MULTIPROCESSING IMPROVES THROUGHPUT AND RESPONSE IN A VECTOR TO RASTER CONVERTER
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EMI SUSCEPTIBILITY TESTING OF COMPUTER SYSTEMS
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CIRCLE 3 ON INQUIRY CARD
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Exploring the forefront of electronic display technology, the 1980 Society for Information Display Seminar and Symposium will cover flat panel, electroluminescent, liquid crystal, plasma, and avionics displays; image processing; and display graphics.
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1632HCO 32 discrete outputs, high current drive
1632TTL 32 TTL I/O lines
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- Tape and Disk Controllers
- and even DEC-manufactured LSI-11 and LSI-11/23 microcomputers and other accessories.

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- BULK MINI
- Tape and Disk Controllers
- and even DEC-manufactured LSI-11 and LSI-11/23 microcomputers and other accessories.
CONFERENCES

APR 8-10—International Reliability Physics Sym, Caesar's Palace, Las Vegas, Nev. INFORMATION: Glen T. Cheney, Bell Laboratories, 555 Union Blvd, Allentown, PA 18103. Tel: 215/439-7628

APR 21-24—International Magnetics Conf, Sheraton-Boston Hotel, Boston, Mass. INFORMATION: D. I. Gordon, Conf Chm, Naval Surface Weapons Ctr, White Oak, Silver Spring, MD 20910. Tel: 202/394-2167


APR 28—Invitational Computer Conf, Atlanta, Ga. INFORMATION: B. J. Johnson & Assoc, 2503 Eastbluff Dr, Suite 203, Newport Beach, CA 92660. Tel: 714/646-6037

APR 28-MAY 2—Society for Information Display International Sym, City Hotel, San Diego, Calif. INFORMATION: Lewis Winner, 301 Almeria Ave, PO Box 343788, Coral Gables, FL 33134. Tel: 305/466-8193


MAY 6-8—International Sym on Computer Architecture, Casino, La Boule, France. INFORMATION: Jacques Lenfant, Iris Campus de Beaulieu, 35042 Rennes, Cedex, France


MAY 20-22—CENCON '80 Industrial Electronics Conf, Public Auditorium, Cleveland, Ohio. INFORMATION: Mike Lapine, Cleveland Electronics Conf, Inc, 2728 Euclid Ave, Cleveland, OH 44115. Tel: 216/241-5515


JUNE 2-5—Sym on Incremental Motion Control Systems and Devices, Ramada Inn, Champaign, Ill. INFORMATION: Incremental Motion Control Systems Soc, PO Box 2772, Station A, Champaign, IL 61820

JUNE 3-5—Networks '80, Bloomsbury Centre Hotel, London, England. INFORMATION: Online, Cleveland Rd, Uxbridge UB8 2DD, England

JUNE 3-5—Sym on Multiple-Valued Logic, Northwestern U, Evanston, Ill. INFORMATION: Jon T. Butler, Dept of Electrical Engineering and Computer Science, Northwestern U, Evanston, IL 60201. Tel: 312/492-5628

JUNE 8-11—International Conference on Communications, Red Lion Inn, Seattle, Wash. INFORMATION: ICC '80, PO Box 88465, Seattle, WA 98188

JUNE 10-12—International Input/Output Systems Sym, Stockholm Sheraton, Stockholm, Sweden. INFORMATION: Carroll A. Greathouse, Input/Output Systems Assoc, PO Box 1333, Stamford, CT 06904. Tel: 203/323-3143

JUNE 16-18—ATE Seminar/Exhibit, Hynes Auditorium, Boston, Mass. INFORMATION: ATE Seminar/Exhibit, c/o Benwill Publishing Corp, 1050 Commonwealth Ave, Boston, MA 02215. Tel: 617/232-5470


JUNE 19—Computer System Integrity, Technical Sym of the ACM and NBS Institute for Computer Sciences and Technology, National Bureau of Standards, Gaithersburg, Md. INFORMATION: Angela Turvey, 4910 Butternut Dr, Rockville, MD 20853

JUNE 23-25—Design Automation Conf, Minneapolis, Minn. INFORMATION: Harry Hayman, PO Box 639, Silver Spring, MD 20901. Tel: 301/439-7007


SEMINARS

APR 10-11—Data Communications; APR 24-25 AND MAY 5-6—Data Base Management; AND APR 22-23 AND MAY 12-13—Computer Graphics: Update on Applications and Technology, Hyatt Regency, Chicago, Ill; L'Enfant Plaza, Washington, DC and Hyatt Regency O'Hare, Chicago, Ill; and L'Enfant Plaza, Washington, DC and Hyatt on Union Square, San Francisco, Calif. INFORMATION: Barbara Tarrin, Center for Management Research, 850 Boylston St, Chestnut Hill, MA 02167. Tel: 617/738-5020

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- S2350 USRT
- S6821 Peripheral Interface Adapter (PIA)
- S6821 High Speed PIA
- S6840 Programmable Timer Module (PTM)
- S6840 CRT Controller
- S6840 Video Display Generator (VDG)
- S6840 IEEE 488 Bus Adapter
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- S6850 Synchronous Serial Data Adapter
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- S6810 32K Static RAM
- S6834 4K EPROM
- S68364 64K Static ROM
- S6845 16K ROM with on-board I/O and Timer

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TI's family of bubble memory systems offers you the non-volatility of magnetic storage media, plus compactness, silent operation, solid-state reliability, and lower error rates and faster access times than disk and cassette systems.

Because TI bubble memory systems are easily interfaced to microprocessor systems, many designers have already made their choice. And, they've chosen from the TI family of bubble memory systems. It's a design decision that makes sense. That's why you'll find TI bubble memory systems improving the performance of intelligent terminals, word processors, industrial process controls, instrumentation and telecommunications equipment, add-on buffer/cache memories — and more.

Because bubble memories are so small and lightweight, they're ideally suited to portable applications such as small computers, data loggers and a variety of educational
and home entertainment products.


New bubble memory systems with storage capacities ranging from 23K to 768K bytes are being supplied. All the custom-designed peripheral and support circuitry for bubble memory systems are available.

New wafer processing techniques, including state-of-the-art planar construction — coupled with TI's innovative two-micron technology — are making newer and better things happen all the time.

TI's eight years of experience in bubble memory design and production have provided keen insights into customer requirements.

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Only Texas Instruments can offer you a full family of bubble memory systems. A family built on know-how and experience. A family that reinforces TI's established position as the leader in bubble memory technology — and products.

**Systems components**

TI's complete family of bubble memory systems is comprised of component devices with capacities from 92K bits to 1 megabit. With access times from 4.0 to 11.2 ms.

These various capacities, along with the necessary support circuits, offer you a wide choice of compact systems for ease of use and design configuration flexibility.

The 1 megabit TIB1000, for example, is electrically and physically interchangeable with family members TIB0500 at 512K and the 256K TIB0250. Both are supported by the same comprehensive line of custom interface circuits.

The planar processing techniques, and new refinements in photolithography allow TIB1000 to offer the highest commercial bit density ever — by a factor of two.

**Custom support circuits**

All TI bubble memory systems contain a complete set of interface and peripheral circuits — including two custom controllers. One for the 92K devices. One for the megabit family. So, it's not necessary to emulate controller function and you save a design step. Both are available.

These circuits, designed specifically for bubble memories, encompass state-of-the-art bipolar and MOS integrated circuit technologies. This provides high level interface between all of today's popular microprocessors and all of TI's bubble memory products.

The 92K TIB2023 is supported by its own family of custom peripheral circuits. The binary TIB0250, TIB0500 and TIB1000 are all supported by a common set of interface circuits.

<table>
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<th>Tl's FAMILY OF BUBBLE MEMORY SYSTEMS</th>
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<tr>
<td>PART NUMBER</td>
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<tr>
<td>------------</td>
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<td>TMM90/210-1</td>
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<td>TMM90/210-2</td>
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Custom support circuits for all families of devices include: coil drivers, sense amplifiers, function drivers, controllers and function timing generators.

An advanced family of support circuits, coming soon, has been designed for parallel operation as well as error correction.

**Bubble memory systems**

To provide ease of use and a convenient production board, each new member of TI's bubble memory family is available on a completely assembled, fully tested, compact printed circuit board.

**TBB5005 and TBB5010 systems**

Non-volatile bubble memory systems assembled on a 4" x 6" board with custom controller and all other peripheral devices and using the new family components. Features common to both systems include: up to 128K bytes of memory capacity, interface with TMS9900, 8080 and Z80 microprocessors, access times of 11.2 ms, data transfer rates of 85K bytes/sec., system expansion capability and a choice of board connector styles.

**TM990/210 system**

Here's a non-volatile bubble memory system using the production-proven 92K bit TIB0203 device. Up to 69K bytes assembled on a single board, including a full complement of custom control circuits. Interfaces directly with TMS9900-based microcomputer modules. This system is in stock and available for immediate off-the-shelf delivery from your TI distributor.

**TM990/211 system**

A non-volatile bubble memory system utilizing the TIB1000 with up to 768K bytes capacity. Bus compatible with TM990/100 microcomputer modules, the TM990/211 system features 11.2 ms access time with data transfer rates of 85K bytes/sec. A new module, coming, will be able to be combined with the TM990/211 system to provide a megabyte bubble memory system with on-board error correction, direct memory access, and compatibility with TM990 file management.

And the innovations keep on coming

Texas Instruments is firmly committed to innovative, cost-effective bubble memory technology and product development.

So, for a full line of bubble memory systems — standard or customized to your application — turn to the leader — turn to Texas Instruments for magnetic bubble memory products.

For more information, write to Texas Instruments Incorporated, P.O. Box 225012, M/S 308, Dallas, Texas 75265. We'll send you our new 8-page brochure along with details about the bubble memory course offered at the TI Chicago Regional Technology Center.
To the Editor:

Your readers should be warned that the arbiter circuit described in "Queue Handling Arbiter Solves Shared Resource Conflicts" (K. Sø Højberg, Computer Design, Nov 1979, pp 129-135) while logically correct cannot be reliably implemented. The circuit will suffer from what has been called synchronizer failure (T. J. Chaney and C. E. Molnar, "Anomalous Behavior of Synchronizer and Arbiter Circuits," IEEE Transactions on Computers, April 1973, pp 421-422).

Specifically, because a real flipflop is not a discrete device, there are input conditions, such as data and clock inputs, changing at about the same time, which will cause the flipflop to enter a metastable state in which it may remain for an unbounded amount of time. Depending on the logic family used, this metastable state may have different characteristics such as oscillations between a 1 and 0 output or an output halfway between 1 and 0.

While Højberg's circuit will indeed work most of the time, it will fail (due to synchronizer failure) with some finite, nonzero, probability. Indeed, it is a well-known fact that it is impossible to reliably synchronize two systems which have independent time bases unless provisions are made for doing something like starting and stopping the system clocks.

Edward H. Frank
Carnegie-Mellon University
Pittsburg, Pa

The Author Replies:

For a given application an arbiter should be evaluated in connection with its job and its environment. The consequence of eventual inclusion of nonideal synchronizing elements as well as other nonideal conditions should be estimated as a whole. In this connection, noise on the power supply and reset lines, and consequences of limited component reliability can be mentioned.

The method adopted in the state machine arbiter (K. Sø Højberg, "Queue Handling Arbiter Solves Shared Resource Conflicts," Computer Design, Nov 1979, pp 129-135) for reduction of the probability of metastable conditions at the expense of clock interval time is the control delay method (D. J. Kinniment and J. V. Woods, "Synchronization and Arbitration Circuits in Digital Systems," Proceedings of the IEE, Oct 1976, pp 961-966). By means of this (and other methods) a system of known reliability can be constructed. For example, a system containing a simple flipflop with delayed sampling of its output can have a response time below 50 ns and a mean time between failures of 31,700 years (Kinniment and Woods).

K. Sø Højberg
Riso National Laboratory
Roskilde, Denmark

Note:

Formulas published in the Application Note, "Reliability Computations on a Handheld Programmable Calculator," by C. R. Lewart, p 140 of the Nov 1979 issue of Computer Design were from an unpublished Appendix to Ref 2 of that Note: J. Zussman, "Forecasting Computer System Reliability With a Handheld Programmable Calculator," copyright Computer Design Publishing Corp, Mar 1979. A footnote to that fact was inadvertently omitted.
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FLEX 02... complete RX02 emulation on a dual-width card that plugs directly into any LSI-11, media compatibility, uses DEC-provided software, available with DEC look-alike 2-drive cabinet, runs RX02 diagnostics, compatible with Q-Bus®, and comes with single or dual head drives.

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CIRCLE 10 ON INQUIRY CARD
Broadcast techniques offer a reliable system design approach for establishing communication between distributed processors. All processors share a common medium, such as coaxial or fiber optic cable, or a radio frequency channel. Arbitration or contention in accessing the medium is handled locally at each processor interface. Since the medium itself is usually passive, no active element failure will inhibit communications for other processors.

A ground radio packet switching system is one means by which many geographically distributed users may communicate. Ground radio systems have been in use for many years; one such network is the Aloha system, which interconnects various islands in the Hawaiian group to the University of Hawaii Computer Center. The Aloha system uses a radio broadcast channel, with transmission occurring at random. A refinement of this access method, called slotted Aloha, provides a time slot equal to the transmission time of a single packet and all transmissions must start at the beginning of a slot. In both slotted and pure Aloha systems, when two or more packet transmissions overlap in part or totally on the broadcast channel, they will interfere with and destroy each other. However, slotted Aloha reduces the period vulnerable to interference to one-half that of the pure Aloha scheme (Fig 1).

Access Methods for Broadcast Channels

How to share and control access to the channel with an acceptable level of performance is the main problem in broadcast techniques. As an example, each of a collection of devices is attempting to transmit over a shared communications channel. When two separate source transmissions overlap, they interfere with each other. If communication channel propagation delay between any source and destination node is relatively small with respect to that of the transmission duration, it is more efficient to sense if the channel is idle before attempting transmission. The interface at the transmitting end should be able to monitor the channel through the use of a carrier detect signal. If the signal is heard, the transmitter will recognize that the channel is in use, and will defer or postpone its transmission until the channel is sensed to be idle. This method of operation is known as carrier sense multiple access (CSMA).

The implementation of carrier deference does not guarantee channel acquisition. Two or more devices may detect the channel idle and attempt transmission. However, the detection of carrier from another transmitter may take the end-to-end propagation delay time of the medium. Under these conditions, interference from multiple
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NEC Spinwriter terminals are fine-quality communications devices that are enriching thousands of terminal networks.

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They come in six models, including an APL/ASCII model. They have numerous operator convenience features. They are available in both RO and KSR configurations. And they offer a wide variety of forms handling options.

Our APL/ASCII model, for example, supports the APL programming language and character set. Automatic tab setting simplifies printing of columns. And our unique 128-character print elements allow you to convert easily — by switch or under software control — from APL to ASCII mode.

Spinwriter terminals offer more forms-handling options than other terminals: vertical, horizontal or bidirectional tractors; and pin-feed, friction-feed, bottom-feed, front-feed and cut-sheet devices. Most are operator-changeable.

NEC Information Systems, Inc.

CIRCLE 11 ON INQUIRY CARD
Now that Infoton has changed its name to there's only one button to push for

We’re General Terminal Corporation, GTC, for short.

Over the past decade, as Infoton Incorporated, we’ve come a long way by pushing all the right buttons for our customers.

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And we don’t have far to go.

Because we already have extraordinary products like the GT-101 and GT-400. Both right on the button for quality, versatility and reliability. Both with standard features that’ll beat the options off their competitors.

Because we already have the capacity to deliver and service our products anywhere in the world, at push-button speed.

Because we’re now the one and only display terminal manufacturer with major production and service facilities on both U.S. Coasts. So we can help you keep a button on today’s ever-increasing freight costs.

And because we’ve always been willing to break away from button-down thinking. To try new-fangled innovations in the spirit of old-fashioned service.

So if you’re ready for all these things today, and more to come in the years ahead... you don’t have far to go.

Just push the right button.
General Terminal Corporation,
all your display terminal needs.

GT-101
ENGINEERING HIGHLIGHTS
• Z-80 microprocessor • Solid state
• Modular firmware keyboard
STANDARD FEATURES
• Block mode
• Dual intensity
• Reverse video
• ADM-3A mode
OPTIONAL FEATURES
• Composite video output
• 8-user programmable function keys
For more information on GTC products and services, call toll-free today. In California, dial 800-432-7006; anywhere else in the United States, dial 800-854-6781. Ask for Barbara Worth. Or write Barbara Worth at General Terminal Corporation, 14831 Franklin Avenue, Tustin CA 92680. We have offices throughout the world. In Canada, contact Lanpar Limited, 85 Torbay Road, Markham, Ontario, L3R 1G7. 416-495-9123.

GT-400
ENGINEERING HIGHLIGHTS
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• Block/character mode
• Function keys (8 std./24 option)
OPTIONAL FEATURES
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• 2 additional pages of display memory
• Modern cable/modem printer cable
• Hazeline 2000 emulation
• Timesharing option

The right button to push.
General Terminal Corporation

CIRCLE 12 ON INQUIRY CARD
The MSC 8001 is a MULTIBUS compatible single board computer designed to provide new dimensions in function and versatility. Built around the powerful eight-bit Z80™ CPU, the MSC 8001 provides a flexible memory addressing scheme and extensive input/output capabilities at prices well below competing single board computer products. Using the MSC 8001 as a master module, you can select I/O and special feature modules to configure a system of virtually any complexity or refinement.

**Expand SBC 80 systems** Upgrade existing SBC 80 systems that are being slowed down by limited memory size or restricted execution cycles. All existing I/O boards and memory expansion cards will operate with the MSC 8001.

**Expand to meet future needs** The MSC 8001 is designed to accommodate a wide range of versatile configurations. Almost any combination of memory, interface complement, and other options can be configured to meet your specific requirements without hardware modification. For additional information on the MSC 8001 and our other 41 Monolithic Systems Corp. products and systems, please contact us at 14 Inverness Drive East, Englewood, Colorado 80112. (303) 770-7400. Telex 45-4498.

Z80A is a trademark of Zilog, Inc.
Vulnerable period for slotted Aloha, pure Aloha, and simultaneous transmissions may occur (Fig 2). The transmitting node determines that its previous transmission was unsuccessful due to the absence of a positive acknowledgment from the receiving node, and reschedules its transmission of data. The receiving station itself usually determines that the transmission was in error through the use of a cyclic redundancy coding of the block.

A contention access problem arises when a device determines that its transmission was unsuccessful due to interference. It must then reschedule the packet for retransmission. To avoid collision of interfering devices upon retry, they must attempt transmission at time differences that are greater than the propagation delay between them. To a great extent, the rules for deciding when a device may attempt retransmission will determine the channel capacity.

Contestion Comparisons

Three types of persistent CSMA protocols, known as 1-persistent, non-persistent, and p-persistent, have been proposed and studied. These various protocols differ in the action that the user takes after sensing the channel.

The channel can employ a non-persistent protocol that schedules packets in the following manner: if the channel is idle, the packet is transmitted; otherwise (channel busy), the packet is rescheduled for transmission at some later time according to a delay distribution function. In contrast to the non-persistent user, a 1-persistent approach can be applied. With this method, the packet is transmitted with probability-one when the channel is sensed idle. A p-persistent scheme differs only in the fact that it will transmit with probability P on detection of idle.

Analytical models and simulation results are available for several CSMA access methods. In the analytical models, the channel is assumed to have Poisson traffic arrivals.
We've just been caught exceeding the speed limit.
Our F100K family of subnanosecond logic ECL circuits is the fastest in the industry. It's been cited doing 750 ps, which is 2-3 times faster than the competition.

Not only are our components faster, but your systems get faster because we've reduced interconnect delays. Which allows for serial processing with fewer parts.

While being the most complex ECL circuit family available, it's still the easiest to use in system design. Because it's fully voltage and temperature compensated and has higher integration levels.

Plus, the family offers some important advantages over TTL. Such as lower voltage swing, complementary outputs and a constant power supply current to reduce noise.

Introducing a new family member—
The F220 8-Bit Slice.

Our F100K family includes the F100K SSI/MSI, F200 Gate Array, and a totally new member, the microprogrammed F220 8-Bit Slice family.

With five devices, featuring 1,000-gate density and subnanosecond delays, the 8-Bit Slice family allows for excellent flexibility and building-block versatility over a wide variety of general-purpose applications.

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Where do you use the F100K family?

Anywhere speed is essential. Especially in large high-performance computers. And right down the line, from mainframes to midis, minis and special processors. Even in communications and instrumentation equipment.

The F100K family is in production and is available now. More and more design engineers are beginning to design it in every day. In fact, 80% of the companies that build mainframes have already implemented it into their systems in order to stay at the leading edge of technology. With its faster speed and ease of use, the F100K family has helped increase system performance while decreasing design time.

Another superior product from the Bipolar technology leader.

The F100K family benefits from Isoplanar-S, Fairchild's evolutionary new Bipolar process for scaling down Isoplanar geometries. With it, we're giving the computer industry and related fields superior memory and logic products. And we'll continue to do so for a long time to come.

If you're not using Fairchild's F100K family, you're wasting both system and design time. And, sooner or later, you'll want to take full advantage of its performance benefits. Why not make it sooner? For more information about the fastest family in the business, call Bipolar LSI Logic at Fairchild Semiconductor Products Group, P.O. Box 880A, Mountain View, California 94042. Telephone: (415) 962-3941. TWX: 910-379-6435.
Fig 3 Effect of propagation delay on channel capacity in CSMA. Channel capacity is dependent on ratio of propagation delay to packet transmission time. When ratio becomes large, CSMA performance degrades to that of Aloha schemes.

Fig 4 Delay vs throughput for various access schemes. Message delay (normalized to packet transmission time) is dependent on throughput of communication channel. Various CSMA persistent schemes provide excellent delay performance when propagation delay is small compared to packet transmission time (a = 0.01).

The models show that packet size, transmission rate, and propagation delay can be traded off to obtain an acceptable level of performance. An analysis of channel capacity relative to the ratio "a," propagation delay time per packet transmission time (Fig 3), reveals that as "a" becomes large, the channel capacity is reduced. For large values of "a," CSMA schemes approach performance levels of the pure Aloha. Hence, the CSMA scheme is useless when propagation delay time between devices is large. This is because the sensed channel state provides obsolete information about the channel. In all of these access methods, retransmission of a data packet is according to a randomly distributed transmission delay. The delay a message may encounter in transmission will be dependent on this retransmission delay, as well as the offered traffic to the channel. Communication delays of various protocols are illustrated in Fig 4. The use of messages to schedule events in other processors will be affected by this channel delay, which will vary if there are fluctuating traffic conditions. The common communication channel provides a means by which separate system components and processors can access and update shared variables and resources. The statistically varying channel delay complicates the problem of event synchronization, which is usually necessary for this sharing of resources. Research is currently being carried on in the areas of synchronization functions and primitives for distributed system architectures.

Shared Resource Synchronization

A properly functioning distributed system must provide a mechanism that will guarantee asynchronous access to shared resources. This is necessary to protect data and devices from being changed simultaneously by two or more processors. It follows that there must be some form of mutual exclusion in order to allow one process to lock out access to a shared resource by other processors in a critical section. A critical section is a code sequence that, once begun, must complete execution before another process enters a code section that accesses the same shared resource. A Boolean variable or semaphore can be used to indicate whether or not a process is executing a critical section. Since the testing and setting of such a variable is itself
OUR MICROCOMPUTER TALKS TO YOUR WORLD.

When you need a powerful processing system that talks to your world... you need a COMMANDER COMPUTER. Four standard RS-232C ports handle serial data to 19,200 baud, allowing you to add low speed peripherals or even communicate with remote devices over a phone line. But if you need higher speed or more flexibility, use COMMANDER's parallel I/O under program control. And, if that's not efficient enough, select the optional DMA port to process parallel data on a cycle-steal basis direct to memory. COMMANDER's optional IEEE/488 controller gives you direct interface to the world of instrumentation and a host of compatible devices readily available. The optional Real Time Interface module gives you individual bit I/O to input status lines and digital sensor signals ...or to output alarms and commands. And you can use up to four independent programmable real time clocks for precise time interval control without wasted processor time. Inquiries for custom features are welcome.

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CIRCLE 16 ON INQUIRY CARD

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The M-120. Easy to recommend. Easy to own.
The M-120 is priced to be competitive with ordinary printers.
But this is no ordinary machine. This one prints as many as six copies at once. With crisp, easy-to-read print. In condensed, standard or expanded characters.

It's designed for minimum cost of ownership. There's no preventive maintenance needed whatsoever.
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Fully compatible with our 340 cps printer.
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Dataproducts
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Albert H. Surprenant Inc. is alive and well producing high-quality ALSUR® wire and cable to Mil Spec, UL, and CSA standards at our plant in Jaffrey, New Hampshire.

We've been busy recently making the transition to a subsidiary company of Teleflex Incorporated (USA). The transition is now complete and we are totally up to speed. That means substantial inventories on many popular items so we can make immediate delivery from stock. It means also that we've got the best turn-around time on specials of anyone in the business.

There are other positive changes. We have plans for expansion as well as new product development, much of it in conjunction with other Teleflex products. We also have streamlined our marketing, and will now handle all order processing from the Teleflex Fluoroplastics facility in Randolph, New Jersey.

One thing that hasn't changed is Surprenant quality. We will continue to meet or exceed Mil Spec, UL, and CSA standards. Teleflex wouldn't have it any other way. Like us, they have a well-earned reputation for quality in demanding industries such as aerospace and electronics.

Rest assured that the Surprenant symbol still represents today, everything it represented in the past. But now that the symbol is backed by Teleflex, it means considerably more.

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a critical section, this function must be performed by a single indivisible (atomic) operation. If it is not an atomic action, two or more processes may test the variable simultaneously and then set it. This action would allow simultaneous execution of critical sections, and the result could be erroneous multiple accesses to peripheral device controllers or global memory parameters.

Mutual exclusion can be accomplished in software through two primitive operations described by Dijkstra for "N" parallel processes. Designated as P and V, these primitives operate on integer variables called semaphores. The V procedure increments the semaphore in a single indivisible operation, while the P procedure loops in a busy wait state until the semaphore is greater than zero, at which time it decrements it.

A bus lock operation can be issued to make certain that the fetch, increment, or decrement and store are not interrupted by another processor in a multiprocessor system. The program should test the semaphore before issuing a bus lock to avoid the continuous locking and unlocking of the shared system bus while looping in the wait state. However, a second test is required after the lock to insure that another processor has not also found the semaphore greater than zero and has tried to enter the critical section at the same time.

P and V operations of semaphores, as well as the system bus locking scheme, provide a means of mutual exclusion in a multiple processor system. These techniques permit the sharing of resources by two or more processors. However, such schemes are not very attractive in distributed systems where communication delays become rather large compared to the processor instruction cycle. Locking of the communication bus will result in inefficient utilization of the data channel. Continued research in this area will most likely uncover improved synchronization techniques.

References

8. R. Pardo, "Interprocess Communication and Synchronization for Distributed Systems," PhD Dissertation, Department of Computer and Information Science, Ohio State University, Columbus, Ohio, 1979

The third and final part of Mr. Gable's column discusses communication protocols and system design considerations. It will appear in our April issue.
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CIRCLE 20 ON INQUIRY CARD
Newly Adopted CCITT Communications Standards Find Early Support

Recently established Recommendations X.20 and X.21, terminal to network interface standards for asynchronous and synchronous transmissions respectively, were developed by the International Consultative Committee on Telegraph and Telephone (CCITT) in the early 1970s. They specify electronic and circuit level interfaces covering in scope the number of pins on a plug to the level of how call connections can automatically be made (Autocall) through the network.

Both recommendations have two parts. One calls for replacing existing EIA RS-232 and CCITT V.24 electrical interfaces with a simpler, lower cost alternative, replacing existing 25-pin with 15-pin connectors. Second part of the standards calls for the replacement of the previous RS-336 and CCITT V.25 switched network interface standards, that required two different physical connections for a computer or terminal to access a switched telecommunication network. A device with full X.20 or X.21 capability will be able to access such a network automatically through a simpler, single interface. In many respects the new standards can be thought of as performing the same functions as a full X.25 packet-level protocol, without any of the complexities of packet switching.

Among the first to support the new standards is Tran Telecommunications Corp., 2500 Walnut Ave, Marina del Rey, CA 90291, with its M3200 series network processors and network access concentrators. These will continue to support existing communications standards, and since X.20 and X.21 specify the low end, electronic, and circuit level interfaces, the new standards are expected to be used in conjunction with higher level protocols already supported by the M3200 series.

M3200 provides several forms of switching for both virtual and physical circuits: packet, circuit, and “Pacuit,” a proprietary hybrid switching technology. Adding X.20 and X.21 support brings several advantages. It provides a low cost network access means for X.20- and X.21-compatible computers, front ends, and terminals; simplifies isolation of malfunctions in terminal and communications equipment; and eliminates the 50-ft (15.24-m) limitation for local terminals forced by some computer architectures.

The capacity of the M3200 architecture to concurrently support several switching technologies makes it easy to add the new standards. The need for X.20 and X.21 support is expected to grow substantially by late 1981. Tran interfaces are scheduled for the second quarter of next year.

The development of both standards, especially that of X.21, has been supported by carriers and computer vendors alike. Many of the details of the standards derive directly from AT&T and IBM contributions. Early in January 1980, IBM announced that X.21 support for some terminals and computers would begin almost immediately. This will almost certainly bring a broad base of support and acceptance for X.21, and should, indirectly, ensure a similar future for the X.20 asynchronous standard.

### Systems Group Formed For Data, Voice, and Viewdata Services

Anticipating “explosive growth” in data communications and continuing strong growth in the demand for voice communications, the establishment of a new group, GTE Communications Network Systems, has been announced by General Telephone & Electronics Corp, One Stamford Forum, Stamford, CT 06904. The group will be responsible for marketing public data network services, private data and voice network systems, standalone private branch exchanges (PABXs), and electronic data base services. The new group includes three operating units (GTE Telenet, GTE Telecommunications Systems, GTE Information Systems), and development and field engineering organizations.

GTE Telenet, a key component in the new alignment, plans a major expansion of its nationwide packet-switched public data network that will add 160 central offices (switching and network access centers) to the system, bringing the total to 250 in 1980. Later this year, an electronic mail service for message communications and document distribution will be inaugurated. Included in the 1980 plan is the addition of network interface facilities to accommodate such high speed terminals as IBM 3270-type, 2780, and HASP workstations.

In 1981 the network plans to implement a high capacity, high bandwidth satellite packet broadcast system, with dedicated ground stations located at major central office sites, and using existing communications satellites. Also in 1981, portions of the basic terrestrial network will be upgraded in transmission speed from 56k to 1.5M bits/s, reducing end-to-end transmission delay time from 200 to less than 50 ms. Further downstream, the company plans to use the new 10-GHz frequency bands, expected to be allocated by the FCC for multipoint digital communications, for intra-city packet radio transmission.

In extending these network services, the capabilities and equipment of Cambridge Telecommunications, Inc, will be included. This firm, acquired by GTE Telenet in late 1979, is engaged in the development and design of equipment and software for interfacing computers and terminals to packet-switched networks. GTE Telenet is located in Vienna, Va.

GTE Telecommunications Systems will concern itself with PABX interconnect sales, and private voice/data networks.

GTE Information Systems, providing data base and communications services for the investment/brokerage business, will pursue these and other specialized information markets, including the Viewdata program. Earlier this year, GTE acquired exclusive U.S. rights to this British-developed system (Computer Design, Oct 1979, pp 10-17). It is currently in operation on an experimental basis, providing database information from the company computer center in Tampa, Fla.
Look What's Happening at Teleray!

the Model 11...
...smart choice for APL

Teleray's Model 11 is the most useful and usable APL/ASCII terminal on the market. Why? Because we spent more than five years talking with APL users and designing and building APL terminals for them before we built our first Model 11. And it paid off!

The Model 11 is smart. It offers a full range of editing and formatting features, and it has a reserve buffer of 527 characters for up to 32 programmable functions.

The Model 11's APL overstrikes are easily readable, and its programmable wide-character display and "overstrike replay" features are unique among today's terminals.

Like other Teleray terminals, the Model 11 features snap-out/snap-in modules for easy, no-tools servicing. Costly service calls and downtime are virtually eliminated.

The Model 11 is a truly smart choice for the APL user... and most economical. We'd like to tell you more about it. Call for additional information.
Fast FIFOs from inventory.
For years MMI has made the world's fastest FIFOs. 
Now they're even faster, and come in four-bit and five-bit versions.

Our standard FIFO—the 64 x 4 bit 67401—comes with a guaranteed 10 MHz data rate ideal for disc controllers, communications, signal processing and more.

But now we're also offering the 67401A, with 15 MHz guaranteed, making it perfect for even more demanding applications such as digital video.

And we mean now! We have them in stock. Each in space-saving 300-mil-wide packages with industry standard pinouts.

Also new, a 5-bit FIFO that reduces your parts count.
That's right. The 67402 and 67402A also guarantee 10 MHz and 15 MHz data rates. Combine these 64 x 5 FIFOs with our 4-bit devices and create a 9-bit organization using two packages instead of three.

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The same devices come in mil-temp versions, and can be processed to MIL-STD 883B. Get up to one thousand off-the-shelf; up to five thousand in six weeks.

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The use of Power/Mate’s new monolithic chip permits the reduction of parts count by 20% for a much higher MTBF, backed up with a two year warranty. Reliability has been greatly improved by use of computer-aided ‘worst-case analysis’, individual testing of every/Component monolithic, and a comprehensive burn-in program.

These carefully packaged units have extremely high component density for maximum wattage per cubic inch. The standard unit has a 5V primary regulated output and two 12 or 15V regulated outputs, plus 5V and 24V semi-regulated outputs. Special units are manufactured to order with voltages specified from 5 to 28V for each of the three regulated outputs and 5 to 50V for the two semi-regulated outputs. Total continuous output power of the unit is 100, 200 or 300 watts. (See charts)

The Econo/Switch multiple output supply gives you exceptional versatility, combined with reliability, efficiency and compactness... at low cost.

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- Up to five outputs, three regulated and two semi-regulated.
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- AC Input: 95-132 and 190-264 VAC, 47-63Hz.
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- Noise and Ripple: 50mV±p-p on first output, 150mV±p-p on all other outputs.
- Temperature Coefficient: ±0.02% per °C on first output, ±0.05% per °C on all other outputs.
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CIRCLE 23 ON INQUIRY CARD
The central memory receives and stores information from various sources, and sends data to users on demand. While using the public switched telephone network as a medium, the system also uses facilities of the GTE Telenet packet-switched network, said to be a first for such a system.

**Programmable Concentrator Services up to Sixteen Terminal Ports**

![Diagram of programmable concentrator configuration.](image)

For networks operating under host computer or terminal protocols, COMDATA model 600 can support a mixture of lines, speeds, protocols, high speed route-through, multidrop, and inter-computer communications. Based on dual 8085A microprocessor architecture, the unit can operate four to 16 terminal ports, each of which may use a separate protocol and unique speed, parity, and control hierarchy. The concentrator is a product of Tectran Corp Pty Ltd, 83 York St, Sydney, NSW, Australia 2000.

A frontend 8085A services the high speed (19.2k bits/s max) primary link, which may communicate with a host computer or another model 600. Asynchronous, synchronous, and binary synchronous protocols may be programmed, including X.25 and other frame-oriented standards.

Terminal ports are serviced by the backend microprocessor which monitors port activity, allocates prime link availability, and manages protocol requirements under control of a realtime executive program. Terminal port speed is 9600 bits/s max.

A special auxiliary port is supplied on all models to provide transparent route-through, protocol conversion, interactive reconfiguration, network monitor and error statistics collection, data capture, or batch store and forward capabilities. The auxiliary port may be synchronous or asynchronous.

Other features include integral self-diagnostics, modular construction, and a 4-char system status display for operator information. Terminal port characteristics can be factory set, on-site loaded or altered, or downline loaded.

**The Versatec Connection**

The KMW VP Series random vector processor accepts random vectors and symbols from a host mainframe, reduces the information to raster form, and outputs it to a wide variety of popular electrostatic and matrix plotters, including most models manufactured by Versatec, CalComp/Gould, Houston Instrument, and Benson-Varian.

The VP System also accepts data in "line printer" format, outputting it to the attached printer/ploter operating in hardware print mode.

KMW also offers a full FORTRAN graphics package with CalComp compatible subroutines.

**FEATURES**

- Plot input in random vectors and symbols.
- Minimal mainframe processor and memory required — generally less than that used by pen plotter support software.
- Hardware symbol generation at orientations of 0°, 90°, 180°, and 270° with variable height/width ratios.
- A variety of input options.

For more information, please call or write:

**KMW SYSTEMS CORPORATION**

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CIRCLE 24 ON INQUIRY CARD

**CIRCLE 400 ON INQUIRY CARD**
Six years ago Biomation brought you the first logic analyzer. Today we bring you the industry’s broadest selection. And there’s more on the way.

Keeping abreast of the latest technological advances is half the battle these days. If you’re designing with digital logic — especially microprocessors — you know how fast things are changing.

The new demands of digital logic are what Bill Moore, Biomation’s first chief engineer, had in mind when he developed the logic analyzer, back in ’73. He called it a “glitch fixer,” designed to track and unravel the mysterious electronic glitches that plague digital logic designs.

Bill Moore was named Man of the Year by Electronics magazine for his invention. We’re proud of that. In fact, pride is a big part of everything we do. It’s the secret ingredient in each logic analyzer in our broad line.

Our other “secret ingredient” is good hearing. We listen carefully to our customers. Then design our products to meet your needs. And we keep a finger on the pulse of technology. So we can understand the special demands it puts on you.

As a result, we’ve been first with each important logic analyzer advance. For example, when we developed “latch mode” we gave you the capabilities to latch onto glitches — random pulses — as narrow as 2 nano-seconds in current models.
Today our K100-D includes latch mode — and much more. It's the premier logic analyzer for the most complex logic problems. It combines built-in display, keyboard input, 16 channels (up to 32 with adapter) and 100 MHz sampling rate.

Not every application requires such a powerful tool. To meet your special needs, we can deliver seven models, with 8, 9, 16, 27 or 32 channels, sampling rates to 200 MHz and memory lengths to 2048 words.

Which glitch fixer is best for your application? Call us at (408) 988-6800 to discuss your needs — or any time you need technical assistance. Our application engineers are here to help. For more information on our complete line of logic analyzers, write for our catalog.

Write Gould Inc., Santa Clara Operations, 4600 Old Ironsides Dr., Santa Clara, CA 95050.

And the next great glitch fixer? One thing you can be sure of. It — and the one after it — will be wearing our name.
Computer Communication System Provides Voice Response

Especially suited to applications where a data base is accessed by a large number of calls per day and where response to an entry or inquiry is short and straightforward, the ADC2000 general purpose communications processor is designed to interface audio/data communications via TouchTone® telephones into a variety of teleprocessing networks. It is comprised of up to eight ADC1500 microprocessor based buffered terminal controllers that provide computer voice response to remote terminal devices, and an ADC1700 control unit, that processes incoming calls, and interfaces incoming lines from the 1500s with the host computer. The system is available from Wavetek Data Communications, PO Box 651, San Diego, CA 92112.

The 1500 is a multifunctioned microprocessor based general purpose controller which, when linked between the 1700 control unit and the telephone system, provides computer voice response to remote terminal devices. It can perform I/O operations on up to 32 telephone lines simultaneously, and has a vocabulary of up to 940 words and/or phrases. The 1500 multiplexes terminal lines through a single serial communications channel.

An integral data set receiver accepts serial TouchTone data, translates them into digital information, and buffers it pending transfer to its microprocessor. It also receives information from the microprocessor, converts it to a form suitable to the terminal, and transfers it to the user in either voice or "beep" response. The beep indicates reception of data and reduces computer turnaround time. The unit will also transmit frequency shift key (FSK) signals at 150 or 300 baud. The data set receiver manipulates all control signals relevant to the terminal, modem, or data access device to which it is attached.

The 1700 control unit, based on a DEC PDP-11 minicomputer, processes incoming calls, and interfaces the host computer to the incoming lines from the 1500s. Memory capacity ranges from 16k to 128k words, depending on the number of 1500s in the system. The control unit includes a floppy disc for program load and a DecWriter II™ for console control and data logging. In a standalone environment, a disc/mag tape system captures the data.

The 1500s can be remotely located from the 1700 via modems over dedicated lines. Data integrity is preserved by use of an asynchronous protocol with error checking between the 1500 and the 1700, and by bisynchronous protocols between the 1700 and the host.

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ST-711RLY16D, S1045 Singles

(ST-724 .......... S595 Singles)

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CIRCLE 26 ON INQUIRY CARD
Choosing a 16-bit MPU is no easy job. We know. We went through it ourselves back in '78. We chose the Z8000 because we believed you'd choose the Z8000. Because it's better. Here's why:

"The AmZ8000 has a better architecture."

It has 16 registers. All general. All for you. Use them for data or addresses. Use them to write more efficient software with less code and faster execution.

The AmZ8000 has gobs of address space: 8M bytes of direct addressing in each of four possible address spaces. It has memory management with sophisticated relocation and protection features. It has a rich instruction set that operates on data types from quad length words right down to single bits. You can even map the I/O into memory or keep it separate.

As if all that weren't enough, the AmZ8000 has a whole series of string-oriented instructions to move, translate or compare up to 64K bytes of data in a single instruction.

"The AmZ8000 has a better future."

The AmZ8000's architecture and instructions fit perfectly with today's computation, communications and instrumentation markets. So do the peripherals. And all the popular existing parts for the 8080A/8085A, including the Am9511A and Am9512 floating-point processors and the Am9517A

"The AmZ8000 is better for your application."

Sven Simonsen, Vice President and Technical Director, Advanced Micro Devices
DMA circuit, work great with the AmZ8000. There’s a CPU that’s just right for you. For imbedded controllers, where 64K of memory is enough, there’s a compact 40-pin CPU that uses less memory for programs. For addressing large memory spaces, there’s a 48-pin CPU that’s software compatible.

But best of all, we’re getting ready to introduce a bunch of new bipolar and MOS peripherals. There’s an I/O device with a built-in FIFO, a chained DMA controller, error correction circuits and an editing CRT controller, just to name a few.

As technology develops, newer and better software-compatible CPUs with higher throughput will be coming your way.

"The AmZ8000 has better support."

We know you need supporting documentation. And we’ve got it. Ask us for our Data Book, our Processor Interface Manual and our Processor Instruction Manual.

We know you need software development tools. And we’ve got them, too. There’s our macro assembler with powerful high-level constructs and a relocatable linking loader, and a PASCAL compiler. Cross-software is available, too.

If you need a hardware development system, our AmSYS8/8 with in-circuit emulator was designed just for the AmZ8000. So was our Am96/4016 Evaluation Board. (To learn all about them, come to one of our field seminars or take one of the courses offered by our Education Department.)

And soon, you’ll need parts. With the AmZ8000 you’ve got two major U.S. manufacturers with a mask-exchange agreement. We have international partners, also. When you need parts, we’ll be there.

"The AmZ8000 is better because we’re better."

Advanced Micro Devices didn’t become the nation’s fastest growing IC company by accident. We did it by design. We only manufacture high-quality, high-volume parts. And from the day we opened for business, we’ve thrown in a freebie with every order: MIL-STD-883.

If you want your application to be better, get the MPU that’s better. Get the AmZ8000. It’s the best 16-bit family for you.
Coaxial Packet Network
Links Office Equipment

A passive communications medium, Ethernet,* for linking different types of office equipment used at business sites, has been announced by Xerox Corp, Stamford, CT 06904. The network allows each element of an office system, such as a workstation, printer, or disc file, to exchange information with any other element. One unit may also send a message to a selected group of other stations in the network, or a document may be created at one workstation and be printed at other locations. Ethernet has no switching logic and is not controlled by a central computer; it simply accepts and passes on transmissions from attached system elements. If one element fails, others are not affected.

The network consists of a coaxial cable made up of one or more segments typically several hundred meters long, and a communication transceiver for each element in the office system. Each transceiver is under control of its attached element, which has a unique address. Information is transmitted in packets, and each packet includes the message data, the address of the destination, and the address of the source. Each transceiver monitors the network before transmission to make sure it is idle, and during transmission to detect interference due to transmission by another element. If interference occurs, the packet is retransmitted when the network is clear.

In receiving data, each element recognizes and accepts messages with its own address, and ignores others. On the completion of a transmission, the receiving station sends an acknowledgment message to the sender. Ethernet is used to connect system elements within a building. Other transceivers with associated processors can be used to connect separate Ethernet networks to each other, and to outside facilities for long distance communication. Each Ethernet itself has a unique address that is used in internetwork communications. Once a packet has passed from one network to another, it is handled identically to one sent locally.

The 860 information processing system, recently announced by the company’s Office Products Div, will be the first commercial product to use Ethernet. Interconnection of 860 system elements via the network is scheduled for fourth quarter 1980.


IBM Hosts and RJE Terminals Supported by New Service

Rates have been filed for Datapac 3304, a new access service to the Datapac network, by the Computer Communications Group (CCG) of the TransCanada Telephone System (TCTS), 160 Elgin St, Ottawa, Ontario K1G 3J4. Datapac is the TCTS packet-switched data transmission network.

The new service is designed to support IBM-compatible host computers and remote job entry (RJE) terminals. It supports the IBM binary synchronous (BSC) multi-leafing communications protocol as implemented by CCG for Datapac access. Principal users of the service will be service bureaus, government, and large business organizations with customers or branches using the services of a central computer.

A main objective of Datapac 3304 is to support multi-leafing terminals with a minimum of changes. Terminal-network connection is via a network interface machine (NIM), which supports the multi-leafing protocol and converts data blocks to packets and vice-versa. Each dedicated 3304 access line offers 2400-, 4800-, and 9600-bit/s transmission speeds.

Two methods of host to network interface are provided. Transparent communications may be established between an RJE configuration and a host without modification to customer equipment, software, or operation. A NIM-supported dedicated 3304 synchronous access line is connected to the network from each host port or RJE terminal. In non-transparent communications (customers whose host subscribes to Datapac 3000 access and whose terminals subscribe to 3304) the host will connect to the network using CCG’s X.25-compatible standard network access protocol.

CCG says the new service will afford reliability, lower communication costs, and better utilization of computer resources.
These new Grayhill Series 88 sealed keyboards are available now in 3x4 and 4x4 button configurations with one-half inch button centers. The graphic overlay, which seals the keyboard surface and the contact system, resists the vast majority of common contaminants. Thus, these keyboards can be used out-doors as well as in applications that require a washable front surface. Graphic overlays come in a variety of standard colors and formats; custom nameplates can also be provided.

Grayhill Series 88 keyboards are flange mounted. Special gaskets seal the flange surface for either front panel or sub-panel mounting.

The Grayhill Series 88 electrical characteristics have been designed to be compatible with logic circuitry and are rated at 3,000,000 operations per button. The Series 88 is offered with matrix, 2 out of 7, 2 out of 8, or single pole/common bus circuitry. The snap dome contact system provides positive audible and tactile feedback to the operator.

Engineering data and prices are yours for the asking in Bulletin No. 297.

Spill-proof, contamination-proof
Snap-dome contacts give positive operator feedback
One of five standard 3x4 legends
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CIRCLE 28 ON INQUIRY CARD
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High performance memory design is a fast track. The winners are those who match advanced components precisely with today's system requirements. When it comes to static memory, only one supplier has the broad selection of high speed, low power RAMs, and the delivery you need to bring your product to market ahead of the field.

Over 50 Purebred RAMs
From the beginning, Intel has been the leader in practical, producible MOS memory technology. First NMOS. Then high performance HMOS, the high reliability technology that's produced more than 14 million fast static RAMs—as well as our industry standard 16-bit microcomputer, the 8086. Now HMOS II is here, bringing you the same reliability and a new generation of even higher speed static RAMs.

Today, Intel gives designers the widest selection of 1K and 4K static RAMs in the industry. Over 50 different versions let you tailor speed, power, density and organization precisely to your system requirements.

Record breakers for high speed systems
Nowhere is the precision matching of memory components to function more important than in high speed cache, buffer, control store and main memory. At Intel, you'll find static RAMs to cover your full range of design goals.

For highest speed and low power, no bipolar can touch our HMOS II 2115H/25H 1K static RAMs. One version gives you record access times of 20ns; three others let you choose speed/power combinations to 35ns. For designs requiring speeds from 45-70ns, our 16-pin industry standard HMOS 2115A/25A series covers the spectrum. All of these 1Ks are pin-compatible replacements for 93415/25 bipolars, and all give you dramatically lower power, too.

In a 4Kx1 format, our HMOS 2147 is the industry standard for low power and speeds to 55ns. Today, designers requiring even higher performance will find a winner in our new HMOS II 2147H—with versions as fast as 35ns and standby power dissipation of only 30mA.

Finally, for special wide-word memories, including control store and bit slice designs, Intel's 1Kx4 bit 2148 is out in front. It gives you all the performance advantages of the HMOS 2147, plus the modularity that lets you save 75% on board space compared with 1K designs. And, you can expect even faster speeds in the future as we apply HMOS II to wide-word memory devices.

Pick the best performer for microcomputers
For years, microcomputer system designers have relied on Intel's 18-pin industry standard 2114 static RAM in 1Kx4 designs. Now we've used HMOS technology to improve performance with our new 2114A. It's a direct descendent of our 2114, but with a 30% smaller die size, 40% faster speeds, and 43% less power dissipation. The 2114A gives you performance equal to that of our 4Kx1 bit 2141, so you get optimum efficiency no matter what modularity you need—no matter how basic or how advanced your microcomputer application.

Intel gets you off and running now
We're delivering all of these fast static RAMs today. To order, or for more information, including our HMOS Reliability Report, RR18, contact your local Intel sales office or distributor. Or write Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.
HEWLETT-PACKARD TAPE SPEED BARRIER BROKEN BY DATUM

Need more speed than 45 ips for your Hewlett-Packard system? Datum breaks the speed barrier with compatible vacuum column tape systems operating at 75 and 125 ips, as well as 45 ips. Dual Density is standard in all 3 speed configurations.

A new concept in tape subsystems, the 1041 Series is compatible with Hewlett-Packard Models 1000, 2100, 2144, 2115, 2116 and 2100 MX minicomputers. A single EIA rack-mounted external controller is the heart of the Datum system.

Along with increased system thru-put, Datum's Series 1041 offers you multi-transport operation using NRZI and/or PE formats. Up to four tape transports may be driven by each controller.

And we're software transparent to all Hewlett-Packard operating systems.

See Datum break the Hewlett-Packard tape speed barrier for yourself: contact your local Datum sales representative or headquarters today. And Datum gives you one more very special benefit. A superior price/performance ratio!
Programmable Control System Decreases Maintenance And Operating Costs

584 control system (left rear) uses P190 programming panel (right) for entry of control logic in form of relay ladder diagrams, as well as 200 and 500 series I/O modules. Modules provide 4 or 16 input or output circuits each and contain circuitry to optically isolate and convert field voltages to signal levels compatible with processor.

The 584 programmable controller uses state of the art technology to provide reliable solutions to a variety of control problems in a unit built to stand up on the factory floor. Developed by the Modicon Div of Gould Inc, 155 W Big Beaver Rd, Suite 104, Troy, MI 48084, the mainframe contains 32k of memory, two MODBUS communications ports, register access panel, and drivers for 4096 I/O points. It incorporates capability to increase productivity, decrease maintenance/operating costs, and reduce cost of implementation.

In addition to serving as an alternative to relays, counters, and timers for sequential and interlock control systems—traditional programmable controller functions—the unit can perform computer like calculations as well as control and reporting functions on analog and numeric data. It includes functions to simplify diagnostic (machine) monitoring and distributed control. Sufficient memory, I/O capacity, and speed are incorporated to allow for applications growth.

When control system equipment malfunctions, a limit switch or motor starter is normally at fault. The 584 provides indicators and displays to allow the problem to be diagnosed visually without external meters, programmers, or oscilloscopes. In addition, optional diagnostic logic can reside within the unit to detect, identify, and report faults as they occur. Repair by replacement procedures allow production to resume quickly if an internal component fails.

Using a set of logic and wiring diagrams the plant electrician can use field circuit indicators provided on the I/O modules to check limit switches and motor starters, for example. At the 584 mainframe the built in register access panel (RAP) verifies that circuits are operating properly.

The RAP displays any logic, analog, or numeric signal coming from or entering the controllers as well as preset and internal data. Internal values and outgoing signals can be manually overridden to facilitate troubleshooting.

Diagnostic monitoring implemented within the controller will provide preprogrammed logic checks to pinpoint failures. These diagnostics are

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Manufactured under one or more of the following patents: 3967084, 4042439, 4085306

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CIRCLE 31 ON INQUIRY CARD
Data Warehouse.
When Floppies aren't enough. But you can't live without them.

There comes a time when your system outgrows flexible disk drives. You need more storage capacity and higher throughput. But you don't want to give up the input/output convenience of floppies.

The Remex Data Warehouse storage system just solved this dilemma. It gives your system 20MB Winchester capacity, reliability and speed. Plus, it gives you the flexibility of floppies.

And Remex put it all together in one self-contained package under the common command of an advanced controller/formatter.

THE BRAINS BEHIND THE DATA WAREHOUSE.
The most complex and time-consuming task in building your own disk subsystem is designing the controller. We've done it for you.

Our very intelligent, microprocessor-based controller gets you to market quickly, with "capabilities previously associated only with large disk-oriented systems," to quote Computer Design magazine.

In fact, our built-in controller is so powerful that it increases throughput by 40% or more over existing systems.

Normally about half of I/O overhead is between CPU and disk. We've cut these communications to a bare minimum with techniques such as DMA (direct memory access) of commands and status, as well as data.

PACKET POWER SUPERCHARGES YOUR SYSTEM.
Whenever data is transferred to or from the disk, the controller retrieves packets containing all command data via DMA. The starting memory address of these packets is stored in the programmed I/O portion of the CPU. And that's all the CPU needs to instruct the controller to retrieve data, perform functions, transfer data and communicate status of that function to the CPU. When the function is complete, the controller returns the starting memory address of the packet to the CPU.

With DMA, multiple sector transfers of up to 64K words are accomplished with a single command.

The Data Warehouse also copies "off-line" so that updated or newly-created files can be safely stored outside the system.

Simply, the Data Warehouse distributes intelligence to the disk and frees your CPU for computing.

AVAILABLE NOW. SO YOU DON'T HAVE TO LIVE WITHOUT IT.
The Data Warehouse is built for 19" rack mounting and includes its own power supply. Only one CPU slot is needed for interfacing. And a variety of interface cards for minicomputers and microprocessors are available.

Best of all, Data Warehouse is available today in OEM quantities. Write Remex Division, Ex-Cell-O Corporation, 1733 East Alton Avenue, P.O. Box C19533, Irvine, CA 92713. Or call (714) 957-0039.

Ex-Cell-O Corporation
REMEX DIVISION
DATA WAREHOUSE

CIRCLE 32 ON INQUIRY CARD
Modicon's 585 programmable controller contains four basic components. Processor consists of I/O processor which communicates to I/O section and provides controller's fixed intelligence; processor which makes all logical decisions for controller; and memory board which stores system parameters, programmed logic, and numerical values.

The controller is programmed through the P190 CRT programmer which incorporates 9" (22.9-cm) CRT screen and a character generator designed specifically for relay ladder diagram displays. A tape device and ASCII keyboard are also incorporated. This unit connects directly to the controller, permitting it to be programmed in relay symbology.

Designed for use on the plant floor, the 584 can handle 60 °C ambient temperatures at 95% relative humidity and high levels of emi and rfi with no special shielding requirements. The unit's two MODBUS communications ports provide simple connection to CRT programmer and supervisory computers. The system produces extensive ladder listing tools that document the system's logic, greatly reducing the time, effort, and cost of documenting an evolving system.
BRAIN CELLS.

Employed by smart engineers for reliable, dependable, rechargeable power.
Now available in four, basic 2V cell sizes, ranging from 2.5 to 25Ah, for dozens of battery configurations and hundreds of applications.
With outstanding float and cyclical characteristics and superior storage life.
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GATES ENERGY

CIRCLE 34 ON INQUIRY CARD

Circle our number on the reader service card for additional input.
Capture it with Mostek’s 3870 family of pin compatible microcomputers.

For single chip applications, no other microcomputer family can offer you more design momentum than Mostek’s 3870. None.

Consider: When properly designed in, any 3870 family device may be replaced with any other 3870 family member in the same socket without hardware redesign. We call the concept in-socket expandability.

Let’s say you start with the 2K bytes of ROM and the 64 bytes of RAM in the 3870. Need more RAM? Double it with the 3876. In the same socket. Need more ROM and RAM? Get 4032 bytes of ROM and 128 bytes of RAM with the 3872. In the same socket. Want to prototype and test your systems prior to ordering mask ROM programs? Plug in the 3874 with its piggyback EPROM and emulate all 3870 family members. In the same socket.

The right idea for a fresh start.

As a new design path, the advantages are compelling, too. Not only does the 3870 offer you a variety of choices for the initial design, but it also simplifies planning for subsequent designs as well. In the same socket, expansion or upgrading can be accomplished as easily as exchanging one 3870 family device for another. There’s no new architecture to learn. No retooling of artwork. No new software to buy. No concerns about debugging. No new vendors to qualify. Simply stated, there’s no loss of momentum.

Design it in with confidence.

Mostek’s 3870 is the proven 8-bit single chip microcomputer industry standard. Over a million parts have already been shipped. For hundreds of applications. From microfilm recorders and electrocardiographs, to appliances, computer peripherals, and more. Supported by multiple second-sources, the 3870 has made a whole new technology affordable for scores of cost-sensitive applications.

It’s a powerful way to design.

All the pin-for-pin compatible 3870 family members operate on a single +5 Volt power supply. All standard members have 32 lines (4 ports) of bidirectional I/O. Or you can order the standby power option to protect the extra 64 bytes of RAM in the 3872 or the 3876, and still have 30 I/O lines available. The versatile programmable binary timer can operate in three modes: internal timer, pulse width measurement, and event counter mode. And the compact instruction set has over 41 single byte instructions letting you do more in less memory.

All our 3870 family members are supported with complete development systems. Choose from the economical EVAL-70 all the way up to our Matrix™ floppy disk development system with real time in-circuit emulation.

An intelligent choice for the future.

To continue the momentum, more 3870 family members will be available soon. Including CMOS versions. And the 3873 serial I/O version which will interface to devices such as terminals, shift registers, and CCD memories.

If you want an intelligent design for the future, start with the microcomputer family that has expandable designs for the future: Mostek’s 3870 family.

For more information, write Mostek, 1215 West Crosby Road, Carrollton, Texas 75006. Or phone (214) 323-6000. In Europe, contact Mostek Brussels, phone 660.69.24.
Flexible Test System
Detects Shorts/Opens
In Bare or Loaded PCBs

Providing capability for from 2400 to 4096 test points, AFIT 4500 shorts/continuity tester from Fairchild is self-programmable from known-good board. Tester controls voltage to device under test in three ranges, and has dual-solenoid/dual-port option that allows testing of two devices on same fixture.

Production throughput is increased by using the AFIT® (automatic fault isolation tester) 4500 to detect continuity and shorts in bare and loaded PC boards before transferring them to in circuit, functional, or system testing. Introduced by the Subassembly Test Systems Div of Fairchild Camera and Instrument Corp, Testline Instruments Facility, 1400 White Dr, Titusville, FL 32780, the system has a basic 2400 test point capability, expandable to 4096 in increments of 128, and can test at a rate of 6 to 10 s for a 2400-point board.

Typically, one of three loaded printed circuit boards contains defects that cause the board to fail after the soldering process; 50% of these failures are attributable to shorts. By testing boards with a shorts/continuity tester, nonproductive sorting and recycling of loaded boards through test systems is minimized, and throughput and utilization of existing in circuit, functional, and systems testers is increased.

The system’s basic 2400 test point capability expands to a maximum of 4096 points in increments of 128 points. A dual-solenoid/dual-port option allows alternate testing of two boards on a single bed-of-nails fixture.

The unit is self-programmable from a known-good board. The system learns board topology, generates a test sequence, and transfers it to a mini-floppy disc for storage. Test program generation typically requires from 8 to 10 min.

Voltage to the devices is controlled by the tester, keeping it low enough to test devices without damage. Selection of three crossover points is available to increase flexibility and to prevent unintentional turn-on damage to devices on the board. Selections are 10 Ω ±20% at 50 mV, 100 Ω ±20% at 100 mV, and 1 kΩ ±20% at 2.5 V.

Single-density minifloppy discs used for program storage can hold up to ten 2400-point self-learn formatted programs or three in self-learn format with full translation to user printed circuit board pin code.

The system is configured as a 2-bay unit; error printout tape, test fixture, CRT, and operator control unit are located on the tabletop. Base price of a system configured for 2400 points is $39,000. CIRCLE 271 ON INQUIRY CARD

Standalone Small Business Computer Offers Growth Potential

Competing with small and midsize IBM Systems/34 and /38 models, Univac BC7, and some NCR and Burroughs units, the System 10, model 320 small business computer provides standalone data processing as well as communications capability. Upward growth potential and immediate cost-effectiveness are claimed by ICL Inc, Distributive Systems Div, 415 E Airport Freeway, Irving, TX 75062 to give the system an advantage against its competition.

All software developed for its predecessor model 220 (see Computer Design, Aug 1977, p 46) and other System 10s is fully compatible, creating a sequence of upward compatible machines behind the 320. This provides the small user with an economic growth path that preserves software investment while maintaining advantages of distributed processing and multiprogramming.

A basic model 320 processor has a 60k semiconductor memory that expands to provide as much as 200k of user memory in 60k increments. 60-, 120-, and 180-char/s matrix printers are available as well as 75-, 150-, 300-, and 600-line/min printers. Cartridge module drives have capacity for 60M bytes, while storage module drives provide up to 160M bytes capacity.

Four industry compatible tape drive units are offered. System 10 is accomplished with the standard System 85 video display unit. Under multiprogramming discipline, as many as 20 display stations with associated peripherals can communicate simultaneously with the CPU, each accessing a different program. The standard disc management facility serves as the basic operating system.

Price for a minimum 320 configuration will begin at approximately $35,000. This price will range up to $100,000 or more, depending on the amount of disc memory and peripheral mix chosen. CIRCLE 272 ON INQUIRY CARD
System Packages Offer Processor Variations, Peripheral Alternatives

Ten low and midrange system packages incorporating CLASSIC 7810, 7830, and 7835 CPUs are intended to operate as a nucleus for larger systems or as standalone systems using MAX III or IV operating systems. Built around the high end CLASSIC 7861 and 7870 CPUs, eight packages offer memory variations from 256k to 1M bytes and disc capacities ranging from 10M to 67M bytes. All packages, put together by Modular Computer Systems, Inc, 1650 W McNab Rd, Ft Lauderdale, FL 33310, include maintenance kit, diagnostics, utilities, hardware/software documentation, and installation.

Low and Mid Range Systems

Low end 7810-A10A, built around the 7810 CPU uses MAX III realtime multiprogramming operating system with 128k bytes of parity MOS memory, system protect, and operators control panel. Priced at $23,000, the system also provides 5M of fixed and 5M bytes of removable disc storage and a conventional CRT console device.

A midrange package using the 7830 CPU with 128k-bytes MOS memory, the 7830-A10A has 10M bytes of disc storage, and CRT console. The similar -A10B is equipped with hardcopy console instead of the CRT. Using the same processor, the -A21A package provides 128k bytes of memory, 21M bytes of fixed media moving head disc storage, and a 9-track, 800/1600-bit/in (315/630/cm) magnetic tape subsystem, as well as CRT console. Additional storage is supplied by the -A67A combination which incorporates 67M bytes of high performance removable media disc storage.

Using the MAX IV operating system, the -B20A package offers 256k bytes of memory and 10M bytes of fixed and 10M bytes of removable disc storage. This communications processor and integrated communications subsystem offers direct memory access for up to eight asynchronous or synchronous full duplex channels (expandable to 16) and supports up to four conversational CRT terminals and one hardcopy console.

Built around the 7835 CPU, the midrange -A67A has arithmetic accelerator, uses the MAX III operating...
The AmZ8000 is better. And we can prove it.
You've read all about the AmZ8000. You've checked the specs. You've compared it with the other 16-bit MPUs. And you think the AmZ8000 is better.

Now you can prove it.

ADVANCED MICRO DEVICES
INTRODUCES THE Am96/4016
EVALUATION BOARD.

The Am96/4016 is a fully assembled and tested evaluation board designed to give you an easy, inexpensive way to put the AmZ8000 through its paces.

Use the Am96/4016 to execute AmZ8000 software at 4MHz. Use its monitor software program for register inspection, reading and changing of memory location, and debugging. Use the optional line-by-line assembler for writing the critical programs you need to prove the feasibility of your system design.

If you want to check out your specific design applications by adding other components, our Am96/6410 board is for you. If you need to add more RAM, the AM96/1064 lets you add up to 64K bytes. If you want a hard copy of your results, just connect the Am96/4016 to a serial or parallel printer.

The Am96/4016 has an optional, low-cost ASCII keyboard/display, so you can use it all by itself. Or use it with your own CRT. Or with our AmSYS8/8 Z8000 Development System.

But most of all, use it to prove once and for all that the AmZ8000 is the best 16-bit family for you.

---

**Standard Features:**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>AmZ8002</td>
</tr>
<tr>
<td>Memory</td>
<td>Sockets for up to 12K bytes of PROM; 8K bytes of RAM.</td>
</tr>
<tr>
<td>Input/Output</td>
<td>Two RS232 serial ports; three parallel ports; three interval timers.</td>
</tr>
<tr>
<td>Firmware</td>
<td>A 4K byte monitor allowing program entry, modification and checkout.</td>
</tr>
<tr>
<td>Physical Size</td>
<td>SBC Format.</td>
</tr>
</tbody>
</table>

**Optional Features:**

1. A full alphanumeric keyboard with 20-character display.
2. PROM-based, line-by-line assembler.
3. Additional memory expansion.
4. Universal prototyping card to add your own special circuitry.
5. Card cage with integrated power supplies.
6. AmZ8001 adapter.
THERE ARE A LOT OF ALTERNATIVES TO THE DISK BACK-UP PROBLEM.

FLOPPY DISKS
Storage capacity: limited.
Handling problems.
Low cost.

REEL-TO-REEL TAPE DRIVES
Low performance: 36 megabyte capacity.
High performance: 90-100 megabyte capacity.
Large, bulky, high cost drives.
Cost: very expensive, up to 20 times that of floppy disks.

DISK CARTRIDGES
Storage capacity: 5-10 megabytes.
Back-up data remains on a disk.
Large drive mechanisms.
Cost: up to $5000.00.

HERE'S THE SOLUTION.

3M HCD-75 DATA CARTRIDGE DRIVE

- Storage capacity: 75 megabytes formatted (144 Mbytes unformatted).
- Drive dimensions: 4.62" x 7" x 8.625".
- Preformatted tape, allows unlimited record replacement.
- Built-in error detection/correction capabilities.

Fully-buffered I/O channel, permits asynchronous data transfers.
Serpentine recording, eliminates wasted rewind times.
List price, including Controller, $2,150.00.
To learn more, check the listing at the right and contact the Data Products Representative nearest you. Or write: Data Products / 3M, Building 225-5E/3M Center, Dept. 127, St. Paul, MN 55101.

THE DISK BACK-UP SYSTEM THAT'S SUDDENLY WAY OUT FRONT.

3M
system, and provides 128k bytes of MOS memory with battery backup. Input is through a conversational CRT, storage is on a 67M-byte removable media, moving head disc drive.

Designed for OEM use, the 7835-AA provides controllers for a console device and all 417X disc devices. Built around the 7835 CPU, this package contains 128k-bytes memory and battery backup. Packaged with arithmetic accelerator, 128k-bytes memory, and battery backup, the 7835-based -A10A has 5M bytes of fixed and 5M bytes of removable cartridge disc storage.

High End Systems

Built around 7831 and 7870 CPUs, high end packages provide from 256k- to 1M-bytes of memory and offer peripheral equipment alternatives that consist of 10M-byte disc drive or 67M-byte disc with dual-density tape. Users can choose either hardcopy console or 4611 conversational CRT console.

3M DATA PRODUCTS REPRESENTATIVES

Data Products/3M
3M Center, 223-5E Dept. 127, St. Paul, MN 55101
612/733-8992

WEST

Hefte Industries, Inc.
Los Gatos, CA
408/264-8319
CTI Data Systems, Inc.
Long Beach, CA
213/426-7375
P.A.R. Associates
Denver, CO
303/355-2363
P.A.R. Associates South
Albuquerque, NM
505/291-5000

MIDWEST

OASIS Sales Corporation
Elk Grove Village, IL
312/640-1850
Carter, McCormic & Peirce, Inc.
Farmington Hills, MI
313/477-7700

EAST

J.J. Wild of New England, Inc.
Needham, MA
617/444-2366
Wild & Rutkowski, Inc.
Jericho, Long Island, NY
516/935-6600
COL-INS-CO., Inc.
Orlando, FL
305/423-7615

TECHNOLOGY REVIEW

Logic Circuit Test/Programming System Offers Online Facilities

The microprocessor based 3PX651 provides online test program generation and management in addition to comprehensive logic circuit test and troubleshooting capability. Three Phoenix Co., 21639 N 14th Ave, Phoenix, AZ 85027, in introducing the unit, emphasized its suitability for high volume production testing as well as engineering design and field service return/repair applications.

Magiclip™, a computer guided diagnostic probe, allows rapid troubleshooting by low skill test operators by accomplishing automatic troubleshooting. For production testing, a designated test program is automatically transferred to the test head for execution. Stored program logic vectors or pseudorandom patterns are applied in a specified timing sequence to the circuit under test. Responses can be verified simultaneously at selected program steps or singularly by waveform signature analysis. Circuit test failures are reported by fail indicator lights, while failing test numbers, pin numbers, and TNT signatures are listed either on the teleprinter or CRT display.

Online programming and testing meet needs of changing logic circuit parameters and configurations by providing convenient test program verification and modification. The MIRTEST test programming language allows straightforward program generation in a high level user oriented language.

Modular design of the unit allows users to add capability as needs increase. Additional test heads are available to permit multiple department use. Other options include addition to TTL or high voltage driver/sensor pin modules, interface adapters, high speed pin subsystems, expanded RAM, and TTY or CRT keyboards. Base price of the unit is $42,000.

CIRCLE 274 ON INQUIRY CARD
"Our energy exploration seismic modeling evaluations. there's no wait at all."

Opportunities for discovery are better, and data analysis is faster, since Conoco began using computer graphics to interactively model the seismic response of prospective rock strata.

Conoco's search for hydrocarbon fuels begins by pounding the test site with mechanical vibrators, and recording reflected sound waves as two-dimensional seismic graphs.

Enter Tektronix graphics. Rather than bundle guesswork interpretations of those graphs back to the home office for batch processing, geologists and geophysicists at the nearest exploration center digitize and display their theories of subsurface layer patterns on the high-resolution Tektronix 4014-1.

Users can continually compare a computer-generated seismic response of their hypotheses against the actual field-collected seismic data. When the two compare favorably, they have a highly probable picture of rock types, thicknesses, porosities, and other indicators of the character and quantity of hydrocarbon deposits.

"There can be more than 300 layers involved," says Conoco's Wes Rice. "Our
teams used to wait a week for
With Tektronix graphics,

graphics equipment lets us digitize each rock layer configuration in seconds so we can quickly test concepts of what's going on in the earth."

Conoco's equipment includes more than the 4014-1. Research and operations facilities also include Tektronix file managers. Graphic tablets. Hard copy units. Digital plotters. To lessen loads on their mainframes and cut data transmission costs, Conoco is adding Tektronix' intelligent options. These fully equipped 4014 work stations, along with Tektronix 4081 graphics systems, effectively address Conoco's expanding graphics needs.

From exploration to refinery engineering, Tektronix is a proven resource for cutting the costs and speeding the processes of energy supply. Whether you're wondering what's under the earth or what's going to happen down the road, we'll give you the clearest picture. For more information, call your local Tektronix sales office or our toll-free automatic answering service at 1-800-547-1512 (in Oregon, 644-9051 collect).
The MSC 3605 is an add-in, single-board semiconductor memory system, designed to extend the capabilities of DEC computers, utilizing full hex-wide UNIBUS or Modified UNIBUS slots. On-board provisions include a standard parity Control Status Register (CSR) for parity generation and checking. Expandable in 32K byte increments to 128K bytes with or without parity, the MSC 3605 provides OEM designers and end-users with a number of important operating advantages:

**Design Versatility** The MSC 3605 is switch selectable between Modified UNIBUS and Standard UNIBUS interfaces. On-board DIP switches allow the user to quickly set up starting address and storage capacity in 1K boundary and CSR address.

**Memory Reliability** Low power consumption and fewer components contribute to the high reliability inherent in the MSC 3605. Predicted MTBF is over 40,000 hours.

**Future Growth** Socketed elements provide for both simplified maintenance and future expansion.

For additional information on the MSC 3605 and our other 41 Monolithic Systems Corp. products and systems, please contact us at 14 Inverness Drive East, Englewood, Colorado 80112. (303) 770-7400. Telex: 45-4498.
18-Track Recording Heads
Quadruple Density On 0.5" Magnetic Tape

A major step towards the goal of greater storage capacity at less cost, an 18-track magnetic head, developed by Nortronics Co, Inc, 8101 Tenth Ave N, Minneapolis, MN 55427, is capable of increasing storage capacity of 0.5" (1.27-cm) computer tapes four times. In addition to doubling the number of tracks, the head can increase recording density from 6250 to 12,500 bits/in (2460 to 4921/cm) when using the group coded recording (GCR) system.

With GCR encoding, there are 9042 flux reversals/in (3559/cm) on the 9-channel format. The 18-track head can record as high as 20,000 flux reversals/in (7874/cm) using GCR techniques.

In designing the magnetic head, it was necessary to significantly reduce the size of its reading and writing tracks and to maintain practical electrical performance. Write tracks in the head are 0.014" (0.356 mm) wide compared to the 0.044" (1.118-mm) tracks used in 9-track designs. Read tracks have been reduced from the previous 0.040" (1.016 mm) to 0.010" (0.254 mm) in width. In addition, the head design permits backward compatibility—in the read function only, allowing the 18-track head to read standard 9-channel tapes.

Another facet of the development program producing the 18-track heads provides the option of using permalloy or ferrite as the core material in the head. While the use of permalloy has been extended to this high bit density system, it has limitations. The high frequency characteristics of the permalloy used in the conventional core does not provide the system with the same capability in recording high density as is supplied by the characteristics of other materials such as ferrite or thin film heads.
Heads having ferrite cores have the potential for longer life, lower maintenance and greater density. Ferrite heads may have the potential for a cost advantage as well. However the longer time necessary to get delivery on the ferrite heads will influence the decision of drive manufacturers.

To use this head, existing tape drives will not require total new development. Some modifications to accommodate the increased number of data channels will be necessary, however. Existing electronics designed for high speed OCR tape drives should be usable in slower speed, high bit density, 18-channel tape drives.

These high recording densities, however, approach the ultimate usefulness of current 0.5" (1.3-cm) computer tapes. Although tapes now in use on 9-channel systems can be used with the 18-channel head, they are marginal when used at more than 10,000 flux reversals/in (3937/cm). Because of this, some tape drive manufacturers will use different tapes, such as those used for instrumentation recording. A quantity of the heads have been shipped to drive manufacturers for testing. Manufacture of the heads could begin late this year or early next year.

**Speech Recognition Systems Double Operating Speed, Approach Continuous Goal**

Doubling the speed at which voice data entry to a computer or other voice actuated systems can be operated, Quiktalk™ speech recognition systems greatly reduce the required pause time between spoken words. This development from Threshold Technology, Inc., 1829 Underwood Blvd, Delran, NJ 08075, closely approaches the goal of connected word or continuous speech recognition.

With the systems, moderately experienced speakers have attained better than 99% accuracy at entry rates of 180 words/min using the basic 32-word vocabulary (expandable to 256 words). More than twice the rate attainable with previous isolated word recognition equipment, this speed has been achieved with only a modest increase in cost. Thus prices for the units have been held to approximately 10% to 20% above those of current models. Most systems in the field can be modified to provide the high speed recognition capability.

In earlier systems, it was necessary to pause for 0.1 to 0.2 s between words to permit the device to discriminate between true word ends and certain intraword drops in signal energy that are a natural characteristic of speech. This requirement made it impossible for speech recognition equipment to match keyboard entry speeds in some applications.

To overcome this problem, the company's engineers devised an electronic means of recognizing strings of words as units rather than as individual words. Thus, the shortest possible pause between words can now be reliably detected.

The two models featuring the high speed capability are the 580 and 680. The 680 Voice Data Entry System is a complete interactive terminal capable of handling voice recognition, speaker training, speaker reference storage data, and all functions necessary to translate human speech into computer compatible data or machine commands. This unit provides a CRT or 16-char alphanumeric display and can serve as a direct replacement for a CRT keyboard or teleprinter, with no host computer modifications or special software required. It can be used for data entry, inquiry-response, timesharing, editing, or command and control applications.

Offering the same speed advantages in a lower cost system, the 580 uses a host computer for controlling the training process, operator prompting, storage of individual speaker reference data sets, and interpretation of word output codes. This type of operation permits usage as a completely host controllable speech recognizing peripheral device. Operation is achieved by interaction of the unit and the host CPU over an asynchronous serial communications protocol. A 16-char alphanumeric display is provided.
Field-programmable PALs available in quantity.

PAL offers economic alternative to TTL logic.

National now offers a family of Programmable Array Logic devices designed to replace standard TTL logic. A single PAL can replace 4 to 10 SSI/MSI packages. All PAL devices are fully field-programmable to provide the utmost in design flexibility and efficiency.

PALS basic logic implementation is the familiar AND-OR array, where the AND array is programmable and the OR array is fixed. Variations on this theme include the number of OR gates in the array, invert or non-invert following the OR, the number of inputs and outputs, and registered or non-registered outputs.

The programmable AND array is a matrix of Titanium-Tungsten fuse links that initially connects every input and its complement to every OR gate. Programming the array removes some of these connections to form an AND function of the remaining device inputs (or their complements) on the selected OR gate inputs. For devices with registers, the register outputs are also in the AND matrix.

Saves space, time and money. A single 20-pin PAL can replace at least 4 SSI and MSI packages in a typical application. And depending on the specific logic function being implemented, a package-for-package replacement ratio of up to 10-to-1 can be achieved.

PAL's standard AND-OR logic and flexible I/O programming provide hitherto unknown design and production efficiency. Because logic modifications can be made more quickly and easily with PAL than with discrete random logic.

Reliable products from a dependable source. Under license from Monolithic Memories, Inc., National is producing TTL-compatible PALs with the same time-tested technology used to manufacture PROMs. The reliability of Titanium-Tungsten fuses is well established both through internal Rel testing and three years of field use. And with 15 different PAL devices to choose from (including both mil- and commercial temp), logic design efficiency and reliability is truly maximized.

National's high volume production capability means a dependable source of reliable PALs at the lowest possible cost.

PAL is a trademark of Monolithic Memories, Inc.
BLC Series/80 Family stresses practicality and reliability.

National doesn't just make over seventy-five Series/80 computer products. They make them practical with test points, options, functional design and availability.

Some manufacturers build flashy boards loaded with far-out technology that you don't need and won't ever use. But not National. They make practical, reliable boards that do just what you buy them for.

And National makes more kinds of those practical, reliable Series/80 products than any other manufacturer.

The Series/80 Family is by no means just a second source supply. No other supplier beats National's reliability, functionality of design, user options, or variety of products.

The Series/80 Family includes CPUs, memories, controllers, analog and digital I/O, peripheral controllers, firmware, card cages, power supplies, cables and just about anything you need for just about any application.

Test procedures make them practically perfect.

National's boards are designed to be functional, easy to design in and totally consistent in operation. That's why test points have been designed into each board. So testing becomes an integral part of the design phase and continues throughout National's unique dynamic high temperature burn in.

To further ensure reliability, you also get a full one-year warranty with each Series/80 board that you buy from any of National's distributors worldwide. The longest warranty in the industry.

All from the Practical Wizards who finally brought space-age technology back down to earth.

AF137 dual PCM filter tuned to PBX industry.

National's AF137 dual PCM transmit/receive filter was designed primarily for PBX and other digital telephone systems that are based upon an 8kHz sampling rate.

The AF137 filter is packaged in a single precalibrated package. And since it requires no tuning or external components, the laser-trimmed AF137 offers significant savings in terms of both design space and inventory costs with minimal power dissipation.

Both the transmit and receive filters incorporated into the AF137 are third order elliptic low pass filters. The transmit filter provides a flat bandpass response from DC to 3.0kHz. The receive filter compensates for the S/N response of the sampled input, thereby restoring it to a flat bandpass characteristic.

The AF137 dual filter is the least sensitive to time and temperature of any active filter available. That's because the Wizards at National feel that their filters shouldn't just be the best — they should stay the best.

LH0084-The logical choice in instrumentation amps.

The LH0084 programmable gain instrumentation amps were designed specifically for data acquisition systems where settling time and input impedance are critical to the systems' integrity. As a result, the LH0084s settle to 0.1% in only 4μsec or less and offer 500pA input bias current and a typical input impedance of 10¹¹Ω.

Gains for the LH0084 are set internally in two stages. The first stage is software programmable in highly accurate gain steps of 1, 2, 5, or 10. This stage, controlled by a 2-bit TTL-level input word, allows software to set gains dynamically within the system.

For additional flexibility, the second stage can be pin-strapped to gains of 1, 4, or 10. So the gain ranges most widely used in instrumentation can now be provided by a single LH0084 high-performance amplifier.

The LH0084 programmable gain instrumentation amps are available in both military and commercial temp versions. Both versions come in hermetically sealed 16-pin metal DIPs.

The LH0084 is truly the logical choice when it comes to instrumentation amps.
National is seriously in the ROM business and is committed to capturing the major share of the market.

"At National Semiconductor we’re in the ROM business in a big way. We’ve made a major, no-holds-barred commitment to ROM production, and our fabrication lines are now ROM exclusive – not shared.

"And we’re committed, also, to delivering every ROM we make on time. Without exception, thanks to our increased capability for volume deliveries. Which means no missed deadlines for our customers.

"With the number of products we offer, we’re truly a first source company, and intend to stay that way. Our line features the MM52116, MM52132, and MM52164 ROMs, 16K, 32K, and 64K respectively. All are 2716 PROM-compatible, fully static, single ±5V products.

"Every model in our line has good, stable circuits which meet and, in many cases, exceed applicable specifications. Our prices are truly competitive, too.

"With the addition of a geared-up, production commitment to ROMs, National becomes a supplier for all your needs. We have focused our manufacturing capabilities on ROMs, no ifs, ands, or buts, and fully intend to dominate the marketplace.

"Call or write us here at National today and let us show you how committed we are."

Low-cost commercial temp BIFET op amps guarantee lowest drift.

National Semiconductor guarantees the industry's lowest $V_{os}$ drift with their new line of commercial temp BIFET op amps. With these new low-cost op amps, the need for costly special testing has been eliminated. The LF351A-1 and LF351B-1 single BIFET and the LF353B-1 dual BIFET op amps require 1.8mA current yet maintain a 4MHz gain bandwidth and a 13V/µsec slew rate. But perhaps of greater significance is their offset voltage drift:

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Initial $V_{os}$</th>
<th>Max Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF351A-1</td>
<td>2mV</td>
<td>20µV/°C</td>
</tr>
<tr>
<td>LF351B-1</td>
<td>5mV</td>
<td>30µV/°C</td>
</tr>
<tr>
<td>LF353B-1</td>
<td>5mV</td>
<td>30µV/°C</td>
</tr>
</tbody>
</table>

These new op amps are ideal for applications such as high-speed integrators, fast D/A converters, and sample-and-hold circuits.

The Wizards, known for their premium mil-temp BIFET op amps, are now setting the pace for high-quality, yet low-cost commercial temp BIFET op amps. Each with a guarantee that can't be beat.

BIFET is a trademark of National Semiconductor Corporation.

What's new from the National archives?

006 □ Special Functions Data Book ($3.00)
009 □ ROM MM52116 Data Sheet
010 □ ROM MM52132 Data Sheet
011 □ ROM MM52164 Data Sheet
022 □ LF351A-1/351B-1/353B-1 Data Sheet
025 □ PAL Brochure
026 □ AF100-1CN, AF100-2CN Data Sheets
027 □ AF137 Data Sheet
032 □ LH0084 Data Sheet
035 □ Additional Series/80 Information

Enclose check or money order based upon appropriate currency. Make checks payable to National Semiconductor. Allow 4-6 weeks for delivery.

NAME ____________________________
TITLE ____________________________
COMPANY __________________________
ADDRESS __________________________
CITY ____________________________ STATE ZIP____________________

For desired information, mail coupon to:
National Semiconductor Corporation
2900 Semiconductor Drive
Mail Stop 16250
Santa Clara, California 95051

In Europe, mail coupon to:
National Semiconductor GmbH
Industriestraße 10
D-8080 Fürstenfeldbruck
West Germany

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Conductive Modifiers Improve Electrical Properties of Plastics

Electrical and thermal properties of molded plastic products are improved by addition of series 100 modifiers. The modifiers are aluminum alloy flakes or fibers which, when added to such materials as polyesters, polycarbonates, or nylon, provide emi shielding, static charge dissipation, resistive heating, and heat conduction. Developed by Transmet Corp, 1375 Perry St, Columbus, OH 43201, the modifiers meet the demands of virtually any compounding, extruding, or molding process.

Equipment enclosures produced with modified plastics offer inherent shielding against electromagnetic interference. When modifiers are used in the molding process, emi shielding is accomplished, eliminating the need for the painting or metal spraying now used to provide protection. A similar cost reduction is accomplished when the modified plastics are used as an alternative to metal enclosures. In addition to the elimination of environmentally generated noise, the plastic enclosures weigh less and offer improved appearance.

Total shielding effectiveness of an emi shield is the sum of the energy reflected plus the energy absorbed. Design controllable parameters are part thickness, $\rho_e$, and bulk resistivity. Thicker parts will have more modifier between the emi source and receptor, thus the amount of shielding will increase. Highest shielding effectiveness is obtained using the highest conductivity resin (lowest $\rho_e$).

In general a $\rho_e$ less than 500 $\Omega$-cm gives some shielding and good electric static discharge protection. A $\rho_e$ of less than 100 $\Omega$-cm will yield good shielding; $\rho_e$ less that 25 $\Omega$-cm provides excellent shielding.

Because modified plastics readily conduct electricity they can be used in applications where a build up of static charge cannot be tolerated. Molding the hubs and outer surfaces of wheels and rollers from modified plastics provides static bleedoff for their metal counterparts as well as lighter weight and corrosion resistance. Sudden static discharges can have disastrous effects on sensitive instrumentation with erroneous reading or erasing of accumulated data resulting from a single occurrence. Housings made of modified plastics can ensure continuous grounding and prevent the interruption of critical functions.

Although the material conducts electricity it has a finite resistance, therefore a current passing through will produce energy in the form of heat. Since the resistivity can be altered by the material’s formulation and the heating ability by the configuration, resistive heaters formed of the material can conform to virtually any

Typical curves (top) show emi shielding effectiveness of Transmet’s modifiers using shielded box, shielded room, and coaxial transmission line measurement techniques. Curves on bottom show effect of frequency on shielding effectiveness in phenolic and polycarbonate materials.
heating application within the resin system's thermal limits.

The material's heat conduction properties also adapt them to use in removing heat from heat producing components. By molding heat sinks as an integral part of the equipment enclosure, the cost of a special piece of hardware can be eliminated. In addition to absorbing heat from specific components, enclosures made from the material keep internal equipment temperatures lower by dissipating heat to the surrounding environment.

Economic advantages of using modified plastics become apparent when the cost of manufacturing a product using current coating technology is compared with the cost of producing an identical product using modifiers. The example is an equipment enclosure with a surface area of 13 ft² and nominal wall thickness of 0.125" (1.2 m² and 3 mm) to be shielded.

Series 100 conductive modifiers are flake and fiber products based on the melt extraction and melt drag techniques developed at Battelle Memorial Institute Laboratories in Columbus, Ohio. The particles are formed directly from a molten bath, eliminating variations inherent in machining techniques. K-102 flake and B-103 through -106 fibers provide a range of shapes and lengths (3 to 18 mm) to meet needs of compounding, extruding, or molding processes. The flake orients itself to the direction of flow and gives minimal flow resistance. Higher aspect ratio fibers can also be used in injection molding. Flakes can also be used in sheet and mat molding applications; longer fibers can be used if dispersed across the E-glass mat.

### Distributed Data System Built Around Intelligent Terminals

Communications capabilities necessary for distributed processing, intelligent data entry, and distributed printing are a major feature of the 5280 distributed data system introduced by International Business Machines Corp, General Systems Div, PO Box C-1645, Atlanta, GA 30301. Comprising the family are single- and dual-keyboard/display stations which attach to a control unit.

For use with the system, the 5225 printer offers upper and lower case impact matrix printing as well as condensed printing in various sets of up to 192 characters. Print speed is independent of character set size and line length for lines of up to 7.4 to 13" (18.8 to 33 cm) depending on the model. Maximum rated speeds of the four models range from 280-lines/min at 10 char/in (4/cm) and 195 lines/min at 15 char/in (6/cm) for the model 1 to 560 and 420 lines/min, respectively, for the model 4.

Other printer attributes include 132 printing positions at 10 char/in and 198 positions at 15/in. Condensed printing allows a report previously printed on 14.875 x 11" (37.82 x 28-cm) paper to be output on 8.5 x 11" (21.6 x 28-cm) paper at 15 char/in and 8 lines/in (3/cm).

Software for the system includes a system configurations program to tailor IPL for the operating environment, initial program loader that initializes any 5280 system for program execution, and a close failure recovery program that allows users to identify and specify an end of data record in a diskette data set in the event of an abnormal program termination. DERPC programming facility allows interactive data entry, high volume key entry, and user defined processing. This software provides multiple screen formats, high function keyword editing, an RPG subset of calculation operation codes capability for subroutines or batch oriented standalone programs, diskette data set support, and a source

### Table: Current Technology vs Modified Plastics

<table>
<thead>
<tr>
<th>Description</th>
<th>Current Technology</th>
<th>Modified Plastics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials Cost</td>
<td>$0.75 to 1.27/lb</td>
<td>$2.50 to 3.50/lb</td>
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<td></td>
<td>$0.029 to 0.055/in²</td>
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<td>$0.52 to 0.99/ft³</td>
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<td>Molding, 100 s/cycle</td>
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<td>$1.25/part</td>
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<tr>
<td></td>
<td>$0.115/ft³</td>
<td>$0.096/ft³</td>
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<tr>
<td>Secondary coatings, labor and materials</td>
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<td>No cost</td>
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<tr>
<td>Total Cost/ft²</td>
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<td>$30.50 to 45.06</td>
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<td>Average Part Cost</td>
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</tr>
<tr>
<td></td>
<td>Average Savings/Part</td>
<td>$12.54</td>
</tr>
</tbody>
</table>

**CIRCLE 278 ON INQUIRY CARD**
Qantex IMPACT PRINTERS

150 CHARACTERS PER SECOND
80/136 COLUMNS PER LINE
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entry program. Both COBOL-OS/VS and COBOL-DOS/VSE host compiler and library will be available as is a sort/merge package for use with any diskette data set organization supported by the system.

Communications utilities consist of communications access method support and an interface to the access method for communications programs written in any of the system's languages. Users can communicate using BSC and SDLC in System/370, 303X, 43XX, and System/3, /32, and /34, as well as Series/1, 3740, 5260, or another 5280.

A representative 5280 configuration consists of programmable keyboard/display station with main storage of 64k characters, two diskette drives that accommodate 1.2M characters each, a 120-char/s model 5256 serial printer, and a communications adapter. This system has a purchase price of $16,660. Shipments are scheduled to begin in June.

Keyboard/display stations are available with 480-, 960-, or 1920-char screen displays featuring extended highlighting with reverse image, high intensity, blink, underline, nondisplay, and column separators. Keyboards are either data entry, data entry with proof arrangement, or typewriter style. Available character sets include 94-char upper and lower case EBCDIC, 94-char ASCII, and 188-char multinational sets.

The 5285 programmable data station is a keyboard/display unit with built-in programmable controller and diskette drive. This unit provides 480-, 960-, or 1920-char displays, 32k, 48k, or 64k bytes of main storage, and a second optional diskette drive. Transmissions use BSC and SNA/SDLC communications lines.

A standalone programmable controller with one diskette drive, the 5288 programmable control unit has 32k to 160k bytes of main storage and facilities for three optional diskette drives. The unit provides for a cluster of up to four keyboard/display stations and attachment of up to four 5256 or one 5225 printer.

Consisting of dual keyboard/display station, built-in controller, and two diskette drives, the 5286 dual programmable data station provides 32k, 48k, or 64k bytes of main storage and 480-char displays. The unit functions as two independent programmable data stations.

---

**Conferences Will Focus On Pattern Recognition, Software Engineering, and Microcircuit Applications**

Research papers on all aspects of pattern recognition are being solicited for presentation during the International Conference on Pattern Recognition in Miami Beach, Fla, on December 1 through 4. Cosponsored by the IAPR and the IEEE Computer Society, the conference will consist of long (6000-word) and short (3000-word) papers, chosen from those submitted.

Topics include methodologies—statistical, structural, and syntactic methods, and clustering techniques; preprocessing and feature extraction—image enhancement and restoration, line drawings, waveform analysis, and shape and texture analysis; and implementations—digital systems, special processors, optical techniques, interactive systems, data structures, data bases, and innovative computer architectures. Also of interest are applications in the areas of character recognition, speech recognition, robot vision, medicine, and biomedicine.

Four copies of a full length draft should be submitted by April 1 to the Program Chairman: Prof Y. T. Chien, Dept of EE and CS, U-157, University of Connecticut, Storrs, CT 06268.

The International Conference on Software Engineering will serve as a forum for technical and managerial interchange on the issues facing the field during the 80s—the need to improve productivity, enhance quality, and
Who debugged debugging?

Introducing one of The Glitch Grabbers™ from Philips: the PM3540, a new logic analyzer that's specifically designed for digital debugging. It gets the bugs out fast because the PM3540 is the only compact instrument in the field today that allows data to be displayed, analyzed and then be directly related to real-time situations.

At the touch of a button the PM3540 changes from a logic analyzer to a two-channel oscilloscope, with interactive triggering from the same data word. This gives you an exact cross-reference between data and timing—essential for digital troubleshooting.

The PM3540 allows you to work with data in binary, octal or hexadecimal formats. You can capture a data block of 64 x 16 bits anywhere along the data stream. Page the display at the touch of a button through the data stream. Analyze and track down the fault and then set the PM3540 to trigger internally as an oscilloscope.

With the PM3540 you get both logic and real-time analysis in a single, compact, high-performance instrument. An instrument that speeds up your job of locating the bugs and correcting the digital faults.

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Philips, of course.
Hewlett-Packard's 2649 Series terminals are making a lot of OEMs look good these days.

Here are three reasons why:

The HP 2649A. Build in the performance you want. The microprogrammable HP 2649A lets you take full advantage of your knowledge of 8080 assembler and really get "inside" the machine for sophisticated programming. What's more, all the circuitry for each specific function—data communications; keyboard interface—is on a single plug-in module. So you can pick the individual cards you need to refine your product further: serial or parallel I/O boards and RAM, ROM, and PROM memories.

HP also provides a powerful set of development tools to help you get the most from the HP 2649A in the least time. These include a RAM-based development terminal with cross assembler and debug features, comprehensive documentation, and a practical, hands-on training course.

The HP 2649I. Applications programming simplified. The user-oriented HP 2649I lets you do high-level programming in BASIC. You get up to 220K bytes of mass storage on dual cartridge tapes, and
eight programmable keys provide menu-like instructions to guide the operator step-by-step through the job. You can even split the HP 2649I memory into four separate user areas for rapid switching between data sets, instruction menus, or data entry forms.

The HP 2649G. High-level graphics with a high-level language. The HP 2649G is a full capability, OEM-discounted graphics station, with raster scan technology, selective erase, pattern definition, and much more. And with AGL, our high-level extension to BASIC, graphics is a snap. Set axis, scaling, and location, for example, with a simple three-statement program. Or you can use our powerful Multi-Plot feature to run simple pie, bar, or linear charts without any programming at all.

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19400 Homestead Road, Cupertino, CA 95014

CIRCLE 45 ON INQUIRY CARD
TECHNOLOGY REVIEW

develop effective project management and control guidelines. To be held in San Diego, California on March 8 through 12, 1981, the conference is sponsored jointly by ACM's SIGSOFT, the National Bureau of Standards, and the IEEE Computer Society.

Papers in all areas of software engineering are invited; of particular interest are the topics of pragmatic or formal techniques or tools addressing problem definition, specification, development, certification, and maintenance of complex software systems; definition, quantification, and experimental design for assessing software productivity; models and metrics for comparing and analyzing environments for software engineering; and the impact of software engineering on the development of distributed systems and the impact of the microcomputer revolution on software engineering.

Interested authors should submit five copies of a 2000- to 6000-word paper to the program chairman: Dr. Leon G. Stucki, Boeing Computer Services Co., PO Box 24346, Seattle, WA 98124; deadline is June 1.

Highlighting microelectronic applications and development trends derived from Government sponsored military or nonmilitary efforts, the Government Microcircuit Applications Conference will focus on the themes of directions of government electronics in the 80s. To be held in Houston, Texas, from November 17 through 21, the conference will discuss VLSI and terrestrial applications of aerospace technology.

To fulfill this aim, papers arising from programs sponsored or conducted by the government are being sought for presentation. Areas of interest include, but are not restricted to, digital and analog signal processing, gigabit logic, design for testability, self-repair, life cycle cost modeling and analysis, programmable signal processing, architecture and simulation, packaging and assembly, voice processing and synthesis, electro-optics, fault tolerance, and logistic support methods.

Deadline for receipt of a 35-word abstract and 300- to 500-word summary of a paper suitable for 20-min oral presentation is April 9. Submissions should be addressed to Hildegarde Hammond, Palisades Institute for Research Services, Inc., 201 Varick St, New York, NY 10014.

GOOD CRT'S COME IN SMALL PACKAGES

Who says a CRT terminal has to be big and bulky to do a good job? At Ann Arbor Terminals, we offer a full 15-inch screen and detached keyboard as standard on all our desktop terminals. And the case is only 14” wide by 15” high by 13.6” deep.

We're known throughout the industry for our high quality and reliability. On top of this, we probably have the widest range of available options in the field. Display formats from 256 to 4800 characters. Foreign language character sets. Special command sets. Custom keyboards. Editing, protected fields and block transmit.

And if your application doesn't lend itself to a desktop terminal, we offer display controllers (especially good in industrial environments) for use with free-standing monitors. Or buy our terminal without the case and mount it in your own console.

So when the CRT is the focal point of your system, why settle for a large case and small screen? You can have excellent readability without taking up a lot of room. And get the features you need. Call us for more information at Ann Arbor Terminals, Inc., 6175 Jackson Road, Ann Arbor, Michigan 48103. Tel: (313)663-8000. TWX: 810-223-6033.

Display System Processes Japanese Kanji Characters

A general purpose display system that processes Japanese Kanji characters, IKIS (interactive Kanji input system) allows users of Data General computers to input and display the 6000 characters that form the Japanese alphabet. Produced in a joint venture between Data General Corp., Rt 9, Westboro, MA 01581 and Nippon Mini-Computer Corp., the system solves a long standing problem in Japanese computer applications.

Permitting keyboard entry of the simpler Katakana or phonetic character set, the system screen displays up to 768 Kanji characters. An attached printer allows hardcopy output of formatted data and reports, providing users with the ability to obtain information and reports in the familiar Kanji character set. The character conversion package includes a sophisticated dictionary that can be expanded for specific applications.

Multiple stations can be operated under the advanced operating system for the Eclipse computer. Applications can include standard commercial data processing and reporting as well as word processing.
Our 64K ROM is like our 32K ROM is like our 16K ROM.

For new system designs and for upgrading existing systems, the flexibility of our totally static 64K ROM gives you that extra edge. And it's backed to the hilt with proven high performance.

The SY2364 is the latest addition to our family of 24-pin ROMs designed around a common industry standard pinout. That means maximum system flexibility. All three — 16K, 32K and 64K ROMs — can plug into the same socket. System upgrades are just a matter of substituting the new ROM for the old. With no increase in power.

We offer compatibility that's more than pin deep. All our ROMs are fully static (no clocks to worry about), so they all have the same timing waveforms. If speed is your concern, you can select one of our standard 450nsec versions or upgrade to our high performance 300nsec versions. All six are available now in quantity production.

<table>
<thead>
<tr>
<th></th>
<th>300ns</th>
<th>450ns</th>
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<tr>
<td>2K x 8</td>
<td>SY2316B-3</td>
<td>SY2316B</td>
</tr>
<tr>
<td>4K x 8</td>
<td>SY2332-3</td>
<td>SY2332</td>
</tr>
<tr>
<td>8K x 8</td>
<td>SY2364-3</td>
<td>SY2364</td>
</tr>
</tbody>
</table>

No matter what your needs, we have just the ROM for you. And that includes the SY2316A, SY4600 and SY2333 (pin compatible with the 2732/2732A 32K EPROM). For further information, contact Memory Product Marketing direct at (408) 988-5611. For Area Sales Offices and distribution references, call Headquarters Sales direct at (408) 988-5607. TWX: 910-338-0135.

Synertek performs as a major MOS supplier of high volume parts with advanced technologies and techniques behind everything we make. ROMs. Static RAMs. EPROMs. Custom circuits. Single-chip Microcomputers. Systems. 6500 Microprocessors and Peripherals.

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Resistor Design Reduces Discrete Component To Planar Form

Thick film multilayer technology offers a method of reducing a discrete component or components to planar form. Producing trim factors in excess of 1000 with excellent stability, the patented design, from Electro Materials Corp of America, 605 Center Ave, Mamaroneck, NY 10543, provides circuit designers with an alternative approach to network construction.

The resistor is constructed on a ceramic substrate by printing a circular geometry over a multilayer dielectric. Termination of the resistor is accomplished at its center with a via to buried conductor and at its circumference with a conductor ring on the dielectric layer (see diagram).

An initial aspect ratio equal to the radius divided by the circumference at a point midway between the center and the outer conductor ring is achieved. This gives a value of $R$ (ohm per square)/$r$ or approximately one-third that of a square resistor made with the same ink.

By trimming the resistor in a spiral between the inner and outer conductors, it is possible to generate over 100 squares of length in a relatively small area. Minimum resistor widths are easily maintained and potential for hot spotting due to current crowding is alleviated.

Calculations made on a resistor of 0.480" (12.192-mm) total diameter and maintaining a minimum resistor width of 0.040" (1.016 mm), yield a trim factor of approximately 400:1. A reduction of minimum width to a more realistic 0.020" (0.508 mm) increases the trim factor to 1600:1—all accomplished in less than 0.25 in$^2$ (6.35 mm$^2$) of substrate area.

Several variations of construction are possible. The substrate can replace the multilayer dielectric as the required insulative layer. By utilizing plated through holes, electrical contact can be made with the center of the resistor from the back side of the substrate.

Porcelanized steel substrates offer another design possibility. Constructing a via in the glaze and exposing the steel base would provide a method of making electrical contact with the center of a resistor deposited over the opening.

Since wide resistance variations are possible with a single ink printing, wide-band tuning of RC networks using discrete capacitors is possible. It is also possible to manufacture planar RC networks incorporating both lumped and/or distributed capacitance by placing a thick film capacitor dielectric underneath the resistor either as the conductor isolation layer or as a sublayer to the material used for isolation. Low power divider networks with close tracking of resistor properties can be manufactured, since all resistors will be made of the same material. Wide adjustment capability allows the same basic circuit to be used in several similar end products, saving manufacturing cost.
Sylvania breaks the color barrier.

Introducing America's first 19-inch color data display tube. Not just a tube with color. A tube with gorgeous, glorious, sharp Sylvania color. Color that provides clearer images and better contrast than anything available anywhere. Color that makes small characters a breeze to read, with less fatigue. Crystal clear color created by a high density tri-dot mask. Color sharpened by a multiple-beam electron gun and enhanced by a Chromatrix dark surround negative guard band, and a rare earth phosphor system. Sylvania color. It's completely changed the picture in data display tubes. Write Product Marketing Manager for our latest catalog:

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SYLVANIA

CIRCLE 48 ON INQUIRY CARD
WHAT SPERRY UNIVAC IS DOING IN THE MINICOMPUTER BUSINESS.

WE'RE GIVING OEMs THE BUSINESS.

Literally.
We're out to build the biggest, best OEM base in the industry. And we've decided to do it the fastest, surest way possible. By offering OEMs the best deal in the business.

HOW DO WE DO IT?
Easy. You tell us your problem. We'll solve it. For example:
Have you ever been interested in becoming a supplier to a specific vertical market only to find you already had too much invested in software to warrant conversion to a new system with an expensive start-up price tag?
We've got a plan that provides you with a specific vertical market software package. We know where to find software that runs on our hardware with all the necessary capabilities. So we can practically eliminate start-up time and make your new system profitable with your very first sale.

WE WANT TO SUPPORT YOU.
Opening doors to vertical markets is only the first step in our plan. After we get you started, we keep you going. We'll provide marketing support suited to your specific market. And we'll provide leads from your geographic area.

YOU CAN'T LOSE.
Because we're out to win. And we've got the support that can make it happen. Sperry Univac was first in the computer industry. And we're growing from the success established by Sperry Univac with over $10 billion in installed systems worldwide.

That total support includes a heavy commitment to the kind of research and development that produced some of the first systems to run COBOL, FORTRAN, PASCAL, RPG II, TOTAL, Timesharing, Transaction Processing and a mix of communications protocols concurrently.

And we're going to keep it up. Providing a wide-range of products at the forefront of technology is as much our business as selling and delivering equipment.

We've done just about everything we can think of to make working with Sperry Univac easy. And of course, all our products are supported by 10,000 technicians servicing our hardware worldwide.

If you can think of anything else we can do for you, give us a call right now. We mean business.

For more information write to us at Sperry Univac Mini-Computer Operations, Marketing Communications, 2722 Michelson Drive, Irvine, CA 92713. Or call (714) 833-2400, Marketing Communications.


In Canada, write Headquarters, Mini-Computer Operations, 55 City Centre Drive, Mississauga, Ontario, L5B 1M4.

SPERRY UNIVAC IS A DIVISION OF SPERRY CORPORATION
Interconnection Test System Offers Software Flexibility

Interconnect verification and error detection for backplanes and bare PCB board test fixtures having up to 130,000 points are provided by the N161. In this tester, Teradyne, Inc, 183 Essex St, Boston, MA 02111 has used solid state electronics packaged in fixture cards to interface to units under test. Software, together with a high performance tape system for program storage, provide increased speed, flexibility, and ease of use.

System software offers a choice of testing, and diagnostic modes for different applications. Modular architecture leads the user through job planning, editing, or testing operations using an English language menu displayed on the CRT. In this way, executive software features such as programmable job load sequence, go/no-go or error threshold testing, and single-pin and single-network testing can be implemented online.

A basic system is made up of an M365CX computing controller with 16k memory, control and measurement system, and H747 tape system with four independent cartridge drives. Standard peripherals include CRT display with interactive keyboard, line printer to output error diagnostics, network listings, and remote start unit for production line testing.

Advantage can be taken of a dynamic memory algorithm by expanding basic memory to 112k. This algorithm automatically uses available memory for job plan residence to minimize reference to the job plan on tape, saving access and rewind time. Testing speed is further enhanced by automatic optimizing of the job plan, ordering the test sequence for efficiency, and high speed characteristics of the tape system.

Fixturing configurations, based on standard 64-, 88-, or 128-pin fixture card modules, interface with different backplanes and bare board contacting fixtures. Individual fixture cards are linked daisy chain fashion with single 14-wire cables; two cables connect this chain to the system.

To allow for production line implementation, testing operation has been simplified by providing English language mode choices or default modes. Operator messages can be programmed in a job plan and directed to a CRT display or line printer, alerting the operator to special setup procedures or diagnostic routines.

Automatic software system self-checks provide notification of setup mistakes or errors in system function.

An optional management statistics communications package provides realtime datalogging and direct serial communication with a host computer. Consisting of RS-232 interface, realtime clock, 16k of memory, and expanded executive software, the option compiles statistics such as error distribution over time and system utilization. It also permits data to be uploaded to a higher level computer for integration with other management information.

CIRCLE 283 ON INQUIRY CARD
RELIABILITY. IT'S WHAT MAKES FUJITSU THE WORLD'S LARGEST MANUFACTURER OF OEM WINCHESTERS.

That's right! Fujitsu produces more Winchester technology disk drives for the OEM market than any other manufacturer in the industry. The reason for this success is the unequalled reliability of Fujitsu products.

For instance, Fujitsu's M228X Winchester drive delivers more than 10,000 MTBF power on hours of high performance. That's 40% better than the industry standard. And the M228X is fast: 6ms track-to-track (27 ms average) access time. With this kind of performance, up to 169 megabytes of unformatted storage, and Fujitsu's competitive pricing—there is no other choice! Optional head-per-track capacity of 655 kilobytes also available with this series.

80 and 50 MB cartridge drives with SMD Interfacing

Fujitsu's advanced technology does not stop at Winchesters! The two front-loading cartridge drives with SMD capability shown here, have statistics only Fujitsu could guarantee. Like access times of 6ms track-to-track (30 ms average), and a reliability factor of over 6,000 poh MTBF. That's 50% better than the industry standard.

And whether you order the M2211 (80 MB) or the M2201 (50 MB) drive you can say goodbye to data staging. Plus you get a servo/track record system that assures the cartridge interchangeability you need. With features like these it's no wonder Fujitsu's got the world on a platter.

For technical information, (outside California only) phone toll-free 800-538-8175. For sales and service, or evaluation unit, contact: Fujitsu America, Inc., 2945 Oakmead Village Court, Santa Clara, CA 95051, Phone 408-989-2300, Telex 357-402, TWX 910-538-0047.

The first word in reliability.
The last word in performance.

CIRCLE 51 ON INQUIRY CARD
PROS AND CONS OF CURRENT 8 AND 14" WINCHESTER DISC DRIVES

OEM system designers who plan high capacity products around recently introduced 8" Winchester disc drives may lose a strong competitive edge, according to W. Ferrell Sanders, vice president of marketing at Shugart, Inc, 435 Oakmead Pkwy, Sunnyvale, CA 94086, a company which offers both 8 and 14" drives. Mr Sanders’ concern is that designers will close their minds to the benefits offered by 14" Winchester drives because of the attention generated by the introduction of 8" units by at least eight companies. "As a result of this publicity, users may overlook advantages of the 14" Winchester fixed disc drives," he stated.

In general, he points out, Winchester drives are the most cost-effective and reliable rotating memory peripherals available. "Three of the technology’s major attributes are largely responsible for this reputation. First, the drives employ low mass heads which start and stop in contact with the media. These head assemblies, which are relatively simpler and contain fewer parts than those in prior technologies, significantly contribute to the low cost factor.

"Secondly, performance is enhanced because the heads operate at a reduced flying height relative to other rigid disc technologies. This allows reading of more densely packed data than has been possible with previous products. Finally, the media and read/write heads are enclosed in a sealed environment. Thus, Winchester disc drives provide inherent protection from various kinds of contamination that may occur with removable or other types of fixed media."

Winchester drives complement the widely used floppy disc products. OEMs designing higher performance systems, however, are not presented with an alternative to use in lieu of floppy products for system residence memory, operating system storage, and mass storage memory. If the designer chooses to upgrade to Winchester technology, the 8" drives introduce the dimension of size into the capacity and performance question. Even then there are no firm guidelines because both products overlap extensively in both cost and performance.

This results from the opposing product design objectives used by the various manufacturers, according to Mr Sanders. "For Shugart and apparently one other company, low cost was the most important goal." At Shugart this was achieved by minor tradeoffs to obtain the lowest cost, resulting in 5M- and 10M-byte units costing $995 and $1205 in OEM quantities. "Pertec and IMI, on the other hand appear to have targeted for higher performance and capacity... . the Pertec drive with 20M bytes sells for about $1600 and the IMI 11M- and 20M-byte units for approximately $1600 and $1900. Between these two categories, is a 14.5M-byte 14" drive, Shugart's SA4004, which costs less than $1300 in OEM quantities." This product fits a 5.25" (13.34 cm) panel space and weighs 35 lb (16 kg). A 29M-byte version (SA4008) sells for approximately $1600.

"On a cost-per-megabyte basis, the 14" drives are usually the most cost-effective solution when the requirement is for more than 10M bytes. For example, Shugart’s SA4004 has a cost/megabyte of approximately $86," according to Mr Sanders, while "the SA4008, has a cost of $57/megabyte." "Low end 8" drives, SA1002 (5M-bytes) and SA1004 (10M bytes) have an estimated cost of $187 and $113/megabyte, respectively."

Mr Sanders sees the floppy size package as being the key advantage of the 8" fixed discs. "These disc drives can be easily exchanged for floppies because some of them fit right in the same slot that a floppy does. Additionally, in Shugart’s case similarity of electronics is also a design feature. This enables users to build a common interface to handle both fixed and floppy drives."

However, according to Mr Sanders, manufacturers might be wise, as system requirements for capacity and performance increase, to place less importance on package size and more on price/megabyte capacity. The user must also consider the difficulty of new product start-up when projecting system designs around 8" units, since the 8" units are not available in quantity and 14" units have been in production for sometime already.

INTERACTIVE SOFTWARE AIDS IN DESIGNING EFFICIENT, LOGICAL DATA BASES

Many corporations are searching for a means to design more efficient database structures which will save time and personnel resources and lower future maintenance costs. At the same time, it is important that the companies be able to understand and define their information requirements to meet the needs of end users.

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Extensions to the FMS-11 forms management software allow its use not only on small and medium systems but also on PDP-11 minicomputers and terminals running the RSX-11 operating system. Consisting of a series of utility programs that use key VT100 terminal features, the package, from Digital Equipment Corp, Maynard, MA 01754, enables screen equivalents of standard forms to be developed.

The revised implementation supports applications written in FORTRAN IV, FORTRAN IV-PLUS, BASIC-PLUS-2, COBOL, and MACRO-11. Applications programs can call for data input; neither compilation or linking is required to bind the application to the terminal driver. All user and terminal I/O functions are developed separately from the program and data processing aspects of the application.

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**Improved Software Expands Capacity of Multiterminal Computer**

Software improvements for RSX30 Marathon multiterminal computer systems save time, and provide greater security, capacity and ease of use. Among the enhancements developed by Rexon Business Machines Corp, 5800 Uplander Way, Culver City, CA 90230, is a direct file access method based on a variation of B-tree technology which greatly reduces the time required to generate a record in a direct file, while keeping access times for growing records constant.

The security feature protects proprietary software from unauthorized distribution. A pair of coded plugs are provided to authorized users. Insertion of both plugs permits unlimited access to software; without them there is no access.

In addition, the number of files which may be resident on one disc has been increased from 736 to 1500. The number of devices that may be opened concurrently from one task has also been increased from the standard 8 or 10 to a maximum of 63.

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**Hardware/Software Pack Achieves Interactive Graphics with VAX**

Graphic 7 display system users can achieve interactive stroke/refresh graphics with the DEC VAX-11/780 by programming in FORTRAN subroutine calls. This capability is provided by the 5714 high speed parallel DMA interface and 7771 VAX I/O driver software package offered by Sanders Associates, Inc., Daniel Webster Hwy S, Nashua, NH 03061.

Written in VAX assembly language, the I/O driver runs with the VMS operating system. Both hardware and software of the Graphic 7 system are compatible with the DR1/B interface option in the VAX.

The model 7764 FORTRAN support program for the display system permits the user to work in his own coordinate system. Consisting of a series of utility commands, the package, from Digital Equipment Corp, Maynard, MA 01754, provides easy to use facilities for program maintenance.

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**Interactive Software Serves in Online Program Maintenance**

An online program maintenance tool, PROMT is an interactive terminal oriented software product that provides easy to use facilities for program development, library maintenance, data entry, and job submission. Developed by Card Systems Corp, PO Box 29481, Columbus, OH 43229, the software runs as an application under the Westinghouse WESTI teleprocessing system.

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Applying Microprocessors to Machine Tool Controller Design, Part 1

This design case study has been divided into two parts. Part 1 carries the discussion through linear interpolation and data representation; Part 2, to be published in April, begins with parabolic interpolation and completes the review.

Once strictly the province of specialized controllers and minicomputers, numerical control applications are now commonly handled by microcomputers. For instance, all normal functions found in a 5-axis contouring controller can be performed by an 8080 microprocessor, almost entirely in software. The key is the careful partitioning of software functions and the simplifying of computations.

In a typical example, a controller that provides ultra-high precision utilizes a moderate performance minicomputer. Positional information is maintained to tenths of microinches and key variables to 64 bits. This computer system uses virtually no special purpose hardware since all control functions are performed in software. However, it is feasible to replace the minicomputer with a microprocessor based controller, thereby simplifying the processing requirements for typical numerical control applications.

Numerical controllers move machine tool slides and rotary tables in response to digital commands from a paper tape reader or a control computer. Servo drives replace handcranks and gear driven screws on the machine tool. Some systems also have measurement devices, such as laser interferometers, attached to the slides for position feedback. Early controllers were built with custom digital logic and magnetostrictive delay lines for memories.

For economic reasons, the first use of computers involved control of several machine tools. This configuration—known as direct numerical control (DNC)—was generally unsuccessful due to cost and reliability problems. However, as minicomputer prices dropped, it became practical to dedicate a single computer for each machine tool. Called computer numerical control (CNC), this technique has enjoyed greater success than DNC systems.

Numerical controllers fall into one of two categories: point-to-point and contouring. Point-to-point controllers precisely position the machine tool to discrete points only; the path between points is of no importance. Examples of applications using point-to-point positioning include a numerically controlled drill press or spot welder. On the other hand, milling machines and lathes require precise control of the path of the cutter between prescribed points. In these applications the controller drives the machine tool through a specified contour, which may be a straight line or, in more complex controllers, a parabola or a circle.

Core of many numerical controllers is the digital differential analyzer (DDA). This circuit simultaneously generates servo commands for linear contouring and keeps track of the distance traveled. Combining functions in this manner was ingenious at the time digital circuitry was expensive. Some designs have tried to duplicate the DDA function in software, but with mixed results. The major problem is that the DDA function must be executed at relatively high speed (10,000/s) to provide reasonable servo control. Adapting this technique to microprocessors rapidly saturates their processing capabilities.

One solution lies in analyzing numerical controllers as separate sampled data systems, optimizing each function according to requirements of the application. To date, the use of microprocessors in numerical controllers has been limited by their reduced computational capacity. Yet, with careful system design, the capacity of many 8-bit microprocessors is more than adequate for complex numerical control applications.
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Digital Differential Analyzer

A digital differential analyzer (DDA), which approximates the integration of a function by summation, solves differential equations for use in machine tool controllers. Consider the simple differential equation to describe linear motion in dimension \( x \):

\[
x = x_0 + \dot{x} t
\]

where

\[ \dot{x} = \frac{dx}{dt} \]

Eq (1) can be solved by digital circuits (Fig 1) that add the integrated value to the sum when given an add command; these commands are issued at a constant frequency for integration with respect to time. The initial integrand value is \( \dot{x} \), and may be changed during integration with the increment/decrement command. In a machine tool control application, the overflow output directs a slide positioning servo to move a small incremental distance, such as 0.001" (0.025 mm). Overflows from the sum register represent the integral and occur at an average rate proportional to \( \dot{x} \) (velocity command); the total number approximates the integral of velocity over time. A velocity command of 75% of full-scale velocity is illustrated.

Overflows ensue at irregularly spaced intervals, a major problem for stepping motors. A solution to this problem generates overflows at a higher rate than necessary and then divides them with a counter to the desired rate. This averages the pulse rate, but it requires additions to be performed much faster than before.

The addition rate makes it impractical to implement DDA algorithms in software, especially when using microprocessors. Other difficulties arise when cascading DDA circuits for higher order functions, such as parabolic interpolation, since the errors may be integrated from one stage to the next at an unacceptable level.

Sampled Data Control Systems

Sampled data systems process signals by transforming them to discrete points with a sampler. Digital circuits in general and computers in particular are ideally suited for complementing sampled data systems because of their incremental structures. Originally, analog circuits with actual samplers were used to construct sampled data systems, but that quickly changed as digital computers became readily available.

A fundamental requirement of all sampled data systems is that the sampling must be at least twice the rate of the highest frequency applied to the inputs (Shannon’s theorem). In numerical control applications, sampling will depend on the performance required of the machine, but is usually very slow (envision the rate at which a tool slide could be made to oscillate back and forth). Nonetheless, the sampling rate should be moderately high to minimize errors unavoidably created by representing a time-continuous signal with discrete points. Consider, for instance, a machine with 0.001" (0.025-mm) position feedback moving at 1" (25.4 mm)/s. Sampling positions at a rate of 100/s will result in data changing about 10 units/sample, which may seem excessive if 0.002" (0.050-mm) accuracy is specified. This may be more than adequate when compared to the upper frequency response of the slide, which may be 10 Hz. Mechanical frequency responses rarely exceed 200 Hz (for very high performance servos), and heavy machine tools are usually limited to a few hertz or less.

Linear Interpolation

The fundamental control procedure drives the machine tool in a straight line path between two points [Fig 2(a)]. Computing points along the path is called “interpolation” or, since it is a straight line, “linear interpolation.” (Other types of interpolation are circular and parabolic.) The interpolation process occurs in the block labeled “contour generation” [Fig 2(b)], which is fed the interpolation endpoints, \( x_i \) and \( y_i \). A sequence of discrete points representing the contour is fed to two position feedback control loops, one for each axis.

Machine tool slides move from one position to the next in a series of small steps whose size is dependent on the velocity and the sampling rate. The previously mentioned step size of 0.001" (0.025 mm) between samples would probably be unacceptable if the slides actually moved nonuniformly, speeding up as the position is incremented, and stopping until the position is updated again. A servo feedback control loop prevents
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DIGITAL CONTROL AND AUTOMATION SYSTEMS

this from happening; instead, the feedback loop maintains approximately the correct machining velocity between samples [Fig 2(c)]. This is the principal difference with the DDA technique, which attempts to regulate on a much finer scale. The computational process used is identical to the DDA, but the system design philosophy is substantially different.

To understand the contour generation process it is helpful to begin with the basic equations of motion. These are first presented in continuous form and are then converted to their discrete counterparts. For a first order system, the continuous equations of motion are

\[ x = x_0 + \int_{x_0}^{x_1} \dot{x} \, dt \]

and

\[ y = y_0 + \int_{y_0}^{y_1} \dot{y} \, dt \]

Integrals are approximated by a summation

\[ \int_{x_0}^{x_1} \dot{x} \, dt = \sum \dot{x} \Delta t \]

This operation is performed at discrete intervals in time (\( \Delta t \) is the sampling period). Instead of being continuous variables, the values of \( x \) and \( y \) are also computed at discrete intervals. In the following discrete formula, the particular interval is represented by the subscript \( i \):

\[ x_{i+1} = x_i + \dot{x} \Delta t \]

The continuous equation of motion is approximated by executing this computation from \( x_1 = x_0 \) to \( x_i = x_i \), where the number of iterations depends on the values of velocity, \( \dot{x} \), and the sampling period, \( \Delta t \). This single equation is all that is needed to implement a linear interpolator.

Fig 2(c) illustrates a few steps of the interpolation process on a magnified scale. Commanded position increases by relatively large steps at every sampling point. Initially, the x slide is not moving, creating an error. This error generates a servo command, accelerating the slide. After a few samples, the slide is closely tracking the commanded position, and the velocity between samples is constant.

Data Representation

A vital aspect of digital designs, whether using hardware or software, is the representation of data within the system. Selection of the format must not only satisfy the accuracy requirements, but also consider errors incurred during computations such that the system accuracy is within specifications. Data must be stored efficiently for the shortest computation time and, in some cases, minimal memory utilization. Since numerical controllers are used with many types of machine tools, any data representation analysis must make compromises.

A key format is positional data. Representing 100" (254-cm) spans to 0.001" (0.025-cm) resolution requires five decades of range. With 10 bits required per three decades (in binary), 17 bits plus 1 sign bit are sufficient. Several bytes are used to store each set of data (three, in this case), leaving six extra bits of precision. These are stored in consecutive memory locations [Fig 3(a)].

Fig 2 Linear interpolation. Contouring system has logic for each axis to generate intermediate points from endpoints (a). Intermediate points are fed to position servos to achieve smooth motion. Feedback control operates from error, or difference, between commanded and actual position to develop drive command (b). Interpolation steps are shown in (c).
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Fig 3 Consecutive memory locations. Machining data require more accuracy than afforded in one 8-bit byte; multiple precision data are stored in consecutive steps (a). Because accuracy is still insufficient for interpolation calculations, two extra bytes are carried for total of five bytes.

in turn, is a function of the elapsed time during interpolation. An error in the LSB will propagate to the position data bits after 65,000 iterations, or 650 s at a 100-Hz sampling rate. Any combination of machining velocities and distances taking no more than 650 s will keep the interpolation accurate to within 1 LSB.

The term $\dot{x}_i \Delta t$ is calculated prior to starting interpolation; since it is a constant, it need only be computed once. Values for $\dot{x}$ will generally not be provided as input data, which states the "feedrate" between given points (the velocity along the machining path). The $x$ and $y$ velocities can be computed from

$$\dot{x}_i = \frac{\Delta x_i}{(\Delta x_i^2 + \Delta y_i^2)^{1/2}} \text{ (FEEDRATE)}$$

and

$$\dot{y}_i = \frac{\Delta y_i}{(\Delta x_i^2 + \Delta y_i^2)^{1/2}} \text{ (FEEDRATE)}$$

(5)

where $\Delta x_i = x_{i+1} - x_i$ and $\Delta y_i = y_{i+1} - y_i$. A burden is placed on the software if this feedrate has to be computed to 40 bits.
Our solutions could solve your problems in CRT data displays.

Bell & Howell - Fernseh
DISPLAY DEVICES

An all-new line of data display monitors is now being manufactured by Bell & Howell-Fernseh for OEM applications.

Available in 5-, 7-, 9-, and 12-inch screen sizes.

Wide range of options—hundreds of possible configurations
• 15.75 KHz, 16.2 KHz, 18.6 KHz or other scan rates
• Dynamic focus — standard
• EIA P4, P31, P39, or P42 phosphors
• Kits and metal chassis available for all screen sizes

For more information about these new data display monitors, contact Bell & Howell-Fernseh Display Devices, 4000 Birch Street, Newport Beach, CA 92660, (714) 752-7602.

Fernseh Inc.
the Video Corporation of
Bell & Howell and Robert Bosch
DIGITAL CONTROL AND AUTOMATION SYSTEMS

INPUT:

H, L ADDRESS of \( x_1 \)
D, E ADDRESS of \( x_2 \)

OUTPUT: \( x_1 \) IS REPLACED BY SUM

MAS05:

LOAD D GET FIRST BYTE OF ONE ARGUMENT
ADD M ADD FIRST BYTE OF OTHER ARGUMENT
STAX D SAVE FIRST BYTE OF SUM
INX D ADVANCE DATA POINTERS TO NEXT BYTE
INX H REPEAT SEQUENCE FOUR TIMES
ADD M EXCEPT USE "ADD WITH CARRY"
STAX D INSTRUCTION TO PASS CARRIES
INX D BETWEEN BYTES
INX H

LOAD D
ADD M
STAX D
INX D
INX H
LOAD D
ADD M
STAX D
INX H

LOAD D
ADD M
STAX D
INX D
INX H

LOAD D
ADD M
STAX D
INX H

RETI

Fig 4 5-Byte addition subroutine. Coding without loops provides shortest possible execution time

Fortunately, examination of the extreme cases shows that floating point arithmetic with 24-bit mantissas is sufficient. To make 65,000 iterations without position overflow, \( |x \Delta t| \) must have 16 leading zeros, or 24 bits carried in the computation. For the unlikely case where \( |x \Delta t| \) is a full-scale value, only one iteration is possible without overflow. This also requires only 24-bit precision. Note that 40-bit precision is not necessary, but 40-bit range is. This observation allows the use of available floating point software packages.

The principal piece of software needed for the interpolation process is a 5-byte addition routine. Fig 4 is a program listing of such a subroutine for the 8080 microprocessor. Memory addresses of \( x_1 \) and \( x \Delta t \) are loaded into the D,E and H,L register pairs, respectively. This subroutine executes in 86 \( \mu \)s (8080 at 2 MHz), or less than 1% of the sampling interval. Clearly, this operation would not be a limiting factor in the number of axes that one microprocessor can control.

Mass termination leadership:
The only mass terminated coaxial cable in the world.

Thanks to an AMP breakthrough in ribbon coaxial cable design, you can cut your coax cost with mass termination. In any length assembly you require, and without degradation of system performance or the need for board redesign.

The reason is that our ribbon coax cable is made up of individual coaxial cables, each with a solid center conductor and a foil wrapped drain wire shield. Enabling you to make reliable mass terminations anywhere along the cable.

We also have a complete line of ribbon coax cable and connectors that feature:

- 50, 75, or 93 ohm ratings on .100" centers
- 95 ohm rating on .125" centers
- standard .025" post mating and paddle board types
- board mount pin headers and I/O post compatibility

Together, our connectors and cable provide a reliable, multiple circuit assembly that is unmatched in simplicity of design and ease of termination. So whether you order complete assemblies, or opt for the cable, connectors, and tooling to make your own, your coax applied costs go down.

For more information on this and other mass termination capabilities, call the Mass Termination Information Desk at (717) 780-8400. Or write us. AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.

CIRCLE 59 ON INQUIRY CARD
Join Aramco Services Company in Houston for top salaries, unique experience

When Aramco Services Company, a wholly owned subsidiary of Aramco, the largest oil-producing firm in the world, hires you as a process computer specialist, you'll get a top salary. Plus a great benefits package. You'll also be starting out on what could be a very rewarding Aramco career position.

Work in Houston on the world's biggest overseas projects
Aramco is the key firm involved in the development of the energy resources of Saudi Arabia.

Many Aramco projects are very large in scope, complexity, and in the application of advanced technology. There are challenging smaller projects, as well.

Many of the projects are supported in Houston by process computer specialists who serve as the key liaison between Saudi Arabia and U.S. vendors or turnkey contractors. Often, the smooth start-up and trouble-free operation of a project costing millions, or even billions, are aided by an individual or a team in Houston.

Can you think of any other place in the country quite like this where you could start to carve out such an interesting career?

This could be the job you've waited for
In this key job supporting major Aramco projects, we require process computer software engineers with BS degrees in engineering, math or computer sciences, and 3 or more years' experience in various real-time processes or SCADA projects.

We also need process engineers with BS degrees in chemical engineering, and 3 or more years' experience in designing and maintaining process computer and instrumentation systems.

Process computer hardware systems engineers are needed with BS degrees in electrical engineering, computer science or engineering technology, plus 3 or more years' experience in designing and maintaining process computer and instrumentation systems.

You'll be based in Houston, but from time to time you will be required to travel to vendors in the U.S. and to field sites in Saudi Arabia.

Interested? Send us your résumé and we'll get back to you very soon. Write: Aramco Services Company, Section DOM, Dept. CD030080JSA, 1100 Milam Building, Houston, Texas 77002.
DIGITAL CONTROL AND AUTOMATION SYSTEMS

AC/DC Threshold Sensing Optocouplers Designed For Industrial Control Computer Input Boards

Guaranteed input threshold specifications and logic compatible output are features of the HCPL-3700 voltage/current threshold detection optocoupler introduced by Hewlett-Packard Co., 1507 Page Mill Rd, Palo Alto, CA 94304. Combined in the device are a threshold sensing input buffer IC, made up of a reference voltage circuit and a comparator that compares the input signal with the reference voltage; an internal LED that lights when the threshold is reached; and a high gain photon detector. Hysteresis is provided in the input buffer circuit for extra noise immunity. An open collector output provides both TTL compatible saturation voltages and CMOS compatible breakdown voltages.

Setpoint Controllers Add Alarm or Control Capability to Digital Panel Instruments

Self-contained instruments with front panel thumbwheel switches for setting high and low limits, the AN2580 and 2581 digital setpoint controllers add alarm or control capability to any digital panel instrument. The AN2580 has a single set of thumbwheel switches and can be preset for only one limit; the 2581 has two sets of switches for two limits. The instruments compare sign and magnitude of digital inputs with the preset limits and generate outputs relevant to the comparison. Control action begins when a measured variable reaches one of the limits.

Both units, offered by Analogic Corp, Audubon Rd, Wakefield, MA 01880, include high impedance TTL/CMOS compatible inputs with programmable logic sense. The plastic cases fit a standard DNI/NEMA cutout (92 x 45 mm). Basic units are powered by 5 Vdc at 20 mA and provide open collector output control signals capable of sinking up to 50 mA at up to 30 Vdc. Standard power options include choice of 8 to 28 Vdc and 110 or 220 Vac.

Mass termination leadership:
Total system capability for .050" & Ribbon Cable.

Four complete assembly systems give you all the capability you'll ever need in .050" ribbon cable.

The AMP-LATCH and AMPMODU .100" & two row interface systems, featuring:
- compatibility with over 4,000 header variations
- post, receptacle, paddleboard, dip, and card edge styles
- capability to mix wire and cable in the same assembly
- mass terminated shielded cable capability without cable preparation
- daisy chain capability
- precision tooling and cable for lower rejection rates
- assemblies on quick delivery
- compatibility with 20 to 30 AWG cable

For RS 232 applications, there are AMPLIMITE HDF connectors, which feature:
- subminiature D configuration
- choice of 9, 15, 25, or 37 positions and mating headers
- daisy chain capability
- compatibility with AMP filtered connectors

And, for .085" & application, there are CHAMP connectors, featuring:
- telecommunications-style housings
- wire-to-wire, wire-to-panel, or pc board application capability
- IEEE #488 interface
- jacketed cable and discrete wire capability

For more information on this and other mass termination capabilities, call the Mass Termination Information Desk at (717) 780-8400. Or write us, AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.
ADVANTAGE:
FLEXIBILITY

Another way the Model 730 aces the competition!

Centronics’ Model 730 miniprinter shatters the rules of the game. Greater flexibility than any printer is one of the reasons why.

APPLICATIONS FLEXIBILITY Now you can meet a wide range of applications requirements with just a single printer: the Model 730. Payroll checks on pre-printed continuous forms. Inventory listings on fanfold. Direct mail on company letterhead. General information on roll paper—and change from one to another quickly.

INVENTORY FLEXIBILITY Model 730’s versatility means no more costly inventories of limited-use printers. Stock only one set of spares. One set of service tools. Train to service only one highly reliable machine.

INTERNATIONAL FLEXIBILITY To make your overseas marketing easier, international models of the 730 can print 95 character U.S., British, French, German, Italian, and Swedish/Finnish. Available in all standard international power requirements.

Here are more reasons why the Model 730 is the newest sensation on the circuit.

Its simple design ensures reliability. Combine that with an attractive purchase price and you have a very low cost of ownership.

Although it’s surprisingly affordable, Model 730 sets new quality standards. Its 7x7 dot matrix produces crisp, clean characters, and its quiet, compact, and stylish design makes it welcome in any environment.

Best of all, because of Centronics’ manufacturing capabilities, volume delivery is assured.

ADVANTAGE: MODEL 730 Model 730 leads the way to a whole new era. Naturally, it’s from the leader: Centronics. No other company can match our strong serve in performance, selection, and value. And every Centronics printer is backed by one of the largest worldwide service organizations of any independent printer company.

On flexibility, features, price, and support, the Model 730 is a clear winner. For more information on products or employment opportunities, please write or call today: Centronics Data Computer Corporation, Hudson, New Hampshire 03051 
(603) 883-0111.
Traffic Registration Induction Loop Detector Is Controlled by Microprocessor

A microprocessor controlled loop detector, said to be the world's first, measures highway traffic loads in a more exact manner than previously possible. Introduced by Siemens AG, Postfach 103, D-8000 Munich 1, Federal Republic of Germany, this product is not marketed in the United States but is available for application in other countries. Sensitivity of the M-detector can be set over a wide range. For instance, it can be high if all vehicles, including bicycles, are to be counted or if the detector is to be imbedded beneath a very hard road surface. If loop inductance changes over a long period of time, the microprocessor adjusts the sensitivity; in addition, an error detection circuit alerts the control processor if a short circuit or loop interruption occurs.

Circle 452 on Inquiry Card

Energy Management System Available for Buildings Using Over $1000/Month Fuel

Logical and efficient control of energy systems in commercial buildings consuming fuel at a cost of more than $1000/month can be maintained at a savings with a microprocessor based system that senses and adjusts heating, ventilating, air conditioning, lighting, humidity, and machine loads. The AET 8/16 energy management system, from Atlantic Energy Technologies, Inc, 55 Lake St, Nashua, NH 03060, provides 16 variable inputs for measurement of environmental factors and 8 outputs, as well as 8 switch inputs, realtime clock, timers, and both telephone and RS-232-C communication links. The standalone controller can be interfaced to a central processing unit if desired. Included in the system are data logging and arithmetic capabilities, RAM with battery backup, and self-diagnostics.

Circle 453 on Inquiry Card

Positioning Servo Interface Links
Microcomputer Bus to Feedback Device

PS-10, a single-board Multibus compatible positioning servo interface, directly connects an Intel Multibus processor to an incremental encoder position feedback device. It is compatible with any incremental position encoding system that provides phase quadrature signal outputs and can obtain simultaneous position data for multiaxis contouring motion control by slaving two or more axes. Available from Controlsmith, Inc, 17 Airport Rd, Nashua, NH 03063, the interface provides an analog voltage that is compatible with most velocity servo loops and includes an onboard 12-bit incremental up/down counter as well as inputs and logic levels for absolute zero position sampling. Signal inputs are compatible with TTL levels for maximum common mode noise rejection.

Circle 454 on Inquiry Card

Mass termination leadership: Total system capability in webbed cable.

AMP gives you three complete interconnection systems that cover every conceivable application. With the tooling, headers, mounting hardware and technical support that goes with them.

MTA is our .100" and .156" single row connector family. And it features:
- reliable wire-to-post connections
- capability to mix wire and cable in the same housing
- tin or gold plate

Choose the AMPMODU system for .100" double row applications. With these features:
- higher density capability
- wire and cable in the same assembly
- unique contact design which incorporates insulation support
- modular housing designs
- complete line of headers—over 4,000 variations
- compatibility with 20 to 30 AWG cable

The CHAMP connector system is also available for webbed cable applications, featuring:
- telecommunications-style housings
- wire-to-panel or wire-to-wire capability
- IEEE #488 interface
- jacketed cable and discrete wire capability

Together, these three systems give you all the capability you'll ever need in webbed cable applications. Plus the cost-effectiveness of mass termination every time you apply them.

For more information on these and other mass termination capabilities, call the Mass Termination Information Desk at (717) 780-8400. Or write us. AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.
Model 5321 is an off-the-shelf drum printer, already engineered for your tough jobs. Jobs that demand heavy-duty print cycles, long hours of reliable operation and consistent print quality — at high speed! This is a full-size printer for mainframe-size jobs.

Years of dependable service in countless installations have earned it a reputation as "the workhorse of the computer industry." The MDS 5321 is no slouch. It can produce human-readable or machine-readable hard copy, on a wide 160-column print line, 1-up, 2-up, 3-up or 4-up, at speeds to 1250 lines per minute*.

A variety of type fonts is readily available. Gothic style, IBM-compatible, ECMA, OCR, and CMC 7 or E13B MICR fonts — so important in financial applications where secure check imprinting is involved.

The 5321 is completely buffered. A full line of print data with its associated formatting instructions is stored in memory while the previous line is still being printed. This means maximum throughput and no missed dates for your production schedule — no overruns on your print budget!

Consider the outstanding features of MDS 5321:

- High-speed paper slewing to 75 ips
- Additional tractor pins to minimize tearing of form holes
- Low-inertia servo motors to considerably reduce maintenance requirements
- Quick-loading VFU mechanism designed for extended form-loop life
- Failure-proof sensing switches for No Paper or Paper Low conditions
- Advanced ribbon mechanism to assure maximum usage of entire spool
- Optional extended interface for additional status monitoring.

The 8-bit interface is already in place. The next move is yours. Whether you're in the OEM business or a systems house specializing in custom applications, it will pay you to look into the MDS 5321. Quantity discounts available.

Send coupon today for a detailed Fact Sheet. Or call collect, J. Hill at (315) 866-5300 or J. Engstrom at (714) 772-0803.

*Using standard 48 contiguous characters. 64, 96 and 112 character sets optionally available.
DIGITAL CONTROL AND AUTOMATION SYSTEMS

Automatic System Produces NC Program From Digitized Points on Drawing or Model

By simply tracing a desired tool path on a 2-dimensional drawing with a stylus attached to a digitizer, or by guiding the stylus along the outline of a model or a sample part, the operator of the Automatic Parts Programming System (APPS) can produce a numerical control program. The system reads lines/curves in a continuous flow of points and generates a minimum number of straight line and circular interpolation commands to represent the points. Alden Self-Transit Systems Corp, N/C Div, 2 Mercer Rd, Natick, MA 01760, reports that the APPS computer accepts x, y coordinates from the digitizer, smooths the tracing, analyzes the points, and generates a smooth sequence of circular interpolations and straight-line commands that will reproduce the trace. The system is based on a Digital Equipment Corp PDP-11/03 microcomputer with dual floppy disc memory, but software rights may be bought separately for suitable existing computers.

Circle 456 on Inquiry Card

Control Programmers Maintain Up to 200 Functions

Four additions to the microprocessor based DCP 7700 digital control programmer line have been introduced by Honeywell Inc, Process Control Div, 1100 Virginia Dr, Ft Washington, PA 19034. Models 770012 and 770013 combine a variable setpoint vs time programmer with two or three controllers, respectively. Each controller functions independently to provide individual outputs, derived from the single programmed setpoint and individual process variable output signals.

Model 770022, providing two channels of programmed control, and 770033, with three channels, can configure and store as many as nine master programs with a total of up to 200 functions. Each master program includes one subprogram for each instrument channel. A function is entered as a segment in a subprogram, with all 200 functions distributed among all subprograms. Controller outputs, individually controlled either automatically or manually, may be current proportional, time proportional, time proportional duplex, and position proportional.

Inputs are set and program progress is displayed on 7-segment LED displays in engineering units. Ramp rates are programmable in 1° or 0.1° increments, or as a transition time between setpoints from 1° to 7999°. Event timing can be set from 0.1 to 999.9 hours or minutes at ±0.1% accuracy. A self-diagnostic program for all electronics and displays is stored in permanent memory.

Circle 457 on Inquiry Card

Mass termination leadership:
Unmatched cost-effectiveness in transmission cable assembly.

Now you can have all the performance advantages of transmission cable—and the cost-saving advantages of mass termination in one easily applied, completely solderless assembly.

We can offer you these benefits because when we mass terminate, it's done with slotted-beam technology. That means you can use a more economical cable because the need for expensive heat resistant dielectric is eliminated.

Here are some of the features you get with our transmission cable connectors:
- designed for 50, 75, 90, or 100 ohm cable on .025" clad
- compatible with shared or separate ground cables
- redundant dual gold-plated spring members at the contact/post interface.
- .100" x .100" or .125" x .250" industry standard interface
- common grounding buss
- selective ground pin out with programmable application tooling that terminates in 40 seconds

The features of our connector combine to give you an assembly with more controlled impedance. And that means you've got the extra signal integrity to run higher data rates. Reliably. And with the kind of cost-effectiveness never before available.

For more information on this and our other mass termination capabilities, call the Mass Termination Information Desk at (717) 780-8400. Or write us. AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.

AMP
CIRCLE 59 ON INQUIRY CARD
Why Did 'PCS' Become 'XYCOM'? 

When you’re prepared — and you know it — you can’t wait to get going.

Our time has come and we’re ready. We even have a new name.

Over a decade ago we started in the industrial computer field by producing industrial control systems. The problems of dust, dirt, heat, cold, vibration and atmospheric pollutants were outstanding — but so were our solutions. That was our beginning. We learned that general purpose computers wouldn’t work in a hardhat environment and that we had to design, build and test differently. Solutions we take for granted today still plague manufacturers of general purpose computers that try to use them in hostile environments.

Over the past decade, our products have been used in virtually all industrial applications. As our line of modules, target and MicroHost™ computers grew, we solved more and more problems. It took over a decade of perseverance to develop the line of ‘industry and environment specific’ products we offer today.

Our new name, XYCOM, replaces PCS, the one we used in our ‘formative’ years. Our products and design integrity remain. So, call XYCOM, we’re ready.

P.O. Box 984, Ann Arbor, Mich. 48106. (313) 429-4970

XYCOM
The Hardhat Computer People
Microcomputer Package Automates Industrial Data Acquisition and Control Operations

DAS-16, made up of a 16-bit microprocessor module and several I/O modules, handles from 128 to 976 digital control points and up to 256 single-ended or 128 differential analog inputs. The system, from Technico Inc, Computer Products Group, 9051 Red Branch Rd, Columbia, MD 21045, has 16 digital to analog output ports. Each system is housed in an industrial 6- or 10-slot, 19" (48-cm) rackmount chassis, functions with either a 3M tape cassette or up to four 8" (20-cm) floppy disc drives, and can support as many as six RS-232-C compatible terminals, CRTs, printers, or modem interfaces. Options include front panel with alphanumeric display and hexadecimal keypad for operator input. Editor, assembler, and linking loader for assembly language, extended BASIC, and FORTRAN IV Level II are available as software packages.

Circle 458 on Inquiry Card

Programmable Controller Receives Software And Hardware Improvements

Advances for the EPTAK® microprocessor based controller system from Eagle Signal Industrial Systems, 736 Federal St, Davenport, IA 52803, include two software packages and two hardware additions. The software packages are said to provide added programming flexibility and capacity, while the hardware additions provide stable analog control.

ECL2 and ECL2/P advanced control language packages combine EPTAK control and assembly language (ECL and EAL) instructions. They are said to virtually eliminate the need to assemble and load language subroutines into the system memory separately. The base of logic instructions is common to programmable controllers. Included are 235 EAL plus 29 standard ECL instructions.

The CP750 solid state analog input module and the CP746 analog calibration card are used with the controller system's CP745 ADC module. Each input module can condition up to eight analog inputs and provide the ADC with an accurate line or output that is then converted to a directly proportional digital value. One ADC can handle up to 15 input modules under software control. The calibration card is a manually programmed constant current and voltage standard that is inserted into the controller's logic chassis to calibrate the ADC. It supplies reference and logic signals to the ADC via the controller's backplane without need for software.

Circle 459 on Inquiry Card

Mass termination leadership: Ideal solutions in 3 amp flat cable, and flexible circuitry.

The advantages of Flat Flexible Conductor cable—greater vertical density, flexibility to stress, and 3 amp capability—are almost as obvious as the need for a cable to deliver these advantages consistently. Our solution to this need is just such a cable. And the interconnection system to match. Together, they constitute a better way in FFC assemblies.

Beginning with the cable, AMP developed a unique manufacturing process. Instead of electrodipping or etching, we use a superior bonding technique to bond the conductor to the insulation. We then score it and strip off the excess conductor. This results in precisely controlled width, thickness and spacing. And that means unprecedented quality and variety in conductor configuration.

But that quality doesn't stop with the cable. We also offer the high quality connectors to match. They feature:

- Intermateability with AMPMODU headers
- Insulation displacing contacts for greater reliability and no cable preparation
- Single or double row housings
- Pin, receptacle, card edge, and screw tab styles
- Capability to mix flat cable and discrete wire in the same housing
- Conductive ink capability

Of course, we also provide all the application tooling and technical assistance you need. Or you can opt for completed FFC assemblies made by AMP. Either way, we've got a better way.

For more information on this and our other mass termination capabilities, call the Mass Termination Information Desk at (717) 780-8400. Or write us. AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.
SOMETIMES YOU HAVE TO PAY A LITTLE MORE TO SAVE A LOT.

We know tape transports can be made cheaper; and they can be sold cheaper. A bargain, maybe, but only in the short run.

The TDI-1050 Synchronous Tape Transport is built to give the OEM and End User dependable service despite rugged, demanding environmental conditions.

That's the only way we know how to build tape drives.

We developed our electronic expertise during our years with Tandberg Data; and we've incorporated that Tandberg concern for quality in every peripheral product we design. For example, all Innovative Data Technology products pass a rigid series of quality control tests that stress the equipment far beyond any real life applications.

ANYTHING THEY CAN DO.

The 1050 Synchronous Tape Transport reads and writes ANSI, IBM and ECMA compatible ⅛" magnetic tape for both 7-track and 9-track NRZI and PE formats. Dual format is standard for all IDT tape drives.

Designed for reels up to 10½" the 1050 utilizes a data density of 1600 cpi PE or 800, 556, 200 cpi NRZI at speeds up to 45 ips with an average rewind speed of 200 ips.

By embedding the TDF-4050 Formatter inside the 1050 unit, saving rack space, our tape transport becomes an even more flexible unit that allows you to daisy-chain up to 4 drives.

For even greater flexibility, IDT provides an additional slot for embedding either a IEEE 488 bus controller, a RS-232C controller or a dual buffered parallel controller.

Besides being totally industry-compatible for many tape drive applications, we give you more.

EVEN MORE FOR THE MONEY.

The 1050 has comprehensive self-diagnostic capabilities, MTBF more than 5,000 hours, a dual ceramic-blade tape cleaner and microprocessor-based control logic that gives your system the flexibility and easy maintenance that means improved performance and greater cost efficiency.

However, performance and maintainability are where the TDI-1050 and TDF-4050 really pay off.

In fact, when you pay a little more for an IDT product, you really save. In the long run.

INNOVATIVE DATA TECHNOLOGY
4060 Morena Boulevard
San Diego, CA 92117
(714) 270-3990

CIRCLE 72 ON INQUIRY CARD
Process Control Language Improves Programming Procedures

Industrial Pascal, introduced by Process Computer Systems, Inc, 750 N Maple Rd, Saline, MI 48176, for programming process control, allows users to maintain and extend their operating programs. It is stored in PROM for instant start-up without machine loading at each shift change. This eliminates the need for floppy disc units at each remote station. The block structured language also aids the program writer in developing programming habits and enables fast revisions. Featured are n-dimensional arrays, high speed floating point mathematics, integers, Boolean logic, a modified “P-code” pseudo machine, and flexible data presentations.

Circle 460 on Inquiry Card

Programming Panel Has Ladder List Options

A programming panel compatible with many RS-232-C or current loop compatible display terminals, the Deluxe P180 includes an optional ladder list feature that allows the user to obtain hardcopy listings of relay ladder programs resident in any 484 system made by Gould Inc, Modicon Div, Andover, MA 01810. Ladder listing features include the ability to list all networks resident in a 484 controller, cross referencing by type, coil to network, input to network, sequencer to network, and register to network (with contents). The panel is compatible with printers and CRTs with a minimum of 72 or 80 columns and with a T158 telephone interface for remote display terminals. It operates with choice of eight rates (selectable at the factory) from 110 to 9600 baud.

Circle 461 on Inquiry Card

Terminal Collects Factory Data For Central Computer

Automatic monitoring of production at workstations and collecting of data for periodic transmission to a central computer are performed by a Datamonitor terminal introduced by Sierra Research Corp, Data Systems Div, 6520 Powers Ferry Rd, Atlanta, GA 30339. Terminal panels contain status indicator lights, digital display units, keyboard, operator assistance request switch, and a lock that allows only authorized persons to change the program format. Power is supplied to as many as 16 terminals through low voltage cables on the communications lines.

Circle 462 on Inquiry Card

Mass termination leadership:
Complete mass terminated assemblies for any cable you require.

In our cable assemblies, all the precision engineering that goes into cables, connectors, and tooling come together to save you time and money. What's more, these assemblies come with the kind of reliable performance you expect from AMP. That's because we control the production, every step of the way. And if they don't pass our testing procedures, you don't get them. When we are satisfied, you get them fast. And all the time we're producing them, you're saving money on front-end tooling costs.

Here are the different assembly styles available:
- single ended
- double ended
- daisy chain
- custom/mixed connector styles
- flat conductor jumpers

With these interface styles:
- .100" single or double row receptacle
- .156" single row receptacle
- subminiature D type
- .085" telecommunications style

No matter which combination you choose, you get the same thing: AMP reliability in a cable assembly that saves you money—right from the beginning.

For more information on this and our other mass termination capabilities, call the Mass Termination Information Desk at (717) 780-8400. Or write us. AMP Incorporated, Harrisburg, PA 17105.

AMP has a better way.
Introducing Microstreamer™
The 100% solution to disk backup.

The Low Cost Solution! The Microstreamer™ Tape Drive provides the unique disk backup benefits of ½ inch tape for a cost of less than half of a standard tape drive. Microstreamer's price includes formatting electronics, power supply, chassis - even UL and CSA approval. There is no more economical tape based backup device.

The Capacity Solution! Cipher's Microstreamer Tape Drive provides up to 46 Mbytes of data to backup even the largest capacity disk.

The Speed Solution! At 100 ips, the Microstreamer transfers 46 Mbytes of data in 4.8 minutes with full error correction. No waiting.

The Size Solution! 8¾ inches vertical. That's all the operator sees, since Microstreamer provides fully automatic loading from the front and is designed to be mounted in a compact desk system.

The Compatibility Solution! The phase encoded Microstreamer is ANSI and IBM compatible using standard 10½, 8½ or 7 inch reels so the user gets worldwide interchange and access to common database.

The Reliability Solution! Spec'd at 1 in $10^{10}$ hard errors, the Microstreamer provides reliability approaching that of the Winchester disk – absolutely essential for effective backup.

The Tape Drive Solution! The exciting Cipher Microstreamer also functions as a 25 ips tape drive for traditional applications and operates in a daisy chain of up to eight streamers and/or standard tape drives.

Don't settle for less than the 100% solution. Orders for the Microstreamer are being taken now. Call Cipher Data Products, Inc., 5630 Kearny Mesa Road, San Diego, California 92111. (714) 279-6550.
Now, that's excitement!
"Give us one hour and we'll prove you can program a VAX faster than any other 32-bit OEM computer."

Larry Wade, Marketing Manager, Technical OEM Group, Digital Equipment Corporation.

We want to prove to you the programming power of the VAX-11/780, and what it can do for your development time.

So if you have a terminal with an acoustic coupler, we'll give you a demonstration right in your own office. Then you be the judge.

"Four good reasons you should dial up a VAX."

1. You start with more software. VAX gives you more software than any other 32-bit minicomputer, so there's less system development work for you to do.

The VAX/VMS operating system is composed of a number of functional layers around a highly efficient real-time executive. This means you can either interface at the I/O level, or you can use our highly versatile file management system to set up sequential, random or multi-key ISAM file structures.

And VAX/VMS gives you unequalled networking and communications capabilities, with other Digital systems and with competitive mainframes.

2. You have to work with our programming tools to believe them. With VAX/VMS, all your programming, editing and debugging take place right at the terminal, whether you're programming interactive or batch applications. Our symbolic debugger even lets you interactively monitor and control your programs and variables—using the same symbolic names and data formats you created in the source program.

And if you need help at any stage of your work, simply type HELP. The Digital Command Language will help you solve your problem with clear, English-like statements.

And you can choose from five languages: FORTRAN IV-PLUS, COBOL, PASCAL, BLISS, or MACRO. Plus PDP-11 BASIC-.
PLUS 2 and FORTRAN in compatibility mode. That’s more than any other 32-bit minicomputer system offers you.

With tools like these to work with, your gains in programming efficiency can be enormous.

What’s more, VAX/VMS is just a simple step up for PDP-11 users. In fact, VAX/VMS runs RSX-11M programs and development tools.

3. **VAX is a new level of system integration.** While other software systems were designed around existing hardware, Digital’s software and hardware engineers worked together on VAX from the very beginning. The result is the most efficient virtual memory system on the market.

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And if you have a lot of programs to convert, you’ll be surprised how easy VAX/VMS makes that, too.

“Now about that offer…”

We think it’s well worth 60 minutes of your time to discover what VAX can do for your development work. If you agree, just send the coupon to me, Larry Wade, at the address below.

Is one hour enough time to prove everything we’ve said here? Frankly, I doubt it. But it should be plenty of time for you to prove to yourself that VAX software is way ahead of the competition.

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**Digital Equipment Corporation,**
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CIRCLE 75 ON INQUIRY CARD
The 17 sessions of this year’s Society for Information Display Seminar and Symposium will explore the forefront of electronic display technology with the advent of the 1980s. Symposia, which will run from Tuesday afternoon, April 29, through Thursday, May 1, will cover topics including CRTs, flat panel and avionic displays, image processing, and display graphics.

Welcoming remarks by General Chairman John L. Simonds and Program Chairman Ifay F. Chang will formally open the conference on Tuesday morning. Opening ceremonies will also include the presentation of the 1979 Symposium Best Paper Awards. Following the awards, R. M. Harden, Special Assistant for Information Management to the President of the U.S., will present the keynote address. In his address, Mr. Harden will provide a progress report on the Executive Office of the President and its Demonstrative Information Display System. Preceding the opening, SID president T. Du Puis will conduct the annual SID business meeting.

To augment the scheduled symposium topics, the conference will feature several invited addresses. Most of these are included within the coverage on the relevant session. One, however, entitled “Encounter with the Almost Star: Voyager Examines the Jovian System,” will be presented at the Wednesday, April 30 lunch, when J. L. Mitchell of the JPL Photoscience group will discuss how the Voyager images of Jupiter may help determine the differences between stellar and planetary formation. Following in the space vein, a visit to the Reuben H. Fleet Space Center in Balboa Park, San Diego, Calif, is scheduled as a special event. Blast off will be at 5:30 pm, Wednesday, April 30.

To round out the spectrum of information display technology coverage, the program will include ten tutorial seminars, three evening panel sessions, and blocks of time scheduled for authors’ interviews. Slated for 5:15 to 6:15 pm on Tuesday and Wednesday, and 5 to 6 pm on Thursday, the author interviews will be informal sessions where attendees may talk with and query the authors. Evening panel discussions are scheduled for Tuesday, April 29 at 8 pm. The one to one and one-half hour seminars are scheduled for the days before and after the conference, Monday, April 28 and Friday, May 2, with five on the agenda for each day. Selected symposia sessions, evening panels, and seminars of interest to *Computer Design* readers are profiled.
ROLM'S 1602B: An Army Standard Computer Designed for Full Integrated Logistics Support

IT'S A COMPLETE PROCESSOR IN A SINGLE 20'' CHASSIS.
The 1602B (AN/UHY-19) has space for 7 I/O modules, control panel interface, CPU and 64K of directly addressable memory. An additional 15 I/O slots can be made available with ROLM's 2150 Expansion Chassis.

IT HAS SINGLE SIDED ACCESS.
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EXCELLENT DELIVERY WITH FULL SUPPORT.
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THE PRICE.
A ROLM 1602B including appropriate software, 32K of memory, a control panel interface and a CPU (in single quantities) costs $33,250. Managers have true cost control because they can buy the exact processor configuration needed for their application. Plus, the new 1602B is directly compatible with ROLM's 1602, 1602A and 1650 processors.

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The innovative μPD765, developed and introduced by NEC, has become an industry standard and will soon be second-sourced by a U.S. semiconductor company. It's simple to build into your system, because the standard 40-pin, +5V design is totally compatible with IBM single- or double-density format floppies and 5¼" mini-floppies, as well as standard 8" drives.

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For board applications, you get all the capabilities above and more. The BP-2190 board includes the 765 and 16K of dual-ported RAM (expandable on-board to 48K), along with priority and refresh logic. Disk-to-RAM transfers are under DMA control.
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For more information, attach your business card or letterhead to this page and send to NEC Microcomputers, Inc., 173 Worcester Street, Wellesley, MA 02181. Or contact the regional office near you.

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CIRCLE 77 ON INQUIRY CARD
Symposia

Feature of the Flat Panel Displays session will be an invited paper on recent flat panel display developments in Japan. Technological activity areas that will be cited include liquid crystal, electroluminescent, LED, vacuum fluorescent, and plasma displays. Configurations and performance highlights of ladder mesh and slalom electron guides for flat CRT displays will be presented, as will a large area cathodoluminescent flat panel TV display system that uses electron beam guides.

The electronics, displays, control units, and realtime software for Advanced Integrated Display System, a generic system for all Navy CTOL/V/STOL aircraft display and control requirements, will be detailed in two of the Avionic Displays presentations. A lightweight, wide field of view, helmet-mounted display system will also be covered. This system presents pilotage and navigation nighttime imaging as well as daytime symbology to attack helicopter pilots. Also offered will be an airborne electronic terrain map system that generates, via computer, a terrain map display of forward-looking perspective or planimetric data.

Thin film electroluminescent panels have emerged from research and development to practical applications in alphanumeric, graphic, and TV displays. Electroluminescent Devices will discuss the use of developing technologies in several applications. One use disclosed will be a matchbox size (25 x 38-mm) TV display system that uses thin film electroluminescent panels with hybrid drivers that are attached to and folded behind the display surface. The display area will contain 512 x 680 elements with a 500-line/in (200/cm) resolution. To be presented in another paper will be the high density evaporated bridge method that allows interconnection of the 500-line/in electroluminescent display to the hybrid electronic substrate.

Foremost of the Image Processing developments to be discussed will be an approach for realtime spatial filtering and correction of video images. In the same session, an image processing algorithm that provides halftoning for electronic image systems where I/O devices do not have consistent pixel spacing will be advanced. Also cited will be an interdisciplinary image processing research and application laboratory that produces dynamic vector displays and generates color static and dynamic images.

Several developments in the field of Passive Displays will be reported in one session. Performance and life testing data on sealed 7-segment digit displays that have been fabricated using either anodically grown or reactively-sputtered iridium oxide electrochromic display and counter electrodes with aqueous electrolytes will be discussed. Two other papers will focus on electrochromic displays. The first will describe electrochromic materials for data display applications, detailing the design, construction, and operation of a practical 4096-pixel display. The second will present response and lifetime improvements using oblique evaporation of the WO$_3$ layer. Also to be reported is progress in the encapsulation of the magnetic particles and fabrication of the addressing matrix and memory for magnetic particle displays. A dye-foil digital display whose performance and temperature rival LCDs will close this session.

NOW YOU CAN AFFORD TO IMPROVE YOUR IMAGE.

BLACK AND WHITE MODEL 3400
COLOR MODEL 3450
Graphics data optimization techniques that are implemented at the post-processor level for immediately usable results will be discussed in the first of the Display Graphics papers. Another paper will report on a compact, 3-dimensional graphics generator developed for dot matrix devices. This device is comprised of a 2-dimensional graphics curve generator combined with a preprocessor to perform 3-dimensional transformations and curve projection. Also to be considered will be an algorithm, and its hardware implementation, for ultra-fast generation of analytical curves. The algorithm is based on solving differential equations in a binary logical way.

Two papers will cover DC Plasma Display Technology. A self-scan panel that is a complex cell sheet using a thin glow spacer and a grooved face plate will be described. The other plasma display to be presented is a dc pulsed multicolo r display that has memory, uses a tetrode structure, and combines a primary channel, drift space, and display layer. Also to be discussed will be three photoluminescent phosphors that have been developed for the three primary colors of a gas discharge panel display. The phosphors, \((\text{Y,} \text{Gd}) \text{BO}_3: \text{Eu}^{3+}\) — red, \(\text{BaAl}_{12} \text{O}_{19}: \text{Mn}^{2+}\) — green, and \(\text{BaMgAl}_1_2 \text{O}_{4}(\text{Eu}^{3+})\) — blue, possess radiant efficiency and required characteristics to reproduce color TV pictures.

Heading the session on CRTs will be a report on color picture tube design trends. The transition from delta-gun orientation with dot screens to inline guns and line screens will be described, along with a projection of future developments. Another paper will compare the critical performances of state of the art penetration phosphor, high resolution shadow mask, and high performance monochromatic CRTs. Brightness, resolution, and contrast capabilities of these CRTs will be quantitatively compared. A filter phosphor composed of a combination phosphor core and a specific pigment will be the subject of another paper. Tubes with this filter phosphor can be operated at high ambient light levels without degradation of picture quality.

Three of the Liquid Crystal Display papers will discuss dichroic LCDs. The first will present transmission spectra, reflectance, contrast ratio as a function of incidence angle and temperature, contrast/reflectance tradeoff, and response time data for a dichroic dye, cholesteric LCD without polarizers. The second will detail a bright color, negative or positive display that uses dichroic dye doped (guest-host) nematic liquid crystals. This LCD exhibits good color contrast at low voltage. The third will cover a 6 x 4" (15 x 10-cm) dichroic liquid display with integral touch entry that displays a positive or negative image or outline via phase control of excitation applied to special electrode patterns. Also presented in this session will be a double-layer electrode LCD — two isolated electrode layers on the same glass substrate — and a 70 x 150-line, 36-line/in (14/cm) ZnO varistor controlled LCD.

An invited paper on computer output printing technologies will lead off the Hardcopy/Printers session. It will review the major technologies for computer output printing in the 1980s, discussing both impact and nonimpact technologies including band, laser/electro-

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We've made raster technology affordable. So OEM systems designers can finally buy flicker-free graphic display terminals with high resolution and rapid response once available only on custom-designed systems.

**CLEARLY A CASE OF BLACK AND WHITE.**

The microprocessor-based Genisco 3400 generates a full-screen raster, black and white pattern with 768 horizontal lines and 1024 pixel locations along each line. This ultra-high, full-bit-mapped screen density practically eliminates distortion and stair-stepping. And makes it possible to selectively change picture elements in a fraction of a second.

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The Genisco 3450 is the first reasonably priced graphics terminal with precise color control at each pixel location. That's a resolution with 384 lines and 512 addressable pixel locations.

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CIRCLE 78 ON INQUIRY CARD
If you’re an OEM or system builder, no doubt you’ve been subjected to the 8-inch Winchester hustle.

Well, Century Data thinks it’s time to rack up the facts and lay them on the table.

First off, the 14-inch Winchester is rebounding. Just as predicted. And Century’s new Marksman disk is the perfect example.

Sure 8-inch drives will be available some day. But can you afford to wait?

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Evening Panel Discussions

"Display Technologies in Computer Graphics" will address the major role that display developments play in the expanding field of computer generated graphics. Discussed will be the trends in graphics systems, the impact of various CRT architectures including raster versus calligraphic and refreshed versus storage, distribution of intelligence and storage, and the value of color in graphic presentations.

During the past 25 years, considerable effort has been applied to the advancement of "Flat Panel Displays." Early publicity spoke of a thin TV picture on the wall. That goal has not yet been reached. But flat panel technology has come into its own in calculators, watches, terminals, and test equipment. Despite these recent accomplishments, investors and supporters in industry and government are, more than ever, questioning whether the investments will offer rewards, an appraisal that will be made by the panelists.

Seminars

Monday’s seminars, which are profiled here, will highlight the various technologies being developed as flat panel displays. As many of the display technologies have limited multiplexing capability, the first seminar will offer a review of the "Active Matrix Addressing Techniques" used to overcome this problem. "Liquid Crystal Display Technologies and Characteristics" will describe prototypes that have been built using various liquid crystal electrooptic modes, drive schemes in direct matrix addressing, and active matrix concepts. A comparison of prototypes will allow the status of LCD flat panels to be evaluated. The seminar on "Electroluminescent Display Technologies and Characteristics" will discuss the characteristics of electroluminescent devices which underlie their advantages and disadvantages in various applications. "Electrochromic Display Technologies and Characteristics" will review recent developments in WO₃ devices that have lead to improved stability and reduced response times. The preparation and properties of iridium-oxide based devices, and new developments in organic and reversible electrodeposition will also be presented. The electrophoretic display is noted for its pleasing image quality and low power operation; in the final Monday afternoon session, "Electrophoretic Display Technologies and Characteristics," its optical and electrical properties as governed by choice of material and mode of operation will be discussed. Direct and assisted matrix addressing techniques for the displays will also be compared.

Registration

Symposium registration fees are $50 for members and $65 for nonmembers in advance, and $60/75 for members/nonmembers at the conference. Registration is $70 to attend one day of seminars and $110 for both days. For more information contact Lewis Winner, 301 Almeria Ave, PO Box 343788, Coral Gables, FL 33134. Tel: 305/446-8193.
LAST NOVEMBER, DATA GENERAL AND DEC ANNOUNCED NEW COMPUTERS. THE SIMILARITY ENDS THERE.

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<th>Data General ECLIPSE S/140 System</th>
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<td>System including S/140 with 256KB ERCC MOS memory, Model 6100, 25MB non-removable moving head disc with integral 1.26 MB diskette floating point hardware and Dasher TP2 180 CPS console printer</td>
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ECLIPSE S/140 is: 43% faster, 65% faster, 10% lower price

What more can we say? Our new ECLIPSE® S/140 is not only a great deal faster than the 11/44, it's also a great deal, period. Read the chart. Then you'll understand why our ECLIPSE S/140 is your only choice. Break the speed limit without paying the price. Send in the coupon.


*As reported in DATAQUEST Research Newsletter, Nov. 30, 1979; COMPUTER SYSTEMS NEWS, Dec. 3, 1979. CIRCLE 187 ON INQUIRY CARD
In 1964, Dr. Charles Kao of ITT was the first to see the communications potential of optical fiber.
Many commercial ITT designed and installed fiber optic systems ranging to 45 Mb/s are already in use. All are delivering the interference-free communications expected. Additional systems are currently in production.

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North Star now gives you hard disk capacity and processing performance never before possible at such a low price! Horizon is a proven, reliable, affordable computer system with unique hardware and software. Now the Horizon's capabilities are expanded to meet your growing system requirements. In addition to hard disk performance, the Horizon has I/O versatility and an optional hardware floating point board for high-performance number crunching. The North Star large disk is a Century Data Marksman, a Winchester-type drive that holds 18 million bytes of formatted data. The North Star controller interfaces the drive(s) to the Horizon and takes full advantage of the high-performance characteristics of the drive. Our hard disk operating system implements a powerful file system as well as backup and recovery on floppy diskette.

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North Star OEM System Prices

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<td>Horizon computer with 64K RAM, 2 quad capacity mini drives and one HD-18 hard disk drive</td>
<td>Additional 18Mb hard disk drive for expansion of HD-1, or your present Horizon</td>
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*In OEM quantities
He should have used a CMOS Monochip.

Here's another good idea that didn't quite make it because the designer didn't choose the right technology for his circuits. If he had used CMOS, he could have cut the power consumption, size, and weight of the finished product.

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Unlike ordinary line printers, the TermiNet 340 can take the punishment of the broadest range of operating environments—from front office to factory floor—without complaining. The key reason? A tough, ruggedly engineered design. As a result, it keeps on performing under tough-use conditions when other line printers would sputter and break down.

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From top to bottom, the compact TermiNet 340 line printer is engineered with long-life components designed to keep the printer on-line. And businesses on schedule.

One reason: extra-thick, heavy-duty, environment-resistant materials chosen for the base and housing. Together, they provide this rugged printer with the impact strength, dimensional stability and resistance to adverse environments needed to keep working.

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The fact is, TermiNet 340 line printers are such productive workers, they require very little attention and very little maintenance once they're up and running. Should service be needed, you can count on getting these printers back on-line in a hurry. That's because of convenient self-test features that make troubleshooting easy and fast. And because of a responsive nationwide service network that keeps downtime to a minimum and operating costs low.

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CIRCLE 85 ON INQUIRY CARD
It is often necessary to generate hard copies of displays viewed on some type of cathode ray tube console. When cathode ray tubes with raster driven deflection systems are used, the task of obtaining a hard copy is fairly straightforward because the printer or plotter is also, typically, a raster driven device. There is little or no data conversion processing needed under these circumstances, and any processing that might be required before the cathode ray tube input display can be sent to the plotter is easily accomplished in either hardware or software. Although other types of plotters are available, only raster driven plotters will be considered.

If the cathode ray tube (CRT) has a random position deflection system, the task of obtaining a hard copy becomes significantly more complex, because vector data are used to drive this type of deflection system. In this case, a vector to raster conversion routine must disassemble each vector into discrete points before the display data can be sent to the plotter. Current designs dictate use of bit slice architectures to meet the high processing bandwidth requirements of this task. In addition to a longer and more hardware-intensive development effort, there remains the difficult proposition of maintaining the microcode.

The first approach examined the Texas Instruments 16-bit 9900 microprocessor and found that even in assembly language this machine was too slow and too limited in addressing range to accomplish the conversion in what was considered to be a reasonable amount of time. A second attempt to attain the high throughput required of the vector to raster converter used a distributed, multiple bus, multiple microprocessor system incorporating relatively powerful single-board microcomputers. A further goal was to use a high level language
Fig 1 Simplified diagram of display control words. Combination of these control words is used to generate picture on CRT. Same display buffer which drives CRT also serves as input to raster converter. Each word is four bytes long and typical picture in this CRT format occupies about 6k bytes.

Table: Display Word Arguments

<table>
<thead>
<tr>
<th>Display Word</th>
<th>Display Word Arguments</th>
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</thead>
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<tr>
<td>Type - 4-bit Code</td>
<td>Base Position (Intensity - 2 Bits)</td>
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<tr>
<td>Character</td>
<td>X-coordinate (10 Bits)</td>
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<tr>
<td>Symbol</td>
<td>Character 1 (8 Bits)</td>
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<td>Line</td>
<td>Character 2 (8 Bits)</td>
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<td>End Word</td>
<td>Character 3 (8 Bits)</td>
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<tr>
<td></td>
<td>Size (1 Bit)</td>
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<td></td>
<td>Symbol Modifiers (12 Bits)</td>
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<td></td>
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<td></td>
<td>Range Data (10 Bits)</td>
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<td></td>
<td>Octant Code (3 Bits)</td>
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<tr>
<td></td>
<td>Slope Data (10 Bits)</td>
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</tbody>
</table>

Fig 1: CRT to plotter intensity mapping. Simulating intensity on hardcopy device requires that single CRT pixel be represented by multiple points on hard copy. Plotters with high resolution will give effect of plotting intensity by appropriately filling correct number of plotter nibs being used to represent single CRT pixel.

for the overall program structure and to drop down to assembler code for the inner loops only.

A brief description of the CRT display console illustrates the magnitude of the storage requirements during vector to raster conversion. The 13" (33-cm) high by 10" (25-cm) wide CRT has a resolution of approximately 102 pixels/in (40/cm), which translates to a picture of 1382 CRT lines, with each line consisting of 1056 pixels. Four intensity levels are provided by this display; therefore, two bits of coded data represent the intensity of each pixel. Total number of CRT pixels is 1,459,392. Doubling this number and dividing by 8 yields 364,848 bytes required to hold the bit map of an entire display if the intensities are saved in coded form.

Fig 1 shows the control words used to generate the display. It is clear that these words are not in raster form and must be processed before being supplied to a raster driven plotter. The maximum total time allowed to produce a hard copy of the CRT screen on a Versatec model 1200A electrostatic plotter is 30 s in this application. Intensities can be simulated with this plotter by letting a 4-nib dot matrix represent a single CRT pixel (Fig 2). For this to be feasible, the plotter must have at least twice the resolution of the CRT it is copying. This restriction applies only to plotter width, of course, since the length of the copy may vary. The model 1200A plotter offers a total of 2112 nibs/plotter line, exactly twice the number of pixels per line of the input CRT.

The plotter generates approximately 110 CRT lines/s. Therefore, a display consisting of 1382 CRT lines would take nearly 13 s to plot, leaving 17 s to complete vector to raster conversion.
**Conversion Example Based On 9900**

Efficiency of a microprocessor based vector to raster converter depends, to a large extent, on the efficiency of system software. In this instance, the system software must process an input display buffer consisting of vector words. To evaluate the potential performance of this system effectively, only the conversion software need be considered. Although additional support hardware and software are needed, such as plotter hardware and software interfacing, the execution of conversion software accounts for most of the hardcopy process overhead.

Development systems, such as the Tektronix 8002 Microprocessor Lab and the Intel MDS-230, make it possible to evaluate potential application software without constructing a prototype of the target system. Besides assisting in software development, these systems can usually monitor and time the execution of application programs to give an idea of program efficiency. The 8002 system was used to develop and evaluate a conversion software routine written in 9900 assembly language.

The heart of any vector to raster conversion routine is the algorithm used to generate the individual points on a given vector. The algorithm chosen for implementation on the 9900 driven vector to raster converter is based on the equation of a line, \( Y = mX + b \). This algorithm requires a floating point or fixed point scaling division routine to determine the points on lines with nonzero, finite slopes.

A second major design consideration in any vector to raster converter is its memory organization. The 9900 microprocessor has a direct addressing range of 65,536 bytes, significantly less than the 364,848 bytes required to contain a bit map of an entire display. Since system operating speed is critical, any overhead such as memory paging must be avoided. An alternative to expanding system memory is to reduce system memory requirements by processing the display in slices. This software approach makes a complete pass over the input display buffer to generate the raster for each display slice, owing to the randomness of vectors that comprise the input display buffer. A sorting routine could be implemented to sort the input display buffer so that the raster data for a particular slice would be generated by processing a corresponding section of the sorted buffer. However, the software and hardware overhead involved in the sorting process makes this approach unattractive.

Regardless of whether a sorted or unsorted input display buffer is processed, a memory organization based on a single output buffer dictates that the buffer be sent to the plotter before each succeeding pass. This forces the vector to raster conversion process into a wait state until the output buffer is ready to be filled again. If a dual output buffer is implemented and direct memory access (DMA) capabilities are included in the system design, concurrent processing and plotting are possible. Optimizing system software by limiting the unnecessary, repetitive processing performed during each pass, and implementing a DMA process to allow concurrent plotting and processing could yield a vector to raster converter with reasonable operating speed.

The multipass system was chosen for the 9900 microprocessor conversion software. The 8002 development system was used to edit, debug, perform, and time the execution of the application program. A general version of the multipass system was implemented to allow timing of various system configurations. The algorithm was verified by plotting the actual raster output on a model 1200A plotter. This was not performed in real time, but rather by transporting the raster via magnetic tape to a Digital Equipment Corp PDP-11/70 minicomputer which drove the plotter.

The Table shows timing results obtained for various output buffer sizes on the TI 9900 microprocessor and illustrates the tradeoff between memory size and number of passes required. Software divide times were measured on the Tektronix development system, while the hardware divide measurements were calculated assuming an Advanced Micro Devices AM-9511 arithmetic processor.

---

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<th>Output Buffer Size (Bytes)</th>
<th>No of CRT Lines Passes/Processed Per Pass</th>
<th>Total Processing Time (s)</th>
<th>Processing Time Per Pass (s)</th>
<th>Total Processing Time (s)</th>
<th>Processing Time Per Pass (s)</th>
<th>Total Processing Time (s)</th>
<th>Logical Processing Time/Pass (s)</th>
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*Does not include I/O, intensity decoding, or buffer initialization
†Logical processing time equals total processing time minus divide processing time.
was implemented. Addressing restrictions were ignored. With this hardware configuration, the greatest decrease in processing time per pass came when going from a single-pass to a 2-pass system. Timings that included software fractional divides were much too slow for the required system. The faster times, which assumed implementation of the AM-9511 arithmetic chip, were much more reasonable, but still too slow.

These results indicate that it is at least feasible to perform the vector to raster conversions in software on a 16-bit microprocessor. Since system operating speed is still below the required level, several changes in the system design are needed. Initially, the algorithm upon which the conversion routine is based must be reconsidered. A delta scheme, which steps up or down through memory, is one possible alternative approach. If the delta factor—the tangent of the line segment—is known or easily determined, then the process is trivial. As Fig 1 shows, the tangent is given in line display control words, and the stroke generators for the character and symbol words could be configured to contain this type of information.

A second area of concern is how much memory beyond the 64k-byte direct addressing range of the 9900 microprocessor must be accessed. System operating speed could be increased by using a microprocessor whose direct addressing range is sufficient to handle this particular task. Intel's 8086 is one candidate, since it is capable of addressing 1M bytes directly.

Changing the CPU and the algorithm upon which the conversion routine is based dictates development of new software. Although the vector to raster conversion routine for the 9900 microprocessor was written in assembly language, the knowledge gained by implementing the first example system suggests the possible use of a high level language. Any required code optimization could then be achieved by coding inner loops of the program in assembly language. The savings in software development time when using a high level language lend credence to this approach. Intel's isbc 86/12 microcomputer board will be the system module in the enhanced vector to raster converter. Another configuration uses two 86/12 boards for multiprocessing, with one of the boards used as an intelligent DMA controller. PLM-86, Intel's high level language for the 8086, is a candidate language for developing application software.

**isbc 86/12 Based Vector To Raster Converter Example**

An isbc 86/12 system may have a number of bus masters. The vector to raster converter incorporates two bus masters, although one of the processors acts as a slave to the other. When more than one master simultaneously requests control of the Intel Multibus, bus arbitration must occur. A bus clock, usually supplied by one of the bus masters, provides a timing reference for resolving contention among multiple requests from bus masters. This feature allows different speed masters to share resources on the same bus. Actual data transfer over the bus proceeds at a speed that depends only on the transmitting and receiving devices. Investigation of the vector to raster converter will implement the 86/12 in lieu of the 9900 microprocessor.

Fig 3 shows the target system, as well as the development system used to prepare the software and integrate that software with the hardware. Two 86/12 boards are used in this vector to raster converter. The "conversion processor" 86/12 is the system master. It is responsible for directing the operation of the second microcomputer. This second 86/12 is implemented as an input/output (i/o) processor (IOP). As a bus master, the IOP can perform DMA transfers as well as process data being transferred. Six 64k-byte random access memory (RAM) boards meet the large memory requirement of the system. Including the 32k bytes of onboard RAM, the total system memory is now 548k bytes, more than sufficient for i/o buffers, program memory, and scratch memory.

Fig 3 also shows the plotter connected to the auxiliary connector, instead of a serial or parallel i/o port, because the plotter will be hardwired so that the IOP sees it as a 64k memory space segment. Data, therefore, can be transferred to the plotter across the local iop data bus without having to access the Multibus. Required drivers and interfacing hardware reside on a separate prototype board.

The mds-230 development system in Fig 3 has an 800-bit/in (315/cm) tape drive tied to its bus, in addition to a flexible disc drive and a printer. Either Intel's ice-86 in-circuit emulator or Intel's isbc-957 in-circuit emulator 86/12 interface package can be used to downline load programs into the 86/12 onboard RAM and to control 86/12 execution. While the in-circuit emulator has the advantage of being able to partition memory gradually between the development system and the target system, the interface package works adequately in its absence.

Although the 86/12 appears well suited to multiprocessing applications, there are no development tools presently available for controlling multiprocessor operation during software and hardware integration. Currently, only one central processing unit (CPU) at a time can be controlled by either the ICE-86 or the ISBC-957; therefore, software must be written to commence program execution in the second processor. This software might be controlled by a reset switch. Software in the operational program could then monitor execution of software on the slave microprocessor.

Use of a high level language, PLM-86, introduces a second area of concern. The PLM-86 compiler does not allow programs to change data pointer values dynamically beyond a 64k segment. Linking to a procedure written in assembly language must be accomplished to access more than one data segment of memory dynamically. The physical addresses associated with these data segments must be calculated by a CRT to memory mapping algorithm, which effectively maps each CRT pixel to a memory location without losing the integrity of the picture.

**Design Considerations With the 8086**

When working with more than one 64k-byte segment of memory, it is important to understand how the 8086 formulates its 20-bit physical address. All accessible
registers in the 8086, including segment registers, are 16 bits wide. The 8086 hardware, however, shifts the contents of the appropriate segment register four bits to the left before adding any offset. This is performed in an internal, 20-bit register whose output is the effective physical address. The offset added to the shifted segment address is a 16-bit value. It can address every location within a given segment. Physical address wraparound because of an offset carryout is a distinct possibility that must be considered.

One major vector to raster converter design problem is how information displayed on the CRT should be mapped into memory. The given vector data, together with knowledge of the present CRT beam position, supplies sufficient information to establish an X,Y coordinate to any point or pixel on a given vector. This X,Y coordinate is relative to a coordinate system whose origin is at the bottom, lefthand corner of the CRT display.

With a raster driven plotter, the CRT display must be copied from top to bottom and from left to right. This means that the highest Y coordinate and the lowest X coordinate must map to the lowest output buffer memory location. One way to achieve this is by subtracting each Y coordinate from the maximum possible Y coordinate; this maximum Y value varies when the picture is processed in slices.

There are 1056 pixels for each Y coordinate, which must also be considered when mapping a pixel to a memory location. Each CRT pixel is represented by a 2-bit intensity code. Each horizontal stripe on the CRT display therefore requires 264 bytes of memory. Any pixel to memory mapping algorithm must first multiply

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**Fig 3 Development and target system block diagram. Application software development and software/hardware integration can be significantly facilitated by using microprocessor development system. Debugging aids such as ICE (in-circuit emulator) can prove to be invaluable when trying to isolate software or hardware problem.**
the Y coordinate by 264. The resulting address is not unique, and must be adjusted using the X coordinate information.

An efficient mapping algorithm packs four pixel intensities into a single byte. Fig 4 shows the bit organization of a single byte with four sets of pixel intensities, or cells, packed into it. The physical location of a single pixel now includes not only a 20-bit address, but also a cell number. The cell number must come from the unused part of the coordinate, the X coordinate. Since there are only four cells per byte, only two bits of the X coordinate are needed to determine which cell is affected. The remaining bits of the X coordinate represent an offset from the address determined by multiplying the Y coordinate by 264. The complete physical address of a CRT pixel is, therefore, the combination of the calculated physical address and the cell number.

Once the physical address with the cell number of a pixel at the beginning of a line segment is known, a CRT line can be drawn in memory by adding a delta factor to the starting pixel address. Fig 5 shows the eight possible directions a pixel may move away from its present position. Any change in the Y direction is actually a change of some multiple of 264 bytes in the physical address of the pixel. The only consideration here is an increment or decrement in the Y direction. Fig 5 also shows that the pixel could move in the X direction. Since the Y coordinate is not changing and X is changing by plus or minus one, only the cell number is affected, as shown. Care must be taken to adjust the offset part of the physical address if the cell number exceeds three or goes negative. Movement away from the present pixel position at 45° angles is handled by adding in fractional parts of the delta factors. The fraction turns out to be the tangent of the line angle.

Although assembly language code must be used to generate addresses of data when these addresses span a 64k-byte data segment, it is still desirable to use a high level language whenever possible in developing application software. The executive portion of the application software, for instance, can be written in a high level language without adversely affecting system operating speed.

Applications such as the vector to raster converter usually contain a small section of code that accounts for most of the execution time. If this portion of the code is programmed in assembly language and then linked to the remaining portion of the program, which is written in a high level language, the resulting program usually executes at least an order of magnitude faster than a program written entirely in a high level language. Some compilers do not allow the insertion of assembly language code within programs written in a high level language. In these cases, subroutines or procedures written in assembly language usually can be linked in prior to load time. Writing a subroutine or procedure in assembly language that is to be activated by a high level language program requires knowledge of the parameter passing convention and the calling sequence implemented by the particular compiler to insure that procedure execution does not destroy the linkage mechanisms set up by the compiler.

---

**Fig 4** Data format for raster display. With 20-bit address, CPU addresses each byte, which contains encoded intensity information for four pixels or cells.

**Fig 5** Possible pixel position changes. Incremental change in CRT's pixel position is reflected in memory by appropriate change in pixel's associated physical address. Actual change in address is determined by direction of pixel movement relative to its previous position.
One of the most straightforward methods for interprocess communication involves use of a common memory area. Each processor locks out the other processor when writing into common memory. The 8086 has a lock instruction prefix that performs this operation. The communication protocol used by the two processors is somewhat application dependent and can be set by the programmer to pass necessary information as efficiently as possible. In this example, most of the information that must pass between the two processors involves buffer control. Since one processor is essentially a 1/O controller, it must be told when the next output buffer is ready to be sent and where this buffer resides in memory. The 1/O must, in turn, inform the conversion processor when it has emptied and freed the output buffer.

Deciding where the common memory area is to be located involves consideration of bus contention possibilities. In this vector to raster converter example, the common memory area could reside on either processor board or on the separate memory boards. If it is located on either the 1/O board or the conversion processor board, local bus contention between the onboard and offboard processors could result. Locating the communication area on a separate memory module would eliminate any contention on the local bus when one of the processors is polling the communication area while waiting for a particular event to occur.

Proper synchronization between processors is equally critical to successful operation of any multiprocessor system. Synchronization of the system can usually be accomplished by a system reset, either hardwired to each processor or with one processor resetting the remaining processors in the system once it has been reset externally. The master processor in the system would naturally have this responsibility and could accomplish this task through a hardwired interrupt or processor reset.

**Summary**

Faster microprocessors afford an alternative to microprogrammed hardware in design problems requiring both fast response and high data throughput. Although the multiple microprocessor approach introduces potential problem areas, such as interprocessor communication and system bus contention, the high throughput offered by loosely coupled microprocessors makes this design approach useful when operating speed is considered critical.

The first attempt to implement a microprocessor based vector to raster converter indicated that the software solution was feasible, but did not meet performance criteria. However, this design suggested that a multiprocessing system, programmed largely in a higher level language, would perform well if the hardware were configured to fulfill application requirements.

A second implementation combined high level language executive software with assembly language code in a dual-microprocessor hardware environment. Problem solutions treating interprocessor communication and synchronization, system bus contention, shared resource contention, and language interfacing were customized to the application, producing a high performance system that is inherently easy to enhance and maintain.

Using a second microcomputer board essentially as an I/O controller may be overkill in some applications. When slower system operating speed is acceptable, a single CPU approach could be sufficient. The introduction of special purpose I/O chips, such as Intel's 8089 and other DMA type devices with limited processing capabilities, affords increased system throughput without the overhead incurred by adding a second CPU. Advantages of microprocessor based, high level language software over microprogrammed hardware accrue in either case.

**Bibliography**


P. Caudill, “Using assembly coding to optimize high-level language programs,” *Electronics*, Feb 1, 1979, pp 121-124


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James A. Mello is a project engineer at Naval Underwater Systems Center in Newport, RI. Working primarily with microprocessor based systems, he has been involved with all aspects of system design from the conceptual design phase to actual prototype implementation. He holds a BSEE from Southeastern Massachusetts University and will complete his MS requirements there in June 1980.

Operating a consulting firm in Santa Rosa, Calif, John Greaves previously helped to build a program in computer engineering at Southeastern Massachusetts University, managed research grants, and did consulting work in the mini and microcomputer systems area. He received a PhD degree in electrical engineering from the University of California at Santa Barbara.
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LSI HARDWARE IMPLEMENTS SIGNAL PROCESSING ALGORITHMS

Dedicated LSI multipliers used in realtime digital signal processors achieve data rate reduction, pulse compression, high speed convolution, and fast Fourier transformation.

William J. Finn  TRW LSI Products, El Segundo, California

A major factor in the effectiveness of a digital signal processor is the function of multiplication. Most aspects of digital signal processing require a large number of multiplications. Unfortunately, multiplication has traditionally been the most time consuming and expensive computational function to implement. As a result, designers have been forced to deal with the hardware constraints of the signal processor.

Of the proposed approaches to the problem many have been based on exotic programming techniques intended to reduce the number of multiplies. As the schemes became theoretically complex, the move towards computational conservation was initiated. As a result, the number of multiplies and the amount of memory required became the measure of complexity for digital signal processors. A typical practice in early digital signal processors was to use a very fast multiplier and time multiplex it over all the functions requiring multiplication. As a result, very fast emitter coupled logic (ECL) array multipliers were designed and built. Array multipliers, however, are expensive and power consuming; an early proposal, a 40-ns, 17 x 17 array multiplier, used 164 ECL adders and consumed 60 W of power.

A solution to this problem lies in the monolithic LSI multiplier, which was developed by TRW in the early 1970s. This single chip is capable of performing a complete 16 x 16 multiply in 100 ns, while consuming only 3 W (Fig 1).

Most signal processing schemes require as many adds as multiplies. Consequently, there are also monolithic LSI multiplier-accumulators (MACs), ranging in size from 8 x 8 to 16 x 16 bits. The larger multiplier has a 35-bit accumulation register, which gives a complete 16 x 16 multiply as well as an addition or subtraction in 115 ns (Fig 2).

Standard signal processing algorithms used in finite impulse response (FIR) filters, matched filters, and complete fast Fourier transforms (FFTs), which depend on multiply and add operations for all data computations, can be implemented using LSI hardware. The cost per multiply per unit of time has become so negligible in a large digital signal processor that design emphasis has
shifted from complex software routines to a single-chip, dedicated hardware approach.

**Matched Filtering**

In a receiver for pulse compression radar, for example, the received signal and the original transmitted signal are cross-correlated in a matched filter. A matched filter optimizes the peak signal to noise power ratio in the presence of additive Gaussian noise, maximizing the probability of detecting a target. Since the filter is exactly matched to the transmitted signal, the impulse response is the time-reversed complex conjugate of the transmitted signal, and the output is the auto-correlation function (ACF) of the transmitted signal.

A standard approach for achieving this filter type is to use discrete Fourier transforms (DFTs). A DFT differs from a continuous Fourier transform because it operates on sampled waveforms defined over finite intervals. The resulting spectral components in the frequency domain are then coherently added, using a fast Fourier algorithm to achieve high speed DFT convolution.

In this technique, \(x(n)\) and \(h(n)\) are time sampled sequences of received and transmitted data, respectively. Each 2-point DFT (also called a butterfly) consists of one complex multiplication, two complex additions, and two complex subtractions (Fig 3). The resulting transforms, \(X(k)\) and \(H(k)\), are combined by multiplication and the product, \(Y(k)\), is inverse transformed to yield the output \(y(n)\) (Fig 4). Using the multiplier-accumulator described earlier, a 2-point butterfly can be performed in less than 1 \(\mu s\).

**Computational Requirements**

In pulsed radar, the time span from the beginning of one transmission or pulse to the start of the next pulse is called an interpulse period (IPP). All computations must be performed within one interpulse period; thus, the convolution discussed previously must be performed in 1 ms for a 1-kHz system. The number of butterflies for an N-point, radix-2 FFT is

\[
N \log_2 N \tag{1}
\]

The FFT algorithm consists of \(\log_2 N\) stages, with each stage requiring \(N/2\) butterflies.

The total computation time for one convolution is

\[
T_c = (N \log_2 N) T_B + N T_M \tag{2}
\]

where \(T_B\) is the time required for one butterfly and \(T_M\) is the time required for one multiply (in most cases \(T_B = T_M\)). A 4k-point transform for such a system would require a multiplier speed of 20 ns for realtime operation on 8-bit words. However, by designing the
Fig 2 Multiplier-accumulator. Optimized arithmetic unit performs multiplications and product accumulations inherent in most digital signal processing algorithms.

Fig 3 Radix-2 decimation in frequency butterfly. Two complex additions and subtractions and one complex multiplication are necessary. Complex multiplication requires four MAC machine cycles.
Fig 4 High speed DFT convolution. Achieved when two time-sampled sequences are frequency transformed using FFT algorithm, convolution results are complex multiplied (using MAC). Product $Y(k)$ is then inverse transformed to complete process.

Fig 5 Nth-order predictive mechanization. Function can be implemented as FIR filter with fixed or varying coefficients which weight incoming data based on statistical analysis of previous data. Redundant information can be removed to reduce amount of information to be transmitted.

Fig 6 FIR filter architecture. In simplest form architecture consists of data memory, coefficient ROM, multiplier-accumulator to perform sums of partial products, and simple logic to control sequencing and data shuffling.
architecture so that the multiplier is continuously serviced with new data to process (pipelining), computational efficiency of this process can be increased, reducing the total time to approximately

$$T_c = 3NT_m$$  \hspace{1cm} (3)$$

Using the previous example, the required multiply time would be only 83 ns, well within the capability of presently available LSI multipliers.

**Digital Signal Processing Architectures**

A major function of a digital signal processor is data rate reduction, and an FIR filter utilizing predictive coding schemes is one method of achieving just that. A 1-dimensional, Nth-order, predictive mechanization is illustrated in Fig 5. Radar systems are particularly well suited for a predictive mechanization. The effectiveness of this kind of approach is highly dependent on the accuracy of the *a priori* knowledge (good predictions) of the incoming sampled data; in radar, knowledge of the expected signal can be very accurate.

The approach is to predict the value of $X_n$ based on past values of $X$ located in $N$ storage bins. Previous knowledge of the source (statistical analysis) determines the coefficients of prediction ($A_0$ through $A_{n-1}$). Updating the coefficients allows the impulse response of the filter to be adaptively improved. If the prediction is satisfactory, $X_n - P_n$ will be smaller in magnitude than $X_n$, so that less information will have to be transmitted. An Nth-order predictor, like the type shown, requires $N$ multiplies and $N + 1$ adds, making it a natural process for a multiplier-accumulator.

Since most transmitted radar signals are time limited, operation of a matched filter is equivalent to a finite impulse response filter, in which the convolution of the transmitted signal is used as the impulse response of the FIR matched filter. Fig 6 shows how an FIR filter can be implemented.

In this architecture, all computations are performed within the multiplier-accumulator; therefore, external arithmetic logic is not necessary. The microinstruction sequencer and memory control can be designed with presently available bit-slice elements. If computation is done in batch mode, the main data and output memories are important because they store the batch of information to be processed.

For continuous realtime processing, these memories can be as simple as local storage registers or they can be eliminated entirely, depending on the overall processor requirements and timing constraints.

The computational requirements of a digital signal processor often exceed the capabilities of the hardware if conventional architectures are used. One solution to this problem is an architecture that lends itself to a pipeline structure. The pipelined architecture (Fig 7) not only provides filter design flexibility but also helps optimize filter throughput.

Advantages of this architecture center around the two data buses. A multiplier-accumulator serves as the central computational element, but in this case, two capabilities have been added. The first, a high speed multiplexer, allows the two data buses to be switched or pingponged.
Therefore, the MAC can be serviced either by incoming data from the source, or by intermediate computational results taken from local storage memory.

The second, and most salient capability, is the fast scratchpad memory and adder. This function provides local storage and, in conjunction with the second data bus and the multiplexer, maximizes pipelined computation. Throughput for realtime processing therefore is minimized. The adder is included so that partial products can be summed without interfering with the primary computation being performed in the MAC.

A standard approach to designing a matched filter is to use an FFT (Fig 8). Input data are stored in random access memory (RAM) via an input data buffer, and the associated coefficients are stored in programmable read only memory (P/ROM). P/ROM is used so that the coefficients can be easily adjusted or changed to fit a particular FFT requirement. The control hardware (which is implemented using bit-slice elements) takes data and the corresponding coefficient out of memory and busses them into the high speed butterfly; results of each DFT are then stored back into RAM. The final results are addressed and bused out via the output data buffer. By utilizing a multiplier-accumulator (16 x 16) to perform the high speed butterfly, a 1k-point FFT can be computed in less than 6 ms (assuming a 150-ns cycle time with each butterfly requiring eight cycles).

**Summary**

The described architectures demonstrate how LSI dedicated hardware can be utilized to effect data rate reduction by means of a predictive mechanization, pulse compression utilizing an FIR matched filter, computational capabilities via pipelining, high speed DFT convolution, and an FFT processor. Although radar is used as a vehicle for discussion, the concepts presented can be applied to any system that requires realtime digital signal processing.

Digital signal processors are particularly attractive because they provide a high degree of flexibility. A digital processor must be able to perform many different algorithms, as well as have the ability to adapt easily. Flexibility is the prime reason for using an LSI dedicated hardware approach to realtime system design.

**Bibliography**


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William J. Finn earned his BS degree in electrical engineering from California State University at Northridge. His background includes work in reliability engineering, new product development, and commercial aircraft navigation system design. At TRW, he has specialized in spectrum analysis and digital filtering for radar and telecommunications.
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Problems caused by electromagnetic interference are examined and accompanied by a description of a test instrument that provides quantitative determination of system noise susceptibility.

Joe E. Deavenport  DEDCO, San Diego, California

Today's electronic circuits are characterized by ever increasing bandwidth and sensitivity. This, combined with the proliferation of sources of electromagnetic interference, has created a serious problem for equipment designers, manufacturers, and users, and calls for an examination of the nature of electromagnetic noise and of the problems it can cause. An instrument that produces standard, repeatable sources of electromagnetic noise is available for evaluating the noise sensitivity of digital equipment, and for troubleshooting noise problems in systems and components.

Electromagnetic Interference

Electromagnetic interference (emi) is any unplanned electrical signal that impinges on an operating electronic system and causes system performance degradation or malfunction. It is generally viewed as an external interference, one having many possible sources, and with no high or low frequency limit. In a computer system, problems resulting from emi can range from single bit errors to complete destruction of programs or files.

In its simplest and most familiar manifestation, emi is superimposed on dc power supply voltages in the form of drift, unplanned dc voltages, ripple, and noise. In operating circuits emi is also generated by signal reflections and crosstalk due to common impedances: resistance, capacitance, and both mutual and self-induc-
Cumulative and Statistical Considerations

Three characteristics of emi should be considered in evaluating system susceptibility. First, all forms of emi add directly to a signal. Worst case coincidence of peak emi from all sources determines the likelihood of failure. Second, circuit response to emi depends on polarity. For example, if there is a high level input to a gate, positive emi superimposed on the input may have little or no effect; however, negative emi may be amplified and transmitted. Finally, a large computer system may run for several minutes before interfering crosstalk is created by a worst case combination of signals.

These considerations dictate that, for an adequate evaluation of system susceptibility to emi, testing must last long enough to encounter the coincidence of worst case power supply variations, internally generated noise, and externally injected emi. For a reasonably sized system, this requires several minutes testing at a number of different system locations while applying thousands of external noise transients.

Susceptibility Testing

Most system manufacturers conduct power supply margin tests. In the past, when slower circuit response was involved, it was adequate to determine whether or not individual circuits could tolerate specified power supply variations. Now that circuit response is measured in nanoseconds, and interconnections reflect delays that exceed signal rise and fall times, power supply margin testing also helps evaluate internally generated emi when all circuit states are exercised to create worst case emi patterns.

The broad frequency response of today's circuits requires additional testing for susceptibility to externally generated emi, which often appears as very high frequency transients. There was no need for such testing when circuits would not respond to these transients; no equipment was developed for this purpose, and no standards were established. As the state of the art in circuit design advanced, and the need for such testing became apparent, any device that would create emi was put to use: self-chattering relays, fluorescent light banks, Tesla coils, drill motors, and light switches. These techniques were hardly productive of quantitative information or repeatability, or a potential for standardization.

The most severe and familiar sources of externally generated emi are ac line transients and electrostatic discharge from the human body. On or off switching of even such a low power device as an electric typewriter can create 1000-V line transients. A great many of these transients are coupled, either capacitively or through the safety ground connection, to other systems as common-mode signals, signals that affect all signal paths equally with respect to ground. A human body can accumulate static charges up to 25,000 V, depending on the ambient humidity. (At relative humidity above 50%, leakage is generally sufficient to prevent static accumulation.) This charge readily arcs to any grounded metal, such as a system frame.
Both these typical transients produce similar effects. The system frame with its various distributed impedances to earth ground is shock-excited into complex common-mode resonances in the 10- to 100-MHz range. These also appear in all parts of the system contained within the frame. While common-mode signals are not a problem by themselves, unbalanced circuits invariably convert common-mode signals to differential-mode signals, signals that affect all signal paths differently and cause interference. Fig 1 illustrates these two mechanisms for external generation of emi. Conversion of common-mode transients to differential-mode interference is shown in Fig 2.

Of these two causes of external emi generation, electrostatic discharge (ESD) is generally the most severe and the easiest to simulate. ESD is an arc with a rise time in the nanosecond range. Line transients are frequently generated by arcs with similar rise times, but their source is generally remote, and their high frequency components are well attenuated by the time they reach other systems. In any event, it is considerably more difficult to simulate high frequency transients on an active ac line.

The ball and wand tester was devised to simulate ESD and thereby provide a gross indication of emi susceptibility. This device consists of a metallic ball mounted at the end of an insulating handle. A discrete capacitor is charged to high voltage and discharged into the ball through a resistor when the ball is touched to a metallic enclosure. However, this technique suffers from a lack of standardization, no repeatability, and low accuracy. These factors inhibit the utility of the ball and wand approach for design and troubleshooting applications.

There are other shortcomings to this technique.

1. The discrete capacitor and discharge resistor are intended to simulate human body capacitance and impedance; however, there is no “standard body.” Capacitance values used have ranged from 100 to 1000 pF, and resistances from 10 to 1000 Ω. Empirically derived complex networks have also been used.

2. “Acceptable” discharge voltage levels range from 500 to 15,000 V. Generally, lower voltages and lower resistances are combined with higher capacitances; higher voltages and higher resistances are used with lower capacitances.

3. An arbitrary distinction is made between testing a system for moderate or severe ESD in controlled and in uncontrolled environments. Environments are seldom constant.

4. The operator controls the rate and number of discharges applied to the system under test. The rate may vary from 1 to 3 discharges/s, with only 50 to 100 discharges applied at any location on the enclosure. Except by rare coincidence, this is not sufficient to show the true noise threshold.

5. No attempt is made to simulate distributed capacitances to earth or to the equipment.

6. The arc is open to the ambient atmosphere, leading to inconsistent characteristics.

7. The 6- to 8-ft (1.8- to 2.4-m) long ground return wire to the discrete capacitor is part of the discharge circuit. This will not only distort the waveform due to inductive effects, but noise radiated from this wire may also distort test results depending on the routing of the lead.

Another Approach—Background and Description

Several years ago International Business Machines Corp (IBM) recognized the need for standardized emi susceptibility testing. As a result of research into emi problems in computer systems, the Electromagnetic Compatibility Simulator (EMCS) (Type 1) was developed to provide IBM field engineers with a reliable, controllable, and repeatable test method for determining the emi susceptibility level of newly installed systems. Once these levels had been measured and recorded, the instrument could be used later to determine the effects of changes

![Diagram](image)
Fig 3: Zapper assembled for basic system susceptibility testing. Crossed vanes are 3' (91.5 cm) high by 18" (46 cm) wide. Mercury switch assembly attaches to one edge of vanes at adjustable height. Hardened steel point (covered by protective cap in photograph) protrudes from switch assembly to make direct contact with frame of system under test. Power supply in case provides high voltage to charge vane and drive voltage for mercury switch.

Fig 4: Alternate locations for instrument in system susceptibility testing. System with separately powered peripherals is represented in (a), while (b) shows system with local terminals. Arrows indicate potential noise current paths. Distributed impedances indicate how complex resonances can be excited.

to the system or to warn of degradation, by a direct comparison of the initial and the current susceptibility levels. This objective required precision, repeatability, and independence from environmental and operational factors not previously obtainable. The instrument also provided a standard, repeatable emi source for use in system design phases. Accessories extended its utility for application as a valuable troubleshooting tool. The EMCS (Type 1) was made available only to qualified IBM service organizations. An identical, field-proven unit, called the Zapper, is now available to the entire industry. Fig 3 shows major components of the instrument assembled for basic system susceptibility testing.

The unit achieves the required precision and repeatability for several reasons.

1. The vane is one plate of a capacitor with fixed dimensions. With the discharge point in contact with the system under test, the distributed capacitance is established by the fixed separation and is exactly repeatable. With the vane standing on the floor, the distributed capacitance between it and the floor (earth) is established, fixed, and repeatable.

2. Two distributed capacitances are included in the high frequency discharge path: from frame to earth, and from earth back to the vane. The only lumped inductance along this path is through the switch, resistor, and discharge point, about 3" (7.6 cm) in total length.

3. The rate of discharge is at the 50- or 60-Hz line frequency, but can also be controlled manually with a pushbutton.
(4) Tests at any one location are run for a fixed length of time, typically 3 min. At a 60-Hz rate, 10,800 transients will be injected during this period. This is of major importance in finding the most noise-sensitive condition in the system.
(5) The vane charging voltage, up to 2500 V, is adjusted at the power supply and is read on the integral voltmeter.
(6) Very high current transients are created because the discharge current is limited by only 15 Ω.
(7) The discharge arc is inside a sealed mercury switch and is independent of atmospheric conditions.
(8) A timer is provided to switch off the high voltage after selectable durations of up to 15 min.

Susceptibility thresholds likely to cause a malfunction are precisely repeatable at any time, provided all physical conditions are duplicated, including the point of contact with the system under test. This makes it possible to evaluate changes in operational systems, and makes the tester equally useful during design evaluation. The effect of any physical change to the system, even the effect of rerouting a cable, can be measured with confidence.

The implications of identical physical conditions during tests cannot be overemphasized. No two seemingly identical systems exhibit the same noise thresholds, and a single system will exhibit different noise thresholds, in two different environments. A host of factors can affect susceptibility to noise: circuits, temperature, cable dress, floor construction, frame bonding, grounding, ambient noise, to name a few. Humidity primarily affects electrostatic noise generation, not equipment susceptibility.

The instrument provides standardized emi for evaluation of peripherals or other electronic systems as well as computers. A fixed physical configuration is all that is required. Fig 4 shows a few possible ways of using the Zapper.

**Indirect Discharge**

The testing system is also useful for systems with nonconducting enclosures, or for qualitative evaluation of broadband noise field effects, eg, near cable runs. In these applications, the switch assembly is lowered to the bottom of the assembled vane and the discharge point is made to contact and discharge to the grounding tab provided on the power supply, creating a broadband noise field. If the vane is fixed in orientation and distance with respect to a system with a nonconducting enclosure, capacitive coupling to internal circuitry is created, and repeatable, qualitative data regarding system susceptibility can be obtained.

**Radiating Probes**

Four handheld discharge probes are provided for generating more localized noise fields as an aid in isolating areas of noise sensitivity. When using these, the switch assembly is mounted inside a probe converter, and the high voltage is cabled to it. A discrete capacitor inside the converter is charged and discharged by the switch into a 15-ft (4.6-m) shielded twin-conductor cable, terminated into 50 Ω on one of the insulated handheld radiating probes. These allow the operator to probe the system discretely and isolate noise-sensitive areas.

Handheld probes have proved to be highly useful in locating faulty connector contacts and imperfect solder connections. The effect of a bad connection may be visualized by referring to Fig 2. If the illustration is viewed as a cable configuration, and the impedances $Z_1$ and $Z_2$ represent either connector contacts or solder joints, it is apparent that, if one of these changes or opens, the circuit balance will be upset, and common mode will be converted to differential mode, creating interference in the signal path.

**Summary**

While emi can be scientifically analyzed, exact specifications are almost impossible to define because of the many variables that affect emi susceptibility in systems. There is now a standard source of emi that can be used to determine the relative effectiveness of system designs and modifications on susceptibility to emi. Using the standard source, accurate data can be obtained, and minimum levels specified. Degradation below such levels indicates excessive noise sensitivity.

The same instrument is useful in troubleshooting noise problems. In these applications, however, emi design and troubleshooting skills must be developed by experience. This requires familiarity with those systems' performance, construction, and environmental features that affect susceptibility to emi.

**Acknowledgment**

Thanks are due to William Gross for his contributions in the preparation of this article.

**Bibliography**

“Electromagnetic Compatibility Simulator (Type 1), Theory, Operation, Maintenance, Parts Catalog,” Publication sy27-0109-1, IBM Corp, White Plains, NY
“The Zapper, Operation and Maintenance Manual,” DEDCO, 8141 Engineer Rd, San Diego, CA 92111
“The Zapper, Electromagnetic Compatibility Testing,” *ibid*

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Joe E. Deavenport is a cofounder of Wavetek and has been an independent consultant for the last 17 years. His most recent work has been in the emi field related to the user environment of computers and peripherals. He has a BSEE from Texas Tech University.
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CIRCLE 90 ON INQUIRY CARD
Calculator Interface Circuit Drives Large External Display

Interconnecting large 15-digit, 7-segment readout display to a handheld calculator with a converter/driver circuit achieves increased visibility and readability.

R. Alan Snyder  
Hewlett-Packard Company, Loveland, Colorado

An external digital interface circuit, designed for several commercially available handheld and desktop calculators, connects the calculator to a large digit display device that enlarges readouts sufficiently to be legible at up to 40' (12 m). The interface, designed specifically for HP 35, 45, 46, 55, 55-70, 50, and 81 calculators, features duplicate number of digits in display to preserve calculator accuracy and resolution; low power battery operation; small, single package containing both interface and display for portability; low parts count for reliability; minimum interference with calculator operation; and low cost. Examined are the calculator display timing and data formats, interface data acquisition and conversion methods, and interface driver and display techniques. Circuit alternatives are evaluated along with the rationale for the design selections.*

Interface Approach

The interface design approach for a large external display is governed heavily by the particular display device; no universal interface works with all displays. For this reason, the type of display must be chosen before the interface design can be started. For example, liquid crystal display (LCD) or light emitting diode (LED) displays need storage latches for each digit, but data can be off loaded rapidly from the calculator. Magnetic vane displays (MVD) do not need data storage latches, but data must be off loaded from the calculator comparatively slowly. Data decoding is independent of the display type, but how data are used after decoding is controlled by the display choice and the interface circuits.

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LEDs that require high current power supplies, and vacuum discharge and neon-type displays requiring high voltages. LCDs offer low current and low voltage but are not yet available in sizes large enough for this application.

Light reflecting MVDs have been used in airport message boards, stock exchange monitor boards, and sports stadium displays. These displays consume power only when changing state, similar to complementary metal oxide semiconductor (CMOS) devices, require no power while resting, and have, in effect, inherent storage latches. The MVD is available in a standard 7-segment plus decimal point format. A 1.5" (3.8-cm) high version is well-suited for this 15-digit application. Calculator output signals, MVD input signals, and required interface functions are listed in the Table.

**Calculator Display Data Format**

HP calculators use a power saving technique to scan LED displays. A particular digit position is selected, and the required seven segments of the digit are selectively scanned one at a time so that not more than one LED segment is on at any given time. A custom integrated circuit (IC) extracts scanning sequence information from data in the listing. Timing analysis reveals that straight logic tables or Karnaugh reductions are not effective in decoding 7-segment data, due in part to the unequal pulse widths of the various data lines, eg, clock $\phi_1$. Since the MVD driver circuits need pulsed data for the 7-segment and decimal point lines, pulse width inequality is no problem.

**Data Decoding**

Clock pulses define the digit window that indicates the beginning of a digit scan period. The start line indicates when a full frame of 15 complete digit scans begins, with 15 clock pulses for every start pulse. This digit window is further divided by the $\phi_1$ and $\phi_2$ lines into four subwindows that contain the 7-segment number information, of which some is redundant for this interface design. The five data lines (A to E) roughly correlate to five of the 7-segment lines, with the remaining two lines (F and G) being decoded from the five data lines. The 7-segment lines plus the decimal point line are defined in terms of the A, B, C, D, E, $\phi_1$, and clock lines at the calculator output.

This data coding technique results in pulsed data during $\phi_1$ time and provides one pulsed segment per time window, except segment B, which unavoidably has two pulses per time window. The presence of the second pulse does not cause problems because data decoding formats are stored in a 2708 programmable read only memory (PROM).

**Look And Skip Scan**

MVDs require special techniques in interfacing because of slow response times. The total time for one full scan cycle is approximately 1 ms. Display specifications state that 30 ms are needed to turn the display on or off. Consequently, a data stretching circuit is needed. A look and skip technique looks at a single digit frame (full 7-segment scan) and then lets several full frames go by before stopping at the next digit position. For example, the scanner looks at digit position 2 and then goes around n times before stopping at digit position 3 for the next look.

When the scanner stops at position 2, the digit information that has been decoded from the calculator for position 2 is loaded into a bank of 1-shot multivibrators. It then continues scanning and waits for these multivibrators to time out before stopping at the next digit position. In this manner, data are presented to the MVDs for sufficient time to set or reset them. Since the display set time is 30 ms and the scan cycle time is 1 ms, the scanner must go around 30 times before looking at the next digit position. Since there are 15 clock pulses per scan cycle, a divide by 450 counter counts the clock pulses and places the scanner at the same position in the display every scan cycle. To advance the counter one position, an extra count is added to move the scanner stop position one digit to the right every time it stops. Therefore, the resulting divide by 451 counter strobes data into the MVDs and progresses sequentially from digit to digit.

**Output Position Counter**

The output position counter (OPC) synchronizes the interface and determines which MVD digit will receive data available in the P/RROM code.
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Converter (Fig 1). Only one digit at a time is enabled, so that the data from the calculator can be latched into the display interface. The opc—a programmable divide by n counter (MC14526CP)—is programmed to divide by 15; it is reset to binary 14 (1110) every 450 transitions of the calculator start line. In the event that the state of the counter does not match the position of the calculator scan, either at power on or due to a glitch, the interface needs only to wait at most 450 start cycles (500 ms) before the output display and the calculator display become resynchronized. Since the divide by 15 counter divides down, the outputs of the decoder must be reordered. Also, because the calculator scans its digits from 15 to 1, the 4- to 16-line decoder (MC14515CP) outputs must drive the MVD digits as shown.

<table>
<thead>
<tr>
<th>Calculator Digit</th>
<th>OPC Output</th>
<th>Decoder Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>16</td>
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<tr>
<td>15</td>
<td>13</td>
<td>11</td>
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<td>1</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>13</td>
</tr>
</tbody>
</table>

**1-Shot Display Predrivers**

Twelve 1-shot circuits (ic2 to ic7) serve three separate functions. They accept look and skip data from a divide by 451 counter (ic8) and gate on all 1-shot circuits except ic1A and B; generate 30-ms set and reset signals to drive MVD drivers; and monitor shortened decimal point window and reset 1-shot circuits appropriately.

One-shot ic1A, set for a pulse width of 30 µs, triggers at every 451 transitions of the clock line. Triggered output (Q) is connected to the enable input of 1-shots ic4 to ic7. As long as ic3A remains untriggered, ic4 to ic7 are disabled and will not respond to data that are constantly available at the P/ROM decoder (ic1) output. When ic3A triggers, ic4 to ic7 are

---

**Fig 1** Converter circuit. Converter interfaces handheld calculator to large readout display. Signals from calculator are decoded in 2708 P/ROM. 1-shots compensate for magnetic vane display's slow response time.
enabled for 30 μs, allowing the 7-segment data for one digit to be set into them. The Q and \( \bar{Q} \) outputs from ic4 to ic7 are connected to two set and reset AND gates (ic11 to ic14), respectively, which connect to the MYD driver transistors (MPSA12). The ic3B 1-shot triggers on the falling edge of the ic3A output. The Q output from ic3B, set for the 30-ms required by the MYDs, drives all the set and reset AND gates.

The ic3B and ic4 to ic7 1-shots are triggered essentially simultaneously (30 μs apart). The ic3B is triggered for 30 ms, and ic4 to ic7 are preset for 35 ms. Therefore, the true data outputs of the AND gates can last for the full 30 ms. The extra 5 ms of ic4 to ic7 guard against false data from appearing at the AND gate outputs in the event that an ic4 to ic7 times out early.

The ic2 1-shot pair only activates during decimal point display time. The time window for decimal point data is approximately 12 μs wide, thus ic4 to ic7 must not be enabled timing out for the full 30 μs, thereby preventing ic4 to ic7 1-shots from getting false data.

**Magnetic Display Drivers**

MYDs have two solenoids per segment. The 1.5” (3.8-cm) high segmented displays are typically visible up to 40° (12 m), require a 30-ms wide 30-mA pulse at 12 Vdc, and consume no power while inactive. Each segment has three control wires—set, reset, and common.

Segment driver transistor pairs (MPSA12) are driven by AND gates from the ic4 to ic7 1-shot circuits, with only the SET or RESET line pulsed since they connect to the Q and \( \bar{Q} \) outputs, respectively. All eight segments (segments A to G and decimal point) for a given digit have their common lines connected and are, in turn, driven by an associated digit driver pair. For example, all ic3A segment set and reset solenoid wires for all 15 digits are respectively connected together.

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**Summary**

The final large digit display design (Fig 2) provides increased calculator readout and visibility. A critical design problem—power consumption—is overcome with an extremely low power consuming battery type display and extensive use of CMOS ICs. Because of careful design, calculator interface connections require the addition of only a single 9-pin connector. The high cost of a p/rom decoder can be significantly reduced by using a custom designed code converter ic. The final interface design results in a lightweight, portable, and battery operated readout device. This device can be easily modified to accommodate magnetic vane displays of up to 12” (30 cm) in height by retiming all circuits to compensate for slower set and reset pulse requirements.

For full design information, contact R. Alan Snyder, Hewlett-Packard, Loveland Instrument Div, PO Box 301A, Loveland, CO 80537.
Drive Mechanism Design Reduces Errors in Mini-Floppies

A mini-floppy disc drive design increases track and flux densities, and ensures error-free operation even under worst case temperature, humidity, and diskette interchange conditions.

Dennis Resnik Micropolis Corporation, Canoga Park, California

Standard mini-floppy diskette drives offer a maximum, unformatted data capacity of 110k bytes. A high capacity drive has been developed that provides 480k bytes, unformatted, for single-sided and 946k bytes for double-sided recording. The drive mechanism incorporates modified frequency modulation encoding for increased bit density, and 100-track/in (39/cm) recording for increased track density. Modified frequency modulation doubles the nominal capacity of 110k bytes. The increase from 35 to 77 nominal track yields $77/35 \times 220 = 480k$ bytes.

The ability to record and read data reliably at double-bit density is achieved by using a high resolution recording head, excellent track positioning accuracy, careful read/write (R/W) circuit design, optimum selection of write current and read-gain bandwidth, and a phase lock loop data separator for decoding. "Encoding/Decoding Techniques Double Floppy Disc Capacity" details the differences between modified frequency modulation (MFM) encoding and various other schemes. By reducing the data cell transition time from the 8 µs required for standard frequency modulation (FM) encoding to 4 µs, MFM doubles the number of cells per track without increasing the total number of flux transitions on the diskette. This technology maintains a data error rate of less than 1 error in $10^9$ bits.

Increasing track density from the standard 48 tracks/in (19/cm) to 100 tracks/in (39/cm) relies almost entirely on the ability to maintain head to track alignment over the required operating temperature and humidity ranges, permitting diskette interchange between drives. Because materials used in drives have various coefficients of expansion and the diskette expands and contracts with changes in humidity as well as temperature, fluctuations in either temperature or humidity will create positioning inaccuracies.

A typical 48-track/in drive may have a total head positioning inaccuracy of ±0.004" (±0.102 mm). When reading a track, the R/W head...
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could be as much as 0.008" (0.203 mm) off the written track position. With 0.021" (0.533-mm) track to track spacing, 38% error is possible. Satisfactory performance can be achieved with up to 50% offtrack error in an MFM system. If this same drive is modified for 100-track/in operation by changing the head design and making the positioner turn about half as far, the ±0.004" error would approach the distance between tracks. To achieve a 100-track/in design, the head must be positioned at least twice as accurately as in a 48-track/in drive.

**Positioning Mechanism**

A steel lead screw with a loaded-ball follower combination (Fig 1) was chosen over a plastic cam or hand positioner because of its inherent accuracy. The chosen mechanism also leads to a unique head referencing method. A 7.5°, 4-phase, permanent magnet stepper motor using four sections of stamped-cup type stator elements is coupled to a precision-ground lead screw with 8.33 threads/in (3.28/cm) pitch to yield a rotary to linear motion conversion ratio of 30° = 0.010" (0.254 mm). Four 7.5° steps move the head from one track to another. While some track to track access speed is sacrificed, a significant improvement in overall accuracy is achieved by making 4 steps/track with a 4-phase stepper motor: the same stator pole is expected. In practice, experiments have shown that a nonaccumulative error of ±0.5°. Since 30° lead screw rotation yields a linear motion of 0.010", a maximum track position error of 167 µin (4.24 µm) is expected. In practice, experiments have shown that ±0.25° accuracy is easily achieved. This leads to a motor positioner accuracy of ±83 µin (±2.11 µm).

Inherent friction is used to damp the oscillating motion of the positioning system. This leads to a dead-band angle, due to hysteresis, which depends on the maximum friction ($T_f$) and the torque/angle stiffness ($F_f$) of the stepper motor. After a step, the motor may stop anywhere within the dead band, ±θ. In practice, θ = ±1.05°, which yields a hysteresis effect positional error, due to friction, of ±350 µin (±8.39 µm).

**Temperature And Humidity Compensation**

The head positioner accurately locates the head over the correct track under static conditions. Without any operational temperature and humidity compensation, expansion and contraction of both the Mylar diskette and the chassis or casting cause a worst-case misalignment of several thousandths of an inch. If the head is referenced via a cam, band, or lead screw to the positioner, which, in turn, is referenced to the chassis, the chassis will expand as temperature rises and move the head away from the spindle. Mylar has an expansion coefficient of 9.4 µin/in/°F. Over a temperature range of 50°F (10°C), this effects an expansion differential of 900 µin (22.8 µm) on a track at the center of the positioner stroke with no temperature compensation.

In Fig 1, the lead screw is preloaded with a force of 2.5 lb (11.1 N) against a thrust bearing, located in the spindle housing, by a flexure spring attached to the stepper motor case. This flexure provides degrees of freedom that preclude the need for accurate alignment of the motor body to the baseplate. Thus, the temperature compensation loop includes the diskette, lead screw, and spindle housing. It excludes the baseplate, and stepper-to-base and spindle-to-base mountings from the head positioner mechanism. Expansion of the baseplate results only in a change of preload.

Since the diskette and the lead screw are both referenced to the spindle housing, thermal expansions of the media, lead screw, and spindle housing occur in the same direction. Spindle housing material is selected so that when the head is positioned at reference track 36, the coefficient of expansion for the head, lead screw, and spindle housing matches that of the media. Worst case misalignment due to thermal factors (tracks 0 and 76) is less than 200 µin (5.08 µm).

Humidity, or hygroscopic expansion, is not compensated in the drive design. Floppy diskettes suffer from a dimensional stability problem because of Mylar's 6-µin/in/% relative humidity hygroscopic expansion coefficient. Error due to this hygroscopic effect can be ±350 µin (88.9 µm). Practical results of diskettes are significantly better than the design values for ordinary Mylar (see the
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Table) due to the stabilizing influence of the oxide recording surface.

**Other Design Factors**

The positioner design locates the head accurately, even under dynamic conditions imposed by temperature and humidity variations, diskette interchange, and shipment. It is also important to ensure that the diskette is accurately registered with respect to the spindle. Centering schemes that use a hub may miscenter a diskette with a maximum tolerance hole diameter by as much as 0.002" (0.051 mm). After writing and then interchanging or reclamping the diskette, the track appears to revolve eccentrically under the head. This misalignment over part of the track is equivalent to positioning mechanism inaccuracy.

Drive design eliminates registration error as follows. After the diskette is inserted, the receiver and clamp are lowered so that the diskette center hole engages with the profiled hub on the spindle shaft, centering the diskette. Spindle rotation assists centering action as the clamp is lowered. Once the clamp is in position, a spring provides 3 to 5 lb (13 to 22 N) of clamping force. The central part of the clamp registers with a projection on the drive shaft, so that the clamp is concentric with the hub, and neither rotates relative to the other.

Hub dimensions provide a line to line fit when the hub diameter is at minimum tolerance and the diskette center hole is at maximum tolerance. Thus, at the other extreme of the tolerances, an interference fit of approximately 0.0025" (0.063 mm) exists. This fit is taken up by movement of the diskette. The spindle contour allows for a large-radius bend in the Mylar, preventing permanent diskette distortion. Experimental data show that a diskette centering accuracy of ±250 µin (±6.3 µm) is achieved by the combination of the profiled hub, the hub rotation during loading, and the design tolerance. Spindle runout—the total allowance for spindle, shaft, and bearing eccentricity—is less than 200 µin (5.08 µm).

Remaining factors affecting the positioning accuracy of the head and media involve adjustment of the positioner, or radial alignment. An eccentric lobe or cat's eye pattern alignment disc with an accuracy of ±200 µin (5.08 µm) is used. An additional ±100 µin (0.25 µm) is allowed for human factors that may arise during adjustment.

### Head-Media Positioning Errors

<table>
<thead>
<tr>
<th>Contributing Error Factors</th>
<th>Design Goals (µin)</th>
<th>Practical Results (µin)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning Mechanism</td>
<td>±83</td>
<td>±83</td>
</tr>
<tr>
<td>Motor Accuracy</td>
<td>±500</td>
<td>±250</td>
</tr>
<tr>
<td>Hysteresis Effects Due to Friction</td>
<td>±200</td>
<td>±200</td>
</tr>
<tr>
<td>Lead-Screw Accuracy</td>
<td>±83</td>
<td>±83</td>
</tr>
<tr>
<td>Temperature Effects</td>
<td>±200</td>
<td>±200</td>
</tr>
<tr>
<td>Hygroscopic Effects</td>
<td>±200</td>
<td>±200</td>
</tr>
<tr>
<td>Disc Run-Out</td>
<td>±200</td>
<td>±200</td>
</tr>
<tr>
<td>Disc Centering Accuracy</td>
<td>±250</td>
<td>±250</td>
</tr>
<tr>
<td>Spindle Run-Out</td>
<td>±200</td>
<td>±150</td>
</tr>
<tr>
<td>Alignment Accuracy</td>
<td>±200</td>
<td>±200</td>
</tr>
<tr>
<td>Standard Disc Accuracy</td>
<td>±200</td>
<td>±200</td>
</tr>
<tr>
<td>Human Factors</td>
<td>±100</td>
<td>±100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>±1768</td>
<td>±1518</td>
</tr>
</tbody>
</table>

**Total Error Affects Head Design**

While it is highly unlikely that all error factors would simultaneously apply in one direction, a worst-case combination of temperature, humidity, alignment disc inaccuracy, and positioner inaccuracy would place the head 1768 µin (44.9 µm) off track. Maximum allowable head offset from true track position determines the parameters necessary to specify a head design for 100-track/in operation. Floppy disc systems use magnetic heads consisting of a R/W element together with two erase elements on either side. Two implementations of such a head are the tunnel and straddle erase systems. Although harder to implement because of the additional erase timing circuits required, the tunnel erase method has been chosen because of its superior data performance.

Fig 2 shows a R/W core of width 2W with two tunnel erase cores, one on each side, each of width E. The erase gaps ensure clean guard bands between tracks so that, when the head is reading an offtrack location, it does not pick up portions of previously recorded information. Fig 3
FOR DATA ENTRY . . .  

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Fig 3 Track overwrite situation. When track is rewritten, even small head mispositioning will result in some old data remaining on disc. In MFM or FM reading, small residual signal may cause errors. Tunnel or straddle erase eliminates old data.

Fig 4 Adjacent track situation. With track A written offset to left and track B written offset to right, track A will be reduced in width by effect of erase gap E.

depicts a track written with the head offset to the right by an offset of O, new information written with the head offset to the left by offset O without the erase head energized, and an attempt to read the new information with the head offset to the right, again by amount O. The head will read the correct information, as well as part of the previously recorded information, at the track location. The relative amplitudes of the information are: NEW = 2(W - O) and OLD = 2(O). In typical cases, without erase, the ratio of NEW/OLD approaches 1, making data recovery impossible.

In Fig 3, the following inequality must be satisfied for all old information to be erased:

\[ E \geq 2W - 2(W - O) \text{, or } E \geq 2O \]  

(1)

The width of the erase gaps must equal or exceed twice the worst-case offset. The amount of track that can be read in the worst case is 2(W - O). Two conclusions can be drawn: the greater the erase core width, E, the more offset can be tolerated; and the greater the offset, and therefore E, the less track width remains in the worst case. Since the remaining track width is 2(W - O), this condition would appear to require increased R/W width; however, other limitations apply.

Fig 4 depicts track A written with an offset to the right. When the head is reading track A with an offset to the left, the amount of track being read is 2(W - O). Suppose that track B is written with an offset to the left of its true position. Then, the erase head will erase some of track A. To prevent the erase head from reducing the amount of track A to less than 2(W - O) available for reading at any position of the read head, the following inequality must be satisfied:

\[ T - (W + O + E) \geq W - O \text{, or } T \geq 2W + E \]  

(2)

Track spacing must equal or exceed the R/W gap plus the erase gap. Thus, head design essentially trades off allowable track offset for reduction in signal amplitude. The final, 100-track/in (39/cm) head design has a R/W core width of 0.00625" (0.16 mm), and erase core width of 0.00355" (0.089 mm). Fringing effects yield an effective erase core width of 0.00355" (0.0902 mm).

Substituting these values into Eq (1) shows that

\[ E \geq 2(O) = 3550 \, \mu\text{in} (90.2 \, \mu\text{m}) \text{, and } \]

\[ O \geq 1775 \, \mu\text{in} (45.1 \, \mu\text{m}) \]

This is consistent with the design goal of track error value. Also, by substitution into Eq (2), T \geq 0.0098" (0.249 mm). Since T = 0.010" (0.254 mm), the inequality is satisfied. Remaining worst-case track width is 2W - E = 0.00625" - 0.00355" or 0.0027" (0.068 mm), and percent signal remaining is 0.0027 \div 0.00625 = 43.2\%. This signal reduction is well within the dynamic range capabilities of the read electronics.

As listed in the Table, the worst-case head mispositioning, or offset, does not exceed 1768 \, \mu\text{in} (44.9 \, \mu\text{m}), and the read amplitude always exceeds 43.2\% of optimum (with the head directly over the track). Therefore, error-free performance is assured, even under worst-case temperature, humidity, and diskette interchange situations.

**Bibliography**

E. Dunstan, "100 Tracks Per Inch on a 5½" Floppy," Micropolis Corp, Canoga Park, Calif, 1977


"1015 Flexible Disk Drive Engineering Specification," Document #100112, Micropolis Corp, Canoga Park, Calif, June 1978
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Fast Differential Analog to Digital Conversion

Tracking converters and successive approximations are combined in a differential A-D converter

Successive approximation converters are almost universally used for high speed analog to digital conversion. However, for high accuracy, in the order of 12 to 16 bits, conversion times increase by approximately $2^n$, where $n$ is the number of bits. Another comparison must be made for each additional bit, and the settling time is approximately doubled for each doubling of accuracy (bit).

The differential conversion technique shown in the figure is a hybrid achieved by combining tracking converters and successive approximation techniques. Analog to digital (A-D) conversion is performed on the difference between the present input signal and the last converted value, which has been stored in the accumulator. This digitized difference signal is added to the previous digitized value to attain the new value representing the digitized analog input.

Since the A-D converter used in this technique digitizes only the difference signal, it performs significantly faster than a converter required to digitize the complete answer. After the difference is digitized, it is added to the previous stored value, and the converter must be allowed to settle before another conversion cycle is started. Conversion time is one settling of the $n$-bit digital to analog (D-A) conversion, $m$ bits of the A-D conversion, and the add time, which totals less than $n$ settlings of the $n$-bit D-A conversion normally required.

Accuracy is limited primarily by the D-A converter. Offset and gain errors in the A-D conversion should be less than 1 bit, which is easily attained. The converter cannot handle rapidly changing inputs because it is slew limited; however, it will recover input transients without overshoot or extra settling time. Additionally, the output of the $m$-bit A-D converter is useful as a digital derivative of the input signal.

Note

This work was done by Arthur G. Birchenough and William J. Rice of Lewis Research Center, 21000 Brookpark Rd, Cleveland, OH 44135. No further documentation is available (LEW-12909).

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Computer Interface for Mechanical Arm

Man/machine interface simplifies operation of computer controlled mechanical arm

A computer controlled mechanical arm has six degrees of freedom and is directed through a supervisory control mode, in which all motions of the arm follow a set of preprogrammed sequences. The program is stored beforehand in a computer.

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This type of an interface can operate a computer controlled arm to handle radioactive or explosive materials, or command an arm to perform functions in hostile environments.

Note
This work was done by W. L. DeRocher and R. O. Zermuehlen of Martin Marietta Corp for Marshall Space Flight Center. For further information, write to: Aubrey D. Smith, Code AT01, Marshall Space Flight Center, AL 35812.

Patent Status
Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Leon D. Wofford, Jr., Mail Code: CC01, Marshall Space Flight Center, AL 35812. Refer to MFS-23849.

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CIRCLE 99 ON INQUIRY CARD
Conditional and unconditional input/output techniques were introduced in last month's column, accompanied by discussions of handshake cycles, strobed input/output, flags, semaphores, and interlocking. Block diagrams illustrated the input/output techniques, providing an idea of how a microcomputer and an input/output device can be interlocked, as well as what role a semaphore plays in this interlocking process. This month's column, as a prelude to subsequent ones, compares flowcharts, structure charts, and the written statement form of describing microcomputer algorithms. The approach followed is patterned after the Swiss article by Baumann.1

Structured programming is a set of conventions and rules that yield programs which are easy to write, test, modify, and read.2 Turner defines top-down structured programming as a method for solving a given problem or implementing a given definition in which the problem or definition is more specifically refined at each step of the procedure until a final step of refinement results in executable code. The same limited set of syntactic structures is used at every stage of the problem's refinement.3 Refs 2 through 4 discuss structured programming in the context of microcomputers. The basic approach was first proposed by Dijkstra;5,6 another useful reference is the book by Yourdon.7

This widespread technique, discussed and employed in most recent computer science texts, is still not commonly taught to engineers and scientists who usually learn either FORTRAN or BASIC. Due to space limitations, these common "structures"—the basic building blocks of structured programming—will only be summarized.

The first structure, the sequence block, is a single instruction or computational statement, or any sequence of computational statements, with only one entry and one exit. Fig 1 depicts a pair of sequence blocks. The first computational
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Fig 1 Pair of sequence blocks. Flowchart, structure chart, and written statements for two sequential operations are depicted; same format is followed with all subsequent figures. One entry and one exit is common with structured programming.

Fig 2 DO-WHILE mechanism. Generalized loop-and-test structure shows microcomputer timing loop.

Fig 3 DO-UNTIL (REPEAT-UNTIL) mechanism. Form of timing loop is typical of that used in microcomputers.
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statement is "change data in buffer," and the second statement is "set semaphore high." These two statements can be combined into a single sequence block. In Fig 1, the pair of sequence blocks is represented in flowchart notation, structure chart notation, and written statement form. The remaining Figures are set up following the same format. Computer scientists find the written statement technique convenient when developing programs on cathode ray tube terminals.

The second structure is a generalized loop-and-test structure, usually called the DO-WHILE block or mechanism. Again, observe that there is only one entry and one exit (Fig 2), a fundamental characteristic of all basic structures in structured programming. In Fig 2, the loop-and-test structure is a microcomputer timing loop, in which a counter is successively decremented until it reaches zero, at which time the loop is exited. A related loop-and-test structure is the REPEAT-UNTIL block. Fig 3 provides the form of the timing loop that is typically employed in microcomputers; in other words, the counter usually is first decremented, then the zero flag is tested, and finally a branch occurs depending upon the logic state of the flag.

A selection-based-on-a-test structure is the third basic form, universally called the IF-THEN-ELSE block or mechanism. With still only one entry and one exit, the example in Fig 4 is a simple binary test—yes or no. If the answer is yes, the THEN alternative is executed; if the answer is no, the ELSE alternative is executed.

The sequence, DO-WHILE, and IF-THEN-ELSE mechanisms

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-comprise the three basic structures. Two other structures commonly found in microcomputer programs are the CASE and REPEAT mechanisms. The CASE block or mechanism in Fig 5 is also a selection-based-on-a-test structure, but with more than two alternatives to select among. This type of structure can be implemented with microcomputers in several ways, such as by a sequence of IF-THEN-ELSE statements or by a command decoder. Single entry to and single exit from the structure are basic characteristics shared in Figs 1 through 5.

Fig 6 depicts the REPEAT mechanism, also known as the LOOP-FOREVER mechanism, which is not one of the basic structures in structured programming. Nevertheless, it is occasionally used in microcomputer programs, such as those that employ interrupt-driven input/output (I/O). In such situations, the microcomputer program loops (perhaps forever) until an interrupt occurs. These notations will be employed next month to continue the comparison of conditional and unconditional I/O techniques.

References
Meet two new Printers from Anadex:

Resolutionary!

Introducing two totally new alphanumeric line printers from Anadex - Models DP-9500 and DP-9501 - featuring 132/175 or 132/220 columns, respectively.

Both models employ a new, Anadex-manufactured 9-wire print head with 150 million character life (optionally, 650 million) that makes them ideal for high-resolution printing requirements including high-density graphics where print quality and reliability must go hand in hand.

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The three ASCII compatible interfaces (Parallel, RS-232-C, and Current Loop) are standard in every printer; so interfacing is usually a matter of "plug it in and print." With simplified interfacing, the printers also feature sophisticated communications capability including control of Vertical Spacing (6 or 8 lines/inch), Form Length and Width, Skip-Over Perforation, Auto Line Feed, and full point-to-point communications capability.

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Nature of Business

CIRCLE 61 ON INQUIRY CARD

Zilog's MCZ-1/20A and -1/25A microcomputers are designed as modular system building blocks with Z80 CPU and 64k RAM for general purpose industrial and business uses

Hardware elements that are intended for commercial small business and industrial applications are two modular microcomputer subsystems without CRT and software, and two ready to run pre-integrated systems, each with a CRT and one of two versions of software. Zilog, Inc, 10460 Bubb Rd, Cupertino, CA 95014, simultaneously is announcing a Multi-Terminal COBOL option that accommodates up to five users.

Flexibility is the key to the desktop MCZ-1/20A and rackmounted MCZ-1/25A multipurpose microcomputer systems. Standard features of a Z80 microcomputer, 64k bytes of RAM, 4k bytes of PROM, interrupt driven console capability, and floppy disc controller may be enhanced by such options as additional disc capacity, Multi-Terminal COBOL capability, and asynchronous communications.

The desktop version has integral dual floppy disc drives, while the rack-mounted enclosure is packaged with either integral dual floppy disc drives or cartridge disc drives. Both units are prewired for the addition of up to four floppy discs and four 10M-byte cartridge discs.

Advancing from these basic modules are the desktop MCZ-1/50 and rackmounted MCZ-1/70 systems. Extra slots in the standard 9-slot cardcage allow the systems to be configured with customized boards. Additional discs to extend the data base and up to four terminals for multiterminal functions further expand the capabilities.

Containing the same basic components as the modular computers, the -1/50 includes a CRT and integral dual floppy disc drives for 600k bytes of storage; the -1/70 with CRT has either integral dual floppy disc drives or cartridge disc drives. These packages, too, may be upgraded to four floppy disc drives and/or four 10M-byte cartridge disc drives.

The system CRT offers full cursor control, blinking, blanking, and...
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When you need maintenance-free rechargeable batteries, you'll find the broadest range of sizes in the Carefree® line—models either more powerful or less powerful than those available from our competitors.

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Just tell us how many contacts you need—from 2 to 150—and it’s yours, right now.
With no special engineering. No custom mold. No lost time. No extra charges.
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There are some other very nice features, too. For example:
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Probing ports let you check any circuit and do it with the power on.
You can’t mismatch boards and connectors—special keys prevent it.
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For high-speed/low noise circuits, our 254 DFC Series offers matched impedance 50 ohm contacts with low VSWR. They’re available with 2 x 17 P/C contacts, plus 4 co-ax contacts. Or 2 x 31 P/C contacts with 6 co-ax contacts, in a two-piece connector.

The 254 DFT and DFC Series. Just tell us what you want and it’s yours. Call or write us today for a quote on pricing and delivery.

Series 254 DFT
2 to 150 contacts, snap-on mounting ears.
reverse video. An integral numeric pad is included, along with RS-232-C or 20-mA current loop interface. Baud rates range from 50 to 9600. Options for the systems are additional CRTs, a matrix printer, Z80 serial interface board, and letter quality printer with text formatting package.

All four systems are supported with the RIO operating system that handles system resource management, supports device independent I/O and user defined commands, and permits command linking. Also included are a text editor, debugger, macro assembler, and file management capabilities.

High level languages are BASIC, COBOL, FORTRAN, Pascal, and PLZ. Specialized utilities are a text formatting package, along with ASYNC for intercommunication among MCZ systems. Communications and multiterminal packages suit the computers to distributed processing environments, and applications in which the same information must be accessed by several users.

Multi-Terminal COBOL designed to be run on the MCZ systems, allows up to five users to simultaneously access a data base, or it can limit access to one user. Applications include inventory control, data entry, or other transaction processing. The interactive program offers most Level 1 and several Level 2 features of 1974 ANSI X3.23 COBOL. Existing programs for minicomputers and mainframes can therefore be executed on the microcomputers.

The software is implemented with the addition of the serial interface board, allowing four extra terminals to be connected to the system. The standard RIO operating system has been enhanced with an interrupt driven, multiterminal hardware driver to support the interface board. An interactive debugger and online program editing facility ease COBOL program development and debugging.

Industrialized A-D Board Gives High Common Mode Noise Rejection

SineTrac ST-LSI-RLY relay-isolated inputs provide 126-dB common mode rejection and safe handling of common mode voltages up to 250 V rms. It is used with Digital Equipment Corp’s LSI-11, LSI-11/2, and PDP-11/03/23 series microcomputers in industrial environments where low voltages from sensors are often obscured by high voltage noise. Full hardware and software compatibility is assured.

Fitting DEC’s half-quad spacing, the 8.430 x 5.187 x 0.50” (21.412 x 13.175 x 1.27-cm) board offers eight differential A-D channels. Datel-Intersil, 11 Cabot Blvd, Mansfield, MA 02048, has included an ADC-EK12 to perform A-D conversions. A 2-bit program word controls the programmable gain amplifier for gains of X1, 2, 5, and 10. This circuit is autozeroed. A programmable gain amplifier processes analog input signals ranging from ±10 mV to ±1.0 V (bipolar) FSR or 10 mV to 2.0 V unipolar. The 12-bit ADC which provides resolution to 1 part in 4096 (±1/2 LSB), changes these to a digital code.

The memory mapped device uses two consecutive address words in the microcomputer’s memory. Both the base address and interrupt vector address, while factory set, may be reset by the user.

Overall system throughput is 36 ms to sample to sample (28 samples/s). System zero tempo ranges from 0.5 to 20 µV/°C (gains from X1 to X100, respectively). For the same range of gains, typical system gain tempo varies from 12 to 40 ppm of FSR/°C. Standard binary, offset binary, or 2’s complement digital output coding may be set by the user.

A paper tape diagnostic program allows checkout of system performance. Operating temperature is from 0 to 70 °C. Power requirements are 5 Vdc at 1.5 A max, and 12 Vdc ±5% at 70 mA max.

CIRCLE 411 ON INQUIRY CARD
In an earlier America, every living thing enjoyed its rightful place. Our abundant country provided wild animals with every environment needed for their survival—green forests, lush wetlands, untouched deserts, and clear, free-flowing rivers.

Over the years we have made good use of our lands, waterways and other resources. But we have also needlessly defiled and destroyed many of them. Today, many of these areas, like some of the animals they once supported, are endangered species.

- In Maine on the St. John River, a proposed, unnecessary dam threatens 500,000 acres of habitat that now provide food, water and cover for moose, lynx, bobcat, osprey, and deer.
- In California’s Dove Springs Canyon, reckless use of motorcycles and other off-road vehicles is driving more than 75 species of birds, reptiles and mammals from their desert home.
- In Nebraska, diversions of water are menacing the habitat of the rare whooping crane, a few surviving bald eagles, and millions of migratory waterfowl at the Big Bend of the Platte River.
- In Louisiana’s Atchafalaya Basin, a plan to drain and cultivate 800,000 acres of wooded wetlands would wipe out the home of more than 300 species of birds, 50 species of mammals, and countless thousands of aquatic creatures.

These are just some of the endangered habitats the National Wildlife Federation is working to save. We can’t turn back the clock, but we can protect habitats we still have. Without them, there will be no wildlife.


Save A Place For Wildlife.
THE MOST FIELD PROVEN IS NOW THE MOST VERSATILE.

Telex introduces the new Tri-Density 6250 Tape Subsystem for OEM’s.

In 1978, Telex introduced and delivered the first high speed 6250 BPI tape transport for OEM mini-computers. It lets you compact more data in less space. At faster speeds. Since then we’ve built up more field proven reliability than any other 6250 OEM tape drive manufacturer.

Now this rack-mounted 6200 Series tape family has been expanded to include the 6253 tri-density tape subsystem. The high performance drive and formatter combines three densities – 6250 BPI (GCR), 1600 BPI (PE), and 800 BPI (NRZI) – into a single unit. And as with all 6200 models, tape speeds of 50, 75 or 125 IPS are available. Telex formatters attach up to four 6200 Series drives and up to eight with an expansion option.

One key to the reliable operation of the 6200 Series is our patented Supr-Lite™ Capstan. It weighs only 1.9 grams, and combined with our patented new tape path, lets us use a smaller, more efficient drive motor. Tape handling at high program rates is improved.

Most importantly, the 6200 Series now offers you extreme versatility in matching and field converting a wide range of features and system options. The 800/1600 BPI dual density model 6240 can be easily field upgraded to tri-density. And such options as a 360/370 channel adaptor, high altitude and seismic feature, and dual speed capability will enhance your system configurations and performance many times over.

For more information about the 6200 Series — including its price/performance competitiveness — call your nearest Telex OEM representative. Or phone our OEM Marketing Department in Tulsa at (918) 627-1111.

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**DIGITEC'S 6450 & 6460 THERMAL ALPHANUMERIC PRINTERS**
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DigiTec's popular 6400 Series Printers now offer you a choice!

DigiTec has added two new thermal models to the tried and proven 6400 Series Alphanumeric Printers. You can now choose thermal or electro sensitive printing and get all the DigiTec benefits with either. Fewer moving parts than impact printers guarantee increased reliability. Plus, non-impact means no hammer to clutter or wear out and no messy ribbons to change.

A built-in microprocessor provides the simplest possible interfacing.

Input configurations satisfy all the popular data communication interfaces. The serial models are programmable for either RS-232-C or 20 mA current loop at either 110 or 300 baud while parallel input models accept data at rates up to 1000 characters per second (higher rates optional).

These features combined with compact size, quiet operation and designer-styled goof-locks produce dependable printers that are perfect for your application.

Choose either thermal or electro sensitive... if it's DigiTec, you've made the right choice.

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**Micro Data Stack Computers, Elements, and Systems**

**Digitizer Graphics**

**Board Stores Video Data For Multibus Systems**

Total video acquisition and display are handled by the VG-120 Intel Multibus compatible single-board graphics system. It acquires a full screen of display information from any EIA standard video source, simultaneously digitizes and stores the realtime data, and enters them into an 80k-byte onboard memory. They are available for computer read/write access and display on a TV monitor. Autoincrement screen address registers permit easy sequential data access.

The Multibus based computer can evaluate and modify video data for in-place enhancement, as well as generate its own binary memory pattern for display as video. The computer can also transmit the same memory information to a remote site for display or analysis. Applications include graphic generation, image processing, scan conversion, and transmission of TV images over voice grade telephone lines (with a modem).

High density video binary storage and regeneration offers 320 H x 240 V pixels, with 6-bit pixel resolution. Datacube, Inc, 670 Main St, Reading, MA 01867, produces two output video versions—black and white with 64-level luminance or pseudocolor with 64 color shades. Average access time is 800 ns.

Input section consists of an EIA standard video input, realtime 6-bit ADC, computer controlled frame grab, and H-V or composite sync camera drive. The output portion contains the 6-bit realtime DAC, EIA standard video output, H-V and composite sync outputs, and RGB video outputs (on applicable models). Bus and video drive signals are TTL compatible. Video timing meets EIA spec RS-170, and the board can be crystal controlled or referenced to an external timing source.

Indirect (X,Y) memory addressing is via horizontal and vertical vector ports. Indirect addressing with an auto increment mode allows up to a 1.2M-byte/s data transfer rate. Ports may be addressed either in I/O or in memory mapped mode.

CIRCLE 412 ON INQUIRY CARD
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Capacities from 30 to 130 CFM

For quick delivery and competitive pricing evaluate these Lamb Electric fans for your cooling requirements. All models incorporate a sealed lubrication system for continuous circulation of lubricant in the bearing area. This patented lube system is designed to increase fan life with the unit mounted in any position. These fans are component-recognized by Underwriters Laboratories Inc., and are available in 115 or 230 Vac designs for 50/60 Hz operation. Both Blazer and Blazer 30 fans can be supplied as a skeleton design if shrouding is not required. Cord sets and finger guards available to customer specifications.

Put Lamb Electric's proven productive capabilities to work for you. For pricing and delivery details, call: Norman Anderson, AMETEK, Lamb Electric Division, 627 Lake Street, Kent, Ohio 44240. (216) 673-3451. Telex: 98-6497.

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BLAZER 30 FANS

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ZEPHYR FANS

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*U.S. Patent 3,763,386

CIRCLE 110 ON INQUIRY CARD
Support Package Adapts Development System To 6805 Microcomputer

Existing EXORciser and EXORterm equipment convert to the development and realtime emulation of MC6805 microcomputer systems with the addition of the MEX6805 support system. Basis of operation is the 2-processor approach of the 6805 microcomputer operating with the 6800 CPU in the development system, isolating the 6805 from the development system buses while allowing interprocessor communication through status/control registers and shared memory. Existing M6800 hardware and software can be used to develop 6805 systems.

This support system from Motorola Semiconductor Products Inc, PO Box 20912, Phoenix, AZ 85036, consists of the PC board module, extender cables for user systems evaluation (USE-6805), and an MDOS diskette with the 6805 macro assembler and FIVEbug, the system debug/monitor program. The module's shared memory scheme allows multiple processors (four maximum) to run in the user target system, with the debug function limited to one processor at a time. A separate socket allows use of the 6805 self-test capability to verify chip functionality.

All onboard RAM, EPROM, and external memory may be used; single-step and set one breakpoint function or halt-on-address may be applied to pro-

Emulating single- or multi-6805 systems independent of the EXORciser bus, Motorola's support system features software selectable EPROM/mask ROM/external memory options; 6805 data/address lines available for hardware analyzers; 6805 self-test socket; and jumper selectable memory options. Extensive debug capability and macro assembler are included. Memory block A-F in user wirewrap area is fully decoded to provide custom I/O implementation.
grams in these memories. Up to eight breakpoints can be set for programs in onboard RAM, EPROM, ROM, or external memory programs run in realtime. System operation may be in standalone mode, forfeiting interrupt-driven debug capabilities.

The USE system extends debugging capabilities into the prototype hardware to evaluate combined hardware and software. FIVEbug firmware commands are for MEX6805 module configuration; data manipulation to load and verify tape or disc files and to display and change memory or registers; processor control to display, set, or reset breakpoints; and memory change or display of contents of a memory location.

The MC6805 macro cross assembler and linking loader extend software development capabilities to include assembly of 6805 source code. Macro assembler supports include macros, conditional assembly, relocation, and linking. The linking loader combines relocatable object modules to produce an absolute object image.

Unit price of the system in 1 to 5 quantities is $2000. Minimum system requirements are an EXORciser I, 2A, or 2 with EXORterm 100 or 150; or EXORterm 200 or 220; with EXORDisk II or III/III E; and 24k of memory.

CIRCLE 413 ON INQUIRY CARD

Single/Multiple Emulators Support Peripheral Interface Microcomputers

Two in-circuit emulation options for debugging and integrating software and hardware designs support the iSBC-80/30™ single-board computer and other designs based on 8085 masters and 8741A or 8041A slaves. The ICE-41A™ in-circuit emulator emulates the 8741A and 8041A universal peripheral interface microcomputers while the Multi-ICE™ software package provides multiprocessor development support. They can be used on any Intellec system model with the company's standard ISIS-II diskette operating system.

Advanced techniques of symbolic debugging are provided by Intel Corp., 3065 Bowers Ave, Santa Clara, CA 95051, in the ICE-41A emulator, making it unnecessary for the designer to keep track of the address changes. Assigned names or symbols of subroutines are used in simple commands, while the Intellec system and ICE-41A software handle program access and diagnostic display. There are 18 commands available along with a range of modifiers. The designer can obtain trace information following
realtime emulations run at 6-MHz clock rates, or can single-step through a program.

ICE-41A is able to uncover hidden onchip functions such as program execution by providing equivalent functions and a trace memory on the emulation board. A user can access these functions through the system's CRT display/keyboard console, controller board, and ICE-41A support software. The emulation board contains the data memory and logic functions necessary to emulate the UPI-41A devices. The controller board is an 8080 microcomputer subsystem that interfaces the Intellec system and the emulator.

Enhancement to the previously introduced Multi-ICE package enables one Intellec system to control and coordinate operations of three in-circuit emulator combinations: the ICE-85/ICE-41A; two ICE-85 emulators to develop systems with multiple 8085 microprocessors or 8085-based iSBC systems; and ICE-85/ICE-49 for systems with 8021, 8035, 8039, 8048, 8049, and 8748 microcomputers.

Creating a software interface between the user and the ICE units, the Multi-ICE package executes a host process, as well as two ICE processes. The host process communicates with the user at the Intellec console and translates commands into execution lists for itself and the two ICE processes, which control the ICE units. Commands may originate from the console or from diskette files.

ICE-41A is provided with its own software support package on flexible disc for $4200. This includes emulation and control boards to plug into the development system chassis, along with buffered cabling to interface the development system and user's prototype design. The enhanced Multi-ICE package will be supplied without charge to purchasers of the original ICE-85/ICE-85 and ICE-85/ICE-49 package. Purchase price of the enhanced package is $1750.

Peripheral Implements Storage With Magnetic Bubble Memories

TM990/210, offering nonvolatile storage without battery backup power, is designed by Texas Instruments, Inc, PO Box 225012, Dallas, TX 75265, for bus compatibility with the TM990 series of microcomputer modules. Complete with the necessary support circuitry for bubble devices, the storage peripheral contains two, four, or six 92k-bit TIB0203 bubble memories for 23k, 46k, or 69k bytes of storage, respectively.

Single- or multipage data transfers from the module occur in memory-mapped mode. Access time is 4 ms and data transfer rate is 45k bits/s. Standard 5- and ±12-V power supplies are required. The module operates over a 0 to 50 °C temperature range.
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CIRCLE 113 ON INQUIRY CARD
Analog I/O Boards For LSI-11/2 Offer High Performance

Two analog I/O systems, each mounted on a standard Digital Equipment Corp dual-height board for backplane and software compatibility with LSI-11, -11/2, and -11/23 computers, cover the range of high and low level analog inputs. Common features are a 16-channel, 12-bit A-D conversion system, two 12-bit DAC channels, a software efficient digital interface structure, and timing and control circuits.

Operating from a single 5-Vdc power supply, the systems include optional 14- or 16-bit A-D conversion systems as well as a software programmable gain amplifier. Throughput rates of these versions are 10 and 2.5 kHz, respectively.

The standard 12-bit, 25-kHz version of model DT2781 is jumper selectable for single-ended or differential input configuration. Analog input voltage ranges from 0 to 5 V, 0 to 10 V (unipolar), ±5 V, or ±10 V (bipolar). With a gain of 1, input system accuracy is ±0.03%, ±0.01%, and ±0.0075% FSR for 12-, 14-, and 16-bit conversions, respectively. A PGA-option software programmable gain amplifier produces code selectable gains of 1, 2, 4, and 8.

Accepting low level analog input signals with values between 10 mV and 10 V, the model DT2785 exhibits the same accuracy and throughput rates of DT2781 versions. Field adjustment by a single resistor allows the -85 to accept voltages within any full-scale range between millivolts and 10 V. Code selectable gains from the software programmable gain amplifier are 1, 10, 100, and 500, for unipolar and bipolar full-scale ranges of 0 to 20 mV and ±20 mV, respectively.

The output system is comprised of two independent D-A converter channels which accept unipolar, straight binary input; bipolar, offset binary; or 2's complement digital input codes. Unipolar 0- to 10-V output or bipolar ±5- or ±10-V outputs can be jumper selected. Both D-A channels have guaranteed monotonicity at 25 °C, with integral and differential linealities of ±1/2 LSB. Each DAC has a 16-bit word selectable input buffer register to prevent indeterminate analog output states.

Both boards have been designed by Data Translation, Inc, 4 Strathmore
Easily acquire the data you need.

Select parallel state, parallel timing, serial, or signature operation. Simply press the appropriate key.

Choose synchronous or asynchronous sampling. Use the clock of the system under test or the 308's own internal clock. In either case, sampling rates up to 20 MHz are possible.

Enter the word you want to use as a trigger to acquire data. Other keys let you select an external trigger and trigger delay.

Press "start" and you're done. Now, you can view the acquired data in the format you want. Or, store the data in the reference memory by pressing the "store" key. Other function keys allow you to acquire new data and compare it with the reference memory.

Of course, the 308 Data Analyzer can do a lot more than we've shown here. For example, there's a self-test routine at power-up, plus seven diagnostics, to ensure accurate results. And the 308 weighs only 8 pounds (3.6 kg), for easy portability.

For the full story, contact your local Tektronix Field Office, or write us.

For immediate action, dial our Toll Free Automatic Answering Service 1-800-547-1512
and an on/off switch and circuit breaker on the rear panel control power within the enclosure. The circuit breaker gives protection to 6 A before it will trip; once tripped, the breaker must be reset for normal operation.

The standalone switch/indicator module has three front panel switches, two LED indicators, line time clock logic, and power sequence logic. The standard P101 switch group interfaces to the backplane via a cable that plugs into the signal connection pin pattern. This group provides interrupts on power-up sequencing only while an optional P103 group provides interrupts on power-down sequencing as well.

**Communications Interface Supports Parallel/Serial Data And Color Video**

An approach that combines a Z80A microprocessor with currently available peripheral devices results in a programmable communications processor that handles any mix of 8-bit parallel (for nonencoded keyboards, digitizer tablets, and printers), asynchronous or synchronous serial, and color video graphics. The single dual-width board is compatible with the Digital Equipment Corp LSI-11 family. It may be equipped with a mix of up to 8k bytes of RAM and up to 16k bytes of ROM.

Optional low resolution NTSC color video alphanumeric/graphics are available, with fully programmable RAM resident text fonts. Display resolution is 256 x 192 points in 15 colors. Text can be displayed in a 24-line x 40-column format. The video display is suited to business and industrial control applications.

Basic configuration of parallel port, 2k EPROM monitor, and 1k RAM is priced at $325. Other configurations include a video package, an answer/originate serial unit, and various memory options. To develop and test applications control software on a host LSI-11, Nortek Inc, 2432 NW Johnson St, Portland, OR 97210, has equipped a full-option OEM development version with downline loader, debug package, source code resident monitor, model device handlers, and a macro cross assembler and relocating linker that run under RT-11 ($1950).

PCP-11L may add an optional dialer interface to provide auto-answer, auto-dial support for most serial communications protocols. Since protocol overhead is primarily managed onboard, choice of formats is invisible to the host system. Data transfer rates may exceed 48k baud.

Biasync, SDL, DDCMP, Bell 801 Auto Calling Unit, and intelligent graphics controllers; NBS data encryption routine; resident assembler; and high level language interpreter are among the planned software modules. Control software resides onboard in volatile memory or can be downloaded from the host. The latter allows the device to be reconfigured to meet user needs.
The inside story of our DEC-11® Winchester disk system with fail-safe cartridge tape back-up.

Why we did it:
The HD-11 Winchester Disk system is CRDS's fail-safe solution to data loss should the sealed disk ever be unrecoverable.

We've combined the industry-standard Shugart SA4000 Winchester Drive with an optional DEI cartridge tape back-up module. CRDS disk/tape controller, interface cards and all related hardware complete the package. Of course, the HD-11 is RL01 instruction set compatible, and is equally at home in a PDP-11 or LSI-11 based system.

So now you can have an ultra-reliable storage system for the most popular CPU's available, in a familiar software environment, all at a cost many times less than DEC peripherals!

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What we give you:
In a single, complete 10½" rack-mountable enclosure, you get the equivalent capacity of four RL01's. HD-11 disk-only system single-quantity price is $6,500; backup tape option is $2,200. Plus you get:

- 21 megabyte formatted disk storage
- RL01 instruction set compatible
- 15 MB cartridge tape backup option
- ECC data protect on both disk and tape
- O-bus and Unibus compatible
- Four write-protect switches
- High-technology controller prevents latency while using bandwidth more efficiently
- 2-way peripheral for most cost-effective, reliable approach to storage applications

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*Registered trademark of Digital Equipment Corporation
8-Bit CPU Card Appeals To Multiprocessor And Dedicated Applications

ZBC-80 is a 4-MHz Z80 based, single-board computer, compatible with the Intel Multibus. Included in the advanced chip set that maximizes processor speed and efficiency are a dedicated arithmetic processor, 16-level programmable interrupt controller, two 8255 peripheral interface chips giving six parallel I/O ports, six programmable timer/counters from two 8253 counter/timer chips, and a serial communications controller. Port modes are uni- or bidirectional with or without handshaking.

There are 16k/64k bytes of RAM and sockets for up to 40k of P/ROM-ROM. The onboard RAM does not require the CPU to insert wait states in memory access cycles; thus, the card runs 20% faster than other CPU cards, according to Matrox Electronic Systems, Ltd, 5800 Andover Ave, Montreal, Quebec H4T 1H4, Canada.

Higher system throughput for processing requirements may be achieved with two or more processors running concurrently. For these multiprocessor applications, bus arbitration logic allows up to three masters to share the bus according to serial priority; additional external logic allows up to 16 masters to be handled in parallel priority. Other masters communicate with the CPU card in a pseudo-DMA manner via an onboard input.

Two AM9519 8-level universal interrupt controllers with maskable interrupts are cascaded to produce a 16-level controller that operates with fixed or rotating priorities. Programmed inputs respond to positive or negative transitions on the interrupt lines. A programmable vector can be generated in response to an interrupt acknowledgement from the CPU. A vectored interrupt structure is employed; nested interrupts are permitted when a device of higher priority requests service while a lower priority device is being serviced.

A serial communications channel provided by an RS-232-C interface and 8251 USART supports synchronous and asynchronous transmissions up to 64k and 19.2k baud, respectively, with half- and full-duplex signaling.

Arithmetic processing functions of the CPU are enhanced by an optional high speed math chip. The Am9511 performs 16- or 32-bit fixed and 32-bit floating point arithmetic; trading speed and number of functions for greater precision, the Am9512 performs 32-bit fixed and 32- or 64-bit floating point arithmetic.

From the software end, the computer runs CP/M 2.0, the 8080/Z80 disc operating system, which makes available a range of packaged software—asmsemblers, text editors, debuggers, and high level language utilities such as FORTRAN, Pascal, COBOL, and BASIC, as well as business and scientific application programs. Reprogramming the various controller chips changes the specific hardware configuration; thus, the card can be tailored in software to meet most hardware requirements.

CIRCLE 420 ON INQUIRY CARD

Clock/Calendar Module Operates Without CPU Involvement

Timekeeping functions may be added to Multibus systems to maintain and update the present time and date. MC1460 interfaces directly to the system bus, for such applications as system clocks, data logging systems, elapsed time measurements, resource usage monitoring, and timed task initiation.

Independent random access input ports provide binary data representing

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High performance hardware of Matrox Electronic Systems ZBC-80 single-board computer with 16k of RAM supports Digital Research's CP/M 2.0, hardware and software are configurable to meet desired multiprocessing and dedicated tasks.
Dataram’s S33 interfaces Digital Equipment Corporation’s (DEC®'s) PDP-11 series to a wide selection of SMD (storage module drive) and Winchester type disk drives. The S33 emulates DEC’s RM02 and is fully software compatible with RM02 diagnostics and RM02-supporting operating systems. Up to four drives per S33 controller, almost 300 MB of disk storage. The microprocessor-based S33 controller has 2 KB of data buffering, multiple sector transfers, and built-in self-test capability. And media compatibility with DEC’s RM02 drive. All this and amazingly packaged on one DEC hex board...the only controller to make this claim!

One-board means you need only one hex SPC slot. One-board means easy insertion and optimum air flow.

One-board with its attendant features of minimized interconnections and low component count means lower power, complete accessibility, higher reliability...and best of all, lower cost.

If you’re interested in one of our one-board S33 controllers, or a whole bunch of them, we’d like to hear from you. If you operate in the LSI-11® world, still contact us. Our LSI-11 cousin of the S33 is on the way.

DEC, LSI-11 and PDP are registered trademarks of Digital Equipment Corporation
the month, day, hours, minutes, and seconds. Outputting the time and date to the appropriate ports sets the module. An external battery supplies power whenever the system power is shut off.

Another feature of the module from Micro/Sys, 1353 Foothill Blvd, LaCanada, CA 91011, is the periodic and power-fail interrupt system. Periodic interrupts of the CPU are enabled under software control at intervals ranging from 10 ms to 24 h. Power monitoring circuitry generates a power-fail interrupt whenever system power is lost.

The 50/60-Hz line frequency as a timing reference assures longterm accuracy. During backup power operation (5 V ± 10% at 12 mA max), an on-board crystal oscillator maintains proper time and date operation. Port addressing, power monitor configuration, and interrupt level selection are switch selectable.

Floppy Disc Controller Increases Online Data And Doubles File Size

Disk 2+2 single-density 8" (20-cm) floppy disc controller increases the Apple II microcomputer's online storage capacity under Apple DOS 3.1 or 3.2 to 1M bytes. This also expands the file size and reduces the number of discs handled by the user. Existing software for the Apple will run with the peripheral, providing instant upgrade for systems facing file size restrictions. Data exchange from the Apple to other IBM 3740 format users is an added feature.

Manufactured by Sorrento Valley Associates, 11722 Sorrento Valley Rd, San Diego, CA 92121, the device controls up to four industry standard 8" (20-cm) floppy disc drives—Shugart SA800/801 or equivalent—under Apple DOS or assembly language control. Providing the industry standard IBM 3740 format, the 1771 LSI controller assures reliable data storage and compatible data exchange.

Drives are powered independently of the computer (with a 48k-byte memory). Data transfer rate is 256k bits/s. Average access time is 260 ms. Additionally, two business packages—a general ledger and financial management system—have been configured to run with the peripheral.

CIRCLE 422 ON INQUIRY CARD
WHEN IT COMES TO PUTTING IT ALL ON DISPLAY, THE ORION-60 STANDS ALONE.

A display terminal that won’t stand alone can’t be as versatile or as adaptable as the Orion-60, the modular plasma display system that stands by itself or interfaces with existing hardware to let you create your own programs.

To begin with, the Orion-60 is an easy touch: besides offering full alphanumeric, floppy disc and rear-projection capabilities, it lets you create displays and enter data simply by touching the screen with your finger.

That means you can project a slide onto the screen coordinates and plot your own course over it. You can program your own character sets. You can generate vectors of any length to absolute screen coordinates. In short, you’ll have a flexible terminal that will keep up with your needs today—and grow with your operations tomorrow.

Of course, since Magnavox was a leader in the development of plasma terminals, you can be sure your Orion-60 will have a bright, high-contrast display free from jitter and distortion.

There’s a lot more you should know about the ways this remarkable terminal can help you get more out of graphic displays. For a demonstration, call or write Tyler Hunt at Magnavox Display Systems, 2131 S. Coliseum Blvd., Ft. Wayne, IN 46803, (219) 482-4411.
Microcomputer Adapts To Standalone Or User Control Applications

The PCU 6800 single-card microcomputer for EXORterm/EXORciser processing and control uses is delivered with 1-, 1.5-, or 2-MHz speeds. Multiple memory combinations permit up to 16k of RAM and up to 28k of EPROM or ROM. Each RAM/EPROM or ROM socket is addressable in 32-byte increments.

Memory map space requirement is reduced to only 24 bytes for peripheral addressing. These bytes may be embedded in any memory block area. The gate array's 11-bit address decoding allows the PCU to use smaller portions of the memory map.

Onboard buffers and drivers, which give address, data, and control, provide the interface to the EXORciser bus. Output of UVA or VMA by jumper selection allows the EXBUG debugging board to be used with the microcomputer.

Other components are 40 parallel I/O lines, 3 timers, and an RS-232 interface. Onboard or remote 4-position DIP switch selects 16 baud rates. A flexible clock system is composed of an internal crystal clock with provisions for an X1 external clock input and for external slow and dynamic memories.

Phoenix Digital Corp, 3027 N 33rd Dr, Phoenix, AZ 85017, delivers the board with the MDB 6800 monitor, debugger, and test stimulus generator, in a second ROM, to provide trace instructions, multiple breakpoints, memory plus register display and modification, program execution commands, and test stimulus routines. Signature analysis test techniques perform system test, diagnostics, and troubleshooting. Stimulus software provides complete hardware component test and debug, as well as system test and performance verification.

Total System Bundles

Dekchester is an interactive business system packaged by ABC Computers Inc, 500 Tonopah, Tahoe City, CA 95730, with all necessary hardware, software, service, and support. The 36" H x 20" W (91 x 51-cm) system is comprised of a Digital Equipment Corp LSI-11/2 or -11/23 CPU, a CRT video scope, quad I/O port, 17M-byte tape cartridge backup unit, and 20M-byte Winchester drive. Memory consists of 64k bytes. A 40M-byte Winchester disc is optional.

Specifications of the Winchester disc are a 960k-byte/s transfer rate, 2400-r/min rotational speed, and 43-ms average access time. The TC-2000 or DC500A cartridge tape is characterized by a 1600-bit/in (360/cm) phase encoded recording density, 4-track serial record mode, and dual recording head.

Digital Equipment Corp's RT-11 operating system allows execution of BASIC, FORTRAN IV, DBL (DIBOL), Macro II, and Multi-User BASIC. The word processing package is integrated with high speed database storage and retrieval. Accounting software consists of order entry invoicing and inventory control, accounts receivable, accounts payable, general ledger, and an optional payroll program.

Total System Bundles
Fixed Disc Drive With Microcomputer

Total System Bundles
Fixed Disc Drive With Microcomputer

If you process gray scale or color images, you need to know about the EyeCom II. The scanner can be used to view real images, transparencies, opaque or microscope images. The field of view is digitized with a resolution of 640 x 480 x 8 bits, B/W or color using separation filters. (The refresh memory displays 640 x 480 x 24 bits max.) Real time adder/processor also available.

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CIRCLE 118 ON INQUIRY CARD

COMPUTER DESIGN/MARCH 1980

CIRCLE 423 ON INQUIRY CARD

CIRCLE 424 ON INQUIRY CARD
The 20 or 80 megabyte Burroughs FD 210 fixed disk subsystem is the newest member of our growing family of intelligent, compatible peripherals for OEM's.

This unit has an average access time of 36 ms and a transfer rate of over 7 million bits per second. An in-built microprocessor controller lets you select the interface factor to match your system transfer rate. The controller performs high level functions such as asynchronous file search and off-loads the following tasks from your system:

- Track seek and sector location
- CRC generation and check
- Sector relocation
- Error detect/correct
- Confidence/diagnostic tests

By working with a storage subsystem, not just a drive, you get your product to market quickly and easily. The FD 210 has a simple parallel interface and command set for fast integration with your system. It's also interface-compatible with our new 6 megabyte floppy drive, so one interface suffices for both products.

Build the FD 210 into your system. Put it in your cabinet or choose the optional rack mount or free-standing cabinet.

Call or write Burroughs OEM Marketing, Burroughs Place, Detroit, MI 48232. (313) 972-8031. In Europe, High Street, Rickmansworth Hertfordshire, England. Telephone 09237-70545.

Burroughs
3M's DC-300-XL Data Cartridge always finishes last because it records and stores at a field-tested rate of 6400 bpi on 450 feet of tape. And that's 150 feet more than standard data cartridges.

Which means you won't have to change it so often. And you'll have fewer cartridges to mess with.

Or lose.

Like all 3M DC-300-A data cartridges, the DC-300-XL has the same metal baseplate. And the ANSI three-point positioning system.

What's more, it's the exact same size as other 300-foot cartridges. So you can use it in any drive that accepts standard cartridges. Yet the DC-300-XL stores 50% more data.

You see, sometimes finishing last has its advantages, too.

For information about where to get the DC-300-XL, call toll-free, 800-328-1300. In Minnesota, call collect: (612) 736-9625. Or write: Data Products/3M, 223-5E, 3M Center, St. Paul, MN 55101.
THE TIME MACHINE

- Battery supported calendar clock
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**Endangered Species.**

Habitat.

An earlier America once provided wild animals with all the green forests, lush wetlands, untouched deserts and free-flowing rivers they needed for survival.

Over the years, we have made good use of many of our lands and resources but have needlessly destroyed others. Today many wildlife areas are endangered species.

In Louisiana’s Atchafalaya Basin, a plan to drain and cultivate 800,000 acres of wooded wetlands would wipe out the home of more than 300 species of birds, 50 species of mammals, and countless thousands of aquatic species.

From Louisiana to California, from Maine to Nebraska, habitats are endangered. The National Wildlife Federation is working to save them and the wildlife they support.


Save A Place For Wildlife.

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**Portable Software System Compiles And Executes COBOL Programs**

CIS COBOL is a software system for compiling, testing, debugging, and executing standard COBOL programs. A compact version requires 32k of RAM, while the standard version uses 48k (see Computer Design, May 1979, p 139). Supporting interactive operation, the system is aimed at small business systems. Micro Focus, Inc, 1601 Civic Center Dr, Santa Clara, CA 95051, supplies the package to OEMs under private label if desired, as well as to end users.

A compiler and runtime system, both portable, and interface module comprise the software. The runtime system is usually written in the assembly language of the target microcomputer—Intel 8080 or 8085, Zilog Z80, or DEC LSI-11. The interface modules are specific to the respective operating systems: ISIS-II, CP/M, and RT-11. Optional features are Forms for screen formatting and Forms 2 for program generation.

GSA certification for government use of the CIS COBOL microcomputer version exceeds government specifications for lower intermediate COBOL, a level in advance of many minicomputer COBOL versions. Conformance to the 1974 ANSI standard ensures that application programs will be portable to or from other COBOL machines, regardless of size.

CIRCLE 427 ON INQUIRY CARD

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**Z80 Operating System Boosts Capabilities Of Microcomputer**

Providing a UNIX like tree structure file hierarchy and I/O system, OS-I is an operating system for the Z80. Release 1.0 is single tasking, but multiple user. It is downward compatible with CP/M, and upward compatible with releases 2.0, 3.0, and UNIX. Multiuser versions 2.0 and 3.0 (multitasking) will support bank select, memory segmentation, and paging.

In addition to examining files and directories, and executing commands, the command processor performs simple logical comparisons and branching. Developed by Electrolabs, PO Box 6721, Stanford, CA 94305, it also performs redirection of standard I/O.

File structure of the software is suited to highly interactive environments, with its multidirectory, multiuser, multifile system. Each tree structure node, which must be a directory, file, or device, contains protection information. Maximum file size is set at 16M bytes, but the number of files with the tree system is practically unlimited. Random file access and dynamic allocation of disc space are used.

Two I/O tables generalize all I/O devices into block and nonblock types. Virtual names assigned to each device are posted in the file system’s directories so that there is only one set of names for all devices and files. Thus, a program written to access files also works with any device, and the naming, protection, and searching features of the file system apply to the I/O system. Internal cache buffering and the kernel provide a full set of I/O routines.

Finally, the operating system provides a software adapter with source code for CP/M. Users may write an adapter program, which is treated as a command for running programs of simple file systems, using a small amount of code.

CIRCLE 428 ON INQUIRY CARD
Five Reasons Why Engineers Rate MPI's Dual-Head Mini "Technically The Best":

1. **BAND POSITIONER**
   MPI's patented stepper-band positioning provides the industry's fastest access time (5ms) and most accurate positioning. The stepper band is simpler in design compared to a cam or lead screw. It is virtually frictionless, which provides extremely accurate and reliable positioning, yet requires the lowest power. As a result, it moves five times faster than other positioning systems.

2. **HEAD & CARRIAGE**
   Our high-performance mini floppy drive was developed as a dual-head, double-track, double-density unit. It is not an up-graded single-head, single-density design. The carriage and head concepts are based on IBM's — except for one important innovation: our bottom head is fixed, while only the top head loads. The heads are centered between two parallel rods (not cantilevered) to eliminate radial-positioning errors. To minimize media wear, we designed the longest head carriage which insures flatter head landings.

3. **HUMAN ENGINEERING**
   Our dual-head (Model 52) and single-head (Model 51) drives are human engineered. Key features include: a full-closing, push-button front door to provide greater media protection; a patented ejector mechanism that makes diskette removal easier; and a choice of bezels.

4. **DISKETTE CENTERING**
   True diskette centering is accomplished by MPI's proprietary clutch mechanism. As the front door is closing, our extra-long clutch expands and gently engages the mylar media. When the clutch is seated, the diskette is locked securely in position to within .0008 inches. The result: most accurate positioning, longer diskette life, and trouble-free operation. MPI’s diskette ejector — an industry first — pops the diskette out within easy finger-tip reach.

5. **POWER CONSUMPTION**
   MPI drives have the industry's lowest power consumption (6W standby, 12W operating) due to the following:
   - A high-precision stepper motor with Samarium-Cobalt magnets. This motor is accurate to 3%, has less heat dissipation, and longer life;
   - Proprietary electronics, packaged on a single PCB, incorporating low-power Schottky; and
   - A low-friction positioning mechanism.

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**OPERATING AND STANDBY POWER**

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**CIRCLE 124 ON INQUIRY CARD**

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If you’re heading upwind and getting nowhere fast in your present job, we’d like to suggest a new tack: to Boeing.

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- Command and Control
- Banking
- VM370CP
- Avionics

Analyzer Adds Capability For Testing 6800 Microcomputer—Field interchangeable interface of the T-8 analyzer connects it to the 6800 for hardware and software debugging. The tester single-steps through the microcomputer system development, user, or diagnostic programs; Patuck, Inc, 5073 Russell Ave, Pennsauken, NJ 08109, also provides breakpoint capability. . . .

Memory Offers Add-in Expansion of 16k or 32k Words—Available from ASR Corp International, 3-15-8, Nishi-shinbashi, Minato-ku, Tokyo 105, Japan, in two versions—16k x 16-bit MSV11-ZC and 32k x 16-bit MSV11-ZD—these memory modules are compatible with the DEC LSI-11/2 and -11/23. Access time is 240 ns. Also included are onboard memory refresh and addressing at any 4k bank boundary through the 0 to 128k address range. . . .

8048 Family Personality Modules Double Microcomputer Analyzer Coverage—Time-domain analysis, in-circuit emulation, and signature analysis capabilities of the MicroSystem Analyzer-Series 4000 allow functional board and systems testing as well as node level fault isolation of 8021, 8035, 8039, 8041A, 8048, 8049, and 8748 systems. Three pods from Millennium Systems, Inc, 19020 Pruneridge Ave, Cupertino, CA 95014, adapt to support these microprocessors.

Optoelectronic Input Device Functions With Video Board or Terminal—Simplifying communication among the operator, microcomputer, and video screen, the light pen features response of <100 ns and high resolution for character and graphics displays. The S-100 interface board included by Landmark Systems, Box 5516, Santa Barbara, CA 93108, requires only a video signal input. . . .

Z80 Based Small Business Microcomputer Systems—R2E of America, 47 Bedford St, SE, Minneapolis, MN 55414, has packaged the model 80-20 as a single-board system with a Z80 CPU; 32k of RAM; two single-sided, double-density minifloppies; ASCII keyboard; and parallel Centronics printer interface. A 1024-character CRT display, BAL language, and a macro assembler complement the system.
With Raytheon new Beam-Penetration Color CRT's. Designed specifically for computer color graphic system applications, Raytheon Beam-Penetration Color CRT's offer better color resolution and better overall system performance than conventional color tubes and other beam penetration CRT's.

Available in 15" to 25" diagonal rectangular and 10" to 23" dia. round sizes, Raytheon Beam-Penetration Color CRT's feature the unique Raytheon patented split-anode design. And this means faster switching, constant focus voltage and good spot size for all colors.

Such tubes are just one example of Raytheon's wide choice of versatile, performance-proven CRT's that are available in a variety of electron-gun types and phosphors and in all shapes and sizes 3" to 25".

Color it right. Color it with Raytheon Beam-Penetration Color CRT's. For complete information, contact the Marketing Manager, Raytheon Company, Industrial Components Operation, 465 Centre St., Quincy, MA 02169. (617) 479-5300.
Diskette Hardware System Operates With Single- or Double-Density Recording FORMATS—Multibus compatible bulk storage system ZX-710/720 includes two Shugart S4801 drives for up to 2M bytes of online data. The Zendex Corp system (6398 Dougherty Rd, Dublin, CA 94566) replaces Intel's MDS-710, 720, 725, DDS, and SBC-201, 202, 211, 212 on the MDS-800 and Series II computers . . . . Operating System, Interpreter, and Database Management System Comprise Z80 Software—Stand-alone TIS-Z80 APL for interactive applications using a Z80 based Altos Computer System, Cromemco System III, or Intertec Superbrain has been released by Telecompute Integrated Systems Inc, 251 Spadina Ave, Toronto, Ontario M5T 2E2, Canada. This implementation features monadic and dyadic APL operators, SYSTEM and FILE commands, and online program development . . . . Magnetic Tape Coupler Interfaces LSI-11 to Dual-Density Imbedded Formatter Tape Drives—with TM-11 emulation circuitry and handling of Streamer mode operation, the quad-size model DQ130 couples eight drives to one LSI-11 Q-Bus slot. The module from Distributed Logic Corp, 12800-G Garden Grove Blvd, Garden Grove, CA 92643, interfaces with 800-bit/in (315/cm) NRZI, 1600-bit/in (630/cm) PE, or dual NRZ/PE formatted tape transports with speed ranges from 12.5 to 125 in (31.8 to 318 cm)/s.

Assembler/Editor Runs on Computers Using North Star DOS—ASM-48 develops assembly language programs for Intel 8021, 8022, 8039, 8048, and 8049 single-chip microcomputers, supporting the MCS-48 assembly language instruction set and pseudo-operations. Programs developed on a Z80/8080 host machine must be offloaded to the target processor for test. It may be ordered from Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107 . . . . Single-Card Computer Serves Communications/Control Applications—Vantage Data Products, 550 W 200 S, Suite 8, Provo, UT 84601, has assembled the Z80 CPU with serial I/O, parallel I/O, RAM, and EPROM (either 2K 2716 or 1K 2708) on a single card. Asynchronous RS-232 serial communications are programmable at standard baud rates up to 56k. Modern control functions are provided.

Apple Microcomputer Communicates With RS-232-C Serial Devices Via Plug-in Card—Supporting full- or half-duplex operation, the 7710A asynchronous serial interface for the Apple II is fully compatible with Apple PASCAL. Developed by California Computer Systems, 309 Laurelwood Rd, Santa Clara, CA 95050, the card functions with baud rates from 50 to 19.2k, full handshaking, and power-down ROM . . . . Subsystem Interfaces Digital Cartridge Drive to MicroNova Computer—DMN-1 cartridge tape subsystem from Alloy Engineering Co, Inc, 908 Concord St, Framingham, MA 01701, connects up to two 1600- or 6400-bit/in (630 or 2520/cm) DEI cartridge drives with Data General MicroNovas. Requiring no card slots or power from the computer, the subsystem allows the drive to emulate a standard 9-track NRZI tape peripheral.

Static RAM Replaces Core Memory for Multibus Computers —ASC-1600 4k, 8k, 12k, or 16k-byte RAM with simple power maintenance circuitry is compatible with Multibus CPU boards and systems. Produced by Alewife Systems Corp, 26 Otis St, Cambridge, MA 02141, the board also functions as a general add-on memory with separately addressable 4k memory banks needing only 0.74 A, 5V . . . . Digitizer and Software Drawing Package Produces High Resolution, Mass 6-Color Graphics—VersaWriter has been designed by Rainbow Computing, Inc, 9719 Reseda Blvd, Northridge, CA 91324, to adapt to a variety of applications, acting as either a pointer or as a digitizer. Sixteen commands control cursor movement, horizontal and vertical scaling, and centering on the screen . . . .Multibus Dynamic RAM BOARD Holds 32k Bytes—Electronic Solutions, Inc, 5780 Chesapeake Ct, San Diego, CA 92123, has introduced RAM-032, which is compatible with Intel's SBC-680 Multibus. Memory access time is 450 ns.

Buffered, Expandable 6800 Microprocessor Combines With Onboard Memory Sockets—The 7802 processor card, which interfaces with memory, I/O, and peripheral cards produced by Pro-Log Corp, 2411 Garden Rd, Monterey, CA 93940, expands a STD BUS system to full 6800 memory and I/O capacity. Memory consists of 1024 bytes of RAM with sockets for up to 4096 bytes of RAM and 8192 bytes of ROM or EPROM . . . . Stand-alone Interface Requires Minimal Software Support From Host CPU—STD BUS compatible System Video Interface I consists of a 64 x 16 format video interface, 8-bit keyboard and 4-bit parallel input ports, and 8-bit parallel output port. Spurrier Peripherals Corp, 10513 Le Marie Dr, Cincinnati, OH 45241, has incorporated screen refresh RAM and system clock circuitry on the single-board peripheral . . . . Power Supply Outputs Five Voltages For Microcomputer Systems—Used with microcomputers, single or dual Shugart floppy disc drives plug into output connectors on the power supply board, which has metal pass transistors, cermet ports, and ceramic ICs. Introduced by CEI Corp, PO Box 501, Grenier Industrial Pk, Londonderry, NH 03053, model FD502 offers 5 Vdc at 5 A, 12 Vdc at 1 A, -5 Vdc at 3/4 A, -12 Vdc at 1/2 A, and 24 Vdc at 1/4 A.

Floating Point Support Subroutines Run On Z8002 Microcomputers—Using a 32-bit binary floating point format, reentrant and interruptible subroutines provide fast arithmetic operations (200 to 400 μs), integer-float and float-integer conversions, float-ASCII string representation, and ASCII-string float conversions. The format used by Hemenway Associates, Inc, 101 Tremont St, Suite 208 Boston, MA 02108, gives between 6 and 7 digits of precision . . . .CPU/Memory On Same Board Eliminates Timing Problems and Bus Noise—Model Z80/64 features a Z80 microprocessor and 64k bytes of dynamic RAM, with provisions for 2k of EPROM and vectored interrupts. Transparent refresh occurs during unused processor time. Single-board design by GMC Marketing Corp, 10611 Harwin Dr, Suite 406, Houston, TX 77036, allows full 4-MHz operation with no wait states.
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Software Adapts Microcomputer to Test Run COSMAC 1802 Programs—COSAPPLE, an 1802 simulator and debug package, permits a 16k or larger Apple II 6502 based computer to run programs coded in 1802 machine language. Developed by Dann McCreary, Box 16435-V, San Diego, CA 92116, the package aids checkout of modest 1802 applications, with the user controlling every aspect of 1802 operation. ... Powerful Single-Board Computer Supports CP/M and Pascal—The 64k TCB-85 Multibus compatible microcomputer, manufactured by DOSC, Inc, 500 Fifth Ave, New York, NY 10033, contains dual-density floppy disc controller, CRT controller, RS-232 serial I/O port, parallel printer interface, and strobed or scanned keyboard interface ... Interactive Programming Language Possesses Powerful Primitive Functions—Comparable to full APL, SOFTRONICS APL (36 Homestead Ln, Roosevelt, NJ 08555) operates under the CP/M, residing in 30k bytes of memory. The interpreter runs in a variety of character set configurations, including standard ASCII.

Assembly Language Test Diagnoses and Repairs Memory Systems—A user interactive memory diagnostic of 14 tests and 6 combinations, selected by a single command, runs on 8080, 8085, and Z80 systems using 3k bytes. Eagles Computer Works, PO Box 22664, Denver, CO 80222, supplies a manual that relates the MEmDoc diagnostic to memory testing. ... STD BUS Compatible RAM and EPROM Cards Operate From Single 5-V Power Source—SRC-2712 handles up to 16k bytes of AMD's 9124 or 2114 RAM with 300-ns access time. The second card released by Northwest Microcomputer Systems, 749 River Ave, Eugene, OR 97404, SPC-2714, handles up to eight 2716 EPROMS or combined EPROM/RAM. Access times range from 350 to 450 ns.

Trainer Aids Microcomputer Analog Signal Interfacing—EID-1 Experimental Interface Designer connects to MMD-1 or -2 microcomputers from E&I Instruments, Inc, 61 First St, Derby, CT 06418, or adapts to other 8080 based microcomputers. I/O signals are provided or simulated by built-in components; analog signals converted to digital input can be displayed via LED readout ... FORTRAN Cross Assembler Handles Z80 Instruction Set—Standard Z80 mnemonics and all standard Z80 instructions are supported by the cross assembler, available from Tufts University, Dept of Chemistry, Medford, MA 02155, on floppy disc or paper tape. Output of the assembler, which can run on a PDP-11 under RT-11, is a listing and a binary file which can be downline loaded into a minimal Z80 system.
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CIRCLE 128 ON INQUIRY CARD
MEETING EPROM REQUIREMENTS OF ADVANCED MICROPROCESSORS

Tim Coffman
Texas Instruments, MOS Memory Division
Houston, Texas

Increased performance requirements for semiconductor memories result naturally from advances in microprocessor capabilities. High performance microprocessors are much faster than their standard counterparts, requiring access times usually on the order of 360 ns or less. This allows less time for decoding of chip selects and acquisition of data from the memory device. Thus, the total propagation delays of memory control signals and data become more significant at these speeds.

Access Problems of High Performance Microprocessors

A typical memory read timing diagram for a high performance microprocessor (Fig 1) shows that maximum interval of 310 ns is available to present valid data after address is stable. Since conventional 5-V EPROMs have worst case access times no faster than 350 ns from address stable and chip enable, it would be possible to read invalid data from the memory because it is accessed 40 ns before data are guaranteed valid. In general, standard nonvolatile MOS memories pose problems for standard nonvolatile MOS memories.
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The ICM7224 offers high frequency counting, (15MHz guaranteed; 25MHz typical at 5V). For those applications that require low frequency counting, down to DC, a Schmitt trigger on the count input allows accurate operation in noisy environments or with slowly changing inputs.

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Current requirements of the ICM7224 are 10µA up to 1KHz and 1mA at 10MHz with a 5V supply. That means less than 10mW power consumption when counting from DC to 15MHz...terrific for long battery life operation.

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memories are not fast enough for use with advanced microprocessors because of their long access times.

One situation that exemplifies the design problem inherent in the use of standard EPROMs is indicated in Fig 2. In this simplified system a 512 x 8 bipolar P/ROM is used for decoding chip select and power-down functions. A significant savings in power is realized from this common practice, because the EPROM remains in standby mode until accessed. However, the P/ROM expends some of the available access time for address decoding. The P/ROMs max access time is 60 ns, thus microprocessors with 310-ns memory access time would require EPROMs with 250-ns max access, thereby excluding conventional EPROMs for this application.

A relatively inefficient way to utilize slower EPROMs with high performance microprocessors involves the introduction of synchronous wait states to extend the memory read access time. However, the minimum amount of time that can be added is one clock period, in this case 500 ns (Fig 3). A memory access then would take 810 ns—a much larger interval than most EPROMs would require. If the average instruction requires four clock cycles, a wait state with every instruction fetch would add 25% to program execution time. This effect becomes even more pronounced in systems involving considerable memory access, such as interactive graphics, word processing, communications, and some realtime applications.

In general, a design that uses a standard EPROM with a high performance microprocessor seriously reduces the effectiveness of that microprocessor. In some cases it might become necessary to reduce the microprocessor's operating frequency until the memory's worst case conditions are met. However, slowing the clock frequency defeats the purpose of using a high performance microprocessor in the first place.

One solution to the problem can be found in the use of bipolar memories. However, in most implementations, bipolar P/ROMs would represent an overkill, since they provide more than twice the access speed required by a high performance microprocessor. In addition, their cost would
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CIRCLE 130 ON INQUIRY CARD
be higher than that of comparable MOS memories, including such factors as the costs of programming and power supplies. The PROM's nonerasability is a major disadvantage. Other penalties associated with the bipolar solution include power dissipations above 500 mW.

High Speed MOS Approach

The straightforward solution is the development of high speed MOS EPROMs, capable of providing the required access times. Evolving design and process methods have contributed to across the board improvements in MOS memory fabrication.

One example of this advancing technology is the TMS 2508 (Fig 4), a memory that has been added to the Texas Instruments 5-V EPROM family. This device, designed as an 8k memory (rather than being a partially functional 16k) is believed to have the highest EPROM speed and smallest 8k bar size in existence, occupying less than 15k sq mils (9.7 mm²) of silicon.

Parameters of this device include maximum access time of 250 ns for the fastest version, maximum power dissipation of 446 mW active and 131 mW on standby, full TTL compatibility, and a 3-state output for OR-ties. Organized as 1k x 8, the memory is fully static, with maximum access time equal to cycle time, and offers automatic chip select and power-down. With regard to the design problem posed in this column, this device satisfies the requirements of high performance microprocessors.

Continuing advances in microprocessor speed requirements and in memory design will maintain this evolution's momentum, and will lead to further design tradeoff considerations. As processor speed requirements reach the point where bipolar memory speeds are appropriate (rather than overkill), and as bipolar energy requirements are reduced, MOS EPROM designs will need to advance to stay competitive with bipolar memories. The required advances will be facilitated by the fact that EPROMs and MOS microprocessors draw on the same evolving technology. The memories will continue to track the processors in the future.

Summary

Advances in memory technology allow EPROMs and other memory types to follow a learning curve with respect to such major parameters as bar size, timing, and power dissipation. Even faster and lower power devices in higher densities can be expected in the near future. Just as MOS static RAMs have achieved access times in the bipolar realm, EPROMs can be expected to approach bipolar speeds. These evolving memories will play a major part in fulfilling the requirements arising from microprocessor advances.
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*CIRCLE 131 ON INQUIRY CARD
10-Bit Double-Buffered Multiplying DACs Offer Processor Compatibility

Accuracies of 8, 9, and 10 bits are available in the MICRO-DAC™ series of 10-bit resolution, CMOS, 4-quadrant multiplying digital to analog converters produced by National Semiconductor Corp, 2900 Semiconductor Dr, Santa Clara, CA 95051. These devices are double buffered and can load two 8-bit bytes with the data format either right or left justified. The MDACs appear as memory locations or I/O ports to a microprocessor, and are designed to interface directly with the 8080, 8048, 8085, Z80, and other processors. However, they can also operate on a standalone basis without a microprocessor. They are intended to fulfill the need for low cost microprocessor DACs in servo control, programmable gain amplifier, digital attenuator, and synchro to digital converter applications.

The 24-pin DAC1000, -1001, and -1002 (offering accuracies of 10, 9, and 8 bits, respectively) represent the top of the line, providing all available logic features of the series, including the capability of loading all ten bits simultaneously. They provide a RDYOUT output signal for introducing a wait state to accommodate high speed microprocessors having write strobes narrower than 100 ns.

Specified for use with right-justified data, the 20-pin DAC1003, -1004, and -1005 make up a second subfamily of 10-, 9-, and 8-bit accuracies. Similarly, the 10-, 9-, and 8-bit accurate DAC1006, -1007, and -1008 operate with left-justified data, and are also provided as 20-pin DIPs.

Additional features of the family include a current settling time of 500 ns (typ), gain tempco of 0.0003% FSR/°C, and typical power dissipation (including ladder) of 30 mW, operating from a single 5- to 15-V supply and drawing only about 600 µA from a 10-Vdc reference supply. Logic compatibility between these devices and standard TTL levels is achieved through the use of a special biasing circuitry onchip that makes use of the parasitic NPN bipolar transistors which are inherent in the complementary MOS structure. The logic inputs meet TTL voltage level specifications, having 1.4-V logic threshold, independent of Vcc. All options make use of standard microprocessor control signals, and the data on the bus can be read by the computer in a standard write cycle.

The analog section is identical to the industry standard non-microprocessor compatible AD7520 (DAC1020). Addition of the buffers for the digital input

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Model DC-946 features:
- modular construction
- 5" cathode ray tube (12.7 cm)
- solid state
- DC operation—12V dc inputs
- choice of signal inputs:
  - TTL (standard)
  - Composite video (plug-in module)
- standard 15,750 KHz horizontal scan frequency
- 650 lines resolution
Data not only allows for storage of these data, but also provides a way to assemble the 10-bit input data word from two write cycles when using an 8-bit data bus, without affecting the analog output. Furthermore, the double buffering allows many DACs in a system to store current data as well as the next data. Updating each converter is also not time critical. When all DACs are updated, a common strobe signal can be used to cause them to change simultaneously to their new analog output levels.

Data formatting is handled by providing flexibility in the way the digital data are entered into the input latch. To allow operation with either an 8-bit (two write cycles) or a 16-bit (one write cycle) data bus, all 10 locations of the input latch are enabled on the first write cycle from the microprocessor. Then, depending on the data format, the next write cycle, if used, will overwrite two of these locations with the proper data.

The CMOS-implemented series has none of the basic problems inherent in similar bipolar designs. These devices have virtually infinite current gain and, therefore, have no alpha or beta errors. Also, there is no analog term to offset voltages in these products. Rather, an ON CMOS switch is used, which looks like a small value resistor, with its resistance value controlled by device geometry.

To avoid the temperature coefficient and piezoresistive problems of diffused resistors, silicon chromium thin film resistors are used, which track to within 1 ppm, insuring excellent initial matching and temperature tracking characteristics. A feedback resistor, normally required with an external op amp, is provided onchip to maintain a low temperature coefficient of the gain or full scale reading.

Absolute maximum ratings limit supply voltage \( V_{CC} \) to 17 Vdc and voltage at the \( V_{REF} \) input to \( \pm 25 \) V, with voltage at any digital input required to lie between \( V_{CC} \) and ground. The allowable operating temperature range is \(-40\) to \(85\) °C for LCD-suffix and \(-55\) to \(125\) °C for LD-suffix parts. In storage, temperature must remain between \(-65\) and \(150\) °C. Package dissipation at \( T_a = 25\) °C must not exceed 875 mW.

4k CMOS Static RAMs Provide High Speeds At Low Powers

A pair of 4096-bit static random access memories from Fujitsu Microelectronics Inc, 2945 Oakmead Village Court, Santa Clara, CA 95051, feature 250-ns (max) address access times and 370-ns (max) cycle times. Maximum power dissipation for both chips is 17 mW/MHz in operation and 275 µW on standby. These chips are suited for use in microprocessor systems and other applications where low power dissipation and high performance are required.

The MB8404E, organized as 4k x 1, is a plug-in replacement for the industry standard 6504. Organized as 1k x 4, the MB8414E can replace the industry standard 6514. Both RAMs are provided in 18-pin DIPs.
Panasonic non-impact printers:

You know how it goes. You have to design your next calculator, data logger, computer terminal or what-have-you down in size, so you need a smaller printer. Here's your answer: our EUY non-impact printers - the family with the envelope dimensions that leave you with room to spare.

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<td>32, 40, 64, 80</td>
<td>5.0</td>
<td>7.68 X 2.56 X 2.76</td>
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Available in both electrosensitive and thermal versions, Panasonic printers are small, low cost, quiet. All feature the reliability of a design that eliminates all moving parts except print head and paper transport. And all pack the character-forming flexibility and legibility provided by a 5 x 7 dot matrix print head that prints up to 128 alphanumeric characters and symbols, including a full ASCII character set.

Add the all-DC power requirements, plus the 8-bit parallel/bit serial compatibility of our own microprocessor-based printer interface controller, and you've got the ideal small-space printing solution. For information and prices, write to: Panasonic Company, Electronic Components Division, One Panasonic Way, Secaucus, NJ 07094; or call (201) 348-7289.

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CIRCLE 146 ON INQUIRY CARD

your answer to the "make it smaller" syndrome.
9-Bit Accuracy
Offered by
High Speed 8-Bit DAC

Featuring a 15-ns settling time, 51-mA full scale output current, and MECL 10k compatible inputs, the 9-bit accurate MC10318L9 digital to analog converter finds applications in high speed instrumentation and communication equipment, display processing, storage oscilloscopes, radar processing, and TV broadcast systems. This 8-bit DAC from Motorola Semiconductor Products Inc, P.O. Box 20912, Phoenix, AZ 85036, is a 9-bit accurate follow on to the MC10318L, an 8-bit DAC of 8-bit accuracy produced by the same manufacturer.

The recently announced converter guarantees ±0.10% maximum non-linearity over the 0 to 70 °C temperature range. Operation from a standard -5.2-V supply, MECL input capability, and an output compliance range of -1.3 to 2.3 V allow convenient interfacing between high speed processors and video level circuitry.

Other characteristics, which this monolithic chip shares with its predecessor, include complementary current outputs and a power dissipation typically less than 500 mW. A board using microstrip layout techniques is available for evaluating the operational performance of the chip.

The device is provided in a standard 16-pin ceramic DIP, priced at $45.00 in quantities of 100 to 999. Maximum ratings require that power supply voltage $V_{EE}$ lie between -6.0 and 5 V, with digital input voltage, $V_i$, constrained to a range from zero to $V_{EE}$. The upper limit on applied output voltage is 5.0 V. Reference current ($I_{ref}$) and output current ($I_o$) must not exceed 5.0 and 75 mA, respectively. The allowable temperature range is 0 to 70 °C in operation and -65 to 150 °C in storage. CIRCLE 351 ON INQUIRY CARD

Chip Uses NBS Algorithm
And 56-Bit Key Variable
To Encrypt/Decrypt Data

Based on an N-channel silicon gate process, the MC 884 data encryption chip uses the National Bureau of Standards Data Encryption Standard algorithm to encrypt or decrypt 64 bits of data per encryption cycle, based on a 56-bit key variable stored in the key.
register of the chip. Once loaded in the chip, the key variable cannot be accessed.

Operating at 1.25 MHz (max), the device accepts either synchronous or asynchronous inputs. This chip is normally used in conjunction with an encryption control chip, MC 883, issued by the same company, Burroughs OEM Marketing Corp, Burroughs Pl, Detroit, MI 48232.

In the encryption process, the key can be encrypted before the key register is loaded. To encrypt the key, the encrypt key line should be set at high and the key will be loaded in the chip via the data input lines. In this case, the key is treated as data and is encrypted with the key variables present in the key register. The encrypted key byte is transferred to the key register as a new data byte is loaded into the data register.

When eight bytes of data are loaded in the chip, the encryption process begins. The busy signal remains at high level until the encryption process is complete. Upon completion of the encryption, busy returns to a low level and the output available signal goes high. At this point, the encrypted byte can

To be honest, we could. But our customers have come to expect a lot more from us. They've come to appreciate our desire to innovate, to improve upon, to blaze new trails in floppy disk technology. That's how we got our reputation as the industry's undisputed technological leader.

96 TPI is nothing new for us.

Consider the current hubbub about "new" 96 TPI disk drives. You should know that what may be new to our competition is anything but new to us.

After all, we brought the 100 TPI MegaFloppy™ disk drive to the marketplace more than two years ago. And we've delivered more than 50,000 drives already.

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We should also mention that our double track disk drives give you all the storage capacity of an 8-inch floppy in the body of a 5¼-inch floppy. And with our double head version, you get up to 1.2 megabytes. That's more than ten times the capacity of other 5¼-inch floppies.

But our innovations don't stop there. Over the years, many of our ideas have gone on to become industry standard. And many more will. Things like stainless steel, precision-ground lead screws instead of cheaper, less reliable plastic positioners.

We also developed a special disk centering mechanism that is the most accurate in the industry. And who do you think successfully adapted Group Code Recording technology to the floppy disk drive industry? None other than Micropolis.

Remarkable as our technical achievements may be, some people still wonder how we got to be number two so rapidly in such a fiercely competitive business.

Obviously, we did it by design.
be unloaded and a plain byte of data can simultaneously be loaded in the chip. As the eighth encrypted byte is unloaded and the eighth plain byte is loaded, a new encryption process begins. If the encryption process is required to start with less than eight bytes, the DATA TRANSFER input must be set to a high level while the data are being loaded in the chip. DATA TRANSFER goes low upon completion of data loading.

An error output is activated if the key or data shift lines are inoperative, or if an illegal combination of control functions occurs, or if a parity error is found on a key byte. A parity error does not affect the operation of the chip, so it can be ignored if the user chooses.

Other characteristics of the device include TTL compatibility, a system reset affecting everything but the key, and a battery backup option to prevent the destruction of the key variables upon power failure. Absolute maximum ratings limit negative voltage on any pin to −0.3 V, while positive voltage is limited to 16 V on V CC or any input pin and to 8 V on V DD, KEY VOLT, or any output pin. Temperature must stay between 0 to 70 °C during operational and between −55 and 150 °C in storage.

Functional diagram of Harris Semiconductor HI-516 analog multiplexer. Device can be used as single-ended 16-channel MUX or as dual 8-channel differential MUX.
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The reliability we take to sea...

is echoed on dry land.
The Hazeltine sonobuoy is a marvel of reliability and performance in a low-cost package. After surviving a drop from an airplane, it deploys itself beneath the surface of the ocean, and uses sophisticated electronics to detect and locate submarines. Since sonobuoys aren't recovered at the end of the mission, their cost has to be low.

These same qualities make the Hazeltine 1420 conversational terminal a marvel of EDP display equipment. It's so reliable, in any environment, that we are able to warranty it for two full years, the longest "no-cost" warranty in the terminal industry. Yet it costs less than other terminals with similar performance and capabilities.

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Answers for the eighties

CIRCLE 136 ON INQUIRY CARD
HOW DO YOU IMPROVE THE ACCURACY AND RELIABILITY OF A PERFORATED TAPE, FILM OR CHART DRIVE?

USE LA VEZZI HIGH PRECISION SPROCKETS, NATURALLY

Precision is more than just a word at La Vezzi. It has been the underlying concept for nearly 75 years of manufacturing sprockets, Geneva starwheels and drivers, and other critical machine parts.

La Vezzi's record for achievement is testified by practically every motion picture projector used in the cinema today ... in tape control systems, in medical analytical equipment, geophysical and astronomical recording systems, as well as data processing and business equipment.

The reason! La Vezzi has developed the technology to produce components with tight tolerances, and instituted quality control standards to verify the integrity of their parts.

Look to La Vezzi for an accurate way to drive your ideas. Our catalog tells all.

A 10-bit tracking analog to digital converter announced by Datel-Intersil, 11 Cabot Blvd, Mansfield, MA 02048, supplies continuously updated conversion data on full scale sinusoidal signals up to 300 Hz without the need for a sample and hold. The ADC-856 is linear to ±1/2 LSB (max) and is monotonic over its entire operating temperature range.

This circuit is implemented in bipolar, monolithic form, and contains a fast window comparator, tracking logic, an up-down counter, a D-A converter, a precision voltage reference with amplifier, data transfer gates, and a data latch/shift register. External parts required for operation have been held to a few passive components, allowing external programming of the analog input voltage range. Gain temperature coefficient of the circuit is ±10 ppm/°C, exclusive of reference.

The chip is optimized for operation in a continuous tracking mode. In this conversion technique each conversion of an analog signal is based on the last converted value of that signal. For signals that do not vary faster than the converter can track (1 LSB/µs), continuous tracking will provide a valid, updated conversion result every microsecond.

Logic control inputs contribute to this device's usefulness in many different applications. Data transfer gates allow selection of the rate at which the output latch/shift register is updated. The rate may vary from once every microsecond to updating only upon receipt of a command from an external controller. External control also allows selection of output data form, which may be parallel or serial (by supplying optional clock input). Outputs may be disabled completely in either mode by holding the device's output-enable input low.

The ADC operates on ±5-Vdc power at 50 mA with a power supply rejection of 0.1% V/°V. It is packaged in a 28-pin ceramic DIP and is available in two operating temperature ranges: 0 to 70 °C (commercial) and -55 to 125 °C (military). Maximum ratings limit supply voltage to ±7 V and logic input voltage is required to lie between 0 and Vcc.

CIRCLE 354 ON INQUIRY CARD
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In fact, Air Couriers International can make a delivery just about anywhere in the U.S. in the incredible average time of 6 hours. And we'll even confirm delivery with a free call, giving you the time delivered and the person who signed.

On top of everything else, we offer this hard-to-beat guarantee: If we don't deliver when promised, you don't pay.

So next time you have a panic delivery and tomorrow is too late, call Air Couriers International. We will get it there today.

SAVE $5 ON YOUR NEXT DELIVERY.

We'd like to send you our free "Panic Delivery Survival Kit," including a certificate worth $5 off on your next delivery with Air Couriers International. To get yours, just mail this coupon or call us toll-free.

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CIRCLE 138 ON INQUIRY CARD
Monolithic ADC
Outputs 3½ Digits
Plus Multiplexed BCD

A monolithic CMOS analog to digital converter, produced by Teledyne Semiconductor, 1300 Terra Bella Ave, Mountain View, CA 94043, provides multiplexed BCD data outputs and 3½-digit outputs. It is appropriate to applications where high power LEDs and gas discharge displays are used and where microprocessor or printing interfacing is required. The circuit also finds uses in low power panel meter applications.

This chip, the 8751, contains a dual slope A-D converter and all digital circuitry necessary to provide a multiplexed BCD output. An external resistor and capacitor determine the internal clock frequency, allowing up to 15 conversions/s. Also, an internal network of analog switches provides logic output for polarity (auto-polarity) and compensation for internal offsets (auto-zero) during each conversion cycle.

The display reading may be held at any time by applying a logic 0 to the display hold input. This has no effect on the conversion cycle. The display automatically blanks when the input voltage exceeds full scale (F/S) for the selected input range. This range is set by the reference voltage, i.e., $F/S = 1.999 \text{ V for } V_{\text{REF}} = 1.0 \text{ V}$, and $1.999 \text{ mV for } V_{\text{REF}} = 0.1 \text{ V}$.

Other features include an end of conversion signal, a low input noise of 30 µV (typ), low input current of 10 pA (typ), and power consumption of 10 mW (typ). The device can be used with either an internal or external clock.

Absolute maximum ratings limit power dissipation to 1200 mW, derated by 12 mW/°C above 50 °C. Voltage limitations require that $V_{\text{DD}}$ relative to ground lie between $-0.3$ and 6.5 V and that ground relative to $V_{\text{SS}}$ lie between $-9.0$ and 0.3 V. Temperature must remain between $-40$ and 85 °C in operation and between $-65$ and 150 °C in storage. Clock frequency must not exceed 60 kHz. The device is provided in a 28-pin plastic or ceramic DIP.

CIRCLE 355 ON INQUIRY CARD
We'll take on any floppy in this magazine, head to head to head.

FD250

Judge for yourself. Flip through this magazine and look at anyone else's advertising for 5¼" floppies. Then compare. Our FD-250 is a double-headed wonder. It can replace the Shugart SA 400, take your on-line capacity to 437.5K bytes and not need a single screw hole re-machined.

More importantly, we can deliver them to you immediately...in quantity. Because we're already shipping them in quantity.

Our FD-200 is the single-headed 5¼" floppy answer to your system. Up to 250K bytes per side. Forty tracks. Available in quantity now.

And just in case you can't find a lot of contenders in this magazine, neither did we.

For sales information, call (213) 996-1333 (Western Region); (603) 883-2100 (Northern Region); or (305) 784-5220 (Southern Region).

For technical information, call (213) 999-2020, Ext. 281. Or write Pertec Computer Corporation, 21111 Erwin Street, Woodland Hills, Ca. 91367.
Dual Independent Timers
On Single Chip Cut
Power Use by 94%

Containing two independent micro-power timer sections on a single chip, the XR-L556 dissipates approximately 1/15th the power of conventional dual timers. This integrated circuit, produced by Exar Integrated Systems, 750 Palomar Ave, Sunnyvale, CA 94086, is the dual version of the XR-L555 from the same manufacturer. It finds use in battery-operated or portable equipment applications, where its low power dissipation is a critical requirement. Specific applications include pulse shaping and detection, micropower clock generators, micropower oscillators, power-on reset controllers, sequential timing, pulse width modulation, and remote control sequencers.

Power dissipation is less than 2 mW typ, (<1 mW per section), at 5-V operation. The device can operate down to 2.5 V without sacrificing such key features as timing accuracy, temperature stability, and output current-sourcing capability. It can operate in excess of 500 h with only two 300-mA-h NiCd batteries. The two timer sections have separate controls and outputs, but share common supply and ground terminals. Each output can source up to 100 mA of output current or drive TTL circuits. The output is free of switching transients ordinarily associated with conventional 555-type timers.

Other features include a timing capability from microseconds to minutes, operation in both monostable and astable modes, and CMOS, TTL, and DTL compatible outputs. Provided in a 14-pin DIP, it functions in most applications as a direct pin-for-pin replacement for the NE-556 dual timer circuit. Operating temperature ranges are 0 to 75 °C for plastic- and ceramic-packaged commercial versions designated by suffixes CP and CN, respectively. The ceramic-packaged military version, suffix M, is designed to...
The program to reduce software costs.
Microprocessor Pascal System.
New. From Texas Instruments.

Learnability. Transportability. Maintainability.

The features of Pascal, plus the benefits of TI's learning curve experience, are offered in the new Microprocessor Pascal system.

A system designed for microprocessor applications.

A system developed for the 16-bit 9900 Family, including the TM990 microcomputer modules, and 990 minicomputers.

A system to effectively lower your software costs today. And keep them low tomorrow.

At TI, Pascal is the first and only corporate-wide approved high-level programming language. For a lot of good reasons.

Pascal lets you solve your application without getting involved in the intricacies of machine architecture. And, Pascal's block structure results in fewer programming errors, because the code is easier to write, read and modify.

TI's Microprocessor Pascal system consists of six parts and provides the most Pascal capability ever offered:

• Source Editor — specifically designed to create/edit Pascal programs and check program syntax.

• Compiler — compiles conventional Pascal programs as well as TI's Pascal concurrent extensions into interpretive code, which can then be executed directly, or converted into 9900 native machine code.

• Host Debugger — over fifteen options for tracing variables and modifying data.

• Configurator — enables the target system to retain only the parts of the runtime support necessary for program execution.

• Native-Code Generator — converts Pascal interpretive code into 9900 native machine code.

• Run-Time Support — both interpretive and native-code execution provide a speed/memory trade-off.

TI's continuing commitment to innovative, cost-effective 16-bit microprocessor software means an increased applications capability and decreased development time for you.

Find out how you can reduce your present and future software costs. Put the new TI Microprocessor Pascal system to work for you, today.

For more information, call your nearest TI field sales office or authorized distributor, or write to Texas Instruments, P.O. Box 1443, M/S 6404, Houston, Texas 77001.
operate over a range from -55 to 125 °C.

Absolute maximum ratings limit power dissipation with the ceramic DIP to 750 mW, derated above $T_A = 25$ °C by 6 mW/°C. The corresponding values for the plastic DIP are 625 mW, derated above 25 °C by 5 mW/°C. Storage temperature must stay between -65 and 150 °C. Max allowable power supply is 18 V.

**Quad Transceiver Drives IEEE-488 Bus**

A quad bidirectional transceiver from Advanced Micro Devices, Inc, 901 Thompson Pl, Sunnyvale, CA 94086, meets the requirements of IEEE-488 standard digital interface for programmable instrumentation for the driver, receiver, and composite device load. The Am3448A provides one pull-up enable input for each pair of transceivers. This input forces the driver outputs into either an open collector or active pull-up configuration. Each receiver also features 600-mV input hysteresis for improved noise margin while power-up/down protection eliminates spurious noise and invalid information from being transmitted to the bus.

Typical operating characteristics of this TTL-compatible part include a 20-ns propagation time, single 5-V supply, high impedance inputs, and 3-state outputs. With power removed, the device bus (receiver input) changes from standard bus loading to a high impedance load.

Absolute maximum ratings require that supply voltage not exceed 7 V nor input voltage 5.5 V. Driver output current must not be greater than 150 mA. The part undergoes 100% product assurance testing to MIL-STD-883 requirements.

**CMOS Multiplying DACs Achieve 10 and 12 Bits Without Laser Trimming**

Three monolithic multiplying digital to analog converters introduced by Micro Power Systems Inc, 3100 Alfred St, Santa Clara, CA 95050, use advanced HD/CMOS and thin film technologies to achieve 10- and 12-bit performance without laser trimming. Typical applications for the 10-bit (16-pin) MP7530 and 12-bit (18-pin) MP7531 include digital-analog multiplication, CRT character generation, programmable power supplies, and digitally controlled gain circuits. Both are DTL, TTL, and CMOS compatible, have a nonlinearity tempco of 2 ppm of FSR/°C and a 20-mW typ power dissipation, including the ladder network.

The low cost 10-bit (16-pin) MP7533 is a 4-quadrant DAC. It is used for digitally controlled attenuators, programmable gain amplifiers, function generation, and linear automatic gain control.

These devices are exact second source replacements for the AD7530, AD7531, and AD7533, with permission from Analog Devices. They are provided at competitive price levels of $7.90 for the two more advanced models and $5.80 for the lower cost model, in lots of 100.
PENRIL’S DATACOMM SOLUTION
Means Over 25 Modem Products to Choose From...

In selecting the best modem for your data communication system, consider existing equipment compatibility, data volume, data rate, transmission distance and cost. Then choose from our FCC registered modems... compatible with Bell 103, 113, 202, 201, 212 or 208... or CCITT V.22, V.26, V.27, V.29 compatible units for European installation... or our low-cost, short-haul modems for local data communication.

...With Complete User Support.

Before your modems leave our factory, they have been extensively tested and burned-in by our quality assurance team. Once your Penril modems are installed, you choose the field service plan... factory return, on-site service by one of our four hundred service locations or overnight spares delivery. But what really makes the Penril solution unique is our self-contained diagnostics. From the analog and digital loop-back of our 300/1200 modem to the more sophisticated integral network diagnostics of our 2400, 4800 and 9600, Penril modems help you avoid or shorten down-time.

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For additional information, call or write Penril Corp., Data Communications Division, 5520 Randolph Road, Rockville, Maryland 20852. 301-881-8151; TWX 710-828-0522.

Penril DATACOMM
...We Still Care.

CIRCLE 143 ON INQUIRY CARD
8-Bit DAC Features
0.1% Accuracy and 200-ns Settling Time

Features of an 8-bit digital to analog converter, NE/SE5119, produced by Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94086, include a settling time of only 200 ns (typ), an accuracy of 0.1% (±1/2 bit), and low zero scale and gain tempcos of 5 and 20 ppm/°C, respectively. The NE/SE5118 is identical to this in most of its parameters, including settling time and temperature coefficients, but provides an accuracy of 0.2% (±1/2 bit).

These monolithic devices offer low loading data inputs of less than 10 µA, addressing capability, and complying logic levels. The series also provides a programmable current sink of 0 to 2 mA and a timing requirement of less than 1 µs. Applications are to be found in IC semiconductor test equipment, programmable power supplies, flow meters, graphic displays, temperature sensing, and A-D converters.

Data inputs have input latches, controlled by a latch enable pin. The latches appear transparent when the LE input is in the low state. When LE goes high, the input data present at the moment of transition are latched and retained until LE goes low. This feature allows compatibility with most microprocessors.

The chip includes a stable voltage reference (5 V nominal), which can be externally trimmed with potentiometer for easy adjustment of full scale, while maintaining the low tempco. This reference is short circuit protected.

Additional characteristics include internal feedback, an output having high voltage compliance, and monotonicity to 8 bits. The operating temperature range is 0 to 70 °C for NE prefix and −55 to 125 °C for SE suffix.

CIRCLE 359 ON INQUIRY CARD
Selectable storage means getting as much disk as you need. But not having to buy more than you want.

Ampex disk storage modules are available in six models in two distinctive series. Choose from the DM-900 family: 5-high disk packs, with capacities of 40, 80 or 160 megabytes, for rack, console or table-top mounting.

Or select from the DM-9000 series of free-standing models, with 10-high disk packs, in 100, 200 and 300 megabyte capacities.

Either way, you'll get proven Ampex performance, uptime dependability, reliability and serviceability. A single industry-standard SMD interface is used for all Ampex storage modules. And with six models to choose from, you can select the storage capacity you need now, and upgrade as your requirements grow. And models within each series may be field-upgraded to the maximum capacity for that series.

Selectable storage. It's just one of the surprising Ampex line of digital systems products. From plug-compatible memories for nearly any CPU you can name, through a wide range of tape peripherals. Even intelligent controllers, our own minicomputer, and completely-packaged, all-Ampex minicomputer systems.

Call Gary Owen at 213/640-0150 for full details on our selectable storage and the full Ampex Product line. Or write to him at Ampex Memory Products, 200 North Nash Street, El Segundo, California 90245.
Gas Discharge Display Drivers Offer Multiple Segment-Current Levels

Utilizing signals originating from MOS and TTL circuitry, IC segment drivers, the DI-232/242, are designed to drive gas discharge display devices. These monolithic silicon dielectrically isolated circuits, produced by Dionics, Inc, 65 Rushmore St, Westbury, NY 11590, deliver nine outputs as groups of four and five, each output group having a different and independent programmed segment-current level. This capability overcomes the difficulty of supplying the significant variations in segment current required for segmented gas discharge alphanumeric displays.

The chip can provide for simple interfaces with displays such as the Beckman, Burroughs, Cherry, Dale, or Pantek types. Each output is a switched programmable constant current sink with a voltage compliance of 80 or 125 V, for the -232 and -242 models, respectively. Input voltage capability is 40 V with an output current of 5 mA max. All output currents in each group of outputs are programmable with a single resistor.

Two of the units ganged together provide 18 outputs (two groups of 4 and two of 5), each individual group having different and independent programmed segment current levels. The manufacturer indicates that four different current levels from 18 outputs satisfy any gas discharge alphanumeric display requirement.

IC Operates as F-V Converter

The CS-2917 series of frequency to voltage converters are particularly well suited for air core coil drive functions such as in the control of dc motor speed for tape drives. An IC belonging to this family consists of an input regenerative comparator, a frequency doubling charge pump circuit for F-V conversion with low ripple, a general purpose op amp/comparator output circuit, and a shunt regulator circuit.

These devices, produced by Cherry Semiconductor Corp, 99 Bald Hill Rd, Cranston, RI 02920, are available in three package configurations. One of these (suffix -D8) is an 8-pin DIP. The other two (suffixes -D14 and -1-D14) are 14-pin DIPs, the latter of which contains an added feature of an open collector transistor for a buffered high level output signal at a frequency equal to the input frequency.

Low Cost ROMs Draw Low Power

Fully static CMOS read only memories, offered for as low as $5.45 each in lots of 104, require only 8-mA (typ) operating current and 7-µA (typ) standby current. Max values for these same parameters are 20 mA and 100 µA, respectively.

Other features of the CM3200 from Supertex Inc, 1225 Bordeaux Dr, Sunnyvale, CA 94086, include a single 5-V power supply, two mask programmable chip select inputs, 3-state outputs, and TTL compatible I/O. Access time is 450 ns (typ) and 600 ns (max). A high yield, low cost version (suffix -2) provides a max access time of 800 ns. Another low cost (suffix -3) version is 1802 microprocessor family compatible, with VCC ranging from 4.0 to 6.0 V, and an access time of 1.5 µs.
WK-7 COMPLETE IC INSERTER/EXTRACTOR KIT $29.95

INDIVIDUAL COMPONENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Price</th>
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<tr>
<td>MOS-1416</td>
<td>14-16 PIN MOS CMOS SAFE INSERTER</td>
<td>$7.95</td>
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<tr>
<td>MOS-2428</td>
<td>24-28 PIN MOS CMOS SAFE INSERTER</td>
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<td>EX-1</td>
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</tbody>
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MINIMUM BILLING $25.00. ADD SHIPPING CHARGE $2.00. NEW YORK RESIDENTS ADD APPLICABLE TAX.
User Can Program Monolithic Controller For Stepper Motors

Implemented in NMOS on a single chip, and using a single 5-V supply, the CY500 stored program stepper motor controller is user programmable. It executes 22 separate function oriented commands, specified using single letters such as P for position, S for slope, and R for rate.

The TTL-compatible controller, manufactured by Cybernetic Micro Systems, 445-203 S San Antonio Rd, Los Altos, CA 94022, can be commanded by a standard ASCII keyboard. When the device is in the ASCII mode of operation, the instructions form a function oriented high level language that is easy to learn and use. In this mode, parameters are entered as ASCII decimal numbers. The chip can also be placed in a binary mode to facilitate computer control using binary coded commands and data.

A key feature of the controller is its ability either to execute commands at once in the command mode or to store a sequence of commands as a program and then run the program. This feature allows program looping using do-while instructions and program waits using wait-until instructions. Other powerful instructions control single- or multi-step mode operation, full- or half-step operation, absolute or relative positioning, and ramp-up, slew, ramp-down operation.

Numerous input and output control lines allow synchronization with external events or devices. Each step can be triggered separately, and control of direction and starting and stopping may be affected via either external hardware or via software control. One output control line is completely under software control. An abort line can be used to abort any stepping command. Control of step rates up to 3500 steps/s is possible. Asynchronous communication with the chip can be achieved either serially (using several baud rates) or in parallel fashion using a simple ready line from and a write strobe to the chip.

DOD Grants JAN Certification

The Defense Electronics Supply Center (DESC), an agency of the U.S. Department of Defense, has granted full JAN certification for production and qualification testing of military electronic components to Monolithic Memories Inc (MMI), 1165 E Arques Ave, Sunnyvale, CA 94086. This certification will allow the company to submit Qualified Parts List (QPL) reports to DESC for its bipolar P/ROMs in early 1980.

Currently, MMI is listed for QPL II for MIL-M-38510/203 (1k P/ROM) and MIL-M-38510/204 (2k P/ROM). QPL II reports for MIL-M-38510/207 (256-bit P/ROM) and MIL-M-38510/209 (8k P/ROM) have been submitted to DESC for review.

Prior to achieving full certification, MMI was certified to produce bipolar P/ROMs for JAN applications, but for qualification testing, components had to be sent out to a DESC approved lab. As a fully certified supplier of components for JAN applications, the company now has greater control over production schedules, can shorten lead times, and reduces costs.

Full JAN qualification was granted after a series of on-site inspections in which conformance with MIL-M-38510 standards was examined. Manufacturing and test procedures were reviewed by DESC personnel and its representatives for over a year to make this certification.

Peripheral Chips Are Second Sourced

SynerTek Inc, 3001 Stender Way, Santa Clara, CA 95051, has granted a second source agreement for the manufacture and marketing of its proprietary SY6551 asynchronous communications adapter chip. The agreement permits Rockwell International, 3310 Miraloma Ave, Anaheim, CA 92803, to manufacture and market the microprocessor peripheral device on a worldwide, nonexclusive basis.

This chip provides interfacing for 6500 and 6800 microprocessor families to serial communications data sets and modems. A unique feature is the inclusion of an on-chip programmable baud rate generator requiring only an external crystal to operate.

In addition, Rockwell will manufacture the SY6545 CRT controller chip, a SynerTek designed product whose development was jointly funded by SynerTek and Rockwell. Replacing discrete ICs, this circuit provides more features with fewer components at a lower cost. The device is directly compatible with both the 6500 and 6800 microprocessors, and it does not need memory contention circuits. It also has an internal status register that enables the processor to check its status, and a dual refresh memory address, which can be either binary or row and column.

14 Models of Low Power dc/dc Converters Are Available in Series

A total power output of approximately 1 W characterizes a family of low power dc/dc converters introduced by the Power Products Division of Computer Products Inc, 1400 NW 70 St, Ft Lauderdale, FL 33309. Designed for direct printed circuit card mounting, the PM600 series converters allow the design engineer greater leeway and flexibility in determining PC card component layouts. The devices are provided in 24-pin DIPs.

Fourteen single- and dual-output models are available, providing dc outputs of 5, 12, 15, ±12, or ±15 V from inputs of 5 Vdc or 12 Vdc. All models provide tight line/load regulation and isolation voltage up to 50 Vdc. The devices also feature thermal overload protection and short-circuit protection for up to eight hours, plus epoxy encapsulation for added durability.
For years, manufacturers of computers, processors and other electronic equipment have improvised all too freely when running interconnecting cables outside cabinets. The results have been cumbersome, unattractive, often costly and sometimes hazardous.

Brand-Rex, long a leading supplier of Tape Cable® for internal use, now has the answer for external applications. A line of UL-listed jacketed Tape Cable.

With shielding or without, it's made to fit a full range of temperatures and voltages up to 105°C and 600 volts. Now, interconnections can be efficient, economical, hazard-free, often even invisible.

Get complete information about Brand-Rex jacketed or shielded-and-jacketed flat cable. Write to Brand-Rex Company, Electronic and Industrial Cable Division, Willimantic, CT 06226. Or call 203/423-7771.

**THE SAFEST CONNECTION BETWEEN TWO POINTS IS NOW A FLAT LINE.**
Double-Sided, Double-Density
Floppy Disc Drives
Provide 1M-Byte Storage

Two double-sided, double-density floppy disc systems introduced by Charles River Data Systems boost available storage to 1M bytes/drive. In addition, an LSI read circuitry chip increases read margins by 150 ns. Both systems use Shugart SA850 disc drives and are DEC compatible.

The MF-411 is a completely self-contained system with LSI-11/2 microprocessor, backplane, memory, power supply, and two floppy disc drives (it will accommodate the LSI-11/23 when available). FD-411 is an add-on system for Q-bus or Unibus applications.

Characteristics and Capabilities

Both systems are downward compatible with the manufacturer’s MF-211 and FD-211 single-sided diskette systems. A single dual-height card contains controller, interface, and formatter electronics and provides software/media compatibility with DEC’s RX02 floppy disc system. Total RX02 emulation and other intelligent functions are handled by a 2901 microprocessor controller.
A bootstrap loader enables automatic loading of system diskettes on power-up or when the Init/Boot switch is activated; in the MF-411 this loader eliminates need for the BDV-11AA boot function and reduces backplane space requirements. In addition, through a feature not available on the RX02, an MF-411 user can format any diskette with IBM 3740 headers. DMA data transfer is provided on a per sector basis. Advancements in read circuitry are said to have been provided in order to assure media compatibility with DEC's single-sided, double-density diskettes.

The MF-411's front panel is removable for access to system modules, which plug directly into a 4-quad (or optional 8-quad) slot backplane. Pivoting the backplane card cage upward provides access to the floppy disc drives. Two internally mounted fans cool the MF-411.

**Specifications**

Floppy disc drive capacities include 77 cylinders, 2 tracks/cylinder, 26 sectors/track, 256 bytes/sector, 1M bytes/disc, and 2 heads/drive. Access times are 2 ms track to track and 91 ms average seek. Transfer rate is 500 bits/s. Track density is 48 bits/in (19/cm) and recording density is 6816 bits/in (2683/cm).

Enclosure dimensions for the MF-411 and FD-411, respectively, are 19 x 10.5 x 22" (48.3 x 26.7 x 56 cm) and 19 x 5.25 x 22.1" (48.3 x 13.33 x 56.1 cm). The MF-411 can be slide-rack mounted or used as a tabletop unit. Power consumption for the MF-411 (with LSI-11/2 and 32k words) is 4 A; for the FD-411, it is 2 A. Respective operating temperature ranges are 59 to 90 °F (15 to 32 °C) and 50 to 100 °F (10 to 38 °C), both at 20 to 80% relative humidity, noncondensing.

**Price and Delivery**

A complete MF-411 double-sided, double-density floppy disc system including front panel console with switches is priced at $6980. The FD-411 add-on system is $4250. Delivery is 30 to 45 days ARO. Charles River Data Systems, Inc, 4 Tech Circle, Natick, MA 01760. Telephone: 617/655-1800.

For additional information circle 199 on inquiry card.
Encryption Devices Ensure Integrity
Of Stored As Well As Communicated Data

Placed in the communications path between a user’s terminal and the host computer, either of these data encryption devices will ensure the security and privacy of stored data as well as communicated data. DataLocks accept commands from both terminal and computer via a standard RS-232-C interface. No software or hardware modifications are needed. Both units use the National Bureau of Standards Data Encryption Standard.

A user is able to encrypt data entered through a terminal and decrypt data returned to the terminal, encrypt/decrypt files stored in a computer, encrypt communications between two system users, and encrypt data transmission over communications links. When not in use, the units are invisible to system operation.

Model 150 is located near the user’s computer terminal and connected by standard communications lines. It is controlled by the user through the terminal. The encryption process is started and stopped by brief commands at user chosen spots during data entry. Automatic decryption of retrieved data is achieved by trigger commands inserted by the unit in the encrypted data stream, or by explicit user commands. Data files sent from the computer are encrypted or decrypted by the unit and the processed version is returned. A user’s entry key entered through the terminal at the beginning of a session is inaccessible by any means.

Added capabilities enable the model 250 to function with an entire system. It accepts control commands from the computer as well as the user’s terminal and can operate as a shared resource. Encryption keys may be changed to accommodate different users.

Present systems operate with any asynchronous protocol; a synchronous protocol version will be available soon. Baud rate is adjustable from 110 to 9600.

SPI Data Systems, Inc, 488 Cowper St, Palo Alto, CA 94301.
Circle 200 on Inquiry Card

180-Char/s Impact Printer
Has 7 x 7 Half-Dot Matrix Font

A slower version of a dot matrix impact printer previously announced by the manufacturer, the M-120 has a speed of 180 char/s in a bidirectional, logic seeking mode. It uses a 7-wire printhead rather than the 14-wire, dual-column head of the faster model. Throughput averages 120 lines/min and varies from 75 lines/min for full 132-char lines to 200 lines/min for 40-char lines. Standard or expanded characters are printed in a 7 x 7 half-dot matrix font. The operator replaceable head is rated for better than 200M char and continuous loop fabric ribbons housed in cassettes have 5M-char lives.

There is no required preventive maintenance. A self-test feature is built into the printer and an optional LED diagnostic display indicates which cycle the printer was in at the time it went offline.

Operating specifications include 10" (25.4-cm)/s min paper feed speed, 50-ms max single line advance, 500k-byte/s max data transfer rate, and choice of standard 8-bit parallel or optional RS-232-C interface. Character size is 0.074" W x 0.105" H (1.88 x 2.667 mm) with a 128-char ASCII set. Line spacing is 6/in (2/cm) standard, 6 or 8/in (2 or 3/cm) optional. Character spacing is 10/in (4/cm) standard with interface selectable double-width characters, 16.7/in (6.6/cm) optional.

A forms control tractor feed mechanism is adjustable from 3 to 6" (8 to 15 cm). Loading of continuous fanfold, edge perforated forms is standard front and bottom, optional rear. An original plus 5 copies can be made. A 12-channel direct access vertical format unit is standard; a tape controlled version is optional.

Physical dimensions are 7.9" (20 cm) in height, 26.1" (66.3 cm) in width, and 23.3" (59.2 cm) in depth. Weight is 70 lb (31.8 kg). A pedestal is optional. Input power is 200 W max, 125 W standby. A voltage of 115 Vac +10, −15% at 60 Hz ±1 Hz is standard; 220 Vac +10, −15% at 50 Hz ±1 Hz is optional.

Dataproducts Corp, 6200 Canoga Ave, Woodland Hills, CA 91365. Circle 201 on Inquiry Card
At Lear Siegler, you don't have to decide among dozens of smart terminals, each slightly different, but none quite right for you. We have just two smart terminals. But they can handle a range of tasks equal to four, five, or even six models from other manufacturers. After all, we want to make your life simpler, not more complicated.

**THE ADM-31 & ADM-42 WILL LET YOU CHANGE THEIR MINDS.**

When we designed the ADM-31 and ADM-42, we realized that no matter what capabilities we offered, somebody would always want something different. So we did the next best thing. We gave each a truly flexible personality by putting the instruction sets inside their PROMs. So, unlike the hardware, the firmware is capable of easy OEM reprogramming.

We even have a special Applications Engineering Staff to answer any questions you may have about reprogramming, interfacing or special applications.

Feeling your life getting simpler yet?

**ALL THE TERMINALS YOU'LL EVER NEED.**

Even if you decide not to reprogram their PROMs, our two terminals come with all the standard smart terminal features. And then some.

Features like full editing capabilities. Formatting. Reduced intensity for identification of protected fields. Blinking, blanking, and reverse video. High resolution monitors. Even limited line drawing capabilities.

What's more, both the ADM-31 and ADM-42 come equipped with a microprocessor and function keys making them even more reliable and easy to use.

**THE CHOICE IS SIMPLE.**

You can choose your new smart terminal one of two ways. Start sifting through dozens of data sheets, talking to dozens of salesmen, and looking at dozens of expensive, slightly different terminals. Or look at two smart terminals from Lear Siegler—the ADM-31 and ADM-42. Complete with user-reprogrammable personality, function keys, and an eager and willing Applications Engineering Staff to help you with any reprogramming problems.

The choice seems pretty easy to us. But if you want more information, call or write to us at Lear Siegler, Inc./Data Products Division, 714 North Brookhurst Street, Anaheim, California 92803, (800) 854-3805. We'll be happy to tell you all about the ADM-31 and ADM-42. And show you how you can make your terminals behave.

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**PERSONALITY PROMS AND FACTORY ASSISTANCE MAKE USER-REPROGRAMMING A SNAP.**
Data Acquisition Device
Multiplexes 10 Analog Channels

A single-card, 10-channel analog scanner, the SL104 data acquisition device connects directly to input sensors. Interchannel isolation of 1 GΩ assures the ability to obtain intermixed microvolt signals even in the presence of common mode voltage as high as 310 V. The industrial rated device plugs into a standard 6.25" (15.88-cm) card slot. It operates with random combinations of grounded or ungrounded thermocouples, voltages, and currents and then references, scans, amplifies, filters, and controls selected signals. Voltage dividers and current shunts in individual onboard channel sites enable operation over full-scale ranges from millivols to volts and microamperes to amperes.

Onboard CMOS control logic is fully TTL/CMOS compatible without buffering and is configured for bus operation with microprocessors. It obeys single encode commands, remembers current channel and mode selections, switches the multiplexer, and provides status signals. Group digital outputs are parallel busable up to 160 channels (16 units).

A precision reference junction automatically compensates all thermocouple inputs and passes them to a low thermal reed multiplexer. Zero stabilization provides zero referencing and eliminates time based zero drift. Following amplification, signals pass through an active filter that removes all remaining 60-Hz noise. Analog outputs can be bused together through an output multiplexer.

Digital inputs are TTL/CMOS compatible with additional protection for static discharge; digital outputs are 3-state and allow for fanout of 2 normal TTL loads. Power requirements are ±15 and ±0.5 V at 30 mA max each and ±5 V at 130 mA max. Input impedance is >4 MΩ. Other features include true isothermal reference junction, automatic thermocouple break detection, span calibration option, automatic common mode attenuator, and National Bureau of Standards traceable calibration.

San Diego Instrument Laboratory, 7969 Engineer Rd, San Diego, CA 92111.
Circle 202 on Inquiry Card

Microprocessor Controlled Fixed Disc Drives
Ease Software Burden on Host Processor

FD 211 (20M-byte) and FD 214 (80M-byte) 14" (36-cm) Winchester technology fixed disc drives feature built-in microprocessor controllers that perform many of the tasks normally handled by the host systems, eg, asynchronous file search, confidence/diagnostic tests, cyclic redundancy check generation, error detection and correction, and sector relocation. These FD 210 series drives are interface compatible with the company’s MD 122 3M- and 6M-byte dual-minifloppy disc drives. Both disc drive series use the same controller electronics and may be mixed on the same host system controller.

Drive modules are sealed units with 1 or 4 nonremovable discs mounted on a common spindle. Two flying heads are moved across each surface by a rotary positioner to access the data tracks. Servo tracks at specific locations on each surface are used by the microprocessor controller to correct for alignment variations caused by environmental changes. Standard interface for integration with a host system is a parallel data and control bus.

Host system software is also simplified by activities of the microprocessor controller. Because, as soon as disc drive power is turned on, the microprocessor controller determines and reports to the host system how much storage capacity is available (20M or 80M bytes, for FD 210 series or 3M or 6M bytes for the MD 122), disc subsystems can be mixed, replaced, or upgraded without software changes.

RETMA rackmount, freestanding cabinet, and power supply options are available. The supply voltage requirement is 5 V ±10%. Absolute value of common mode voltage between host and device grounds must be <5 V. Line drivers and receivers are RS-422 compatible. Max cable length is 25 ft (7.6 m). Burroughs OEM Marketing Corp, Burroughs Pl, Detroit, MI 48232.
Circle 203 on Inquiry Card
If you’re an OEM, you already know what Control Data has done for disk technology. Now we’re determined to earn the same reputation for excellence in band printer technology. By giving you versatility and maintainability. By giving your customer reliability, superior print quality and economical operation.

Engineered for component commonality

All three members of our 9380 family of band printers look pretty much alike. Inside and outside. So your servicing, training and inventory requirements are simplified. Yet you can choose from three print speeds, 69 print bands and lots of other options.

Built with the features and economy to attract end-users

Our 360/720 lpm models offer a compressed pitch option. That saves your customer money in paper expense. And gives him the capability to print 132 columns on standard 8½ by 11 inch paper. Bands switch in seconds. Paper loading is easier. Operator controls and adjustments are minimal. And your customer will like the clean, crisp impressions delivered by our proven hammer technology.

Put quality behind your nameplate. Let us send you data sheets and print samples. Call us at 313/651-8810 or if in Europe, contact one of our European representatives. Or return coupon to:

Control Data Corporation
1480 N. Rochester Road, Rochester, MI 48063

Please send literature and sample printouts on your band printers.

Name ___________________________ Title ___________________________

Company ___________________________ Phone ___________________________

Address ___________________________ ___________________________

City ___________________________ State ___________________________ Zip ___________________________

CD 30

Addressing society’s major needs

CIRCLE 150 ON INQUIRY CARD
ENDLESS LOOP MAGNETIC TAPE TRANSPORT

An industrial quality unit, model 4 accepts continuous loop standard NAB, A, B, or C cartridges with from 13 to 1500' (3.9 to 457.3 m) of tape. Precise 4-point head mounts (both head positions) provide separate zenith, height, and azimuth adjustment. Pressure roller is self-aligning and maintains constant pressure without readjustment, virtually eliminating tape edge wear and skew caused by tape pulling up or down. Preloaded precision spring components compensate for wear and hard usage. Standard ac motor is hysteresis synchronous for accurate speed in spite of line voltage variations; dc motor is governed internally for constant speed over wide voltage range and is shielded to prevent stray electrical radiation. Tape speed accuracy is specified as 1.5% (ac motor) or 2.5% (dc motor). Flutter and wow are less than 2% pulse to pulse jitter. Start and stop times of solenoid operated models are less than 100 ms. Operating temperature of the transport is in the 5 to 50 °C range, and weight of the unit is 6.25 lb (2.81 kg) or less. Unit is available in an electrically controlled version for remote operation or in an economical manual model. Amilon Corp, 49-12 30th Ave, Woodside, NY 11377.

Circle 255 on Inquiry Card

IEEE-488 0.5" TAPE SYSTEMS

A GPIB (IEEE-488) magnetic tape system, the model 2101 provides transfer rates in excess of 100 kbytes/s and dual buffering capacity to 16,384 bytes. Once data are on 0.5" (1.27-cm) magnetic tape, they may be transferred into any computer for analysis. Data may also be transferred back to the GPIB controller from tape. A dedicated 280A microprocessor manages bus interface, formatter, and tape transport functions within the system. Systems may include as many as 4 tape transports, systems may be 7- or 9-track, NRZI, PE, or dual mode, in a variety of reel sizes with or without code converters. The unit provides read after write error checking with automatic correction and automatic conversion of ASCII to/from IBM EBCDIC tape formats. Dylon Corp, 3670 Ruffin Rd, San Diego, CA 92123.

Circle 256 on Inquiry Card

POLARIZED SUBMINIATURE CONNECTOR

Plasticon™ connectors have a snap-in mounting device, which is part of the insulator, to provide quick, hardware free connection. Units are completely interchangeable, intermateable, and intermountable with std D-type subminiature connectors. The connector is available in a 25-pin arrangement using both shell and contact polarization which assures proper and easy mating. Phosphor bronze contacts can be provided in various tail styles with gold plating. Overall max dimensions are 0.472" (1.19 cm) high x 2.030" (5.158 cm) long. Contact resistance is 14 mΩ max with a current rating of dry circuit to 3 A. Insulation resistance is 5 MΩ min. Temp rating under operating conditions is -40 to 105 °C. TRW Cinch Connectors, 1501 Morse Ave, Elk Grove Village, IL 60007.

Circle 257 on Inquiry Card

EPROM PROGRAMMER

Completely self-contained, model 7816 programs both 2708 and TMS 2716 EPROMs and requires no personality module or host computer. Operation is based on a 2k-byte editing RAM. Data may be entered into RAM from keyboard, master socket, or serial interface where it can be examined and modified as required. When editing is complete, the contents of the RAM are programmed into the copy P/ROM. After programming, copy is automatically verified against the RAM and a 4-digit checksum is displayed. Separate copy and read only master sockets prevent accidental damage to the master P/ROM. The unit includes RS-232-C serial interface with keyboard selectable baud rate, and data entry and command keyboard with 8-char alphanumerics display. RMD Inc, PO Box 206, Bristol, PA 19007.

Circle 258 on Inquiry Card

LASER BAR CODE SCANNER

Metroscan MS 106, plug compatible with lightpen systems, gives accurate high speed scans with minimal operator training and involvement. In addition to the laser scanner the unit includes a microcomputer for decoding labels and managing data, an optional CRT, and optional printer. System has a plug-in modem board and selectable baud rate. The beam from a low power (BRH Class II) helium-neon laser is scanned in a fine line that can read small labels at distances from 2 to 6\" (5 to 15 cm). This reduces wear since the scanner doesn't touch the labels; it can even read them through glass or plastic. Extra accuracy is assured by the high scan rate and constant speed; at 40 scans/s each label is read several times. Scanner mounts in any orientation for operator convenience and is ruggedly built to withstand abuse. The microcomputer decodes and validates the signal from the scanner and can interface with a line printer or computer. The unit can be programmed to read Codabar, UPC, or other bar codes on tubes, cartons, bottles, or packages. Metrologic Instruments, Inc, PO Box 307, Bellmawr, NJ 08031.

Circle 259 on Inquiry Card
Until today you couldn't get your hands on a plasma display without the terminal. Today you can.

Introducing Interstate's PDA 300 Plasma Head. Tough, bright, with more than 10,000 hours of service life.

Now you have the flexibility to design in a rugged, long-life plasma display in tough system environments with Interstate's flat-panel PDA 300 Display Head. It displays alphanumeric/graphics, and is TTL compatible for easy interface. Inherent memory eliminates display refresh, and the unit is totally digital with no analog circuits. It has a thin profile and is designed to help meet your system RFI/EMI requirements. Optional equipment includes a touch panel, variable brightness control, rack mount, and remote-mounted power supply.

Today, for your best buy decision, consider how the PDA 300 designs into your display system. Deliverable immediately.

For more information, call or write Don Poulos, Product Manager, Interstate Electronics.

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(714) 635-7210.

SUBSIDIARY OF

CIRCLE 151 ON INQUIRY CARD
Thanks to our new Sprint 5 'WideTrack™ Terminal, the days of worrying about wide-document preparation are over. The Sprint 5 WideTrack is a high-quality, letter-perfect printer that's wide enough to handle balance and ledger sheets, accounting reports, oversize-paper printing masters, multiple-page form letters, charts, visual aids, and even special word processing applications. And you can interface it to the Serial RS-232C interface port of your minicomputer. The possibilities are endless.

The Sprint 5 WideTrack is the widest printer on the market today. It spaces 264 columns at 10 characters per inch, 316 columns at 12 characters per inch, and can space in increments of 1/120-inch left or right. Vertical spacing is 1/48-inch up or down, and you control it through the MOS/LSI microprocessor's extensive set of software commands.

As the newest member of the proven Sprint 5 family of terminals, the Sprint 5 WideTrack offers all of the features that have made Sprint 5 an acknowledged leader in the quality font terminal industry. Features like MOS/LSI microprocessor electronic logic. Like the same printer mechanism that guarantees letter-perfect printing and RS-232C Serial Interface. Plus all of the things that have earned Qume its reputation for uncompromising quality and reliability in the thousands of printers that have been produced and delivered worldwide.

The Sprint 5 WideTrack. It's just one more in a continuing supply of innovative new products that Qume has developed to meet the needs of your growing market. And it's available today.

For more information on Sprint 5 WideTrack and our complete family of quality data terminals, just contact your nearest terminal dealer or Qume, 2350 Qume Drive, San Jose, California 95131.
HIGH RESOLUTION COLOR CRT MONITORS

HM-2619/13 and 2719/13 use wide video bandwidth and a 0.31-mm spacing between triad pairs to provide for a trio-dot density twice that of conventional monitors. 2619/13 uses a 19" (48/33-cm) trio-dot shadow mask CRT with a 0.31-mm pitch for resolution of 1280/720 horizontal and 960/540 vertical. This provides for misconvergence of <0.6/0.7 mm within a circle whose diameter is equal to the vertical height of the display. Hitachi America, Ltd, 100 California St, San Francisco, CA 94111. Circle 204 on Inquiry Card

MINIFLOPPY DISC STORAGE SYSTEM

Model 400 communication storage unit adds data storage, editing, and communication capability to distributed processing systems. The Z80 based microcomputer system performs file management, forms entry, and editing tasks, while handling the unit's communications protocol. Typical applications are communications store and forward, message handling, local program storage, and baud rate converter. Batch mode is useful for data logging and remote data collection where front panel control or simple command codes are required. Data transfers occur at rates up to 19.2k baud over an RS-232 interface; storage capacity is 180M bytes on a floppy disc. Software resides in permanent memory. Self-initialization allows use of unformatted diskettes. Columbia Data Products, Peripherals System Div, 9050 Red Branch Rd, Columbia, MD 21045. Circle 205 on Inquiry Card

DIRECT CONNECT ORIGINATE ONLY MODEM

Immunity from room noise and mechanical vibrations is provided by the portable M103 originate only modem. Compatible with the Bell 103/113 data sets, the FCC approved modem plugs directly into the telephone network using the conventional RJ11C modular phone jack or DAA. It connects to any terminal with an RS-232 or 20-mA interface and operates at a max data rate of 450 bits/s asynchronously over ordinary telephone lines, full duplex with or without local copy. Input power is 115 Vac ±10%, 50/60 Hz. Power consumption is 3 W max. Other features are red LED indicators for power and carrier detect, line connect/disconnect switch, and optional local copy. Amb operating temp is 0 to 50 °C. Modtech, Inc, 1958 Helsinki Way, Livermore, CA 94550. Circle 206 on Inquiry Card

AT CAMBION, THE CARDS ARE STACKED IN YOUR FAVOR.

Cambi-Cards* are available as either general purpose pre-drilled PC boards for socketing to your own design featuring distributed power and ground planes, or as hi-density boards to support dual in-line ICs in wire-wrapenable sockets. Fill out the Bingo card for Catalog 121 and useful card info!

Cambridge Thermionic Corporation, 445 Concord Avenue, Cambridge, MA 02238, Tel: (617) 491-5400, Telex: 92-1480, TWX: (710) 320-6399

CIRCLE 153 ON INQUIRY CARD
The future is here. The decade is dawning. Upgrade your PDP-11 for work of a new age.

Upgrade your PDP-11 by front-ending it with our UMC processor system. It plugs into your UNIBUS, shares work with your PDP-11, and gives you powerful yet independent processing.

Use it to support network expansion. Have it control data acquisition, translation, formatting and processing. Or maybe emulate peripheral controllers. Or serve as terminal concentrator.

The UMC is a modular system of boards and support software. Since it's modular, it's flexible. It conforms and grows to meet your needs.

The UMC Processor Board might be all you need. You get a Z80 microprocessor, 4K bytes static RAM and room for 16K bytes PROM. Plus 2 full-duplex serial lines and up to 3 DMA channels.

Need more memory? A UMC Memory Expansion Board gives up to 64K bytes RAM and space for 32K bytes PROM. Need more memory? Add others at any time—up to a whopping megabyte.

Extra serial lines? Our UMC Serial Line Expansion Board accommodates up to 16 full-duplex lines. It has up to 8 Z80-CPUs, each with dedicated expandable memory. Extra lines? Extra boards! A system of more than 100 low-baud-rate lines is possible.

Custom work? Use our ProtoHex Wirewrap Board. It has universal layout and access to all UNIBUS and UMC Bus signals.

And as for software, run our Software Development System in your PDP-11 to support writing UMC software. Or maybe you need a turnkey network program, available soon for 2770, 2780, X.25 and other protocols.

How can the UMC serve you? Check with ACC today. It may just put your system in a whole new light.

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Brighten your future!
PRODUCTS

5-OUTPUT, 200-W SWITCHING POWER SUPPLY

ESM-200 features high component density using the company's monolithic chip for max wattage/in. The std unit has a 5-V regulated output and 2 12- or 15-V regulated outputs, plus 5- and 24-V semi-regulated outputs. Special units may be specified from 5 to 28 V for each of the 3 regulated outputs and 5 to 50 V for the 2 semi-regulated outputs. Line regulation is 0.2%, while load regulation is 0.2% on the first 3 outputs and ±5% on the last 2 outputs with cross regulation of ±3%. Power/Mate Corp, 514 S River St, Hackensack, NJ 07601. Circle 207 on Inquiry Card

DATA DISPLAY TERMINAL

Data are entered or retrieved from computer systems by the 7900 Model I interactive data display terminal. Built-in shields protect against emi, rfi, and electrostatic discharge. The microprocessor based system features a 12" (30-cm) green phosphor screen, with a displayed terminal status line. Asynchronous mode operation is at rates up to 19.2k baud. Special function keys and std adding machine style keypad comprise the typewriter style keyboard. Up to 96 function codes can be user generated. NCR Corp, Dayton, OH 45479. Circle 208 on Inquiry Card

FLOPPY DISC CONTROLLER

As a std for double-density disc controllers, TWO-X provides over 500k bytes on each side of an 8" (20-cm) double-headed floppy disc drive for 1M bytes/drive or a total of 2M bytes of online storage in a double-headed 2-drive system. Data transfer rate of 500k bytes/s at double-density incurs an error rate of <1 recoverable error/10" bits read. Up to 4 8" (20-cm) or 3 5" (13-cm) drives are supported. Also included is an 8251 UART RS-232 serial port. CMC Marketing Corp, 10611 Harwin Dr, Suite 406, Houston, TX 77036. Circle 209 on Inquiry Card

32-CHANNEL A-D CONVERTER

Designed for use with the STD BUS, the ST4303 12-bit A-D converter has an accuracy of 1 part in 4096 (±LSB). It accepts inputs from 32 differential or single-ended input sources with voltage ranges of ±2.5, ±5.0, ±10.0, 0 to 5, or 0 to 10 Vdc. Max conversion time is 10 µs for same channel conversion; switching channels adds 2 to 7 µs. The converter is available in the full 32-channel configuration, or in increments of 8, 16, or 24 channels. Applied Micro Technology, PO Box 3042, Tucson, AZ 85702. Circle 210 on Inquiry Card

SWITCHING POWER SUPPLIES

SB series feature both 115- and 230-Vac inputs, brownout protection, tight regulation, and MTBF of 100k hours. Supplies will operate over a low input range of 115/230 Vac ±10%, -20%. Input frequency can be 47 to 440 Hz. There are 30 models available with single 5-, 9-, 12-, 20-, and 24-V (±10%) outputs rated at 50, 150, 200, 300 W. Line regulation <0.2% for the input range, and load regulation <0.2% for no load to full load. KEC Electronics, Inc, 21535 Hawthorne Blvd, Torrance, CA 90505. Circle 211 on Inquiry Card

ROLLS & TAPES

THE BEST FOR MODERN DATA PROCESSING EQUIPMENT

PAPER TAPE — 7 Colors plus Black Opaque; Printed Top/Arrow; Oiled and Uncoiled Rolls; FOLDED TAPES — For specialized applications.
THERMAL PAPER — Rolls and Folded. Marginally punched and cross perforated for all types of printers and calculators.
MYLAR TAPE — Paper/Mylar Laminations; Foil/Mylar Laminations; Metalized Mylar.
FOLDED LISTER PAPERS — For Digital Print-out Units.
TELETYPE ROLLS: Single copy; Multi-copy Carbon inter-leaved and Carbonless Friction Feed Sprocket feed.
CONTINUOUS TELETYPE FORMS: 8½" x 11" Carbon inter-leaved 1 through 6 part; Carbonless 1 through 6 part (NCR).

ESCO

EASTERN SPECIALTIES COMPANY, INC.
P. O. Box 350, Holyoke, Ma. 01040, Tel: 413 533-7103

CIRCLE 155 ON INQUIRY CARD

CIRCLE 156 ON INQUIRY CARD
Introducing the new BASF 6170 Series 210mm Fixed Disk Drives.

High Performance. Perfect for multi-user multi-tasking applications, the BASF 6170 Series drives give you an average time-to-data of 50 milliseconds...four to seven times faster than standard 8" floppy drives.

Capacity. The BASF Model 6171 provides 8 megabytes and the Model 6172 provides 24 megabytes of fully usable unformatted capacity. Unique BASF circuitry eliminates user mapping.

Easy System Integration. BASF's exclusive SMD interface option offers cost-effective and convenient interface compatibility with industry-supported controllers. Low-cost BASF disk bus, or intelligent BASF host bus with integral controller/formatter also available.

Proven Reliability. BASF, because of its experience in both magnetic media and drives, is highly qualified to develop drives using reliable 3350 Winchester technology. BASF 6170 drives have a 10,000 hour MTBF and require no scheduled maintenance or operator intervention.

Compact Size. Far smaller than 14" drives, the quiet, lightweight floppy-sized BASF 6170 drives are suitable for desktop office environments.

Competitive Price. Get the performance, capacity, and ease of system integration you need right now...at prices you'd expect to pay for far less sophisticated technology. Write now for competitive OEM prices.

If you need high performance, capacity, easy system integration, proven reliability, in a compact size, at a competitive price, right now...

write now.

BASF Systems, OEM Peripheral Sales, Crosby Drive, Bedford, MA 01730
Please send me complete details and specifications on the new BASF 6170 Series 210mm Fixed Disk Drives.

Name __________________________ Title ________________
Company ____________________________________________
Address _____________________________________________
City ___________________ State ___________ Zip __________
Telephone ____________________

In a hurry? Call Dave Edwards at (617) 271-4168
HIGH RESOLUTION CRT MONITOR

HR-1500 raster scan monitor is capable of displaying over 1920 char in either white or green phosphor. It provides 400 active raster lines with horizontal scan rate of 25 kHz, refresh rate of 50-60 Hz, vertical step scan, and dual intensity. The 15" (38-cm) diag CRT screen is nonreflective, using an etched bonded faceplate to eliminate glare.

Electronic components are packaged in one easy to repair board. Telex Computer Products, OEM Div, 6422 E 41st St, Tulsa, OK 74135.

Circle 212 on Inquiry Card

MULTIPLEXER TEST SET

PCM transmission, terminal, and multiplexer testing at 1.544M, 3.152M, and 6.312M bits/s is facilitated by the model SS102 DS1/1C/2 test set. It can measure bit error rate through an M1C or M12 multiplexer with different receive and transmit rates. Built-in latching status indicators and a timer permit long-term unattended measurements of total errors and errored seconds. The set comprises a separate receiver and transmitter, each housed in a portable case. Tau-Tron, Inc, 27 Industrial Ave, Chelmsford, MA 01824.

Circle 213 on Inquiry Card

300-LINE/MIN PRINTER

Plug compatible with IBM 3271, 3272, or 3274(B) control units, the LABEL/300 model 1C/3270 generates variable size char 0.1 to 2.8" (0.3 to 7 cm) with variable aspect ratio. The printer operates both as a std 300-line/min printer and as a special char printer. Font options provide italics, reverse, half-tone, and overprinting. Interfaces and protocols allow connection to almost any host computer. Technical Analysis Corp, 120 W Wieuca Rd, NE, Atlanta, GA 30342.

Circle 214 on Inquiry Card

WAVE SOLDERABLE CHIP RESISTORS

MCR-18, a thick film chip resistor, attaches directly to either side of a PC board and is flow soldered along with other components. In conjunction with automatic mounting methods, devices offer improvements in packaging density, production costs, and reliability. Measuring 0.125 x 0.062 x 0.023" (3.2 x 1.6 x 0.06 mm), the unit has tolerances of ±2%, ±5%, or ±10%, and is multirated from 0.0625 to 0.5 W. Values range from 2.2 to 10M Ω.

R-Ohm Corp, PO Box 19515, Irvine, CA 92713.

Circle 215 on Inquiry Card

NEW! STAR MICRONICS

MODEL DP-822 MINIATURE DOT MATRIX IMPACT PRINTER

STAR'S NEW MODEL DP-822 is the ideal alphanumeric printer for automated banking terminals, desktop calculators, electronic cash registers, medical and scientific instruments—and many other products requiring a reliable, low-cost dot matrix impact printer. It has a replaceable printing head with minimum life expectancy of 15 million characters and is operated by a single 12-volt DC power supply. You get up to 21-column hard-copy printing at a speed of 2.5 lines per second with serial impact strong enough to print two clear copies on carbonless tapes or a single copy on standard 2¼" adding machine tape. A 5 x 7 matrix array yields printed characters in any alphanumeric font up to .071" wide by .114" high.

The Star DP-822 costs only $42.95 each in quantities of 1000 units—and control electronics also are available at low cost. Write today for complete information.

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Visit Us at Interface '80, Booth 133.
INTELLIGENT TERMINAL CONTROLLED SWITCH

Micro600 port selector, based on the 610 intelligent port selector, provides enhancements including support of current loop interface terminals and integral Bell 43401 local datasets for short haul data transmission. Any asynchronous terminal may be connected to the unit directly or by means of dial-up or dedicated modems or integral local datasets, to contend automatically for the computer ports attached to the unit. Micom Systems, Inc, 9551 Irondale Ave, Chatsworth, CA 91311. Circle 292 on Inquiry Card

SUBMINIATURE LED REFLECTIVE SCANNER

LED reflective scanner S13224 can detect a 0.03" (0.76-mm) target at a distance of 0.3" (7.6 mm) and is able to detect small objects up close and white bond paper as far away as 1" (2.54 cm). Unit consists of IR LED, collimating lens, and matched photosensor in aluminum body. IR energy focused on target is reflected back to photosensor. Filter protects sensor from ambient visible light and attenuates most radiation from other light sources. Skan-A-Matic Corp, PO Box S, Elbridge, NY 13060. Circle 294 on Inquiry Card

10M- TO 12.5M-BYTE DISC CARTRIDGES

Front and top loading disc cartridges for 10M- to 12.5M-byte drives are designed and tested for use with the units manufactured by Data General, Hewlett-Packard, and Perkin-Elmer (Wangco). The cartridges feature a 0.075" (1.905-mm) metal substrate and a proprietary coating and are 100% certified to OEM standards. Both front (style 2315) and top (style 5440) loading configurations are available to match drive and system requirements. Athana Magnetic Media, 1815 Mullin Ave, Torrance, CA 9051. Circle 293 on Inquiry Card

RECEIPT/AUDIT PRINTER

Dot matrix impact printer with split paper feed for receipt applications offers 3-line/s bidirectional printing and 10-line/s line feed, and prints two 18-char columns at 12 char/in (4.7/cm). Line width of the M-520 is 1.5" (3.8 cm); paper width is 1.75" (4.45 cm) for each roll. The printhead consists of 7 clapper type solenoids which activate 7 print-wires, and is designed for continuous service without overheating. Printhead life is 100M char. LRC, an Eaton Co, Technical Research Pk, Riverton, WY 82501. Circle 295 on Inquiry Card

14-BIT MULTIPLYING DAC

Encased in a 24-pin double-DIP, DAC9331-14 maintains ±0.003% linearity over the specified 0 to 70 °C temperature range. Dynamic laser trimming assures max accuracy and temp tracking of precision, thin-film ladder network and internal feedback resistor. Compatible with TTL/DTL and CMOS logic, the unit operates from a single 5- or 15-V supply and consumes a max of 30 mW. Reference input range is ±25 V; digital input coding is binary or offset binary for 2- or 4-quadrant multiplying operation, respectively. Hybrid Systems Corp, Crosby Dr, Bedford, MA 01730. Circle 297 on Inquiry Card

INTEGRATED TERMINAL

Incorporates the Bell 43401 local data terminal. Micom Systems, Inc, 9551 Irondale Ave, Chatsworth, CA 91311. Circle 292 on Inquiry Card

WIRING CONTROLLED SWITCH

Circle Micro600 switch to the unit for the computer ports attached to the unit. Micom Systems, Inc, 9551 Irondale Ave, Chatsworth, CA 91311. Circle 292 on Inquiry Card

RECEIPT/AUDIT PRINTER

Dot matrix impact printer with split paper feed for receipt applications offers 3-line/s bidirectional printing and 10-line/s line feed, and prints two 18-char columns at 12 char/in (4.7/cm). Line width of the M-520 is 1.5" (3.8 cm); paper width is 1.75" (4.45 cm) for each roll. The printhead consists of 7 clapper type solenoids which activate 7 print-wires, and is designed for continuous service without overheating. Printhead life is 100M char. LRC, an Eaton Co, Technical Research Pk, Riverton, WY 82501. Circle 295 on Inquiry Card

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BEI accuracy begins at our code erating device, The BEI Divided chine presently attains pattern to centerline absolute position accuracy of better than 0.3 second of arc! BEI's commitment to accuracy is evident in every aspect of encoder design. Check these features from our absolute position series: Non-ambiguous code formats • Linear and nonlinear codes • Reference amp compensate for variations in temperature and supply voltage • Dual readout stations of Optical Resolver™ Series cancel effect of bearing eccentricity and shaft loading.

BEI Electronics, Inc.

Industrial
Encoder
Division
Goleta, California

1101 McAlmont Street Little Rock, AR 72203
(501) 372-7351 TWX 910-722-7354

CIRCLE 160 ON INQUIRY CARD

CIRCLE 161 ON INQUIRY CARD
At TTI, we're excited about the future and we've created an environment where new ideas are respected and progress is the goal. We're constantly seeking talented and creative professionals who are committed to producing the highest quality technical achievements — like the sophisticated banking systems we designed for Citibank, one of the world's largest financial institutions, utilizing the latest in state-of-the-art Electronic Funds Transfer Systems (EFTS). More importantly, we're searching for people who are as excited by change and dedicated to it as we are.

Besides providing career-oriented individuals with advanced technical challenges, TTI is a firm believer in seeking out and encouraging individual recognition and advancement. Now is the ideal time to bring your expertise into one of the following career assignments:

- SYSTEMS PROGRAMMING
- ON-LINE APPLICATIONS PROGRAMMING
- TEST ANALYSIS
- PRODUCT DESIGN
- DIAGNOSTIC PROGRAMMING
- TECHNICAL MANAGEMENT
- SYSTEMS ENGINEERS
- TECHNICAL WRITERS

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Los Angeles, CA 90024

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CIRCLE 162 ON INQUIRY CARD
POWER SUPPLY TEST SET

Model 1500 synchronous ac power line interrupter can simulate line voltage dropouts or apply ac load power for preselected intervals ranging from 0.5 to 499.5 cycles in half-cycle increments. A TTL level sync pulse is available for triggering external monitoring equipment and an autotrigging mode permits continuous cycling of loads for life testing. Interrupts are synchronized with zero-crossing of the ac line voltage for min load stress and rfi.

The unit features

INTEGRATED DISC STORAGE SUBSYSTEMS

Disc/diskette subsystems incorporate a 12.5M-byte fixed media disc and 1.26M-byte diskette. Available for Nova®, Eclipse® and microNova™ computers, one model includes the 25M-byte disc and 1.26M-byte diskette, another consists of 25M-byte disc only. A third model includes both 12.5M-byte disc and diskette. Capacity of the permanent 25M-byte disc is 25,165,824 bytes formatted in sectors of 512 bytes each. There are 384 tracks/surface divided into two 192 track bands on each of 4 surfaces. A separate read/write head accesses each band. Each 8-track disc cylinder has 1,017,424 bytes in 256 sectors. The nonremovable 12.5M-byte disc has 12,582,912 bytes formatted in the same way, but with 4 tracks/cylinder. The diskette uses media with 77 tracks/side formatted into 16 sectors of 512 bytes. Exact capacity is 1,261,568 bytes. Data transfer to/from memory is at a 62,500-byte/min rate. Head positioning times, including seek settling are 25 ms to track, 100 ms random avg, and 253 ms max. Rotational latency is at 360 r/min is 83.3 ms. Data General Corp, Rt 9, Westboro, MA 01581.

Circle 261 on Inquiry Card

SINGLE-STATION PUSHBUTTON SWITCH

Series BXL Box Switch offers the option of incandescent or LED illuminated, or nonilluminated face as well as selection of either momentary or push-lock/push-release mechanism. The LED version features a translucent lens 0.156 x 0.25" (3.96 x 6.35 mm) centered on the pushbutton face in red, green, yellow, or orange. Incandescent and nonilluminated faces are molded of translucent plastic in white, red, green, blue, yellow, or orange. Solder lug/quick connect terminals are std. Leads may be soldered; or mounting is in 100 receptacles may be used. Mouting is in 0.625" (15.88-mm) square holes in panels from 0.031 to 0.093" (0.79 to 2.36 mm) thick. Locking tabs integral with the switch housing hold the switch securely. Switchcraft, Inc, 5555 N Elston Ave, Chicago, IL 60630.

Circle 262 on Inquiry Card

TERMINALS

FROM TRANSNET

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KYNAR PVDF wire insulation gives you excellent abrasion and cut-through protection even though you may pay less for KYNAR than other fluorinated plastics. Get full information. Write KYNAR, Pennwalt Corporation, Three Parkway, Philadelphia, PA 19102. Or call (215) 587-7514.

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HEALTH PRODUCTS

*KYNAR® is a registered trademark of Pennwalt Corporation for its polyvinylidene fluoride.

CIRCLE 164 ON INQUIRY CARD
PORTABLE DIAGNOSTIC DATA COMMUNICATIONS TEST SET

Designed to monitor and interactively communicate with data appearing at the EIA RS-232 interface, the Hawk 4010 Datatrap displays data traffic on a 5" (12.7-cm) CRT. Capabilities are accessible through menu pages displaying instrument configuration status. The microprocessor based unit quickly locates and isolates problems in hardware and software by simultaneously displaying both transmit and receive data. It can be programmed to trap and store 4096 characters, and recall this data for detailed visual analysis. Operating with synchronous data rates up to 19,200 bits/s in both half- and full-duplex modes, the set provides asynchronous operation through 16 internally generated clock speeds ranging from 50 to 19,200 bits/s. International Data Sciences, Inc, 7 Wellington Rd, Lincoln, RI 02855.

Circle 263 on Inquiry Card

DIGITAL OUTPUT BAR CODE WAND

Designed to scan bar code and output a logic level pulse width representation of bars and spaces, the HEDS-3000 uses a precision optical sensor that can read all common bar code formats printed with a min bar width of 0.3 mm. High resolution, high speed emitter/detector sensor is sealed in a module near the tip of the wand. In the module, one-half of a bifurcated precision plastic lens projects visible light from a 0.17-mm dia, 700-nm LED onto the sensing plane. The other identical lens half focuses reflected light onto an integrated silicon photodetector. An onboard transistor in the detector provides added gain. Each lens half has a numerical aperture of 0.3 for maximum light gathering power, and spherical aberrations are eliminated through use of aspheric lens surfaces. Signal conditioning circuitry includes analog amp, digitizing circuit, and output transistor. Energized push-to-read switch, these elements provide TTL and CMOS compatible logic level output. Unit interprets nonreflecting black bars as logic high levels (1), reflecting white spaces are read as logic lows (0). Hewlett-Packard Co, 1507 Page Mill Rd, Palo Alto, CA 94304.

Circle 264 on Inquiry Card

KYNAR® gives you another advantage.

COST-SAVINGS.

In many cases, for less cost than other fluorinated insulations, KYNAR PVDF gives you abrasion and cut-through protection plus exceptional compatibility with wire-wrap equipment. Get full information. Write KYNAR, Pennwalt Corporation, Three Parkway, Philadelphia, PA 19102. Or call (215) 587-7514.

*KYNAR is a registered trademark of Pennwalt Corporation for its polyvinylidene fluoride.
WINCHESTER DISC CONTROLLER

Model 530 provides up to 40M bytes of storage capacity for the DEC Q-bus family of processors. It features complete software compatibility with operating systems having RL01/RL02 support. Disc controller interface is resident on a single 2-sided, quad-width printed circuit board that measures 8.5 x 10" (21.6 x 25.4 cm). Controller uses a bit slice microprogrammable processor along with the company's micromodule approach to design. Most current Winchester disc drives are supported including the BASF 24M byte and IMI 10M byte 8" (20-cm) drives, and Century Data Marksman 14" (36-cm) units. The micro module design technique allows for future expansion to handle other disc drives up to 960M bytes with simple ROM changes. Throttle and interleaving techniques synchronize each disc drive to the Q-bus, 8-sector buffering eliminates potential data rates. A CRC value computed by controller during each write operation is automatically appended to the end of each data and header field. This value is compared with the CRC value computed during read to detect errors.

MICROPROCESSOR CONTROLLED CRT TERMINALS

Included as standard in all models of the smart terminals are upper and lower case, printer/extension port, imbedded numeric pad, remote computer control, selectable transmission rates from 75 to 9600 baud, and editing and special functions. A serial RS-232-C communications interface and 20-mA current loop are also std. Models 920B and 920C differ from the 912B and 912C in that they offer 11 special function, 6 editing, and 2 transmission keys, all contained in an additional row on the keyboard. Keyboards are Teletype style in B models, and typewriter style in C versions. A second page of memory is optional in all. Editing and transmission functions are key selectable, and include char and line insert/delete, line and page erase, send line, send page, and tabbing. Reverse video, underline, and blink and blank are offered plus key controllable conversational and block transmission modes, built-in self-test, and protected fields. Nonglare 12" (30-cm) diag CRT screen provides 12 x 10 dot matrix resolution and dual intensity for 1920 char.

Have you heard about the new OEM printer/plotter?
The VERSATEC V-80

Turnernet trimmers (for precision pulse width and amplitude alignment)
- All packaged in a handsome aluminum case

OAE'S new PP-2708/16 PROM Programmer is the only programmer with all these features:
- Converts a PROM memory socket to a table top programmer. No complex interfacing to wire—just plug it into a 2708 memory socket
- A short subroutine sends data over the address lines to program the PROM
- Programs 2 PROMs for less than the cost of a personality module. (2708s and TMS 2716s)
- Connect 2 or more in parallel—super for production programming
- Connect with DC to DC switching invertor and 10

CIRCLE 167 ON INQUIRY CARD

CIRCLE 168 ON INQUIRY CARD
When it comes to speed, reliability and low cost, systems users in 25 countries in every continent of the world depend on the VRC 4016 head-per-track memory.

It features a fail-safe actuation system that eliminates the potential of media damage and data loss. It's compact and lightweight. All electronics, drive components and head retraction system are mounted outside the drum, making service simple and eliminating risk of contamination.

Applications are endless. Telecom and message switching, process control of all kinds, geophysical exploration, power generation, news editing, typesetting. Wherever low cost-per-bit, fast access and high data storage capacity are required.

For proven reliability, worldwide support, field service and predictable high quality, you can rely on VRC.

Write or call for complete details on the Model 4016 head-per-track memory... a simple, rugged, compact unit to improve the reliability of your system.
Pick this Microperipheral® bundle and you can put together a floppy disk sub-system to meet your design needs. One more example of how we save you development time and money. Because we do all the work for you. We “bundle” together the ideal sub-systems, provide all the equipment (our own) and service them, too.

Example—the 3812. A full megabyte of microcomputer formatted storage. Two floppy disk drives. Power supply. Built-in dual-density controller that handles up to four drives.

The 3812 lets you use your current programs because it reads and writes in single- or double-density. You save on design simplification.

You can use S-100 bus, Intel Multibus™ Motorola Exorcisor™ and other interfaces.

It’s IBM format compatible. Its retractable heads are long-lasting ferrite.

You can have an optimal direct memory access data transfer to and from disk.

The 3812 operates under CP/M.® It supports Microsoft’s FORTRAN, COBOL and BASIC.

It’s the best sub-system we make. Except for the bundle on the right.
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Pick this Microperipheral bundle and you can put together 40MB from one hard disk sub-system. One more example of how we save you development time and money. Because we do all the work for you. We "bundle" together the ideal sub-systems, provide all the equipment (our own), software and interfaces.

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The 4511. We start with 10MB—5MB fixed, 5MB removable. We then include a controller that lets us daisy-chain three drives to it. Which means it can go all the way up to 40MB.

We also include performance in the bundle. The 4511 has 40 Msec average access time. It transfers data at 2.5MHZ. It has a security controller that's bus-oriented, with key-lock.

It speaks FORTRAN, COBOL and BASIC. It has CP/M. It's the best sub-system we make. Except for the bundle on the left.

The 4511 and 3812 are products of Pertec Computer Corporation, an international company that designs, manufactures and services computers and computer equipment. Microperipherals® is a registered trademark of Pertec Computer Corporation.

For more information, write Ray Kristiansen, Pertec Computer Corporation, 20630 Nordhoff Street, Chatsworth, California 91311. Or call toll-free 800-331-1001 in the continental U.S. (In Oklahoma, call collect 918-664-8300).
PRODUCTS

PC BOARD TERMINALS

Rugged 1-piece contacts of terminal blocks provide low resistance connections to solid or stranded wire up to 14 AWG. Round, 1-mm dia solder pins, spaced 5.08-mm on centers, are suited to wave-solder installation on boards up to 3.2 mm thick. Tubular clamp contacts with self-locking screws accept stripped wire ends directly. Type LSV blocks, in lengths of 3, 4, 5, or 6 terminals, are rated 8 A at 150 V; MiniMod blocks, in lengths of 2 or 3 terminals, are rated 5 A at 150 V.
Cogenel, Inc, Entrelec Div, Two Ram Ridge Rd, Spring Valley, NY 10977. Circle 224 on Inquiry Card

MODEM ELIMINATOR

Model E103 eliminates the need for 2 modems or acoustic couplers when connecting an RS-232 I/O terminal directly to a nearby computer, or connecting terminal to terminal with a distance of 1000' (304 m). The unit features asynchronous operation in full- or half-duplex at up to 1200 baud. Connection is accomplished by plugging the 25-pin RS-232 connector from the terminal in either E103 plug, and the cable from the CPU in the other. Western Telematic, Inc, 2435 S Anne St, Santa Ana, CA 92704. Circle 225 on Inquiry Card

HERMETICALLY SEALED SIP RESISTOR NETWORK

Miniature resistor networks in hermetically seam-sealed, 10-lead ceramic packages conform to MIL-STD-883B. Available resistor values range from 20 to 2M , with absolute tolerances to 0.01% and ratio tolerances to 0.005%. The absolute tempco is 50 ppm std to 10 ppm on special order; TC ratio tracking is to 1 ppm/°C. Lead spacing is on 0.1" (0.25-cm) centers. Low profile configuration has a lowboard height of 0.22" (5.59 cm). Electro-Films, Inc, 111 Gilbane St, Warwick Central Industrial Pk, Warwick, RI 02886. Circle 226 on Inquiry Card

DUAL-BUFFER TAPE RECORDER FOR DATA ACQUISITION

Normally connected to a data acquisition system, DB-1050 may be used for any application requiring IBM compatible 0.5" (1.27-cm) tape format. The recorder with an industry standard interface provides 1600-char/in (630/cm) PE or 800-char/in (315/cm) NRZI data density at a 45-in (114-cm)/s speed. Heart of the subsystem is the TDI-1050 synchronous tape transport, which includes an embedded dual-mode formatter and a microprocessor controller with double 2048 front-end buffers. Record lengths of 2048 bytes are temporarily stored in a dual-buffer memory which achieves a 50K-byte/s data transfer rate; when 1 buffer is full, the memory content is written on tape. Innovative Data Technology, 4060 Morena Blvd, San Diego, CA 92117. Circle 227 on Inquiry Card

72-CONDUCTOR CABLE ASSEMBLIES

Panel to panel and backplane to backplane interconnection assemblies mate with the company's straight and right angle cable connector families as well as with PBC edge fingers. High I/O capability (up to 72 conductors) is suitable for insulation displacement connector applications. They are available in 26, 36, 40, 50, and 72 conductors, both single- and double-ended. Mupac Corp, 646 Summer St, Brockton, MA 02402. Circle 228 on Inquiry Card

RS-232 COMMUNICATION LINE MONITOR

Inline status display and true 3-level monitoring for EIA RS-232 communication lines are performed by the CM-232LT. Powered from communication lines, the monitor has 12 2-color LEDs that indicate red for mark (≥ 3 V), green for space (≤ 3 V), and remain unit for signal levels between 3 and ~3 V. Low current draw of ≤3 mA for each LED allows continuous monitoring of marginal lines. Each signal line, except line 1, contains a DIP switch for opening any line. Carroll, 1212 Hagan St, Champaign, IL 61820. Circle 229 on Inquiry Card

TAPE CONTROLLERS

Model 7800 series magnetic tape controller supports GCR at 6250 bits/in (2460/cm), PE at 1600 bits/in (630/cm), and NRZI at 800 bits/in (315/cm) tape densities. The tape controller is software and hardware transparent to host systems which may include VAX-11/780, PDP-11, Nova, Eclipse, and Interdata 7/32, 8/32, and 3220 computers. The control units allow users to read and write gapless records. Information Products Systems, Inc, 6567 Rookin, Houston, TX 77074. Circle 230 on Inquiry Card

WAVE-SOLDERABLE MINIATURE SLIDE SWITCH

Contamination free Mr. Clean II (124 series) uses patented 2-piece principle. Only the exposed base of this switch is subjected to the soldering and cleaning process (fluorinated, chlorinated, or aqueous). Base has insert molded pin terminals; top half of switch which contains the switching mechanism is then snapped on the base. Hard gold over nickel barrier switches are available in spst, spdt, dpst, and dpdt, and form 2 circuit configurations. Chicago Switch, Inc, 1714 N Damen Ave, Chicago, IL 60647. Circle 231 on Inquiry Card

GRAPHICS ALPHANUMERIC VIDEO DISPLAY CONTROLLER

Lexiscope 4000 can emulate std 96-char ASCII alphanumeric display terminals as well as provide moderately high resolution (560 H x 500 V) graphic display in Data General Nova and Eclipse series computer systems. Separate cursors and display memory allow independent programming, display, and erase of the graphic and alphanumeric screens. The display content is contained on a single 15" (38-cm) board that plugs directly into 1 slot in the computer mainframe. Lexicon, Inc, 60 Turner St, Waltham, MA 02154. Circle 232 on Inquiry Card
PC BOARD
SOLID STATE RELAYS

Synchronous switching, 2.5-A rated free-air ac switching, 3 dc input options, and industry std encapsulated packages are features of the FSSR, ISSR, and PSSR miniature relays. Each has zero voltage switching for rfi suppression, and is optically coupled for high isolation between input and output. An internal snubber network protects against false triggering by high line transients. Units are available in both 140- and 280-Vac models. Guardian California, 4030 W Spencer St, Torrance, CA 90503.
Circle 216 on Inquiry Card

BAC-HASP DATA CONVERTER

Communicating with host mainframe via IBM HASP multilearning RJE workstation binary synchronous protocol, converter performs all error checking and correction functions, translates EBCDIC to ASCII and ASCII to EBCDIC, and interfaces with user attached devices in serial asynchronous or byte parallel formats. Unit's multileaving feature permits console support, duplicate character compression, and bidirectional communications, allowing multiple I/O devices to operate concurrently. KMW Systems Corp, 8307 Hwy 71 W, Austin, TX 78735.
Circle 217 on Inquiry Card

MINIATURE SWITCHING REGULATORS

Offering efficiencies to 80%, the μPower-DIP dc to dc regulator series comes in output ranges of 3 to 7, 9 to 15, and 16 to 32 V, as well as a variety of output configurations. Up to 1.5 W of output power can be achieved; efficiency remains high for loads down to 0.1 W. Designed into a 14-pin DIP compatible package, devices feature low standby power drain and output protection against short circuit. External capacitors are required on each output. Integrated Circuits Inc, 13256 Northup Way, Bellevue, WA 98005.
Circle 218 on Inquiry Card

THERMAL PRINTER
UNIVERSAL INTERFACE

The UTI-80 microcomputer based board, measuring 4.75 x 5.5" (12.06 x 13.9 cm), drives TII's 12- and 20-col thermal printer assemblies. The interface includes DIP switch selectable parallel (Centronics std) or serial (RS-232 or 20- and 60-mA current loop) inputs. Switch selectable invert print mode and baud rates are 110, 300, or 1200. Built-in self-diagnostic continuously prints the 64-char ASCII set to check the interface, power supply, and printer. Technology Marketing Associates, Inc, 6559 E Parker Rd, Parker, CO 80134.
Circle 220 on Inquiry Card

6250-BIT/IN TAPE STORAGE
SYSTEM FOR PDP-11/70

A tape transport, formatter, and tape adapter comprise the Omega, which is characterized by fast speed, large capacity storage, and easy interfacing without any changes to the DEC hardware or software. Operating at a speed of 75 in (191 cm)/s, the transport is controlled by the formatter. The system records data at 6250 bits/in (246/cm) in group-coded recording mode or at 1600 bits/in (630/cm) in phase encoded recording mode. In the former mode, a std 2400-ft (732-m) reel of tape can store approx 100M to 180M bytes of data depending on the block size being written. The intelligent tape adapter interfaces the tape transport and formatter to the minicomputer, emulating DEC's TU45 unit. System Industries, PO Box 9025, Sunnyvale, CA 94086.

Circle 219 on Inquiry Card

10- AND 100-KHZ
F-V CONVERTER

Guaranteed specs over the -55 to 125 °C temp range include a non-linearity of +0.005% and full-scale tempco of ±50 ppm/°C for 2 hybrid frequency-voltage converters. Models 4732 and 4734 have a guaranteed dynamic range of 10 Hz to 11 kHz and 100 Hz to 110 kHz, respectively. They are MIL-STD-883 processed to include burn-in and temp cycling. Magnitude of the output voltage is linearly proportional to the input frequency, regardless of waveshape. Teledyne Philbrick, Allied Dr at 128, Dedham, MA 02062.
Circle 221 on Inquiry Card

PC BOARD EDGE CONNECTORS

Modular card edge connector series ESC-100A with 0.100" (2.54-mm) centers and ESC-156A with 0.156" (3.962-mm) centers are available with 2 through 85 and 2 through 50 contacts, respectively. The devices eliminate the need for engineers to design boards around available connectors as well as the extra tooling charges incurred for special connectors, or the need to purchase excess contact positions. Electrosonic Components, Inc, 14115 Chadron Ave, Hawthorne, CA 90250.
Circle 222 on Inquiry Card

DATA COMMUNICATIONS
MESSAGE SWITCH

MS400 for both message and transaction processing environments combines architecture and hardware redundancy. Configurations for a single switch range from 2 to 16 processors. Capabilities can be changed or added by including software processes to support the functions; each terminal type and switching function is supported by a process that executes under the switch operating system. Each pair of processors provides up to 4800M bytes of mass storage, and 2M bytes of memory. Computer Sciences Corp, 650 N Sepulveda Blvd, El Segundo, CA 90245.
Circle 223 on Inquiry Card
DC-DC SOLID STATE RELAY

Relays that operate over a load range of 3 to 50 Vdc switch a dc load with a dc input. Two package sizes with load current maximums of 400 mA and 2 A are offered. Inputs are logic compatible and sensitive to 3 to 24 Vdc with low drive currents. Optical isolation provides max protection for driving logic circuitry, while a clamped output provides max transient protection for the relay. Micro Cube and Mini Cube packages house the devices. Grayhill, Inc, 561 Hillgrove Ave, La Grange, IL 60525.
Circle 233 on Inquiry Card

COLOR CRT MONITORS

IDT-19A, a 19" (48-cm) color monitor, displays 200 to 300 horizontal lines of 450 to 640 dots at a nonflicker refresh rate of 60 Hz with an RS-170 input. It operates with this input in either interlaced or noninterlaced mode. Available configurations are a wire frame module, a 19" (48-cm) rack mount, or a cabinet enclosure. Automatic degaussing and high contrast filter are featured. Electronic controls are on a display control panel normally mounted in a drawer assembly with front access. Industrial Data Terminals Corp, 1550 W Henderson Rd, Columbus, OH 43220.
Circle 234 on Inquiry Card

LIMITED DISTANCE MODEM

Designed for distances under 30 mi (48 km) over private lines or local telephone circuits at std synchronous speeds up to 19.2k bits/s, LM192 with built-in distortion analyzer operates in point to point, multipoint, or multidrop environments. A front panel LED bar graph display indicates receive line distortion in 5% increments from 0 to 50%. Equalization to optimize transmission distance is achieved by tuning for min distortion without external test equipment. Data-Control Systems, div of General Indicator Corp, PO Box 860, Danbury, CT 06810.
Circle 235 on Inquiry Card

MICROPROCESSOR CONTROLLED PROGRAMMER

Universal UP-803 reads, programs, and verifies all programmable devices. Each family of devices is handled by a single FAM (family module); every module can handle several algorithms which are software selected by a personal computer switch. Configurations and pinout are selected by a device adapter. Interactive operation is through a hexadecimal keyboard and 5" (13-cm) CRT display. EIA RS-232-C and 20-mA current loop interfaces are included. The programmer handles devices over 24 address and 16 data lines. Buffer memory consists of 32k bits (up to 256k bits optional). An optional gang module can handle up to 16 devices simultaneously. Digitronics Israel Ltd, 3, Tevuot Haaretz St, Tel-Aviv, POB 39821, Israel.
Circle 236 on Inquiry Card

DUAL-COLOR LED PACKAGES

Two bicolor matched LED chips in a T-1¾ short dome package size are available in red/red, green/red, green/green, green/international orange, green/yellow, international orange/in­ternational orange, and yellow/yellow chip color combinations. The package includes an uncolored diffused epoxy encapsulated, low profile lens for applications requiring a max OFF axis viewing angle. The lens exhibits a typical luminous intensity of 2.0 mcd at 20 mA. OPCOA, div of IDS, Inc, 330 Talmadge Rd, Edison, NJ 08817.
Circle 237 on Inquiry Card

PROGRAMMABLE DIP/SIP SHUNT NETWORKS

As an alternative to individual jumper or bus wiring, both DIP and SIP style series 198 networks feature 0.100" (0.254-cm) centers. SIP styles are available in 2 through 12 pins, DIPs in 4 through 24 pins. The interconnection package is factory preprogrammed or can easily be programmed with a hand tool before or after insertion into the PC board. Programming condition can be visually verified. CTS Keene, Inc, 3230 Riverside Ave, Paso Robles, CA 93446.
Circle 238 on Inquiry Card

MEMORY/LOGIC UPS

Self-contained UPS-2708B is an online system that provides regulated dc computer power for volatile MOS memory and refresh logic during an ac power outage, by establishing a battery back-up dc power bus that is electrically independent of the main dc power bus. It also provides power in systems that have a separate dc power-off switch for overnight or standby system shutdown. A sealed, rechargeable 12-V battery is included. The float type battery charger has an 800-cycle battery life. Stevens-Arnold, Inc, 7 Elkins St, South Boston, MA 02127.
Circle 239 on Inquiry Card

SILVER EPOXY PAINT FOR RFI/EMI SHIELDING

C-608 conductive silver epoxy resin polyamide paint system with a volume resistivity of 0.01+ Ω/cm² in a uniform, 1-mil (0.025-mm) thick film offers rfi/emi shielding and static protection for electronics systems. Paint sprayers or brushes may be used to apply the formulation that resists settling and needs minimal agitation. Cured by air drying, the paint has a 1-h tack-free time and a 12-h pot life at 70 °F (21 °C). Carroll Coatings, Div of Spectrum Coating Laboratories, Inc, 217 Chapman St, Providence, RI 02905.
Circle 240 on Inquiry Card

16-CHANNEL ANALOG SIGNAL MULTIPLEXER

Programmable for random or sequential channel selection, this multiplexer functions with any data acquisition system or DMM. Features are 5-pV noise, up to 16 2-wire data channels or 8 4-wire channels, and a guard connection. Series On resistance is 0.5 Ω/wire and isolation is >10³ Ω between channels. Max voltage on any given channel may be up to ±300 Vdc or peak ac; model 3420 can handle currents up to 100 mA. Operating modes are manual, scan, remote, and slave. Data Precision Corp, Div of Analogic Corp, Electronics Ave, Danvers, MA 01923.
Circle 241 on Inquiry Card
ASCII/EBCDIC

CLOCK/CALENDAR

Datadock 100 communicates the date and time to all computers that support serial asynchronous communications. Installed transparently on the cable that runs from an ASCII or EBCDIC terminal to a computer system, the device can be set as part of the computer's power-up sequence. Software support can be written in such high level languages as FORTRAN, COBOL, BASIC, or Pascal. Qupro Data Systems Ltd, Suite 200, 501 Krug St, Kitchener, Ontario N2B 1L3, Canada.

Circle 242 on Inquiry Card

DISC PACK SUBSYSTEM FOR PDP-11/70

PM-DSW/11/300 emulates the DEC RH70 for the PDP-11/70, and replaces RWP04, RWP05, and RWP06 disc sub-

systems. The controller replaces up to 8 DEC control logics and supports up to eight 254M-byte drives, for a max capacity of 2G bytes. Each disc pack has a formatted capacity of 253.6M bytes, and removable packs provide unlimited offline storage. The system includes error detection and correction. Plessey Peripheral Systems, 17466 Daimler, Irvine, CA 92714.

Circle 243 on Inquiry Card

LOW PROFILE T-1¾ SHORT-LENS LEDS

Featuring 5.33-mm long encapsulations, the X-90B series subminiature tapered LEDs are designed for high efficiency, low current operation. Light-color outputs of red, green, yellow, and orange are available in 4 models each, offering variable luminous intensities ranging up to 12 mc at 10 mA in clear orange, and total half-intensity viewing angles up to 80° in diffuse-lens styles. The light source offers guaranteed min luminous intensity, which is variable upon light-color output and lens diffusion. Max ratings of continuous forward current are 100 mA for red and 35 mA for green, yellow, and orange. Power dissipation for red is 180 mW and 105 mW for green, yellow, and orange. Storage and operating temps range from -55 to 100 °C. Silver plated leads eliminate most common solderability problems; the cathode lead is 25.40 mm long and the anode lead is 26.67 mm long. The low profile, high output, solid state lamp is suited to instrument control panels. Electrical characteristics include a response time of 50 ns. Chicago Miniature Lamp Works, General Instrument Corp, 4433 N Ravenswood Ave, Chicago, IL 60640.

Circle 244 on Inquiry Card

SOLDER PIN INDICATOR LIGHTS

C-series incandescent (CE and CJ), LED (CW and CY), and neon (CS and CT) lamps are equipped with 0.040" - 0.001" (1.016 ±0.025-mm) dia brass tin plated terminals with 0.401" (10.165-mm) straight or 0.318" (8.077-mm) right angle pins. Indicators fit into 0.290" (7.366-mm) dia holes. Housings are made of anodized aluminum with high dielectric molded nylon headers. Reliability ranges from 1k to 60k hours depending on type and voltage. Genisco Technology Corp, Eldema Div, 18435 Susana Rd, Compton, CA 90221.

Circle 245 on Inquiry Card

Customized

sub-fractional horsepower DC motors

Buehler Products, Inc. offers a complete line of permanent magnet DC motors that are performance rated to your specific application for maximum cost effectiveness. These customized, long life Buehler motors are available with a wide variety of options in voltage, current, torque, speed, electrical connections, and frame size. They're used worldwide in office products, business machines, cameras, computer peripherals, tape recorders, marine and automotive applications. Write for full details on the Buehler FPH motor line.

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CIRCLE 172 ON INQUIRY CARD
CIRCLE 173 ON INQUIRY CARD
DEVELOPMENT

MICROPROGRAM DEVELOPMENT SYSTEM

For high speed emulation of P/ROMs, the DS50 can be configured with RAMs of various sizes. Microprogram debugging capabilities such as break and trace are options. The unit may be loaded and edited via keyboard or RS-232 interface. Cassette drive for load, dump, and verify is optional. Control memory size varies from 1 k x 16 to 4k x 64. Currently available RAM speeds range from 20 to 150 ns, with total unit access time down to 34 ns.

Circle 246 on Inquiry Card

FIBER OPTIC DATA LINK

Both receiver and transmitter of OTD-500 data system are packaged in a 0.5" (1.3-cm) high 24-pin DIP for board to board applications. Transmitter features a driver circuit with GaAs (infrared) LED emitter; the receiver features miniature hybrid construction. TTL compatible Op-Tec Link™ offers max noise immunity through adjustable control. A 5-ft (1.5-m) fiber optic cable is std. Operating voltage is 5 V typ. Opto Technology, Inc, 1674 S Wolf Rd, Wheeling, IL 60090.

Circle 247 on Inquiry Card

SINGLE-BOARD CONTROLLER FOR PDP-11/FOUR DISC DRIVES

Emulating the DEC RM-02 controller, the 3211 controller provides compatible formats and interchangeable media without changes to the software disc driver of the host operating system. Up to 4 SMD type drives in any mix of capacities can be interfaced to a DEC PDP-11 series computer. The host resident controller handles data rates from 806k to 1.2M bytes/s. A 32-bit ECC, overlapping seeks, sector interleaving, and multiple sector transfers are featured. Ball Computer Products, 860 E Arques Ave, Sunnyvale, CA 94086.

Circle 248 on Inquiry Card

14-BIT D-S CONVERTER

Driving up to 3 size 11 torque receiver synchros with ±6-min accuracy, the 4.5 x 9.25 x 1" (11.4 x 23.5 x 3-cm), 400-Hz units accept a 14-bit natural binary angle and convert it into 3-wire synchro or 4-wire resolver signals. Output is short circuit protected and current limited. Loading of 5 VA is std. DSC40-PC-L-1 requires a 26-V reference, as well as ±15 V at 375 mA and 5 V at 50 mA. Computer Conversions Corp, 6 Dunton Ct, East Northport, NY 11751.

Circle 249 on Inquiry Card

RACK MOUNTABLE INSTRUMENT PRINTER

Model 5019 is a rack mounted OEM version of the 5020 printer. It offers 5 x 7 dot matrix printing of any character set programmed into the character generator P/ROM. Unit prints 32 char/line line at up to 2 lines/s. Printing mechanism life time is more than 2 x 10⁶ lines; printhead life is more than 7 x 10⁶. Input may be ASCII or BCD. The 5.22 x 8.39" (13.25 x 21.31 cm) printer fits into almost any instrument application. Kontron Electronic Inc, 700 S Claremont St, San Mateo, CA 94402.

Circle 250 on Inquiry Card

MINIATURE DC-DC POWER CONVERTERS

DCE series of 8 models offers accurate 0.02% max error regulated outputs with low noise, 1 mV rms. High attenuation input filter reduces kickback spikes, noise, and reflected ripple caused by inverter switching. I/O isolation impedance of 10⁹ Ω and voltage isolation of 300 Vdc permit separation of the output circuit from the dc bus. Inputs of 5, 12, 15, 24, and 28 Vdc convert to outputs of ±15 and ±12 Vdc at 150-mA output current. Intronic, 57 Chapel St, Newton, MA 02158.

Circle 253 on Inquiry Card

EPROM COPIER

A standalone EPROM programmer copies from 1 to 4 1k, 2k, and 4k EPROMS. Model EP-2A-88 offers copy modules for duplicating 2758, 2732, TMS 2508, TMS 2516, 2716, and 2732 EPROMS. A single pushbutton control initiates the complete programming cycle, ensuring that each EPROM is erased, programmed, and verified. Status of the LED indicators is on when the programming is completed, flashing if the EPROM was not erased, and off if the EPROM was erased but did not program. Optimal Technology, Inc, Blue Wood 127, Earlysville, VA 22936.

Circle 254 on Inquiry Card
Bit-Pad One

Beginning with the digitizer, of which it is the world's largest and most experienced manufacturer, Summagraphics has developed a complete range of graphic systems for both the OEM and end user.

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**Preprocessing systems** for remote job entry. Datagrid II, Systems 1 and 2, are designed for off-line digitizing and storage for subsequent entry into any graphic system or data base.

**Stand-alone computer-aided drafting systems.** Datagrid II, Systems 3 and 4, are complete systems that provide computer processed solutions to a variety of drafting applications.

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- [ ] My phone number is ( ) ____________________

- [ ] Digitizers
- [ ] Preprocessing for remote job entry
- [ ] Intelligent digitizers
- [ ] Stand-alone graphics systems

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CIRCLE 174 ON INQUIRY CARD
Power Supplies
Selection guide lists electrical and mechanical specs, and includes outline drawings and photos for PC board and chassis mounting miniaturized power modules, and for plug-in, programmable, and unregulated power supplies. Acopian Corp, Easton, Pa.
Circle 300 on Inquiry Card

Modular Power Supplies
Catalog features dc-dc converters, switching supplies, and a 4-output microprocessor unit; included are specs, pin configurations, and dimensional drawings for each. Calex Manufacturing Co, Inc, Pleasant Hill, Calif.
Circle 301 on Inquiry Card

Capacitors, Filters, and Relays
Dimensional drawings, photos, specs, and tables provided in catalog supply details on aluminum electrolytic, ac, film-metallized, mica dielectric, and disc ceramic capacitors; emi filters; relays; and decade counters. Cornell-Dubilier, Newark, N.J.
Circle 302 on Inquiry Card

Dual Monolithic Transistors
Specs, pad designations, and performance and key parameters for matched pair transistors are outlined in catalog. Micro Power Systems, Inc, Santa Clara, Calif.
Circle 303 on Inquiry Card

EIA Cables
Color coded diagrams in catalog aid in selection of correct Clear Signal™ cable; also listed are transfer switches, gender changers, cable bridges, and junction panels. Inmac, Santa Clara, Calif.
Circle 304 on Inquiry Card

Bubble Memories
The concept of bubble memories, comparison with other memory devices, an examination of the 7110 and the 1M-bit bubble memories, and support electronics are presented in application note available from Intel Corp, 3065 Bowers Ave, Santa Clara, CA 95051.

Medium and High Speed Line Printers
Product slide rule presents condensed specs for hand, chain, train, and drum printers. Copies are available by letterhead request to Digital Associates Corp, 1039 E Main St, Stamford, CT 06902.

Universal P/ROM Programmer
Brochure lists specs, standard and optional features, and p/rom comparison chart for universal p/rom programmer; also described are paper tape reader, rom emulator, gang programming module, and uv erasable erasable. Digitronics Israel Ltd, Tel Aviv, Israel.
Circle 305 on Inquiry Card

Ceramic Magnets
Booklet explains ceramic magnet processes, includes table of properties, details approach to loud speaker magnet manufacturing, and describes capabilities of ceramic block and motor magnets. General Magnetic Co, Dallas, Tex.
Circle 306 on Inquiry Card

Programmable Motion Control
Brochure describes advantages and application possibilities of programmable products that can control motion in industrial processes; included are stepping motor control module, and absolute encoder input module. Gould Inc, Modicon Div, Andover, Mass.
Circle 307 on Inquiry Card

Noise Control Materials
Descriptions and photos are listed in bulletin for absorption, barrier, and damping types of materials. The Soundcoat Co, Brooklyn, N.Y.
Circle 308 on Inquiry Card

Propeller and Tubexial Fans
Illustrated catalog supplies specs, dimensional drawings, and performance charts for 60-Hz, 400-Hz, multi-Hz, and dc-type Boxer and slim profile fans. IMC Magnetics Corp, Westbury, N.Y.
Circle 309 on Inquiry Card

Monolithic and Hybrid Data Converters
Handbook contains information on A-D and D-A converters, data acquisition systems, computer analog i/o peripherals, sample-holds, analog multiplexers, and op amps and includes data sheets for key products. Datel-Intersil, Mansfield, Mass.
Circle 310 on Inquiry Card

Positioning and Tracking Controls
Joysticks, trackballs, control grips, and interface electronics circuits are illustrated and described in catalog. Measurement Systems, Inc, Norwalk, Conn.
Circle 311 on Inquiry Card

Video Display Terminals And Printers
Brochure highlights Dumb-Terminal® console, smart editing terminal, semi-intelligent terminal, and Ballistic printer. Lear Siegler, Data Products Div, Anaheim, Calif.
Circle 312 on Inquiry Card

Telecommunications and Voice Readout Systems
Design and operational specs for programmable voice readout system, voice response system, and automatic number announcer are among those supplied in catalog. Master Specialties Co, Costa Mesa, Calif.
Circle 313 on Inquiry Card

Logic Analysis Techniques
Ten applications illustrate the use of logic analyzers with system crashes, complex program tracing, asynchronous busses, and turn-on failures. Hewlett-Packard Co, Palo Alto, Calif.
Circle 314 on Inquiry Card

Components
Electrical characteristics and packaging specs for industrial linear ICs, vacuum fluorescent indicator panels, tantalum capacitors, and discrete semiconductors are furnished in catalog. NEC Electron, Inc, Santa Clara, Calif.
Circle 315 on Inquiry Card
Teach us a thing or two.

You know things we don't know.
Okay, so we're the leader in MOS and bipolar VLSI circuitry, sonar, spread-spectrum TDMA digital communication, electronically quiet radar, and much more.
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Ground Systems Group
Professional Employment Dept. DC-3
1901 W. Malvern Ave.
Fullerton, CA 92634

CIRCLE 175 ON INQUIRY CARD
Stepper Motors
Technical guide explains technology, offers applications notes and formulas, and provides torque vs. step rate graphs, wiring diagrams, and dimensional drawings for 12 series of motors. Airpax/North American Philips Controls Corp., Cheshire, Conn. Circle 316 on Inquiry Card

Wire Wrapping and Electronics
Catalog includes wire wrapping and electronic assembly tools and parts for both industrial and hobby users. OK Machine and Tool Corp., Bronx, N.Y. Circle 317 on Inquiry Card

Wiring Accessories
Bulletin includes material specs, product descriptions, dimensional drawings, and packaging information for mounting accessories, harness board accessories, and cable tie installation tools. Panduit Corp., Tinley Park, Ill. Circle 318 on Inquiry Card

Computer Aided Design And Manufacturing
Brochure describes the capabilities of the interactive design, drafting, and manufacturing computer aided graphics system which features finite element analysis, hidden line removal, and drawing layout capabilities. Calma, Sunnyvale, Calif. Circle 319 on Inquiry Card

Uninterruptible Power Systems
Bulletin describes rectifier/charger, inverter, and static switch subassemblies of PWM UPS and details performance during normal operation, ac line failure, and after ac line restoration. Cyberex, Inc., Mentor, Ohio. Circle 320 on Inquiry Card

Wire and Cable
Specs, illustrations, and applications information on line of wire and cable, insulation, cordsets, and electronic accessory products are furnished in catalog. Dearborn Wire and Cable Co., Rosemont, Ill. Circle 321 on Inquiry Card

Magnetic Bubble Memory Devices
Illustrated sections of primer explain the principles of the magnetic bubble memory; also detailed are loop organizations and necessary peripheral circuitry. Fujitsu America, Inc., Lake Bluff, Ill. Circle 322 on Inquiry Card

Information Systems Seminars
Course objectives, course outline, and instructor biography are given in catalog which supplies seminar schedule and enrollment information. Datapro Research Corp., Delran, N.J. Circle 323 on Inquiry Card

Data Monitor
Data sheet illustrates 802A that monitors and stores data for lines up to 56k bits/s and describes operation, special features, and preliminary specs. Halcyon, San Jose, Calif. Circle 324 on Inquiry Card

Lighted Pushbutton Switches
Dimensional drawings, mounting diagrams, switch actuation, bezel styles, lenses, and color options for instrument grade, heavy duty, and oil and watertight switches are given in catalog. EAO Switch Corp., Milford, Conn. Circle 325 on Inquiry Card

Automatic Test Equipment
Test equipment ranging from benchtop manual units to microprocessor based units capable of testing up to 16k points at the rate of 1K points/s are described, and their operating modes listed in brochure. Mtrhead Addison, Mountainside, N.J. Circle 326 on Inquiry Card

Power Line Disturbance Analyzer
Brochure supplies specs and a typical printout for series 606 ac power line analyzer that prints data on impulse, saa, surge, and slow average voltages. Dranetz Engineering Laboratories, South Plainfield, N.J. Circle 327 on Inquiry Card

Thick Film Thermal Printheads
Application report illustrates how printing rate can be maximized by using external means to compensate for the inherent physical properties of the printing element. Gulton Industries, Inc., Metuchen, N.J. Circle 328 on Inquiry Card

Humidifiers
Survey sheet discusses how proper humidification during heating season can reduce static electricity and contribute to increased efficiency of desktop minicomputers. Research Products Corp., Madison, Wis. Circle 329 on Inquiry Card

Communications Test Set

Data Communication Products
Catalog features the Hawk 4000 series Datatraps that provide a CRT display of online data communications; also described are Range Rider data test sets, and cables. International Data Sciences, Inc., Lincoln, Neb. Circle 331 on Inquiry Card

Miniature and Subminiature Switches
Included in catalog are dimensional drawings, electrical specs, plus descriptions of miniature and subminiature toggle, pushbutton, rocker, slide, rotary, push, and precision switches. Impact Electrical Products, Inc., Beaverton, Ore. Circle 332 on Inquiry Card

LCD Circuits
Wall chart features range of LCD watch and clock circuits for radios, alarms, and automobiles, outlining each circuit with simulated displays and list of functions. Oki Semiconductor, Santa Clara, Calif. Circle 333 on Inquiry Card
Intertel
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# Guide to Product Information

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