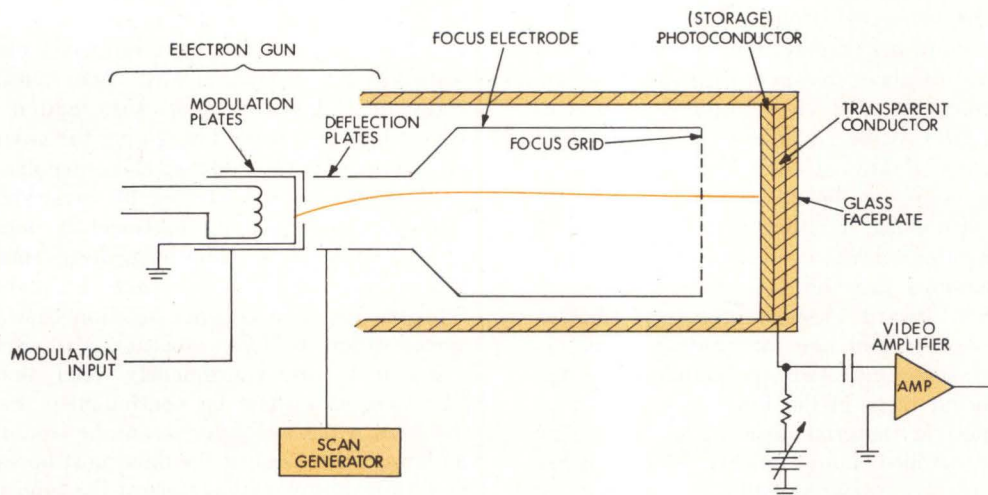


Fig. 3 Storage photoconductor scan converter. Like the transmission grid scan (TGS) converter, this tube has only one electron gun, but stores data in a layer on photoconductive material on the faceplate. Data can also be entered optically in much the same way as a TV camera operates



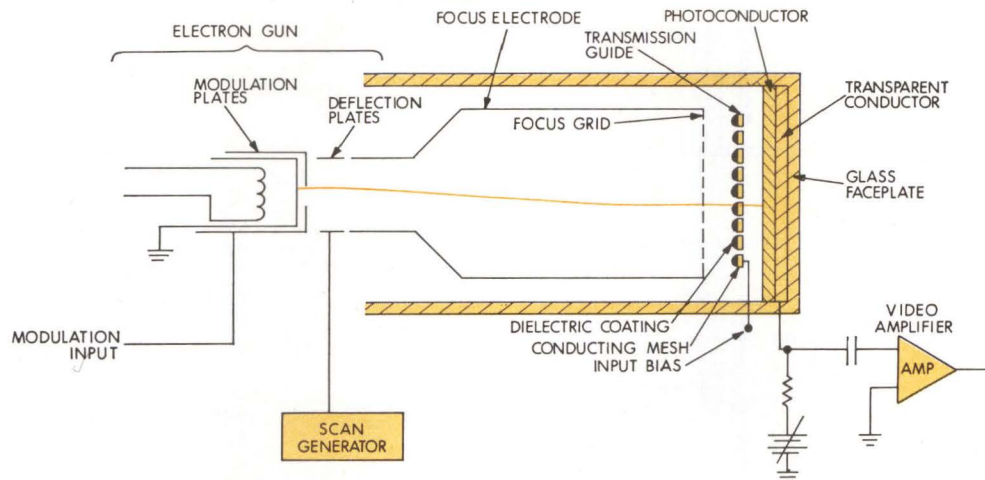


Fig. 4 Electro-optical scan converter. This device is basically a storage photoconductor scan (SPS) converter with a transmission grid added. It can operate in the same way as both conventional types, sharing their advantages and overcoming most of their disadvantages

written optically and retains its resolution when being continuously read, as the SPS tube does. Yet it eliminates most of the disadvantages of all three types.

The grid consists of conductive mesh which has a dielectric coating on the side nearer the gun. This

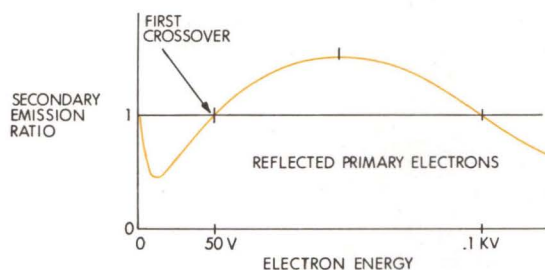


Fig. 5 Secondary emission characteristic. Dielectric coating on transmission grid in new scan converter emits a greater number of electrons than it absorbs from the beam, over a wide range of beam energies. This permits charges on the grid to be erased

coating has a high electrical resistance and a secondary electron emission ratio greater than 1, for a selected range of incident electron energies; that is, when bombarded by the electron gun it emits a greater number of electrons than it absorbs (Fig. 5). Examples of suitable materials for the coating with these properties include potassium chloride, calcium fluoride, and magnesium oxide. Charges stored on the grid can be erased, by biasing it above the first crossover and sweeping it with a low-energy beam. In most applications the beam energy is kept below the lower of the two crossover points in the diagram, so that the secondary emission ratio is less than 1.

An electron beam can write information on the grid in the form of electric charge distributions by using the secondary emission ratio of the dielectric. Thus, when writing at a low data rate, the transmission grid provides the storage capability of the TGS tube, while at high rates the SPS tube's resolution is preserved, making the electro-optical converter compatible with both broadband and narrowband transmission lines.

Because of the tube's versatility, it can operate in various modes, including optically or electrically writing information into the tube, reading information out, transferring information within the tube, and combinations of these.

## Writing

When information is to be stored for a long period, it is written directly on the transmission grid by an external electrical signal. The transparent conductor



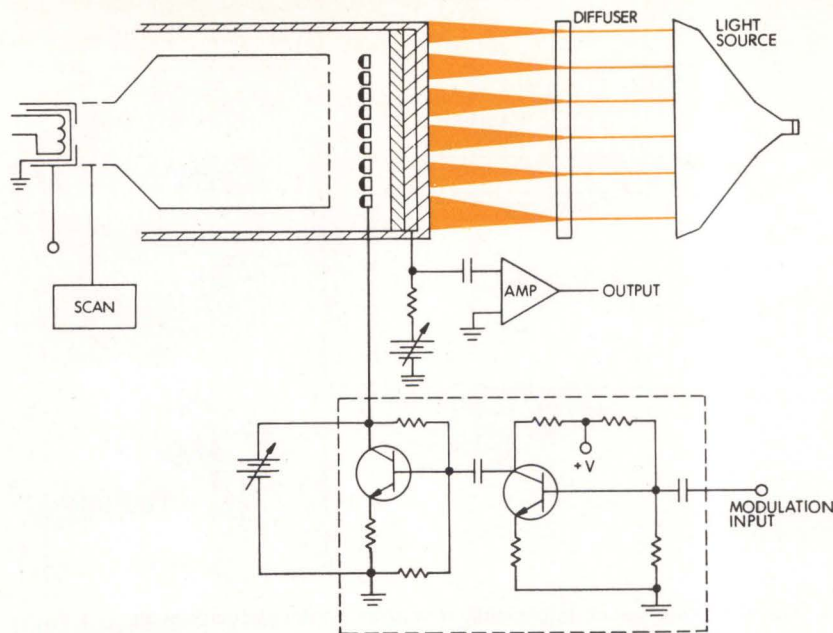


Fig. 6 Writing in electro-optical converter. Electron beam stores data on dielectric layer while photoelectric layer is illuminated. Either beam or grid is modulated. Or, with grid biased off and photoelectric layer illuminated, information can be stored in the photoelectric layer. Either way, data can be transferred from grid to layer, or the reverse with few restrictions. Video amplifier is for reading stored information

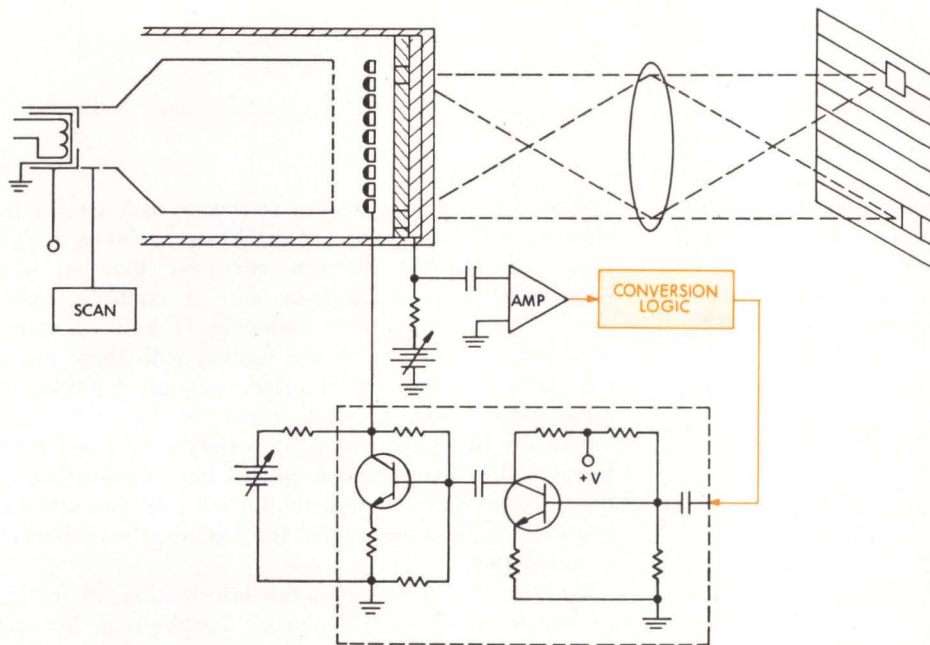


Fig. 7 Image storage and photoelectric-to-grid transfer. Necessary light on photoelectric layer need not be diffuse; if it is a projected image, the layer can store that as well. To transfer image of digital data to grid, amplifier output can be connected to modulator input

is biased positive and the photoconductor illuminated with diffused light (Fig. 6). This light causes positive charges to migrate to the back of the photoconductor, where they are neutralized by beam electrons. Meanwhile, with the transmission grid properly biased and the electron beam at a relatively low energy level, the secondary emission ratio is less than 1, so that the beam builds up a negative charge distribution on the grid. As the electron beam sweeps at a predetermined rate, its intensity—modulated with incoming information—stores a corresponding negative charge pattern on the dielectric coating.

Alternatively, the beam can be unmodulated and the grid bias modulated in accordance with the information. Either process can write information into the tube at as slow a rate as desired, but also permits long-term storage on the transmission grid prior to reading that information from the tube.

Information may also be written on the storage photoconductor, from which it may be read repeatedly and continuously for up to 1 hr; after that, the contrast has usually degraded to an unacceptable level. A diffuse light illuminates the photoconductor only while the information-modulated electron beam sweeps across



it. Both the light and electron beam affect the layer's conductivity, which does not immediately return to normal when the light goes out, but decays over a period of a few seconds. During this time, if the unmodulated beam sweeps across the photoconductor, it generates a current through the photoconductive layer that effectively refreshes the stored data.

If the illumination, rather than being diffuse, carries an image that represents information (Fig. 7)—projected, for example, from the face of a conventional cathode-ray tube, a similar process stores the image in the photoconductive layer.

Finally, information can be written on the transmission grid by storing it first in the photoconductor by either of these two methods and then transferring it to the grid by a process to be described later.

## Reading

Data are read from the dielectric storage grid by modulating the electron beam with the negative charge distribution on the grid. This induces a varying current in the photoconductor, which must be illuminated to act as the collector. When single readouts between long intervals of time are desired, the information is retained on the transmission grid and high-resolution readouts are obtained whenever required.

To read data stored in the photoconductor, the unmodulated electron beam scans the layer, setting up a varying current in accordance with differences in conductivity in the layer. Either way, the current variations are amplified and sent to an external detector for display or retransmission. For continuous readouts, the information stored in the photoconductor is available for up to 1 hr, with high resolution.

For long-term storage of photoconductor data or continuous readout of grid data, the information can be transferred from either one to the other, as described later.

Thus this tube combines the advantages of both the TGS and SPS converters.

## Transferring Information

To convert a stored conductive pattern in the photoconductor to a stored charge pattern on the transmission grid, the video amplifier output drives conversion logic which controls the bias to the transmission grid through a modulation input (Fig. 7). The conversion logic can be as simple as an inverting amplifier; but for high resolution, a more complicated circuit is necessary.

Because the electron beam scans the grid and layer during this transfer, and because the conversion logic and grid modulation circuits impose a delay, the transferred data will be skewed; therefore, some resolution is lost. Also, if the electron beam energy is below that of the first crossover in the secondary emission curve, the transferred image will be the negative of the original image. An inverting amplifier can correct this if necessary.

Information may be transferred from storage on the transmission grid to storage in the photoconductor by sweeping them both with an unmodulated electron beam

and simultaneously illuminating the photoconductor. When the grid is properly biased, it modulates the beam with its stored information; the modulated beam writes the information on the storage photoconductor. Once the information is written, the light is extinguished and the transmission grid biased so that it does not affect the beam's intensity. The electron beam continuously sweeps the photoconductor to retain the storage. Skew is not a problem in this mode of transfer because there is no delay between the grid and photoconductor.

## An Extra Feature

The tube can operate in an addition mode, whereby information is stored both on the transmission grid and on the photoconductor, and the biased grid modulates the electron beam, in accordance with the information stored on it. The current in the transparent conductor is modulated by both arrays of information. Thus, in a sense, the information on the transmission grid is added to that on the photoconductor. This is not necessarily arithmetic addition, because either the photoconductor or grid can completely block the current at one point, and because they both affect the current nonlinearly.

This addition feature can be used in a number of ways. For example, when the tube is operated as a normal vidicon for transmission purposes, portions of the image may be deleted from the transmission signal by putting a negative charge on the corresponding areas of the transmission grid and biasing the transmission. Then the areas of the image corresponding to the charged areas of the grid are transmitted as though there were no light shining on those portions of the photoconductor. In effect, the charges on the transmission grid blank the scanning beam in those areas.

Similarly, the relative brightness of various portions of the image can be adjusted by charging the transmission grid to reflect part of the beam in those areas where brightness is to be diminished, while allowing all of the beam to pass through the grid elsewhere.

## Conclusion

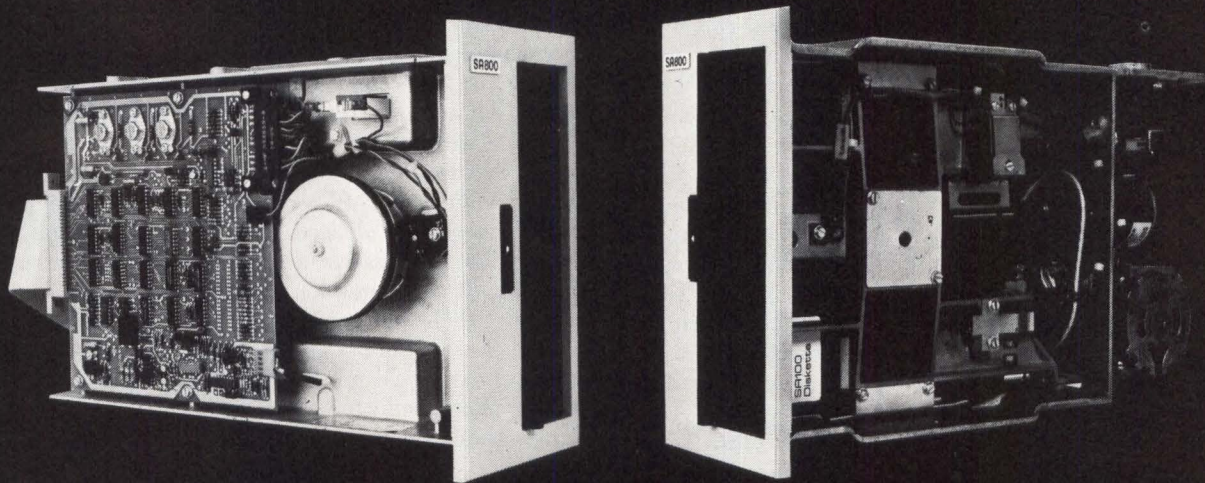
Advantages of the electro-optical scan converter are numerous, particularly in applications involving computer terminals and teaching machines. It permits easy, low cost conversion between relatively low speed transmission channels and high speed data display devices, or from a multiply-accessed data base to numerous displays showing different data from the same base.



Neil M. Poley is a staff engineer at IBM Corp's System Communications Div laboratory. He has been involved in thin film and vacuum technology development and has a number of patents in thin film and display device fabrication. He holds a BS degree in chemical engineering from the Polytechnic Institute of New York.



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*This characterization scheme for testing microprocessors furnishes a powerful technique for putting a unit through its paces; unexpected weaknesses are revealed in one widely used device*

# Microprocessor Test Technique Reveals Instruction Pattern Sensitivity

Dick Hackmeister and Albert C. L. Chiang

Macrodata Corporation  
Woodland Hills, California

Microprocessor testing presents a distinct challenge to the test engineer, because the microprocessor is neither just a combination of logic gates nor a repetitive array of memory cells. It is, rather, virtually an intelligent unit with inherent software capacity and, as a result, requires some new approaches to testing. Classic dc tests, such as leakage measurement, "on" and "off" voltage levels, and the like, play only a very minor role; the microprocessor's software capability calls for evolutionary methods of testing.

In particular, one microprocessor unit (MPU) now on the market, when tested with different sequences of instructions, behaves peculiarly in response to a certain instruction sequence. Specifically, it runs through all its instructions once quite well, but can repeatedly execute certain classes of those instructions only over a limited range of the supply voltage.

When these tests were repeated on 36 devices from various sources over a period of 15 days, the difficulty appeared consistently only in one manufacturer's product. The results should be useful both to the manufacturer and to the user—one can analyze and improve his product to avoid the difficulties that are described here; the other can watch for such problems and avoid them in his own applications.

## Diagnostic Emulation

The testing approach used was diagnostic emulation—a combination of the pattern generation approach and the pattern recognition approach (see panel "Microprocessor Testing Techniques"). The test stores a short data pattern in local, high speed semiconductor memory (see Fig. 1). This pattern consists of one of

### Microprocessor Testing Techniques

Four approaches to microprocessor testing are computer simulation, signature testing, pattern recognition, and pattern generation. Computer simulation executes a test with the aid of a separate general-purpose computer, which runs a logic simulation program that should produce the same result as a program run on the microprocessor. Signature testing applies a common data pattern to two microprocessors, one of which is known to be good, and compares the outputs, which should be identical. It does not account for the possibility that the good device may not stay good—it may fail in its own right after running a number of tests.

This difficulty is overcome by pattern recognition testing, which uses the captured output pattern as a reference rather than the device that produced the pattern. Therefore, the "known good" device need work correctly only once, to produce the data pattern for recording and distribution to many test stations. With this technique, various test stations can be correlated with one another.

The most powerful approach is pattern generation, which provides instruction sequence patterns (instructions, operands, and addresses) to the microprocessor under test. These patterns are generated in real time by one or more control processors, on the basis of the results of preceding patterns. Thus, it can investigate the effect of instruction sequences to which the microprocessor is sensitive. Pattern generation is by far the most flexible approach to microprocessor testing.

each instruction in the MPU's repertoire, along with one or two operands for each instruction. The instruction sequence is executed in real time under control



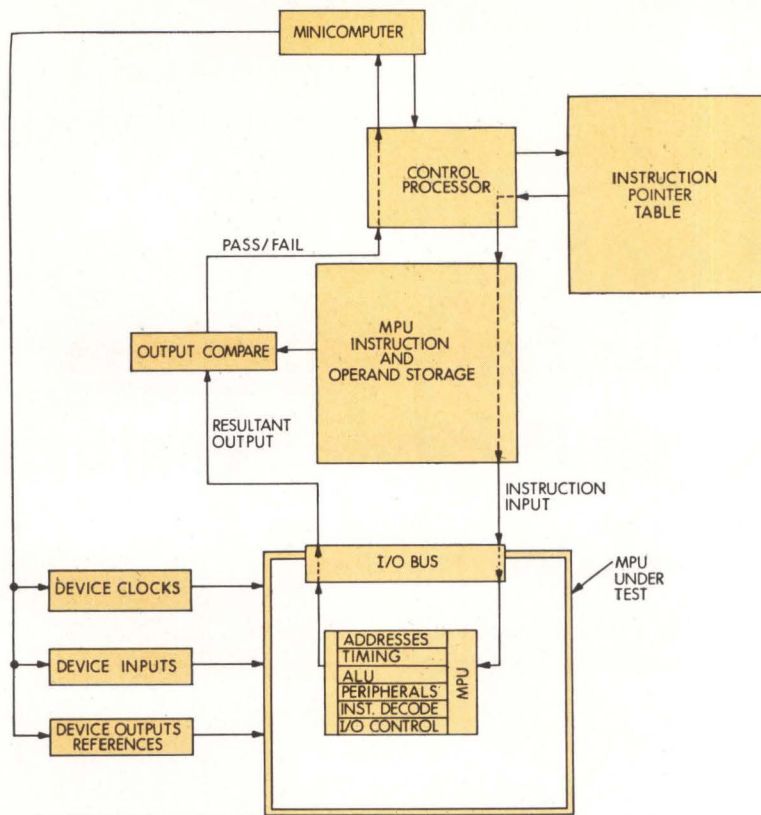


Fig. 1 Diagnostic emulation. Control processor fetches pointers from table; pointers indicate corresponding microprocessor instructions and operands. Control processor operates on pointer table by algorithm, thus creating instruction stream for microprocessor in real time

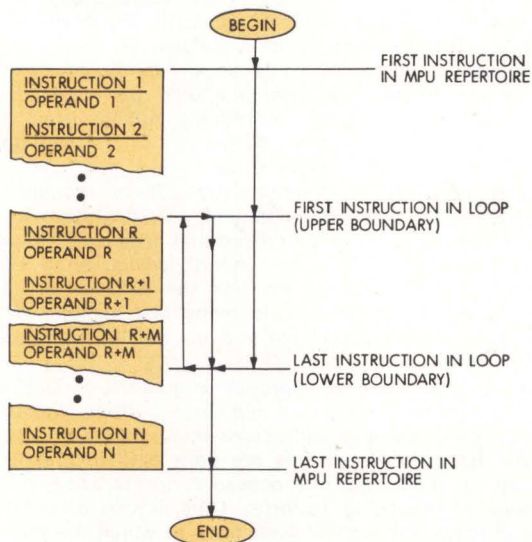


Fig. 2 Imbedded special tests. Indirect addressing test technique permits special tests to be imbedded within normal test instruction sequence. Repeated looping is one such special test; boundaries of loop and number of iterations made through it can be controlled by control processor in tester or by external minicomputer

of a dual processor, which has access to the MPU's entire instruction repertoire and can feed the MPU under test an instruction stream of any length. The control processor can execute a single pass through the instruction repertoire, or it can execute the instructions in blocks, in reverse, with imbedded loops and skips, hops, or in virtually any sequence. If the test engineer suspects a problem within a particular block of logic of the MPU, he can test this one block far more rigorously than the others at little or no additional cost (see Fig. 2). Furthermore, this type of emulation approach provides the flexibility to organize an MPU test with respect to a device's individual clocks, machine states, or complete instruction flow.

Subroutines are programmed within the control processor to accommodate the MPU's various internal machine states—eg, Instruction Fetch, Read, or Write. Calling routines allocate these subroutines in proper sequence to different types of instructions; for instance, Load Memory Immediate requires an instruction fetch, then a read, and then a write. Initial addresses of these allocating subroutines are selected to be compatible with other data, which represent unique addresses in another section of local memory. In turn, these addresses hold the MPU's actual input data (instructions and operands). In this way, individual instructions may direct their own required subroutine allocation. A main, or supervisory, program generates, by algorithm, the sequence of instructions that is fed



to the MPU: the control processor's supervisor program points to an address within the pointer table; the addressed pointer yields an absolute memory address which contains an MPU instruction, along with information which directs its required sequence of control subroutines. The subroutines accommodate the MPU's various internal machine states. (Indirect memory addressing is a similar technique.)

The pointer table is no more than an ordinary memory which contains MPU instructions and operands. From the table, the control processor directs the MPU input data in an intelligent manner without influence by the MPU under test.

The control processor monitors all operations of the MPU under test; it literally feeds it instructions at will, anticipates which machine states the MPU will assume in response to those instructions, and determines how many clock pulses it will require for each of those states. The flexibility that it has in controlling the MPU's clocks allows a test philosophy to revolve around MPU clocks, states, or instructions.

If the MPU fails to yield the proper response at any time, the control processor flags the error and responds to the supervisor program, either by entering a failure analysis routine or by rejecting the device as having failed the test. From this perspective, it is only a short step to literally creating MPU instruction streams as a function of test patterns on a standard semiconductor memory, rather than simply dumping an entirely pre-coded program into the MPU under test. This approach reduces a test designed to verify instructions to a mere sequence of increasing addresses. Likewise, a *decreasing* sequence of pointer addresses is easily created, which would, in effect, run the test program backward.

Outputs expected from the MPU are stored in local buffer memory adjacent to the instructions that should create them. These expected responses can be indirectly addressed, so that any given instruction can have a variety of expected responses available to it. With direct control over the MPU's clocks, the control processor can perform overhead or background operations that are invisible to the MPU under test.

## Characterization Result

This diagnostic emulation procedure was applied to an 8-bit parallel MPU, with an internal memory stack. The first instruction sequence pattern was a direct scan of the pointer table. This pattern produced a sequence of the device's basic repertoire, ordered in such a way as to produce a meaningful result and to allow the sequence to be monitored at selected points along its way. Failure to match any expected output aborted further testing of that device. The control processor produced the incrementing algorithm and monitored a single pass/fail result. A series of these results were processed by a minicomputer that produced shmoo plots of access time versus voltage, while directly controlling the system's clocks and power supplies. These plots demonstrated that access time increased as the power supply approached 0 V [see Fig. 3(a)].

Then, variations on the direct instruction scan were tried. The scan sequence was begun at the first of an

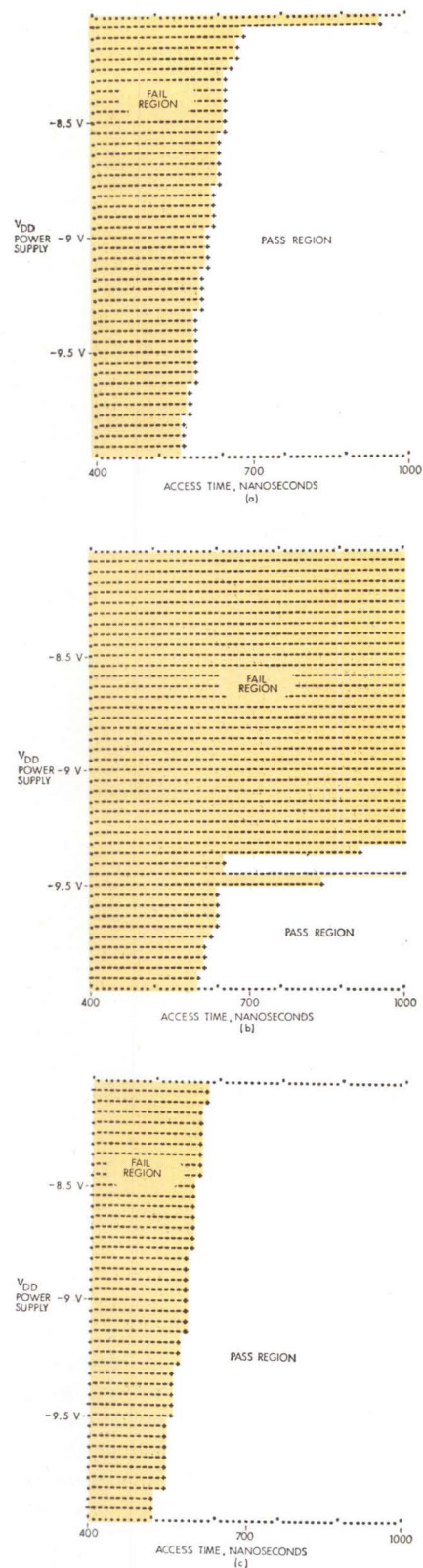
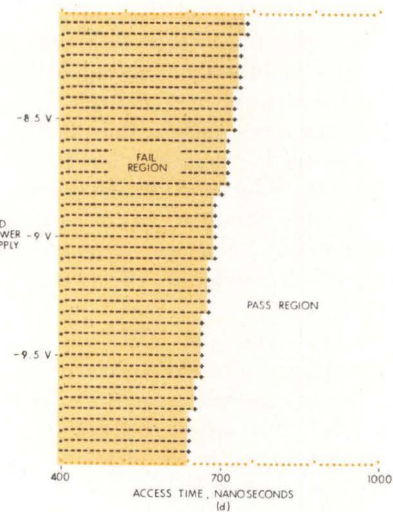
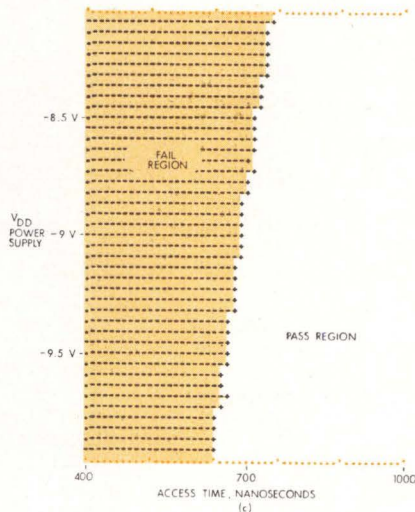
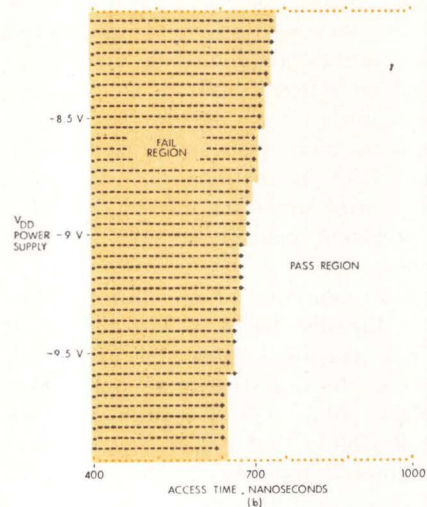
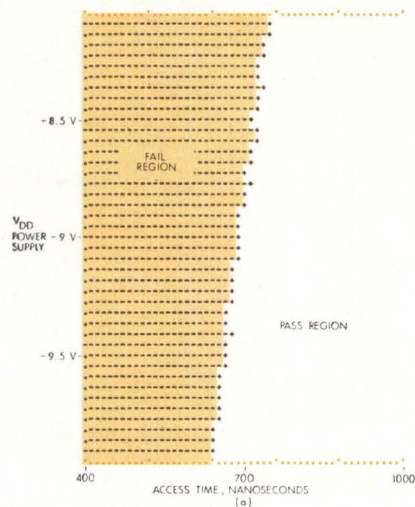


Fig. 3 Instruction pattern sensitivity. Single linear scan of all MPU instructions works normally, with slightly increased access time as supply voltage approaches 0 (top). However, a sequence that includes only subroutine calls and returns (center) works only for narrow range of voltage near extreme of normal range. Sequence consisting of only arithmetic and logic instructions works normally (bottom)





address-stack-test routine, where addresses for a sequence of various call-and-return-from-subroutine instructions reside, rather than at the first instruction in the pointer table. The sequence was terminated at the last "return-from-subroutine" pointer. Thus, the instruction stream consisted only of those instructions designed to verify correct operation of the MPU's internal address stack, while omitting all other tests. Shmoo plots for this abbreviated instruction sequence disclosed significantly different operating regions than those that resulted from the complete instruction stream.

The departures, we thought, might be caused by possible pattern sensitivity within the MPU [Fig. 3(b)]. However, shmoo plots of another abbreviated sequence, consisting of instructions testing the arithmetic and logic sections, revealed that MPU operation was not always pattern sensitive; in fact, it was consistent with the en-

tire instruction pointer scan [Fig. 3(c)].

Since it seemed evident that only stack tests were involved, the next step consisted of working out an instruction-sequence algorithm that would scan the entire MPU repertoire, and execute an additional number of loops through the stack tests. The number of loops executed was controlled by the monitoring minicomputer, which generated a series of seven shmoo plots—one for each scan, with the number of imbedded loops varying from zero to six (see Fig. 4). These plots, using the same vertical and horizontal scales as the previous plots, indicated the device's intolerance of a given number of stack-test iterations. The critical number of iterations varied between three and six for those devices which exhibited this type of pattern sensitivity; when this critical number was exceeded, the MPU under test produced an improper response farther along in the



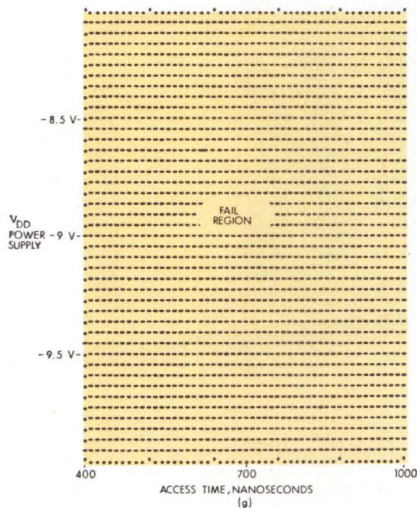
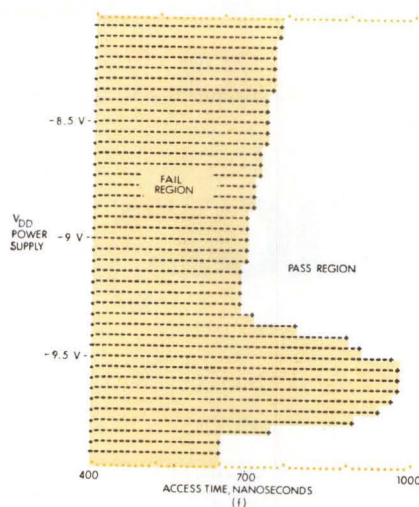
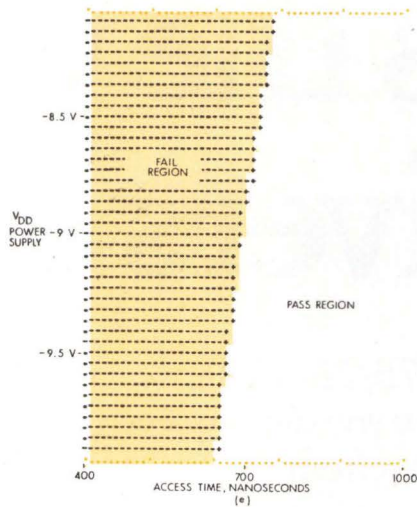


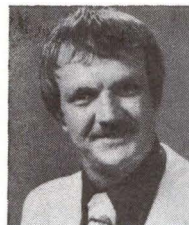
Fig. 4 Iteration sensitivity. Single scan through all instructions with increasing number of loops through address stack works well (parts a through e) until iteration count reaches 5 (part f). At that point, a failing "notch" develops; device fails completely at six iterations (part g)

instruction stream. Apparently, the instruction stream following the stack test is also sensitive to the number of stack test iterations.

These results are just the *beginning* of testing for microprocessor pattern sensitivities. There is much about these tests that is still unknown, especially to users, but more research will develop more efficient testing and characterization schemes.

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- W. Mandl, "Techniques of Microprocessor Test Development," Western Electronic Show and Convention (WESCON), 1974



Dick Hackmeister, a senior application engineer at Macrodata, has 10 years experience in the semiconductor test field. He is currently active in formulating MPU and other LSI device test philosophies.



Director of product applications, test systems, at Macrodata, Albert C. L. Chiang has been active in the development of testing philosophy for LSI devices. He holds PhD, MS, and BS degrees in electrical engineering from the University of Southern California, Chiao-tung University, and National Taiwan University, respectively.



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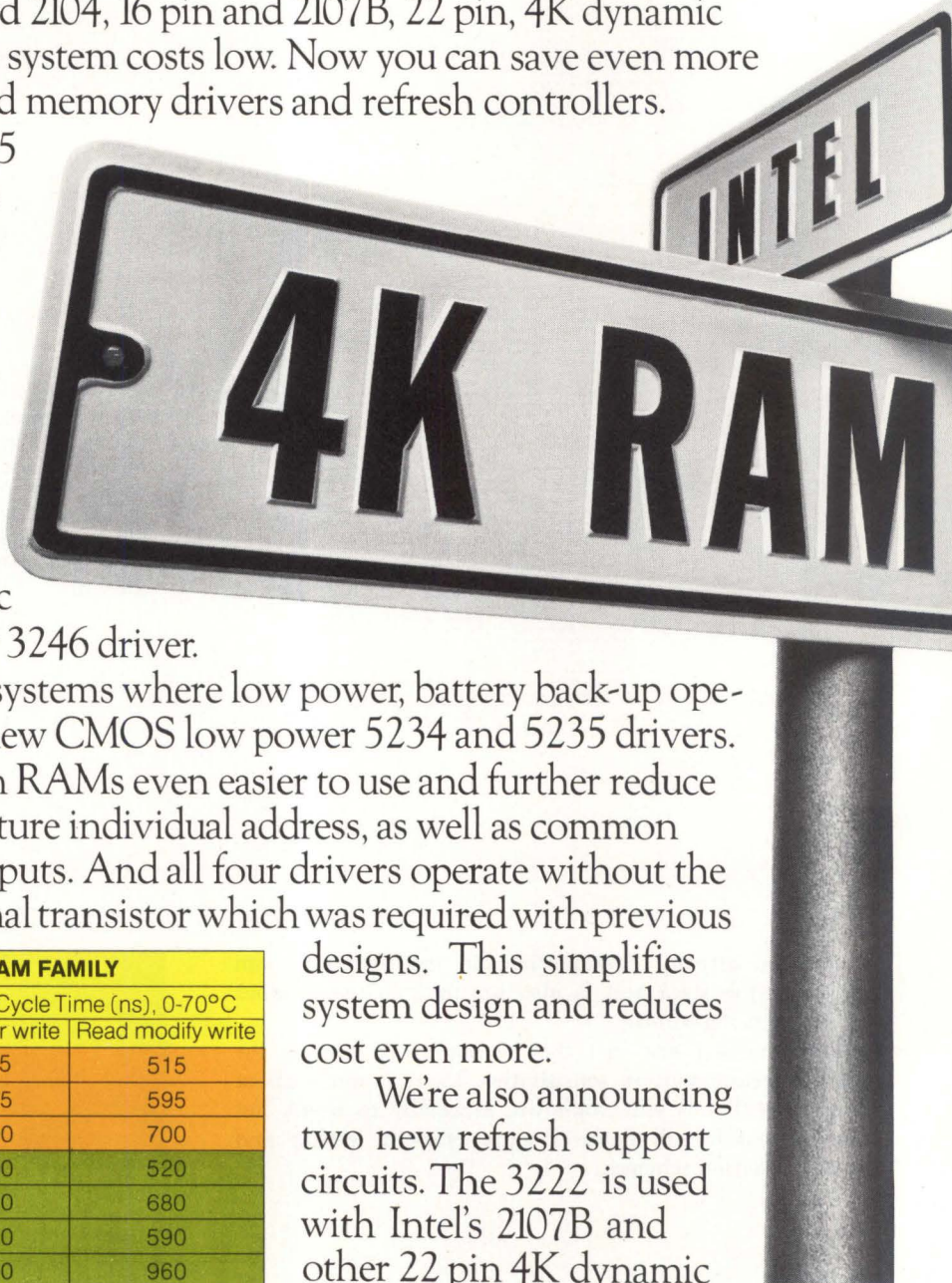
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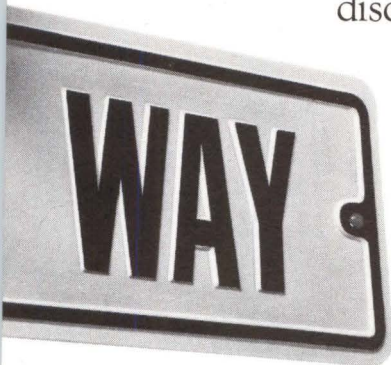
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			Read or write	Read modify write
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D2104-4	16	300	425	595
D2104	16	350	500	700
2107B	22	200	400	520
2107B-2	22	220	470	680
2107B-4	22	270	470	590
2107B-6	22	350	800	960





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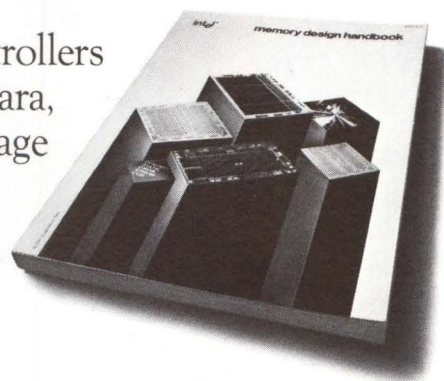
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D5234	CMOS	CMOS	100ns	+12V	3mW @ 0Hz, 39mW @ 1MHz
D5235	CMOS	TTL	125ns	+12V	
D5235-1	CMOS	TTL	95ns	+12V	

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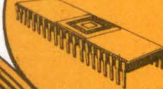
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# Tutorial

Monday, February 23: 9:00 AM  
Jack Tar Hotel, San Francisco

**“UNIQUE ASPECTS OF MICROCOMPUTER APPLICATIONS”**

## Course Outline

1. Introduction to Microprocessors
  - (a) definition
  - (b) implications on applications
2. Microprocessor Architecture and Technology
  - (a) architectures
  - (b) technologies
3. Development Considerations
  - (a) hardware support
  - (b) software support
4. Applications Example
  - (a) detailed description and analysis of one complete microprocessor based system

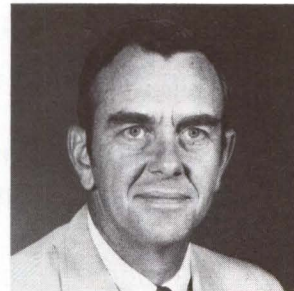
## INSTRUCTOR



Fred F. Coury,  
President,  
Fred Coury Associates

Fred Coury was Minicomputer Engineering Section Manager, Hewlett-Packard Company, Associate Research Engineer and Lecturer, University of Michigan. Mr. Coury is currently an independent consultant in digital designs, specializing in the hardware aspects of microprocessor-based systems design and applications. Mr. Coury received his B.S. and M.S. from the University of Michigan in 1963 and 1967.

## CHAIRMAN: Tutorial Session



Robert H. Wyman, Jr.  
Lawrence Livermore  
Laboratory



**Tuesday, February 24, 1976**

**KEYNOTE SESSION**

● **Morning:**

Conference Keynote Address by **Dr. Edward E. David, Jr.**, Executive Vice President, Gould Inc.

Review of the History of Computing by **Dr. J. Presper Eckert**, Vice President and Scientific Advisor, Sperry Univac.

● **Afternoon:**

**Conference Kick-off Talks:**

**HARDWARE:** Dr. Michael Flynn, Stanford University.

**SOFTWARE:** Dr. Robert McClure, Palyn Associates, Palo Alto, CA.

**FIRMWARE:** Mr. Michael J. Galey, International Business Machines, San Jose, CA.

**TECHNOLOGY:** Dr. Jack S. Kilby, Consultant.

**APPLICATIONS:** Dr. Andy Knowles, Digital Equipment Corporation, Marlboro, Massachusetts.

● **Evening: COMPCON Cocktail Party**

Following the Cocktail Party:

**Conference Panel Discussion** led by Dr. Willis Ware, Rand Corporation.

**Wednesday, February 25, 1976**

● **Morning:**

**1. Short Notes.**

**Chairman: Dr. Martin Graham, University of California, Berkeley, CA.**

**2. What's Going on in the rest of the World?**

**Chairman: Dr. Waldo Magnuson, Jr., Lawrence Livermore Laboratory, Livermore, CA.**

"Computers in Japan — Present and Future," H. Watanabe, K. Shimaya, and T. Mikami, Nippon Electric Co., Ltd., Tokyo, Japan.

"Computing in Western Europe," Speaker to be from IBM World Trade Corp., Washington, D. C.

"Computing in China, Russia, and Eastern Europe," R. Schmidt, Control Data Corp., Minneapolis, Minn.

**3. "What Will Microprocessor Hardware Evolve Into?"**

**Chairman: Dr. Jack Grimes, Tektronix, Inc., Beaverton, Oregon**

"Software Issues in LSI Microprocessor Design," Dennis Allison, Consultant, Menlo Park, CA.

"Technology for Microprocessor Hardware," Peter Verhofstadt, Fairchild Semiconductor, Mountain View, CA.

"Reliability of Microcomputer Systems Using Triple Modular Redundancy," John F. Wakerly, Stanford University.

**4. "Is Distributed Computer Systems Just A Buzz-Word?"**

**Chairman: Professor David J. Farber, University of California, Irvine, CA.**

"The Philosophy of a Distributed Banking System," Philip Ware.

"Compilation in a Distributed Function System," J. L. Baer, University of Washington.

Panel Discussion:

Panelists: Philip Ware, Servaro Ornstein, T. C. Chen.

**5. "Short Notes" (Continuation of Session 1)**

**Chairman: Dr. Martin Graham, University of California, Berkeley, CA.**

**6. "What Can We Expect in Microprocessor Software?"**

**Chairman: Mr. Terry Opdendyk, Intel Corporation, Santa Clara, CA.**

Panel Session: "How is Microprocessor Software Different from Mini Computer Software?"

**7. "What is Happening in Mass Storage?"**

**Chairman: Mr. Eric Salbu, Ampex Corporation, Sunnyvale, CA.**

"The Spectrum of MSS Effectiveness," Lynn Shirley.

"Practical Applications of MSS," R. H. Howie.

**8. "What Can We Expect in Data Communication Techniques?"**

**Chairman: Professor Leonard Kleinrock, University of California, Los Angeles, CA.**

"Techniques for Handling Stream Traffic Via Packet Switching," Robert E. Kahn,



Advanced Research Projects Agency,  
Washington, D. C.

"Communication Network Interfaces,"  
Lawrence G. Roberts, Telenet  
Communications Corporation,  
Washington, D. C.

● **Afternoon:**

**9. "Where are Data Base Systems Heading?"**

**Chairman: Professor David Hsiao, Ohio State University, Columbus, Ohio.**

"Follow-on DB Management Systems: Requirements of a Large, Experienced User," William P. Grafton, Rockwell International.

"Imbedding Data Management Operation in Programming Languages," Anthony I. Wasserman, University of California, San Francisco, CA.

"A Flexible Architecture for Data Base Management," Morton M. Astrahan, Donald D. Chamberlin, W. Frank King, and Irving L. Traiger, IBM, San Jose.

**10. "What Will Win the Solid State Memory Race?"**

**Chairman: Mr. Robert Lloyd, National Semiconductor, Santa Clara, CA.**

"CCD vs RAM's for Bulk Memories," Dave House, Intel Corp.

"I<sup>2</sup>L vs NMOS as a Main Memory Technology," Richard Horton, Texas Instruments.

**11. "What Will Happen With Computer Networks?"**

**Chairman: Mr. David Jasper, Control Data Corporation, Minneapolis, Minn.**

"The Common Carrier Role: A Catalyst in a Competitive Environment," S. B. Erskine, General Engineer, Network Planners Development, Bell, Canada.

"Computers and Networks 1980 — Some Architectural Trends," Earl C. Joseph, Staff Scientist/Futurist, Sperry-Univac Corporation.

"Assuming User Service Quality in a Distributed Computer Network," Thomas N. Pyke, Jr., Chief, Computer Systems Engineering Division, National Bureau of Standards.

**12. "What is the Future of Language-Directed Machines?"**

**Chairman: Dr. Jack Grimes, Tektronix, Inc., Beaverton, Oregon.**

"Graphics in a Language-Directed Machine," S. C. Baunach, Tektronix, Inc., Beaverton, Oregon.

"Personal Language-Directed Systems — Theory and Practice," P. A. Smith and Joseph Myers, International Business Machines, Scientific Center, Palo Alto, CA.

"Problems in the Push-down Stack Approach to the Implementation of High Level Languages," C. H. Smith, C. T. Wright, R. J. Zingg, Iowa State University, Ames, Iowa.

"Language-Directed Representation of Machine Instruction," Eric C. R. Hehner, University of Toronto, Toronto, Ontario.

**13. "Can Data Base Machines be Built?"**  
**Chairman: Dr. Vincent Y. Lum, Computer Science Department, International Business Machines, San Jose, CA.**

"The Role of Storage Hierarchy in Data Base Management," Stuart E. Madnick, MIT.

"Recent Developments in Data Base Management," Bruce Bera, Syracuse University.

"The Architecture of a Data Secure Computer System," Richard Baum, Ohio State University.

**Thursday, February 26, 1976**

● **Morning:**

**14. "Does the Super Computer Have a Future?"**

**Chairman: Mr. W. J. Watson, General Automation, Anaheim, CA.**

"Super User Problems Require Super Computers," Fran Balint.

"The Impact of Microprocessors on Super Computers," Harvey Cragon.

"Will Supers and Minis Squeeze Out the Main Frames," Charles Casale.

**15. "Will the Computer Replace Money?"**  
**Chairman: Mr. B. Ray Traweek, Senior Vice President, National BankAmericard, Inc., San Mateo, CA.**

"EFTS and Economics: Marriage or Divorce?," John B. Benton, TRW Inc., Los Angeles, CA.

"An Opportunity for Success," Charles Jones, Federal Home Loan Bank of Atlanta, Atlanta, GA.



"Today's EFTS Pilot Projects: Tomorrow's Value Exchange Networks," John Totten, National BankAmericard, Inc., San Mateo, CA.

**16. "What Can We Expect in Hardware Design Techniques?"**

**Chairman: Dr. Tom Whitney, Hewlett-Packard, Cupertino, CA.**

"Programmed Logic: A Valuable Hardware Design Tool," Krishna Rallipalli and Dan Wilnai, Fairchild Semiconductor.

"PLA's: When and Where to Use Them," John M. Birken, Monolithic Memories, Inc.  
"Microprocessor Mania," Jerry Washburn, Computer Automation.

**17. "Where is the Money Coming From?"**

**Chairman: Mr. Richard Hanschen, New Business Resources, Dallas, TX.**

"Money for Startup Companies," R. J. Hanschen.

"Intermediate Level Equity Financing," Philip Greer.

"Capital Formation Requirements for the Public Market," William R. Hambrecht.

**18. "How will the Computer Advance Automation?"**

**Chairmen: Dr. David Nitzan, Dr. Charles Rosen, Stanford Research Institute, Menlo Park, CA.**

"Programmable Automation of Discrete Part Manufacture," Charles Rosen.

"Product Systems Productivity," James L. Nevins, Charles Stark Draper Laboratory, Cambridge, Mass.

"Computer-aided Management Tools using Group Technology," Kenneth D. Mehlhope, Cincinnati Milacron, Cincinnati, Ohio.

"Real-time Industrial Process Control," M. Kitcher, International Business Machines, Poughkeepsie, NY.

● **Afternoon**

**19. "Design Automation in 1980"**

**Chairman: Dr. John Hanne, Texas Instruments, Inc., Dallas, TX.**

"Design Systems — A Five Year View," Charles W. Rose.

"The Next Step in Testing and Modeling," Stephen A. Szygenda.

**20. "How are Computers Being Used in Crime?"**

**Chairman: Mr. Daniel Goldenberg, MITRE Corp., Box 208, Bedford, Mass.**

"Computer Security," Edmond L. Burke, Member of the Technical Staff, MITRE Corp., Bedford, Mass.

"Legal Aspects of Computer Abuse," Susan Nycum, Chickering and Gregory, San Francisco, CA.

"Computer and Data Abuse," Donn Parker, Stanford Research Institute, Menlo Park, CA.

"Embezzler's Guide to the Computer," Brandt Allen, Colgate-Darden Graduate School of Business Administration, University of Virginia, Charlottesville, VA.

**21. "Will Software Engineering Get Us Good Software?"**

**Chairman: Mr. Christopher Shaw, Xerox Corporation, Los Angeles, CA.**

"On Software Certification," Ralph Keirstead, Stanford Research Institute, Menlo Park, CA.

"Procedure Extraction for Automatic Restructuring," Guy de Balbine, Caine, Farber & Gordon, Inc., Pasadena, CA.

"Software-First System Design," Robert J. Fleischer, The MITRE Corporation, Bedford, Mass.

**22. "The Personal Computer: Dream or Reality?"**

**Chairman: Mr. Robert Albrecht, Editor, Peoples Computer Company, Menlo Park, CA.**

"The Hobby Computer," Harold Singer.

"The Home Computer," Mr. Keith Britton.

**23. "Computer Science — Is it Related to Computing?"**

**Chairman: Professor H. H. Loomis, Jr., University of California, Davis, CA.**

"Computer Science and Engineering Programs — Today and Tomorrow," Martha Sloan, Michigan Technological University, Houghton, Michigan.

"IEEE Computer Society Curriculum Recommendations," M. Mulder, Bonneville Power Authority.

"IEEE Regional HELP Activities," David Rine, West Virginia University, Morgantown, West Virginia.

"A Bachelor of Arts in Computer Programming," W. McKeeman, University of California, Santa Cruz, CA.



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Requests for refunds must be received in writing no later than February 20, 1976.

Late registrations will be accepted at the Jack Tar Hotel starting Sunday morning, February 22, 1976.

The IEEE membership desk at the conference will be open Sunday evening and Tuesday through Thursday afternoon, February 22-26, 1976. A current student body card is required for Student membership.

When joining IEEE or IEEE Computer Society at the Conference, membership fees will be reduced for Non-Member registrants by the excess of the registration fee actually paid over the corresponding Member rate.

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## Choosing the Correct Flat Cable for High Speed Logic Circuits

Stanley Sullwold

3M Company  
St. Paul, Minnesota

*Before choosing a flat cable for a specific application, a designer should be aware of the standard designs' different characteristics; then, he may decide which best suits his needs*

Flat cables have three common design configurations, offering different characteristics. While their differences may not be critical in many applications, in high speed logic circuits, several factors must be evaluated before making the necessary tradeoff to suit the particular circuit design needs. Principal factors are crosstalk, attenuation, and impedance.

The three designs (with arbitrary A, B, C designations for later reference) are:

- A Several twisted-pair lines, laced together to form a flat ribbon
- B A parallel "lay-flat" cable, with all lines enclosed within the same dielectric material
- C Same as B, with a controlled-impedance ground plane added

These designs were evaluated on the basis of tests made with one wire of each pair grounded, so that characteristic differences would clearly be

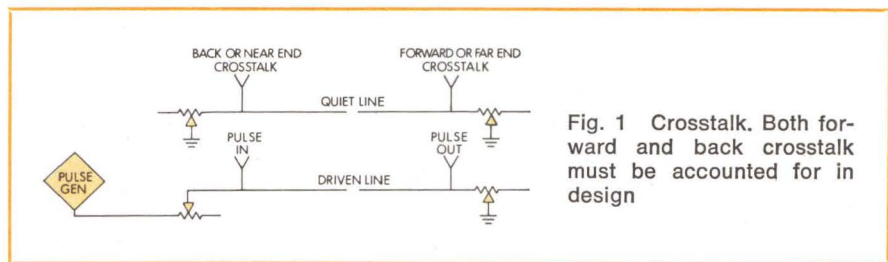


Fig. 1 Crosstalk. Both forward and back crosstalk must be accounted for in design

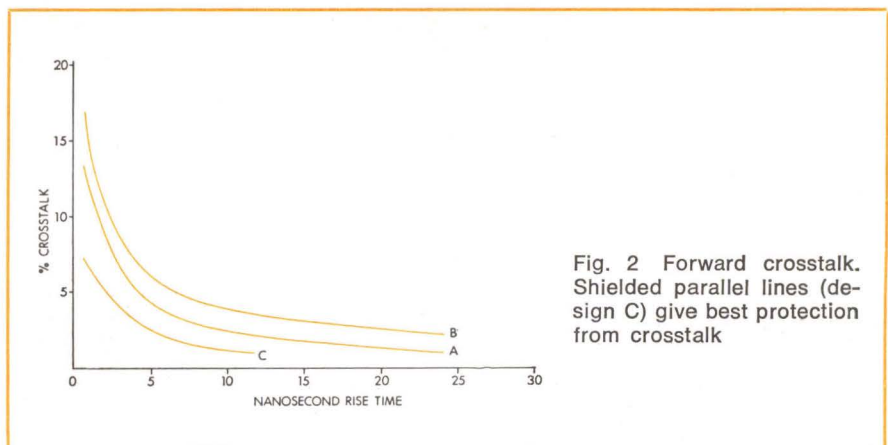


Fig. 2 Forward crosstalk. Shielded parallel lines (design C) give best protection from crosstalk



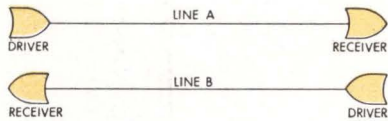


Fig. 3 Oppositely directed drivers. This configuration produces a greater degree of back crosstalk sensitivity

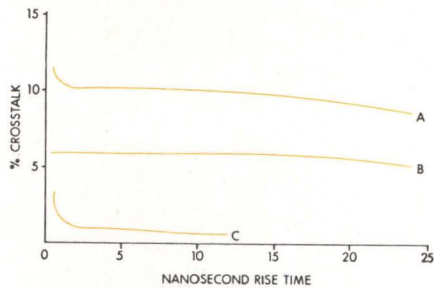


Fig. 4 Back crosstalk. Again design C is best, but performance is less subject to signal rise time

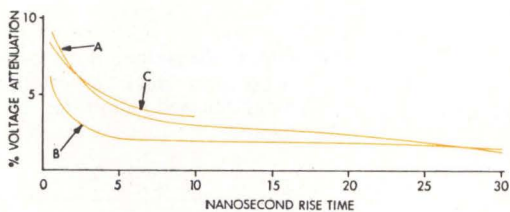


Fig. 5 Voltage attenuation. Unshielded parallel lines perform best, but the three designs behave nearly alike in this respect

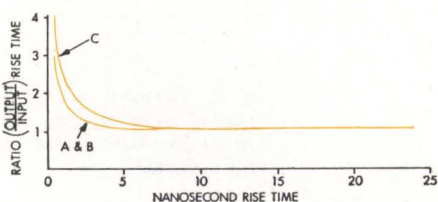


Fig. 6 Rise-time attenuation. All three designs are nearly alike, and nearly independent of rise times of 6 ns or more; design C suffers most for very short times

the result of design variations, not of common-mode noise or of circuit imbalance.

Although each electrical parameter is discussed separately, all are interdependent. Tradeoffs are important; an attempt to improve one characteristic by circuit or component design may degrade another characteristic.

### Crosstalk

Originally, twisted-pair cables were used primarily to minimize crosstalk; however, alternative possibilities should be considered.

Crosstalk is voltage induced in a line adjacent to one being driven. It may be defined as either "forward" or "back" (Fig. 1).

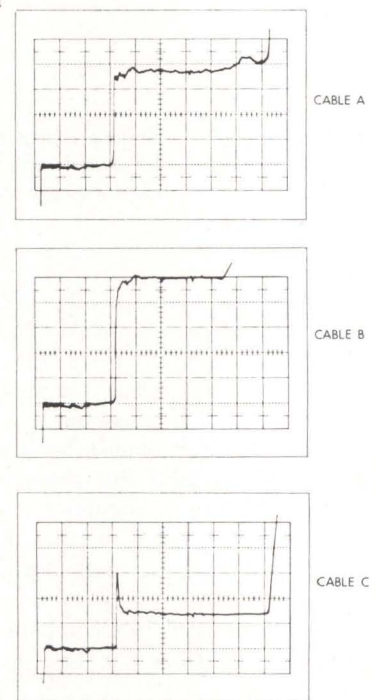


Fig. 7 Reflection coefficients. Characteristic impedances are computed from these scope traces: for A,  $Z_0 = 108 \Omega$ ; for B,  $Z_0 = 150 \Omega$ ; for C,  $Z_0 = 65 \Omega$ . Perturbations in type A trace also show varying impedance along cable length, hence additional small reflections. Horizontal scale is 5 ns per division; on vertical scale, one division represents reflection coefficient of 0.1



Forward crosstalk should generally be no greater than 10%; otherwise, unwanted switching may occur in the quiet line. The shorter the rise time of the logic circuits, the higher the probability of crosstalk. Curves in Fig. 2 show that design C produces only 6.5% crosstalk even at 1-ns rise times, while A and B must be driven by slower signals to achieve that same protection. A further consideration is the logic-circuit choice; emitter-coupled logic can produce rise times of 1.5 ns, tending to limit the cable choice to C. When using transistor-to-transistor logic, however, which has a general minimum rise time of 5 ns, any of the three designs could be safe.

Back crosstalk becomes a special problem when adjacent lines are driven from opposite ends (Fig. 3). Back crosstalk is read at the receiver end of the quiet line, which is the most critical point in the possibility of producing unwanted switching in a receiver. Quite often, driven ends of the lines are connected directly to the driver, with no impedance-matching circuit, and thus have a reflection coefficient of 0.8 or more. Therefore, during the time the gate on the quiet line is turned off, 80% or more of the back-crosstalk signal can be reflected to the forward end of the driven line. This reflection from back crosstalk is another factor that affects the overall forward crosstalk. Some typical back-crosstalk curves are shown in Fig. 4.

### Attenuation

Attenuation has two components: voltage attenuation and rise time attenuation. Our tests do not give absolute values, but they do show trends.

Voltage attenuation (in percent) is the ratio of the voltage drop between input and output to the input voltage:

$$100(E_{in} - E_{out})/E_{in} = \text{percent voltage attenuation}$$

Again, short rise times are associated with high voltage attenuation; for this parameter, design B appears to be the best (Fig. 5). However, the three curves are similar, and since

digital logic depends more on timing than on power transfer, none of the designs should be eliminated from consideration merely because of design B's relatively low voltage attenuation.

Rise-time attenuation is a simple ratio of output rise time to input rise time. Design C has the sharpest attenuation, but with circuit designs having rise times of 6 ns or greater, all three cable designs are comparable (Fig. 6).

### Impedance

Characteristic impedance of the three designs (measured to ground reference) varies from 65 to 150  $\Omega$  (Fig. 7). Impedance was measured with a time-domain reflectometer, a plug-in for a standard oscilloscope. In each trace, the base line at the left results from a 50- $\Omega$  air line connected to the reflectometer; the height of the step is a measure of the reflection coefficient,  $\rho$ ; and characteristic impedance is determined with the relation

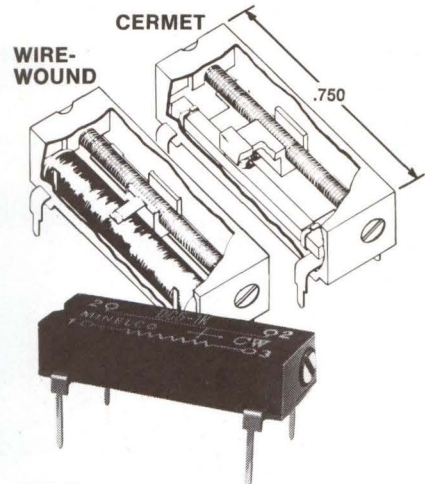
$$Z_0 = 50(1 + \rho)/(1 - \rho)$$

If lines are properly terminated externally, line impedance may not be a problem. On the other hand, if proper termination is not possible, the cable design that has the impedance closest to that of the driven circuit can be selected; it may be the best choice to minimize reflections.

Twisted-pair cables (design A) are subject to another potential difficulty. The scope trace shows perturbations in the magnitude of the reflection coefficient, corresponding to a varying characteristic impedance along the length of the cable. These variations are caused by nonconstant spacing of wires in the twisted pair. Although they are not severe in this case, the perturbations do show that small reflections occur at points where the impedance changes; these would make proper termination more difficult.

Flat cables may be the most practical, economical, and easy to install, particularly in the design of mass-produced equipment. However, a careful evaluation of their high speed logic characteristics is extremely important.  $\square$

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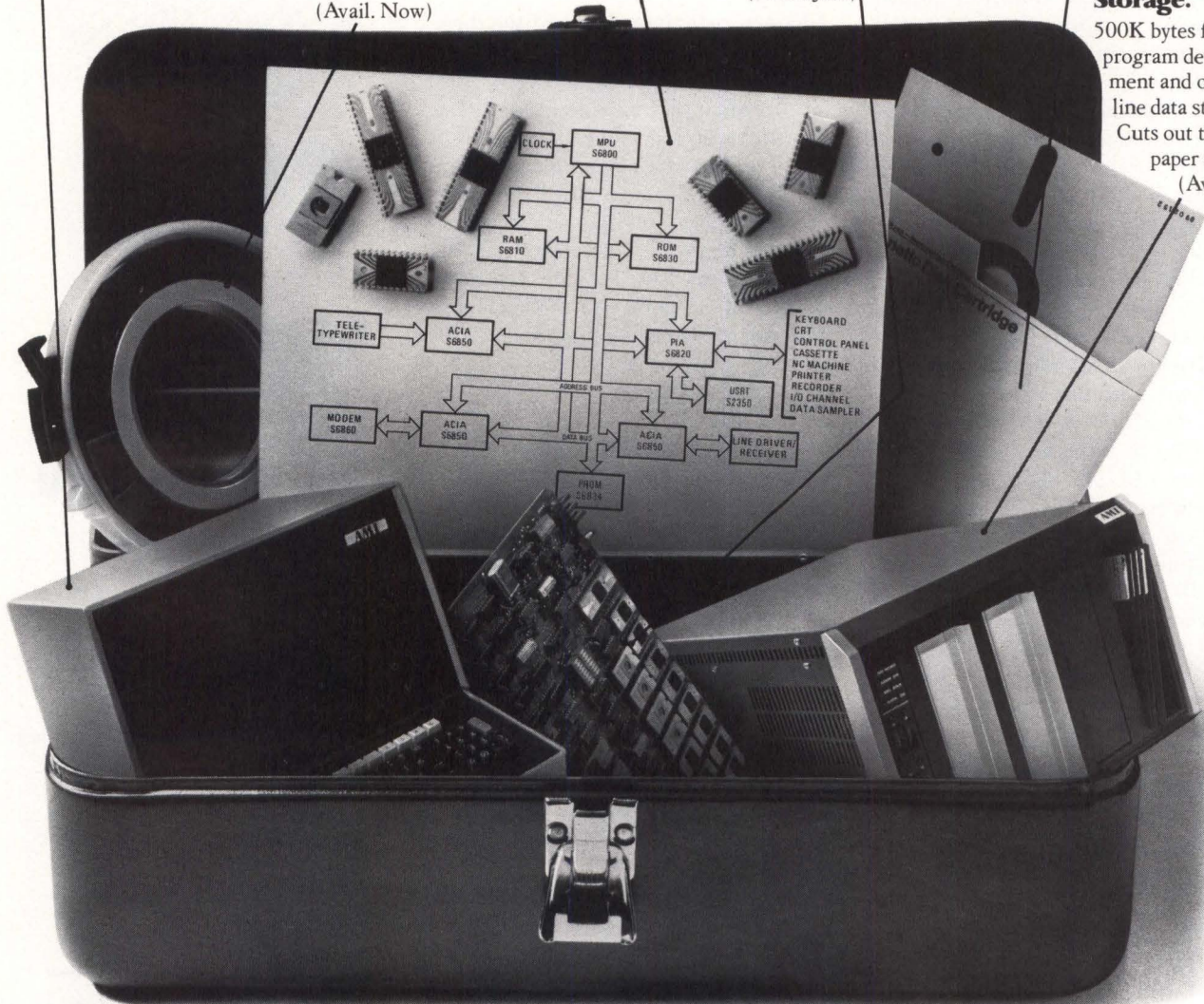
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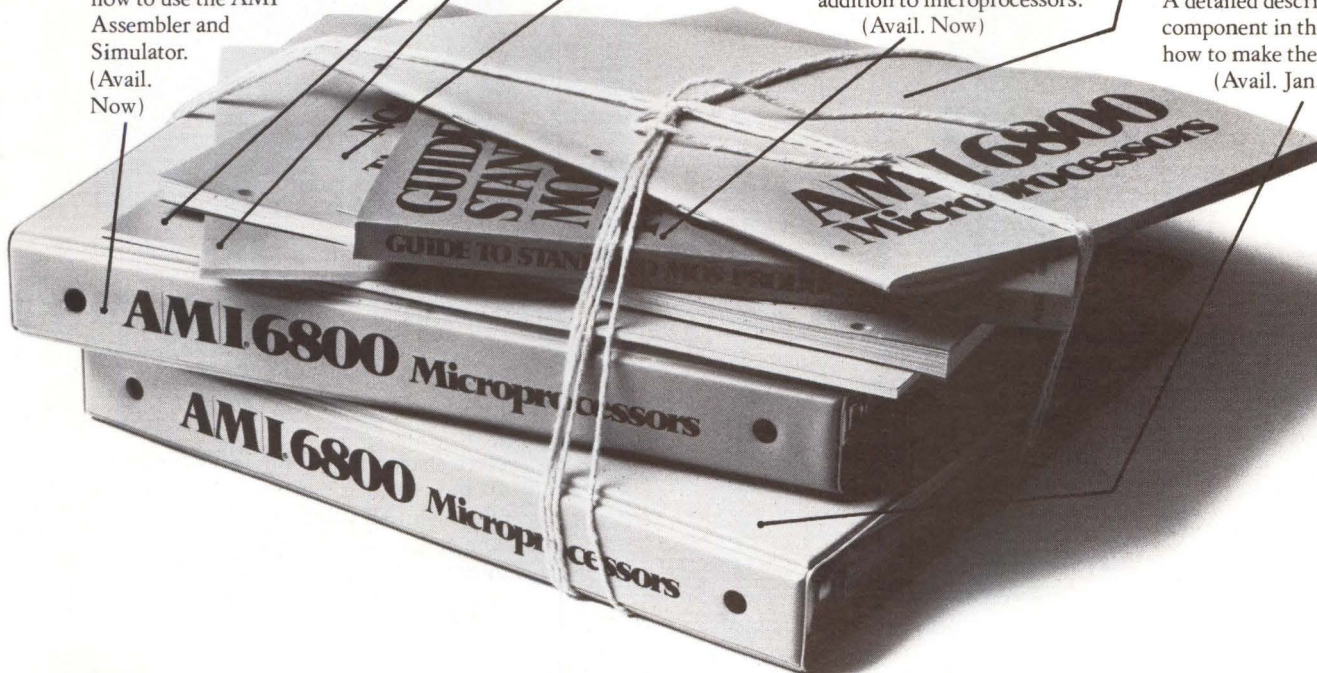
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# MICRO PROCESSOR COMPUTER DATA STACK

## µProcessor in Control Valve Permits Multiple Use by Software Changes

Development of a direct digital control valve combined with a microprocessor totally eliminates the need for analog- or digital-command positioners, at a cost competitive with conventional valve and positioner packages alone. The Smart Valve, from Digital Dynamics, Inc, 830 E Evelyn, Sunnyvale, CA 94086, is essentially a "universal control valve," in that software can be changed to alter the characteristics of the valve, rather than mechanically changing or redesigning it (so that, for an entirely different application, only reprogramming is necessary). Since the microprocessor is only slightly taxed running a digital valve, the user derives the added benefit of "left-over logic" to run the rest of the system in which the valve is being used. In addition, the Smart Valve can inde-

pendently control a separate (slave) digital valve.

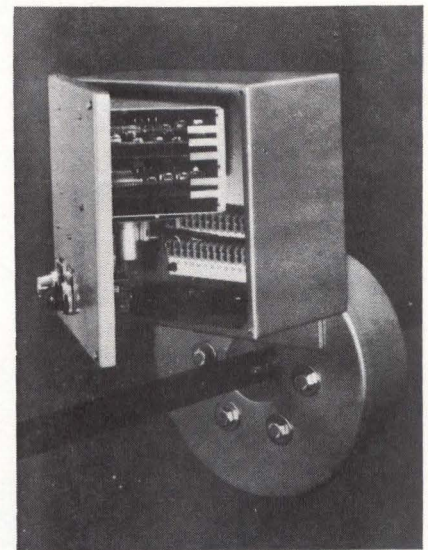
Along with the valve, each unit contains a Pro-Log PLS series microprocessor board which implements the Intel MCS™-4 microprocessor chip set. Six standard microprocessor packages available as Smart Valve controllers include power supply, input/output (I/O) interfacing, programmable read-only memories (p/ROMs), and a screw terminal strip for field wire connections—all housed in a standard NEMA 12 watertight, "black box" enclosure.

The Smart Valve is best suited to the typical, small- to medium-sized control system where only a few pressures, temperatures, or liquid levels are being monitored and controlled continuously. It can precisely control and meter liquid and gas flow without overshoot, drift, sticking, hunting, or settling lags. In addition, other system functions, such as start-up, shutdown, safety switches, or data logging, can be economically han-

dled by the microprocessor. Response time of the microprocessor/valve combination is typically under 100 ms, and flow characteristics are determined by programming—not mechanical trim, as in a conventional valve.

Maximum p/ROM sizes are 1024 and 1536 8-bit words, read out four bits at a time. Scratchpad (random-access) memory sizes are 80 (standard) and 320 (maximum) characters. Display is 7-segment LED, internally scanned, up to eight 0.3" high digits. Analog I/O times are 1 ms or less/50 µs; digital I/O times are 50 µs per four bits.

No instrument air or additional interface hardware is required, as the Smart Valve operates with standard industrial control signals (0 to 5 V, 4 to 20 mA, 120 Vac, contact closures, TTL). A typical medium-sized unit utilizes six digital outputs to

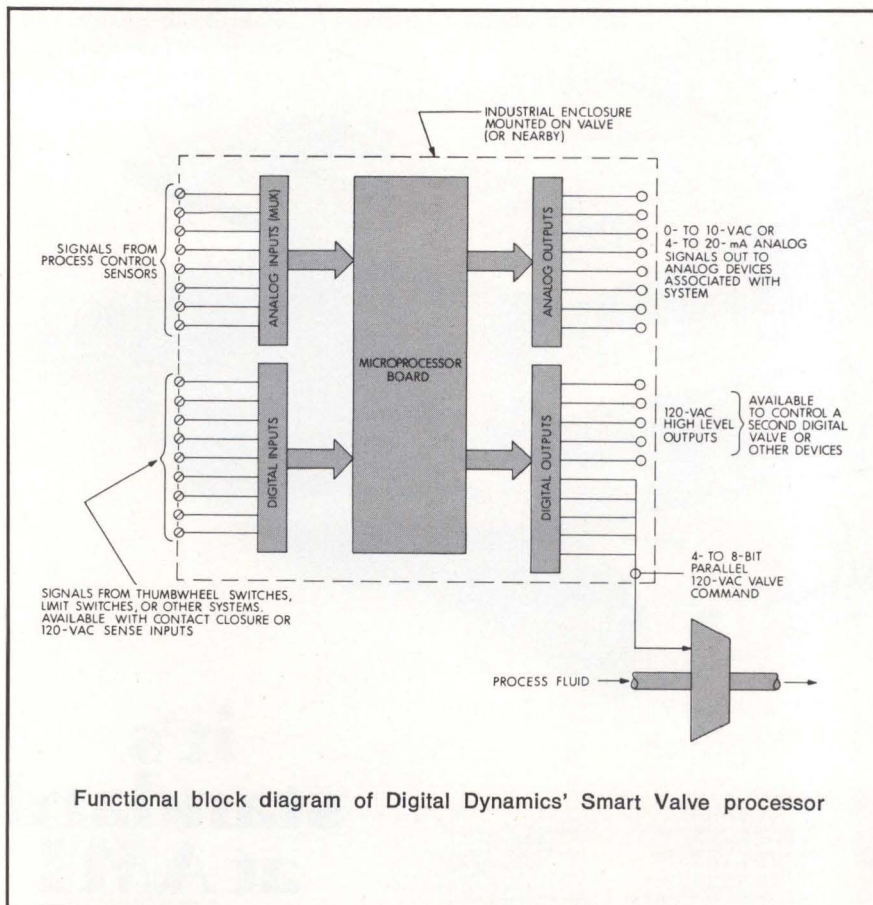


Direct digital control valve is combined with microprocessor for use in small- to medium-sized control systems where only a few pressures, temperatures, or liquid levels are being monitored and controlled continuously

drive its internal 6-bit valve, and has 10 more which can be used with another digital valve, relays, solenoids, lamps, or alarm bells. In addition, four analog and eight digital inputs are available, as are custom configurations.

The company is also offering a low cost "Painless Programming Service" (PPS), which relates the user's knowledge of his own application to the company's in-house programming staff, enabling applications programs to be designed and software-tested before the purchase is processed.

Circle 170 on Inquiry Card





## Intersil, Harris Exchange CMOS $\mu$ Processor Technology

A cross-license agreement recently reached establishes Harris Semiconductor, a div of Harris Corp, PO Box 883, Melbourne, FL 32901 as an exclusive source for the IM6100 complementary metal-oxide semiconductor (CMOS) microprocessor from Intersil Inc, 10900 N Tantau Ave, Cupertino, CA 95014.

The pact also includes certain other Intersil CMOS products presently in development to support the -6100: IM6312 1024 x 12-bit read-only memory, -6101 parallel interface element, and -6402 universal asynchronous receiver/transmitter. Harris has the HM-6508 1024 x 1-bit CMOS random-access memory (RAM) and has in development the HM-6551 256 x 4-bit CMOS RAM—alternate sources for the IM6508 and -6551, also in development. All devices under terms of the agreement will be introduced by both companies concurrently.

The firms have additionally agreed to maintain cooperative product planning efforts, and may become alternate sources for any new devices developed by either one in support of the IM6100.

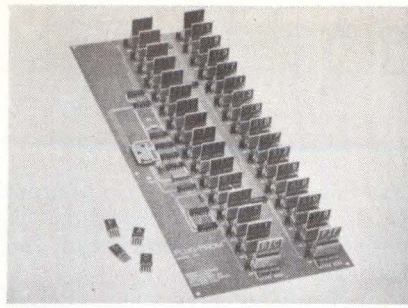
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## ROM Diode Matrix Array Aids Debugging of $\mu$ Computer Programs

Manufacture of a low cost, easy-to-use microcomputer programming and program debugging aid in a variety of sizes and capacities to meet OEM and end-user requirements is underway by Brent C. Olson, Consultant, 1950 Colony St, Mountain View, CA 94043. PLUG-PROM™, a read-only memory (ROM) diode matrix array, is programmed by simply inserting small printed circuit board (PCB) "plugs" into standard PCB edge connectors. Each 0.5 by 1-in. plug is labeled with a hexadecimal value (0 through 9, A through F) that it programs into the diode matrix in any position into which it is inserted.

One plug programs four bits, so that, in a standard 8-bit by 256-word unit, each word is easily programmed by inserting two of the plugs. Changing a program during debugging requires only removal and replacement of plugs.

Electrically equivalent to the Intel 1702 programmable ROM (p/ROM), the device connects to any micro-



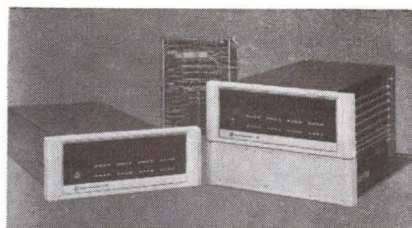
computer system via a supplied cable having a 24-pin plug. Interfacing consists of plugging into a socket in a system that would normally contain a 1702. The PLUG-PROM can be substituted for more than two dozen commonly used ROMs and p/ROMs.

Rather than learning how to program a time-sharing computer or to operate a specialized development system, or buying teletypewriters, CRT terminals, or high-speed paper-tape punches or readers, the user need only build a prototype system, substitute the PLUG-PROM for the ROMs and p/ROMs, write the programs, and move the plugs around until the program is properly executed. The PLUG-PROM can then be moved to a p/ROM duplicator and, once connected, copy p/ROMs can be made. In addition, when execution time is slowed or single-cycled, optional LED indicators light in every word position when a word is selected.

Board dimensions range from 8 by 15 in. to 15 by 30 in., bit/word organization from 8 by 32 to 8 by 256. Circle 172 on Inquiry Card

## $\mu$ Processor-Based Family of Computers Meets Wide Range of User Needs

Competitively priced for OEM applications as well as for end-users, model 990 series digital processors, introduced by Texas Instruments Inc, PO Box 1444, M/S 784, Houston, TX 77001, feature several architectural innovations plus upward-compatible software. The family initially includes a microprocessor, microcomputer, and minicomputer, as well as software development systems, cross



support on time-sharing networks, and a prototyping system.

TMS 9900 is a single-chip, 16-bit microprocessor using metal-oxide semiconductor, n-channel, silicon-gate technology; with a versatile instruction set and high speed interrupt capability, it is said to provide computer power expected from a 16-bit transistor-transistor logic (TTL) computer. Using the TMS 9900 as its central processing unit (CPU), the 990/4 is a complete 512- or 8000-byte microcomputer on a single printed circuit board; it is suited for terminal or machine monitoring/control, and as a CPU for OEMs. For higher-performance speeds, the general-purpose 990/10 minicomputer is a TTL implementation of 990 architecture.

Since all models use the instruction set of the TMS 9900, software developed for the low-end computer will be compatible with the higher-performance machines, so that systems can be expanded with a minimum of interface or software adaptation. Bit, byte, and word addressing of memory and input/output (I/O) interfaces—standard in each 990—facilitates data collection and transfer to remote locations and is advantageous in distributed data bases, data communications networks, or manufacturing automation environments. It also minimizes the cost of interfacing peripherals and communications devices; with the Communications Register Unit, a programmer may perform I/O operations at the bit level, or in a group of up to 16 bits in parallel.

Common to all models is rapid context switching, which enables the computers to operate with high-level efficiency in a multiple-task environment—made possible by programmable 16-word workspaces located in memory. Also, an asynchronous 16-bit parallel I/O data bus called TILINE™ enables the /10 computer to execute high speed I/O operations; it links central processing unit, memory, and high speed peripheral devices and can support high speed as well as slower memory. TILINE thereby minimizes synchronization problems inherent with synchronous, direct memory access channels.

Other standard features include 120-Hz real-time clock input, vectored interrupts, and hardware multiply/divide. As enhancement options, for example, the /4 is available with add-on memory of up to 40 kilobytes on a single board in 8-kilobyte increments. It offers memory expansion to 64 kilobytes (8 kilobytes of dynamic random-access memory [RAM] on the board, 2 kilobytes of either programmable read-only memory [p/



ROM] or static RAM on the board, and 2 kilobytes expandable to 32 kilobytes of erasable ROM). A second, dynamic RAM board is available on the /10, which also has a memory mapping feature that provides memory protection and privileged instructions, and supports memory expansion to 2 megabytes.

Cross support for developing applications programs consists of assembler, linking loader, and simulator on National CSS, Tymshare, or GE time-sharing networks. There are also two standalone software development systems: a low cost version consisting of a /4 with 16 kilobytes of memory, a software development package, and a Silent 700™ ASR data terminal, and a more sophisticated, disc-based system which includes a /10 with 64 kilobytes of memory, up to four 2.2-megabyte discs, ASR terminal, video display terminal, software development package, and optional line printers and card readers. Disc and non-disc operating systems, utilities, and BASIC, COBOL, and FORTRAN compilers are designed to support both OEMs and end-users.

A prototyping system, consisting of a 16-kilobyte /4, ASR terminal, and optional p/ROM programming kit, permits TMS 9900 users to develop custom software and firmware modules.

Deliveries of all elements of the family are scheduled to begin in first-quarter 1976.

Circle 173 on Inquiry Card

### Power Problems of $\mu$ Processors Eased by Noise-Free Supplies

Not only are selection and control of voltage levels in microprocessor systems important, but the quality and shape of the input waveform is critical to accurate and reliable system operation. The 30-W series 4500/4600, announced by Dynamic Measurements Corp, 6 Lowell Ave, Winchester, MA 01890, is designed to solve the problem by delivering power which is virtually free of noise (total noise plus ripple less than 100  $\mu$ V rms maximum), having an output voltage temperature drift of less than 100 ppm/°C, with waveforms shaped specifically for current microproces-

sors. Single-, dual-, or triple-output models provide clean turn-on/off current-limited waveforms with no overshoot.

Supplied in ac input voltage ranges of 105 to 125 V at 50 to 420 Hz, the family features input isolation of 50 M $\Omega$  at 60 Hz, up to 500 V, across the -25 to 85°C operating temperature range. No derating is required, and standard models for international ac line voltages, as well as brown-out versions, are available. The supplies can be provided to match the requirements of any microprocessor system.

Circle 174 on Inquiry Card

### CMOS $\mu$ Processor Offers Maximum Flexibility at Minimum Cost

The COSMAC microprocessor, utilizing complementary metal-oxide semiconductor (CMOS) technology, is now commercially available for the first time, as part of the CDP1800 family which also includes a hardware support kit, microprocessor manuals, and software development packages. Simple yet powerful microprocessor architecture allows the inexperienced user to readily understand and apply the family—designed by RCA Solid State Div, Somerville, NJ 08876 with a total system in mind, to offer maximum flexibility at minimum cost.

Architecture of the CDP1801 8-bit microprocessor permits simple, fast, mostly single-byte instructions, all executed in a single instruction cycle. The sixteen, 16-bit registers on-chip can be used as program counters or data pointers, or for data storage. One register serves as a built-in data pointer for direct memory access.

The CMOS low-power requirement (60 mW typically at 2 MHz) permits use of a single, unregulated, 3- to 15-V power supply, offering potential weight and cost savings. Supply voltage tolerance allows use in battery-powered systems (automotive or portable-equipment applications). Typical noise immunity of 45% of supply voltage suits the microprocessor to industrial applications, and a -55 to 125°C operating temperature range enables its use in systems ranging from arctic equipment to hot industrial processes.

The Microkit hardware support kit—a complete prototyping system—contains the central processing unit, 1000 words of random-access memory, 512 words of read-only memory, space for additional memory and user-designed interface cards, input/output (I/O) decoders, an I/O interface for a teletypewriter or other terminal, and power supply. With resident editor, assembler, and debug board option with user-supplied terminal, the kit provides a complete, independent system for producing debugged programs.

More powerful software development aids offer assembly, editing, simulation, and debugging; this program is available either on the GE time-sharing network or as a FORTRAN IV tape for installation on an interactive computer. Completing the package is a manual on the -1801 as well as manuals on various software design aids.

Circle 175 on Inquiry Card

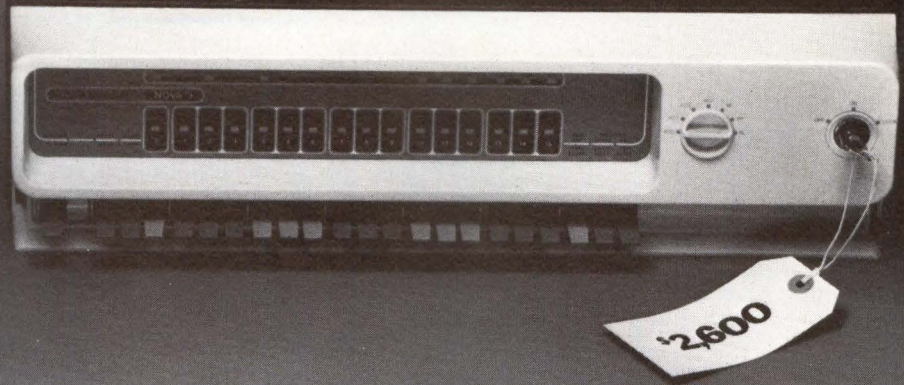
### Software Packages Developed for Airborne, $\mu$ Processor Systems

A complete line of cross-assembler and simulator software packages for airborne and microprocessor systems is being offered by Computer Interactive Services, Inc, 117 Stedman St, Brookline, MA 02146. Typical of the line is ASEM14, a cross-assembler designed to translate symbolic code for the F14 airborne computer. It is a 1-pass assembler that runs on a standard Digital Equipment Corp PDP-11 minicomputer under the DOS (disc operating system).

SIM14—an interactive simulator designed to allow programs to be developed and checked out without the use of the airborne processor—is capable of simulating both analog and digital inputs, and contains a debug module which handles all user debug requests, enabling users to display registers, dump locations, set breakpoints, and change the contents of a specific address. It also runs on a PDP-11 under DOS. All programs can be tailor made and are available off the shelf for RCA, Control Data, Hughes, and Northrop processors.

Circle 176 on Inquiry Card





## Has your \$500 micro ended up costing more than our \$2,600 mini?

If you've had to spend a lot of money on a low priced micro, you may be in a position to appreciate the cost advantages of a higher priced computer.

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When you buy a Nova 3, you don't have to put as much into it to get it to do your job.

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You don't have to worry about Nova 3 availability. We're manufacturing virtually every part of the Nova 3. Including the silicon gate N-channel MOS RAM memories. (They're coming from our Sunnyvale, California facility.)

And you don't have to go it alone. Because when you buy a Nova 3, you can get all the support Data General offers an OEM.

Write or call for the Nova 3 brochure. It may persuade you to buy more and spend less. \*\$2600 is the single unit price for a 4K MOS memory Nova 3. Before the OEM and quantity discounts get figured in.

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CIRCLE 52 ON INQUIRY CARD



## Low Cost $\mu$ Computer Controls Wide Range of Industrial Processes

Intended to simplify the task of unit control in process industries, the UCS 3000 microprocessor-based process controller is said to provide effective monitoring and control of a wide range of functions at a fraction of the cost of conventional computer systems. It communicates with the user in terms that he defines (gallons, temperature, weight, pH) and permits programming changes to be made through an operator's panel using the terminology of instrument engineers rather than that of computer programmers. With minimal training, an operator can use the controller and make any required changes in a process control scheme.

Designed by Bristol Div of American Chain & Cable Co (Acco), Inc, 929 Connecticut Ave, Bridgeport, CT 06602 to supervise only a small segment of a total process, the controller is economical for systems with as few as three to five control loops as well as for multi-unit control systems having thousands of loops. Should failure occur, only a few loops in a process would be affected. In addition, individual controllers can be tied into a larger computer for overall supervision of a process.

With a function keyboard and alphanumeric display on the panel, the operator can call up setpoints, signal names, and values; change signal inputs and outputs, control loop parameters, and intermediate variables; and connect any input to a different function block without making physical wiring changes. Called "rubber wiring," this feature permits the controller to be readily adapted to changes in processing methods and equipment.

Each controller incorporates an Intel 8080 chip as its central processor; features include 74 instructions, 2- $\mu$ s cycle time, eight vectored interrupts, crystal-controlled real-time clock, power-fail shutdown/restart, and parity error detection. Memory-module types available are read-only, programmable read-only, semiconductor random-access, or core random-access, or any combination of these; capacity is 16 to 48 kilobytes.

One controller accommodates up to 80 analog control loops. Noise immunity (analog inputs) is 250 V common mode rejection, 120 dB at-

tenuation; (discrete inputs) 1500-V spike rejection. Communication input/output is ASCII asynchronous, 75 to 9600 baud. MTBF is 10,000 hr; in case of failure, full manual override is available. Built-in security provisions lock out access to certain portions of the controller, preventing individuals from making unauthorized changes to control functions.

Software includes 25 program modules which simulate process control system hardware elements such as PID controllers, timers, integrators, comparators, lead/lag circuits, peak detectors, or loggers. "Fill-in-the-blank" coding sheets for each function permit control engineers to generate a program using only standard instrumentation terminology. No other special skill is required, aside from the ability to prepare a block diagram of the specific control scheme.

A system configuration language specifies hardware elements, measurements on each channel, and process control functions. This, combined with modular programming, permits a controller to be set up for a specific application within 10 man-days, compared to 60 to 90 days for a minicomputer system. It also enables users to specify a control system without revealing proprietary processes. Circle 177 on Inquiry Card

## $\mu$ Processor Technology To Provide 'Intelligent' Control of Valves

Hundley Controls, Inc, Routes 53 & 139, Hanover, MA 02339 has been established to serve as applications engineers and manufacturers' representatives, marketing and integrating customized hardware and software systems aimed at creating cost-effective, rugged, reliable flow control in valves. The company is developing hardware and software around a concept called IVC (intelligent valve control), which will mimic the control actions performed by a skilled operator when closing and opening a valve on an extremely difficult-to-handle fluid, such as a high-temperature, high-pressure slurry with suspended, irregularly-sized chunks of material of varying hardness.

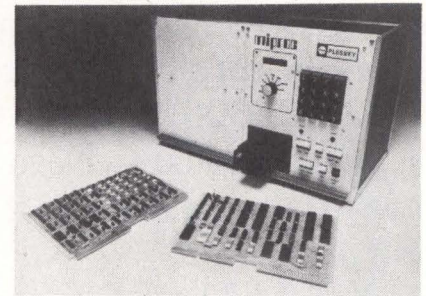
Heart of the IVC will be a partially self-organizing control system im-

plemented by a microprocessor. States John Andersson, principal engineer, "the dramatic reduction in size and price of an intelligent controller coupled with the increase in reliability makes a compelling argument for the use of IVC in distributed valve control systems."

Circle 178 on Inquiry Card

## Processor-on-a-Card Cuts System Development Time in Half

Claimed to be the first 16-bit high-performance processor on a card, the MIPROC 16 microcomputer from Plessey Microsystems, Inc, 1674 McGaw Ave, Santa Ana, CA 92705 features a 350-ns cycle time and 82 instruc-



tions, including multiply-divide. According to Microcomputer Div general manager Jai Jhu, "system development time is cut in half when compared to using hardwired logic or microprocessor chips. There is no hardware to debug and no microprogramming, so that getting online is faster and less expensive."

The unit is configured for parallel fetch and execution, with separate program memory and data memory architecture, enabling most instructions to take a single cycle. Conditional branches require 700 ns; multiply/divide times are 5.6/11.2  $\mu$ s.

Support includes a prototype development system plus FORTRAN IV cross-assembler and simulator for use on Tymshare or GE Mark III networks. Applications range from process control, data acquisition, and machine tools to peripheral control, data communications, and fast-Fourier-transform processing. A ruggedized version is also available.

Circle 179 on Inquiry Card





# You can buy this microcomputer for \$39.95, but...

We would be a bit surprised if you could do anything meaningful without additional hardware and software.



In fact every part including the powerful MC 6800 CPU and the 8K dynamic RAM is guaranteed for 120 days. It has the best

Wave Mate's Jupiter II™ isn't the kind of microcomputer kit you only stare at... when you've completed your Jupiter II just plug in your teletype and you're ready to go. That's because it goes beyond the sum of its high quality parts. It's the ultimate micro kit experience. **In performance, in documentation, in reliability.** First, consider its superb features.

software around, **System Monitor and Debug programs (ROM)**. Includes powerful **text editor and Motorola compatible assembler**. And **BASIC** at no extra cost. Because we've been making microcomputer systems for over 4 years, we can offer you the broadest line of interfaces including TV terminal and dual audio cassette. Impressive. And yet the grandest feature is the experience of completing a kit that works. **Guaranteed.**



It has small **pluggable wire wrapped cards** easily tailored to suit your modifications. **Every IC is socketed and 100% burn-in tested.**

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## PRODUCT FEATURE

Significant improvement in vertical accuracy and plot width three times that of any other electrostatic machine are claimed for the model 4472 plotter and the model 4472A printer/plotter announced by Versatec. Use of a shaft encoder/servo drive provides 0.3-mil plotting accuracy, even in start/stop operation, comparable to that of the best pen plotter. Plot width can be up to 71.68" on 72" wide splice-free paper—either standard electrographic or translucent; plot length is limited only by the length of the paper roll, 500 ft. Standard bed size is 26 x 72" (over 12 sq ft); and an optional extension table provides a viewing area of 76 x 72" (over 36 sq ft).

Dual microprocessor intelligence is optionally available for write timing, system control, and simplified programming. For instance, inclusion of 8-bit Intel 8080 microprocessors (purchaser can specify other processors) provides the ability to evaluate and reformat data from any kind of storage, allowing varied inputs, modification to suit various applications, and simplification of plotter-computer controllers. Logic and software requirements are further reduced by command string architecture.

### Performance and Design Features

In both units, shaft encoder and servomotor drives have replaced paper-drive stepper motors. Timing and writing location are determined by the encoder and the servo moves the paper (in 0.01" increments). Servo control gradually decelerates and stops paper movement without overshooting, thus eliminating the start/stop gaps and distortion found with the use of stepper motors. In addition, operation is even quieter than the usual electrostatic process.

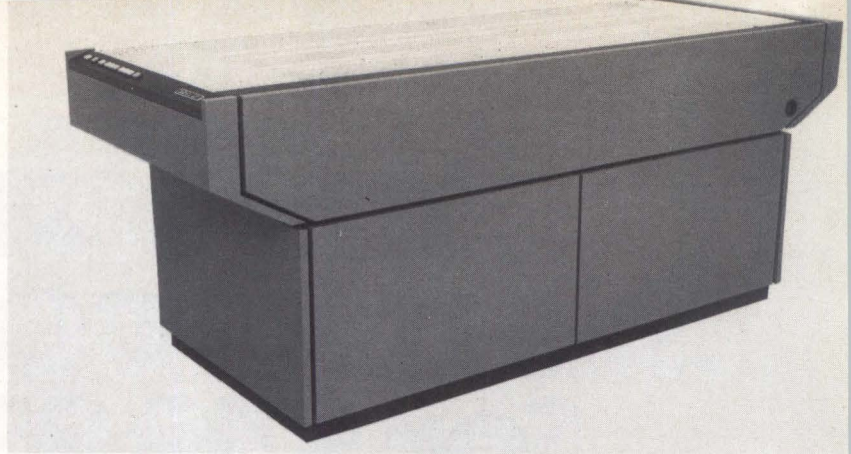
The Matrix Electrostatic Writing Technique (MEWT™), used in the company's previous plotters, is also used in these models. However, the

writing head is much larger and more rugged. Individual characters and plot lines are formed in an overlapping dual array, 100-dot/in., 7 x 9 matrix. Programmed voltage is applied to 7168 writing nibs embedded 0.01" apart in the stationary writing head. Digital commands cause the nibs to selectively create minute electrostatic dots (0.013") on the paper passing over the writing head. Exposing the paper to liquid toner produces visible permanent images.

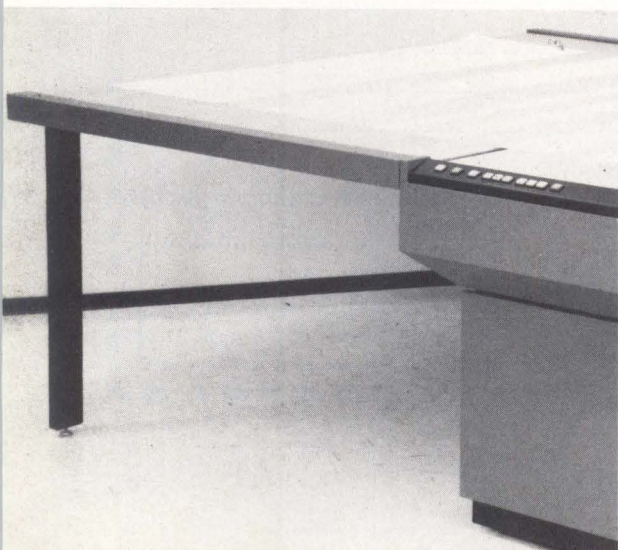
Speed is data and core dependent. At full plotting width, paper speed is 1 in./s. To maintain full speed, minimum input data rate is approximately 110 kilobytes/s. Relatively small computers with 16,000 words of memory can be used in special applications with a limited set of specific algorithms. However, when generalized output is required, larger, 32,000-word computers are necessary to maintain rated speed.

The printer/plotter contains a 256-character ASCII set and prints at 12.5 char/in., horizontally, 6.6 lines/in. vertically. An optional simultaneous print/plot feature permits plot data and hardware-generated print characters to be overlaid on the same scan line.

When a dual microprocessor option is included, the rear-end processor performs write timing and system control while the front-end processor handles a number of optional pro-



## Electrostatic Plotter Offers High Vertical Accuracy on Nearly 72-Inch Wide Plot



Optional extension table available with both electrostatic plotter and printer/plotter permits display of nearly 36-sq ft area. Actual plot can be up to 500 ft long by 71.68 in. wide



grammable functions. Commands interspersed in the data stream can be used to change vertical and horizontal tabs, rotate characters, double character size, or expand plots. A single code command can underline words or lines, add character slashing, modify line-per-inch spacing, or generate a common label for a series of pages. Other microprocessor-available functions include data compression for shading of plot areas, special character set generation, and a choice of additional programmed variables.

### Operational Specifications

Although the standard model handles only 72" wide paper, the first plotter delivered is configured to use paper in 50, 68, or 72" widths. (It is routinely making plots up to 200' long.) Depending upon user requirements, other multi-width configurations could be available as options. Paper winder, manual cutter, and take-up roll are standard.

The toner reservoir holds six gallons. Concentrate adjustment is made automatically from a 32-oz bottle.

Operating voltages may be specified at 100, 115, 200, or 230 Vac  $\pm 10\%$ , at 48 to 62 Hz. Normal operating power is 1800 W; maximum is 3300 W. The units function in environmental temperatures of 32 to 105°F (0 to 40°C) and relative humidities of 10 to 95%, non-condensing.

Standard size of both plotter and printer/plotter is 32" deep, 100" wide, and 40" high. Weight is approximately 1000 lb. With extension table, depth is 117" and weight is 1150 lb.

On/off and paper advance switches as well as low paper and low toner indicators are located on a switch panel. Contrast adjustment and reset controls and online/offline switch are frame mounted.

### Price and Delivery

Plotter 4472 is priced at \$43,500; printer/plotter 4472A, at \$46,900. OEM and quantity discounts are available. Paper costs less than 2¢/sq ft. Delivery is 180 days ARO. Ver-satec, 2805 Bowers Ave, Santa Clara, CA 95051. Tel: (408) 988-2800.

**For additional information circle 199 on inquiry card.**

# NCR

## Terminal Systems Division—Cambridge

NCR's Point-of-Sale Terminal Systems Division in Cambridge, Ohio has several opportunities for computer professionals in the development of present and next generation retail terminal systems.

### RETAIL SYSTEMS ARCHITECTURE

The **Project Leader** will direct the technical functions of a group which is establishing an architecture for a series of Advanced Retail Systems. Supervise personnel in the utilization of systems discipline to determine requirements, synthesize and evaluate alternate concepts for future product systems employing advanced technologies. Candidates should have BS/MS in EE, Systems Science or Computer Science, plus 10 - 15 years experience in product development, product planning, and/or advanced development, with 3 - 5 years of this in a supervisory capacity. A strong technical background in digital systems with a balance of hardware/software assignments is essential.

Respond now to:

Robert W. Donovan  
Industrial Relations  
Terminal Systems Division—Cambridge  
NCR Corporation  
Cambridge, Ohio 43725  
Phone: 614/439-0398

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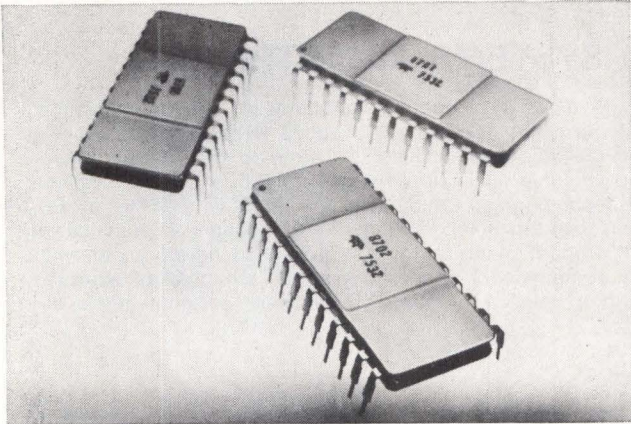
**C. Itoh Electronics, inc.**  
SYSTEMS & COMPONENTS DIVISION  
280 Park Avenue, New York, N.Y. 10017  
(212) 573-9456. Telex: WUD 12-5059

**CIRCLE 38 ON INQUIRY CARD**



# PRODUCTS

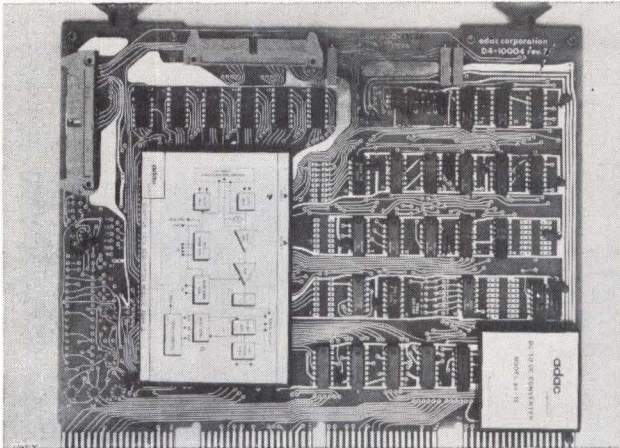
## Single-Chip CMOS A-D Converters Achieve High Accuracy with Charge-Balancing Technique



Three single-chip CMOS A-D converters, claimed to be the first truly monolithic as well as the first to use an integrating principle which provides high linearity and monotonic performance, also feature latched parallel binary outputs, for logical compatibility with processors. The devices are directly compatible with CMOS logic, low power TTL, and TTL-compatible MOS. Single-chip design makes the series economical; CMOS construction reduces power dissipation to 20 mW. Each chip contains charge-balancing circuit (op amp, comparator, and current switch); clock and clock counter, which time balancing operations and conversion cycle; data counter and parallel output latches; and control logic with start-conversion input and data-valid and busy-line outputs. Conversion cycle times are 1.25 ms for the 8-bit 8700, 5 ms for the 10-bit 8701, and 20 ms for the 12-bit 8702. Nonlinearity and relative error are specified at  $\pm\frac{1}{2}$  LSB max. Typ temp drifts are  $<10$  ppm/ $^{\circ}\text{C}$  change in zero offset and  $<30$   $\mu\text{V}/^{\circ}\text{C}$  change in gain over the  $-40$  to  $85^{\circ}\text{C}$  temp range. **Teledyne Semiconductor**, 1300 Terra Bella Ave, Mountain View, CA 94041.

Circle 200 on Inquiry Card

## Data Acquisition System Interfaces Directly With LSI-11 Microcomputer



A 16- to 64-channel, multiplexed 12-bit A-D converter system built on a quad size ( $8\frac{1}{2} \times 10''$ ) DEC-styled PC card, the 600-LSI-11 data acquisition system interfaces directly to the LSI-11 microcomputer's bus and derives power from its 5-V supply. Both software and mechanically compatible with the microcomputer, the unit has a 35-kHz channel-to-channel throughput rate. The system's multiplexer can be connected either single-ended or differentially, and can operate either in sequential or random-access mode. Its 16 multiplexer inputs are expandable to 64 single-ended or pseudo-differential or to 32 true-differential inputs. A high speed sample/hold amp serves as a buffer between multiplexer and ADC, minimizing aliasing errors and providing for digitizing of higher bandwidth signals. The 12-bit ADC uses temperature-compensated current switches and reference voltages to provide stable operation over a wide temp range; LSI circuitry minimizes part count. Four jumper-selectable input voltage ranges ( $\pm 5$ ,  $\pm 10$ , 0 to 5, and 0 to 10) are std. An optional software-programmable gain amp allows the computer to select one of four gain settings for any input channel over a 10 to 1 range. **Adac Corp**, 118 Cummings Pk, Woburn, MA 01801.

Circle 201 on Inquiry Card

## Matched Terminal Units Form Remote Data Processing System



Consisting of matched video data terminal, printer station, and local and remote multiple control units, the Transdata 810 can be connected to Unidata 7000 series systems or to the company's System 4004. Control units concentrate data traffic from individual stations before forwarding it to the processing system, allowing std telephone lines up to 2-km long to serve as links between control unit and data station. The control unit also handles traffic between video terminals and printer stations. Any combination of up to 32 model 8161 terminals and/or 8121 printers or 8112 printer stations can connect to the multiple control unit. Local terminals connect via the model 8170, remote units through the 8171, and can transmit at 230,400 and 19,200 bits/s, respectively. The video terminal displays up to 1920 char on 24 lines of 80 char, and provides both formatted and unformatted operation, as well as cursive, dimmed, or flashing display. The printer operates at 180 char/s, using a 7 x 7 mosaic needle-type head, and can be directly connected to a terminal. The printer station version has a 3584-byte capacity data store, and can function as a central output printer when used with several terminals connected to a multiple control unit. **Siemens AG**, D-8520 Erlangen 2, Postfach 3240, Federal Republic of Germany. Circle 400 on Inquiry Card



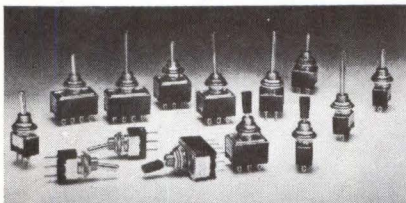
## PRODUCTS

### 5-V LOGIC POWER SUPPLIES

RD5-15/OVP, RE5-23/OVP, and RG5-40/OVP provide 5 V at 15 A, 5 V at 23 A, and 5 V at 40 A, respectively. Typ efficiency is rated at 60% at full load, and as high as 66% at reduced current levels. Multiple ac-input taps optimize efficiency, or obtain wider ac input ranges for extended low line "brown-out" operation. Std features include built-in overload and overvoltage protection,  $\pm 0.02\%$  regulation, and remote sensing. Max ripple is 1.5 mV pk-pk, while transient response is specified at 30  $\mu$ s for a 50% load change. **Power-One, Inc.**, 531 Dawson Dr, Camarillo, CA 93010.

Circle 202 on Inquiry Card

### MINIATURE TOGGLE SWITCHES

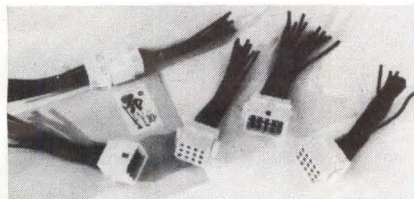


Series 31 with std toggles, 32 with long toggles, and 33 with decorative flat plastic caps each consists of 20 basic models, with either solder or PC terminals; several momentary actions are also available. Rated at 6 A, 125 Vac, switches feature mechanical life of 100,000 cycles at no load and electrical life of 25,000 to 50,000 cycles with specified voltage and current applied, at 12 cycles/min. Contact resistance is 10 m $\Omega$ , dielectric strength is 1300 Vac, and insulation resistance is 100 M $\Omega$  min. **Oak Industries Inc, Switch Div**, Crystal Lake, IL 60014.

Circle 203 on Inquiry Card

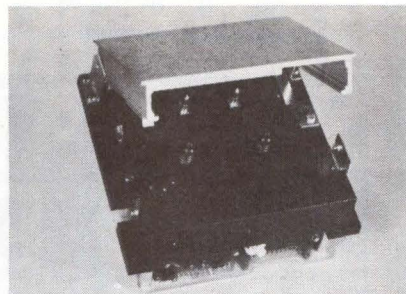
### HARD SHELL PLUG AND RECEPTACLE CONNECTOR

Thrift-Mate, a UL-/CSA-approved device, is designed for cable-to-cable, free-hanging, or panel-mount applications. Available in 1-, 3-, 9-, 12-, or 15-contact position configurations, contacts are produced in strip form for automatic or semiautomatic crimping of wires to terminals. Connector features 0.093" dia pin and socket, crimp-removable contacts for 16- to 24-AWG wire. Easy insertion/removal of contacts is also featured. **Malco, a Microdot co.**, 12 Progress Dr, Montgomeryville, PA 18936.



Circle 204 on Inquiry Card

### DIGITAL CASSETTE TAPE TRANSPORT



Model CD-200, featuring "Accu-Rate" speed control, requires only one 14- to 30-Vdc supply (115 Vac optional). Device has bidirectional read/search speeds and TTL-compatible inputs and outputs, and may be remotely controlled. Rapid start/stop provides <0.5" inter-record gaps and results in more data on less tape. Fingertip release simplifies cassette insertion/removal. The transport is silent and virtually jam free. **Braemar Computer Devices, Inc.**, 11950 Twelfth Ave S, Burnsville, MN 55337.

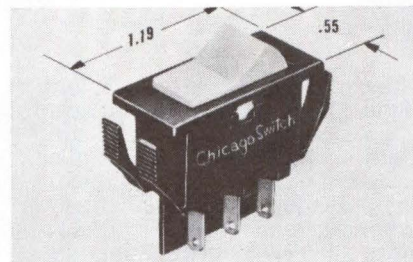
Circle 205 on Inquiry Card

### HAND-HELD OCR READER

Automatically reading alphanumeric data printed in a special OCR "Type A" font, the model 720 OCR wand reads, edits, and transmits data to a POS terminal. Consisting of a hand-held module, which scans machine-printed char and converts optical characteristics to electrical signals, and an electronic module which uses the electrical signals to identify char, reconstruct and verify the original sequence of char, and generate input for the POS terminal, the wand is compatible with and can be interfaced to the company's 902, 909, 910, 925, 930, and 931 POS terminals. **The Singer Co, Business Machines Div**, 30 Rockefeller Plaza, New York, NY 10020.

Circle 206 on Inquiry Card

### DPDT ROCKER SWITCH



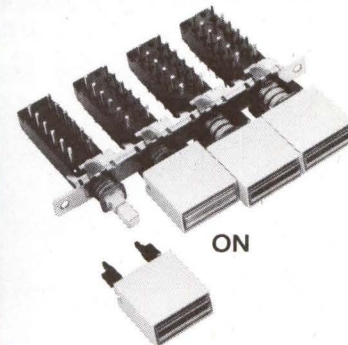
Supplied in a package no larger than the company's single-pole version, dpdt switch is designed for applications where reliable switching and small size are required. Featured are snap-in type panel mounting and a choice of colors. A wide variety of circuits meets UL specs. Terminals are solder or slip-on types. Contacts are rated 6 A inductive at 125 Vac. Heavy-duty or dry-circuit contacts are also available. **Chicago Switch, Inc.**, 2035 Wabansia, Chicago, IL 60647.

Circle 207 on Inquiry Card



When it's  
your move  
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### Visual display



### in a non-lighted pushbutton switch

Now you can add visual display to Centralab non-lighted pushbutton switches. Our new status indicator button with a unique fluorescent reflective surface operates with ambient light to indicate switch status when activated. No power is required. There are no lamps to burn out.

Other features include:

- Choice of 6 display colors, 3 lens options and 5 button colors.
- Available with push-push or interlocking action.
- 140° peripheral viewing angle.
- Vertical or horizontal button mounting.

See your Centralab Pushbutton Distributor or send inquiry card for complete specifications.

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# THE MORE YOU KNOW ABOUT PUNCHED TAPE EQUIPMENT, THE BETTER YOU READ US.



Maybe we haven't been visible quite as long as some of the other guys but that can be an advantage too. For example, the light source in our readers is state-of-the-art fiber optics. It's superior to LED's and you'll even find it in our least expensive reader. (Which incidentally is the least expensive reader on the market.) Some competitors are just switching to fiber optics. We introduced it long ago with our first reader.

Another Decitek advantage is the simplicity of design, which makes it easy to adapt our equipment to specific OEM requirements. And because Decitek is an aggressive little outfit we'll go out of our way to accommodate you and your needs. Now go ahead and ignore us if you can.

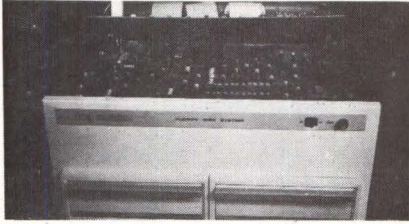
## DECITEK

250 CHANDLER STREET, WORCESTER, MASSACHUSETTS 01602, U.S.A. (617) 798-8731



## PRODUCTS

### FLOPPY DISC SYSTEM

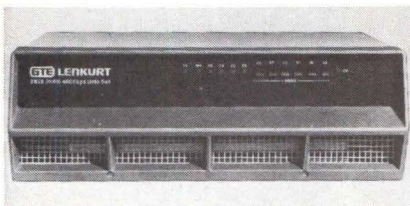


Serial RS-232 ROM programs allow the series 62 Intelligent Floppy Disc to operate as a terminal page storage system or on-line disc storage system. The IBM-compatible disc has 77 tracks and 26 sectors of 128 bytes each. Avg access time is <math><0.5\text{ s}</math> to any sector or page. The online RS-232 program accommodates up to eight disc drives by specific address; the terminal-oriented program by added page numbers. Page capacities are selectable in multiples of 128 char. **Applied Data Communications**, 1509 E McFadden Ave, Santa Ana, CA 92705. Circle 208 on Inquiry Card

### LOW PROFILE PROGRAMMABLE SWITCH

This low-profile version of programmable-in-line package ("PIP") switches provides total security once the switch is set. Since the rocker arms are flush with the top surface of the switch, they cannot be accidentally tripped or actuated, and can easily be sealed prior to board immersion. Height above PC board is 0.265"; red markers are available for positive identification. **RCL Electronics Div of AMF Inc**, 700 S 21st St, Irvington, NJ 07111. Circle 209 on Inquiry Card

### 4800-BIT/s DATA SET



Enabling dial-up direct access to the switched (DDD) telephone network for data transmission, the 262B transmits and receives synchronous, serial binary data in either simplex or half-duplex modes over 2-wire lines. End-to-end compatibility and electrical interchangeability are provided with Western Electric type 208B data sets; the set also conforms to EIA Std RS-232-C and to CCITT Recommendation V.24. Automatic adaptive equalization continuously compensates for delay and amplitude distortion introduced by the transmission facility. **GTE Lenkurt Inc**, 1105 County Rd, San Carlos, CA 94070. Circle 210 on Inquiry Card

### MOS/LSI TEST CIRCUITS

CMOS (metal-gate), p-channel (sato-planox), Si-gate, or charge-coupled device ( $3\phi$  polysilicon or tungsten) types are intended to obtain "hard" electrical probing information from a vendor's wafer process for use in subsequent MOS/LSI circuit design. Test patterns allow evaluation of p- and/or n-channel transistors for gate and field threshold voltages, source/drain breakdown voltage, and transistor gain characteristics. Test structures allow characterizing in-process sheet resistances, diffused diode characteristics, and capacitances. **Mosfet \* Micro \* Labs, Inc**, Penn Centre Plaza, Quakertown, PA 18951.

Circle 211 on Inquiry Card

### MODULAR MINICOMPUTER SYSTEMS

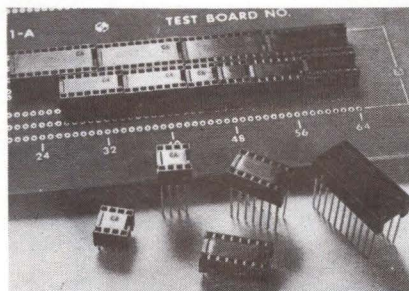


A modular system providing 16 kilobytes of core memory, three cassette drives, and a console keyboard/printer, basic model 140 Minicomputer Systems are expandable to include up to 64 kilobytes of memory, four disc drives (storing 40 million char), 200- to 600-line/min. printers, and multiple input stations (CRTs or keyboard printers). Communications controllers are available, and the system accommodates up to eight remote terminals or CRTs. **Anderson Jacobson, Inc**, 1065 Morse Ave, Sunnyvale, CA 95050.

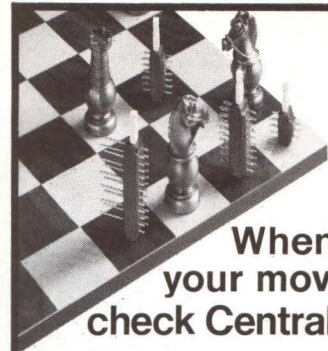
Circle 212 on Inquiry Card

### END-STACKABLE DIP SOCKETS

Featuring end- and side-stackable insulator bodies, the DIP sockets maintain 0.1" center from one to the next in either direction, allowing a continuous-strip socket without loss of grid points on the PC board. Available in 8-, 14-, 16-, and 22-pin models, the devices can be provided with solder-tail, 1-, 2-, or 3-wrap-post length contact pins. Contacts are phosphor-bronze leaf spring; plating is 0.00001" gold over 0.00005" nickel. Individual socket openings are 0.02 x 0.03". **Circuit Assembly Corp**, 3169 Red Hill Ave, Costa Mesa, CA 92626.

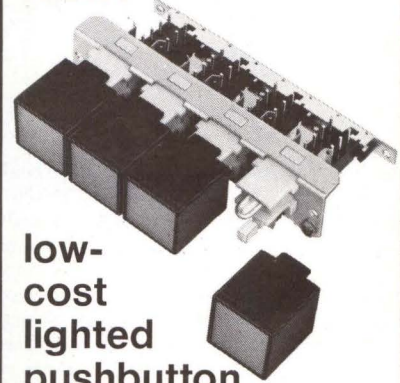


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When it's  
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NEW!



low-  
cost  
lighted  
pushbutton  
switch

Centralab reliability, low cost and new design freedom can be yours in this new lighted switch. Its T1-3/4 wedge base lamp brings the price way down\*. Its many options make it easier than ever to achieve an aesthetically harmonized panel. You get features like these:

- Flat, concave or recessed lenses with uniform light diffusion.
- Eight lens colors.
- PC terminated independent lamp circuit.
- 15mm, 17.5mm or 20mm. spacing options.
- Ganged assemblies through 16 stations.

See your Centralab Pushbutton Distributor or send inquiry card for complete specifications.

\* Per station cost at 1000 pieces, \$1.36  
...2 PDT switch includes bulb.

Isostat Licensed



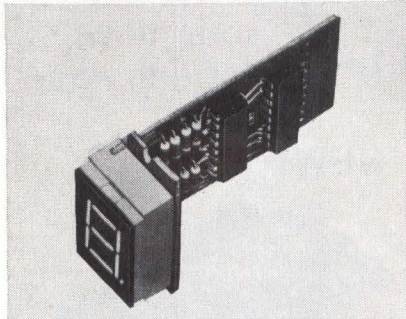
CENTRALAB

Electronics Division  
GLOBE-UNION INC.  
P.O. BOX 858  
FORT DODGE, IOWA 50501



## PRODUCTS

### LED READOUT



Offering a 0.625" LED readout with latch, decoder/driver, and decimal, the 730-0018 consists of a GaAsP LED mounted on a PC board complete with all necessary current-limiting resistors, decoder/driver, and latch. The display features a bright red, highly legible char in a 7-segment format, and is virtually immune to shock and vibration. Four lines in a BCD code are required, which are transferred and decoded when the clock is high. Terminals on the PC board allow automatic blanking on trailing or leading zeroes. **Dialight, a North American Philips co**, 203 Harrison Pl, Brooklyn, NY 11237. Circle 214 on Inquiry Card

### 2-POLE SWITCH

Previously available only in single-pole configuration, a 2-pole, N.O. version has been added to the 05 pushbutton series. With identical package size (0.625" sq panel cutout, 1.216" behind panel), both versions offer optional PC and 0.11 QC terminals in incandescent and non-lighted display. Switching contacts are bifurcated, silver plate. Electrically rated at 0.25 A, 125 Vac, the series offers switch life of 500,000 cycles at logic-level loads. Low contact resistance, bounce, and noise ease interfacing. **Licon, div Illinois Tool Works Inc**, 6615 W Irving Park Rd, Chicago, IL 60634. Circle 215 on Inquiry Card

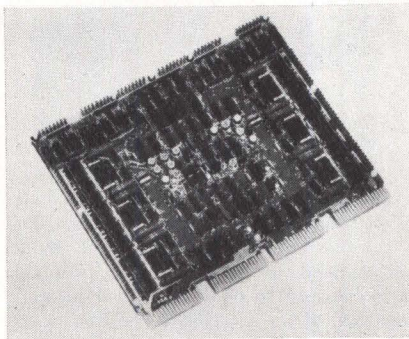
### DATA CONVERSION SYSTEM MODULAR POWER SUPPLIES

Line of supplies meeting requirements of A-D and D-A systems includes four dc-dc converters providing 1-, 2-, and 3-output configurations from 5-Vdc inputs or other input voltages; eight ac-dc miniature modules with one, two, and three outputs from ac power line; and three ac-dc high power supplies in three modules with from two to four outputs, including 180 Vdc for displays. Features include broad bandwidth output-impedance characteristics. **Analogic Corp**, Audubon Rd, Wakefield, MA 01880. Circle 216 on Inquiry Card

### MOS p/ROM PROGRAMMERS

Models MM5203 and 1702A, offering read/modify/write or copy/verify modes, provide fast, uniform programming while maintaining reliability, interactive programming, and simple operation. Reading the DUT after each program pulse, and storing the number of pulses that are required for it to read programmed (X), and then overprogramming it four times X (1702A) or 3 times X (5203), the technique assures that overprogram charge is sufficient to maintain data to manufacturer's specs. Typ programming time is 2 or 4 min., respectively. **Prom Programmers, Inc**, PO Box 4608, Mountain View, CA 94040. Circle 217 on Inquiry Card

### ADD-IN MEMORIES

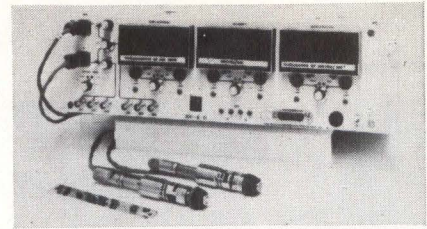


DR-118 and -118/A single-board core memory systems for use with DEC PDP-8 minicomputers are Omnibus™ compatible and can be inserted directly into the backboard of the host machine. -118 is compatible with the PDP-8/E, /F, and /M; -118/A with the PDP-8/A-400 and -500. Both are available in either 16K x 12 or 8K x 12 configurations. Systems occupy only two card slots: one for interfacing to the backboard, the other for clearance of the core memory stack which plugs into the back of the memory module. **Dataram Corp**, Princeton-Hightstown Rd, Cranbury, NJ 08512. Circle 218 on Inquiry Card

### PRODUCTION LINE TEST EQUIPMENT

MITE (mighty integrated test equipment) features an automatic-probe walk-back software package, which includes sync pulses for oscilloscope triggering, execution limits for controlled looping, and an optional comparison technique for hard-to-find dynamic failures. Also provided are stored response testing, interactive program generation, low skill-level troubleshooting, program verification aids, high speed static RAM test execution, 16-bit x 16K-word minicomputer, interactive CRT, floppy disc or magnetic cassette storage, ASR 33 TTY, full hardware capability, and simultaneous go/no-go testing and program generation. **Digital General Corp**, 11000 Cedar Ave, Cleveland, OH 44106. Circle 219 on Inquiry Card

### DYNAMIC ANALYZER



The dual-channel, Metri-Gap<sup>®</sup> 300-6D makes measurements to one-millionth of an inch at a rate of >10 kHz. The std unit provides digital displays for displacement, velocity, and acceleration, and two input channels that may be read individually to study surface characteristics, or in combination to measure thickness, taper, wobble, or runout. Output on direct reading is 1 V/mil; on velocity, 1 V/in./s; and on acceleration, 1 V/1000 in./s<sup>2</sup>. Low pass filters are provided for both velocity and acceleration. **Lion Precision Corp**, 60 Bridge St, Newton, MA 02158. Circle 220 on Inquiry Card

### TIME DELAY RELAY

Featuring fixed time-delays from 0.5 to 60 s only, the 115 Vac, series MCR offers spst relay output in N.C. or N.O. configurations. Relay contacts are rated at 5 A or 1/6 hp at 120 Vac. Repeat accuracy under fixed conditions is ±5%; time tolerances of ±10 and ±20% are available. Electrical interface consists of four 1/4" male quick-connect terminals. Expected mechanical life of the timer is 1,000,000 operations; 500,000 under full load conditions. **Omnetrics, Inc**, PO Box 113, Syracuse, NY 13211. Circle 221 on Inquiry Card

### BADGE AND PUNCHED/MARKED CARD READERS



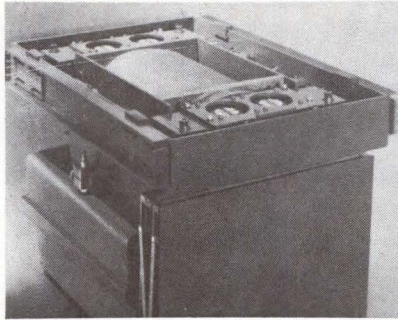
Derived from a "basic work station" that accepts both 22-col employee identification badges and any punched and/or marked cards up to 80 col, interchangeably, the family includes the basic 020-1, a combination badge/card reader that includes cabinet and power supply, and the 020-4, which includes a digital clock for time display and time of data entry recording and eight lever-wheel switches used for entering additional variable information. Units are available as standalone or component devices with bare mechanisms and electronics. **True Data Corp**, 2701 S Halladay, Santa Ana, CA 92705. Circle 222 on Inquiry Card



### RECEIVE-ONLY TELEPRINTER

This self-contained, low-noise, 30-char/s RO unit with built-in service diagnostics is mechanically simple but controlled by a microprocessor and sophisticated electronic circuitry. Selectable online, type choices include u/lc or expanded or boldface char and underlining. Continuous short-line printing needs no fill char. Optionally available are 103, 108, or 113 type built-in modems; selective calling for most 5-/6-/8-level procedures; 20-char answerback; page formatting; and national alphabet or special-char sets. **Extel Corp**, 310 Anthony Trail, Northbrook, IL 60062.  
Circle 223 on Inquiry Card

### HEAD-PER-TRACK DRUM MEMORY



Specifically designed for use in demanding environments, the 3020 contains pretested ceramic ICs, JANTX diodes and transistors to assure approx 15,000-hr MTBF. A freedom-of-movement mounting system provides 2½ to 3 times greater resistance to operating shock and vibration. The unit is sealed and pressurized with nitrogen to isolate the head/media system from contamination. Other features include a rugged cast aluminum housing, failsafe head actuation system to eliminate potential media damage in contact start/stop systems, and capacities of up to 37.9 megabits. **Vermont Research Corp**, Precision Pk, North Springfield, VT 05150.  
Circle 225 on Inquiry Card

### POWER CONVERSION MODULES

Converting 28-Vdc input power to 25, 50, or 100 W of regulated ±15-Vdc power, BBN15A series dual-output modules are capable of operating over the full -55 to 100°C military temp range. Dc input voltages are regulated to 0.5% over the full 20- to 32-Vdc input range. Load regulation is 0.5% for no load to full load at constant input voltage. PARD (ripple and noise) is 25 mV rms, 10-mV pk-pk over the 25 to 100°C range. Tempco is specified at 0.03%/°C. **Abbott Transistor Laboratories, Inc**, 5200 W Jefferson Blvd, Los Angeles, CA 90016.  
Circle 226 on Inquiry Card

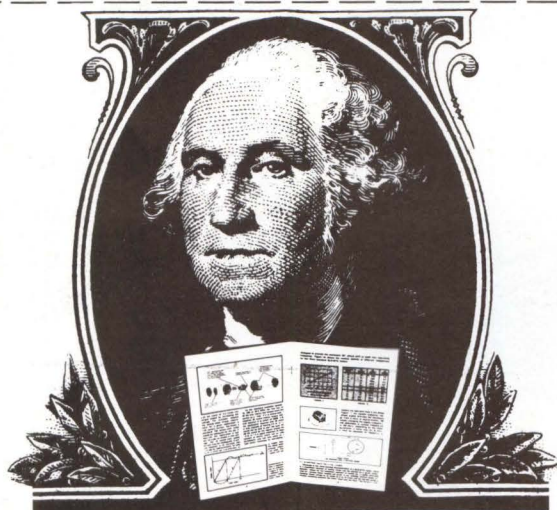
### SMALL SOLID-STATE RELAY

With load-switching capability of 0.1 to 4 A at 120 or 240 Vac at 25°C, the Power Cube measures 1 x 1.2 x 0.85", and is designed to PC mount with the terminals on a 100-mil grid. No additional heat sinking is required for the 4-A load rating. The control circuit of the relay is compatible with logic circuitry operating on 3 to 15 Vdc with a current range of 2 to 9 mA. A second version operates with a control voltage of 14 to 30 Vdc with currents of 3 to 8 mA. **Grayhill, Inc**, 561 Hillgrove Ave, La Grange, IL 60525.  
Circle 224 on Inquiry Card

### MULTIFUNCTIONAL CONTROLLER

Available in MAXI400, MINI400, and MICRO-400 configurations, the Data Controller System 400 operates as a small station controller handling a few terminals up to a huge multidrop controller handling 1000 terminals, and can be used as cluster controller, data concentrator, message switcher, communications controller, front end, or data multiplexer in both real-time or store and forward mode. **Norfield Electronics, Inc, Data Communications Div**, 3 Depot P1, East Norwalk, CT 06855.  
Circle 227 on Inquiry Card

# LET'S TRADE.



Here's our proposal. You send us this coupon clipped to your letterhead or use the reader service number. We'll send you our new design engineer's guide to SLO-SYN® d-c stepping motors. It's worth about a dollar. The ideas in it are worth thousands. Could be the best trade you've ever made.



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ANALOG SERIES No. 2

## AT LAST: HIGH-CURRENT REGULATORS WITH SHORT CIRCUIT PROTECTION.

You've asked for high power capability requiring fewer external parts. Our field-proven 7800 series delivers. Unique voltage regulators with short circuit protection that really works. 7 voltages from 5-24V; TO-220 or TO-3.

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CIRCLE 42 ON INQUIRY CARD

115



## PRODUCTS

### MINIATURE HIGH VOLTAGE CIRCULAR CONNECTOR

With an overall outside dia of  $<1.25$ ", this 7-pin connector safely carries 15 kVdc at 7.5 A/line through a full range of mil environmental requirements. 20-gage, gold-plated contacts are deeply recessed and fully shrouded for safe handling. Glass-filled epoxy silicone rubber interface provides positive sealing, and rib-and-groove polarization prevents mismatching. Connector is available in metal-shelled versions for RFI shielding, and the hermetically sealed receptacle can be provided with either solder-flange or "O"-ring mounting. **AMP Inc, Capatron Div, Elizabethtown, PA 17022.**

Circle 228 on Inquiry Card

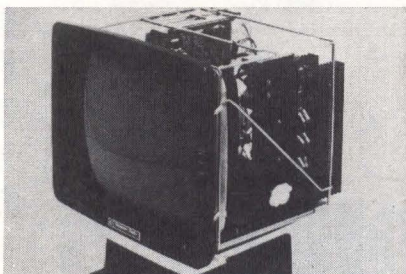
### ELECTRIC KEYPUNCH FOR PLASTIC ID BADGES

Heavy-duty devices for punching Hollerith-type rectangular holes in paper or plastic IBM-size cards or other cards designed to be read by contact or photoelectric static card readers, 2611-00 and 2621-00 are electrified versions of the company's 2610 and 2620. The 2611-00 encodes std 20-col type 2 and 51 credit cards with up to 240 punch positions; 2621-00 encodes  $3\frac{1}{4}$ " high cards and widths such as 22-col type 3, 4, and 5 ID/badge cards with up to 264 punch positions. Both models punch cards up to a nom thickness of 0.04". **Wright Line, div of Barry Wright Corp, 160 Gold Star Blvd, Worcester, MA 01606.**

Circle 229 on Inquiry Card

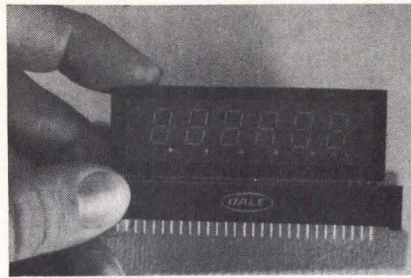
### CRT DISPLAY UNIT

Providing high resolution for alphanumeric displays, graphics, and security systems, where 1000-line resolution and quality images are required, model CO:8277 incorporates a 15" display in a compact pedestal-mounted design that is easily tiltable for operator convenience. Synchronization circuits accept TTL logic for simplicity and permit operation without composite synchronization. Solid-state design and PC boards provide easy maintenance access and reliable operation. **Computer Optics, Inc, Berkshire Industrial Pk, Bethel, CT 06801.**



Circle 230 on Inquiry Card

### GAS DISCHARGE NUMERIC PANEL DISPLAYS



Compatible with most high voltage drive systems, two basic models—for clock and instrument use—are available with 0.4" high, 7-segment digits. Displays operate at low power per digit, providing greater brightness and good readability at a low per-digit cost. Constructed using thick-film technology, panels are designed for operation in multiplexed mode. Like segments of each digit are internally bused, reducing external connections and improving reliability. **Dale Electronics, Inc, Display Dept, Box 609, Columbus, NB 68601.**

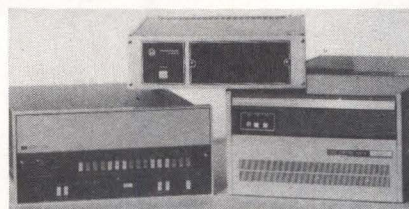
Circle 231 on Inquiry Card

### HIGH DENSITY DIP BOARDS

Incorporating three separate planes on a std double-sided board due to the layout of the copper pattern, the DIP boards contain two voltage planes on the wiring side, and a ground on the component side to reduce noise. All boards are made of G10FR4 epoxy glass, and are available 4.5 x 6.5" with 22/22 contacts on 0.156" centers; 4.5 x 9.6" with 22/22 contacts on 0.156" centers; and 4.5 x 6.5" with 36/36 contacts on 0.1" centers. The 4.5 x 6.5" versions accept a max of 34 14- or 16-pin DIPs. **Vero Electronics, Inc, 171 Bridge Rd, Hauppauge, NY 11787.**

Circle 232 on Inquiry Card

### MINICOMPUTER DISC SYSTEM



Featuring 225-megabyte capacity and 1.2-megabyte/s transfer rate, the MSM-10X High Density Disc Storage System supports up to four disc drives in the std configuration and can be expanded to handle up to 15 drives for capacity of 15 to 4500 megabytes per controller. Heart of the system is a microprogrammed controller, on a 12 x 15" PCB, that is integrated with the host computer's operating system. Features include automatic self-test of both controller and disc, built-in maintenance panel, and controller-resident diagnostics. **Microcomputer Systems Corp, 3068 Kenneth St, Santa Clara, CA 95050.**

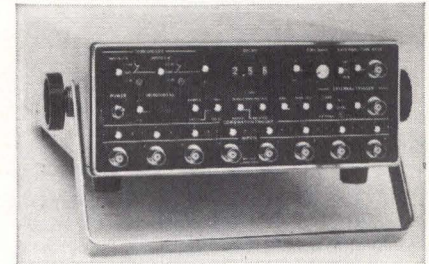
Circle 233 on Inquiry Card

### MODULAR SWITCHING POWER SUPPLIES

The SSD series covers the voltage spectrum from 1.8 to 56 V in 10 models. With overall case and mounting dimensions that are identical to other switching models in the company's line, the devices provide a 25% increase in available output power, a 35% reduction in weight, and 25-W less internal heat dissipation. As a result, the efficiency of conversion at 5-V levels has been increased to 76%. **Sorensen Co, 676 Island Pond Rd, Manchester, NH 03103.**

Circle 234 on Inquiry Card

### LOGIC ANALYZER

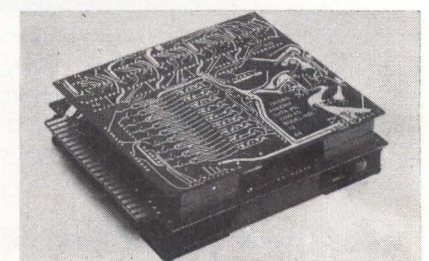


The model 20D LOGISCOPE™, a compact logic analyzer, which provides "snapshot" capture of up to eight different data channels via std BNC-input connectors, allows precise setting of triggers, thresholds, latches, and sweep modes for recording digital data streams with most oscilloscopes. Pre-trigger record mode records up to 256 sample bits before trigger; delay mode allows selectable postponement up to 9990 samples after trigger. Sample settings may be adjusted from 50 ms to 50 ns via front panel controls. Latch capability permits selectable 10 or 100 ns anomalies to be detected. **BP Instruments, Inc, 10601 S Saratoga/Sunnyvale Rd, Cupertino, CA 95014.**

Circle 235 on Inquiry Card

### A-D CONVERTER

ADC1215 has total conversion time of 10  $\mu$ s, resolution of 1 part in 32,767, accuracy of 0.0065%, and can make 100,000 conversions/s. A single foldback technique is used in conjunction with successive-approximation conversions to achieve an equivalent conversion rate of 667 ns/bit. The high impedance analog input circuit accepts a full range  $\pm 10$ - or  $\pm 10.24$ -V signal with optimum system isolation. The analog input can be connected in either single-ended or differential configuration. **Phoenix Data, Inc, 3384 W Osborn Rd, Phoenix, AZ 85021.**



Circle 236 on Inquiry Card



## CASSETTE WORD PROCESSOR

Recording typed material on self-contained magnetic tape Philips cassettes, the WP-80 automatic typewriter allows typists to easily and quickly correct errors, edit, add, or delete material, then rerun the tape to produce an error-free document at 175 words/min. The system uses a heavy-duty IBM Selectric or Selectric II typewriter, combined with a desk module that acts as the information storage, editing, and retrieval unit. Std features include dual cassette decks, and ability to communicate, reverse edit in the modes, and bidirectional search. **International Computer Products, Inc.**, 2925 Merrell Rd, Dallas, TX 75229.

Circle 237 on Inquiry Card

## FLOPPY DISC KIT

Consisting of a single 12.5 x 17.5" PCB disc controller and from one to three SA-800 diskette drives in optional single or double density, the SA8800 "Streaker" kit allows users to add their own cabinet, std power supply, and interface. Controller board handles up to six drives in IBM 3740 format (3.2 megabits/drive) or in double-density format (6.4 megabits/drive), performing all required functions including formatting, serializing/deserializing, seeking, and error detection. **Shurgart Associates**, 435 Indio Way, Sunnyvale, CA 94086.

Circle 238 on Inquiry Card

## CMOS LARGE SCALE READOUT

CMOS-level compatible, series N-10MI readouts with 5" high digits come complete with BCD interface electronics. Series N-10CC digital clock displays provide a ni-cad battery for power failure back-up, power-failure alert indicator, 60-Hz line or ultra-stable input for timing accuracy, and alternate input for display of auxiliary information. In addition, a master clock may be used to drive as many as 25 slave units at distances of >200 ft. **Digilite Corp.**, 91 Rome St, Farmingdale, NY 11735.

Circle 239 on Inquiry Card

## SINGLE-CHANNEL-PER-CARRIER EQUIPMENT

Based on SPADE channel unit technology, equipment designed for INTELSAT earth-station owners carries voice, telegraphy, or wideband data using SCPC techniques. One type has fully redundant common equipment capable of supporting up to 60 channel units at any given site. Initial rack is also equipped with trays wired for up to 12 channel units; subsequent expansion is in racks of 12 channels each. The second, more modest style is a standalone channel unit, with each unit self-sufficient and the common-equipment rack eliminated. **Digital Communications Corp.**, 19 Firstfield Rd, Gaithersburg, MD 20760.

Circle 240 on Inquiry Card

## GLARE-SUPPRESSANT FILTERS

Contoured optical filters for eliminating reflections and improving contrast and visibility of color or monochrome video images are formed to the exact shape and size of CRTs at a cost substantially lower than that of non-glare glass faceplates. They are thermo-formed of mar-resistant Chromafilter<sup>®</sup>—a high resolution optical filter material developed for illuminated electronic readout displays. Produced on existing tooling to fit std JEDEC tube sizes, filters can be supplied with a clear adhesive on the inside perimeter for easy retrofitting of data terminals or other video systems. **Panelgraphic Corp.**, 10 Henderson Dr, West Caldwell, NJ 07006.

Circle 241 on Inquiry Card

## PLASTIC POWER SWITCHING TRANSISTORS

Line of npn, medium power, plastic transistors designed and characterized for switching power supply applications, series UPTA through UPTE are available in TO-92 and -202 packages. Ratings for -92 types are from 0.1 to 1 A and to 500 V. Units in the -202 package are available with collector currents from 1 to 5 A and voltages to 300 V. Fall times are under 200 ns typ and  $f_T$  is >20 MHz. All devices have typ dc-current gains of 40 to 50 at normal operating currents. **Unitrode Corp.**, 580 Pleasant St, Watertown, MA 02172.

Circle 242 on Inquiry Card



## The beauty is more than skin deep.

Introducing the first low cost digital cassette subsystem that's pretty on the outside and downright beautiful on the inside where it counts. Precision performance with the flexibility to serve as a read/write or read-only memory, baud rate multiplier or terminal text/data buffer.

Bidirectional file skip, selectable baud rates and simultaneous RS-232C/20MA loop interfaces are built-in standards, not extra-cost options. Our CT-103 is ready to plug in and simple to use.

The CT-103 was designed and built for long life and error-free operation by KYBE—the #1 name in magnetic media maintenance. More than a decade of tape handling experience went into making the CT-103 the best (as well as the most beautiful) digital cassette subsystem on the market today. Find out for yourself. Contact:



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Tel. (617) 899-0012, Telex 94-0179

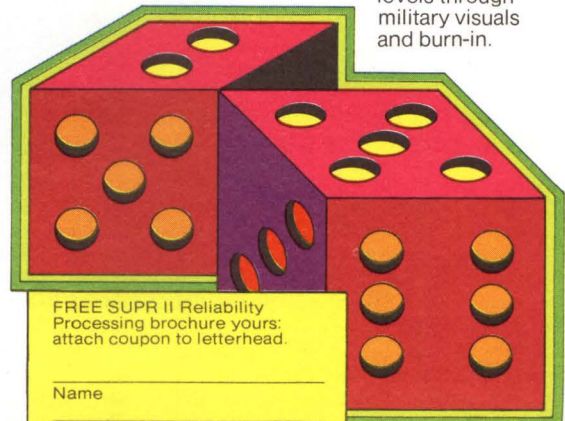
Sales Offices  
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Chicago—(312) 658-7391  
Houston—(713) 524-3111  
Los Angeles—(213) 980-8365  
New York—(212) 594-9273  
Wash., D.C.—(703) 527-2292

CIRCLE 43 ON INQUIRY CARD

## CAPABILITY SERIES No. 1

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CIRCLE 44 ON INQUIRY CARD

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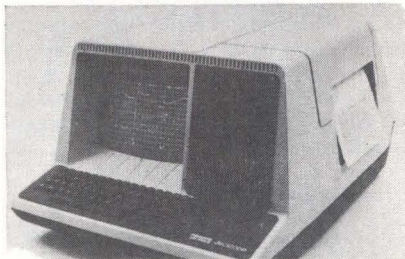


## PRODUCTS

### THUMBWHEEL SWITCHES

Type B-5575 is for applications where 10- to 12-position units are inadequate. Depending on requirements as to decimal or other coded output, number of positions, current level carried or broken, breakdown voltage, or life, either PC or separate silver alloy contact construction is available. Using PCs, a 36-position, 7-bit ASCII II coded output is available; using separate silver alloy contacts, single-pole, 36-position, shorting, and 2-pole, 32-position, shorting, decimal output units to make/break 1 A, 115 Vac resistive load are offered. **Tech Laboratories, Inc.**, Bergen & Edsall Blvds, Palisades Park, NJ 07650. Circle 243 on Inquiry Card

### INTERACTIVE GRAPHICS TERMINAL

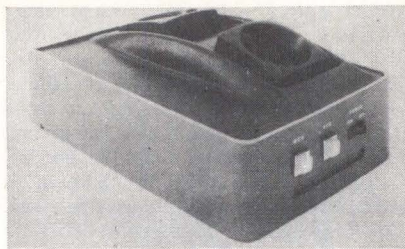


The VT55 DECgraphic scope with optional integrated hardcopy output unit is designed for compatibility with any computer processor. The unit provides interactive graphics with up to 1024 data points, 512 x 256 resolution. Graphic cursors can be used for marking portions of a graph. Horizontal and vertical lines can be displayed for constructing background grids. The terminal provides 24 lines of 80 char, editing cursor, and std ASCII communications at up to 9600 baud. **Digital Equipment Corp., Laboratory Data Products Group**, Maynard, MA 01754. Circle 244 on Inquiry Card

### MODEMS WITH ASYNCHRONOUS TERMINAL INTERFACE BUFFER

To prevent loss of data when high speed asynchronous terminal speeds are not identical, the asynchronous-to-synchronous interface buffer option on the company's medium to high speed modems converts the terminal's serial data stream to parallel words and stores the data in a 48-bit memory buffer. Output section of the buffer then accesses the memory and shifts the words out serially under control of the modem clock signal. Should the modem run faster than the terminal, the buffer inserts extra stop bits into the data stream to compensate for the difference in total bit throughput. **Tele-Dynamics, div of Ambac**, 525 Virginia Dr, Fort Washington, PA 19034. Circle 245 on Inquiry Card

### 1200-BAUD ACOUSTIC COUPLER



Intended for use with remote data entry and retrieval systems, the 1200A interfaces with Bell's 202C reverse-channel modem over the switched telephone network. It can be used in either the acoustic mode, where portability is required, or with a Data Access Arrangement in permanent installations. In normal mode, line control is established via RS-232 signals originated from the remote terminal; in automatic, line control is established by intelligence within the unit. **Omnitec Corp.**, 2405 S 20th St, Phoenix, AZ 85034. Circle 246 on Inquiry Card

### LOGIC BOARD TEST SYSTEM

Featuring both analog and digital capability plus in-circuit component testing, 1024H is intended for high speed functional testing/troubleshooting of PC assemblies during prototype design, production testing, and depot repair. Common failures are rapidly identified by probe control software. Time-sharing capability allows the system's control station to accommodate two work stations, both of which may be operated simultaneously, with each station performing a different task or testing different cards. **Hughes Aircraft Co., Industrial Products Div.**, 2020 Oceanside Blvd, Oceanside, CA 92054. Circle 247 on Inquiry Card

### p/ROM PROGRAMMER

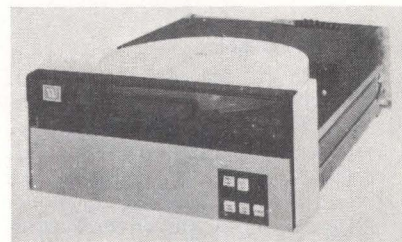


Available to users of the company's MicroPac 80 or 80/A development microcomputers, PB1000, packaged in a self-contained desktop enclosure, can program one p/ROM chip at a time from RAM, or make a duplicate of another p/ROM chip. A complete burning operation typically requires 2 min. The control program can see that each byte of a p/ROM has not already been burned. If it finds a byte that has been burned, it prevents the program from burning the p/ROM and, instead, prints the address and present contents for the first p/ROM byte already burned. **PCS, Inc.**, 5467 Hill 23 Dr, Flint, MI 48507. Circle 248 on Inquiry Card

### EDGEBOARD CONNECTORS

Series SAW 0.156"-center connectors are available with wirewrap terminations in choice of 10/20, 15/30, 18/36, and 22/44 pairs of contacts, and are 0.3" wide; series P9000 devices come with wirewrap or clip-wiring terminals (0.062 x 0.031) in 10/20, 15/30, 22/44, and 30/60 contact configurations and measure 0.36" wide. Connectors are rated at 5 A; op temp range is -55 to 105°C. Insulator material is either black Valox or glass-filled nylon, type 6/6. **Stanford Applied Engineering, Inc.**, 340 Martin Ave, Santa Clara, CA 95050. Circle 249 on Inquiry Card

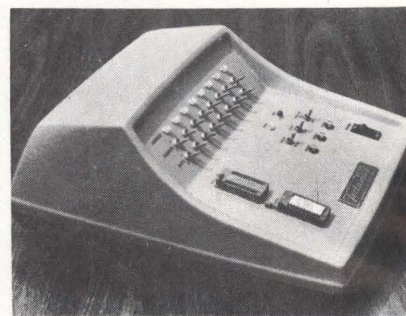
### CARTRIDGE DISC DRIVES



Super Series drives feature front-loading (2315-type) and top-loading (5440-type) models, using removable disc cartridge and an internal fixed disc, and provide capacities from 2.5 to 25 megabytes, recording 100 and 200 tracks/in., with densities as high as 4400 bits/in. in top-loading models. The unit uses a brushless dc motor, which is an integral part of the disc spindle, and has no belts or pulleys. An electromagnetic voice coil actuator, which derives velocity information from the position transducer, eliminates need for a tachometer. **Wango Inc.**, 5404 Jandy Pl, Los Angeles, CA 90066. Circle 250 on Inquiry Card

### LOW COST p/ROM COPIER

Model 107, a low cost, comprehensive p/ROM programmer/copier/reader/verifier, can be used to program EAROMs, copy previously written p/ROMs, read data from addresses sequenced by the machine or randomly selected by the operator, and verify data while writing or reading. Specs include eight data bits; eight address bits (256 addresses); LED display; 50/60-Hz, 115-Vac, 1-A power; dimensions of 12 x 14 x 6"; and weight of <8 lb. **Technitrol, Inc.**, 1952 E Allegheny Ave, Philadelphia, PA 19134.



Circle 251 on Inquiry Card



### 16-PIN 4K RAM

The 2104, a 4096-bit dynamic MOS RAM, features worst-case access time of 250 to 350 ns and a 108 x 176-mil chip. It has the same configuration as the Mostek MK4096. Fastest version of the memory, the 2104-2, is guaranteed to have worst-case access time of 250 ns and read/write cycle time of 400 ns over the 0 to 70°C temp range. Other features include TTL-compatible levels for clocks, address, chip select, data and write enable inputs, and a 3-state, TTL data output. Operation is from std -5-, 5-, and 12-V power supplies. **Intel Corp.**, 3065 Bowers Ave, Santa Clara, CA 95051.

Circle 252 on Inquiry Card

### CLINICAL LABORATORY MINICOMPUTER SYSTEM

A minicomputer for clinical laboratories, the CLINDATA 2202 is a single, online system which automatically collects and reports laboratory test results while generating statements, insurance forms, and management reports. Information may be entered or accessed through different data entry terminals simultaneously. The system includes a high speed printer with 300-line/min. capability. Up to 5000 specimens and test results may be stored online for display or hardcopy output. **BSL Northrop**, 19000 S Vermont Ave, Torrance, CA 90502.

Circle 253 on Inquiry Card

### RACK ENCLOSURE FOR 12 MODEMS

Holding up to 12 modems in a 10½ x 19" space, the SR22 packaging system mounts in a std 19" equipment cabinet. Complete with dual power supplies, it eliminates cumbersome patch panels and relay switches, saves space, and reduces the stacked-up hardware and cable clutter. The plug-in modem modules each have a full LED indicator display and test switches on a "mini" status panel. Backplanes are also PC cards to provide reliability and easy reconfiguration. **Intertel, Inc.**, 6 Vine Brook Pk, Burlington, MA 01803.

Circle 254 on Inquiry Card

### UNIVERSAL CIRCUIT CARDS

Available in 16-pin DIP and discrete component models, each ¼" thick epoxy/glass Snaptrack™ card comes with a 7-position RDI barrier terminal strip, insulating mounting channel, and layout worksheet. Conductor is 2-oz copper, Sealrite coated, and ground and power busing is provided. Up to six 16-pin ICs along with associated components can be mounted on model UC-1; lamp driver, arc-suppression, and other custom circuits can be produced using model UC-2. For large scale projects is model KB22, a 22-pin card for edge connectors. **Reed Devices Inc.**, 21W183 Hill Ave, Glen Ellyn, IL 60137.

Circle 255 on Inquiry Card

### BULK TAPE ERASERS

Handling tape packaging configurations ranging from std cassettes to 2" wide video tape reels, six models deep-erase magnetic tape from saturation to at least -80 dB in 5 s. The units revitalize tape by eliminating the distortion and noise that result from incomplete erasure on tape drive units. Model 30 accommodates reels up to ½ wide x 3½" dia; model 6, 1 x 8" dia; 7, 1 x 8" sq; 8, 2 x 14" dia; 9, 1.375 x 16" dia; and 14, 2.75 x 16" dia. Model 14 includes a 16-ft/min. conveyor belt assembly capable of handling up to 4000 tapes/hr. **Kybe Corp.**, 132 Calvary St, Waltham, MA 02154.

Circle 256 on Inquiry Card

### HIGH VOLTAGE DC SOLID-STATE RELAYS

Providing max load rating of 5 A at 250 Vdc, with two control voltage ranges, model 603-3 offers a TTL-compatible, 3- to 10-Vdc input, the -4 has a high-level logic compatible, 10- to 32-Vdc input. The relays are transformer-coupled to provide 1500-V input/output isolation, and feature direct drive from the control source for low off-state leakage. Package configuration provides screw terminals, quick disconnect terminals, or solder pins for direct PC board mounting. **Teledyne Relays**, 3155 W El Segundo Blvd, Hawthorne, CA 90250.

Circle 257 on Inquiry Card

## THE MACHINE AND MANUFACTURING PROCESSES CONTROLS MARKET

The 1974 machinery control market for the 28 items below was \$796 million. It is projected to grow to \$1.587 billion by 1979 and \$2.828 billion by 1984 (all in constant dollars).

Frost & Sullivan has completed a 339-page report analyzing and forecasting the market to 1984 for these products: sensors (8 types); logic and switching controls (6 types); counters and timers (2 types); sequencing programmer actuators (6 types); microprocessors and minicomputers (2 types); and, in the packaged system category, NC systems and industrial robots.

Each of the 28 different types of controls is examined in terms of market and application areas, current and future technical trends, principal suppliers and share of the market, marketing problems and opportunities. Background data are provided to show how the field got where it is today, and the report suggests where it will go in the future—particularly in regard to the influence of plant-wide integrated monitoring control systems on the configuration of individual machine control systems. Some of the principal companies are examined to see how they achieved their present position and the directions they may take in the future.

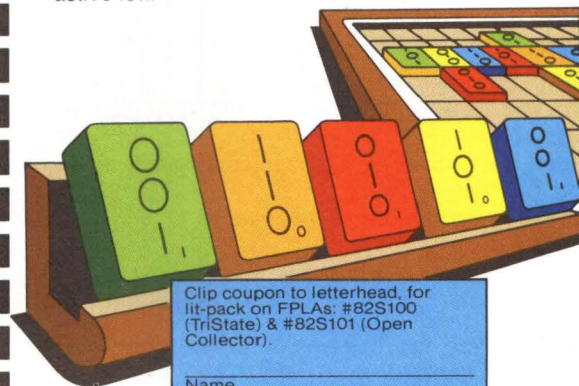
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- 19" Relay Rack-Mount Kit available.

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And best of all, it costs as little as \$995 in OEM quantities!

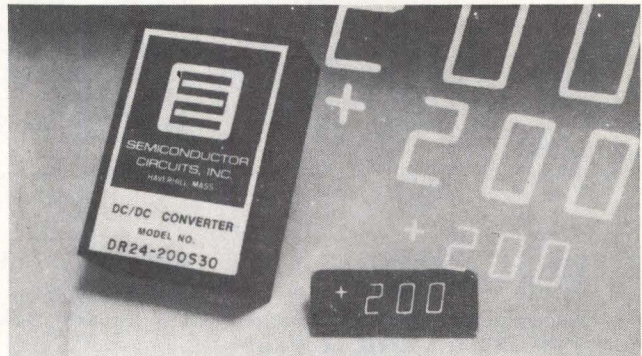
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## PRODUCTS

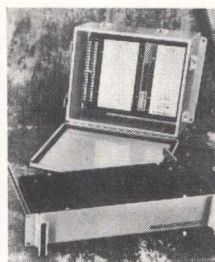
### POWER SUPPLIES FOR PLASMA DIGITAL DISPLAYS



Designed to provide ionization potential for plasma type digital displays, line- and dc-operated encapsulated modules are pinned out identically. Operating efficiency in excess of 75% enables 15°C case temp rise. All models are short-circuit protected and need no derating over their -25 to 71°C op temp range. Std output levels are 200 and 250 Vdc at 30 mA. ED series, line-operated for computer and instrumentation applications, features 105- to 125-Vac power input, 2% line/load regulation, and 300-Vdc I/O isolation (std). UD series accepts a 5-Vdc  $\pm 5\%$  input and provides 1%/1%  $V_{in}$  line regulation and 5% load regulation. In the DR series, one segment accommodates 9- to 18-Vdc input, while another accepts 18- to 36-Vdc inputs. DC series, which operates from a 35- to 70-Vdc input, provides line/load regulation of 2% and includes high isolation. **Semiconductor Circuits, Inc.**, 306 River St, Haverhill, MA 01830.

Circle 258 on Inquiry Card

### DATA ACQUISITION MULTIPLEXING SYSTEM



Micromux™ consists of one or more remote transmitters (located near sensors or contact closure points) and a receiver (located in the control room). Each transmitter receives input from up to 16 data points, digitizes the information, then transmits the data to the central receiver. Data are multiplexed so that all 16 channels are transmitted over a single wire pair. Power to transmitter units is also supplied over this pair. One central receiver can handle up to four

transmitters, thus monitoring 64 individual points in a plant. Up to eight receivers can be connected to each communications interface of a computer for a total of 512 data points in a fully expanded system. Interface is a std 2400-baud teleprinter-like port (20-mA current loop with ASCII coding, using one stop bit and optional parity). **Burr-Brown**, Box 11400, Tucson, AZ 85734. Circle 259 on Inquiry Card

### PROGRAMMABLE CURRENT DRIVERS

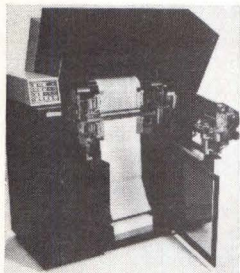
PI-2000 and -3000 are programmable high speed, high voltage interface drivers capable of delivering 50/25 mA, 40/80 V. Output currents can be programmed by means of reference voltages, currents, or resistances. High impedance outputs are both open and short-circuit protected and can be ored with outputs of other drivers for increasing output currents or for generating complex waveforms without loading the drive system or device under test. When used with matched 50-Ω systems, their respective output characteristics are 5/15-ns rise/fall times, 35/10-MHz



max rep rate, 15/50-ns propagation delays, and 35/-30, 75/-65-V max output offset. Compatible with TTL, ECL, and other digital plus linear circuits, drivers can be operated from single power supplies of 15 to 45 and 20 to 85 V, respectively, and installed in off-the-shelf type circuit boards having holes or sockets spaced 0.1" on centers. **Pulse Instruments Co**, PO Box 1655, San Pedro, CA 90733.

Circle 260 on Inquiry Card

### 2250-LINE/MINUTE IMPACT PRINTER



DOC 2250 prints 2250 lines/min., single spaced, using a 48-graphic-char set. The free-standing unit contains its own power supply and control logic. Its integrated controller—a company-developed microprocessor—communicates through its interface with the host system, decodes all commands, controls printer hardware, and reports errors and status. Also std are fully buffered print line, interchangeable char arrays, universal char set buffer, 132 print positions/line

(150 optional), vertical forms control buffer, powered stacker accommodating forms 3 to 24" long, acoustically-insulated powered cover which holds operating noise to 74 dBA, resident micro-diagnostics and maintenance independent of host system, up to 6-part forms, and paper slew to 100 in./s. **Documation, Inc**, Box 1240, Melbourne, FL 31901.

Circle 261 on Inquiry Card

### LOW COST GRAPHICS TERMINAL

Compatible with most mainframe computers and supported by the graphic software available for the company's other graphic terminals, plus an interactive graphing package, 4006-1 features hard copy compatibility plus offline storage. Data rates to 4800

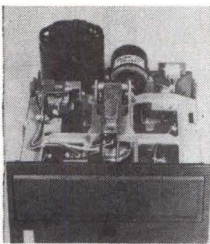


bits/s are selectable in eight steps of 75, 110, 150, 300, 600, 1200, 2400, and 4800. The terminal has 1024 x 780 viewable points; screen capacity is 2590 alphanumeric char. Interface compatibility is with EIA RS-232 A, B, and C (CCITT-V24).

The unit permits rapid communication between operator and computer, in either alphanumeric or graphic operation. Inputs to the CPU can be initiated at the terminal keyboard. Data received can be written or drawn on the display or can control other functions in the terminal. **Tektronix, Inc**, PO Box 500, Beaverton, OR 97005.

Circle 262 on Inquiry Card

### DOUBLE-DENSITY FLOPPY DISC DRIVE



Up to four 6.4-megabit capacity 9404's can be interfaced in a daisy-chain configuration via multiple connectors using a single, flat-ribbon cable. Avg power consumption and heat dissipation have been reduced. Recording medium rotates at 360 rpm while data are read or written on 74 of the 77 tracks of the single recording surface, with the remaining tracks reserved as spares. Data transfer rates are 250 and 500 kilobits/s in single- or double-density modes, respectively. Compatible data interchange with IBM 3540/3740/3790 and System 32 equipment is provided. Random-access storage uses a single, removable diskette capable of hard- or soft-sector format operation. Other std features include ceramic ICs and read/write head, continuously monitored unit-ready interrupts, write-fault circuitry, and write-current selection. **Control Data Corp**, Box O, Minneapolis, MN 55440.

Circle 263 on Inquiry Card

### DATA TERMINALS

Additions to Dataspeed 40 family feature synchronous line transmission protocol at 2400 and 4800 bits/s and permit clustering of keyboard/display and printer terminals in various combinations, up to 24 keyboard/display and 12 printer terminals. Interactive mode suits the devices to computer I/O applications. Additional features include computer-controlled display formatting and data entry, whole char impact printing, built-in internal diagnostics, and modular construction. Binary synchronous line protocol, which conforms to ANSI std X3.28 sub-category 2.4/B2, regulates message traffic by polling and selecting in a manner similar to that used in selective calling systems. This eliminates stations contending for the communication facility and permits the computer to control message flow. **American Telephone and Telegraph Co**, 195 Broadway, New York, NY 10007.

Circle 264 on Inquiry Card

### PROGRAMMABLE CONTROLLER

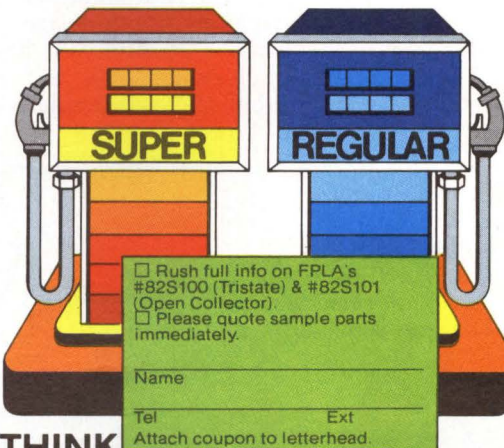
PCC 50/40 communications controller is available in four different table-top enclosures (each with a plexiglass door through which status and diagnostic displays can be viewed), providing from four to 33 card slots for line interfaces or memory expansion. Central control module contains 8 (expandable to 64) kilobytes of memory, real-time clock, auto restart timer, I/O ports, and a microcomputer which features vectored multi-level interrupts, unlimited subroutine nesting, and DMA. Full displays of control lines and data with LEDs are provided on each module. Interfaces include RS-232 and CCITT V.24 synchronous to 19,200 bits/s, asynchronous to 9600 bits/s. Optional modules permit interfacing to 20 or 62.5 mA telegraph current loops, MIL-188, CCITT V.35, or Bell 301 or 801 series data sets. **Micom Systems, Inc**, 20426 Corisco St, Chatsworth, CA 91311.

Circle 265 on Inquiry Card

MEMORY SERIES NO. 12

## HOW MUCH MORE CAN YOU GET OUT OF OUR FPLA'S?

Twice the speed (50ns vs. 100). Two extra inputs: 16 vs. 14, yielding a 4:1 address scan capability, compared to other Field Programmable Logic Arrays. And our bonus extra, chip enable, for expanding our 48 product terms.



THINK  
**Signetics**  
811 E. ARQUES, SUNNYVALE, CALIF 94086



# This isn't just an ink roll — it's the whole inking system.

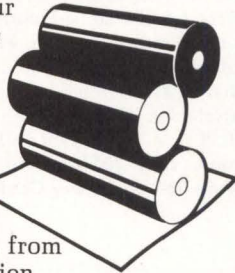


**It's the Porelon system.** An ink-bearing, microporous plastic roll replaces fountains, transfer rolls, distribution rolls, even ribbons on some jobs.

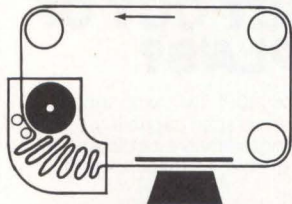


That's because the ink roll is Porelon plastic, with a life-time supply of ink molded into its pores — enough ink for millions of lines of type. This gives you plenty of design versatility.

**It simplifies the space problem, for example.** When your whole inking system is a single roll, you can work it into a small space. And you gain design freedom.



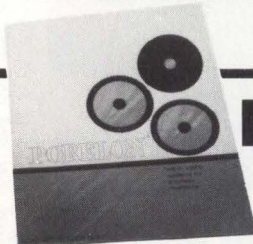
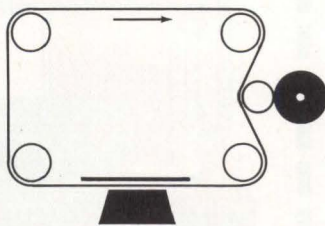
**Location has no restrictions.** Put the Porelon system where it'll do the most good. Forget about gravity. Ink flows from Porelon plastic by capillary action where it meets the type — up, down or in any direction. Forget about accessibility for refilling fountains, too. No one ever sees the ink roll until it needs replacement — after millions of crisp, legible impressions.



**Porelon offers advantages in weight.** The system's complete in a small cartridge that weighs only ounces.

**Porelon can take a load off your mind when it comes to cost, too.** Savings start with design — you transfer a lot of this work to us. And you eliminate many conventional inking components, so you can reduce manufacturing costs substantially. (That's more important now than ever.)

Like to know more about cutting costs? Write for this free booklet: **PORELON "solid inking systems for business machines."**



**PORELON**  
INCORPORATED

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DIVERSIFIED, INC., CD-12  
Racine, Wisconsin U.S.A. 53403  
Porelon is a registered trademark

## PRODUCTS

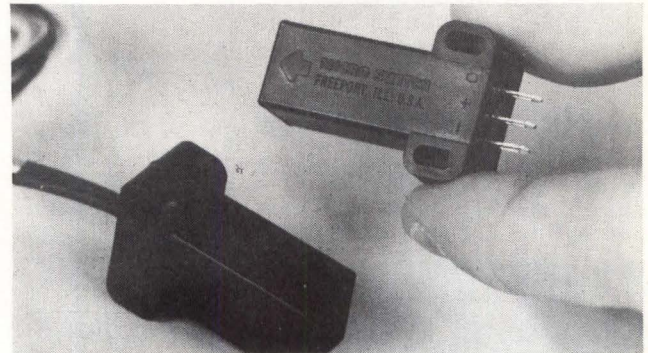
### CRT TERMINAL



The interactive Video 100 can be used for data inquiry and in-house time-sharing applications—generally, in multi-terminal environments requiring fast, visual display of data to supplement users' teleprinters. Compact terminal features a 12" diag screen and 64-char display set, with each char generated by a 5 x 7 dot matrix. Std display capacity is 24 lines, 1920 char. CRT and keyboard are incorporated in a single, 15.5 x 19 x 12.5" molded case. Data are

entered at the bottom of the screen. Pages scroll upward teletype-writer-style for each new line, with overflow going off the screen. An underline cursor homes at the lower left of the screen. Display brightness is operator adjustable. **Western Union Data Services**, 70 McKee Dr, Mahwah, NJ 07430.  
Circle 266 on Inquiry Card

### SOLID-STATE PROXIMITY SENSOR



Utilizing the Eddy current principle, XK series responds primarily to ferrous-metal targets but also to thin, non-ferrous, metal-foil targets, either stationary or moving. The sealed sensor, just over 1" long, is capable of up to 1000 operations/s and handles 6- and 16-Vdc logic-level loads. It interfaces directly with balancing/weighing equipment, parts-detection equipment, paper-/film-handling machinery, and the like, operates at between -40 and 125°C, and switches consistently at 0.06" throughout that range. Push-on or lead-wire termination is available. Slots along the sides accept #4 mounting screws and allow 0.14" adjustment. **Micro Switch, a div of Honeywell**, 11 W Spring St, Freeport, IL 61032.

Circle 267 on Inquiry Card

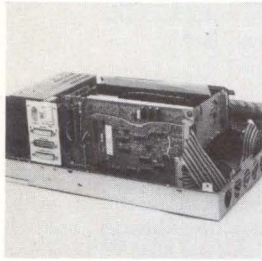
### PROGRAMMABLE LOGIC CONTROLLER/COMPUTER INTERFACE

This card enables communication between the company's model 77 programmable logic controller and computers, data terminals, microprocessors, or other compatible devices. With 128 internal storage locations, the interface is plugged into a reserved slot on the 77, which is connected to an EIA RS-232-C port in a compatible system. By acting as transmitter and receiver of data, it permits a computer to monitor I/O status, command outputs, and select memory segments. It can also interconnect up to eight controllers—all computer interfaced—in a loop to exchange I/O status. When interfaced with a data terminal, it allows the terminal to print programmed messages from memory and, through terminal keyboard, manually command the 77 to energize or de-energize selected outputs. **Struthers-Dunn, Inc, Systems Div**, Bettendorf, IA 52722.

Circle 268 on Inquiry Card



## DATA TERMINAL LSI BOARD



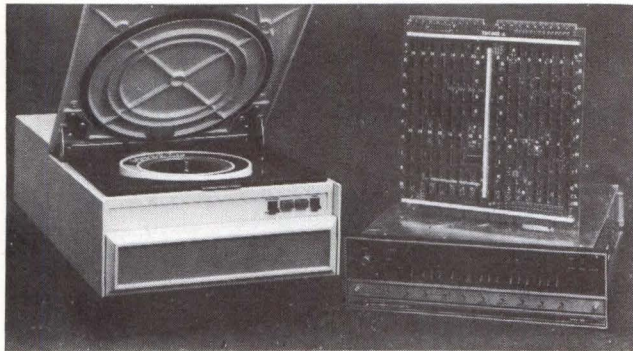
Electronic heart of the Computer Transceiver Systems, Inc Execuport—a portable data terminal housed in a luggage-type case for remote communications with a central computer using a telephone—is a 6 x 10" LSI board. A high density, 2-sided circuit with plated-through holes, it serves to interconnect all major parts of the terminal, including keyboard, printer, and power supply. Logic functions include

clocking data to the computer, formatting received data for the printer, and developing compatible signals to communicate with and control paper tapes and magnetic-tape peripherals. **The Sibley Co**, Bridge St, Haddam, CT 06438. Circle 269 on Inquiry Card

## 4800-BIT/s DIAL MODEM

The low cost GDC 208-5, designed for 2-wire operation on the DDD switched network via CBS or CBT automatic-originate/-answer data couplers, is fully compatible with the WECO 208B data set. It can be used for 4800-bit/s analog extension of DDS circuits. Since it is Bell equipment compatible, the network-designed modem allows the user to mix and match randomly within his network. Typical applications involve exchange of data between two points on a part-time basis and include remote batch dial-up polling using an 801 automatic calling unit. The modem may be rack mounted at high density locations and can be used for dial backup on private lines. **General DataComm Industries Inc**, 131 Danbury Rd, Wilton, CT 06897. Circle 270 on Inquiry Card

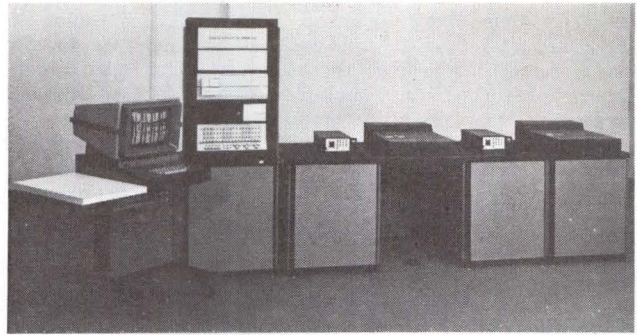
## 50-MEGABYTE DISC SYSTEM



TDC 802, a self-contained controller that interfaces any CalComp Trident series disc drive to Data General minicomputers, plugs into one std I/O slot in a DCC or Keronix CPU chassis and is cabled directly to the disc drive. Reads/writes are fully buffered to accommodate high data rates. Internal RAM holds an entire sector at a time, and DMA increases data transfer rate. Std buffer size is 512 words, permitting up to 476 16-bit words/sector, but may be expanded in 256-word increments to 1024 words. Actual sector size is selected by jumpers in the drive and is variable in 1-word increments. Std software uses 256-word sectors. Overlapped seeks are permitted, hardware checksum calculation is std, sector ID and flags are under software control, and controller device address and interrupt mask are user selected. **MiniComputer Technology**, 1901 Old Middlefield Way, Mountain View, CA 94043.

Circle 271 on Inquiry Card

## DIGITAL IC TEST SYSTEM



The computer-controlled J325 includes a computing controller, CRT terminal, magnetic-tape-cartridge transport, precision voltage/current measurement unit, functional test drivers and comparators, and comprehensive software. Up to four test stations for ECL, TTL, DTL, CMOS, and static MOS devices can be operated manually or in conjunction with wafer probers, automatic handlers, or environmental chambers without loss of testing integrity. Data output modes include data-logged test results, lot summary reports, Shmoo plots, and wafer maps. Data can be displayed by the CRT terminal, printed by a line printer, or recorded on magnetic tape in cartridge or reel-to-reel form. **Teradyne, Inc**, 183 Essex St, Boston, MA 02111.

Circle 272 on Inquiry Card

MEMORY SERIES No. 8

## INTERFACE SAVERS: 20 TTL COMPATIBLE MOS SHIFT REGISTERS

In stock now, and in love with TTL, our MOS registers save on go-betweens. Zero interface cuts parts and power costs. Max design flexibility, all from one source: 20 gives you plenty to pick from.



FREE Short Form Catalog lists all 20 MOS S-Rs. Clip coupon to letterhead for your copy.

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# LITERATURE

## Telecommunications Seminars

Proceedings from recent seminars start with definition of "modem" and proceed through large, interactive time-shared computer networks using multiplexers, concentrators, and front-end processors. **Moxon Electronics**, Anaheim, Calif.  
Circle 300 on Inquiry Card

## Intelligent CRT Terminal

2644A Mini Datastation, with up to 220 kilobytes of built-in mass storage through two tape drives which use a pair of mini cartridges, is detailed in brochure. **Hewlett-Packard Co**, Palo Alto, Calif.  
Circle 301 on Inquiry Card

## Digital Multipoint Recorder

Brochure gives technical data, applications information, and options for the Digistrip, which features a full printed-page output showing digital data for each channel printed in its own column. **Kaye Instruments Inc**, Bedford, Mass.  
Circle 302 on Inquiry Card

## Instrumentation Accessories

Catalog on voltensors, instrumentation amps, function modules, and power supplies describes functions and packaging concepts. **Calex Manufacturing Co, Inc**, Pleasant Hill, Calif.  
Circle 303 on Inquiry Card

## Vertical Bus Bars

Performance characteristics of bus bars in single-conductor and laminated types of up to six independent conductors are described in illustrated data sheet. **Logic Dynamics, Inc**, Gardena, Calif.  
Circle 304 on Inquiry Card

## Voltage-Frequency Converters

Designer's guide covers theory, operation, calibration, and application, and includes diagrams showing circuit connections to actual V-F devices. **Datel Systems, Inc**, Canton, Mass.  
Circle 305 on Inquiry Card

## Solderless Ribbon Connector System

Catalog describes operation of system recently being used for telecommunications equipment, as well as terminating equipment available for use with the system. **TRW/Cinch Connectors, an electronic components div of TRW, Inc**, Elk Grove Village, Ill.  
Circle 306 on Inquiry Card

## Wire and Cable

Revised edition of "Wire/Cable Selection Guide for Process Instrumentation" contains tabular data relating types, levels, and sources of noise to various kinds of sensors and wire/cable classifications. **Samuel Moore & Co, Dekoron Div**, Aurora, Ohio.  
Circle 307 on Inquiry Card

## Commercial/Military Switches, Relays

1975-76 catalog covers commercial toggle, rocker-/paddle-operated, push-/slidebutton, and precision snap switches; relays and electronic controls; rotary switches; military accessories, and more. **Cutler-Hammer, Specialty Products Div**, Milwaukee, Wis.  
Circle 308 on Inquiry Card

## Uninterruptible Power Machines

How UPSs fit in present and future computer installations to protect vital functions is the subject of brochure. **International Power Machines Corp**, Mesquite, Tex.  
Circle 309 on Inquiry Card

## Light-Emitting Diodes

Folder showing nearest-equivalent cross-references for 11 leading manufacturers of discrete solid-state lamps matches them on the bases of size, shape and I/O characteristics. **Chicago Miniature Lamp**, Chicago, Ill.  
Circle 310 on Inquiry Card

## 16-Bit Digital-Analog Converter

MP8116 16-bit DAC, in which the "worst-case" algebraic sum of all uncertainties results in an error band of  $< \pm 1$  LSB, is detailed in brochure. **Analogic Corp**, Wakefield, Mass.  
Circle 311 on Inquiry Card

## Microcomputer Kits

Spec sheets describe complete, ready-to-assembly kits designed around microprocessors from Intel, Texas Instruments, or Motorola. **Cramer Electronics, Microcomputer Center**, Newton, Mass.  
Circle 312 on Inquiry Card

## Power Transistors

Updated, expanded edition of power transistor directory lists transistors and power hybrid circuits and provides selection charts and significant data on the devices. **RCA Solid State Div**, Somerville, NJ.  
Circle 313 on Inquiry Card

## Frequency Control Components

Catalog details temp-compensated crystal oscillators and TC/VCXOs, crystal and LC filters using "initial filter analysis concept," CMOS and TTL logic clock oscillators in DIP and low profile packages, precision frequency stds, computer terminal clocks, and more. **Monitor Products Co, Inc**, Oceanside, Calif.  
Circle 314 on Inquiry Card

## "Smart" Data Logger

Brochure describes the Digitrend 220, a multipoint recorder that provides a wide range of data acquisition capabilities with programming flexibility through use of IC memories and an Intel 8008 CPU microprocessor. **Doric Scientific Div, Emerson Electric Co**, San Diego, Calif.  
Circle 315 on Inquiry Card

## Printer Terminal

User's manual for Carousel 300 includes descriptions, diagrams, and photos of the 30-char/s serial impact printer terminal. **Interdata, Inc**, Oceanport, NJ.  
Circle 316 on Inquiry Card

## General-Purpose Relays

Family of g-p relays with contact rating of  $\frac{1}{6}$  hp of 10 A res, 120/60 Hz is described in brochure which includes specs, selector charts, contact material, enclosure and mounting styles, and terminal types. **North American Philips Controls Corp**, Cheshire, Conn.  
Circle 317 on Inquiry Card

## High-Performance Oscillators

Crystal oscillators with/without ovens, and hybrid, voltage-controlled, and temp-compensated oscillators are covered in catalog which contains technical data, performance curves, and selection criteria. **Greenray Industries, Inc**, Mechanicsburg, Pa.  
Circle 318 on Inquiry Card

## Power Supplies

Illustrated catalog presents complete option and selection information on over 1000 models of ac-dc and dc-ac supplies with output power ratings of 1 through 25 W and output voltages of from 4 to 4000 V. **MIL Electronics Inc**, Lowell, Mass.  
Circle 319 on Inquiry Card

## Analog-Digital, Digital-Analog Converters

Guide to A-D and D-A converters, S/H amps, and a multiplexer includes high performance, g-p, high speed, dual slope, high resolution, multiplying, and high-rel modules; and monolithic CMOS and IC types. **Analog Devices, Inc**, Norwood, Mass.  
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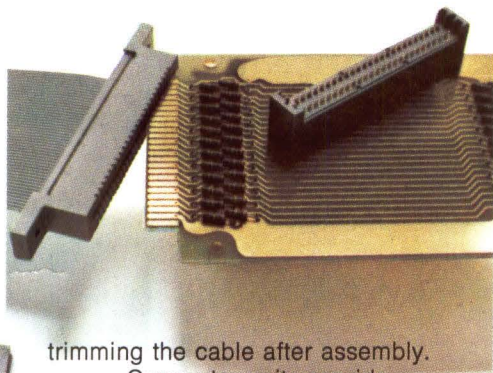
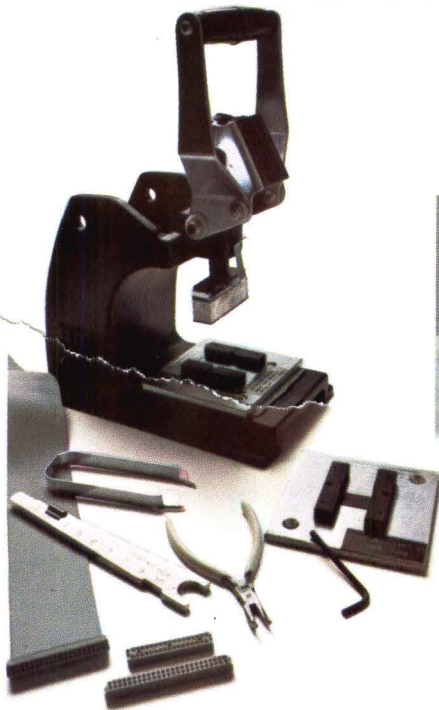
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trimming the cable after assembly.

Connector units provide positive alignment with precisely spaced conductors in 3M's flat, flexible PVC cable. The connector contacts strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

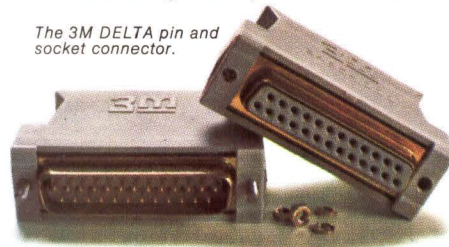
Assembly-cost savings are built in when you design a package with "Scotchflex" flat cable and connectors. But more important, 3M Company offers you the full reliability of a one-source system: cable *plus* connectors *plus* the inexpensive assembly aids that crimp the connections quickly and securely (with no special operator training required).

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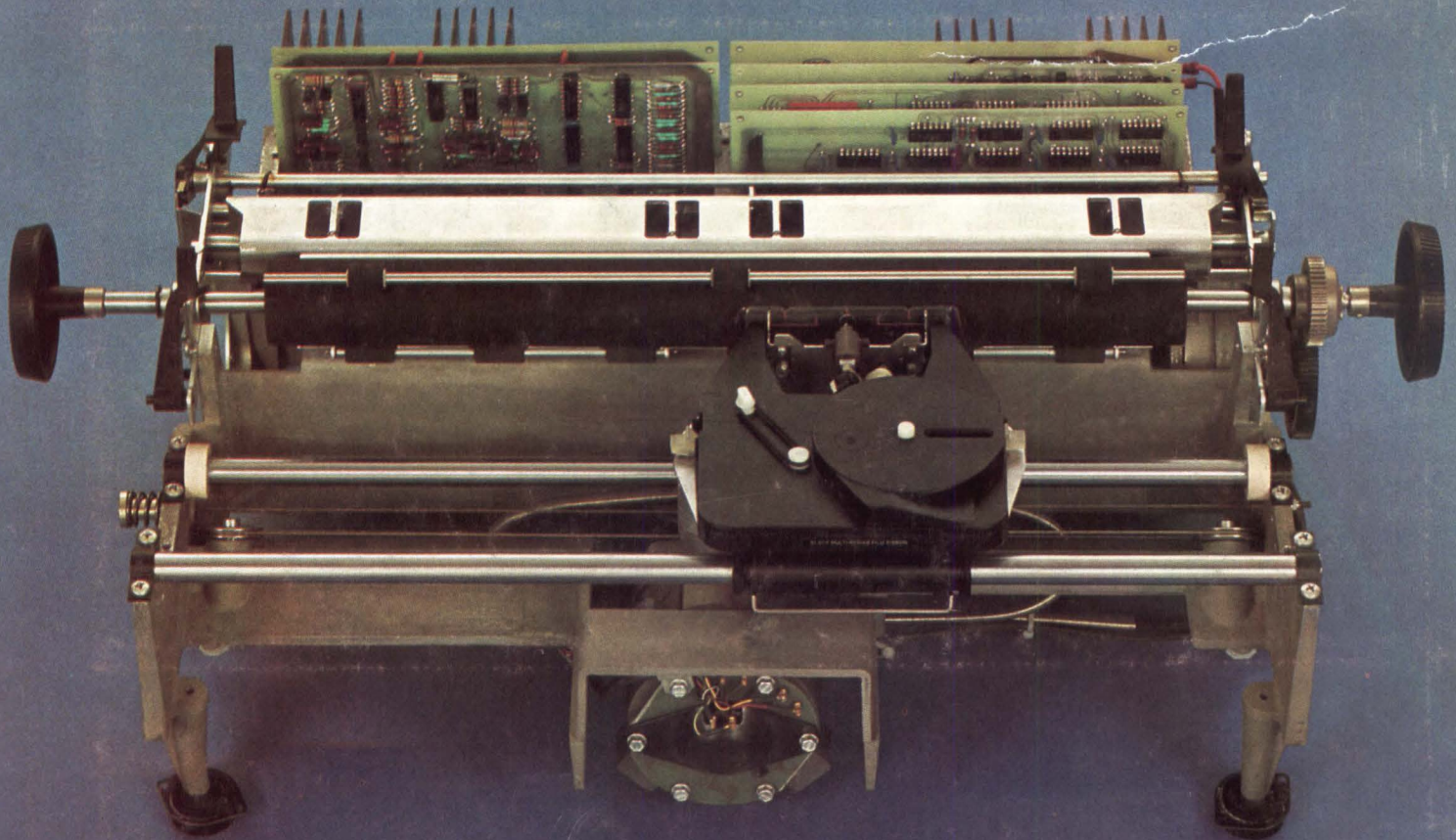
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# MICROPROCESSOR.

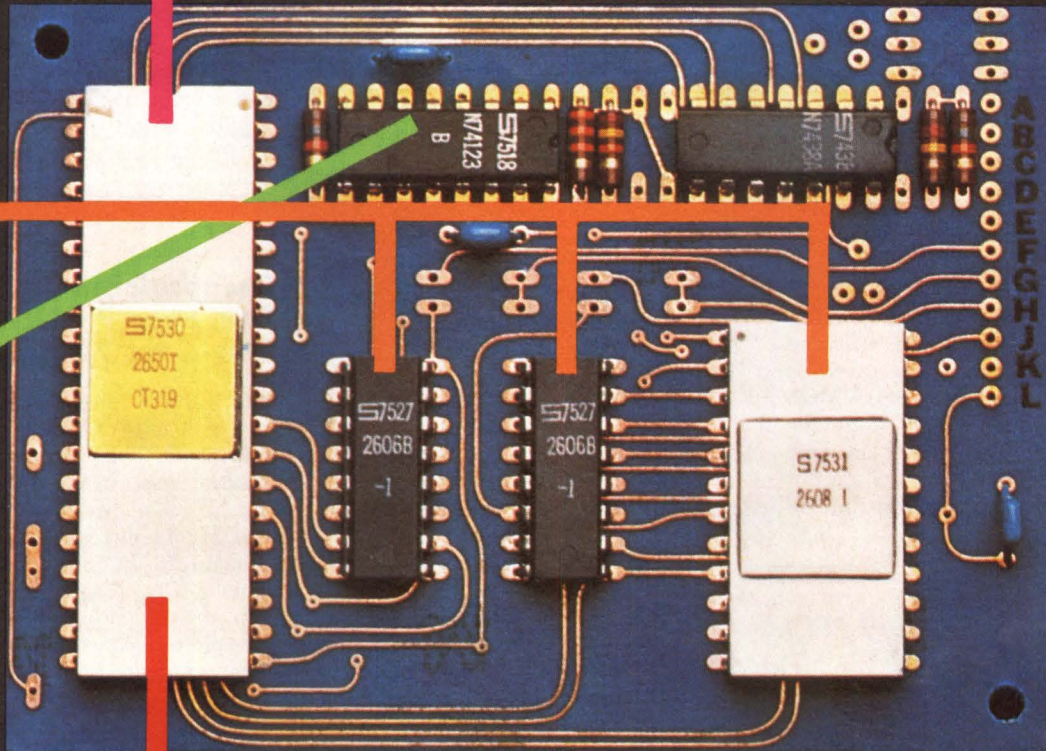


Photo approximately twice actual size.

**4** On-chip serial interface eliminates a 24-pin IC. And its cost. And its space. And its connections.

**5** Where are the special interface chips? There aren't any in this sample system. And not much in any other system you might design with the 2650. With much of the I/O built into the 2650, you can interface the I/O devices with simple, low-cost, industry-standard 74LS, 7400 and 8T circuits.

For instance, get both input and output with the 8T31 Bidirectional I/O Port. Or take the 8T26 Quad Bus Driver as another example. Signetics offers fifty 8T types and nearly everything in 74LS and 7400—all low cost, all industry standards. Lower parts cost means much greater value.

**Software and people to back the 2650 are here now.**

Cross assemblers and simulators are available in batch and on timeshare. (The assemblers come in both 32- and 16-bit formats because we realize that not everyone has a 32-bit machine.) And there's a prototyping card (CPU, RAM, ROM) with debug firmware. Documentation, manuals, application notes. Plus training seminars and

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