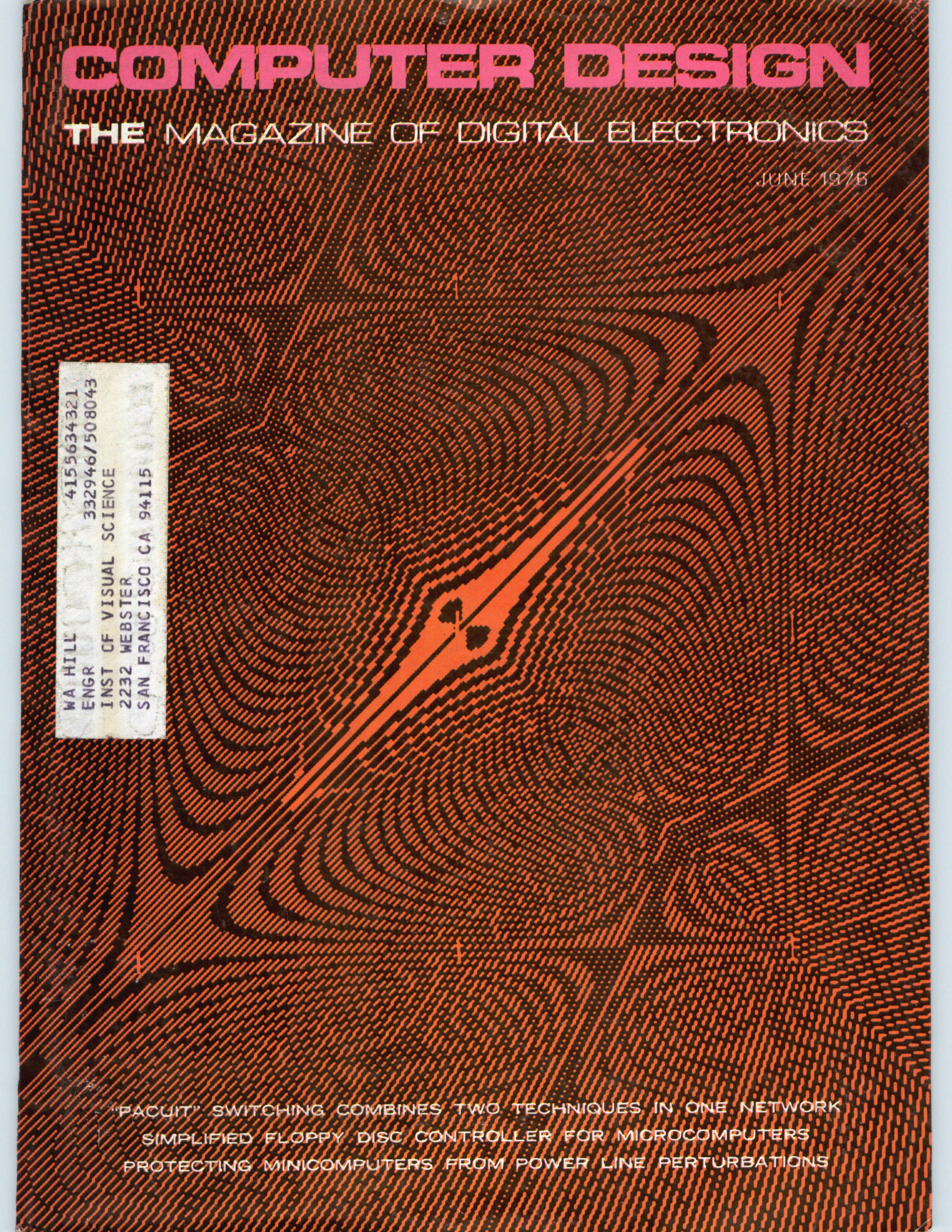
COMPUTER DESIGN

THE MAGAZINE OF DIGITAL ELECTRONICS

JUNE 1976

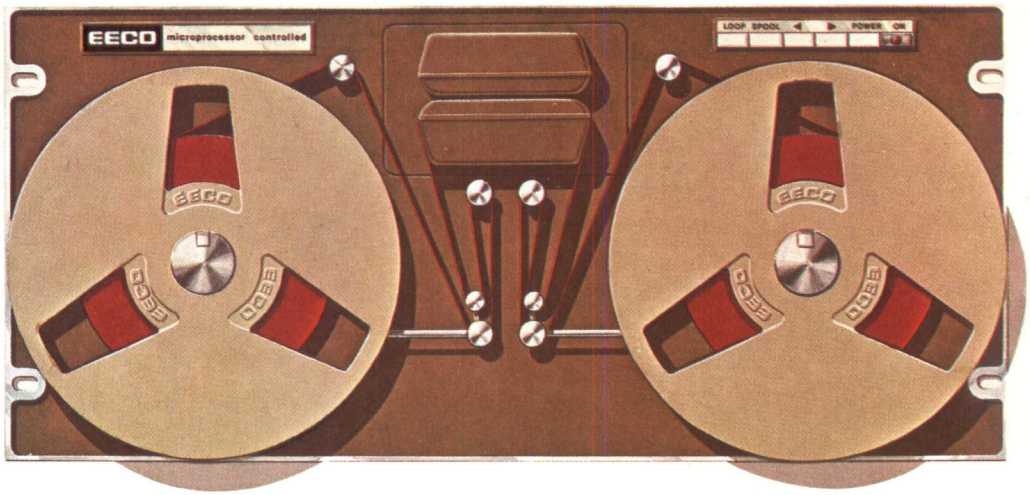


WA HILL 4155634321
ENGR 332946/508043
INST OF VISUAL SCIENCE
2232 WEBSTER
SAN FRANCISCO CA 94115

"PACUIT" SWITCHING COMBINES TWO TECHNIQUES IN ONE NETWORK

SIMPLIFIED FLOPPY DISC CONTROLLER FOR MICROCOMPUTERS

PROTECTING MINICOMPUTERS FROM POWER LINE PERTURBATIONS



This new microprocessor controlled

reader/spooler will read
1000 characters per second,
and still provide *stop on character.*
All of its reader/spooler functions,
such as starting,
stopping,
rewind speed (1500 c/s),
data output,
and interface timing
are controlled by a program
stored in
its microprocessor memory.
Its other advantages lie in the areas of
reading reliability,
high speed stopping,
programmed soft stopping,
the spooler system,
and equipment reliability.
It also includes
step and slew modes, and
a priority interrupt mode.
And like other EECO readers
it boasts LED
and phototransistor optoelectronics,
a step motor drive,
a full tape-width barrel sprocket,
handshake interface logic,
and TTL and DTL compatible electronics.
But wait, we can't sell you one now,
because it won't be shippable until
after the National Computer Conference.*
We're telling you now
just so you
can make plans.
The best is yet to come.

*First public showing.

EECO

READERS/PACKAGING/SWITCHES

1441 East Chestnut Avenue, Santa Ana, California 92701 Phone 714/835-6000

CIRCLE 1 ON INQUIRY CARD

Introducing Model 9300
Quality that's Quick & Quiet

Model 9300 Vacuum Column digital tape transport has characteristics common to all Kennedy recorders — and a few new ones. It's quick (125ips); quiet (noise level of less than 70db), and it has the built-in quality of all Kennedy products.

Utilizing side-by-side vacuum columns and a capacitive tape-location detector for improved tape life; air bearings and Tribaloy coated read-after-write heads to reduce tape wear and improve data integrity, Model 9300 is ideal for minicomputer and data collection applications requiring complete reliability at high tape speeds.

Model 9300 comes complete with all the operational features of the 9000 Series. Performance is guaranteed by crystal controlled timing, read threshold scanning, our read-after-write shortened skew gate and other exclusive Kennedy features. Operation is simplified by such operator-oriented features as a front-accessible test panel, quick-release hubs and simplified tape loading.

Model 9300 has a standard tape speed of 125ips, with data densities of 200/556cpi or 556/800 on the 7-track unit and 800cpi, 1600cpi or 800/1600cpi on the 9-track transport. The format is NRZI/PE.

Model 9300 is not only quick and quiet — it's very competitive. That's quite a lot, considering the Kennedy quality.

KENNEDY CO.
540 W. WOODBURY RD., ALTADENA, CALIF. 91001
(213) 798-0953

KENNEDY · QUALITY · COUNT ON IT

CIRCLE 2 ON INQUIRY CARD

This Tally printer knows the shortest way to double or triple your throughput.

You get there faster if you don't have as far to go. Tally's Model T-1202 optimized bi-directional serial printer prints left to right and right to left while its microprocessor looks ahead for the shortest path to the next line of print. These short cuts add up fast to slash your throughput time by two to three fold. (Of course, throughput savings are tied directly to the amount of white space in your format.)

"Optimized" means moving the print head—left or right—to pick up the closest character on the next print line. There's no lost time with conventional carriage returns. And coupled with a 7 ips slew speed, the T-1202 moves the print head at an accelerated rate to the next print position.

And remember, you get this bonus throughout without taxing the machine—the printing rate remains at 120 characters per second so you haven't sacrificed reliability or increased wear.

The Model T-1202 is the newest member of the T-1000 Series —Tally's fine line of serial printers that offer microprocessor electronics, low acoustic noise level, digitally controlled print head advancement, dual tractor engagement and a convenient snap-in ribbon cartridge.

There's more to tell, so call your nearest Tally sales office.
Tally Corporation, 8301 S. 180th Street, Kent, WA 98031.
Phone (206) 251-5524.

OEM Sales Offices:
New York (516) 694-8444
Boston (617) 742-9558
Chicago (312) 956-0690
Seattle (206) 251-6730
Los Angeles (213) 378-0805
San Francisco (408) 245-9224
Business Systems Sales Offices:
Eastern Region (201) 671-4636
Western Region (415) 254-8350

TALLY

CIRCLE 3 ON INQUIRY CARD

THE
MAGAZINE
OF DIGITAL
ELECTRONICS

COMPUTER DESIGN

JUNE 1976 • VOLUME 15 • NUMBER 6

Front cover computer-generated graphic display courtesy Magnavox Display Systems.

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BPA CIRCULATION OVER 55,000

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by Joe de Smet and Ray W. Sanders

Combining the attributes of voice-grade dial networks with those of polled online call routing, this network approach provides an efficient yet flexible solution to the inefficient maze of overlapping data communications networks

91 SIMPLIFIED FLOPPY-DISC CONTROLLER FOR MICROCOMPUTERS

by Theodore H. Kehl and Lawrence Dunkel

Design of a simplified controller for floppy discs results in higher storage capacity and greater reliability, and adapts the units for use as mass storage media for microcomputers

99 PROTECTING MINICOMPUTERS FROM POWER LINE PERTURBATIONS

by Rex M. Teets

Protecting minicomputers from malfunctions due to the primary power source is now feasible using UPS equipment that incorporates ICs and power semiconductors to reduce cost and size, and increase reliability and efficiency

106 USING A MICROPROCESSOR AT SPEEDS BEYOND ITS APPARENT INTRINSIC LIMIT

by Milt Schwartz and Keith Winter

By using a cycle stealing approach along with standard communications methods, maximum system throughput can be achieved through optimized system resource allocation

130 MICROPROCESSOR CONTROL OF GRAPHICS TERMINAL PERMITS DISPLAY FLEXIBILITY

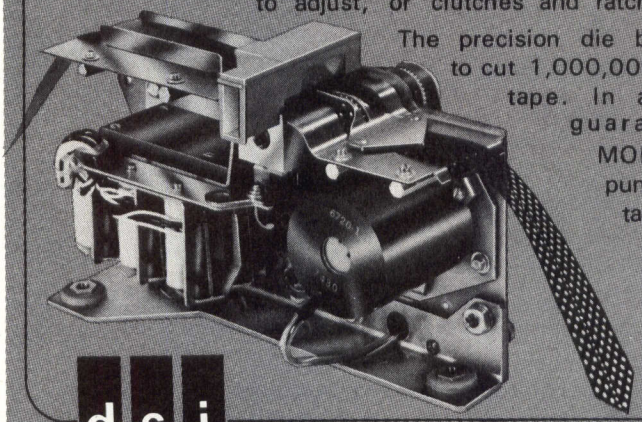
Interactive graphics terminal combines advantages of programmable microprocessor control with benefits of flicker-free plasma display

MODUPERF

The Ultimate in Design Simplicity

DSI has revolutionized the world of paper tape by perfecting MODUPERF; a tape punch built around four independent, field replaceable MODULES. Equipment down time is a thing of the past because the die block and/or data selector may be replaced in less than a minute, without any adjustments!

The whisper quiet MODUPERF employs design innovations that stress basic simplicity, thereby providing unsurpassed reliability, long life and compact size. No intermediate levers or linkages to adjust, or clutches and ratchets to repair.

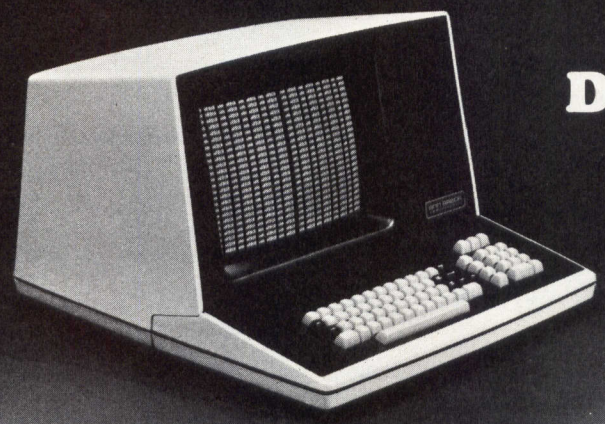


The precision die block is rated to cut 1,000,000 feet of paper tape. In addition, DSI guarantees that MODUPERF will punch **all** types of tape; i.e. MYLAR or paper, oiled or unoiled, folded or rolled.

dsi DATA SPECIALTIES, INC. 3455 Commercial Ave., Northbrook, IL 60062 (312) 564-1800

CIRCLE 21 ON INQUIRY CARD

Data Display: YOUR Way



Ann Arbor makes over 1000 standard RO and KSR display terminal models. Alphanumerics. Graphics. Or both.

We also thrive on *tough* CRT display applications. Unique character sets. Unusual graphics. Difficult interfacing. Custom keyboards. Special packaging. You name it.

Standard or custom, *every* terminal produced is based on a field-proven Ann Arbor engineering concept. DESIGN III desktop terminals to complement any office decor. Compact, rugged Series 200 modular terminals that defy industrial environments. Or barebones board sets for OEMs who prefer to roll their own.

Many companies sell CRT terminals. But Ann Arbor sells creative solutions to CRT display problems, as well.

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Contact us at 6107 Jackson Road, Ann Arbor, MI 48103. Tel: 313-769-0926 or TWX: 810-223-6033. Or see our catalog in EEM, Volume One.

ANN ARBOR TERMINALS, INC

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CIRCLE 5 ON INQUIRY CARD

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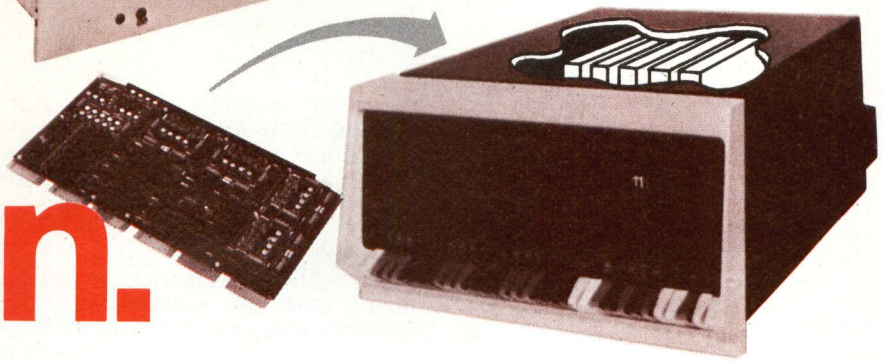
Add-on.

Add-in.



Mini-Memory. From Dataram.

Either way, you get more memory, more throughput, more performance. Everything but more cost.

If you're looking for a way to get more from your minicomputer without putting too much more into it, our family of ADD-ON/ADD-IN mini-memories adds up to the right answer for you.

We're Dataram Corporation, and as the only company dedicated exclusively to core memory products, we make all of our own core, sell raw core to the outside market, string in high volume in three offshore locations, supply stacks to minicomputer manufacturers, maintain our own extensive manufacturing capability, and market a complete line of systems.

Including our new, expanded family of ADD-ON/ADD-IN systems that's ready to go to work for your minicomputer:

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Nova 1200
Nova 1210
Nova 1220
Nova 1230
Nova 2/4
Nova 2/10
Nova 3/4
Nova 3/12

Interdata

Model 50
Model 55
Model 70
Model 74
7/16
7/32
8/32

DEC

PDP-8/A
PDP-8/E
PDP-8/F
PDP-8/M
PDP-11/05
PDP-11/10
PDP-11/15
PDP-11/20
PDP-11/35
PDP-11/40
PDP-11/45

DCC

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116E

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I'd like more answers about mini-memories for my _____ minicomputer.

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☐ Please have a salesman contact me.

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Title _____ Phone _____

Company _____

Address _____

City _____ State _____ Zip _____

CIRCLE 6 ON INQUIRY CARD

CALENDAR

CONFERENCES

July 12-16—CONF ON COMPUTER TECHNOLOGY — MICROPROCESSOR/COMPUTERS, Iowa State U, Ames, Iowa. INFORMATION: Conf Director, Roger Camp, 332 Coover Hall, Iowa State U, Ames, IA 50011. Tel: (515) 294-2663

July 13-15—ELECTROMAGNETIC COMPATIBILITY INTERNAT'L SYM, Washington, DC. INFORMATION: W. C. Green, W. C. Green Associates, 1625 Eye St, NW, Suite 1025A, Washington, DC 20006

July 14-16—SIGGRAPH 76 (CONF ON COMPUTER GRAPHICS, INTERACTIVE TECHNIQUES, AND IMAGE PROCESSING), Philadelphia, Pa. INFORMATION: SIGGRAPH 76, Gen'l Chm, Dr Thomas Johnson, Dept of Decision Science, U of Pennsylvania, Philadelphia, PA 19174

July 27-30—JOINT AUTOMATIC CONTROL CONF, Purdue U, Lafayette, Ind. INFORMATION: IEEE, Technical Activities Board, 345 E 47th St, New York, NY 10017. Tel: (212) 644-7500

Aug 10-12—4TH SYM ON THE SIMULATION OF COMPUTER SYSTEMS, Nat'l Bureau of Stds, Boulder, Colo. INFORMATION: Arthur F. Chantker, Nat'l Bureau of Standards, Technology Bldg, Rm A247, Washington, DC 20234

Aug 24-27—1976 INTERNAT'L CONF ON PARALLEL PROCESSING, Waldenwoods Resort and Conf Center, Waldenwoods, Mich. INFORMATION: Tse-yun Feng, Conf Chm, 1976 Internat'l Conf on Parallel Processing, College of Engineering, Wayne State U, Dept of Electrical and Computer Engineering, Detroit, MI 48202

Aug 31-Sept 2—1976 INTERNAT'L OPTICAL COMPUTING CONF, Capri, Italy. INFORMATION: Sam Horvitz, Gen'l Chm, Naval Underwater Systems Center, New London, CT 06320

Sept 7-10—COMPCON 76 (13TH IEEE COMPUTER SOCIETY INTERNAT'L CONF), Mayflower Hotel, Washington, DC. INFORMATION: Paul L. Hazan, Program Chm, The John Hopkins U, Applied Physics Lab, John Hopkins Rd, Laurel, MD 20810. Tel: (301) 953-7100, X449

Sept 8-10—INTERNAT'L SYM ON TECHNOLOGY FOR SELECTIVE DISSEMINATION OF INFORMATION, Palazzo dei Congressi, Republic of San Marino. INFORMATION: IEEE Computer Society, PO Box 639, Silver Spring, MD 20901

Sept 13-23—UISTA DATA COMMUNICATION CONF, Iowa State U, Ames, Iowa. INFORMATION: Conf Director, Paul Bond, 331 Coover Hall, Iowa State U, Ames, IA 50011

Sept 14-16—ELECTRO-OPTICS/LASER '76 CONF AND EXPOSITION, New York Hilton, New York City. INFORMATION: Industrial and Scientific Conference Management, Inc, 222 W Adams St, Chicago, IL 60606. Tel: (312) 263-4866

Sept 14-17—WESCON (WESTERN ELECTRONIC SHOW AND CONV), Los Angeles Conv Center, Los Angeles, Calif. INFORMATION: William C. Weber, Jr, WESCON Gen'l Mgr, 999 N Sepulveda Blvd, El Segundo, CA 90245. Tel: (213) 772-2965

Sept 20-22—CONVERGENCE 76, INTERNAT'L SYM ON AUTOMOTIVE ELECTRONICS AND ELECTRIC VEHICLES, Hyatt Regency Hotel, Dearborn, Mich. INFORMATION: J. M. Leahy, Micro Switch Div of Honeywell Inc, 17515 W Nine Mile Rd, Southfield, MI 48075. Tel: (313) 424-3744

Sept 21-23—JOINT CONF ON DATA PRIVACY AND DATA SECURITY, U of Linz, Austria. INFORMATION: Das Tagungsbüro der gemeinsamen, Fachtagung ÖGI und GI, "Datenschutz und Datensicherung," z.H. Herrn Dr Roland Traunmüller, Institut für Statistik und Informatik, Universität Linz, 4045 Linz/Auhof

Sept 22-24—APL76 CONF, Ottawa, Ontario. INFORMATION: Comshare Ltd, 304-11 Adelaide St W, Toronto, Ontario M5H 1M2 Canada

Sept 26-29—EASCON-76 (ELECTRONICS AND AEROSPACE SYSTEMS CONF), Stouffer's Nat'l Center Inn, Washington, DC. INFORMATION: EASCON-76, Suite 636, 821 15th St, NW, Washington, DC 20005. Tel: (202) 347-7088

Sept 28-30—CANADIAN COMPUTER SHOW-SALON DE L'ORDINATEUR, Place Bonaventure, Montreal. INFORMATION: Show Mgr, Derek A. Tidd, Industrial and Trade Shows of Canada, 481 University Ave, Toronto, Ontario M5W 1A7 Canada

SEMINARS

Aug 8-13—SYSTEM DESIGN USING MICRO/MINICOMPUTERS; INTRODUCTION TO MICRO/MINICOMPUTERS; MICROCOMPUTERS—PRINCIPLES AND APPLICATIONS, Aug 8-11—MODERN SIGNAL PROCESSING DESIGN TECHNIQUES, Aug 11-13—DESIGN AND PRODUCTION OF HYBRID CIRCUITS, Pheasant Run Lodge, St. Charles, Ill. INFORMATION: National Engineering Consortium Registrar, 1301 W 22nd St, Oak Brook, IL 60521. Tel: (312) 325-5700

Aug 24-25—INDUSTRIAL APPLICATIONS OF HIGH POWER LASER TECHNOLOGY, Aug 26-27—PRACTICAL APPLICATIONS OF LOW POWER LASERS, Town and Country Hotel, San Diego, Calif. INFORMATION: Society of Photo-Optical Instrumentation Engineers, PO Box 1146, Palos Verdes Estates, CA 90274

Sept 12-24—NATO ADVANCED SUMMER INSTITUTE ON COMPUTER ARCHITECTURE, Saint Raphael, France. INFORMATION: Prof Douglas Lewin, Brunel U, Dept of Electrical Engineering and Electronics, Uxbridge, Middlesex UB8 3PH, England

Sept 23-25—MICROCOMPUTER INTERFACING WORKSHOP, VPI and SU, Blacksburg, Va. INFORMATION: Dr Norris Bell, Virginia Polytechnic Institute and State University, Continuing Education Center, Blacksburg, VA 24061. Tel: (703) 951-6328

SHORT COURSES

July 12-13—MINICOMPUTER PROGRAMMING AND INTERFACING TECHNIQUES, George Washington U, Washington, DC. INFORMATION: Director, Continuing Engineering Education, George Washington U, Washington, DC 20052. Tel: (202) 676-6106

July 12-16—DIAGNOSIS AND FAULT TOLERANT DESIGN OF DIGITAL SYSTEMS, July 26-30—MICROCOMPUTER SYSTEMS DESIGN I: HARDWARE, SOFTWARE, AND APPLICATIONS, Aug 2-6—MICROCOMPUTER SYSTEMS DESIGN II: APPLICATIONS, PROGRAMMING, AND IMPLEMENTATION—THROUGH ACTUAL EXPERIENCE, U of Southern California, Los Angeles. INFORMATION: U of Southern California, Continuing Engineering Education, Powell Hall, University Park, Los Angeles, CA 9007. Tel: (213) 746-6708

July 12-16—MICROPROCESSOR APPROACH TO SYSTEM DESIGN, Aug 2-6—RELIABLE OPERATING SYSTEMS: BREAKTHROUGHS, UCLA, Los Angeles, Calif. INFORMATION: Continuing Education in Engineering and Mathematics, Short Courses, 6266 Boelter Hall, UCLA Extension, Los Angeles, CA 90024. Tel: (213) 825-1295

Aug 2-6—COMPUTER ORGANIZATION AND PROGRAMMING, Aug 23-27—MICROPROGRAMMING, Georgia Institute of Technology, Atlanta. INFORMATION: Director, Dept of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332. Tel: (404) 894-2400

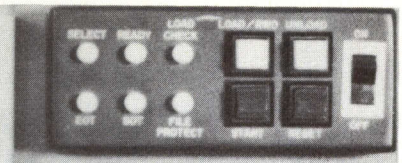
Aug 9-13—COMMUNICATING TECHNICAL INFORMATION, MIT, Cambridge, Mass. INFORMATION: Director of the Summer Session, Rm E19-356, Massachusetts Institute of Technology, Cambridge, MA 02139

Six smart reasons that make the MDS 4025 Tape Drive the Intelligent Choice.

Just a few of the reasons why over 5000 units are satisfying customers around the world.

125 ips The fastest speed ever achieved in a unit this compact (23½"x19"x19"). To preserve tape durability and data quality, the tape comes in contact only with the read/write head and the tape cleaner.

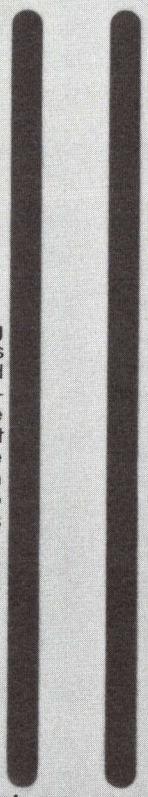
500 ips rewind The quickest rewind speed a machine this size has ever been able to offer. During high speed rewind, tape flies out of contact with the head and cleaner. Consequently, tape wear is minimized.



Air bearings The MDS 4025 features air bearings at all tape turnaround points. The tape travels on a pillow of air, so the edge wear and tape friction commonly produced by roller bearings are eliminated.

Automatic threading system Quick. Transports automatically thread and load all industry hub-compatible reels. Error-free. Tape safety sensors are located at strategic points throughout the threading system—a system that MDS has engineered to proven perfection in thousands of tape drive units world-wide.

For your consideration, IBM-type wraparound cartridges are available as an option.



Linear reel servo sensor system Molded vacuum column sensor rails and photoelectric sensors create the simplest (and therefore, most reliable) reel servo sensor system on the market today. Linear photoelectric solid state limit sensing in the vacuum columns results in precise tape position indication. In addition, gentle, stable program-restriction-free tape handling is provided at all speeds, including high speed rewind.

Volume production Mohawk Data Sciences is recognized as a leader in the OEM equipment field. Our 4025 Tape Drives are highly regarded for their unsurpassed quality and performance record. It's no wonder that the largest OEM companies have installed over five thousand 4025 Systems to date. Proven quality. Proven capability. MDS turns smart reasons into many intelligent choices.

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(617) 890-5870	(315) 867-6472	(714) 772-0803

See us at Booth Numbers 3321-23-25, at the NCC, N.Y. Coliseum, June 7-10.

For more smart reasons about the MDS 4025 Tape Drive, call or write your nearest MDS OEM Sales Office.

Mohawk MDS Data Sciences
The Intelligent Choice.

CIRCLE 7 ON INQUIRY CARD

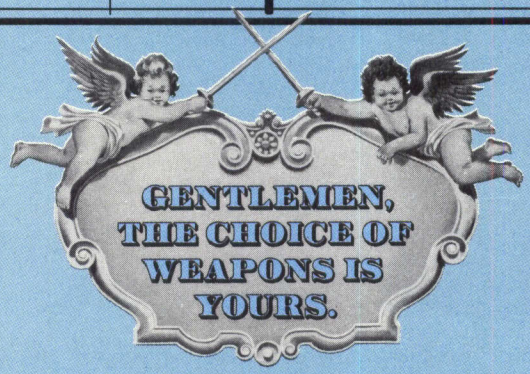
The Battle of the 80's

Think of your next microcomputer as a weapon against horrendous inefficiencies, outrageous costs and antiquated speeds. We invite you to peruse this chart.

Features:	8080A	Z80-CPU
Power Supplies	+5, −5, +12	+5
Clock	2Φ, +12 Volt	1Φ, 5 Volt
Standard Clock Speed	500 ns	400 ns
Interface	Requires 8222, 8228 & 8224	Requires no other logic and includes dynamic RAM Refresh
Interrupt	1 mode	3 modes; up to 6X faster
Non-maskable Interrupt	No	Yes

Features:	8080A	Z80-CPU
Instructions	78	158*
OP Codes	244	696
Addressing Modes	7	11
Working Registers	8	17
Throughput	Up to 5 times greater than the 8080A	
Program Memory Space	Generally 50% less than the 8080A	

*Including all of the 8080A's instructions.



Announcing Zilog Z-80 microcomputer products. With the next generation, the battle is joined.

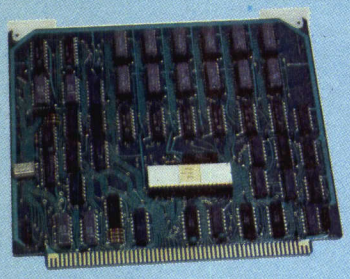
The Z-80: A new generation LSI component set including CPU and I/O Controllers.

The Z-80: Full software support with emphasis on high-level languages.

The Z-80: A floppy disc-based development system with advanced real-time debug and in-circuit emulation capabilities.

The Z-80: Multiple sourcing available now.

Your ammunition: A chip off a new block.



A single chip, N-channel processor arms you with a super-set of 158 instructions that include *all* of the 8080A's 78 instructions with *total* software compatibility. The new instructions include 1, 4, 8 and 16-bit operations. And that means less programming time, less paper and less end costs.

And you'll be in command of powerful instructions: Memory-to-memory or memory-to-I/O block transfers and searches, 16-bit arithmetic, 9 types of rotates and shifts, bit manipulation and a legion of addressing modes. Along with this army you'll also get a standard instruction speed of 1.6 μs and all Z-80 circuits require only a single 5V power supply and a single phase 5V clock. And you should know that a family of Z-80 programmable circuits allow for direct interface to a wide range of both parallel and serial interface peripherals and even dynamic memories without other external logic.

With these features, the Z80-CPU generally requires approximately 50% less memory space for program storage yet provides up to 500% more throughput than the 8080A. Powerful ammunition at a surprisingly low cost and ready for immediate shipment.

Mighty weapons against an enemy entrenched: The Z-80 development system.

You'll be equipped with performance and versatility unmatched by any other microcomputer development system in the field. Thanks to a floppy disc operating system in alliance with a sophisticated Real-Time Debug Module.

The Zilog battalion includes:

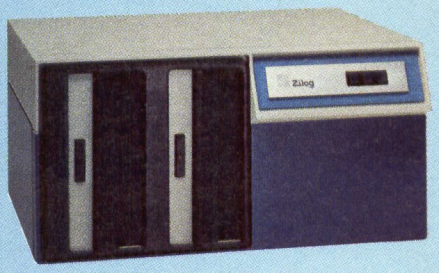
- Z80-CPU Card.
- 16K Bytes of RAM Memory, expandable to 60K Bytes.
- 4K Bytes of ROM/RAM Monitor software.
- Real-Time Debug Module and In-Circuit Emulation Module.
- Dual Floppy Disc System.
- Optional I/O Ports for other High Speed Peripherals are also available.
- Complete Software Package including Z-80 Assembler, Editor, Disc Operating System, File Maintenance and Debug.

On standby: Software support.

All this is supported by a contingent of software including: resident microcomputer software, time sharing programs, libraries and high-level languages such as PL/Z.

On standby: User support.

Zilog conducts a wide range of strategic meetings and design oriented workshops to provide the know-how required to implement the Z-80 Microcomputer Product line into your design. All hardware, software and the development system are thoroughly explained with "hands-on" experience in the classroom. Your Zilog representative can provide you with further details on our user support program.



Reinforcements: A reserve of technological innovations.

The Zilog Z-80 brings to the battlefront new levels of performance and ease of programming not available in second generation systems. And while all the others busy themselves with overtaking the Z-80, we're busy on the next generation—continuing to demonstrate our pledge to stay a generation ahead.

The Z-80's troops are the specialists who were directly responsible for the development of the most successful first and second generation microprocessors. Nowhere in the field is there a corps of seasoned veterans with such a distinguished record of victory.

Signal us for help. We'll dispatch appropriate assistance.

Zilog MICROCOMPUTERS

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CIRCLE 8 ON INQUIRY CARD

AN AFFILIATE OF EXXON ENTERPRISES INC.

COMMUNICATION CHANNEL

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

Satellite Business Systems

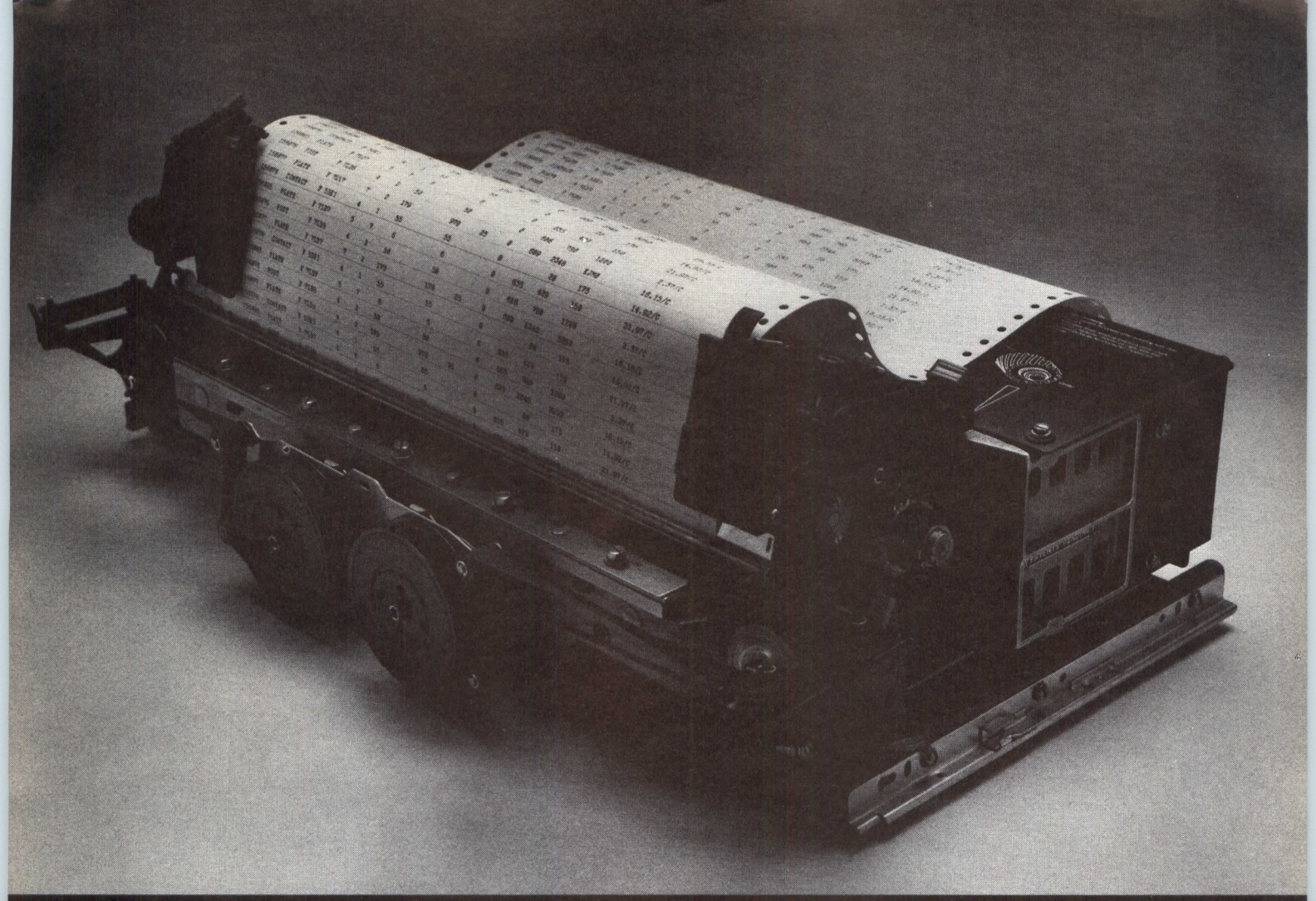
Beginning with the 1968 Carterfone Decision, the telecommunications industry has been shaken continually by a number of major decisions and events relating to the emergence of customer provided communications equipment, and encompassing both equipment and facilities. Direct marketing of private telephone systems by interconnect companies in competition with traditional communications common carriers, as well as the liberalization for user-owned equipment, have been visible factors in this rapidly changing environment. In addition, considerable attention has been given to the formation and licensing of competing carriers.

A recent entry into the telecommunications area is a company called Satellite Business Systems (SBS). The fact that SBS is jointly owned by Comsat General, Aetna Life and Casualty Company, and IBM puts it in a unique position in the specialized common carrier field. The SBS domestic satellite system, which is not expected to be in operation until 1979, will be in direct competition with AT&T. This company's satellites will operate in the 12- to 14-GHz spectrum, frequencies at which it is possible to design and implement earth stations at relatively low cost. Present earth stations have been characterized by their high cost; a compatible SBS station, however, has been estimated to cost approximately $2000, which is equivalent to the cost of many modems available today.

Rather than operating with a few fixed stations, such as the Westar satellite system, SBS satellites are to be designed to accommodate many dispersed stations. Any SBS customer could then economically install and operate a private earth station without a major economic penalty.

It is anticipated that SBS initially will provide only leased line facilities following the same marketing philosophies as those of previous carriers. However, once the SBS satellite network is established, it is expected that switched services analogous to Direct Distance Dial (DDD) will also be offered. SBS would not be the first common carrier to expand its initial services from leased line to include both leased and switched communications services. In the fall of 1975, MCI, the first of the specialized common carriers, announced a "shared service" called Execunet. For regulatory purposes, however, MCI is not actually providing switched facilities; yet to the user, Execunet's operational appearance is like a switched service.

One of the major concerns voiced by various manufacturers of data communications equipment is that IBM may be able to create a closed information system with a significant economic incentive to the user. In both past and present practice,



132 columns. Over 300 lines per minute. Under $2000.*

In printers, it's not just a question of how much they cost, but one of how much you get for your money. And on a price/performance basis, nothing even comes close to the Teletype® model 40 OEM printer.

Besides getting a 132-column, heavy-duty impact printer that delivers over 300 lpm for less than $2000, you also get a printer with outstanding flexibility and reliability.

The big reason behind the model 40's price/performance advantage over the competition is our unique design. Even though it operates at speeds over 300 lpm, wear and tear is less than you'd find in a conventional printer operating at a much slower speed. Fewer moving parts and solid-state components add up to increased reliability and reduced maintenance.

We'd be ahead if we just stopped there, but the model 40 also offers you a number of other features. Like a choice of character sets, operator-adjustable form width and form length, parity error indication, and a built-in self-test feature, just to name a few.

For complete information, please contact our Sales Headquarters at: 5555 Touhy Ave., Skokie, Ill. 60076. Or call Terminal Central at: (312) 982-2000.

TELETYPE

The Teletype model 40 OEM printer. Nothing even comes close.

Teletype is a trademark and service mark registered in the United States Patent and Trademark Office.
*80-column-version available for under $1400.

CIRCLE 9 ON INQUIRY CARD

Intel Zilch.

1. To be announced.

2. To be announced.

3. To be announced.

4. To be announced.

5. To be announced.

6. To be announced.

7. To be announced.

National 7.

1. NS3 Bulk Storage Memory System (General Purpose).
2. NS3000-1 Memory Storage Card (General Purpose).
3. NS21 Memory Storage Card (for all HP 21MX Computers).
4. NS32 Memory System (for special graphics terminal used in simulation).
5. MOSRAM 410 (General Purpose).
6. PAC 216 (for Pacer Microprocessor).
7. MOSRAM 6800 (for Motorola 6800 Microprocessor).

While Intel may have terrific memory systems thinking, we've got something considerably more useful: Memory systems.

Standard systems, to replace core memories. Add-on systems, to increase memory capacity.

Custom systems, for the microprocessor of your choice.

All carefully designed.
All thoroughly tested.
And, most of all, for real.

National Semiconductor, Memory Systems Division
2900 Semiconductor Drive, Santa Clara, CA 95051 CD6
Gentlemen:
Off-the-shelf memory systems, eh? Send me your data sheets. And tell me where you've been all my life.

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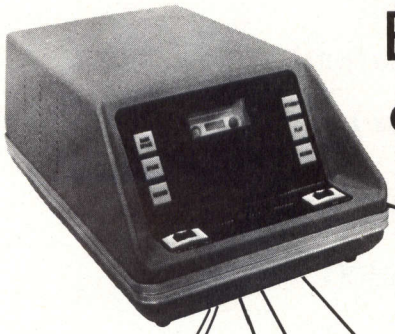
National Semiconductor Memory Systems

IBM has limited its data processing support to data communications products and software, reflecting its own procedures and transmission formats. The popularity of Binary Synchronous Communications procedures (BSC) and later SDLC procedures has been prompted primarily by IBM's ability to significantly influence a major segment of the data processing community, rather than by operational advantages. A major concern of competitive suppliers, including independent equipment manufacturers and AT&T, is that SBS may be structured to provide major cost advantages if the user employs only IBM protocols and equipment.

receive! send! store!
.... with TermiCette –
in Data Collection and Transmission, TermiCette with EIA interface does it all!



- **DECKWRITER II**
  One of the many terminal printers available.

- **OCR WAND**
  Reads standard OCR "A" font.

- **BAR CODE READER**
  UPC and other codes available.

- **CALCULATOR**
  Multiple function calculator with printer and display.

- Remote Polling
- Retransmit
- Automatic Printout
- Unattended Operation

icp
INTERNATIONAL COMPUTER PRODUCTS, INC.
2925 Merrell Road • Dallas, Texas 75229

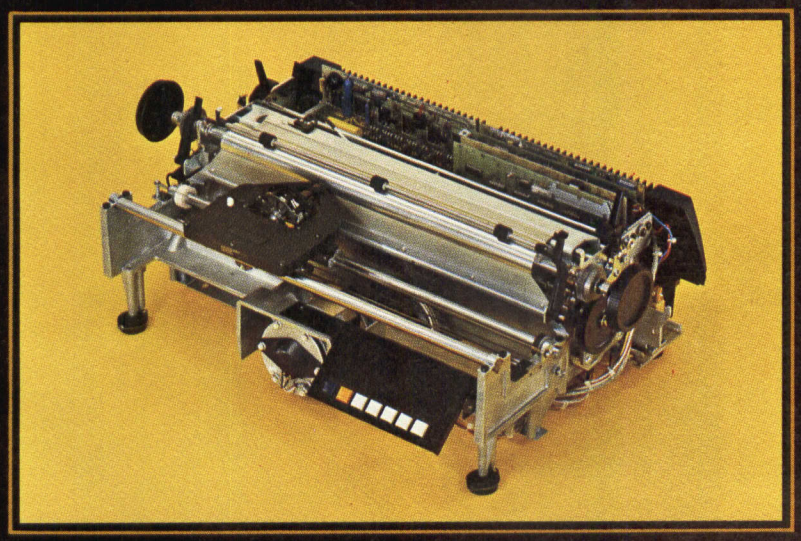
In a moderately extensive computer communications system, the user's continual investment can be divided into three fairly equal parts. First is the cost of leasing and operating the actual data processing equipment, second is the cost of leasing and supporting the remote terminal devices, and third is the continuing cost of accomplishing data transmission between the remote terminals and a central processing site. It is the third part that creates the most frustration and, in many cases, confusion to the user. The idea of having an entire system totally provided and, most importantly, supported by one manufacturer offers a number of psychological and economic advantages to many users.

It can be speculated that IBM's incentive to enter the communications common carrier area has been prompted by two major factors. By controlling the entire information environment, IBM can easily inhibit competitive threats to its existing revenue base. At the same time, this field offers a significant source of new revenue. It is interesting to consider that for AT&T, only 4% of its revenue is derived from leased lines, while almost 60% is from switched services such as DDD, WATS (Wide Area Telephone Service), etc. This direct economic potential, as well as protection of the present and future computer system revenue base, has encouraged IBM to become a major AT&T competitor.

All these factors are presently in their formative stages. It will be at least three years before the direct confrontation between AT&T and IBM begins. In the meantime, however, both companies can be expected to structure their products and services to enhance their ultimate competitive positions. When the confrontation does occur, many data communications users will be profoundly affected by the rapidly developing events. By understanding the implications of this development and continually following the positions of these two suppliers, the user and manufacturer can hope to influence the decisions in an advantageous manner, regardless of the outcome. □

Bidirectional printing
High speed tabbing
Skip-over spacing
Incremental printing
Upper and lower case print
Internal self-testing
Snap-in ribbon cartridge
Microprocessor control
Greater throughput
Lower cost...

What else do you want to know about the new Diablo Matrix Printer?



Our new Series 2300 Matrix printer firmly establishes the breadth of the Diablo printer line. From 40 cps to 200 cps there is a Diablo daisy wheel or matrix printer to suit your application. The Series 2300 Matrix is based on the heritage of Diablo HyType experience, servo knowledge and modern manufacturing capabilities. For more information, write Diablo Systems, Inc., 24500 Industrial Blvd., Hayward, CA 94545 or, Diablo Systems, S.A., Avenue de Fre 263, 1180 Brussels, Belgium.

Diablo

Diablo Systems Incorporated
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CIRCLE 11 ON INQUIRY CARD

New Intel microcom system costs, increase

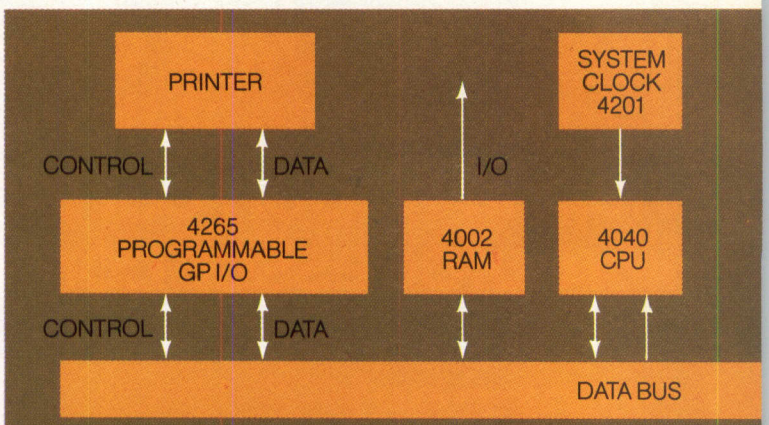
Intel has two new LSI components for the MCS-40™ microcomputer system which will help you cut system costs, increase throughput and reduce the number of components you have to stock for I/O interface requirements. The new Intel 4269 Programmable Keyboard Display and the 4265 Programmable General Purpose I/O devices eliminate the large number of discrete SSI/MSI components previously required for keyboard, control panel, indicator array, alphanumeric display, printer, communications and other I/O interfaces. These new LSI parts increase system throughput up to 50%, and make it easy to add standard Intel memory and system peripherals.

The 4269 Keyboard Display can be software programmed to interface to various keyboard and display elements and makes it possible for you to eliminate fifteen or more discrete components.

It significantly increases system throughput since it performs the scan, storage, refresh, and other simultaneous keyboard/display tasks previously required of the 4004 or 4040 CPU.

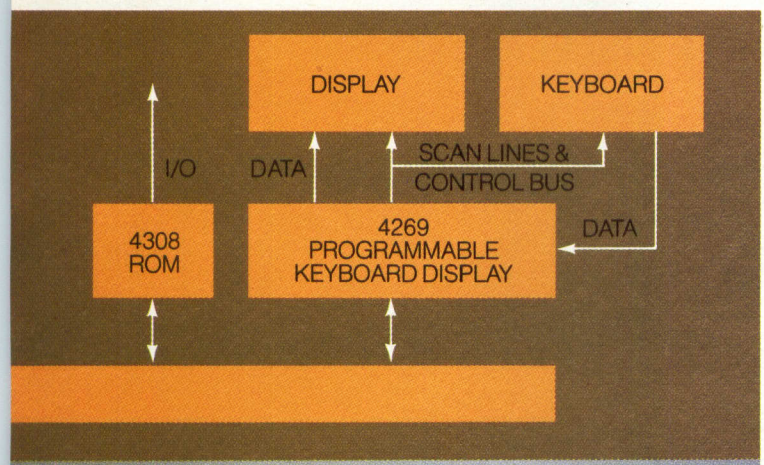
When programmed as a keyboard or line sensor input interface, the 4269 can scan up to 64 key closures or lines. When a key closure is detected, the 4269 generates a system interrupt and stores up to eight characters in its first-in/first-out buffer before requiring CPU service.

In alphanumeric applications, the 4269 eliminates the need to use the CPU



* Self-Scan is a registered trademark of the Burroughs Corporation.

puter I/O devices cut throughput up to 50%



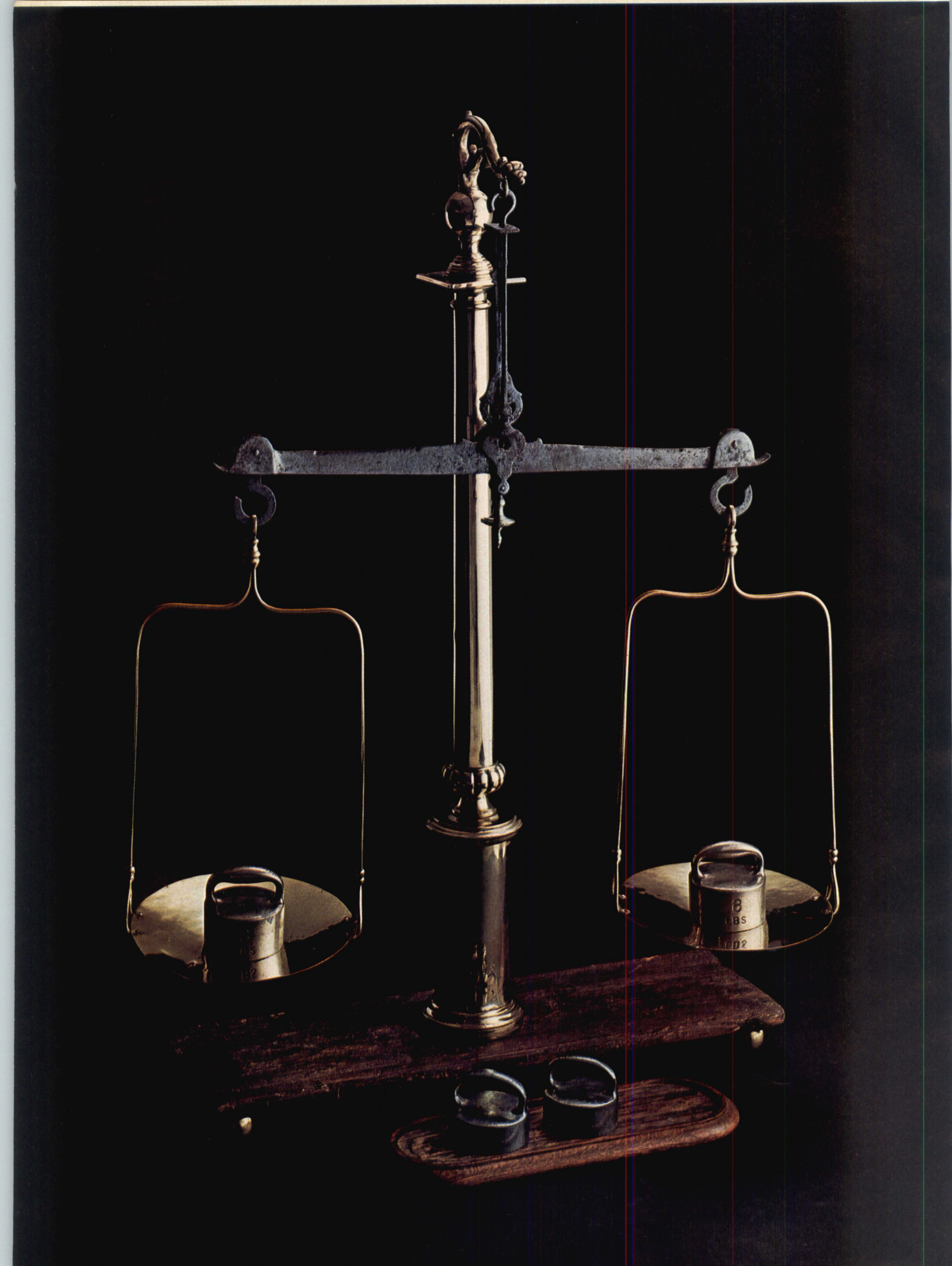
and system memory for display refresh since the necessary memory and control are built in. One 4269 can operate and refresh alphanumeric displays or indicator arrays with up to 32x4 digits, 16x8 characters or any configuration of 128 elements or lights, including a 20-character Burroughs Self-Scan* Display.

The 4265 General Purpose Programmable I/O is ideally suited to implement custom interface requirements. Up to four devices can be controlled by the CPU. Each 4265 has 16 I/O lines organized into four ports which can be used in 14 different data transfer and control/interface organizations. The 4265 provides synchronous/asynchronous control, buffer inputs and outputs, bit set and bit reset capability on output port lines and byte transfer control. It can be used to add industry standard RAM memory such as Intel's 5101 CMOS RAM. And the 4265 lets you use system peripherals such as the 8251 Programmable Communications Interface (USART), the 8253 Programmable Interval Timer or the 8214 Priority Interrupt Control Unit.

To order, contact our franchised distributors: Almac/Stroum, Components Specialties, Components Plus, Cramer, Elmar, Hamilton/Avnet, Industrial Components, Liberty, Pioneer, Sheridan or L.A. Varah. For your copy of our MCS-40™ System brochure, use the bingo card or write: Intel Corporation, 3065 Bowers Avenue, Santa Clara, California 95051.

intel®
Microcomputers. First from the beginning.

CIRCLE 12 ON INQUIRY CARD


8
LBS

The SEL Mini keeps its balance, to help you keep yours.

Any systems designer knows that if you don't have a balanced system going in, the end result can be intolerable.

So at Systems, the SEL 32 Mini was designed to be a totally balanced system, in every respect.

Let's see how the SEL 32 Hardware balances with the SEL 32 Software.

On the hardware side of the scale, we'd like to say a few brief words about obsolescence, throughput, and I/O.

The SEL 32 Mini's powerful CPU architecture is proof against obsolescence. Want to upgrade? Just change a board or two.

Throughput? The SEL Bus is capable of transferring data and commands at a continuous throughput of 26 megabytes per second. Based on a 150 nanosecond clock, this has established the industry standard for bus speed.

Lastly, I/O. The SEL 32 is the only 32-bit mini that employs micro-programmable, independent processor-based I/O, so it doesn't have to steal cycles.

That's all quite nice, but so far, it's just iron. Let's take a look at the other side of the scale: software.

You understand the impact of unreliable software. The SEL 32 software has seen over five years of enhancement and action, so you can be sure it's bug-free, seasoned, and headache-proof.

But there's more to software than a super track record.

The nucleus of our software is provided by a powerful, disc-based Real Time Monitor ...a true multi-programming operating system capable of handling up to 255 concurrently executing tasks.

One of those tasks, the new SEL Terminal Support Subsystem, allows up to 16 CRT operators to develop programs, debug, or activate tasks...concurrently. Result? Increased flexibility.

Another SEL software bonus is our highly optimizing FORTRAN IV Compiler, which reduces the amount of memory and execution time required for a program. In addition to its full ANSI-standard capabilities, several extensions are available which enhance its real-time applications even further.

There's more, of course, such as RJE terminal support, graphics software, a BASIC compiler, and additional operating systems.

Consider, then, this combination: Flexible, reliable software, based on our powerful RTM; and dynamic hardware, with Independent I/O, record-shattering bus speed, and totally upgradeable CPU, which absolutely defies obsolescence.

This is how the SEL 32 keeps its balance... to help you keep yours. (And for as little as $18,000, it's been known to help balance some corporate budgets, too.)

Write or call us today. We'll send you the whole story of the SEL 32 Mini.

The Balanced System.

SYSTEMS
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CD

☐ CALL ME
☐ SEND ME MORE INFORMATION
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gs

CIRCLE 13 ON INQUIRY CARD

Small Business Computer Incorporates Technology Proven in Larger Systems

Sophistication for simplicity. That is probably the key descriptor for the B80 series of very small general-purpose business computer systems announced by Burroughs Corp at its World Headquarters, Detroit, MI 48232. The company claims to have developed highly sophisticated systems to attain ease of use. Chairman Ray W. Macdonald described this introduction as "a very small but powerful and fully featured general-purpose computer system designed to enter minicomputer price levels."

Actually most technological concepts included in this series have been used and proven in the company's earlier products and its large systems. However, the B80 series is the company's first *small* system to fully utilize those concepts. In essence, large system functions are being provided in low cost configurations targetted at small system users.

One of the components introduced is a floppy-type super mini-disc that uses both sides to provide 1M-byte capacity. Average random access time to data is 266 ms. Two such discs on a basic system can store system software, application programs, and approximately 5500 account records. As many as six of these discs, for a total of 6M bytes, can be used on a system. Since these discs have higher capacity than "industry-compatible" floppies, they can not interface with them. However, such compatibility is optionally available by substituting devices to handle the standard discs.

As many as 16 memory modules, each of 4K bytes, can be included. One is a ROM containing system startup and maintenance routines. The others are R/W semiconductor memory. Average main memory access time is 500 ns, and the processor operates at 1 MHz. Up to 11 individual buffered controls can be included for handling I/O devices. System hardware complements a Master Control Program (MCP) through modularity of R/W memory and of I/O controls, all identifiable to the MCP.

The system CPU is a microprocessor made up of nine LSI chips. This microprocessor and the memory subsystem are interfaced by a handshake discipline which allows integration of future advances in memory and processor technology without obsoleting the basic design.

Two consoles are available. One has a 15″ single-pinfeed forms handler, 150 print positions, and a 60-char/s matrix printer that positions at a rate of 160 char/s. The second has a 25.6″ dual-pinfeed forms handler, 256 print positions, and a 180-char/s matrix printer that positions at 450 char/s. A third pinfeed device is optional.

A basic system, with either console, consists of 32K bytes of main memory (expandable to 61K bytes), one magnetic tape cassette station (expandable to four), and a 256-char visual display located on the console. In addition, two to six super mini-disc drives may be incorporated in the console cabinet.

Alternatively, a basic system may be equipped with a dual cartridge disc drive with a capacity of 4.6M bytes and average access time of 145 ms, a dual cartridge disc drive with a capacity of 4.6M bytes and average access time of 80 ms, or a dual disc cartridge drive with a capacity of 9.2M bytes and average access time of 100 ms. A maximum of three dual disc cartridge drives can be used, providing up to 27.6M bytes of online disc cartridge capacity.

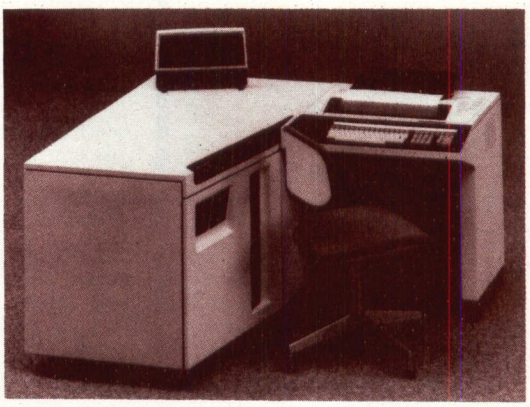
A fully implemented system could also contain up to two 160- or 250-line/min. printers, up to four data communications channels, and up to four input and display terminals. As many as three programs can be run at the same time on a fully configured system. For instance, each of the two high speed line printers and the console printer could produce hardcopy output for a different program—concurrently.

The system is bus organized, with all data highways eight bits wide. Clock rate is 1 MHz; balanced system performance is provided by capability of all interfaces to pass information at that rate. In addition, all hardware I/O interfaces to memory and to the microprocessor for data exchange and control use common techniques—again providing modularity and capability for expansion.

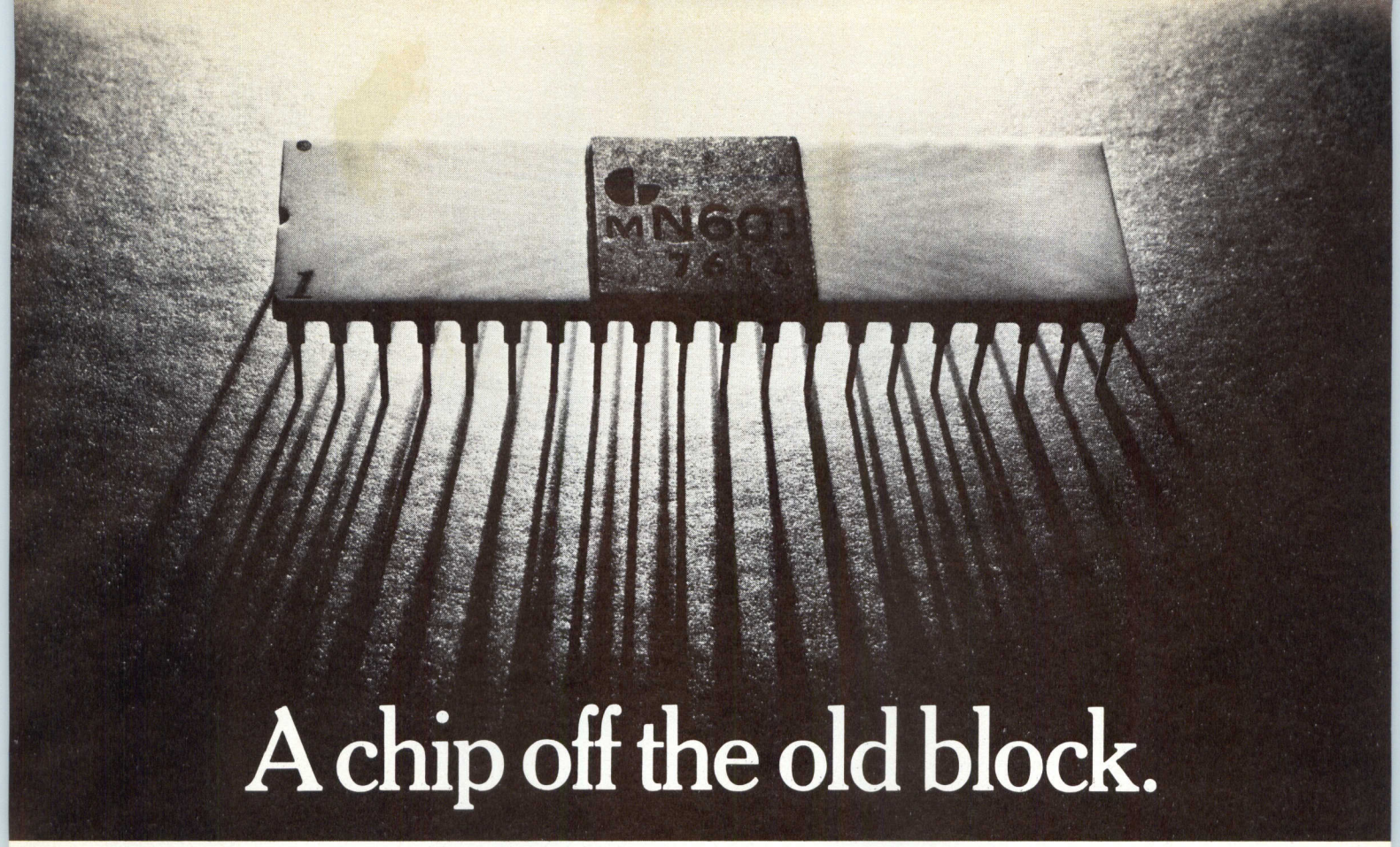
Three types of I/O control are used in the series. One is a "hard" peripheral controller for high performance areas such as the system disc controller. The second is "soft" and is used to drive a hard peripheral controller where specific peripherals require complex control. This high level of control is maintained by the second use of a microprocessor in this system, interposed between the CPU and the hard peripheral controller to provide the necessary greater throughput to the processor. A soft controller is used, for instance, for both the tape cassette drive and the 180-char/s printer and forms handler.

Third controller type is the channel expander unit which provides the capability to expand a single I/O channel into four similar channels. This permits growth of the maximum number of channels in the system from 8 to 11.

Philosophy of the I/O organization is that peripheral devices specify when they want communication with



A basic B80-34—the typical entry level configuration announced by Burroughs Corp—includes a 60-char/s console printer, two super mini-discs, magnetic tape cassette station, and visual display. In a larger arrangement, such as a B80-41, the console printer would be replaced by a 180-char/s unit. In addition, two 250-line/min. printers and three dual-drive disc cartridge subsystems could be included. This maximum system would be able to handle data input and inquiry from multiple input and display terminals



A chip off the old block.

As you can see, this chip is housed in ceramic and mounted in a forty pin, dual in-line package.

As you can't see, it's a NOVA® computer.

Inside that packaging sits a full 16-bit, silicon gate, NMOS microNOVA CPU. The mN601.

The mN601 is the first microprocessor designed and manufactured by a minicomputer company. And it's the highest performance NMOS microprocessor on the market. With our 160 nanosecond RAM, it has a memory cycle time of 960 nanoseconds and the fastest instruction times going. Like an Add of 2.4 microseconds. And a Load of 2.9 microseconds.

The mN601 has the 16-bit NOVA instruction set including hardware stack for easy programming. And 16-bit data for efficient memory use.

It also has hardware multiply/divide for fast program execution. Integral data channel logic for easy interfacing to high performance peripherals. Control and timing for high density RAM memories. Integral hidden refresh logic that overlaps instruction execution timing. Plus a unique I/O encoding scheme for efficient easy interface design. Even the real-time clock is included. All of which reduces the chip count.

And all that computer is in a single chip.

And because the mN601 is a NOVA, it uses the most mature, field-proven software you can get with any micro. So you can cut back on development time and cost by using compatible software like our diskette-based Disc Operating System and our Real-Time Operating System.

Also, the mN601 comes with the full documentation support you'd expect from a minicomputer company like Data General.

If you want more than a chip, you can get it. There's a whole chip set, a 4K computer-on-a-board and a fully-packaged 9-slot microNOVA MOS mini. And there's more.

Don't stop here.

Sign up for a technical seminar on the microNOVA. They'll be held in major cities around the country from New York to Los Angeles. They'll last a half-day. And they're free.

For more information call our toll free number, **800-225-9497** (Unless you're in Massachusetts. In which case, call 1-617-485-9100 Ext. 2509.)

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A giant reduction in the NOVA line.

DataGeneral

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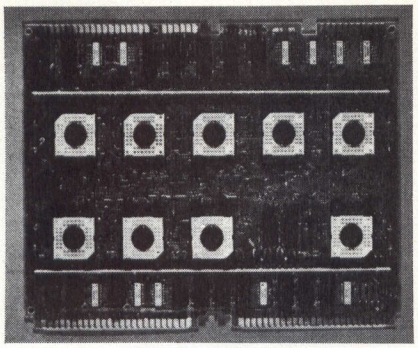
CIRCLE 14 ON INQUIRY CARD



An LSI microprocessor, on nine chips, serves as the system CPU. A similar microprocessor is used in one type of peripheral controller. As many as eight such controllers could be included in the system

the processor and indicate, via interrupt, what service they require. All three types of I/O controllers are self-identifying to the processor and allow the MCP to call from disc into main memory only those I/O segments needed for each specific machine configuration.

Because the system is microprogrammable it can handle vastly differing virtual systems and peripherals. All information transfer within, into, and out of the processor is maintained over the 8-bit data highways. Blocks of data are transferred in a single uninterrupted stream between processor and memory, processor and I/O, or memory and I/O. This data streaming technique enables up to 256 bytes of data to be moved at an 8-MHz rate between important parts of the system. For example, transfer of a 180-byte sector of data from disc controller to memory via the processor requires 1 μs/byte, or 180 μs.

Microinstructions are basically eight bits wide but can be extended to 16 or 24 bits. Implementation of an overlapped fetch and execute control improves performance by approximately 40% over a nonoverlapped microcycle. A microprogram stack enhances microprogram subroutine efficiency and I/O interrupt servicing. In addition, multiple count microinstructions permit repeated execution, particularly useful for data streaming, MCP table manipulation, and byte processing operations.

An exclusive Computer Management System (CMS)—an integrated system of operating and application software—includes Master Control Program (MCP), Data Control System (DCS), higher level language compilers, interpreters, utility routines, Burroughs Data Base Bridging Systems, and Business Management Systems (BMS®) Application programs. Systems feature the use of different individual interpreters for the specific needs of each language, including COBOL, RPG, Network Definition Language (NDL), and Message Processing Language (MPL). A system dynamically alters its logic for each language.

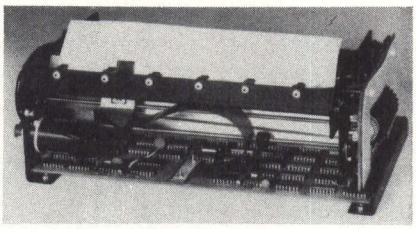
Prices for B80 system configurations begin at $20,000 and extend to over $120,000. According to Mr Macdonald, the current introduction is a forerunner of larger systems to be announced later this year.

Circle 140 on Inquiry Card

Portable Terminal Offers 3-Way Keyboard, Plus 30-Char/s Thermal Printer

Providing a 3-way keyboard in a portable thermal printing, time-sharing terminal, Miniterm model 1203 allows operator selection of TTY, standard typewriter (upper and lower case), or numeric-only keyboard modes. In addition, the unit, introduced by Computer Devices, Inc, 9 Ray Ave, Burlington, MA 01803, can operate at 10-, 15-, or 30-char/s, anywhere a conventional telephone and wall output are available.

Thermal printing technique and solid-state printhead combine to offer quiet operation. The Q3 thermal non-impact printer provides a 5 x 7 dot matrix in a single chassis design that includes print mechanism, paper handling, and drive and control electronics as well as a copy lamp assembly. The 80-col printer is electronically controlled and stepper motor driven; it offers upper and lower case printing, and provides designers with two complete character sets integral to the same unit, yet easily interchangeable and user selectable.



Q3 printing mechanism used in Computer Devices' portable Miniterm terminal uses a solid-state thermal printhead for quiet operation. Single chassis design incorporates print mechanism, paper handling, and drive and control electronics

Printing mechanism provides up to 30-char/s operating speeds, full ASCII 96-char set, adjustable print density, and end-of-paper output signal. Printing on 80-col lines, an automatic carriage return and line feed are given at the 81st character; carriage return requires less than 200 ms. The print mechanism weighs just 4 lb, and is available for OEM use.

A built-in modem and acoustic coupler make the unit compatible with all popular time-sharing systems and central computers, and allow communications via normal telephone lines. The unit is capable of local, full, and half duplex operation; EIA RS-232 interface is standard, 20-mA current loop is optional. Transmission occurs asynchronously at 110, 150, or 300 baud, switch-selectable. Odd, even, or mark parity, and half or full duplex modes are also switch selectable.

When packaged complete with keyboard, coupler, and modem, the terminal weighs approximately 14 lb; an optional carrying case adds 4 lb. Dimensions are 15 x 17½ x 5″.

The unit is completely field serviceable; each part is removable without removing any other. All, except keyboard and printer, which are screwed in, simply clip into place. All switches and indicators are located on the front inside and outside of the unit.

Circle 141 on Inquiry Card

Mini-Based Systems Provide Flexibility and Processing Speed

Based on Cyber 18 family minicomputers—models 18-10, -20, and -30—systems and network terminals use semiconductor memory and microprogramming techniques to provide increased protection of data, greater user flexibility, and faster data processing. Systems are available with main memory capacities that range from 8192 to 524,288 (8-bit) bytes, and with from 512 to 4096 microinstructions, each 32 bits in length.

(Continued on p 26)

Direct input and output of analog and digital signals to your computer.

RTP is a family of standard products that allows direct input and output of analog and digital signals to your general purpose digital computer.

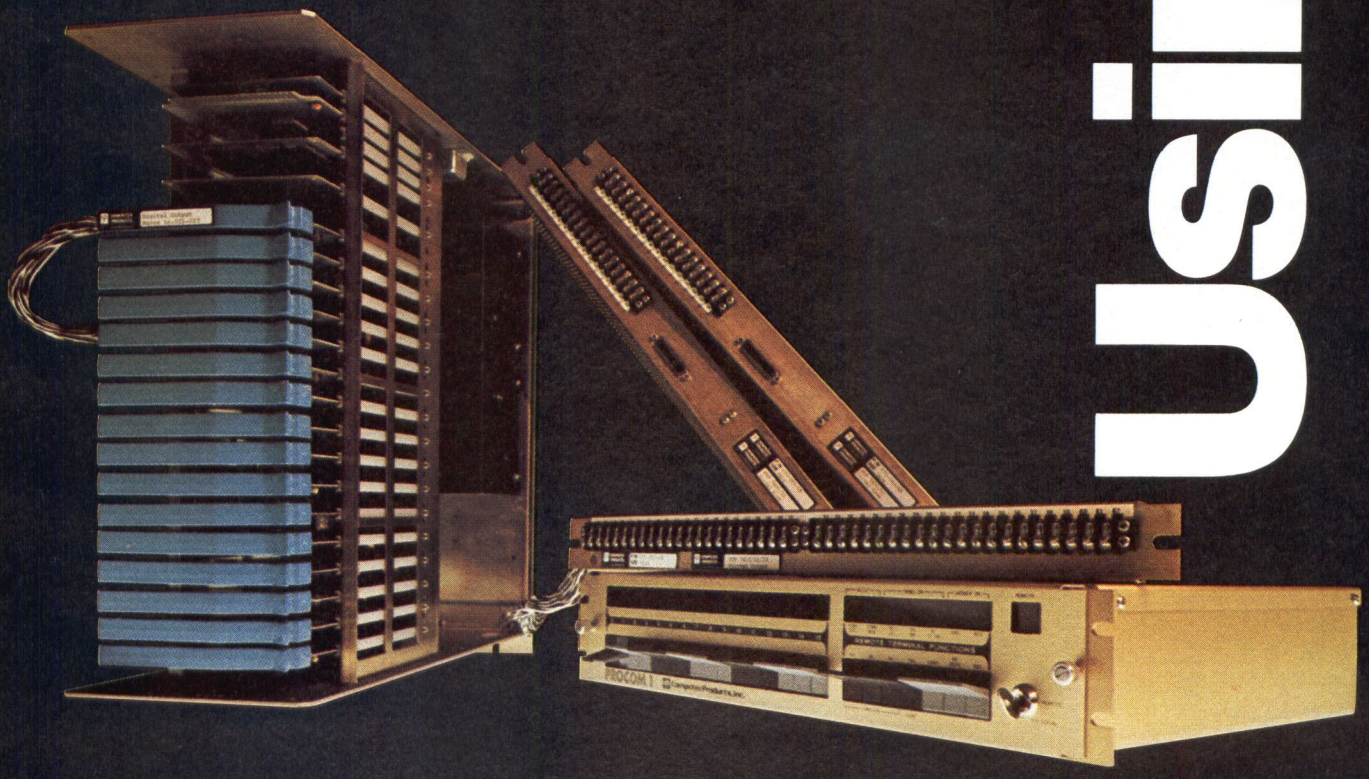
The parameters of RTP design? Unprecedented reliability. Greatly reduced maintenance and ease of servicing. Less engineering design time for the system designer. Extending system life through non-obsolescence. Low cost.

If you're involved in the design of a measurement and control system, we'd like to send you our new booklet "Using RTP." It demonstrates how you can order standard, off-the-shelf products and any popular minicomputer, plug them together, and begin operation of your measurement and control system. Local or remote.

Just circle our number on the reader service card, or, if your needs are immediate, call us at (305) 974-5500. Ask for Larry Buck or Randy Dailey.

Computer Products, inc.

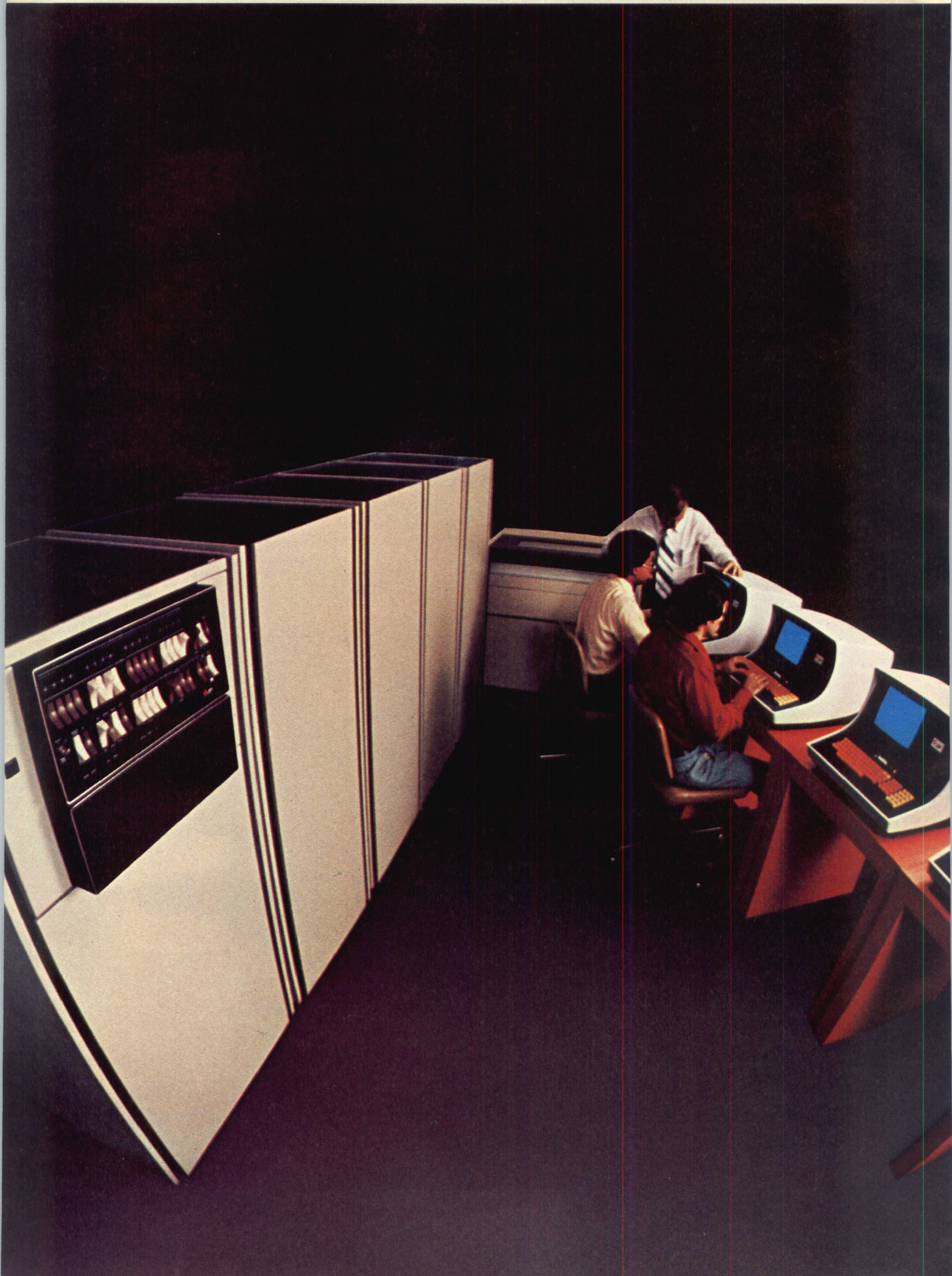
Using RTP.



1400 NW 70 Street, Fort Lauderdale, Florida 33309 • (305) 974-5500, TWX (510) 956-9895.

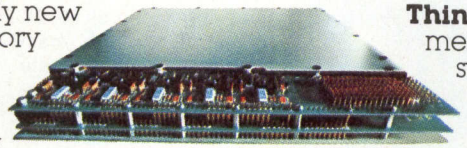
Japanese Distributor: Tamagawa Seiki Co., Ltd. 3-19-9 Shin-Kamata, Ohta-Ku, Tokyo, Japan 144. Phone: 03-731-2131.

CIRCLE 15 ON INQUIRY CARD



Announcing the biggest breakthrough ever in core storage.

MEMORY+. It's an entirely new dimension in bulk memory for minicomputers. An add-on memory system used with MODCOMP computers to give you a whopping 4,000,000 bytes of directly accessible core storage. At far less cost than any other core memory you could ever buy. Until now.



The MODCOMP 256K-byte memory module that made it all possible.

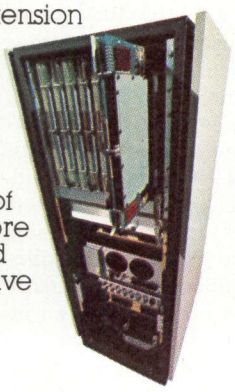
It opens up vast new possibilities for storing those programs and data you can't accommodate in main memory, but frequently need to get at—super fast.

Because now you have the best of two worlds. The capacity of disc. With the high speed and reliability of main memory. At an amazingly economical price.

The big breakthrough came when we found a way to slash the cost-per-bit of core by condensing a massive 256K bytes of memory into a single memory plane. In a single MEMORY+ device, anywhere from one to sixteen of these memory modules go together for a total capacity of 4 megabytes.

Consider what MEMORY+ can mean to you.

Think of it as a giant extension to main memory. It's both word and block addressable, and it swaps data so fast it appears to be a part of main memory itself.



Think of it as a way to beat the sluggish speed of fixed head disc. With its core memory access time, and transfer rates as high as five megabytes per second.

Think of it as a shared memory in multi-processor systems. Two MODCOMP computers can be processing the same data at memory speeds, without tying up main memory.

Think of it as an operating system auxiliary memory. Boosting system throughput by providing fast access to often-used operating system files.

Think of it as a direct data path to main memory for external data, used as a high-speed buffer.

Any way you look at it, MEMORY+ is one giant step forward in real-time bulk storage.

And because of its modular design, you buy only the capacity you need now. As you need more, add more plug-in modules.

It's simple. It works. And it's available. Now.

Call your nearest MODCOMP sales office for full details. Or write for a comprehensive 20-page brochure that explains the whole MEMORY+ story.

Modular Computer Systems, 1650 West McNab Road, Ft. Lauderdale, FL 33309. Phone (305) 974-1380. European Headquarters: Export House, Woking, Surrey, England Phone (04862) 71471

MODCOMP MEMORY+

Four MEMORY+ devices give this MODCOMP computer an external core storage capacity of 16 megabytes, operating at main memory speeds.

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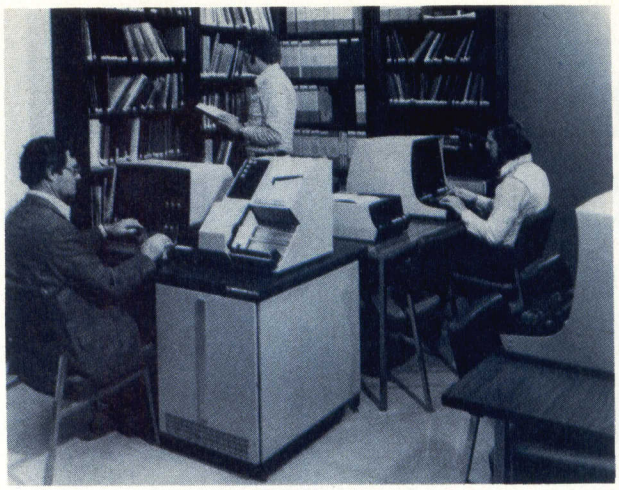


Control Data's Cyber 18-30 minicomputer-based system supports up to 64 time-sharing terminals. The system includes dual processors, 512K bytes of shared main memory, and a separate large capacity microprogrammable memory

Operation of the systems, announced by Control Data Corp, Box O, Minneapolis, MN 55440, is controlled by microprograms resident in semiconductor memory. Programs, or variable control logic, read instructions from main memory and decode them for execution in the microprocessor. Microprograms execute the system instruction set, operate programmed input and output channels, and service computer interrupt and program protect systems. They also control the processor's operating mode or emulation capability, and interface with main computer memory.

There are two files with 256 and 32 registers at the microprogram level. These registers can be stored into and read from by the microprocessor. Micromemory provides 70-ns access and 168-ns average cycle times, and stores as many as 4096 32-bit instructions. As many as four parallel, unrelated operations can be performed during one microinstruction; several microinstructions are executed during a single 750-ns main memory cycle, enhancing processing speed.

Separation of memory into main and micro sections also provides greater protection of data and increased application flexibility. Specific instruction sets to accommodate growing user applications can be added to micromemory, providing upward-compatible growth, while maintaining processor and main memory architectures.

Basically, the processors consist of a cabinet housing power supplies, an operators' panel, and an input/output controller for the communications display unit. Main memory modules and peripheral controllers are contained on 11 x 14″ circuit boards that plug into slots in the basic processor cabinet.

In distributed applications, the 18-10 can function as an intelligent terminal, processing routine data on-site and sending larger jobs to a central computer. Controlware options allow it to emulate IBM 2780 and 3780 terminals, providing compatibility with IBM host computers. The 18-20 supports a range of business data processing applications. Dual processors, more than 500K bytes of shared main memory, and Time-Share software permit the 18-30 to serve up to 64 terminal users.

Systems are supported by storage modules and flexible disc memory drives, conversational display unit, card readers, line printers, and 7- and 9-track magnetic tape transports. Software support includes a stand-alone real-time operating system (RTOS) for small, multiprogramming installations. RTOS residency requires a minimum of 3000 main memory bytes; hardware requirements include a communications device and an input device such as card reader. The mass storage operating system (MSOS 5) includes macro and micro-assemblers, and FORTRAN compiler; it requires 16K bytes of main memory and supports applications requiring dedicated system use or foreground/background processing in real-time environments.

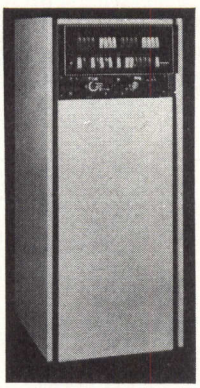
Circle 142 on Inquiry Card

Semiconductor Memory Used in Network Terminal Computer

Designed primarily for use in network applications, a semiconductor memory version of the MODCOMP II minicomputer has been introduced by Modular Computer Systems, Inc, 1650 W McNab Rd, Fort Lauderdale, FL 33309. The II/2 processor offers up to 48K bytes of memory on a single plane, executes the entire instruction set of its predecessor, and uses all standard software that will fit in the memory available. Network users can now purchase a CPU that is sized for the application, rather than install processors with excess power and capacity which result in overkill.

Although the standard model is offered with 48K bytes of memory, 16K- and 32K-byte versions are available. Memory access time is 400 ns; cycle time is 600 ns. Word parity is standard and all memory locations are directly addressable. Seven memory addressing modes are provided in memory reference instructions, permitting unmatched optimization both in assembler and compiler generated code.

Packaging provides six additional locations for peripheral, process interface, and communications controllers. An optional control panel offers capability to enter and display memory and registers. Program fill switch, master clear, and console interrupt are also provided. Remote fill is standard because of the processor's primary intended use, and the



Network terminal member of Modular Computer's minicomputer family, the II/2 has a large instruction set and general-purpose registers, which enable it to execute MAX III and MAX-NET III operating systems. Computing speed and 48K-byte direct addressing range and memory size adapt it for most 16-bit real-time distributed processing applications

Ask CONTROL DATA about the improved Model 9427H "Hawk" OEM Cartridge Disk Drive with double-the-uptime performance.

We have it.

"Hawk:" updated, simplified, field-tested and proven for twice-the-reliability of previous models. 12 MByte standard; 6 and 3 MByte optional. Average access 35 ms. Data rate: 2.50 MHz.

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For interface versatility, you can choose CDC or one of several competitive interfaces. Star or daisy chain configuration. The unit in daisy chain configuration is removable without affecting other units.

For control versatility, the control panel module is removable for placement in a remote location.

Ease of Maintenance

"Hawk's" modular design offers individually replaceable sub-assemblies that simplify maintenance, keep downtime down.

An independent blower motor assures continuous standby capability and clean disk area—and improved reliability.

The power supply is self-contained; the input is universal 100-250 VAC, 50/60 Hz.

"Hawk" even offers a Fault Isolation and Retention Module! This optional device provides diagnosis to board level and stores fault information. Even when power is removed!

Whether large OEM, or small, check into "Hawk." For reliability, performance, options. For Cartridge Disk Drives you can sell with confidence in your system.

Call (405) 946-5421 or return coupon to: Terry J. Hardie, Product Sales Manager, Control Data Corporation, 4000 NW 39th Street, Oklahoma City, OK 73112

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CIRCLE 17 ON INQUIRY CARD

The Hard Hats

Introducing the first microcomputers tough enough to survive in the real industrial world. And, at a price you can afford.

The PCS 180 Series. From single board micros for under $300* to packaged systems with integrated CRT and full ASCII keyboard for $995*. Microcomputers that won't cook in sealed enclosures. With memories that stay up when the power goes off. No one can beat the price. No one can best the performance.

PCS 180s are designed for dirty, corrosive environments. Gathering, analyzing, and sorting data. Monitoring instruments. Starting, stopping, and regulating events. Even communicating with other computers. No matter what the application, there's a PCS 180 ready to put on its hard hat and go to work for you.

SUPERPAC 180. The most advanced general-purpose microcomputer on the market today. Priced at $995*, the SuperPac 180 gives the system builder both full ASCII keyboard and CRT display capability in a single, low-cost attractive package. Desk-top or rack-mounted, SuperPac 180 includes a PCS 1806 microcomputer, as well as a four-slot chassis, power supply, and self-contained keyboard and CRT control unit. The SuperPac 180 provides 16 lines of 16 or 64 characters, 1024 directly addressable character locations, programmable cursor, blink, and reverse video capabilities.

MICROPAC 180. A low-cost, rack-mountable industrial microcomputer system priced at $695*. The MicroPac 180 includes a PCS 1806 microcomputer, as well as a four-slot chassis, power supply, and industrial front panel with on-off switch and status indicators.

PCS 1810. A single board micro with 256 bytes of CMOS RAM, plus provisions for up to 1K bytes of RAM and 3K bytes of EROM/ROM. The PCS 1810 features power fail/auto restart and built-in battery backup that can support the CMOS RAM for up to 10 days. The unit also includes a crystal-controlled clock, 16 digital inputs and outputs, a serial I/O port, a tri-state bus port, and DMA capability. All for $290*.

For applications where built-in battery backup is not important and where more memory is required, PCS offers the 1806 with 1K bytes of RAM and provisions for 7K bytes of EROM/ROM. All for $265*.

Both microcomputers are available with standard four, eight, and twenty slot chassis with power supply at prices starting at $450*.

All PCS microcomputers offer a full range of peripherals designed to enhance program development and support production systems. PCS software permits easy "trouble shooting" and saves programming time by eliminating much of the duplication and repetition that program writing often involves.

Whether you're an OEM or end user, whether you buy in small, medium, or large quantities, PCS offers a cost-effective solution to your automation problem. Equipment in modular construction that makes configuring, changing or expanding a system easy, economical, and trouble free.

PCS systems — a new era in process control.

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5467 Hill 23 Drive, Flint, MI 48507 313-767-8920
TWX-810-235-8667

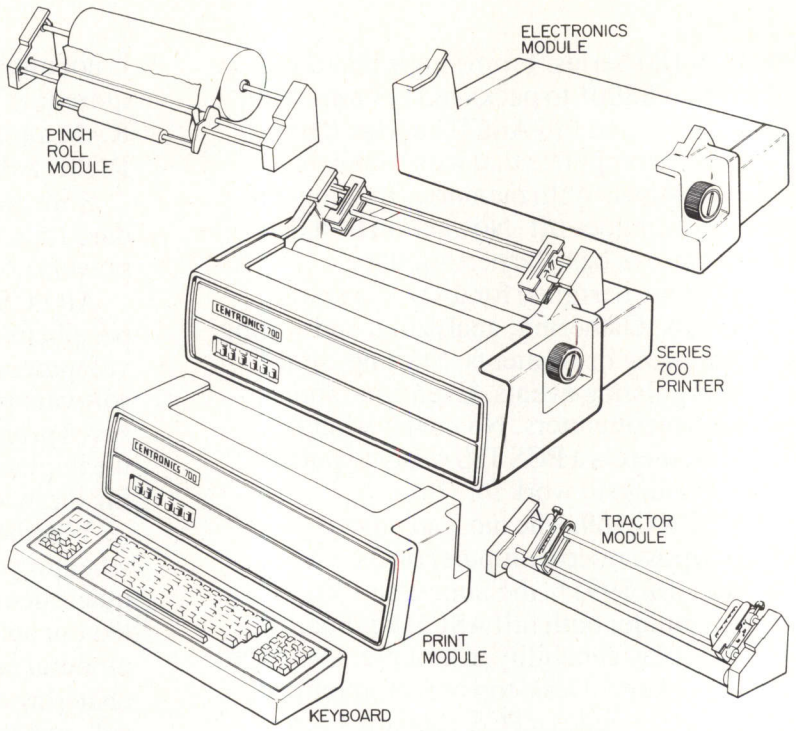
*In quantities of 50

processor can use virtually all standard peripherals.

Direct memory processor (DMP) feature has been made standard, along with eight interrupt levels. Floating-point hardware and microprocessor communications hardware have been excluded because they are not needed in the typical measurement/control, data acquisition, or batch terminal application where the processor will likely find use. The processor will, however, still perform such functions as local data acquisition and process control, preprocessing of data before transmission to the host computer, and local task scheduling; the host computer in each network will provide necessary backup, including program reload, in case of power failure.

By providing necessary capabilities and excluding those not likely to be needed, the machine has been tailored specifically to provide a low cost processor for use with MAXNET software in network applications. This allows the user to realize primary benefits of a distributed computing network, and still be able to afford to extend remote computing capability to areas where cost factors previously precluded the use of small computers.

Circle 143 on Inquiry Card



Modular concept of Centronics' series 700 printers allows customers to specify exactly the unit that fits their needs, which can then be supplied at low cost. Many models are available with choice of front-feed, pinch-roll, or tractor-feed paper handling module. Electronic module contains an LSI printed circuit card to provide selected printer functions; keyboard may be added to other models

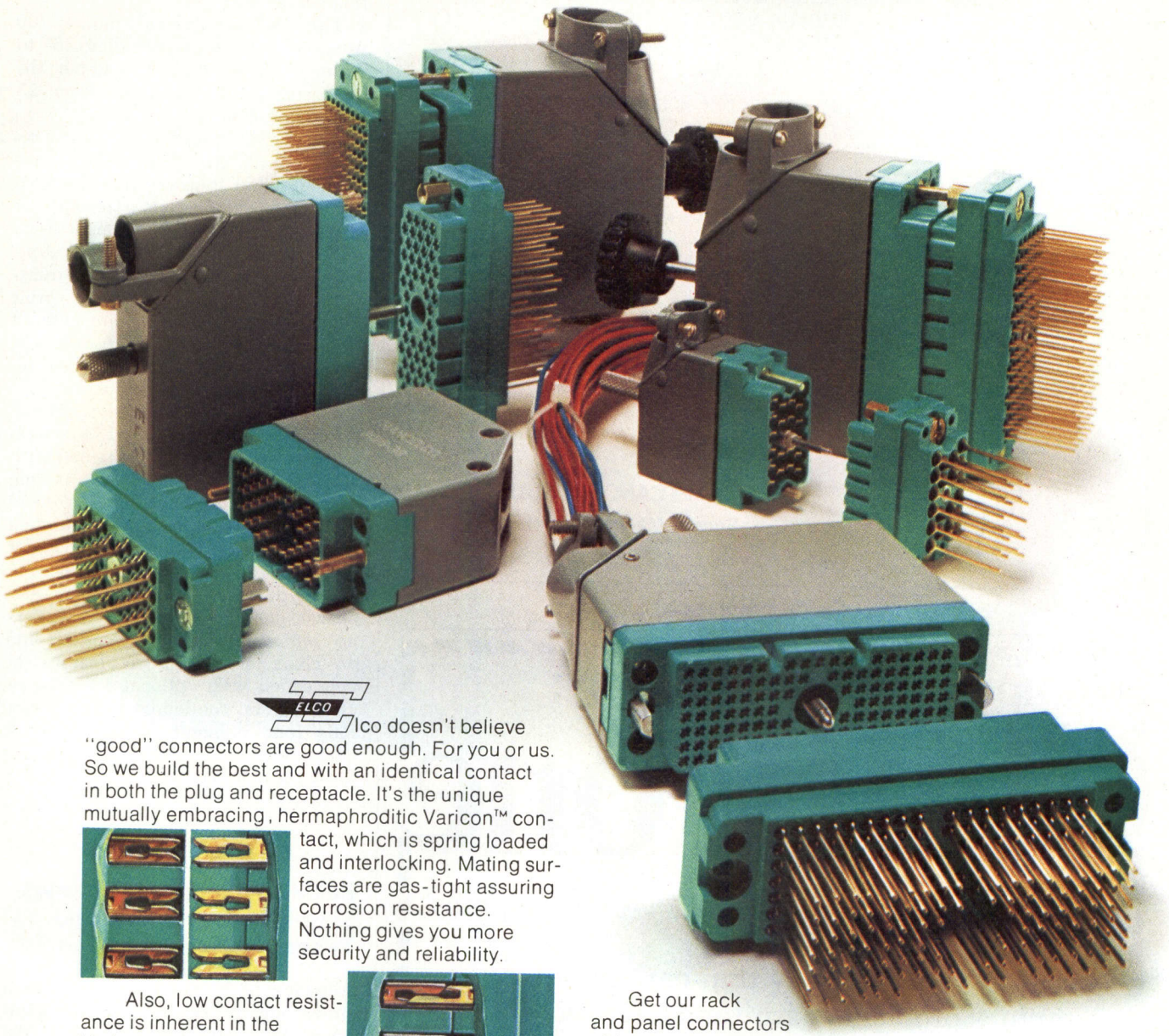
Matrix Printers Achieve Low Cost, High Reliability Through Design Balance

A family of matrix printers for the OEM market has been announced by Centronics Data Computer Corp, Hudson, NH 03051. In the family, designated the series 700, the most important technical characteristic is given as design balance—a careful choice of parts and components to yield both high reliability and low cost. Reliability is easy to achieve by spending enough money, and cost might have been cut by using cheaper parts; in this design, however, the company hopes to have found the happiest of happy mediums.

All four models, the 700, 701, 761 RO, and 761 KSR, share similar design advances, chiefly mechanical. Most innovative of these, perhaps, is the horizontal escapement, which moves the printhead back and forth over the paper. It consists of a steel band that runs continuously in one direction around two pulleys, and a relay-like grabbing mechanism on the head assembly, which grabs the front or the back of the band to move the head to the right or left, respectively. The head can print in either direction. Other features include a modular design, which permits many different configurations to be assembled from a minimum number of subassemblies, and a reduced number of critical dimensions, permitting many manufacturing steps to be carried out by stamping instead of casting.

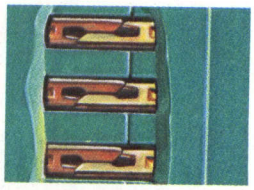
Electronically, the controls for all models in the line have been reduced to a single PC card. The 700 and 701, like their predecessors, use custom LSI exclusively in a hard-wired controller; the 761s are the company's first products to have microprocessor-based controllers, adopted for flexibility of application. Net throughput of the 701 is greater than that of the 700, because it can look at an upcoming line, decide

our high density rack & panel connectors do it with one contact.



Elco doesn't believe "good" connectors are good enough. For you or us. So we build the best and with an identical contact in both the plug and receptacle. It's the unique mutually embracing, hermaphroditic Varicon™ contact, which is spring loaded and interlocking. Mating surfaces are gas-tight assuring corrosion resistance. Nothing gives you more security and reliability.

Also, low contact resistance is inherent in the Varicon contacts spring action. Tests show that in some applications, contact resistance even decreases after a number of mating and unmating cycles. All this contributes to a high current capacity. And Varicons' large mating surfaces exert positive pressure to assure resistance to shock and vibration.



It's an important list of advantages — all yours in a wide range of connector configurations, no matter what your needs.

Get our rack and panel connectors with a variety of grid patterns, in sizes ranging from 20 to 165 contacts, with steel, aluminum and molded covers.

Elco can match the right high density rack and panel connector to do the job you want done at a competitive price and with fast delivery. And thanks to Varicon, we'll do it with one contact.

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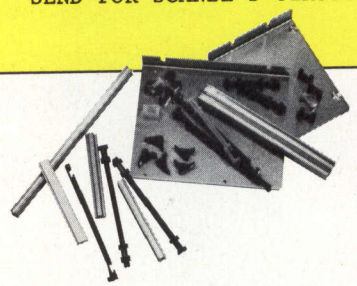

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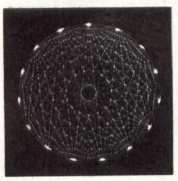

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GRAPHIC SYSTEMS
WHERE VALUE COMES FIRST

CIRCLE 4 ON INQUIRY CARD

which end is closer, and print either forward or backward by starting at the nearer end.

The unidirectional model 700 prints at 60 char/s providing 15- to 90-lines/min. effective throughput; the bidirectional 701 provides from 25 to 120 lines/min.

Model 761 teleprinters are incremental serial terminals which sustain 300-baud transmission. The KSR unit offers immediate viewing of typed data; the RO terminal is a read-only device capable of accepting data from CPU or other transmitting terminal. The units print incrementally when data are entered from the keyboard and use intelligent bidirectional printing when receiving from a remote device.

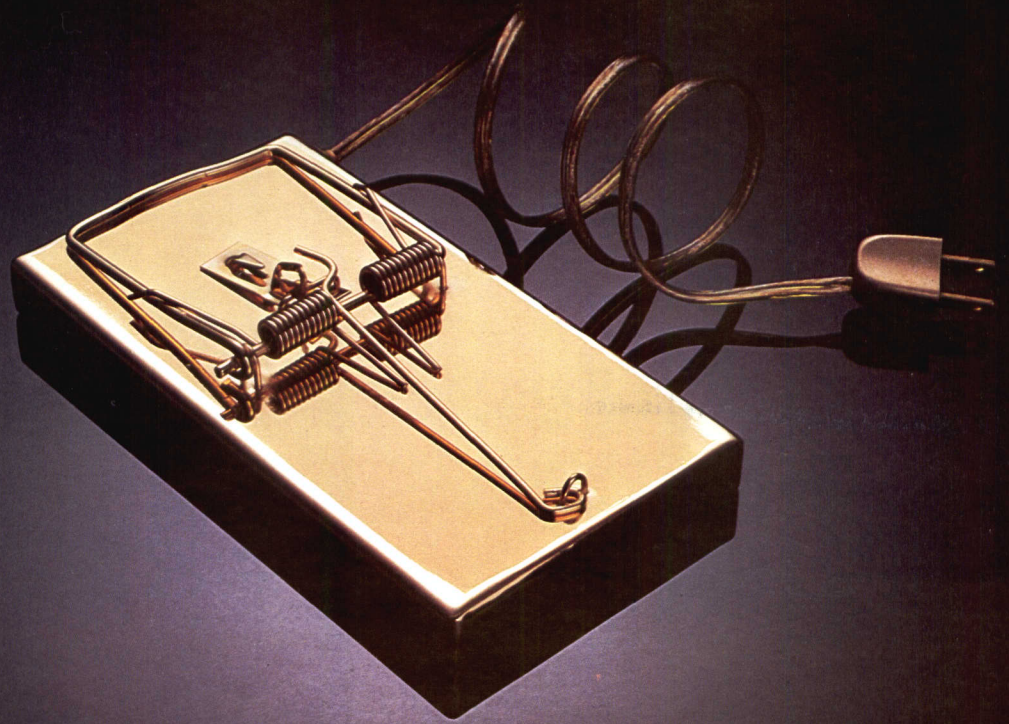
Standard on all units is 80-col print line at 10 char/in.; 132 column with 10 char/in. can be obtained with an optional tractor feed module which allows paper up to 17.3" (439 mm) wide to be used. The printers form characters from a 5 x 7 dot matrix; terminals use a 7 x 7 matrix. Standard character set is the 64-char ASCII set; 96 or 128 characters are optional. Using the standard line or character elongation feature in connection with optional 12-, 15-, or 16.5-char/in. condensed printing permits four different widths of each character.

Circle 144 on Inquiry Card

Business Computer Allows Simultaneous Batch and Transaction Processing

Allowing both transaction and batch processing to be performed simultaneously and independently, the P410, a small business computer available from Philips Data Systems, Eindhoven, The Netherlands, solves problems long associated with the transition from traditional transaction processing to more powerful batch processing. Small processing runs, such as occasional invoicing, can be handled in transaction mode; large runs such as stock control, in batch. System software permits multiprogramming and batch processing with high speed peripherals. One of two simultaneously running programs may be interrupted at any time with the interrupted program

We did it.



We built a better

The AMI 6800.

The verdict is in from engineers, scientists, universities and magazine editors. The 6800 has become the most sought-after microprocessor family in the world.

With our new price breaks, it now makes sense to use the AMI 6800 for all applications—from simple, low-cost controllers to high-end microcomputers.

And with our system, you only need one 5-volt power supply. That brings the cost down even more. So for about the same price you'd pay for a 2-chip system, you can get the fast, flexible AMI 6800. The 8080 needs three power supplies. Not to mention at least four TTL devices. That puts it right out of the low-end ballpark.

Even when you move up to a more sophisticated microcomputer, you'll find the same kind of cost advantage in our favor. With the bus-oriented AMI 6800, you can hook up a total of ten memories and peripherals without adding any TTL.

This point underlines the basic reason for the AMI 6800's superiority. It was designed after a thorough study of the early microprocessors, and was patterned after the most successful minicomputers. Whereas the 8080 was designed to be compatible with the 8008. So it's stuck with many of the 8008's weaknesses.

You can learn a lot from other people's mistakes.

A comparison of the 6800 and the 8080 is a classic example of this truism. In virtually every important feature, the 6800 comes out ahead. Often way ahead.

We've already mentioned power supplies (our single +5V versus their three ±5V, +12V) and interface (no buffering needed for up to 10 devices our way versus 4 to 6 packages for the 8080). But now take a good look at some other key hardware differences.

We have a simple 5-volt non-overlapping clock which is easily generated from a dual one shot such as a 9602. Theirs is a 0 to 8.5 volt or 0-11 volt non-overlapping asymmetrical waveform with specified delays between phases.

Ours has two levels of external interrupt, one of which is non-maskable. Theirs has only one maskable interrupt.

We save program space with two accumulators instead of one. But even more important in terms of space and cost saving is our interrupt stacking. This automatically stores all registers when the program is interrupted. With the 8080, you need an external subroutine of 4 or 5 instructions every time you hit this condition.

Now look at addressing. They don't have an indexed mode. We do. That can be really important, especially in peripheral applications. We give you a very powerful tool in relative addressing, allowing self-relative code. The 8080 doesn't. And we also have direct addressing, which lets the 6800 use two bytes of code to three for the 8080—a saving of 33 percent.

Our instruction set tells you a lot.

Ours is very flexible and much easier to learn, tailored more like a minicomputer. Take the 6800's branching ability. Besides positive, negative and zero, ours can branch on equality and all inequality conditions. The 8080 can't test directly for inequalities. So it has to go through two or three additional steps to test for these conditions.

The 6800 can also isolate and test bits in a word much more easily than the 8080.

All this adds up to a 15 to 30 percent more efficient use of memory space. So the 6800 requires less hardware, less interface, less software. And being so much easier to use, the AMI 6800 microprocessor helps you beat the competition to market with a more reliable product.

The family plan makes growing easy.

The AMI 6800 is now a thriving family of nine, with more on the way.

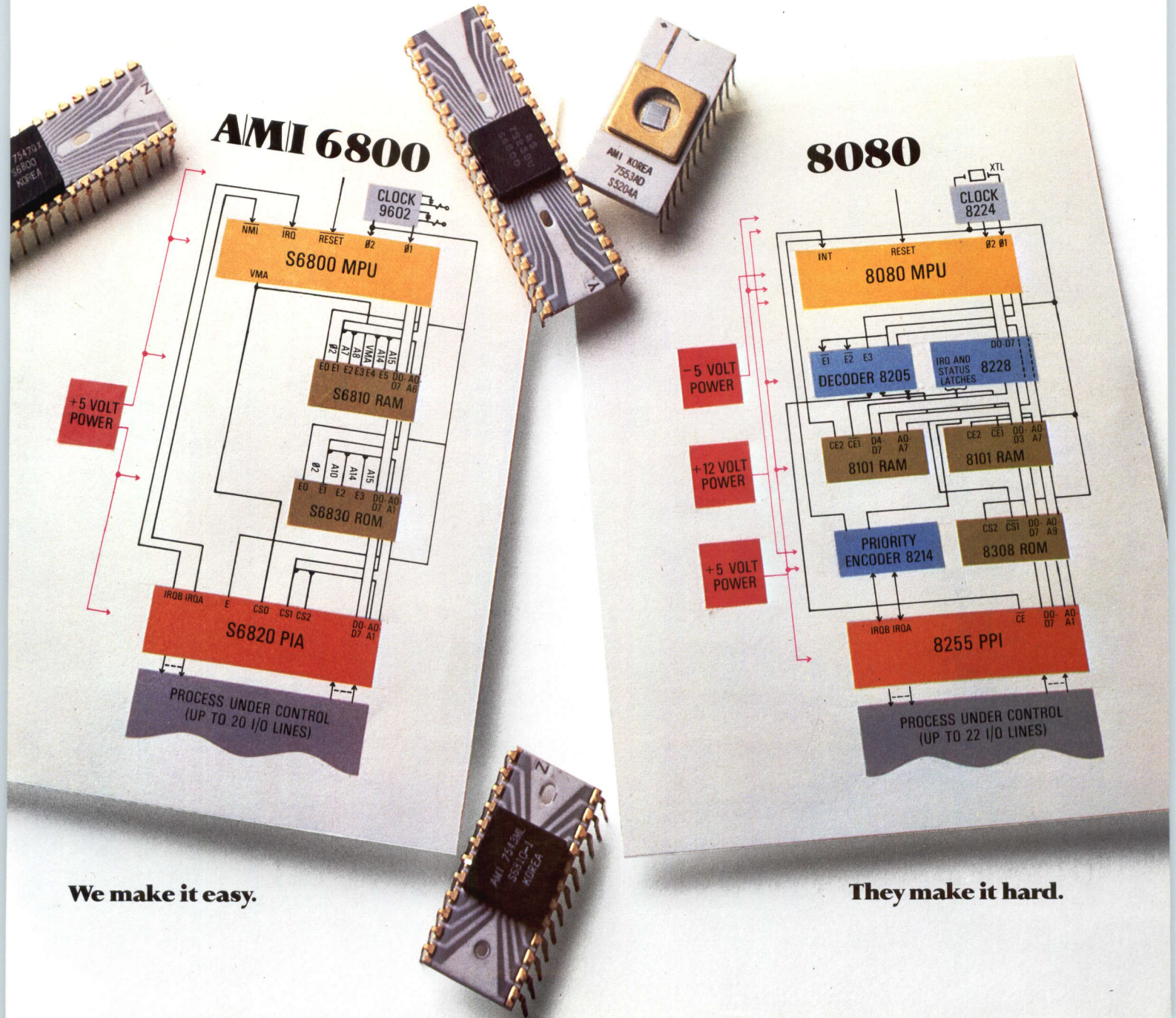
Besides the S6800 MPU, there are the S6810 128 x 8 static RAM; the S6820 Peripheral Interface Adapter; the S6830 8K static ROM; the S6831 16K static ROM; the S6834 512 x 8 EPROM; the S6850 Asynchronous Communications Interface Adapter; the S6860 MODEM; and the S2350 Universal Synchronous Receiver/Transmitter.

For low power or battery backed-up products, our new S5101 256 x 4 CMOS RAM fits right in.

Our S6800 is not only versatile. It can be very tough. It now comes in an industrial temperature range of −40°C to +85°C.

The AMI 6800 microprocessor family: you can't do better than that.

microprocessor.



We make it easy.

They make it hard.

We built a better

The AMI 6800 Development

It's so much better than the competition, they'll have to change their whole development philosophy to catch up.

The standard AMI 6800 Microcomputer Development Center consists of the 80 character x 25 line CRT, the dual floppy disk with disk operating system, an S6834 EPROM programmer, an RS232 interface, 16K words of RAM memory, a software debug package, editor and assembler.

You will also have options coming out of your ears. The most significant for most people probably are a character printer; EPROM and RAM memory modules; and soon an in-circuit emulator so you can use the CRT like a front panel.

Like everything else about the AMI 6800, our development system is a programmer's dream. We avoided the multiple box approach, with lights and switches, in favor of a very smart CRT with full debug software.

This bypasses all those hassles with paper tape, front panels, teletype or cassettes. In many cases, it cuts programming time from hours to minutes.

With your hands on the keyboard, and your eyes on the screen, you can modify programs instantaneously. You can interrupt after every instruction, and get a complete snapshot of the state of the machine. Or look at all the registers and change their values, simply by pressing a key. And you never have to translate addresses into binary to get information. In short, our smart CRT helps you make the right decision right away.

Why learn two processors when one will do?

Strange as it may seem, some development systems have different microprocessors inside than the one you're program-

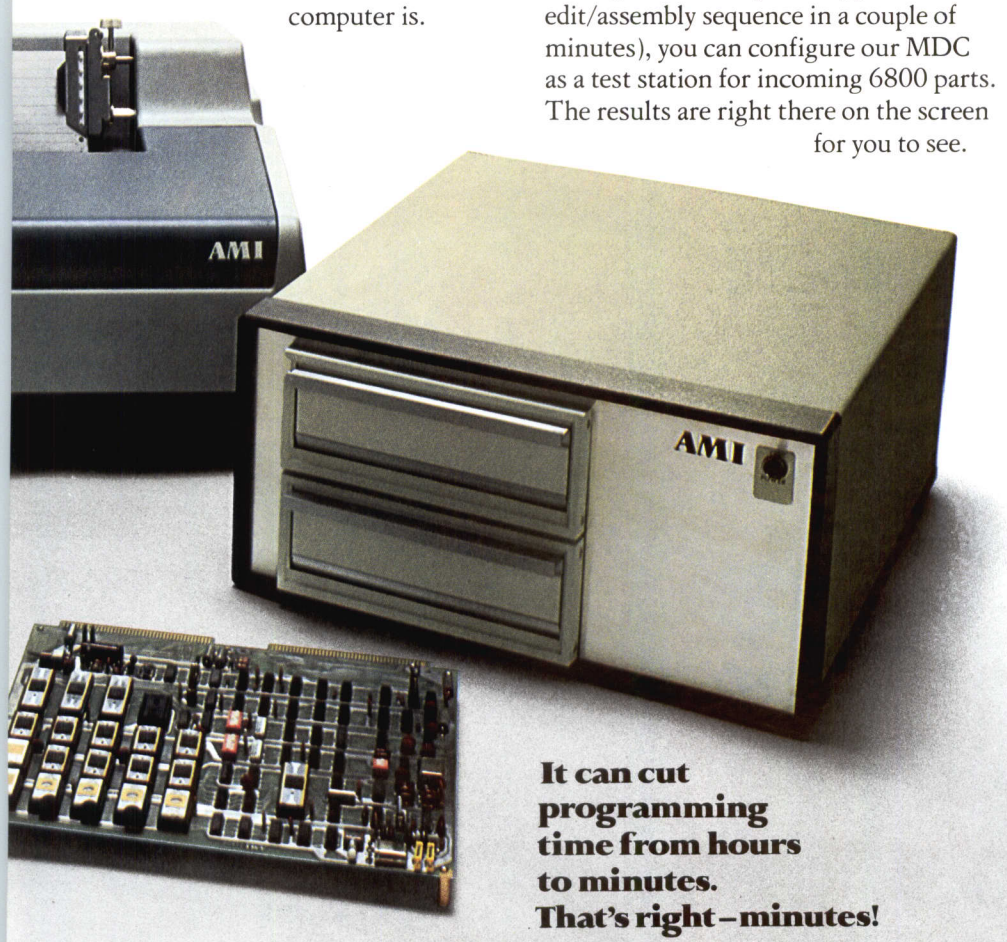
support system.
Microcomputer Center.

ming outside. So you have to learn two instruction sets instead of one.

Naturally, there's an AMI 6800 inside our terminal. And its performance there proves once again how powerful and versatile this microcomputer is.

Among many functions, it edits the screen, controls the communication's interface, and interacts with the disk and keyboard.

Besides high-speed program development (you can complete a typical edit/assembly sequence in a couple of minutes), you can configure our MDC as a test station for incoming 6800 parts. The results are right there on the screen for you to see.



It can cut programming time from hours to minutes. That's right–minutes!

There's no such thing as obsolescence.

With up to one megabyte of storage on-line in the dual floppy disk and a CRT controlled by our versatile 6800, you don't have to worry about this system ever gathering dust.

It converts very easily to a powerful, stand-alone microcomputer for a variety of uses, such as inventory control. Try that with any other development system, and you wind up with a pain in the peripheral. (Ask the competition for even a dumb CRT and they'll send you away to an independent supplier.)

We have another handy development tool, too, called the AMI 6800 Prototyping Board. This helps you debug programs, build 6800 hardware, evaluate parts, and even program our S6834 EPROM in about 40 seconds.

The Board has two 86-pin edge connectors, one for microprocessor bus extension and the other for input/output. Also on-board are 2K bytes ROM; 2K bytes EPROM; EPROM programming; 1K bytes RAM; totally buffered MPU; restart address selection; TTY operating system software; ROM subroutine program library; serial and parallel I/O ports.

In short, there's no better microcomputer than the AMI 6800. And there's no better way of developing it than with the AMI 6800 Microcomputer Development Center.

Don't take our Take theirs.

The facts about the AMI 6800 family speak pretty clearly for themselves. But the actions of some pretty big companies say even more.

Companies like Conrac, Hewlett-Packard, Memorex, Tektronix and TRW have selected the AMI 6800 for new products. And the varied uses they're

word for it.

making of our microcomputer speak volumes for its flexibility, power and organization.

The AMI 6800 turns the Conrac CRT into a highly intelligent terminal that adapts easily to perform a variety of stand-alone and peripheral computer functions. Hewlett-Packard's model 9815 programmable calculator achieves more speed and interface capability with the help of the AMI 6800.

Memorex selected the AMI 6800 for use in their new 1377 high-speed CRT.

In Tektronix' case, it allowed the 4662 Interactive Digital Plotter to include multiple interfaces, resident alphanumeric character generation and digitizing capability in a low-cost package.

TRW's new point-of-sale terminal, through the use of a 6800, offers multiple terminal personalities.

Although everyone recognizes the basic strengths of the AMI 6800, it seems everyone has a different reason for specifying it. Another tribute to its tremendous versatility.

The AMI 6800 has a great past, present and future.

We've been making MOS longer than any other company in the world. In our ten year history, we've never made a bigger commitment to any program, in terms of money and manpower, than we have to this one.

It marks a turning point for us. Although we're still the leading custom MOS manufacturer (and intend to remain so), the AMI 6800 is spear-heading our rapid advance in standard products.

Much of this effort is dedicated to keeping the AMI 6800 as the Number One microcomputer family. Soon 16K RAMs will be joining our 4K EPROM and other compatible memories. And new communications circuits will extend the 6800's capabilities in that field.

With plants in Santa Clara, California, Pocatello, Idaho and Korea, we're geared to handle any size orders. Very small to very big.

That's another important reason the big companies are coming to us. So why don't you get in touch with your nearest AMI sales office, distributor or representative listed on the next page. Or contact us at AMI, 3800 Homestead Road, Santa Clara, California 95051. Phone: (408) 246-0330. You couldn't make a better decision. Take their word for it.

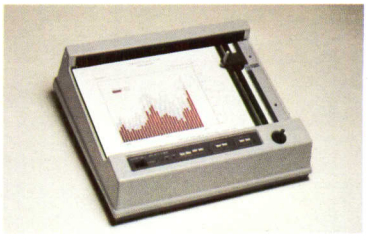
AMI®
AMERICAN MICROSYSTEMS, INC.

The Conrac 480/25 CRT Terminal

The TRW 2001 Point-of-Sale Terminal

The HP 9815 Programmable Calculator

The Memorex 1377 High-Speed CRT



The Tektronix 4662 Interactive Digital Plotter

How do you get the AMI 6800?

It's a snap.

Now it's as easy to get hold of the AMI 6800 as it is to use it.

We've built up our sales and distribution network to give you the products you need as soon as you need them. So snap up some AMI 6800s for your new products. And watch people beat a path to your door.

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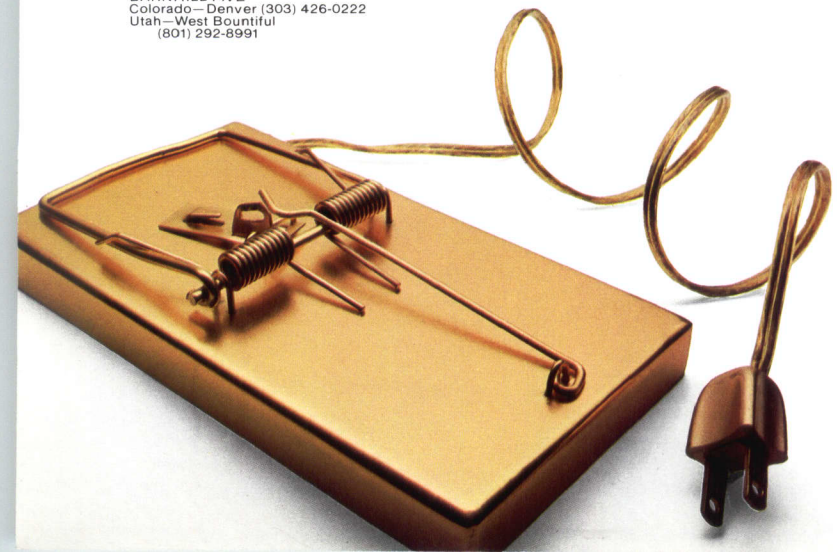

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continuing automatically after the interrupting procedure is completed.

Basic system configuration includes a desk type main cabinet and disc drive with one fixed and one removable disc. An internal peripheral adapter allows connection of up to 16 local and remote peripherals, including two 70- or 200-line/min. printers, up to three additional disc units, card equipment, and remote display stations for 2-way communication.

Main memory with capacity from 16K to 64K bytes is executed in core technology; cycle time is 1.5 μs/byte. Control memory is implemented with MOS ROMs, and has capacity for 6K 40-bit words. CPU features include 64 8-bit registers, and a main memory transfer rate of 550K bytes/s. A 54-instruction set is used, and self-diagnostic procedures continuously check for correct system operation.

DOS 400 software, stored on the fixed disc of the dual disc drive, provides operator programming and data support. Removable disc provides storage for programs and user files. Data for batch processing may be assembled and formatted by off-line key-to-cassette equipment, prepared by other computers, or result from a previous transaction run. Data may also be entered into the computer via magnetic tape cassette station, keyboard, or remote display station.

The operator's panel incorporates a 32-char display for operator prompting and visual checking of typed-in data. All transaction operations occur via a standard alphanumeric and a numeric keyboard. Programs are initiated by simply typing their code names on the keyboard.

Circle 145 on Inquiry Card

Dual-Processor Computer Requires No Complex Environmental Controls

Claimed to deliver twice the performance per dollar of comparable competitive systems, the dual processor DECsystem-1088 features typical performance improvements ranging from 1.4 to 1.7 over its predecessor, the -1080. Most powerful member of the large computer line offered by Digital Equipment Corp, 200 Forest St, Marlboro, MA 01752, the system requires no complex environmental controls, only a conventional computer room environment. This provides a hidden benefit in that environmental support costs will be significantly lower than for other equivalent systems, adding to overall operating savings.

Basic configuration consists of two KL10 central processors, 256K words of 36-bit memory, disc system with two 86-megabyte drives, magnetic tape system with 235-kHz tape drives, 32-line communications system, 1200-line/min. printer, and 100-card/min. reader. The system can be expanded into a dual configuration with redundancy for key operations, offering both maximum system availability and throughput.

Among the system's features are the RP06 disc storage subsystem. Each drive provides storage for 38 million, 36-bit words, and has dual-port capability which permits higher I/O transfer rates through simultaneous access over two channels by the same system. Average access time for the discs is 28 ms; word transfer rate is 2.5 μs. The subsystem effectively doubles the online base storage capacity of the unit—to over 5.6 billion characters. Up to 32 drives can be accommodated on a single system, with up to four individual channel subsystems.

Software support for the system includes Galaxy Batch and ITPS-10 packages. The batch package provides a 50% reduction in both real-time and central processor times over previously available batch-processing software, as well as a 75 to 90% reduction in disc accesses because of its efficiency in a virtual memory environment.

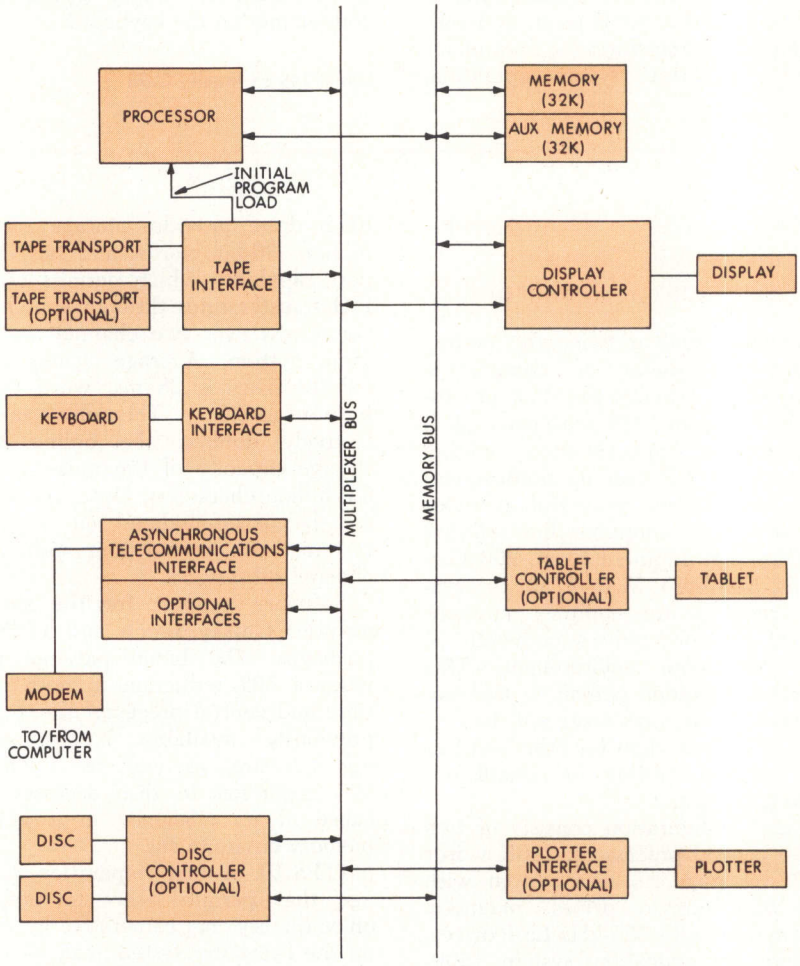
ITPS-10, a text-preparation package that permits users to prepare office-quality or camera-ready copy on the computer system, can be used for photocomposition, typesetting, and word processing. Text editing can be done on a video terminal; output can be photocomposition tapes or printed pages. Justification and hyphenation are performed automatically.

Circle 146 on Inquiry Card

Graphics System Provides Both Storage and Refresh Graphics

First of the 4080 series of computer-based systems which combine refresh with storage graphics for sophisticated applications of interactive computer graphics, the 4081 Graphics System from Tektronix, Inc, Information Display Group, PO Box 500, Beaverton, OR 97077, is designed to serve as an intelligent graphics terminal. It performs scaling transformations, translation, zooming, clipping, rotation, and character generation. By combining refresh with high resolution storage graphics, users can merge dynamic picture manipulation with a highly detailed picture display that has up to 20,000 in. of total image.

This interactive technology is achieved by incorporating two computers: a general-purpose processor and a special display processor. Both are housed in a desk style unit which includes 19″ display, tape cartridge drive, ASCII keyboard, 12 function keys, joy switch, and RS-232-C communications interface.



To combine refresh graphics with storage graphics in an intelligent graphics terminal, Tektronix' 4081 graphics system incorporates two processors: one general-purpose, the other a special display processor. Also included in the desk style unit are 19″ display, tape cartridge drive, ASCII keyboard, and RS-232-C communications interface

Standard software includes a 4014 emulator, which makes the system immediately compatible with the company's 4014 computer display terminal; and an intelligent graphics terminal package, which allows full utilization of the flexibility of refresh and storage graphics, local data storage, and local picture manipulation by the user's host computer application software.

Optional flexible or hard discs provide up to 40M bytes of additional local data storage. The graphics operating system, which supplies users with extensive facilities for picture manipulation, device independent control of peripherals, task scheduling, and host terminal communications, is supported by 32K bytes of standard memory; main memory is expandable to 64K bytes.

Input, output, and mass storage peripherals now available include two graphic tablets (11 x 11″ and 30 x 40″), interactive digital plotter (11 x 15″), 132-col printer, hard-copy unit, tape cartridge drive, and flexible and hard discs.

The system including 19″ display, display controller, computer, 32K-byte memory, 3M cartridge tape drive, ASCII keyboard, RS-232-C interface, operating system, 4014 emulator, intelligent graphics terminal software, diagnostics, and utilities is priced at $27,000.

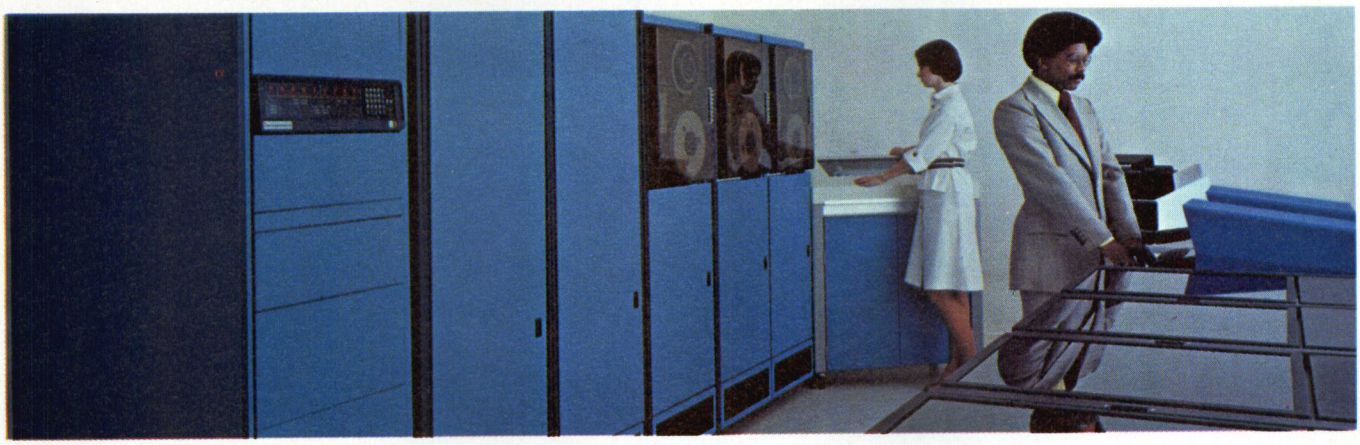
Circle 147 on Inquiry Card

Demonstration Proves Feasibility of Facsimile Communications

Demonstrating the practicality of data compression technology in the field of facsimile communications, an error-free copy of an 8½ x 11″ document was transmitted via satellite in the record time of 20 s. This demonstration was held during the Interface '76 Conference in Miami Beach, Fla.

Transmission was accomplished over a network consisting of a Rapifax 100 digital facsimile transceiver, Codex 9600-bit/s modem, voice-grade communications lines, and the COMSAT terrestrial circuitry (satellite) to a similar modem and transceiver at the Etam Earth Station, Etam, W Va. The circuit was then looped through an INTELSAT IV Atlantic

INTERDATA 8/32 MEGAMINI LIFE SUPPORT



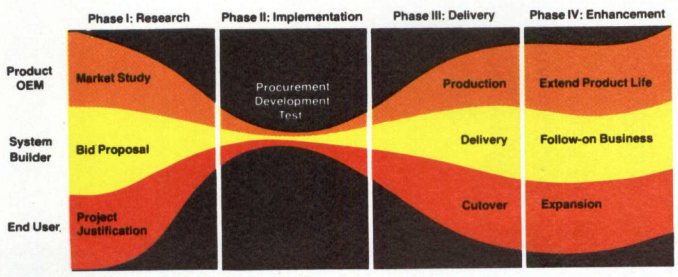
Risk-free computer buying–with power to spare.

You're looking for a computer system so powerful, it takes you over any snags that could cost you extra.

That's why Interdata builds the powerful 8/32 Megamini with 32-bit hardware performance and direct addressing capability of up to one million bytes. With unique software packages that are powerful, flexible and easy-to-use. With Megamini Life Support that means you'll never have to take a risk with:

On-time Delivery. Interdata guarantees on-time delivery of your Megamini. In fact, we've already shipped hundreds of 32-bit computers from production that are completely operational.

Hardware Back-up. Interdata hardware means 32 registers, each 32 bits wide. Fast single- and double-precision arithmetic. Optional, writable control store. And big computer peripherals. It also means that we support you long after your system is operational.



Interdata's computer products and services exist for one reason—to satisfy our customers: The Product OEM, the System Builder and the End User. Each of these computer buyers has a Computer Life Cycle with four specific Phases—Research, Implementation, Delivery and Enhancement. Interdata responds to customer needs during each Phase with Computer Life Support.

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Gentlemen:
☐ Send me more about Megamini power.
☐ My needs are:
__Immediate__6 Months__1 Year__For Reference Only

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"AMP developed a way to terminate up to 60 positions in one minute.
It's called mass termination."
AMP
CHAMP—the world's first insulation displacing, mass termination connector family—fully intermateable with existing types.

It's the direction industry is taking. And AMP, pioneer of this and many innovations, has already developed connectors to meet your needs.

You can terminate practically all types of cable —woven, laminated, twisted pair, even coaxial ribbon cable—without costly wire preparation. This latest technique is further proof of AMP's leadership in keeping connection costs down, because all can be wired directly into pre-assembled connectors, at production volumes.

Currently we have additional mass terminating ideas in our test labs, and this experience is at your disposal to help with your own ideas.

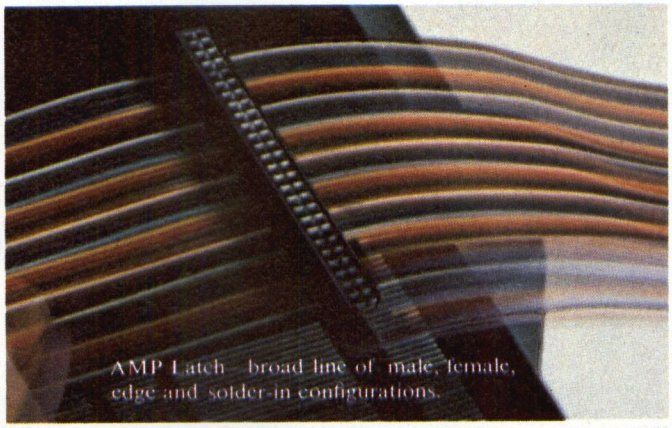
In coming to AMP you can be assured our field and home-office engineers will support you all the way. On the production line, in quality control, in sampling for prototypes, and by working continually with you to aid future designs. Professional engineers deserve support —at AMP, we have an international reputation for providing it.

For information on Mass Termination call (717) 564-0100, or write AMP Incorporated, Harrisburg, Pa. 17105.

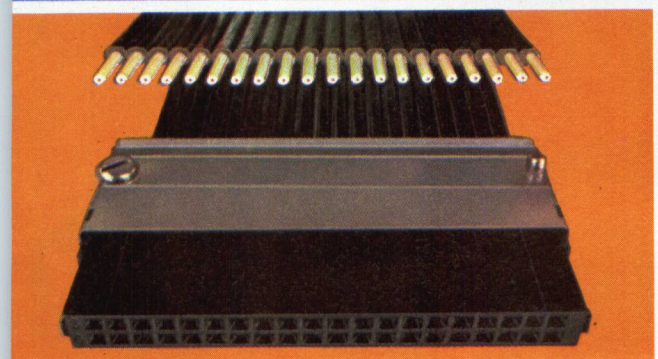
CIRCLE 24 ON INQUIRY CARD

AMP
INCORPORATED

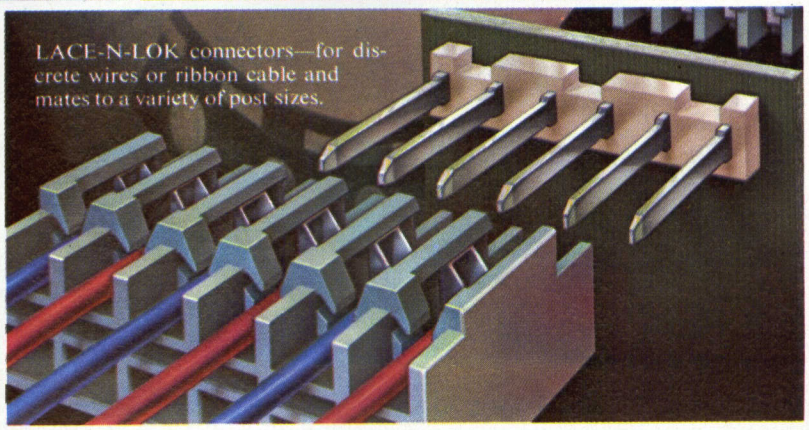
AMPlimite HDF-20—offers the capability of terminating an industry standard 1/0 connector to conventional .050" centerline round conductor flexible cable.



AMP Latch—broad line of male, female, edge and solder-in configurations.



Coaxial ribbon cable system—a true breakthrough in both cable and connection technique, for 50, 75, and 93 ohms.



LACE-N-LOK connectors—for discrete wires or ribbon cable and mates to a variety of post sizes.

AMP, AMPLIMITE & CHAMP are trademarks of AMP Incorporated.

Brownoutproof:

Often the Difference Between Up and Running or Down and Out.

To smooth out the Ups and Downs of today's utility power, digital design engineers are turning to The Dependables – the family of brownoutproof, switching power supplies that virtually eliminates the effects of utility power variations on equipment reliability.

The Dependables can supply their specified outputs at full load over input voltage ranges of 92 to 138 or 184 to 250 VAC; and, in fact, they'll operate for several minutes at inputs as low as 70 or 140 VAC. If AC input fails completely, the supplies will hold up for 30 milliseconds, allowing orderly system shutdown.

In addition to brownout protection, the Dependables feature:

- 0.1% Combined Line and Load Regulation
- 40,000 Hours + MTBF, Field Proven
- 0 to 50°C Operating Range at Full Load with 80% Output at 70°C
- U.L. Recognition

For over 17 years, Pioneer Magnetics has been designing, building and delivering switching power supplies. Today, more engineers are considering them. Because tomorrow, utility power isn't going to be any better.

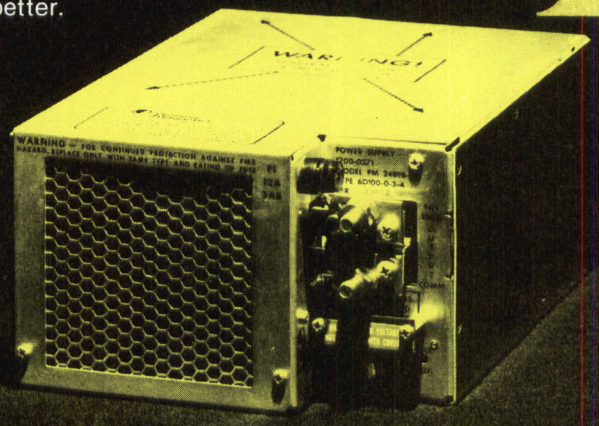
For complete information on our standard and customized switching power supplies, contact: Pioneer Magnetics, Inc. • 1745 Berkeley St. • Santa Monica, Calif. 90404 • Telephone (213) 829-3305 • TWX 910-343-6249.

MULTIPLE OUTPUT SUPPLIES

MODEL	PM2408		PM2486		PM2478		PM2480		PM2462	
	500W		600W		800W		1500W		2000W	
	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps
CHANNEL 1	5	50	5	75	5	100	5	200	5	200
CHANNEL 2	15	10	15	10	15	15	15	15	2	200
CHANNEL 3	15	5	15	5	15	5	15	15	15	15
CHANNEL 4	See Mfgr.		See Mfgr.		See Mfgr.		See Mfgr.		15	15

SINGLE OUTPUT SUPPLIES

MODEL	PM2496	PM2497	PM2498
OUTPUT VOLTS	OUTPUT AMPS	OUTPUT AMPS	OUTPUT AMPS
2	100	200	400
3	60	100	300
5	50	100	200
5	—	150	300
12	23	60	120
15	20	50	100
18	17	45	90
21	14	38	76
24	13	33	66
SIZE (inches)	5x8x11	5x8x11	5x16x11



Pioneer Magnetics

Pioneers in Switching Power Supplies.

CIRCLE 25 ON INQUIRY CARD

satellite and extended from the Etam Digisat (Digital Data Satellite Service) equipment through modems and terrestrial circuit back to a Rapifax 100 transceiver. The copy was received legible and error free. Spokesmen for Rapifax Corp, 6 Kingsbridge Rd, Fairfield, NJ 07006 believe that the transmission serves to demonstrate to medium to high volume communications users the feasibility of using high throughput facsimile systems as a viable alternative to TWX, Telex, mail, and courier services.

Several developments in the field of data transmission have made such transmissions feasible for use in the data processing environment. Of these, most dramatic was the development of digital satellite communications. This was paralleled by deterioration of the domestic U.S. Mail Service and its continuing cost increases, and by the decrease in rates for long distance communications. When the reduction in long distance rates is coupled with the speed of digital facsimile transmission, electronic mail becomes economically feasible.

The move has been further aided by the increased existence of multiplexing capabilities, provided by the high speed modems already installed within large corporations, and the availability of high speed digital facsimile equipment, such as the Rapifax 100, which with software support is capable of becoming an intelligent terminal rather than a communications convenience.

Circle 148 on Inquiry Card

Magnetic Media Seen to Meet Demands Through Error Correction, Testing

Although there is great demand for increased data storage densities and higher read/write speeds, no major technological advances are seen forthcoming in rotating magnetic media and data storage devices. Michael S. Shebanow, vice president of engineering for Pertec Corp's Peripheral Equipment Div, 9600 Irondale Ave, Chatsworth, CA 91311, commented that "the more stringent demands of new minicomputer systems will be met by more reliable production testing on the part of manufacturers and through the implementation of error detection and correction methods that are now chiefly limited to big data system files."

Speaking at a seminar—Magnetic Media: Good or Bad—held at the Invitational Computer Conference in Newport Beach, Calif, Mr Shebanow said that an example of such error correction techniques is the read-head offsetting feature incorporated in Pertec's D3000 disc drive. The read head searches from edge-to-edge of a track location if no signal is found where one is expected. Significant is the fact that this technique is available in an economical disc drive intended for minicomputer applications. Other techniques which Mr Shebanow expects will be used in low cost systems are variations of track or sector reassignment techniques, currently used by large system controllers. These controllers can automatically define the locations of defects on a disc and format information for storage such that these areas are not used. Another approach which may find use incorporates special algorithms to reconstruct data even if a number of bits within a record are missing.

Other changes that will accommodate the demands for higher density, higher speed recording are improved production testing methods. Single disc testing, where the unmounted disc is scanned by a magnetic head at twice the rate of read/write steps for which the disc is intended, has long been considered adequate. However, recent studies show that the test does not ensure high level reliability for worst case applications in advanced minicomputer systems. Thoroughly reliable testing must be done under actual conditions, with the disc mounted in a cartridge within a tester that resembles the drive with which it will be used. Using this setup, the disc must be operated with a test program that imposes worst case read/write operations on the surface. □

Circle 149 on Inquiry Card

Tired of debugging your PDP-11 the small system way?

The Program Debug Console from Formation will change all that. This powerful program debugging tool and systems maintenance aid performs a range of functions on the PDP-11 simply not possible with current software or hardware. Allowing you to stop or interrupt the system at any point, and then examine its various elements . . . and offering a unique "backward" look at the last 16 words that appeared on the UNIBUS, providing a valuable trace of the processor and I/O UNIBUS activity. It gives you, for the first time, a look at the PDP-11 under actual operating conditions, not a slowed-down, simulated environment. And the Program Debug Console electronics are packaged as a small peripheral controller (SPC), which means it's ready to go to work almost immediately.

Think big. Think about the Program Debug Console from Formation. One of the Maverick Systems. Offering the break in tradition their name reflects.

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Wake up the MAVERICK spirit inside you.

formation®
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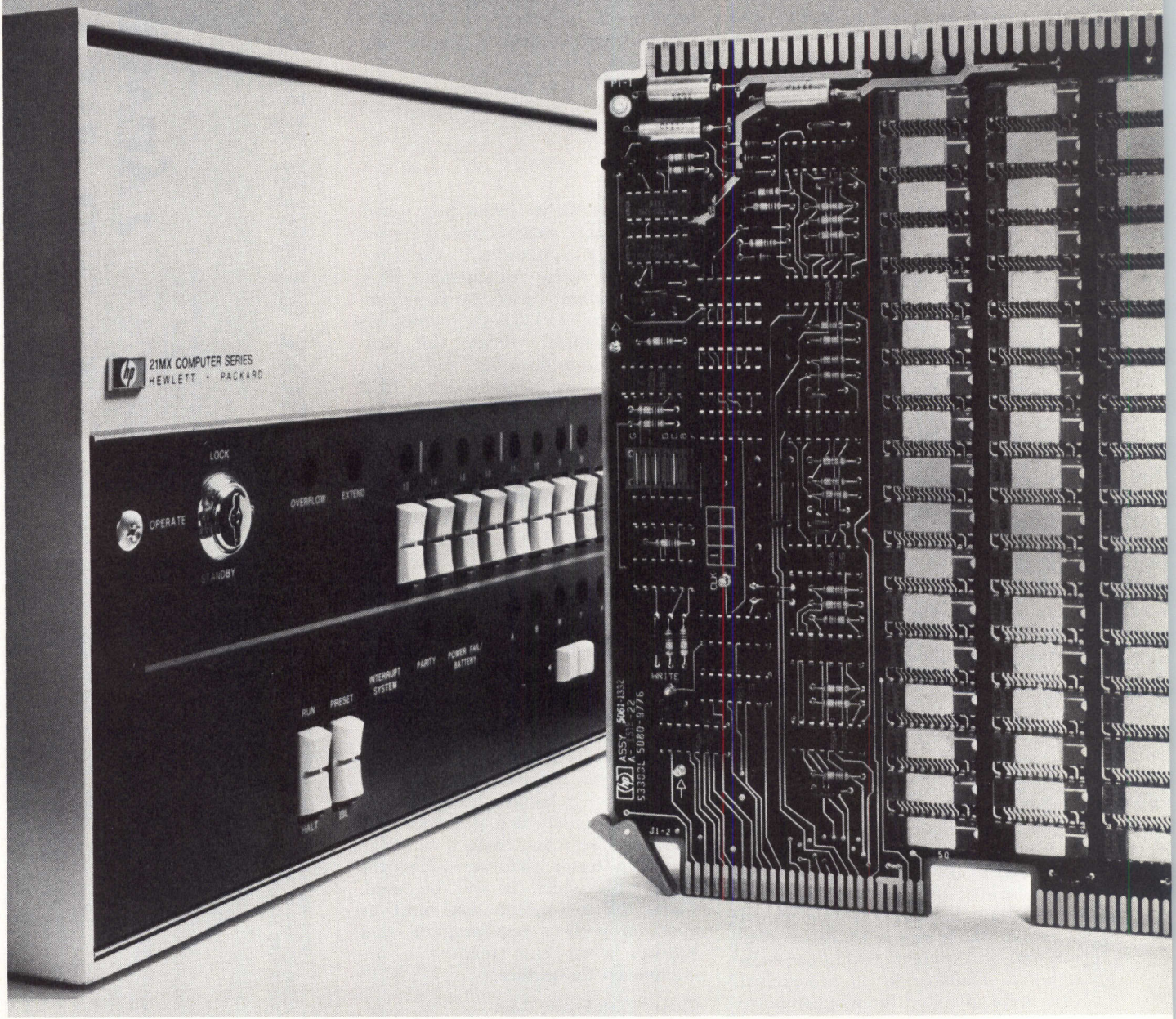
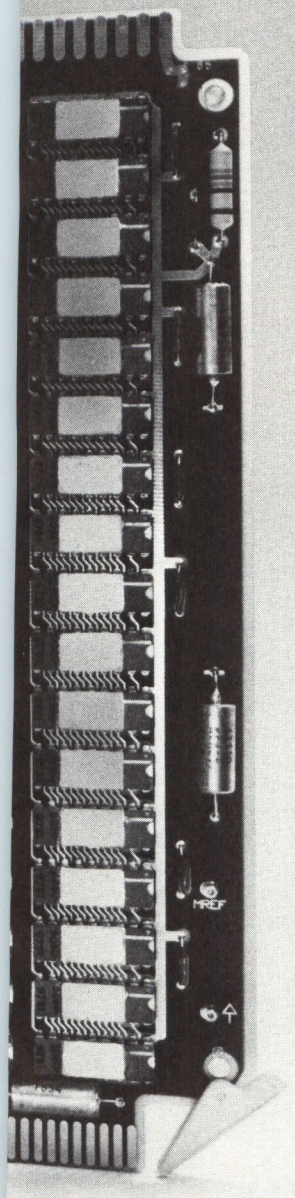
Mt. Laurel, NJ 08057
609-234-5020

CIRCLE 26 ON INQUIRY CARD

The Hewlett-Packard 21MX minicomputer sets a new price/performance standard.



Announcing 16K word memory with parity for $1386.*



Because the majority of a minicomputer's cost is its memory, the $1386 price for HP's new 16K word parity memory module is a significant price/performance breakthrough. And when you consider the low-cost memory along with the other features of the 21MX, it's a combination that's hard to beat. At any price.

Proven 4K RAM Reliability. Hewlett-Packard pioneered minicomputers with 4K RAM memory. Our unequalled field experience with more than 250,000 4K RAMS has proven their reliability. Solidly.

Doubled Memory Capacity. Now pack double the memory into your dynamic 21MX minicomputer. Put up to 32K words in 5¼" of space, or up to 128K in 13", without giving up a single powered I/O slot.

21MX Performance Extras. Each HP 21MX gives you more of what you buy a minicomputer for. Standard features that often are extra-cost options from others include floating point and extended arithmetic, brownout-proof power supply, ROM bootstrap loader, power-fail interrupt capability, and a full front display panel.

HP's Worldwide Service and Support. We're on the spot to provide installation, service and support for you and your customers throughout the world.

We're Shipping Now. The 21MX minicomputer family with the new 16K memory board is available and being shipped today.

HP Minicomputers.
Today's Price/Performance Leader.

	16K Add On Parity Memory	Computer† with 64K Word Memory
HP 21MX	$1386.*	$11,038.*
DEC 11/34	$2046.*	$12,995.*
Nova 3/12	$2368.*	$14,528.*

†Includes CPU, parity memory, memory management, EAU and battery backup. Source: Datapro
*U.S. domestic price. OEM quantity 50.

There's More. Every HP minicomputer and peripheral is designed from the start for easy, "building block" integration. Spend less time on design, and put your system to work faster. Other HP benefits range from installation and software to providing the level of service you specify. Or HP training, if you prefer to do it yourself. If you want more, call your nearest HP field office. Hewlett-Packard, the leader in 4K RAM minicomputers — and a lot more.

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DEVELOPMENTS

Computing Techniques Allow Whole-Body X-Ray Pictures in Minutes

Unconventional hardware and techniques—in both X-ray equipment and computer systems—have resulted in the ability to reconstruct highly detailed cross-section pictures of the human body. A computerized tomography scanner for total-body examinations developed at General Electric Co's Research and Development Center in Schenectady, NY includes a number of "technological breakthroughs" according to company officials.

One such breakthrough involves X-ray detectors that enable scans to be taken in less than 5 s, four to 60 times faster than other total-body scanners now operating at hospitals. The short scan time eliminates most of the lack of sharpness resulting from involuntary patient movement and reduces the necessary X-ray dose to the patient.

In this computerized procedure, the X-ray tube is pulsed 51 times/s for 4.8 s during a full rotation around the patient's body. A fan beam of radiation 30 deg wide covers the body cross-section being studied.

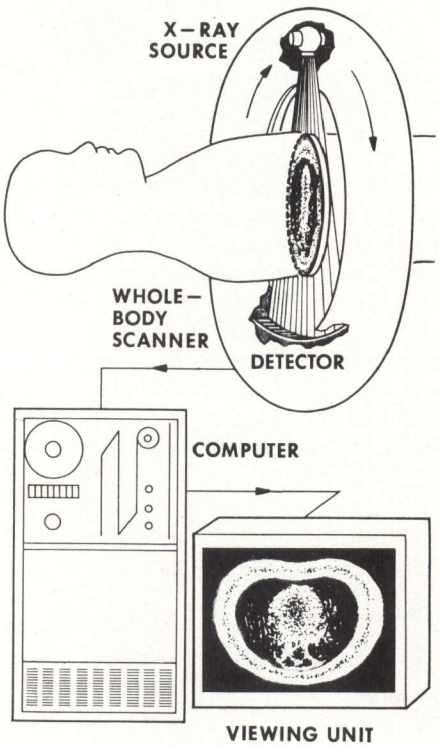
Detectors formed in a 320-element rotating array within a single high pressure xenon chamber collect the varying amounts of radiation that pass through the body. A single pulse is picked up by each detector. Electric charges, produced by ionization of the xenon gas when the radiation hits the detectors, are converted to digital signals by a special analog-to-digital converter. Conversion time is 10 ms.

Approximately 90,000 detector readings per scan are fed via a direct memory access channel into a Data General Eclipse™ minicomputer. Data are stored on an 88M-byte disc. Each slice contains 90,000 to 100,000 data points on scan queue.

More than 54 million computing operations are performed to reconstruct a cross-sectional image of body tissues and organs from the information supplied by the detector readings. Reconstruction is performed in two parts with 27 million operations in each part. Since data enter at all different angles, a convolution type algorithm is used in reconstructing the picture.

"Shadowgraphs" from the scan are combined in the computer. The resulting black-grey-white picture contains 1024 levels of grey. Data are pulled off the scan queue and placed on display queue. When the radiologist wants to view the display for a patient, he types in patient identification and then picture identification. The picture requested appears on a CRT screen. Details in soft tissue, bone, vascular system, and other areas can be emphasized by fine tuning. Electronic magnification can be obtained for specific areas. When desired, photographic prints can also be made from the computer-produced images.

A separate memory in the graphics terminal stores eight TV frames. The display also has refresh memory and a digital-to-analog converter.



Unlike conventional X-ray machines which take single-plane views of the human body, General Electric's computerized tomography whole-body scanner uses a fan-beam of X-rays. The X-ray tube is pulsed 288 times during a 4.8-s complete rotation about the patient. Varying amounts of radiation, collected by an array of 320 detectors, produce charges which are converted to digital signals and sent to a minicomputer. More than 54 million computing operations reconstruct the detector information into a black-grey-white picture on a CRT viewing unit

1M-Byte Semiconductor Memory Meets Needs of Small Computer Systems

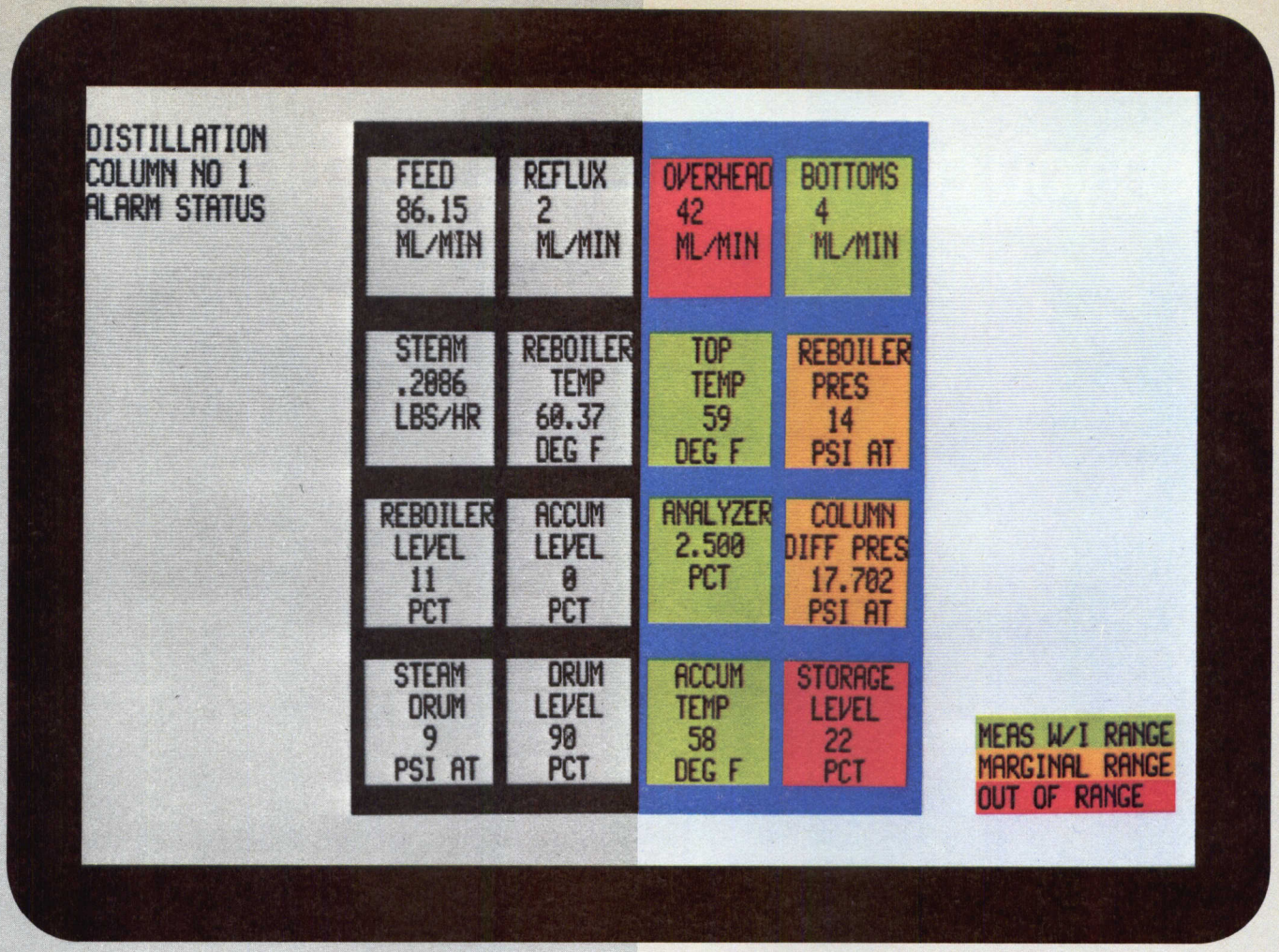
Said to be the first 1M-byte OEM semiconductor memory enclosed in a space of 2 cu ft, the 94550 dynamic random access memory (RAM) is based on 4K metal oxide semiconductor (MOS) storage devices. More than 1.3M bits (128K bytes) are provided on a single high density array card module, configured as 64K words x 20 bits. The basic memory consists of this module and a timing/control card. Application is intended for small computer and communications systems according to Control Data Corp, Minneapolis, Minn.

A full 1M-byte (10M-bit) configuration is attained by increasing the number of 128K-byte memory modules to eight. However, only the single timing/control card is required.

Full cycle (read and write, 1- or 2-byte mode), and partial write cycles are offered with data access time of 325 μs and cycle time of 450 ns. Interface is TTL. Power consumption is 140 W at 1M-byte capacity, permitting air cooling.

Both memory module and timing/control card are 11.75 x 10.9 x 0.34″ (29.8 x 27.6 x 0.9 cm) and mount

CIRCLE 28 ON INQUIRY CARD→



Take your pick.

Presenting visible proof that there are two sides to every story.

For the black and white side, take the MRD 380 or the MRD 980. The 380 is a basic teletypewriter compatible unit; the 980 is more advanced. Both are in a class by themselves, packaged to fit in anywhere. ADDS developed them specifically for the process control industry.

You take it from here.
MRD 380, $1195 MRD 980, $1995.

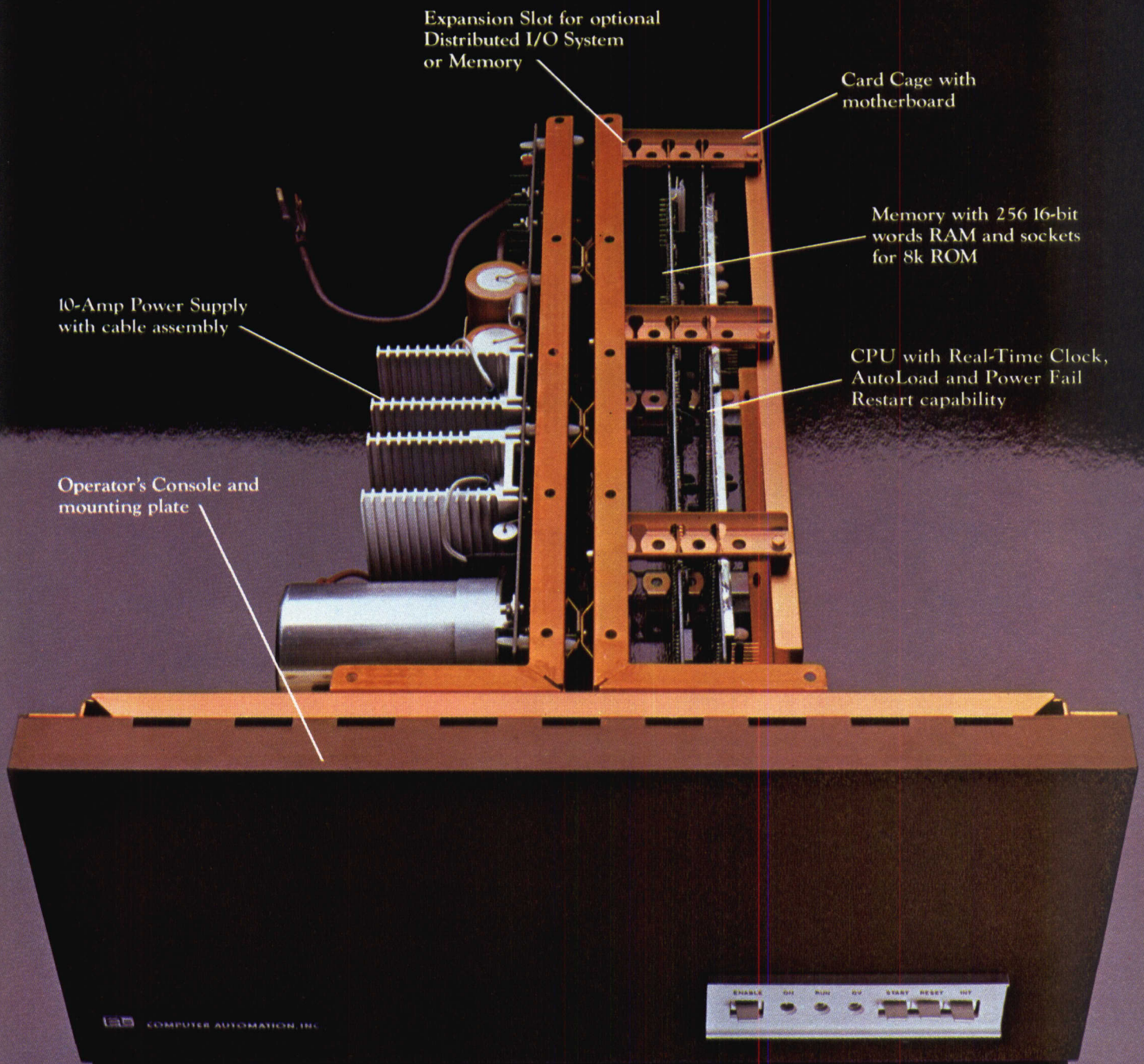
There's another side to the story. The MRD 460—a real show-off. Put it where you need it, and it'll show you what's what in eight snappy colors. If rapid visual indentification of information is important, the 460 is for you. It features graphics, formatting and extensive remote controls. ADDS developed it specifically for the process control industry.

You take it from here.
MRD 460, $3800.

ADDS.

Applied Digital Data Systems Inc.
100 Marcus Boulevard, Hauppauge, New York 11787 (516) 231-5400

When you can buy all this for a total of $701*



The ALPHA™ LSI-3/05 Millicomputer.
The lowest priced, 16-bit, full-scale, packaged computer in the world.

...building your own just doesn't add up.

Sum and substance. An unbeatable combination even for our competition, so you needn't feel too badly.

Especially when you consider everything we've got going for us.

Specialization, of course. OEM computers—*low-cost* OEM computers—are our only business. The NAKED MINI® people, remember? And when you do only one thing, you do it better.

Experience, too. Over 10,000 up-and-running, field-proven computers successfully integrated into all kinds of sophisticated OEM products.

Also, some things Henry Ford would have appreciated. Buying in volumes most OEM's can't manage. Building the same way.

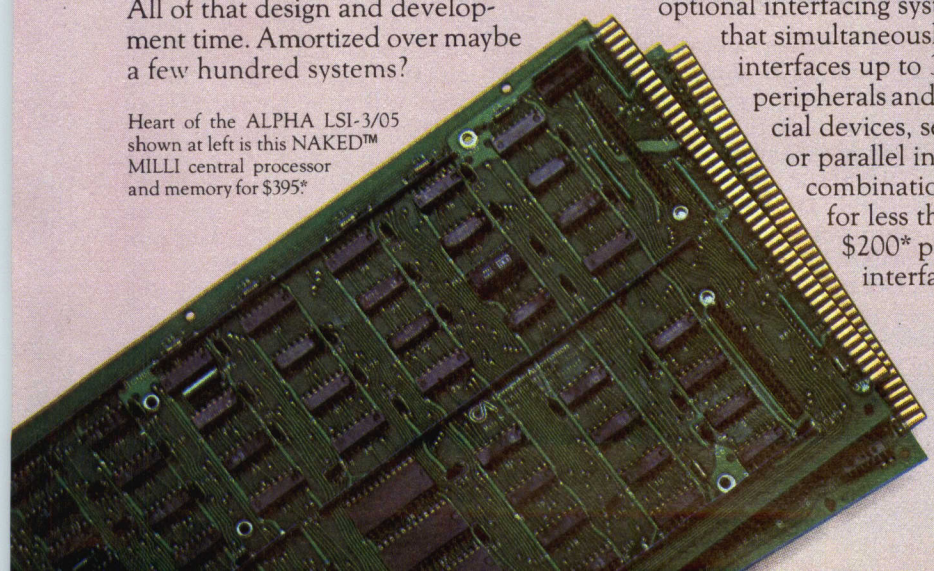
Where all that gets you is on the down-hill side of the learning curve...where we get our pay-off and you get the lowest-priced, most reliable computers around.

That explains why we can, but not necessarily why you can't. Here's the rest of the rationale:

The chip shot: a hit or a myth?

The fallacy of the microprocessor is that a chip set isn't a computer. Even if you got your chip sets *free* you still couldn't build a computer equivalent to our ALPHA LSI-3/05 for $701.

Price out the subassemblies shown in the picture and see what we mean. CPU, memory, card cage, power supply and console. All of that design and development time. Amortized over maybe a few hundred systems?



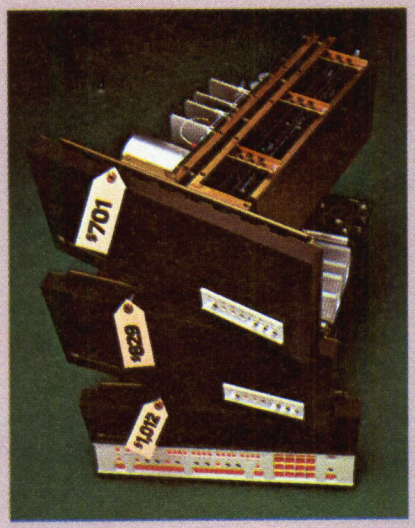
Heart of the ALPHA LSI-3/05 shown at left is this NAKED™ MILLI central processor and memory for $395*

ComputerAutomation will build thousands of ALPHA LSI-3/05 systems.

Then there's the packaging and fabrication. Cable assemblies, too.

Just think about the procurement activity alone. The lead time.

Getting our picture?



The ALPHA LSI-3/05 is offered in three series featuring a choice of card cages, consoles, memories and power supplies.

Computers vs. computerization

How do you talk to a computer?

Mostly with money, it turns out. Interface money. And mostly a lot of it.

Interfacing a computer to one or two peripheral devices can easily cost as much or more than the computer itself.

Which is why we invented the Distributed I/O System. An optional interfacing system that simultaneously interfaces up to 32 peripherals and special devices, serial or parallel in any combination, for less than $200* per interface.

What you see is not exactly what you get

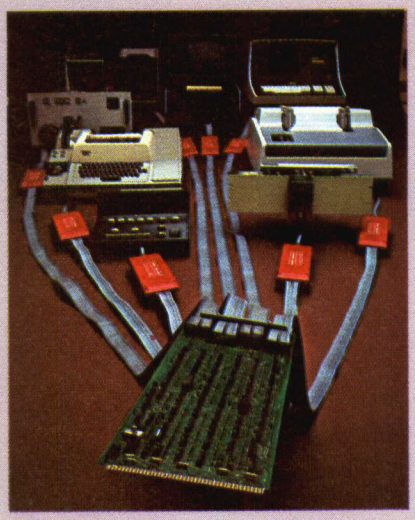
Here's what else you get when you buy an ALPHA LSI-3/05 millicomputer:

- ☐ 95 powerful instructions
- ☐ Individually vectored interrupts
- ☐ Direct Memory Access
- ☐ Memory expansion to 32K
- ☐ Maxi-Bus interchangeability for easy upward expansion to our full line of compatible minicomputers

Plus full-fledged minicomputer software.

From the people who brought you the NAKED MINI

The people with the largest line of compatible computers in the world.



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

The people with the lowest-priced computers in the world.

The people with the first and only Distributed I/O System in the world.

The people who've been simplifying OEM build versus buy decisions for years.

ComputerAutomation
NAKED MINI Division

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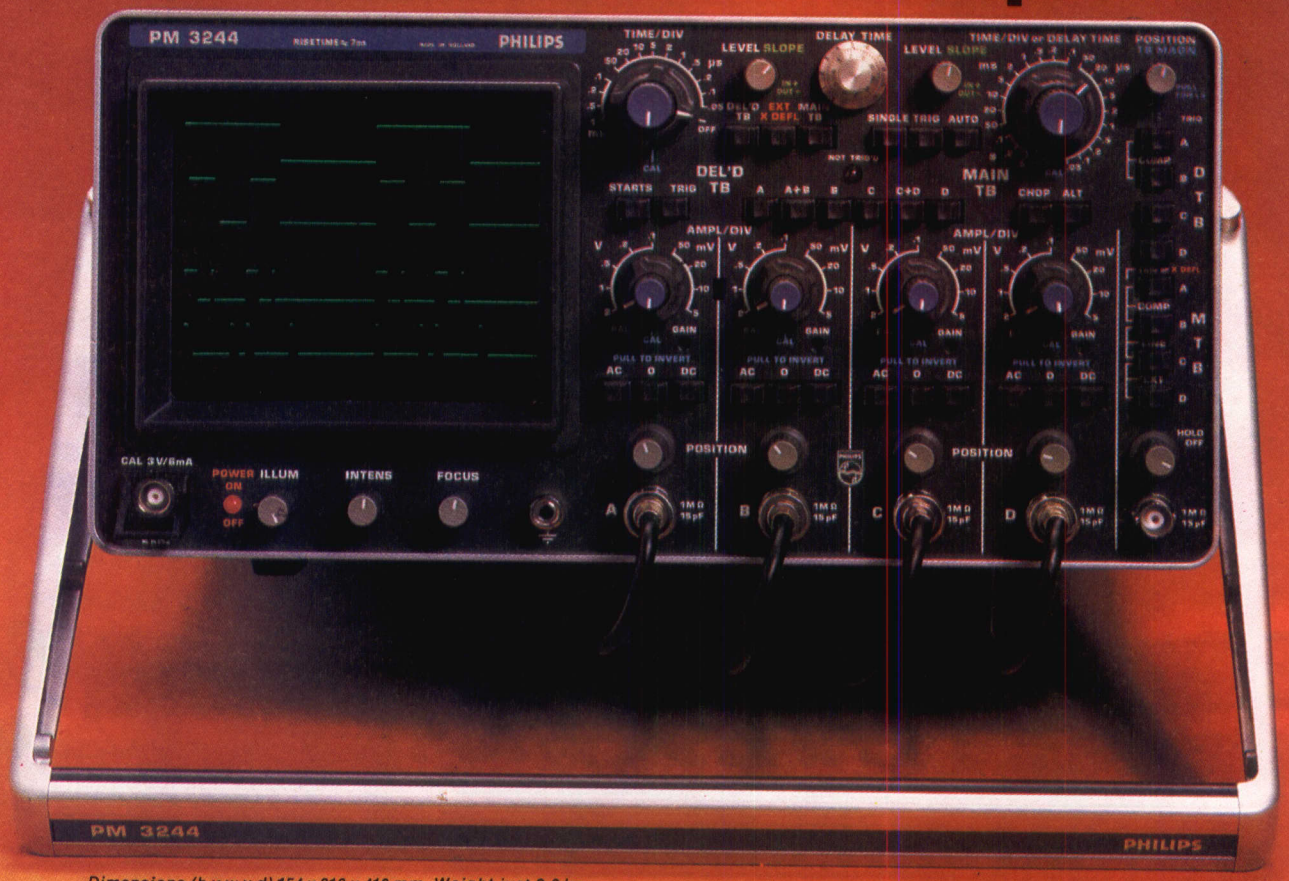
(714) 833-8830
EUROPE Hertford House, Denham Way, Maple Cross, Rickmansworth WD3 2XD, Hertfordshire, England; Telephone: Rickmansworth 71211

*All prices shown are for lots of 100 (U.S.A. only)

Patent Pending

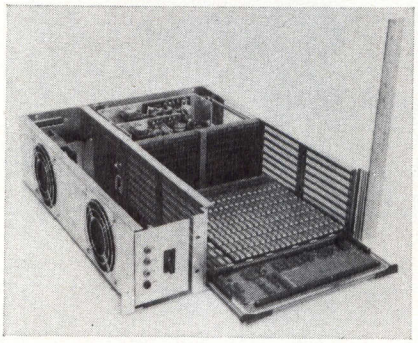
For further information, circle 29 on Inquiry Card.
Please have a salesman call—circle 81 on Inquiry Card.

World's first 4-channel compact...



Dimensions (h x w x d) 154 x 316 x 410 mm. Weight just 9.6 kg.

DEVELOPMENTS



Up to 1 million bytes of RAM can be contained in this 5¼ x 19 x 20" enclosure. Memory modules (one shown in enclosure) use 4K MOS devices and are in 64K x 20 configuration. Only single timing/control card is needed. As shown, enclosure also contains power supply and cooling fans

on 0.5" centers, providing a density of 30K bits/in.^{3} Up to eight memory modules and one timing/control card mount in a 5¼" (13.33 cm) high enclosure that fits a standard EIA 19" rack. This enclosure is 20" (50.8 cm) deep. Cards mount horizontally. Air is directed horizontally across the memory modules and card by self-contained cooling fans.

An integral supply provides dc power needed for a fully-complemented enclosure. Input ac power required is 120/230 V at 50/60 Hz.

Operating temperature range is 0 to 55°C (−40 to 80°C nonoperating) at 90% humidity with no condensation. The memory system is rated for operation to 10,000 ft (3000 m).

Optical System Reads Mixed Handprint and Machine Printed Data

Capable of reading mixed alphabetic and numeric handprinted characters, Grafix I is undergoing its final testing in the central office of the British Dept of Health and Social Security (DHSS), at Newcastle-Upon-Tyne, England. The system is a computer controlled reader developed by Information International, Inc, Los Angeles, Calif.

During factory trials the system has achieved a reading rate in excess of 150 characters/s—mixing handprint and computer printing. The character reject rate ran <2% and the substitution rate was <0.05%.

Grafix is claimed to be the first optical character recognition (OCR) system capable of converting intermixed alphabetic and numeric characters from handprint to a computer compatible form, and the first to recognize the full alphabet, special characters and numbers, in handprint form. The company also claims that it is the only OCR system which can read a mixture of handprinted characters and machine printed information.

In the first year's operation, the system is expected to read 1.6 x 10^9 characters. In the initial DHSS application, forms will be output from computers and distributed among some 1800 clerks who will handprint data on the 11¾ by 10½" forms. The forms will then be microfilmed and the film input into the Grafix system where microfilm page images will be read and stored on magnetic tape. That tape transfers the data into the department's main data processing center. Paper archives are eliminated since only the microfilm need be permanently stored.

If the reader fails to recognize the character automatically, it stores a "picture" or graphic representation of the unrecognized shape—maintaining an index of the char-

...with amazing triggering facilities

There's never been a spec. like this before.
☐ four 50 MHz channels plus
☐ two differentials (simultaneous display if needed) plus
☐ fully independent triggering of main and delayed time bases meaning
☐ main time base triggering on any of the four channels + composite + external + line and
☐ delayed triggering on any four channels plus composite.
☐ Moreover it all comes in a compact 9,6 kg construction.

So now you can display just about anything, for example a magnified view of any delayed section of a signal even when it is not directly related to the main time reference!

Easier to use too

One look at the PM 3244's front panel tells you everything. Controls are logically grouped and positioned to fall naturally to hand. So you study the screen and not the 'scope.

One look inside will tell you how it's done - with a Philips technique called cold switching. This means that the actual switching is performed on the boards with simple DC signals from the controls. The removal of mechanical connections eliminates layout and electrical design restraints, which in turn allows the PC boards to be designed for optimum layouts at all frequencies and for all facilities. Reliability is therefore greater, both mechanically and electrically,and servicing is made easier.

Another Philips development gives you remarkable low 29 W consumption which eliminates the need for ventilation fans and holes. It also boosts reliability and allows the PM 3244 to work from a battery pack as well as just about any voltage/frequency combination. So the world's first 4-channel compact lives up to its name. Going anywhere that 4 channels are needed. Which in todays's digital world means just about everywhere.

Find out more by contacting Philips or utilize our toll free HOT LINE number 800 645-3043. New York State residents call (516) 921-8880 collect.

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PHILIPS

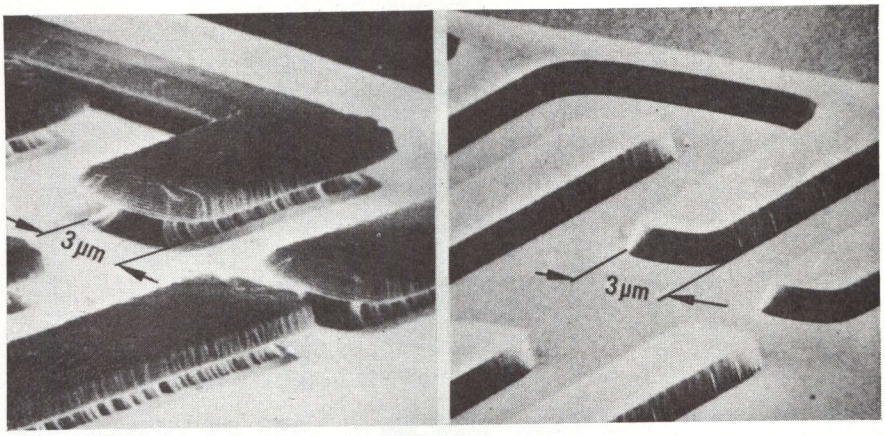
For information circle 30 on Inquiry Card.
For a demonstration circle 31 on Inquiry Card.

acter's position and the file from which it came. At the same time, in a separate operation, the unrecognized image is presented to an operator on a CRT screen. Seeing the garbled letter, or number, in context usually results in easy operator identification. The character is then entered into the system through a typewriter-like keyboard.

Ion Beam Etching May Eliminate Undercutting On Semiconductor Chips

Although the use of electron beams in photomasking processes can produce structure spacings of 1 μm or less, different methods must be used to create the structures defined by a photomask. Chemical etching processes have an undercutting effect in which side walls are washed away from underneath at the order of magnitude of the depth of the etch (left-hand photo). When using superfine structures in the submicrometer range, that amount of undercutting cannot be accepted.

Siemens laboratories in the Federal Republic of Germany are currently working on a process in which an ion beam working mechanically like a sand blasting jet cleanly cuts out even the finest chip structures (right-hand photo).



Comparison of chemical and ion beam etching. Chemically etched structures in the left-hand photo are characterized by undercutting below the photomask and the curved side walls. Ion-etched structures in the right-hand photo are characterized by smooth, straight side walls

Fast argon ions required are produced in the plasma chamber of a special installation and are directed onto the photoresisted silicon chips. Structures are transferred practically without change in dimensions independently of the resist adhesion. The particular advantage of this process is that the side walls of the chip structures are smooth in contrast to chemical etching and the angle of the side walls has a uniform value of around 65 deg. Ion etching is also easily reproducible since exclusively simple-to-check parameters have to be controlled in the process. Because the etching process is dry, without etching or rinsing solutions, there is thus less effluent to be processed in the plant. □

What large OEM's need today:

a short cut into microcomputing

...that's easier to get, easier to use, easier to expand at will.

You've got it. With the new LSI member of our Solution Series. The GA-16/110. A full-fledged 16-bit computer on a single plug-in board. Specifically designed for dedicated computer applications, such as remote data collection and control, terminals, and communications concentrators.

Dollar for dollar, spec for spec: the fastest, most flexible, lowest cost microcomputer *with* full software support and dozens of I/O controllers, now available off the shelf.

Performance twice as fast as the nearest competitor. Powerful repertoire of 120 basic instructions. Memory expansion from 512 words to 64K words. And this "load-and-go" worker, the GA-16/110 system, shares software and I/O compatibility with all Solution Series family members, right up to the GA-16/440 super mini with 2 mega-bytes of memory.

Terrific price/performance tradeoff too. From $474 for a fully-operational 512-word computer. To $1692 for a complete 8K packaged system. (OEM quantities of 200.)

Say you need still more: our GA-16/220 will do the job. By adding more I/O capability, more interactive controls, more displays, you get full minicomputer performance and features at microcomputer prices.

And the rich GA-16/220 software includes: batch operating systems; foreground/background real-time operating systems; indexed file management systems. FORTRAN IV; COBOL; multi-user BASIC; macro assembler; and a lot more. *All* are off-the-shelf software, currently in the field working in applications such as yours.

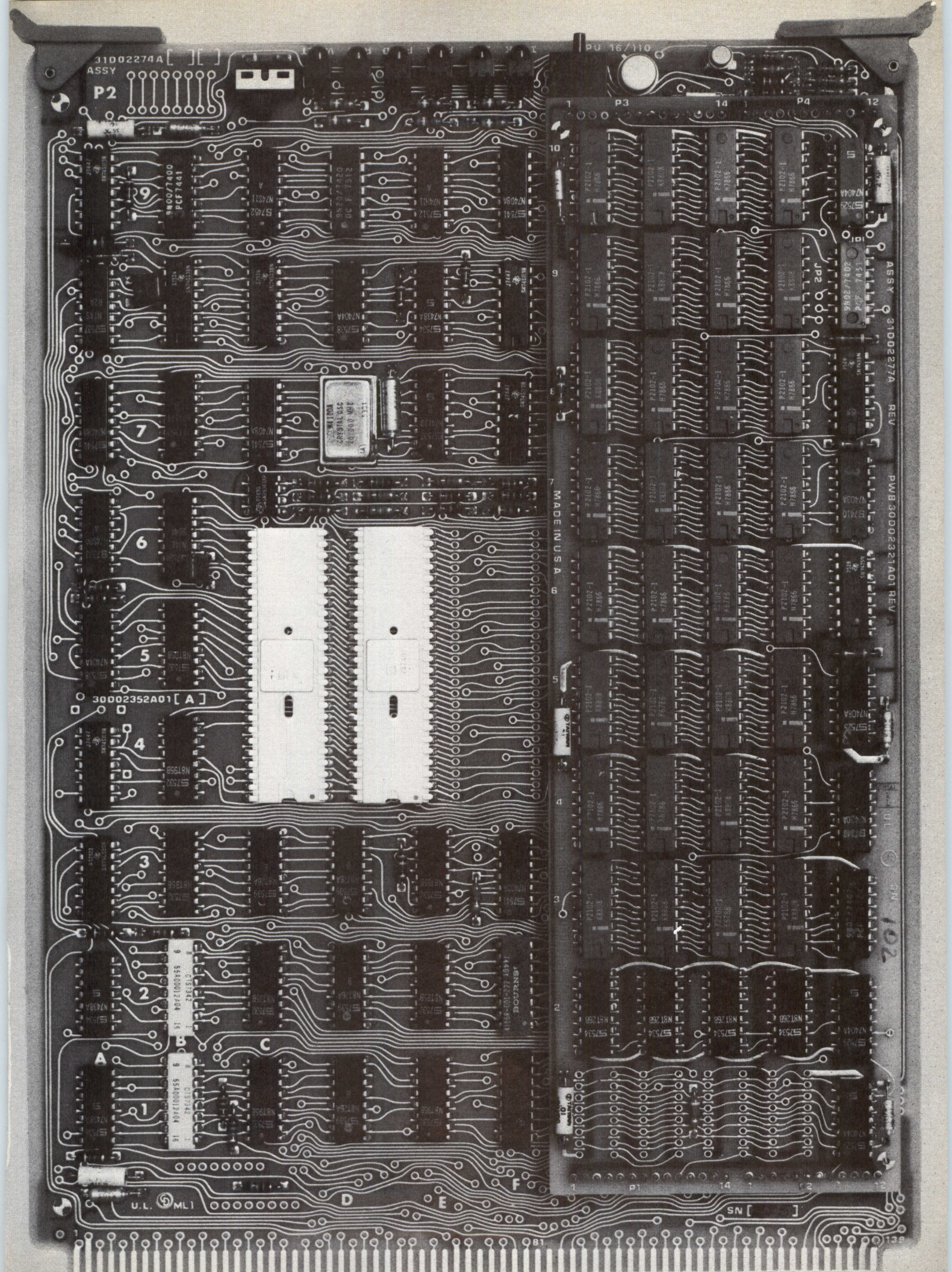
Compared to any computer family in production today, the Solution Series meets your requirements with the largest variety of configurations and range of performance, backed by the broadest software and I/O support. Hands down, the shortest distance to your microcomputer product is the new Solution Series family from a real solution systems company—General Automation.

For product info, write General Automation, 1055 South East Street, Anaheim, California 92805. (714) 778-4800.

Also General Automation, Paris, France and G.A. Computer Ltd., Ontario, Canada.

GENERAL AUTOMATION

CIRCLE 32 ON INQUIRY CARD


31D02274A
ASSY
P2
PU 16/110
P3
P4
JP2
ASSY 31D02277A REV
PWB 30D02321A01 REV
MADE IN U.S.A.
30D02352A01 [A]
U.L. ML1
SN
P1
P2

Microprocessor-Controlled System Diagnoses Tugboat Engine Malfunctions

River- and ocean-going tugboats—although not particularly glamorous and usually inconspicuous alongside the much more visible cargo vessels and tankers—still have stringent maintenance requirements. As with their larger relatives, reduced engine efficiency can mean increased fuel consumption or even missed schedules; and catastrophic engine failure can endanger cargo and crew.

Each tugboat has multiple diesel propulsion and power generation engines of eight to 20 cylinders that develop 1000 to 4000 hp. Since the engines must operate continuously for extensive periods, preventative maintenance cannot be left to the whims or intuition of crew members or depot personnel. Minor repairs and servicing must be performed during the short layovers—and major overhauls must be scheduled well in advance.

That the problem existed was apparent; solving it was not. Tugboat operators could not afford lengthy out-of-operation periods while their engines were torn down for visual inspection. Neither could they afford monitoring and diagnostic equipment that would be too involved for use by busy tugboat captains.

One Solution

At the request of a large tugboat operator, Advanced Electronic Development, Old Saybrook, Conn designed a 128-channel data acquisition system which monitors engine performance, reports periodic maintenance requirements, predicts failures, and identifies actual mechanical failures. It supplies the information to the ship's master as hardcopy printout in a manner he can easily understand. Because crews are not expected to be instrumentation engineers, the system is completely automatic, requiring no crew intervention. It also is designed to fail gracefully, with no false warnings.

Rather than a minicomputer, SIDS (for Seaborne Integrated Diagnostic System) is based on a National Semiconductor IMP-16 microprocessor. Support is provided by 8K words in programmable read-only memory (p/ROM) and 512 words in read/write (R/W) memory, all in 16-bit format. Because the system does not merely acquire data, but also performs necessary conversions, interprets engine conditions, and provides fault diagnostics, it requires this large amount of p/ROM. Half of the R/W memory is battery powered to maintain long-term timer accuracy despite generator fluctuations.

Two turbocharged main engines and two turbocharged generator sets are monitored. Induction air, engine coolant, and lubrication system temperatures for each engine, as well as exhaust gas temperatures at each cylinder, are measured. Numerous pressures are instrumented, including intake manifolds, lubrication system, and fuel lines. Engine speed and alternator output are monitored. In all, 96 of the 128 channels are used.

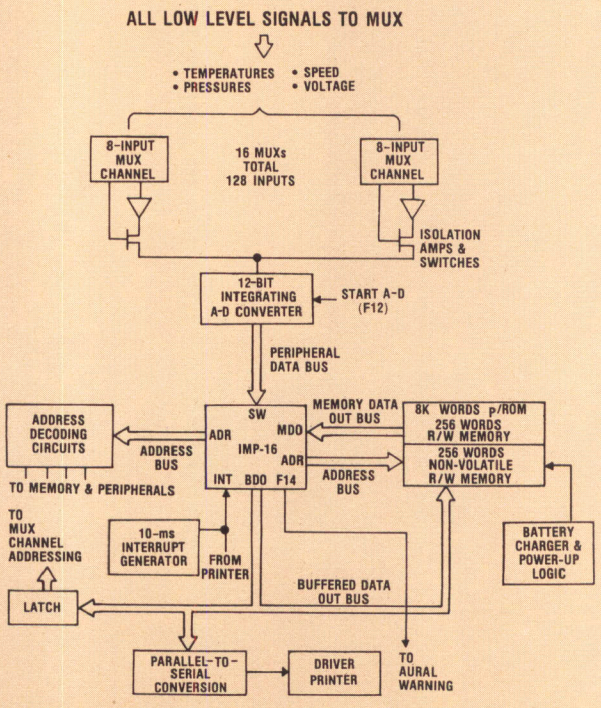
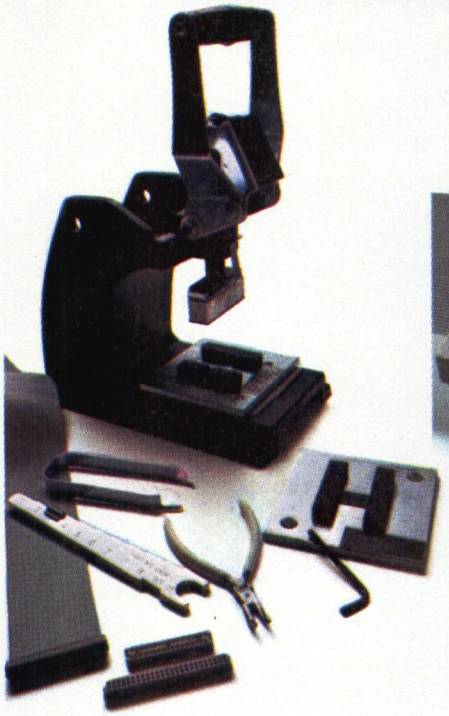


Fig. 1 Data acquisition system developed by Advanced Electronic Development monitors 25 pressures, 65 temperatures, speed, and power on 4-engine tugboat power plant. System is interrupt driven at 10-ms rate. If system hangs up in acquisition, calculation, or fault-tree, it will be reinitiated. Thermocouple reference, gain settings, offset, and scaling are performed with software

(Continued on p 64)

Design with the complete flat cable/connector system.



trimming the cable after assembly.

Connector units provide positive alignment with precisely spaced conductors in 3M's flat, flexible PVC cable. The connector contacts strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

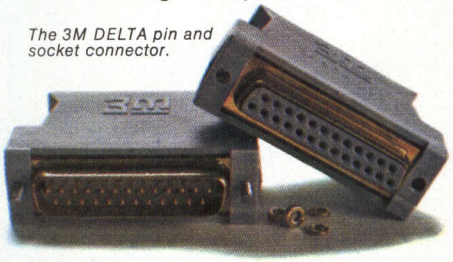
Assembly-cost savings are built in when you design a package with "Scotchflex" flat cable and connectors. But more important, 3M Company offers you the full reliability of a one-source system: cable *plus* connectors *plus* the inexpensive assembly aids that crimp the connections quickly and securely (with no special operator training required).

The fast, simple "Scotchflex" assembly sequence makes as many as 50 simultaneous multiple connections in seconds, without stripping, soldering or

With cable, connectors and assembly tools from one design and manufacturing source, you have added assurance the connection will be made surely, with no shorts or "opens."

And "Scotchflex" now offers you more design freedom than ever. From stock you can choose shielded and non-shielded 24-30 AWG cable with 10 to 50 conductors, and an ever-increasing variety of more than

The 3M DELTA pin and socket connector.



100 connectors to interface with standard DIP sockets, wrap posts on standard grid patterns, printed circuit boards, or headers for de-pluggable applications. 3M's DELTA "D" type pin and socket connectors are now also available. For full information, write Dept. EAH-1, 3M Center, St. Paul, MN 55101.

3M COMPANY

3M's "Scotchflex" line.

See our catalog in EEM 2•1034.

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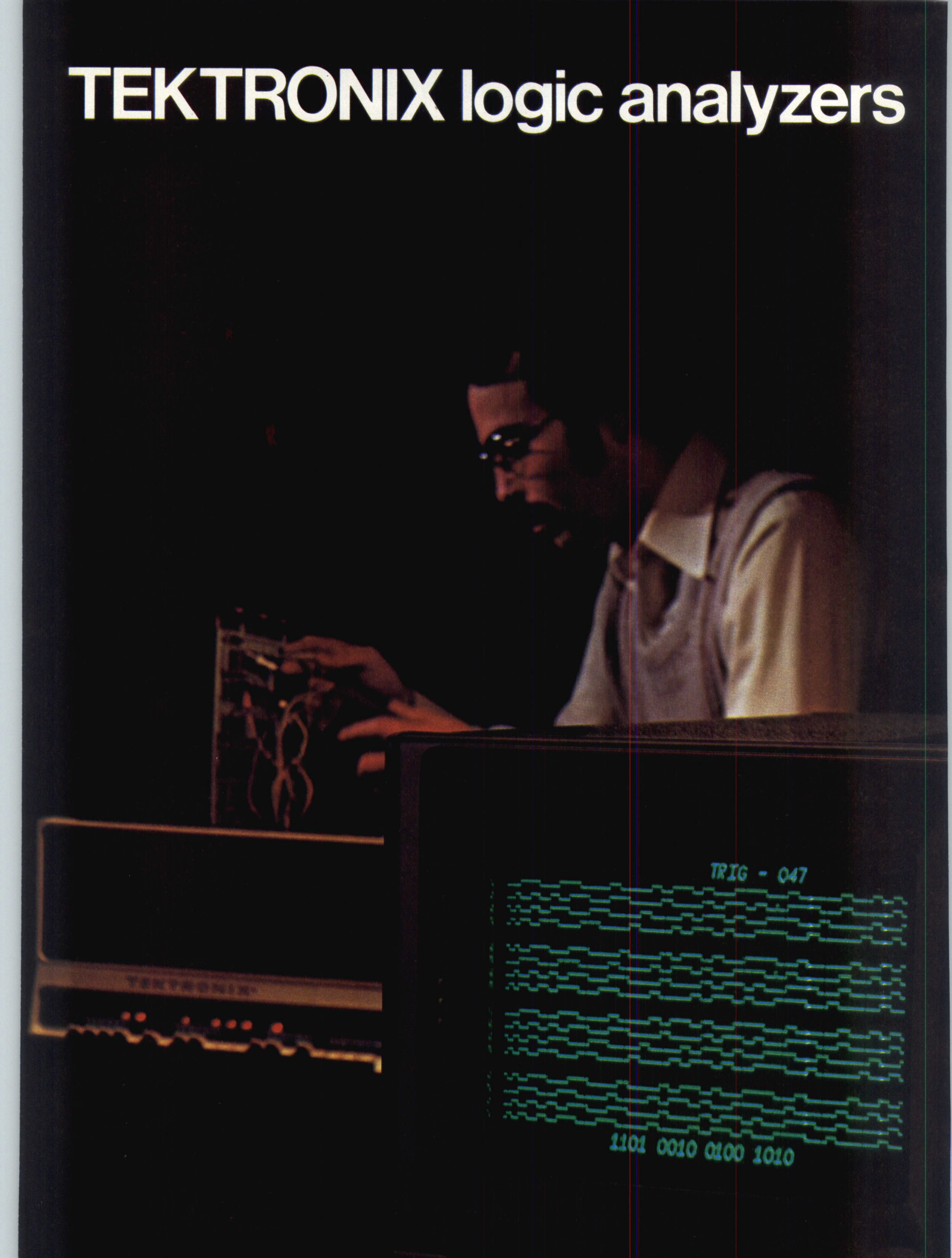
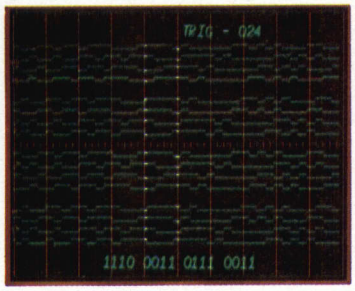
CIRCLE 33 ON INQUIRY CARD

TEKTRONIX logic analyzers



for the digital domain



Timing and binary information together with intensified trigger marker and cursor displayed by the 7D01 Logic Analyzer. The number of sample intervals from the trigger point to the cursor appears at the top of the display; cursor position—displayed in binary—appears across the bottom of the crt.

New Plug-ins with Expanded Capabilities

For digital design and testing applications, you'll find that Tektronix Logic Analyzers and Oscilloscopes are literally made for each other. To expand your digital analysis capabilities, choose either the 7D01 Logic Analyzer (a new plug-in for our 7000-Series laboratory oscilloscope family) or the LA 501 Logic Analyzer and its new companion plug-in, the WR501 Word Recognizer (these two are packaged as modular TM 500-Series instruments to work with almost any oscilloscope).

Features these analyzers have in common include:

- **16 Channel Operation**
- **15-ns Asynchronous Timing Resolution**
- **4k Memory to Store Pretrigger Data**
- **Word Recognition**
- **High Z Probes**

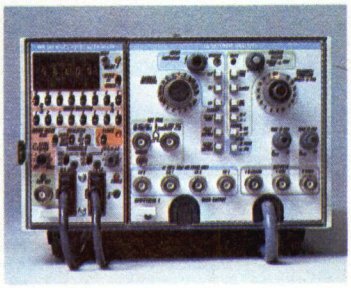
For versatile data acquisition, these logic analyzers let you select the number of channels and the resolution best suited to specific applications:

16 Channels, 20 MHz, 256 Memory Bits

8 Channels, 50 MHz, 512 Memory Bits

4 Channels, 100 MHz, 1024 Memory Bits

You'll like what we've done to **reduce circuit loading problems** associated with testing high-speed and high-impedance logic families. With our new P6451 active probes, which have an input impedance of **1 MΩ paralleled by 5 pF at the probe head,** you'll be able to test virtually any logic family.



LA501/WR501, Members of the TM 500 Series

Take your logic analyzer right to the problem with the LA 501 Logic Analyzer and its new companion word recognizer, the WR 501. Packaged as modular AM 500 test instruments, this pair works with any oscilloscope or X-Y monitor. Now you've got versatile logic analysis capabilities to complement the oscilloscope you probably already own.

Word recognition with digital delay gives you fast access to almost any location in the data stream.

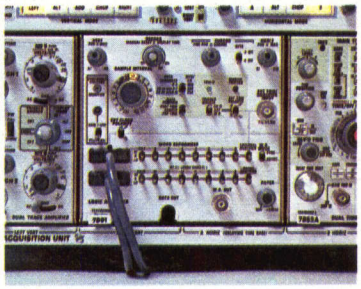
For **channel-to-channel timing comparisons,** you can select any trace and position it next to any other. And **timing tic marks** on each channel enhance visual analysis.

No matter what your application—design, production testing, or service—we've got a TM 500 logic analysis configuration for you.

On the bench, power the LA 501 and WR 501 with the TM 503 mainframe or the TM 504 mainframe (now you've got room for another TM 500 module like the DM 502 Digital Multimeter).

In a rack, use the RTM 506—there's room enough for the LA 501, the WR 501, the SC 502 Oscilloscope, and one more module. Or you can mount the LA 501 and WR 501 in a TM 503 side by side with a 604 Monitor. The 6½-in. display is easy to read.

For **field portability,** try the TM 515 Traveler Mainframe. It's rugged and durable, yet as attractive as carry-on luggage. You can pack the LA 501, the WR 501, and the SC 502 and have a complete logic analysis system in a suitcase.



7D01, A Member of the 7000 Series

Turn any 7000-Series laboratory oscilloscope into a versatile 16-channel logic analyzer with the new 7D01 dual-wide plug-in. Now, gaining logic analysis capability is as simple as adding a plug-in.

With a four-compartment 7000-Series mainframe and plug-ins, you get a truly powerful logic design tool: **a logic analyzer and a real-time oscilloscope in one unit.** Use the 7D01 Logic Analyzer to locate a digital domain problem, then zero in for detailed analysis by using the 7D01's word recognizer to trigger the analog portion of your oscilloscope. Now you can do it with one instrument and display your digital and analog information on the same crt.

With the 7D01 you also get **timing and binary information displayed simultaneously** on the crt. You do it with a cursor. And because the cursor can be moved in single clock intervals, **timing comparisons are faster, easier and more error-free than visual estimates.** When the cursor is moved to a given clock position, the binary word at that point is read out across the bottom of the display.

For more information, ask for our Logic Analyzer brochure A 3341. To get your copy, contact our local Tektronix Field Engineer, or write to Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077. Telephone: (503) 644-0161. TWX: 910-467-8708

Tektronix Logic Analyzers are currently available only in the United States.

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For technical data, circle 34 on Inquiry Card. For a demonstration, circle 35 on Inquiry Card.

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During operation, low level signals from various transducers (Fig. 1) are input to 16, 8-input multiplexers, with each channel clocked at a 10-ms rate. Multiplexer output, through isolation amplifiers and switches, feeds to a single 12-bit analog-to-digital converter (ADC). Twelve-bit parallel data are input to the microprocessor's SW data bus. Start of conversion is controlled by one of the user flags (F-12); end of conversion is signaled by an extra data bit inserted on the SW bus. Channel addresses are selected by decoding the address lines.

Thermocouple signals are directly input; there is no secondary-reference junction. Similarly, there are no signal conditioning or gain setting schemes associated with individual pressure transducers. A single amplifier on the output of each multiplexer provides isolation.

The microprocessor provides all signal conditioning and inserts scaling, gain, and offsets prior to converting data to engineering units for calculation. After the calculations are made, data are compared with p/ROM-located tables through predesignated fault-tree programs in order to supply proper engine diagnostics.

Instead of working continuously, the printer periodically informs the captain of engine conditions from routine to significant. Important signals, accompanied by bells and lights, tell him what to do (Fig. 2).

A typical advisory message might be

STBD MAIN ENGINE
EGT CYLINDER 8
HIGH TEMPERATURE
1280F

Since normal exhaust temperatures are about 1100°F, and other cylinders are normal, this might indicate a partially clogged injector—a condition that can be handled underway.

Scheduled periodic maintenance is logged so that repairs can be made while the vessel is in port:

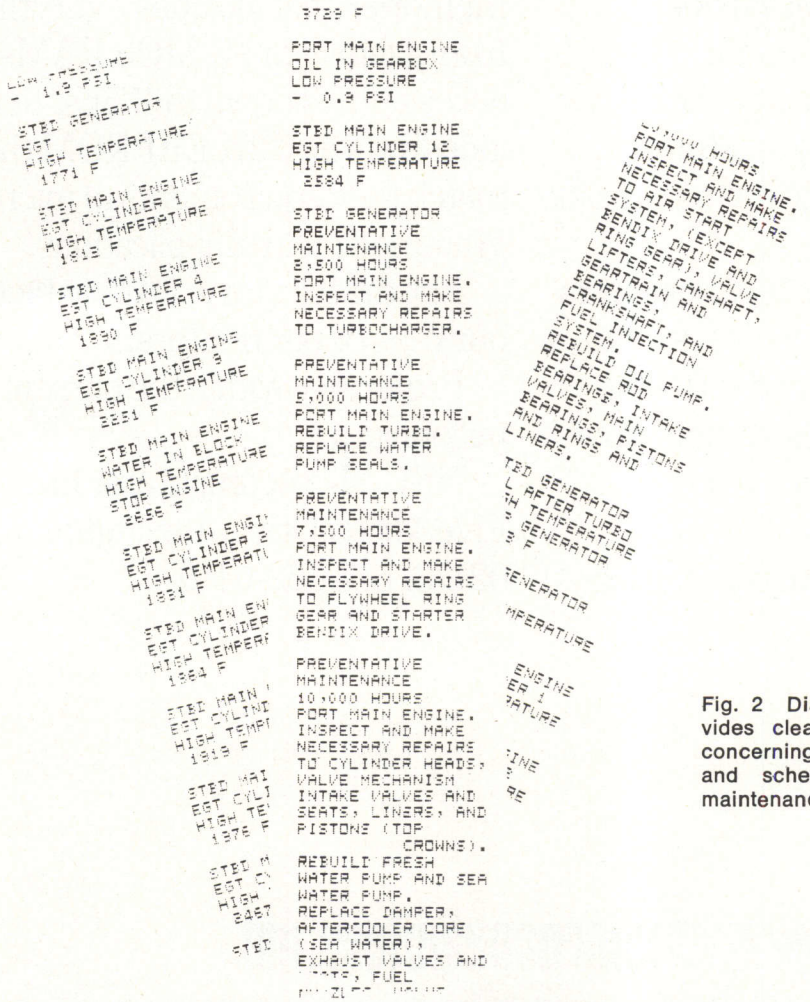

Fig. 2 Diagnostic software provides clear language messages concerning engine malfunction and schedule for preventative maintenance

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We make them all. Over 200 standard and mil range devices. 0°C to 70°C. −25°C to 85°C. −55°C to 125°C. The broadest line of data conversion products in the industry.

Converters built to meet the tightest specs. With guaranteed linearity and accuracy. Incomparably stable. Totally adjustment-free. Compactly packaged. Hermetically sealed. And, competitively priced.

Every one of our products is 100 percent tested. Each circuit is functionally laser-trimmed to eliminate the need for zero and gain adjustments. Our resistor networks have been life-tested for more than 5,000,000 unit hours at 125°C with a typical ratio shift of less than 0.001 percent per 1,000 operating hours. Network tracking characteristics are guaranteed at 1 ppm from −55°C to 125°C. Performance no competitor can best. That's why our converters stay tough . . . everywhere!

DAC-80. 12-bit binary or 3-digit BCD digital-to-analog converters for $19.50 in quantities of 100. Compactly packaged. With their own internal reference supplies and voltage output operational amplifiers. And, a nonlinearity of ±½ LSB.

MN7100. A complete eight-channel, 8-bit data acquisition system that sells for $140 in quantities of 100. Measuring only 2.14 x 1.16 inches, this tiny hermetic DIP has a throughput of 90 kHz, is one-fortieth the volume of a modular system, and uses one-third the power — 1.2 watts.

MN7200. The first low-cost 8-channel, 14-bit resolver-to-digital converter that combines microprocessor and advanced data conversion technologies. Priced at $1,750 in unit quantities. Completely adjustment-free, the MN7200 has an accuracy of four minutes or less over the system's 0 to 70°C temperature range.

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REBUILD TURBO-CHARGERS
REPLACE WATER
PUMP SEALS

The captain also could be alerted to a bell-alarm condition:

PORT MAIN ENGINE
OIL AFTER FILTER
LOW PRESSURE
STOP ENGINE
15.3 PSI

Continued operation at this oil pressure could result in serious engine damage. Therefore the skipper would shut down the designated engine and replace the oil filter.

Use of the IMP-16 facilitated the extensive firmware necessary to combine data acquisition with diagnostics. The 16-bit word length and the extended instruction set allow rapid calculations without extensive program stops. Only about 1000 lines of code were required to implement both the data acquisition and diagnostics program.

There is no data entry keyboard in the system since a tugboat captain has no cause to enter data. He receives important messages from a serial printer in the wheelhouse—sent by a black box in the engine room. He has no need to know and does not care that a microprocessor is involved.

Microprocessor

A number of considerations must be made in choosing the right microprocessor for an application: word size, speed, I/O requirements, programming language, and —ultimately—cost (encompassing engineering and development time as well as system manufacturing costs). SIDS required a data precision of 12 bits for a 4-decimal-digit accuracy. It was also necessary to scan, correct, and process one data point every 10 ms.

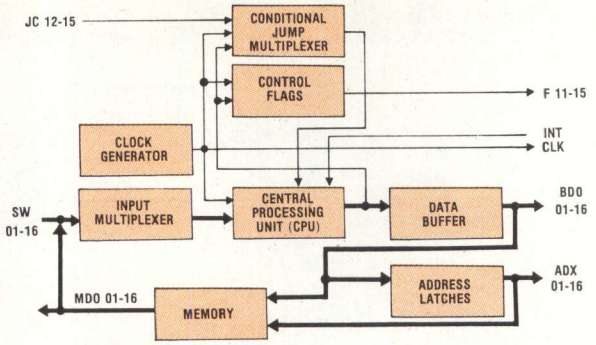

Fig. 3 General configuration of National Semiconductor IMP-16 microprocessor includes separate input (SW), output (BDO), memory (MDO), and address (ADX) buses, as well as four user jump conditions, 16 user flags, and one general-purpose interrupt

Processing included performing two or three 12-bit multiplications (or divisions) while sifting through a multilevel fault-tree.

Eight-bit processors would require double-precision arithmetic to handle 12-bit data from the ADC. While this aspect alone could have been handled by a number of devices, the fault-tree placed more serious time constraints.

It was determined that a 16-bit microprocessor would sift through the tree in under 5 ms, while 8-bit devices required closer to 8 ms. The combination of arithmetic functions and tree sifting would place the 8-bit processor beyond the 10-ms target.

IMP-16 is a 5-chip processor (Fig. 3) with separate 16-bit buses for buffered data (BDO), peripheral input data (SW), memory data (MDO), and buffered address (ADX). Memory locations and peripherals may have the same address, which avoids memory partitioning. The device also has 16 user-available flags, one general interrupt condition, one vector interrupt, and four user jump conditions—important in reducing component count for an interrupt driven system.

Custody Transfer of Crude Oil Automated by Minicomputer

Nearly everyone at some time or another has seen fuel oil being transferred from a truck to a tank in someone's basement. In two or three minutes of actual pumping time, 100 to 150 gallons of heating oil are transferred from the truck to the homeowner's tank. Pumping rates vary from 50 to 110 gallons per minute.

Considerable care is taken to be certain the measuring system is accurate. With today's price of fuel oil, the customer does not want to be undersupplied by even one gallon out of the 150; and neither does the supplier want to deliver 151 gallons when his meters show he can charge for only 150.

Imagine, then, the concern involved when a supertanker, known as a "very large crude carrier" or VLCC, is being filled at an oil loading terminal. A VLCC holds 3.5 million barrels, and pumping facilities can operate at up to 840 thousand barrels per hour. That is approximately 35 million gallons per hour. Even a tiny measurement error can mean loss or overcharge of tens of thousands of dollars.

In addition, vessels the size of a VLCC—477 thousand deadweight tons, or over four times the size of a battleship or aircraft carrier—are extremely expensive objects to have floating in a harbor waiting to be filled with oil. They must be loaded in as short a time as possible.

Automated systems to control and measure oil flow (custody transfer) to the tankers, while maintaining

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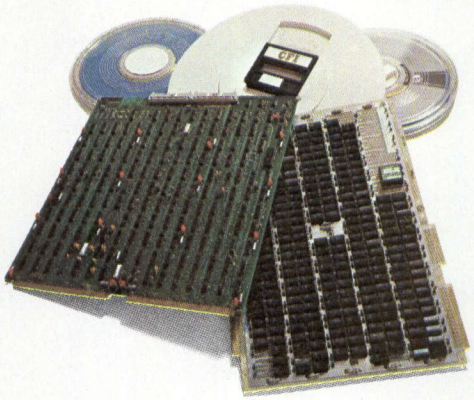
Only DATUM has designed, built and installed over 6000 controllers and systems for so many different minicomputers to interface with so many different peripheral devices. And, of all device-controller manufacturers, only DATUM/Peripheral Products Division has the advantages and expertise given by cooperating in-house divisions that design and build custom data acquisition systems and sophisticated micro-programmed minicomputers.



Off-the-shelf controllers for these computers:

Computer Automation Alpha LSI • **Data General** Nova and Eclipse • **DCC** 112, 116 • **DEC** PDP-8, -8e, -8i, -8l, -9, -9l, 11, 12, 15 • **Harris Communications** Slash 4, Slash 7 (Datacraft) • **HP** 21MX, 2100, 2114, 2116 • **Honeywell** 316, 416, 516 • **IBM** 1130 • **Interdata** 716, 832 • **Lockheed** SUE • **Micro Systems** 810 • **Rolm** 1602, 1603 • **Varian** 620i, 620l, 620f, V73, V74, V75, V76.

DATUM Tape Controllers are available with the following Formatters:

NRZ: 9-track, 800 BPI and 7-track, 800, 556, 200 BPI • **PE:** 9-track, 1600 BPI • **QUAD:** 9 track 1600, 800 BPI and 7-track 800, 556, 200 BPI.

Each formatter controls as many as four drives with individually-driven ports for each tape unit. All drives with industry-compatible interfaces can be accommodated.

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Write for specifications and prices and for a copy of, "How To Buy Computer Peripherals."

Series 4091 Disk Controller

Series 5091
Magnetic Tape Controller

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"Where Do We Go From Here."

All you have to do is to dream a little . . . use your imagination . . . come up with your idea for a unique MICROPROCESSOR/MICROCOMPUTER Application. It can be for immediate use or a far-out idea for future application, but you'll have to use your practical knowledge and give us a good idea of how and why you think it will work.

The field is wide open! Your imaginative MICROPROCESSOR/MICROCOMPUTER Application could deal with its effect on: commerce, medicine, ecology, education, space, mining, transportation, banking, etc. . .YOU tell us "Where Do We Go From Here" with MICROPROCESSOR/MICROCOMPUTER Applications.

YOU MUST HAVE A CONTEST ENTRY KIT FOR FULL PARTICULARS. The kit must be ordered no later than August 9, 1976 . . . to get yours, circle No. 125 on the Inquiry Card in the back of this magazine right now!

WINNERS will be announced in the January 1977 issue of COMPUTER DESIGN.

CONTEST RULES

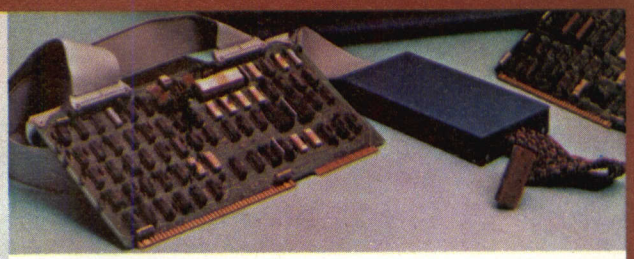
1. Contest closes SEPTEMBER 30, 1976. All entries must be postmarked no later than midnight of that date.
2. All entries must be submitted on official forms contained in the CONTEST ENTRY KIT.
3. MICROPROCESSOR/MICROCOMPUTER APPLICATION IDEAS must be free of restrictions on their use. They may not contain any proprietary, confidential, or patentable information.
4. Ideas submitted must be original with the entrant(s) and must not have been previously published.
5. All materials included with, or as part of, the entry become the property of COMPUTER DESIGN Magazine and will not be
6. Exclusive publishing rights will be held by COMPUTER DESIGN Magazine.
7. The contest is open to everyone except contest judges; their relatives or business associates; or employees, relatives, or agents of Computer Design Publishing Corp. and Intel Corp. or its subsidiaries.
8. Contest is void in locations where prohibited by law.
9. Decisions of the judges will be final.

Circle No. 125 on Inquiry Card to receive your official contest entry kit.

FIRST PRIZE (Valued at $6,150.)

An IN-CIRCUIT MICROCOMPUTER DESIGN CENTER!

Intellec® MDS-800 MICROCOMPUTER DEVELOPMENT SYSTEM is a modular system containing all necessary hardware and software to develop and implement an intel® MCS 80™ Microcomputer System.



Intellec MDS-ICE-80 IN-CIRCUIT EMULATOR MODULE that interfaces to any user configured 8080 system and allows the designer to emulate the user 8080 in real-time, single step the user system's 8080, substitute Intellec MDS memory and I/O for user system equivalents, and extend powerful debug functions into the user system.

Intellec MDS UPP 101 UNIVERSAL PROM PROGRAMMER which allows you to program and verify all intel p/ROMs by initiating p/ROM programming commands from your system console.

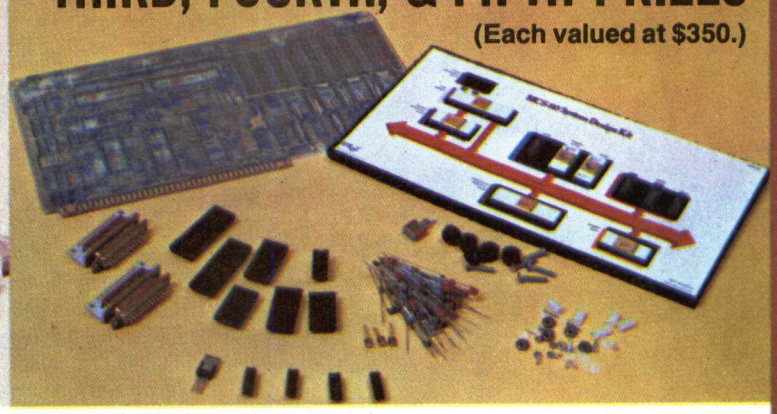
MICROPROCESSOR / MICROCOMPUTER . . . APPLICATIONS CONTEST

SECOND PRIZE (Valued at $3,950.)

Intellec MDS-800 MICROCOMPUTER DEVELOPMENT SYSTEM as described above. In this advanced development system you will receive an 8080 CPU, 16K bytes of RAM, 2K bytes of ROM, power supplies, front panel, and system software.

THIRD, FOURTH, & FIFTH PRIZES

(Each valued at $350.)



intel 8080 SYSTEM DESIGN KIT (SDK-80)
The SDK-80 is a complete 8080 microcomputer system on a single board, in kit form. It contains all necessary components to build a useful functional system.

JUDGES

Edwin E. Klingman, President, Applied Cybernetics

Dr. A. J. Nichols, Mgr., Microcomputer Applications, Intel Corp.

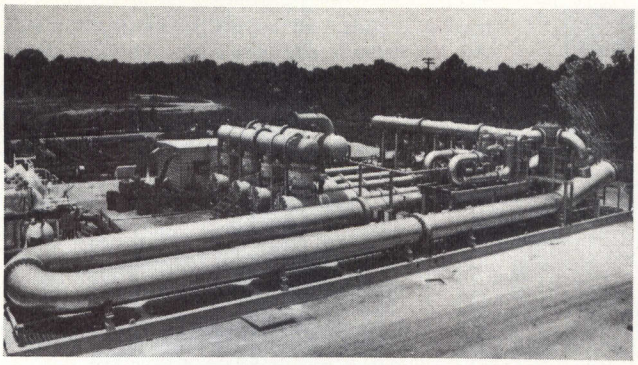
Jerry L. Ogdin, President, Microcomputer Technique, Inc.

Dr. Hoo-Min-Toong, Systems Professor, Dept. of EE & Computer Science, M.I.T.

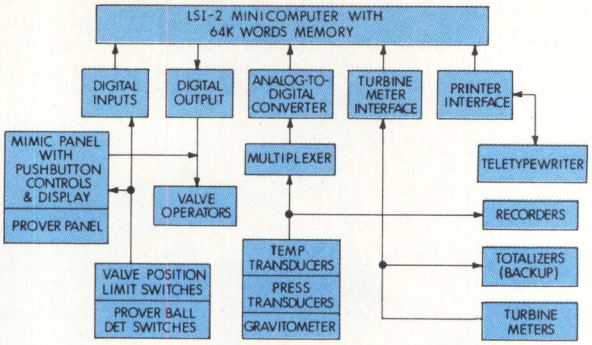
John A. Camuso, Editor, COMPUTER DESIGN Magazine

COMPUTER DESIGN

intel®



Meter and prover station at Dubai Petroleum Co installation in the Arabian Gulf consists of four 16″ stainless steel turbine meters and a 36″ bidirectional prover. Each meter run is rated at 25,700 bph for a total system output of 102,800 bph. A 3.5-million barrel supertanker, therefore, could be loaded in about 34 hours



Electronic component configuration for Daniel Industries system for custody transfer of petroleum products. Computer may be either at metering station or at a remote location

logs for accounting, have been designed and installed at a number of crude oil loading facilities by the Systems Engineering Div of Daniel Industries, Inc, Houston, Texas. These liquid metering systems, with varying pumping capabilities, are based on control by LSI-2 minicomputers made by Computer Automation, Inc, 18651 Von Karman, Irvine, CA 92664. Each computer contains 94K words of core memory.

For flow measurement, electric outputs from turbine meters are furnished to the control electronics. Such meters are commonly 16, 18, or 20″ in diameter. The computer accumulates these pulses, corrects for flow variables (meter factors, temperature, pressure, and gravity), and calculates flow rates and net vol-

The IMSAI 8080.

A commercial yet personally affordable computer.

If you thought you could never afford a computer at home, think again. The IMSAI 8080 is built for rugged industrial performance. Yet its prices are competitive with Altair's hobbyist kit. Fully assembled, the 8080 is $931. Unassembled, it's $599.

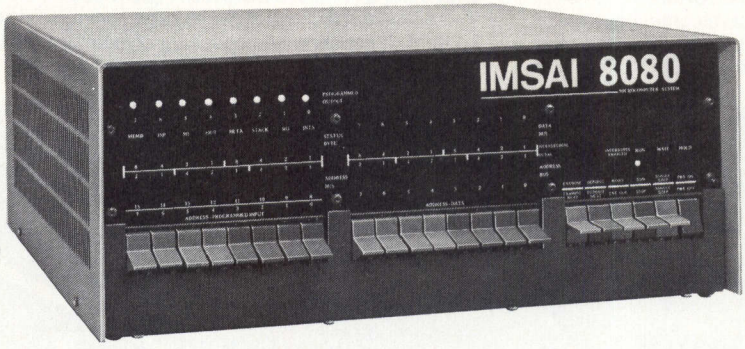
The IMSAI 8080 is made for commercial users, and it looks it. Inside and out. The cabinet is attractive, heavy gauge aluminum. The heavy duty lucite front panel has an extra 8 program controlled LED's. It plugs directly into the Mother Board without a wire harness. And rugged commercial grade paddle switches are backed up by reliable debouncing circuits.

The system is optionally expandable to a substantial system with 22 slots in a single printed circuit board. And the durable card cage is made of commercial-grade anodized aluminum.

The IMSAI 8080 power supply produces a true 28 amp current, enough to power a full system. You can expand to a powerful system with 64K of software protectable memory plus an intelligent floppy disk controller. You can add an audio tape cassette input device, a printer plus a video terminal and a teletype. And these peripherals will function with an 8-level priority interrupt system. BASIC software is available in 4K, 8K and 12K.

Get a complete illustrated brochure describing the IMSAI 8080, options, peripherals, software, prices and specifications. Send one dollar to cover handling to IMS. The IMSAI 8080. From the same technology that developed the HYPERCUBE Computer architecture and Intelligent Disk systems.

Dealer inquiries invited.



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BURROUGHS
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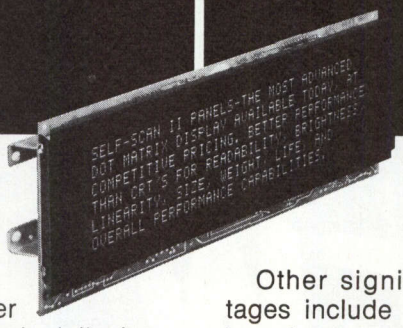
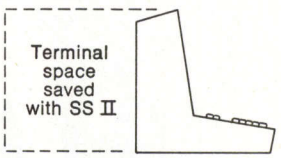


Burroughs' new, low-cost SELF-SCAN II 240-character displays offer many features compared with CRT terminal displays. Contrast and readability are better than ever under all conditions. Characters are jitter- and flicker-free bright neon-orange color, with no fuzziness or loss of linearity at the edges of the display. An all-new manufacturing process has significantly reduced cost, weight, size, and has improved reliability. And, the SELF-SCAN II panel's 40-character line is compatible with popular software. Graphics can also be displayed using additional drivers.

Other significant advantages include easy interface to micro-processors, thin cross-section, small overall size, and rugged construction for long service life under all operating conditions.



Give your data terminals a bright new outlook; call or write for complete information. Burroughs Corporation, Electronic Components Division, P.O. Box 1226, Plainfield, New Jersey 07061. Telephone (201) 757-5000.

You can see the difference

Burroughs

CIRCLE 39 ON INQUIRY CARD

umes. One system, installed for the Dubai Petroleum Co in the Arabian Gulf, contains four 16″ turbine meters. Each meter is rated at 25,700 barrels per hour (bph) for a total capacity of 102,800 bph. Another installation has ten 20″ meters, each rated at up to 42,000 bph. Initially it was set up to measure 340,000 bph but eventually it will be expanded to handle 840,000 bph (over 20 million barrels per day).

At the Dubai installation, the system comprises a turbine meter and power station, a main control console, and minicomputers. The station meters crude oil at 150°F and 375 psig maximum pressure.

Flow measurement is maintained by the four turbine meter runs, which are calibrated by the prover to assure continued accuracy. Meter factors are automatically generated by the computer system by a technique called "proving": crude oil is pumped through a long pipe of known volume and meter readings are compared to norms.

Meters are "proved" automatically both at normal flow conditions and on operator request. This is performed at the initiation of a batch and whenever the flow rate deviates from the previously proved flow rate. Proving operations are controlled by automatic sequencing of block and flow valves. This test proves the accuracy of the meters and assures that proper taxes are calculated. A 36″ prover and a 12″ prover recalibration unit (called a "prover-prover") are used at Dubai.

Crude oil is first pumped from wells to underwater storage tanks where it displaces the salt water. When a tanker is to be filled, the oil is "lifted" from the storage tanks. Block valves open to permit flow from the storage tanks through the meter runs as required to maintain the desired flow rate. Flow valves control volume through each run as measured by the turbine flow meter for that run.

By controlling the block valves, oil from any meter run can be diverted through the prover in either direction without interrupting flow. Meter factor (pulses per barrel) is determined from pulse count, prover volume, and correction factors. In automatic operation, the computer calculates the factor, which it in turn uses in performing automatic computations of oil volume pumped to the tankers. The computer system directly controls prover and meter tube block valves and flow control valves. Block valves are automatically sequenced through the proof cycle. Flow control valves are computer regulated for the transfer stages of proving, normal loading, and topping off.

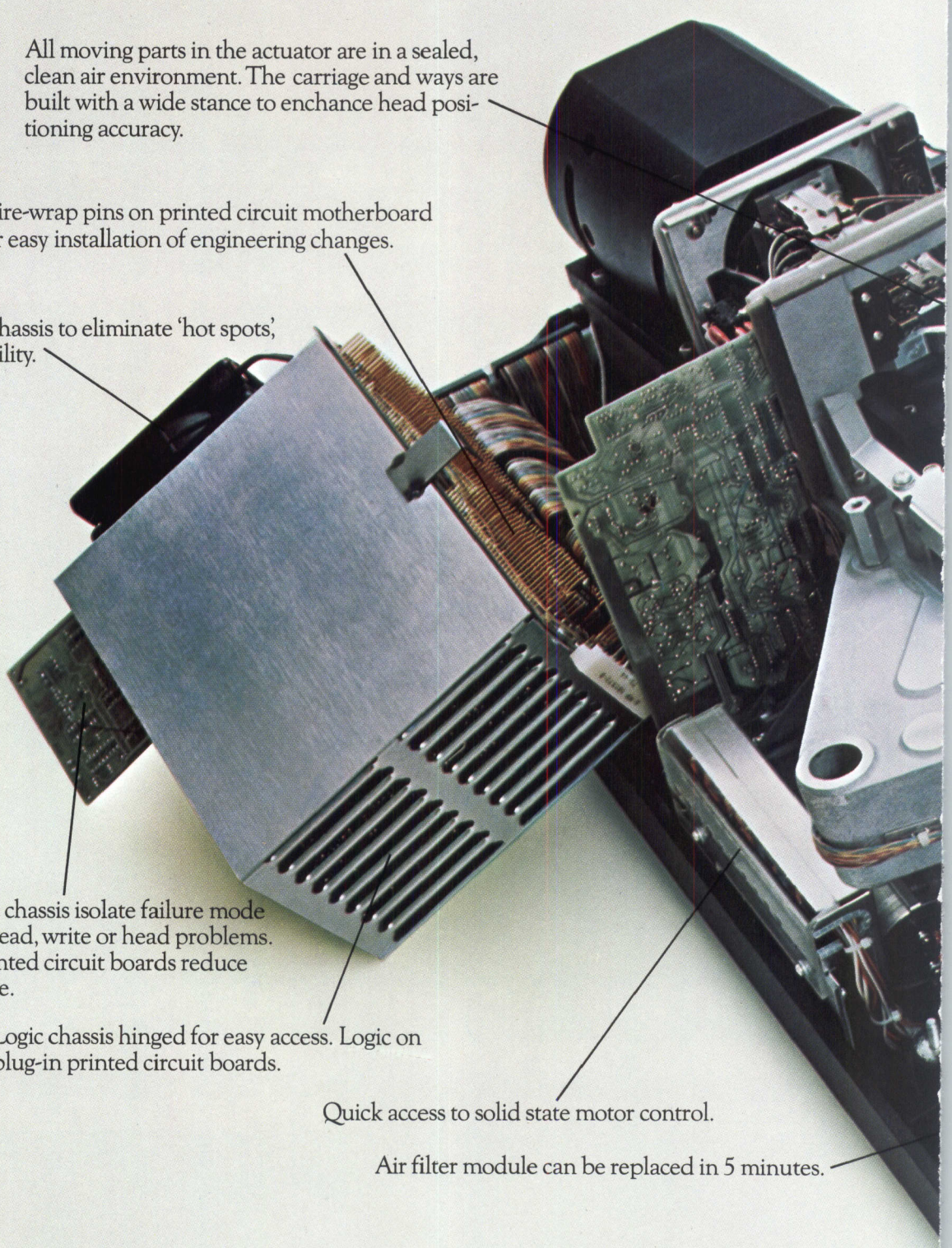
At any given moment, the computer might gather analog information from various transducers, accept digital data from turbine meters, calculate and totalize net oil volumes, scan numerous alarm sensors, initiate valve control, or input or output data via teletypewriter. In appearance, however, these actions seem to occur simultaneously.

Circle 160 on Inquiry Card

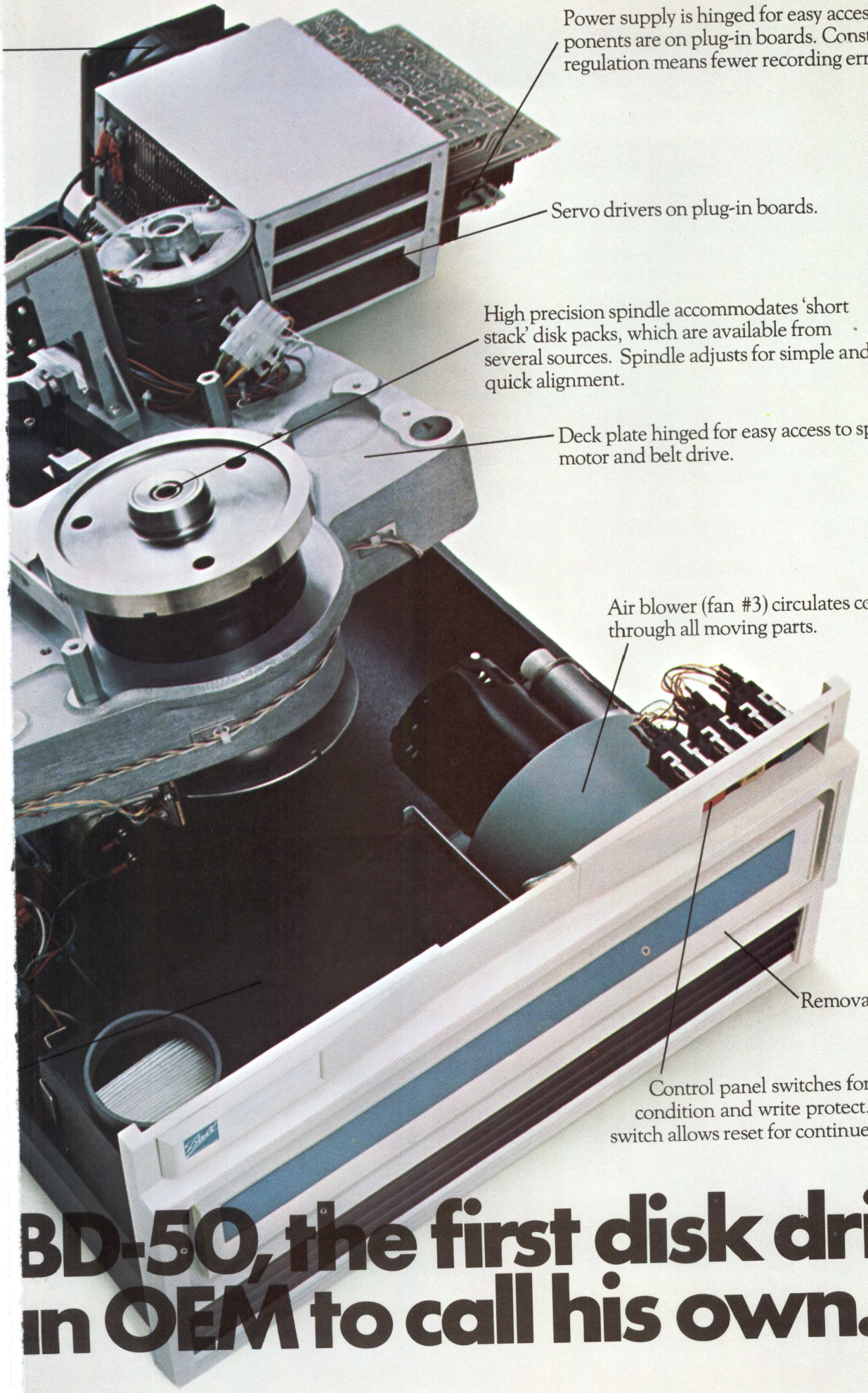
"It's bad enough when the disk drive fails. It's even worse when it takes half the weekend to find the trouble and fix it."

"What I need is a more reliable disk drive; one that's easier to maintain. And when a problem does occur I want to be able to find it and replace the part in minutes—not hours."

"In the systems business, customers demand trouble free performance. It's that simple."



Announcing the Ball
that's good enough for



BD-50, the first disk drive an OEM to call his own.

BD-50 Specifications

Description: The Ball Computer Products model BD-50 Disk Drive provides a new standard of reliability and maintainability for the OEM. The BD-50 accommodates a removable 3330-type 'short stack' disk pack with 50 megabytes of data storage. The BD-50 satisfies the OEM's requirement for large capacity disk files to interface with small and medium size computers in applications where trouble-free performance is critical. The BD-50 combines reliable, proven drive technology with features that ensure high reliability, maintainability, and ease of repair.

Reliable: To provide the highest possible reliability, the BD-50 has the industry's first triple cooling system in a compact design, an actuator mechanism that is sealed in a clean air environment, and a constant-voltage power supply. Together, these features eliminate or greatly reduce the most common disk drive problems: dust and dirt accumulation on precision mechanisms, head crashes caused by contamination, hot spots in circuitry that cause premature component failures, and susceptibility to recording errors resulting from line-power variations.

A track-following servo system is employed, requiring no external reference, nor any reference temperature compensation. A servo track surface on the disk provides reliable operation at all operating temperatures.

Maintainable: The BD-50's maintainability features are organized to speed preventive maintenance, simplify trouble-shooting and repair in the field if a failure should occur, and prevent an operator from inadvertently using the system when maintenance is needed.

Since the most frequent maintenance requirement is clean-air filter replacement, the BD-50 has a quick access filter. The system is fully modular using separate chassis for actuator and motor control mechanisms, power supply and logic. All electronic circuitry including servo-drivers is on plug-in cards, arranged in functional groupings and provided with built-in test points. Deck plate, logic, and power chassis are hinged for easy access.

When a problem is detected, internal latches monitor operation and light LED indicators on the chassis next to the corresponding circuits. The operator can reset the drive from the front panel but the latches can only be over-ridden by opening the cover and pressing the release buttons next to the LED indicators.

All critical electronic parts, including voice coils and heads are readily available from several sources. You're not tied to one source for replacement parts. Disk packs are also available from several suppliers.

Features

Capacity
50 million 8-bit bytes

Transfer Rate
6.45 megahertz
806 Kbytes/sec

Access Time
Track to Track—5 milliseconds max.
Average Positioning—30 milliseconds
Full Stroke—55 milliseconds max.
Average latency—8.3 milliseconds

Pack Start/Stop Time
Start—20 seconds
Stop—20 seconds (Dynamic Braking)

Densities
Track Density—370 tracks/inch
Recording Density—4040 bits/inch
(unformatted) 13,440 bytes/track
67,200 bytes/cylinder
815 cylinders/pack

Disk Pack Characteristics
Disk Pack—IBM 3336-11 Components
Recording Surfaces—5 plus 1 servo surface
Cover Disks—2

Operating Methods
Recording Method—Modified Frequency Modulation
Positioning Method—Track-following Servo

Controls & Indicators
Start/Stop Switch
Ready Indicator
Read Only Indicator/Switch (write protect)
Fault Indicator/Reset Switch

Interface (all digital)
Control & Address Lines—Single Open Ended Collector
Clock & Data Lines—Differential ±0.6 Volts

Physical (Self contained power supply)
17.5" wide x 10.5" high x 31" deep
Weight—185 pounds

Power
Input Voltages—115 ± 15% VAC, 60 Hz, single phase
225 ± 15% VAC, 50 Hz, single phase
Power Cable Included

Environmental Conditions
Operating Temperatures—60° to 90°F 15.6° to 32.2°C
Humidity—10% to 80% noncondensing
Altitude—(−) 1000 feet to (+) 6000 feet

Additional Standard Features
Address Mark Detection
Variable Sector Sizes
Sector Address/Cylinder Address Read Commands
Uniform cooling with individual fans per electronic chassis

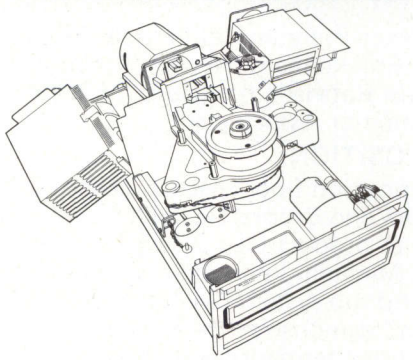
Options
Rack or Pedestal Mounting
NRZ Data Interface
VFO & Encoder/Decoder Functions
Differential Control & Address Lines
Signal Cables; 7, 10, 15 or 25 feet
Read/Write Cables; 7, 10, 15 or 25 feet

Also Available
Ball Model 3300 Comprehensive Formatter with error correction, variable record length and multiple drive capability
CPU Interfaces for various minicomputers

Ball Computer Products, Inc.
SUBSIDIARY OF BALL CORPORATION

Ball Computer Products, Inc., 860 East Arques Avenue, Sunnyvale, California 94086
Regional Offices Los Angeles, (213) 822-1419; New York, (201) 224-2332; Chicago, (312) 593-3450; Boston, (617) 482-0101; Atlanta, (404) 289-0101; San Francisco, (408) 733-6700

The first disk drive that's good enough for an OEM to call his own.



If our four-page disk drive announcement is missing from the opposite page, then you can't read why Ball Computer Products' BD-50 sets a new standard in disk drive reliability and maintainability.

If you select disk drives, you should know about the 50 megabyte BD-50. Use the reader service number below, or call our nearest sales office.

Either way, we'll show you why the BD-50 is the first disk drive that's good enough for an OEM to call his own.

Ball Computer Products, Inc.
SUBSIDIARY OF BALL CORPORATION

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Regional Offices: Los Angeles, (213) 822-1419; San Francisco, (408) 733-6700; New York, (201) 224-2332; Chicago, (312) 593-3450; Boston, (617) 482-0101; Atlanta, (404) 289-0101.

CIRCLE 41 ON INQUIRY CARD

Supervisory and Control System for Remote Stations

Capable of handling communications by telephone, microwave, or radio frequency, TACS serves as interface between a central control station and remote station instruments. Each telemetered acquisition control system, or TACS—announced by Totalert Systems, Inc, 2001 Karbach, Houston, TX 77092—comprises three basic units of hardware: manual control panel (MCP), telemetered data controller (TDC), and remote telemetering unit (RTU).

Each TDC communicates with up to 64 RTUs in the system as well as the central control station computer. It provides data error checking and formatting of computer messages to the RTU and vice-versa. Seven TDCs can be handled by a single computer interface.

The MCP, which acts as a backup in case of computer failure, allows the operator to monitor all RTUs and provides access to all controls and data throughout the system. Safe operation is assured until the computer is again operational. One or two MCPs may be used to operate one TDC and insure higher system efficiency during manual operation.

Data and control communication link at remote stations is the RTU which receives command messages from, and transmits reply messages to, the central station. A unique built-in test panel enables each functional card in the RTU to be tested completely and independently without external test equipment. Optional RTU equipment includes microcomputer, alarm and data logger, CRT, and keyboard to perform local control and monitoring of critical remote station functions.

Standard software is completely modular in design and construction and can be mastered by its operators with a minimum amount of training time. Features include real-time executive, complete floating-point math package, scan program, and online editing. An optional mimic panel, available for training operators in the hardware and software system, allows demonstration of all phases of system operation without interfering with normal routine.

Mini/Micro

COMPUTER CONFERENCE AND EXPOSITION

October 19-20-21, 1976
Brooks Hall/Civic Auditorium, San Francisco

A Major Computer Conference in a Major Computer Market

THE CONFERENCE PROGRAM:

Minicomputers and microcomputers--low cost and versatile--are putting convenient and effective computer power at our fingertips in a vast array of products that will affect every facet of our lives, making minis and micros the fastest growing segment of today's and tomorrow's data processing industry. Designed into systems ranging from traffic lights and numerical control, to paint mixers and kitchen appliances, they offer a new versatility and striking competitive advantages in the end products. We'll examine these aspects--and much more--in the conference rooms at the 1976 MINI/MICRO COMPUTER CONFERENCE & EXPOSITION.

Approximately twenty sessions consisting of eighty papers covering both application and design topics are planned.

Some session titles (and organizers) to date would include:

1. Distributed Processing with Minis.
   (Dan Zatyko - General Automation)
2. Military Applications for Microcomputers.
   (Joe Genna - Delco Electronics)
3. The Effect of LSI Technology on Memory Systems.
   (Dan Bowers - Bowers Engineering)
4. Interfacing the Analog World to Minis/Micros.
   (Larry Brown - Calex)
5. Integrating OEM Peripherals into Computer Systems for End-use.
   (Martin Himmelfarb - Digital Design)
6. Microcomputer Software and Hardware Development Aids.
   (Dave Millet - NEC Microcomputers)
7. History to Current Development of Memory Peripherals for Mini and Micro Computers.
   (Bill Frank - Cal Comp)
8. The Make or Buy Decision.
   (Robert Van Naarden - DEC)
9. Microcomputer Applications; Logic Replacement; Minicomputer Replacement, New Products.
   (Jerry Ogdin - Microcomputer Techniques)
10. Industrial Applications for Microcomputers and Microcontrollers.
    (Ian Ebel - Control Logic)

11.-20. Being organized.

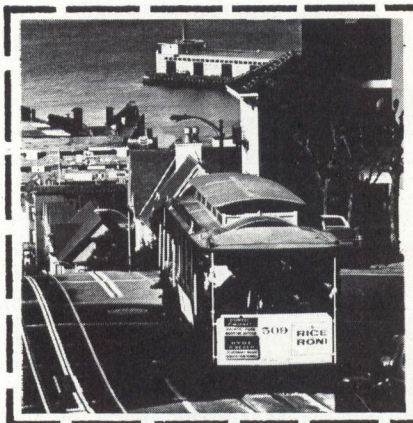
PLUS . . . tutorial sessions on minis and micros and a special session for computer hobbyists!

Conference Program Committee — Chairman: Robert J. Frankenberg (Hewlett Packard); Co-Chairmen: Justin Rattner (Intel Corp.); Manny Lemas (Microcomputer Associates).

THE EXPOSITION:

The exposition floor space in both the Civic Auditorium and Brooks Hall will feature a full spectrum of product displays by leading computer suppliers. Minicomputer and microcomputer systems and sub-systems will be available for "hands-on" demonstration, along with a wide array of computer peripheral devices, software aids and information. This 1976 MINI/MICRO COMPUTER EXPOSITION is expected to be the largest such event in the greater San Francisco area in almost ten years.

If you design mini-micro computers, sub-systems, peripherals, or components, use them in your business--or plan to--the hundreds of product displays will also be of valuable interest to you.



To: MINI/MICRO COMPUTER CONFERENCE AND EXPOSITION
5544 E. La Palma Avenue, Anaheim, CA 92807 Phone: (714) 528-2400

My Primary Interest Is:

☐ **Attending.** Please send me a Preview Program (available in September) listing information on sessions/papers, exhibitors, and containing a complimentary registration form.

☐ **Exhibiting.** Please send a copy of the Exhibit Prospectus.

Name_____

Title_____

Company_____

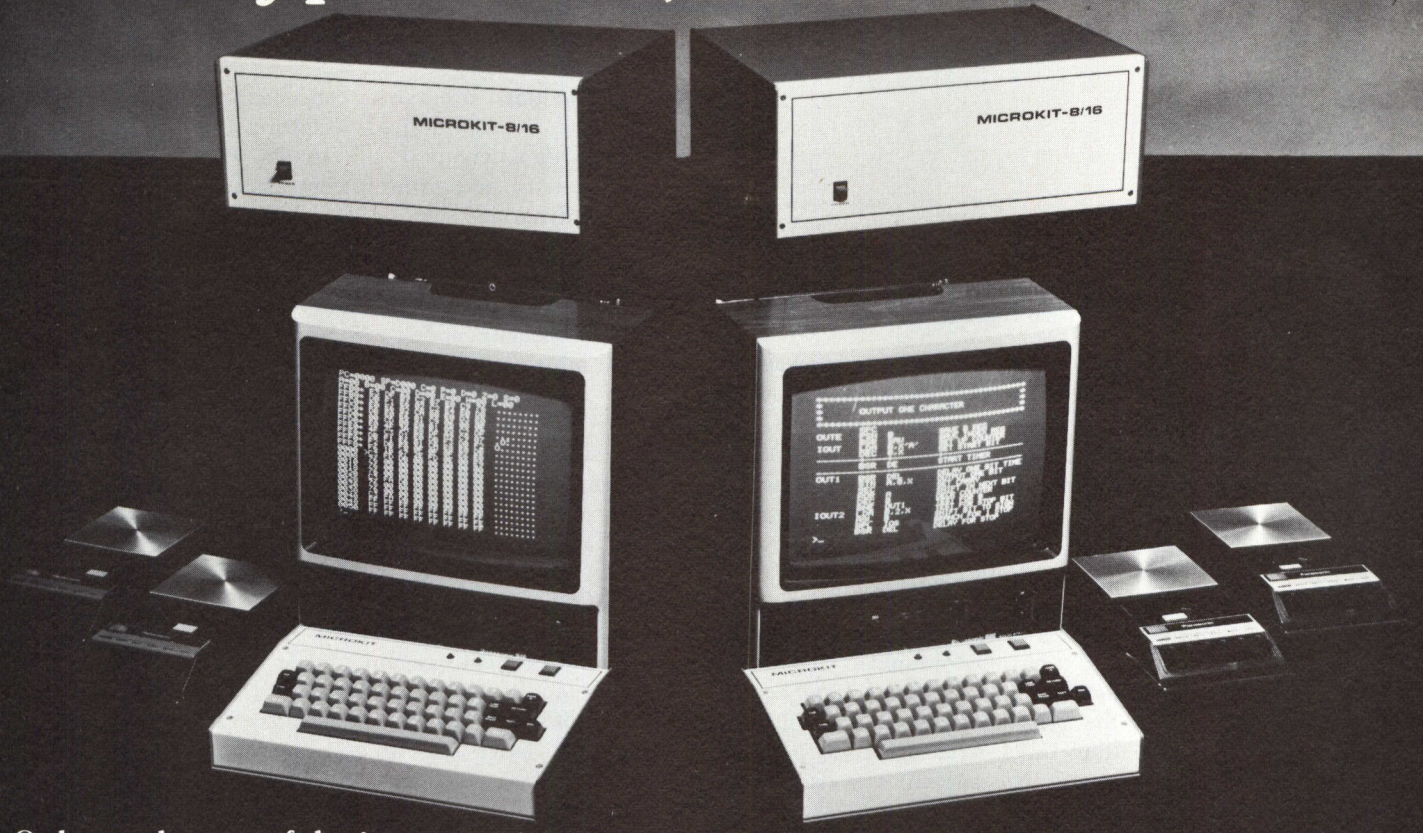
Address_____ M/S _____

City_____ State _____ Zip _____

Sponsored by: MINICOMPUTER INDUSTRY NATIONAL INTERCHANGE (MINI)

CIRCLE 42 ON INQUIRY CARD→

The Most POWERFUL 8080 or 6800 Microcomputer Development System at any price . . . $3,850.00 COMPLETE.



Only a truly powerful microcomputer development system allows you to accomplish your design task quickly, efficiently, and at a minimum cost. MICROKIT has the powerful microcomputer development system you need.

OTHER SYSTEMS OBSOLETE

The MICROKIT-8/16 has a unique CRT display refreshed directly from the microcomputer memory so it can write the full 960 character screen at 20,000 cps, faster than the blink-of-an-eye. Using the fast CRT, our interactive debugger gives you full screen hexadecimal memory dump displays instantaneously. With this kind of fast system response, debugging is a snap.

To match our fast debugger we have a screen based editor that is quickly learned and easy to use, because it lets you see the changes you make instantly and in full context on the CRT display. Rounding out our outstanding software package is a complete microcomputer resident assembler.

Any system without a display as fast as ours and without software like ours cannot possibly match the powerful debugging and editing features we offer.

EVERYTHING FOR $3,850

But how is it that the MICROKIT-8/16 has everything (keyboard, display, tape units, and software) included in the basic price? We keep your cost low by using a standard television set for the high-speed display, and by using audio cassette units for mass storage. And with MICROKIT's proprietary recording technique, you get data reliability comparable to digital cassette units while data is transferred to the casettes at the rate of 2000 bps — 20 times faster than TTY paper tape.

BOTH 8080 AND 6800

The MICROKIT-8/16 can be ordered as either an 8080 or a 6800 based system. At $3,850 either system is the best buy in microcomputer development systems today because they both include the 8K memory, the display and keyboard, the two audio cassette units, and the full complement of development software — debugger/monitor, editor, and assembler. Furthermore, either system can be easily switched to the other processor with our conversion packages that consist of a plug-in processor module and software.

FULL LINE OF ENHANCEMENTS

Rest assured that we also back you up with a complete line of enhancements including In-Circuit Emulators, EPROM programmers, add-on RAM or EPROM memories, line printers, "semiconductor disk" memory resident operating systems, and single or dual drive floppy disks with a super disk operating system.

MICROKIT-8/16'S ARRIVE READY TO GO TO WORK FOR YOU

But don't be misled by our name, our system comes fully assembled, fully tested, fully warranted, and ready to begin helping you with microcomputer development the very day it arrives. The MICROKIT-8/16 is a proven and reliable system which over the past year has received enthusiastic customer acceptance.

Our unbeatable features make the MICROKIT-8/16 an obvious choice for the designer requiring a microcomputer development system. Write or call MICROKIT INC. today, (213) 828-8539, to see just how well the MICROKIT-8/16 fits your microcomputer development requirements.

MICROKIT INCORPORATED

2180 COLORADO AVENUE □ SANTA MONICA, CALIFORNIA 90404 □ (213) 828-8539

DC&AS BRIEFS

Chromatography Software and Multi-User Programming Featured in Laboratory Automation System

A recently announced minicomputer-based laboratory automation system offers extensive turnkey chromatography software for all calculation procedures traditionally used by the chromatographer. As many as eight users can develop and edit analytical programs in BASIC while the system concurrently collects and automatically evaluates real-time data from up to 30 remote analytical instrument interfaces.

This chromatography data system automatically processes the digital output of gas and liquid chromatographs using standard chromatographic methods. Through computer-initiated dialog in terms familiar to the chromatographer, the user determines the setting up of events, sample-handling tasks, data reduction parameters, and report formats. No special knowledge of computers or programming is required by laboratory personnel.

A data system with extended BASIC language and simplified programming features can be customized easily by the user to meet the requirements of any analytical-research laboratory and plant quality-control department. Users can devise their own special analytical methods, any of which may be applied to any chosen channel.

User-written programs can control analytical instruments, make desired interpretation of collected analysis data, compare the results with predetermined specifications, and print further instructions to the operator. Programs can be called from the system console or can be set up to start automatically at the end of a run. Raw data, processed data, and reports can be stored in disc memory for later analysis and review. Security codes can be assigned to protect the stored information.

At any one time the system can handle up to 11 I/O devices, eight of which may be of the same type. Devices may be paper-tape reader and punch, teleprinters, CRT terminals, and thermal printers. Users can route final reports to multiple output devices and determine the number of copies to be produced on each device. A buffer holds the report for the I/O device until it is ready and clear to receive it.

Hardware for the basic HP 3354A data acquisition and management system, made by Hewlett-Packard Co, Avondale, Pa, consists of an HP 21MX minicomputer with 32K words of memory, moving-head disc with 15M bytes of storage, paper-tape reader, instrument interface module, and system console. A-D converters, digital control modules, and terminals are optional.

Program Set Eases Designer's Tedium

Intended to ease the work-load of control-system designers by relieving them of tedious and repetitive calculations, the CADCUM set of FORTRAN programs can be used for online analysis, design, and simulation of single- and multi-input, multi-output systems. (The name for this collection indicates both its purpose and its developer: *C*omputer-*A*ided *D*esign of *C*ontrol Systems from the *U*niversity of *M*anchester Institute of Science and Technology.) The programs, available through National Research Development Corp, London, England, incorporate techniques for linear time invariant control systems. Multivariable design techniques are applied in the frequency domain, and extend Nyquist and Bode concepts. Programs operate in an interactive conversational mode.

Design and analysis techniques offered include specification of system dynamics in four forms: measured frequency response data, transfer function descriptions, differential and algebraic equations, and state-space descriptions. Other techniques are automatic transformation of data from any of these modes to any other mode, plus the inversion of transfer function matrices as functions of either "s" or "jw"; classical frequency domain techniques of Bode, Nyquist, and Nichols and the Evans root-locus method, including the ability to deal with pure time delays; multivariable system design using Rosenbrock's "inverse Nyquist array" approach and MacFarlane's "characteristic locus" design method; automatic simulation of control systems, which allows both open- and closed-loop time responses to be obtained readily; and graphics display facilities, permitting editing of such items as Bode and Nyquist diagrams, inverse Nyquist arrays, characteristic loci, and time-response plots.

By implementing software in overlays of not more than 10,000 words, any desired set of modules can be formed as an integrated subset of the complete design set. The various overlays are normally kept on disc storage and automatically brought into use.

Core requirement is 11,000 words plus the FORTRAN operating system, using disc store and video terminal with graphics capability. A user's guide provides illustrative examples of facilities, and a programmer's guide gives details of the programming conventions used throughout the collection of programs. Future expansion can be made by the user without the need to rewrite development programs.

Implementation to date has been on a Digital Equipment Corp PDP-10 computer with Tektronix 4010 storage-tube graphics terminals. Implementation on a different machine would require changes to the file-handling and graphics routines, but these should be straightforward; work is in progress on conversion to IBM and Control Data machines.

CNC System Updated For Use on Production Lathes

A computer numerical control (CNC) system designed for use with Swedturn production lathes has been updated by American SMT-PULLMAX, Inc, Elk Grove, Ill to reflect the changing requirements of the metal-turning industry. Basically the control's minicomputer has been programmed to perform some of the more complicated calculations that previously required manual input. These innovations are available with a new CNC package or can be added to the CNC lathes already delivered.

In the updated system the need to calculate Cz and Cx values is eliminated, and the setting lengths and the nose radius of tools are now entered separately into the computer instead of being figured into the coordinates for each order block. All a programmer need do is supply the dimensions of the part being machined. All changes incorporated into this CNC unit make part programming easier (eg, to program feed rates in in./rev in addition to in./min.). Both EIA- and ISO-coded tapes can be accepted. Parts can also be programmed in inch or metric values when using the updated control. Lathes that have a dc drive can be programmed in m/min. or ft/min. instead of spindle speed. As a result, for each work routine, the lathe works at a constant cutting speed irrespective of how the diameter varies.

The control also permits thread cutting at higher speeds. Software makes it possible to increase the track speed when threading from 72 in./min. to 250 in./min.

Real-Time Factory Production Control System Offered for License

Software claimed to be "the first real-time, online operational system for minicomputers that combines a data-base manager with a transaction processor" has been developed for monitoring and controlling factory production. The combination permits instantaneous updating of a factory's status while production is underway, thus assuring immediately available product and inventory information.

Called MADTRAN, for Multi-Access Data Manager and Transaction Processing, the system was originally developed by General Electric Co's Research and Development Center in Schenectady, NY for in-house use with Digital Equipment Corp's PDP-11 minicomputers when operational requirements for company manufacturing plants could not be met by existing software. However, since the list of potential applications exceeds those found in the company's plants, the software is being evaluated for outside licensing or lease by other users. In addition, it is also being considered for conversion to computers other than the PDP-11.

During field tests the system processed as many as 3000 transactions per hour and required only 20,000 words of memory on a PDP-11 minicomputer network. By contrast, available data base management systems require 60,000 to 100,000 words of memory and cannot be updated in real time.

MADTRAN is designed for online use by workers unfamiliar with computer operations through such terminals as badge readers, cycle counters, cathode-ray tubes, and alphanumeric keyboards. It includes GE's *m*ulti *a*ccess *d*ata *man*ager (MADMAN) and is based on industry's CODASYL data base task force language.

According to its developers, the system can be adapted to almost any application where a large number of transactions are involved, such as banking, insurance, retailing, personnel registration, command control, and reservations systems, and where a user needs up-to-the-second information. As many as 300 different terminals scattered throughout a user site can be handled, even in a network of several computers. A system of locks and interlocks, called "concurrency control," protects against a bottleneck when more than one user requests the same data.

Dual system operation with another computer assures integrity of the data in the event of hardware failure, and an online dumping feature transfers the data from disc to tape while the system is online. Each transaction is recorded on magnetic tape through a "journalization" process to preserve the data in the event of machine breakdown.

TVA Orders Power Transmission and Control Systems

A contract recently awarded by the Tennessee Valley Authority to LFE Corp's Control System Industries of Santa Clara, Calif calls for delivery of four Area Dispatch and Control Center (ADCC) systems. Major elements in these systems consist of SCADA (Supervisory Control and Data Acquisition) masters, hard-wired remote terminal units (RTUs), and programmable or "smart" RTUs. The systems will be used to monitor and control major power transmission facilities in the 4-state upper Tennessee Valley region.

All ADCC computers are to be data-linked with TVA's existing Power System Control Center (PSCC) located near Chattanooga, Tenn. This arrangement forms a 3-level hierarchy in that computer intelligence is strategically distributed between the PSCC, the ADCCs, and an array of programmable remote terminals.

Each master station features dual Digital Equipment Corp PDP-11/35 computers, dual 1-megaword disc memories, dual 19" 7-color CRT control consoles, and dual communications logic. Full redundancy of all key elements is provided, such that no single-element failure can result in master station failure.

The control center computer is responsible for outputting master reference values to all ADCCs, which then continuously determine desired generation levels for each unit, and forward digital unit setpoint commands to programmable remote terminals located at various generation stations. □

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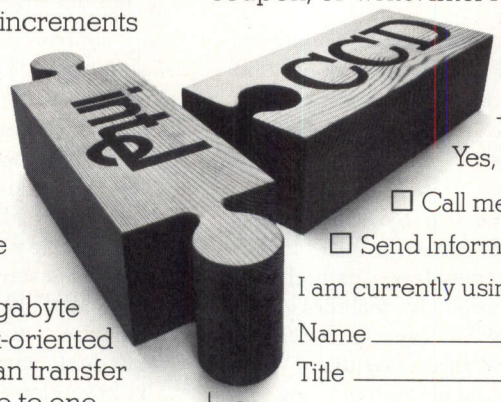

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CIRCLE 43 ON INQUIRY CARD

Packet-switching and circuit-switching are combined in a data communication network, obtaining the benefits of both approaches, yet providing the flexibility to meet virtually any data transmission requirement

"Pacuit" Switching Combines Two Techniques in One Network

Joe de Smet

Consultant

Ray W. Sanders

Computer Transmission Corporation
El Segundo, California

A data communication system that combines advantages of packet-switched and circuit-switched networks arose, in part, from a study of digital communication requirements of the state government of California. The study demonstrated the need for a different approach.

Like governments everywhere, the state's use of computers has grown dramatically over the past few years, and the need for remote access to and from these computers has expanded exponentially. For a time, each agency solved its own data communication problems; but as could be expected, growth of individual overlapping networks resulted in an inefficient maze when viewed as an overall system.

In 1973, the California State Universities and Colleges (CSUC) published a system description based on their present and predicted data transmission requirements. This proposed system combined the attributes of voice-grade dial networks with those of polled digital online call routing. Connections would be established by digital signals online, but the switching media would not depend on the protocol of transmitted data once a connection had been established. Additional features would include error correction, 300-ms turnaround time, and integration of asynchronous time-sharing traffic with synchronous batch traffic for line transmission efficiency.

From an overall system point of view, if maximum line efficiency is to be obtained, traffic from various terminals must be consolidated on one line and routed to distant terminals or computers. A network of switching nodes, each capable of concentrating and routing traffic, is an obvious requirement. Such switching nodes must provide interfaces for all terminals connected to it. They must also concentrate, multiplex, and switch data on demand or by preassignment. Switching nodes are interconnected, either directly or via other nodes, by data links or lines.

During the past few years, interest has been high in packet-switched networks for systems like that of the CSUC proposal. Packet-switched networks transmit data in packets of a fixed size, generally a few hundred or a few thousand bits; every packet carries with it the address of its destination. Users are charged only for the number of packets transmitted, not for the distance they are sent—an efficient and economical procedure for transmitting digital data. In addition, a major advantage of packet switching is its powerful error checking and recovery. However, the process of forming and transmitting packets presents a significant

source of delay and overhead when low speed terminals are used.

In contrast, the traditional interconnection method, circuit switching, sets up a path from source to destination and maintains it solidly for the duration of a transmission. This path does not depend on anything in the data to maintain it, and therefore is transparent to the user after it has been established. However, circuit switching was developed for voice transmission, and more broadly for analog signal transmission; for digital transmission it is inefficient. Error checking can be provided, in some cases with very powerful codes, but it is not intrinsic to the switching technique; therefore the overhead encountered in packet switching is not present.

Pure packet switching is most useful with asynchronous data, because asynchronous terminals tend to offer either weak error checking or none at all. Synchronous terminals, however, often include powerful detection codes such as cyclic redundancy checking.

To provide the best features of both packet and circuit switching, Computer Transmission Corp has combined them in its Tran M3200 system, under the designation Pacuit switching—a combination of *pac*ket and circ*uit*.

A Pacuit is a highly efficient packet structure containing data traveling between a fixed pair of source and destination nodes. The structure is a variable-length entity that effectively compacts data in an optimum manner. Because all data in a Pacuit have common source and destination nodes, there is no need for error checking or for storing packets at intermediate nodes along the path. Instead, only source and destination switches perform packet control functions; all intermediate nodes operate in a pure circuit-switched mode for through traffic. That is, messages are acknowledged only on a network end-to-end basis, minimizing end-to-end delays. Furthermore, intermediate buffer storage requirements are reduced, because the less time Pacuits spend in each node, the less queueing builds up. The logical link established between any source/destination node pair is called a "virtual connection."

Buffer storage requirements at end nodes are also reduced as a result of another difference between the two approaches; namely, that Pacuits are transmitted at regular time intervals from the source node, regardless of their bit count, whereas packets in most systems are transmitted only when they contain a certain minimum amount of data—a threshold that may be reached at irregular time intervals.

This is important because data enter or leave end nodes (to/from resources) at various rates. In pure packet systems, the time that each buffer remains allocated depends on this rate. Since buffer sizes are predefined to be equal to the minimum packet size, slow terminals may tie up considerable amounts of buffer storage for relatively long periods.

In Pacuit switching, however, only small buffers are needed, since they will be emptied at regular intervals, whenever a Pacuit is formed and transmitted. If no data are entered from a particular terminal between transmission of one Pacuit and the next, almost no space will be allotted for it in the new one. The compaction technique ensures minimal overhead for inactive terminals. Furthermore, when a terminal disconnects from the network, it is completely deallocated from the channel.

A single communication trunk can carry both Pacuits and conventional circuit-switched synchronous and asyn-

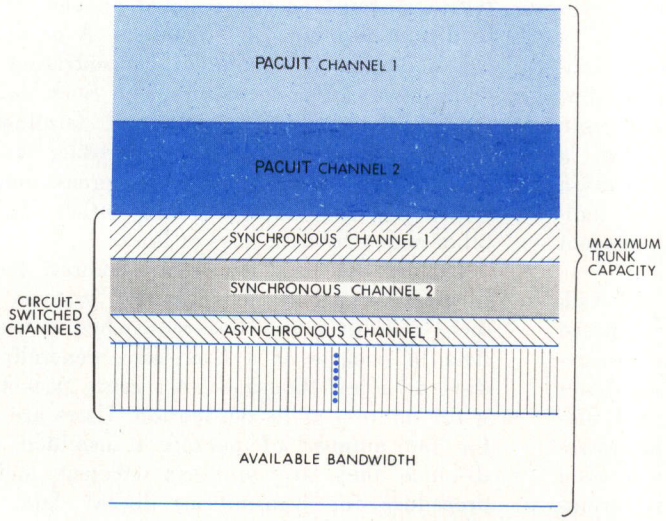

Fig. 1 Many channels, two disciplines, one trunk. Both Pacuit-switched and conventional circuit-switched data can be transmitted on a single multiplexed trunk

chronous data, multiplexed for simultaneous transmission up to the maximum bandwidth of the trunk (Fig. 1).

One Pacuit may contain data from several terminals. Therefore a well-chosen transmission rate results in a high probability that for every Pacuit some channels will have data to send, even if others do not. Every Pacuit contains a fixed amount of structural information. If the transmission rate is so high that the terminals in operation cannot keep up with it, many Pacuits will have a low data content. Clearly, each one must have a mean data content sufficiently high to ensure that the percentage overhead, due to structural information, is low (Fig. 2). On the other hand, it must not be too high; otherwise the advantage of small buffer requirements will be lost.

Transmission rate, in fact, can be dynamically controlled by switch software, using a monitoring and feedback technique. The same technique is used to control dynamic bandwidth allocation, as explained in more detail later in this article.

Nodal Equipment

Nodal equipment consists of two major units: digital switch and stored program controller. The digital switch connects terminals and lines as assigned by the controller.

For example, a terminal requesting service is automatically connected through the digital switch to the controller. The controller determines routing and notifies the switch which output to connect to the terminal. All data to or from that terminal continue to be relayed in both directions by the switch without further reference to the controller, regardless of the data content. Disconnect is handled similarly; besides breaking the connection, the controller must be informed that the output is available for reassignment.

The controller obtains all routing information from programmable tables. It also maintains a test program in the background, checking the switch and lines between requests for routings, and logs traffic information.

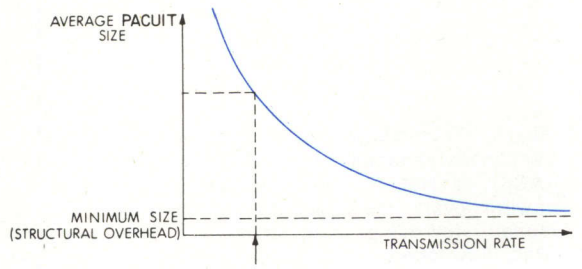

Fig. 2 Optimum transmission rate. High transmission rate may cause Pacuits to have high percentage of structural overhead, whereas too low a rate may require an inconveniently large buffer

Dynamic Bandwidth Allocation

Pacuit- and pure circuit-switched data are time-division multiplexed on trunk lines character-by-character. In earlier systems, this technique utilized the trunk bandwidth inefficiently, because time slot allocations were fixed within the repetitive channel selection sequence used for inserting data on the line. Thus, while no data were being entered from a terminal, its time slots were unused, and were generally filled by "idle" characters.

Now, however, a technique known as "dynamic bandwidth allocation" permits dynamic reassignment of time slots to different data sources. Decision to reassign is based on a data traffic monitoring method referred to as "statistical multiplexing," implemented by software in the switch minicomputer. Statistical multiplexing routines monitor outgoing traffic from a source node at frequent intervals, on a channel-by-channel basis. In this case, each active Pacuit connection is treated as a single channel. The technique insures that a channel has a bandwidth sufficient to carry its composite traffic rate, but no more than is necessary.

The M3200 system offers two types of synchronous circuits, one with flow control, and one without (fixed bandwidth). For flow-controlled synchronous channels, message transmission results in bursts of data from a buffer. In this case, though, the buffer is that of the originating terminal, and not of its network entry node. The rate at which a synchronous terminal buffer is emptied depends on available transmission capacity. A Remote Terminal Interface Unit (RTIU) controls the terminal clock to make use of this capacity. An RTIU may be used between each synchronous terminal and its point of entry to the network if circuit-switched service is required. The unit also serves a second function, that of resource addressing. If fixed bandwidth, dedicated (ie, nonswitched) service is required, no RTIU is necessary.

Dynamic Multiplexing

When several terminals are grouped together some distance from the nearest node, they may enter the network via a multiplexed tail-circuit (Fig. 3). To make optimum use of tail-circuit trunk bandwidth, a technique resembling dynamic bandwidth allocation continually reassigns time slot positions as required in the multiplexed channel selection sequence. The technique is called "dynamic multiplexing." A current

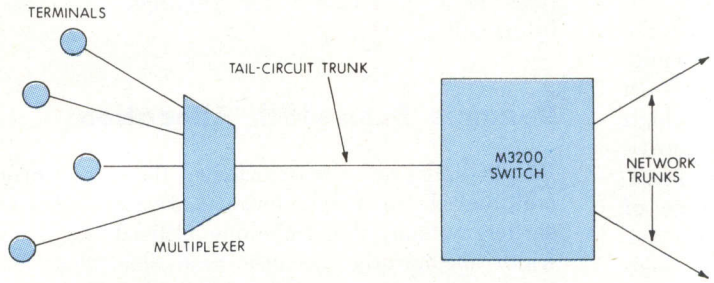

Fig. 3 Tail-circuit. Multiplexing technique can serve a group of local terminals close to one another but well removed from the nearest network switch

specification of time slot/channel assignments is reloaded dynamically from the switch. Dynamic multiplexing permits the tail-circuit trunk bandwidth to be considerably less than the sum of the bandwidths of all terminals attached to the multiplexers. This can result in considerable cost savings, because line and modem costs are usually bandwidth-dependent.

Pacuit operation is logically full duplex—that is, lines are capable of carrying data or response information in both directions simultaneously. Consecutive Pacuits may be transmitted in either direction, without waiting for the response to each one in turn. A proprietary technique permits a single 5-bit response to fully identify the sequence of acknowledgements (positive and/or negative) for up to four consecutively received Pacuits. Such a response is usually carried as part of another being transmitted on the same connection, in the opposite direction to those received

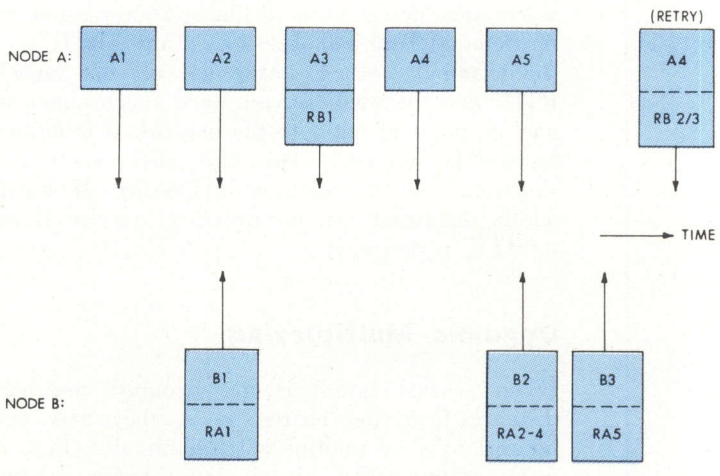

Fig. 4 Transmission with accumulated responses. Instead of an Acknowledge (ACK) or Not Acknowledge (NAK) following every message, as in conventional full-duplex transmission, the Pacuit-switched system can make a single ACK-NAK response for up to four Pacuits at once, usually as part of another Pacuit being transmitted in the reverse direction

(Fig. 4). Labels Al, Bl, . . . , represent Pacuit numbers, while RAl, RBl, . . . , represent the single or accumulated responses. In this example, response RA2-4 indicates good receipt of A2 and A3, but an error in A4, which is therefore retransmitted.

Alternative Routing

Logical link between any node pair for an active user channel is called a virtual connection. When network operation is started cold, no virtual connections exist. Normally, the first to be established are those for preassigned dedicated channels. Subsequently, as each new circuit-switched or Pacuit channel is initiated, it either is multiplexed onto an existing physical connection, or (if necessary) a new physical connection is established for it, with circuit-switching techniques.

Along the path of an established physical connection, source and destination nodes are logically defined to the switch software as assembly or disassembly nodes. Intermediate nodes, if any, are set up for time-division circuit-switching only. However, an intermediate node of one physical connection may also be the source node of another.

A source node is responsible for control of the connection. Initially, the physical connection is set up by a minicomputer at the source node, based on optimum path tables in software. Choice of the physical route depends not only on geographical considerations, but also on current status of relevant internode trunks. If any trunk in the potential route is too heavily loaded or out of service, an alternative route will be selected.

For this purpose, path tables are updated as required, on a demand basis; updating is usually infrequent. This connection approach guarantees that no circuit-switched channels will be dropped in the event of trunk failures during operation. Any such failure (including detection of an unacceptable error rate by any node along the path) is signaled to the source node, which then sets up an alternative route and switches traffic onto it.

Access Security

All resources connected to a Pacuit-switched network are assigned a logical station number by which they may be called, and a set of attributes which govern the resulting connection. Sets of station numbers may be defined as logical "access groups" to the switch software. In most cases, any resource may connect only to a member of its own access group. However, selected resources may be able to call destinations in other specific groups, limited by the requested station's ability to receive the external call.

The access group facility effectively provides a means of partitioning the physical network into a set of smaller logical networks. Each logical network may be entirely independent, or may have limited access to others. Partitioning is an important facility for networks that are

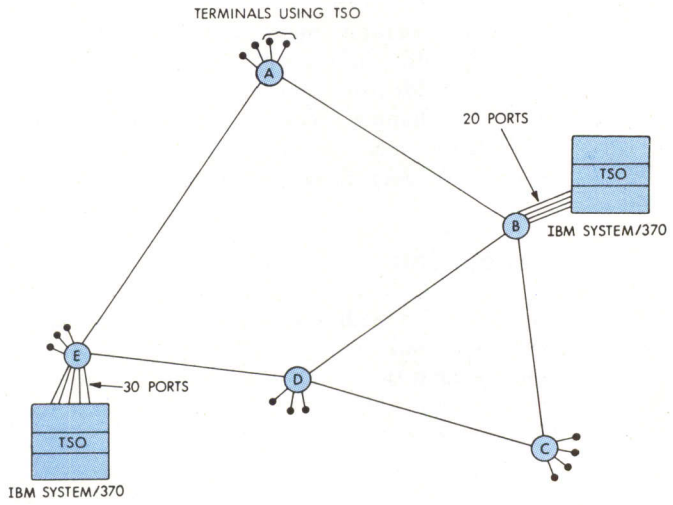

Fig. 5 One hunt group. To a user, the 50 ports on these two time-shared computers, geographically widely separated, are indistinguishable. When he calls for TSO, he can get service from either computer, but he neither knows nor cares which one

shared by several independent organizations—for example, public data network services offered by the telephone companies.

Resource Identification

In a partitioned network, the number of resources in an access group is usually a small proportion of total system resources. Thus, the number of characters or digits required to specify intra-group addresses may be somewhat less than that required for inter-group addressing. This is analogous to the public telephone network in which seven digits are usually required for dialing a local call, whereas 10 are required for long distance calls. The analogy is, however, incomplete inasmuch as a Pacuit-switched network has an abbreviated dial-in facility for frequently used connections that does not depend on distance.

Multiple ports in the same access group of a network, which offer access to similar resources, may be specified as members of a common hunt group—analogous to the hunt group of an automatic telephone exchange. Where several trunks are used in an exchange, a call that might normally be serviced on one trunk, but finds it busy, automatically hunts for another. Only if all lines are occupied does the caller receive a busy signal. Typically, in a Pacuit-switching network, a hunt group comprises several ports connected to one computer and offering access to one set of application programs. Again, however, the analogy with the telephone service is incomplete, since members of a network hunt group may be widely distributed. For example, identical time-sharing services may be offered by two computers at different nodes of a network (Fig. 5). Nevertheless, all ports on both computers may be specified as members of a common hunt group. A terminal user at node A who simply requests a TSO service may be connected to either computer—he does not know or care which one.

Software Architecture

The M3200 system runs under an efficient real-time operating system developed especially for it. Called the Data Switch Operating System (DSOS), the software system, like its hardware counterpart, is modular in structure. Through a system generation process, functional and input/output facilities required by each switch in the network are defined. This allows construction of a tailored version of DSOS for each switch, which is economical in terms of memory requirements and has a minimum performance overhead.

The DSOS dispatching mechanism ensures that high priority tasks receive immediate service, and that all tasks of any one priority receive service before any lower priority tasks. Seven priority levels range from a software system scheduler at the top, which distributes status information for level scheduling, down to a background level, which includes initialization, monitoring, and diagnostic tasks.

Software interface to M3200 hardware architecture is via two powerful program modules: Pacuit processing unit (PPU) and switch processing unit (SPU). PPU assembles and disassembles Pacuits at regular intervals for each Pacuit channel. Transmission and reception of both Pacuit- and circuit-switched data are handled by the SPU, which obtains routing information from channel address tables built and maintained by software.

Network Testing and Diagnostics

As an "intelligent" system, the Pacuit-switching network has many built-in self-diagnostic and monitoring capabilities. This real-time surveillance is automatically initiated by software. Active diagnostics, such as loopback tests of available ports, are performed on a time-available basis at the background level, while monitoring and response to system-generated alarms are at a high priority level.

Each switch monitors its own internal operation, and operations of any multiplexers and trunks that it serves. Real-time diagnostics are designed to locate most fault conditions before the user becomes aware of them. Test repertoire includes switch diagnostics, trunk monitoring of Pacuit channel error rates, port diagnostics, and configuration checks. When these diagnostic results reveal errors, they may be output at user-specified locations. Typically, in small networks, they are printed on the teleprinter console of the switch that diagnosed the error. In larger networks, error alarms can be sent to a network control center.

The operator can also initiate certain tests from the local console of any switch node. Many of these are similar to the self-diagnostics, but are executed with higher priority for specified resources. In addition, the operator may interrogate the network for channel status information; this test is a connection trace that identifies the destination (if any) of any specified channel. These monitoring and diagnostic capabilities increase network reliability and system availability over those of traditional online systems.

Conclusion

Initial service with the system is due to begin shortly with four switches and 19 multiplexers serving 150 stations and two computers. Soon afterward, a second agency with additional computers and 60 stations will be added to the net.

Thus Pacuit switching enables the building of a digital system offering a high level of service at a competitive cost. Furthermore, its cost per station is expected to decrease as the network grows, while it retains the flexibility to meet virtually any data transmission requirements. □

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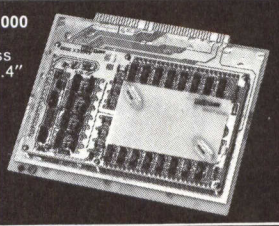

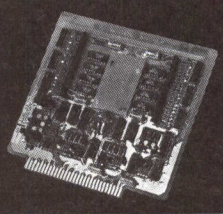

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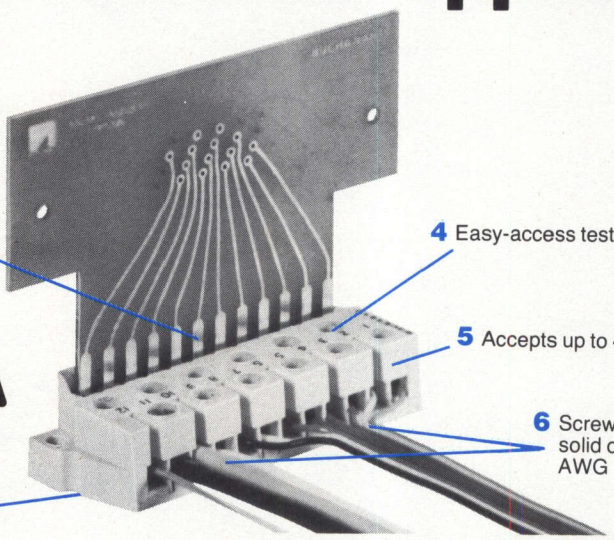

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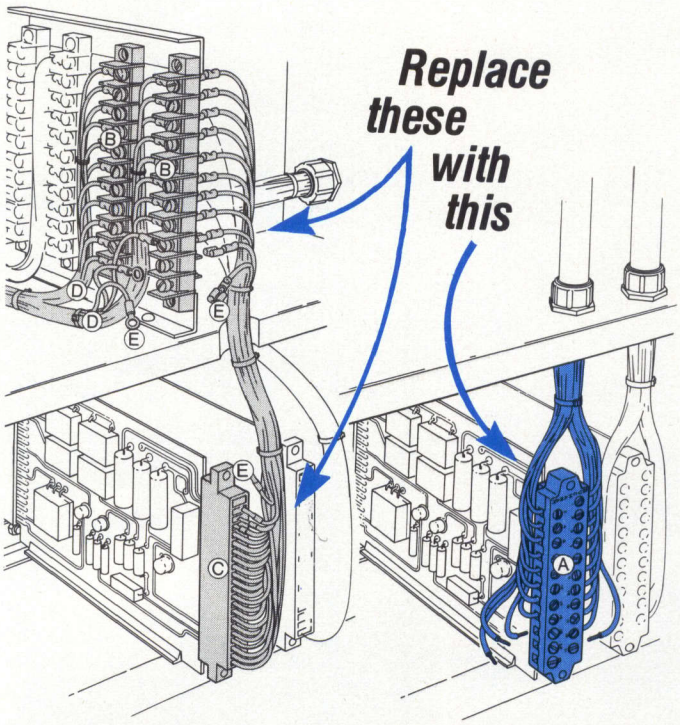

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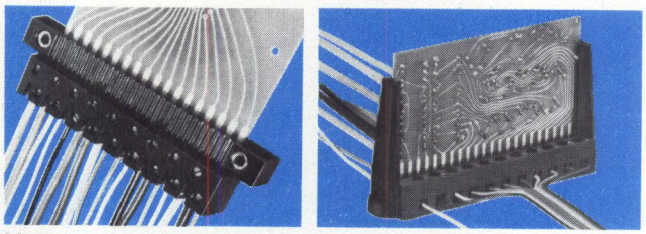

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CIRCLE 45 ON INQUIRY CARD

Originally designed as reloading media for microprograms, and later used for data entry, floppy discs serve well for mass storage in a microcomputer, if the controller is carefully designed

Simplified Floppy-Disc Controller for Microcomputers

Theodore H. Kehl and Lawrence Dunkel

University of Washington
Seattle, Washington

Flexible magnetic discs (floppy discs) are excellent peripheral storage units for microprocessors because their initial cost is low, their storage capacity is reasonably high, and the medium is changeable. However, controller design can be vexing, because conventional approaches result in a system too complex and costly for widespread use, and because a simplified controller with little or no error recovery makes the system too unreliable.

Nevertheless, several microprocessor-based, personal computer systems, built at the University of Washington, use floppy discs as primary system media. In these systems, highly reliable operation is a necessity because operating system, compilers, and software utilities all reside on the disc. An unusual controller design achieves the necessary reliability at reasonable cost.

Surprisingly, conventional controllers seldom reveal the exact nature of an error to the software, even though they perform extensive hardware-error detection. Usually parity bits are included in each word or byte, and a longitudinal redundancy check character (LRCC) in each record. With a cyclic redundancy check character (CRCC) applied as a self-correcting code, but without the byte location, a detected error cannot be corrected. The controller provides only a status word indicating that an error exists somewhere in the record or sector. With this meager information, the software's error recovery is limited to rereading; after a predetermined number of unsuccessful attempts (usually 10), the operating system can only conclude that the record is permanently bad and abort the read operation.

Floppy disc systems are subject to four general types of errors:

(1) Most familiar are errors in data that are read. Data are flux changes on the magnetic surface, sensed and converted into a sequence of pulses. These are combined into words by a serial-to-parallel conversion and sent to the computer memory. Bits in the serial sequence are dropped or picked up because of worn media, worn heads, power-line fluctuations, or faulty head positioning.

(2) Track-positioning errors can cause wholly erroneous data to be read. They are purely mechanical and usually occur when one or more tracks are missed during head movement.

(3) A photocell and light source detect passage of a slot or hole in the disc, identifying the start of a sector. A similar track-origin mark resynchronizes the sector count. One or more sectors, or the track-origin mark can be missed, because of an obscured mark or a burned-out light.

(4) Rotational speed errors can occur but are unlikely. Most systems use either accurately controlled servomotor systems, rotational speed sensing, or self-clocked data. The controller cannot compensate for speed variations due to severe under- or overvoltages in the primary power line.

In general, these errors may be divided into recoverable and permanent errors. Permanent errors result from an outright failure and, to a trained eye, are relatively easy to find. Recoverable errors are transient; consequently, their sources are difficult to identify.

Reasons for a Simplified System

Floppy discs that are compatible with the IBM 3741 or 3742 are restricted to a fixed format. Initializing this format and writing in it are ordinarily controlled by a great deal of hardware. Unfortunately, while imposing this format, the designers neglected error recovery, perhaps because floppy discs were originally designed, not as computer peripherals, but as microprogram loading devices, and were later used as data entry devices.

Most controllers simply send an "address-no-match" signal to the processor; however, error recovery would be greatly facilitated if the last address actually read by the drive before giving up the attempt were sent instead. Error recovery *software* could then make a diagnosis and take appropriate action. It might discover, for example, that the address is not on the track where the head is positioned, which would indicate that the accompanying read command should have been preceded by a seek command to a different track, or that it was improperly executed. Various error-recovery strategies which can be used are discussed later; the point is that as much raw hardware information as possible should be provided to the software.

In designing the simplified system, goals included (1) less hardware complexity, to lower the system failure rate; (2) more error information for the software, to allow better error recovery; and (3) a less complex disc format, to make more space available for data. The resulting format can store 45% more data than the IBM format (see table).

IBM 3741 or 3742 floppy-disc format consists of 77 tracks numbered 00 to 76. Track 00 is an index track, containing information that identifies data on the disc, protects it from alteration and eradication, and substitutes alternative tracks for use in case any track acquires an unrecoverable error. Tracks 01 to 73 are data tracks, each consisting of 26 sectors; one sector stores 128 bytes in the 3741 and 80 bytes in the 3742. Tracks 74 and 75 are the two alternative tracks, and 76 is a spare.

Each data sector in IBM format consists of a sector-ID portion and a data portion. Sector ID begins with an ID-address mark, a unique 8-bit byte that synchronizes the electronics when reading, followed by a sector address and a 2-byte cyclic redundancy check character (CRCC); sector address, in turn, is subdivided into track number and sector number. The data portion includes a data-address mark, another unique 8-bit synchronizing byte, which is followed by space for 128 or 80 bytes and another 2-byte CRCC.

Before a new disc can be used in a system for the first time it must be initialized. Initialization includes writing sector identification and data-address mark. Later write operations occur only on the data portion of any sector; the sector-ID portion of the IBM format cannot be written in. Furthermore, every read or write operation first reads the sector-ID portion to determine that the correct sector has been reached. A short gap between sector-ID and data portion of the sector allows time for sector-address verification when reading, and when writing, for the high-current write circuits to be turned on.

Format Comparison

	IBM	Simplified
Total tracks	77	77
Data tracks	73	77
Sectors/track	26	8
Total 8-bit bytes/sector	187	646
Pre-index gap	46	0
Index mark	1	0
Post-index gap (recorded 0's) plus Sync burst	32	16 + 2
Sector ID	7	2
ID gap	17	0
Data	128	572
CRCC	2	2
Bytes/track	4862	5168
Data bytes/track	3328	4576
Data bytes/diskette	242,944	352,352
Data storage improvement		45%

Our format also has 77 tracks, but all 77 are used for data. Sectors are much longer, with only eight instead of 26 around the disc; each stores 572 bytes. The sector is regarded simply as a record; its first word is the sector address, which includes, like IBM, a track and a sector number. Last word in the sector is a checksum, the logical sum of all the words in the record, including the sector address (Fig. 1).

Because sectors are longer and the disc has fewer of them, a smaller proportion of the disc surface is necessary for addressing and checking. Use of less complex addressing methods reduces this proportion still further. As a result, each track holds 4576 data bytes, compared to 3328 in IBM format; an entire disc holds 352,352 bytes, a 45% gain over IBM's 242,944.

Although discs may be initialized, it is less important than in the IBM format, because the format includes no gap between sector address and data portions. Therefore, sector address must be rewritten at the beginning of every record that is written. To insure that the record is written in the correct sector, the preceding sector can be read and its address verified, and write circuits turned on in time to start the new sector. In practice, the best strategy is not to write single sectors, but to accumulate up to eight records in the system's main memory, transferring them to a whole track of the disc in a series of successive writes. Although the operating system does write whole tracks, this strategy need not be observed; users may write single sectors.

Data Path Organization

The simplified floppy-disc controller has a straightforward data path (Fig. 2). During a write operation, 8-bit data from the processor's I/O bus are copied into a multiplexer/latch (74298). A second-level multiplexer (two quad 2-to-1 circuits, 74157) routes the latched data to an adder (74283) which forms a run-

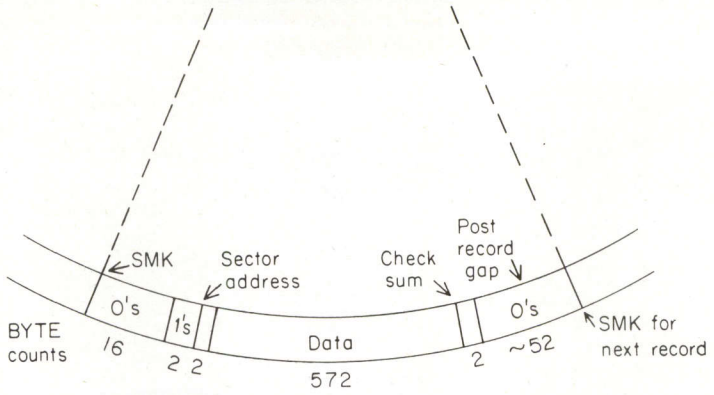


Fig. 1 Simplified floppy-disc format. This format reliably stores more data by using longer sectors (fewer per track) and less addressing and other overhead information between sectors than are found in the industry standard

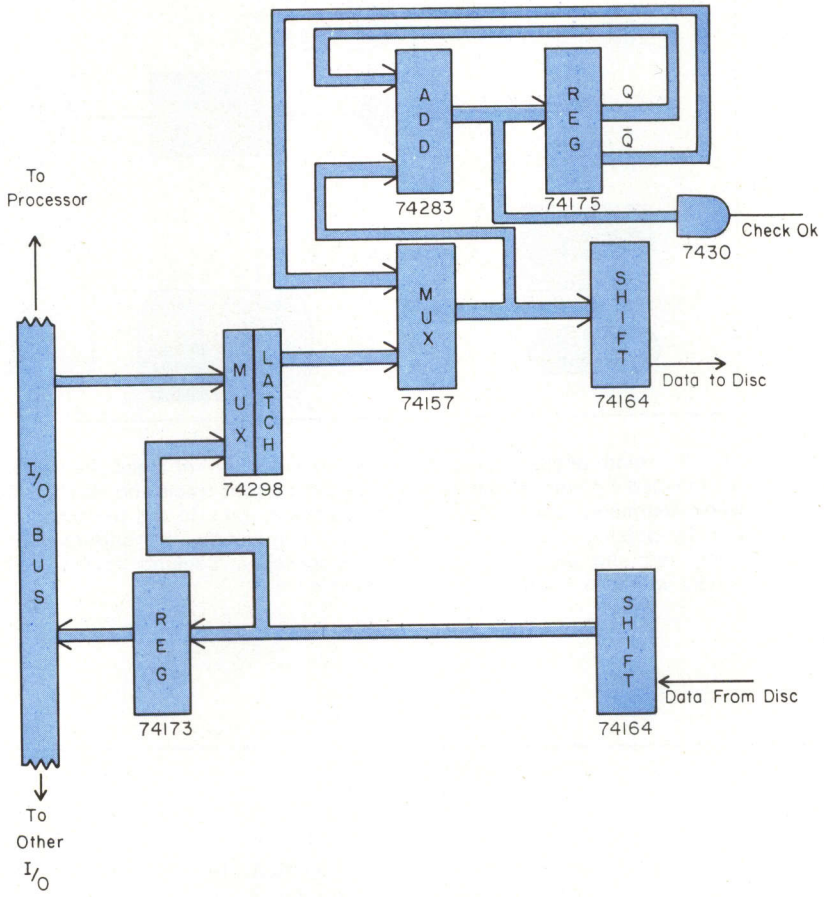


Fig. 2 Data path. Disc controller is connected to processor's I/O bus, converting parallel bus data to serial and vice versa, and generating checksums for error detection

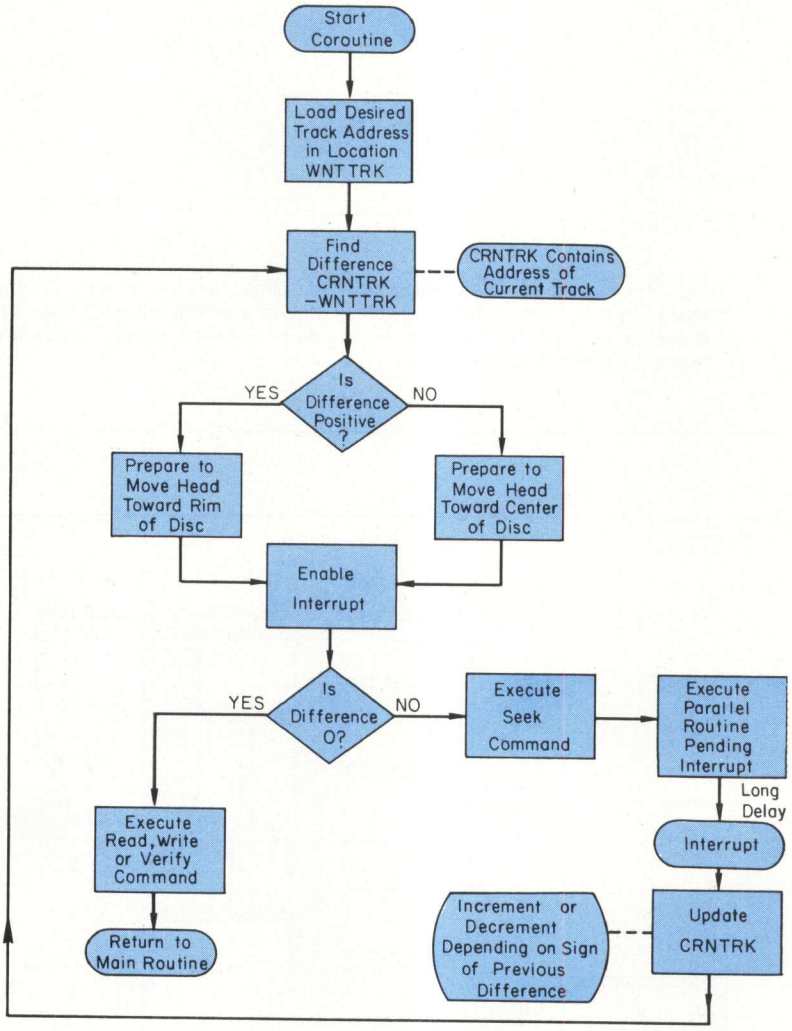


Fig. 3 Head positioning with software. Direction of head movement is established by sign of difference between current track and desired track. Seek command moves head to next adjacent track in the indicated direction by pulsing a stepping motor; upon completion, the difference is recomputed and the seek repeated if necessary. Seeking across multiple tracks with one command is not possible

ning checksum that is accumulated in its own register (74175). Simultaneously, the second-level multiplexer puts the data in parallel into the output shift register (74164), from which they are shifted serially to write circuits in the disc drive. After all data are written, the multiplexer gates the complement of the checksum into the output shift register.

When all data are read, the checksum word read from the disc is passed to the multiplexer/latch (74298). Because the complement of the checksum was written, the sum of the checksum read and the accumulated checksum in the register should be a word of eight 0's. This is confirmed by an 8-input NAND (7430).

Floppy-disc drives use stepping motors to move the heads, instead of proportional-seek servosystems as large drives do. A proportional-seek servosystem drives the heads radially across the disc at a speed propor-

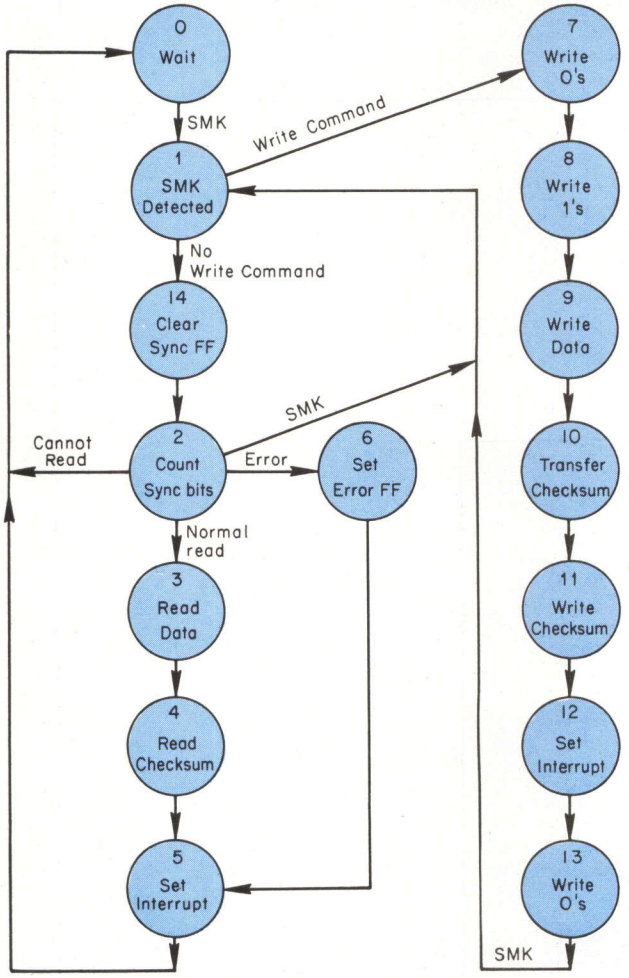


Fig. 4 Controller logic. Circles indicate 14 stable states through which controller steps during read and write operations. Details of "error" and "cannot read" conditions are given in text of article

tional to the difference between the current and the desired location of the heads; long seeks give fast head movements in the early phase of the seek.

However, with stepping motors, a constant amount of time—about 10 ms—is required to move the heads from one track to the next. Therefore, to move across several intervening tracks requires several seek commands. In a complex system, the processor could specify the desired track address, with the controller keeping track of successive seek operations. To simplify things, we use the processor to compute the difference between the current and desired track. This takes about 10 instructions that are executed, on the average, in 1 μs each; computation, therefore, adds only 0.1% overhead to the processor's operation.

In software control of head positioning, when a new track is desired, a coroutine* is activated. A word of main memory contains the current track address, and another main memory location holds the desired track address. The difference—plus or minus—is computed to determine magnitude and direction of the seek. A step command is sent to the controller, which interrupts the central processing unit (CPU) when the step is complete. In the interrupt response, the CPU increments or decrements the current address and recomputes the difference. This process is repeated until the difference is zero (Fig. 3), when the head is presumed to be over the correct track.

Writing and Verifying

Ordinarily, when writing a new record, sector address and new data are written in a single burst, after the correct track and sector are located, as described previously. For maximum reliability, the sector address can be checked before writing takes place, by reading the first word from the previously recorded sector (that is, the sector address), and looking for disagreement between old and new checksums or between old and new addresses. Since this can require as much as two whole revolutions of the disc to write a single sector, the precheck can be bypassed to save time if somewhat less reliable operation is acceptable.

If this address check is done simply to assure that a preceding seek has been completed properly, only track number, the same for every sector on that track, is important. In this case, the check requires the extra disc revolution only if the sector in which the track number is verified happens to be the one in which the new record is to be written. On the other hand, if both track and sector number must be checked, after the sector has been located, the head must ride all the way around before writing can begin; the controller must count off the intervening seven sectors and be ready to write when the desired sector comes around again.

Verification is another reliability-enhancing technique. A simple procedure consisting of reading a sector without transmitting the data to memory, verification usually takes place immediately after a write operation. If a checksum error is not indicated after verification, the sector is assumed to have been correctly written. Additional confidence in verification can be gained by transmitting only the sector address to memory, assuring the system that it has verified the correct sector.

* Coroutines are similar to subroutines with the exception that the instruction sequence of one is not considered subsidiary to that of another. A single call to a coroutine will result in multiple reentries.

Control Logic

The floppy-disc controller has 14 stable states, indicated by circles in the state diagram (Fig. 4). Each state sets up unique pathways in the data flow diagram. State 0 is a waiting state, occupied, for example, while a seek is in progress or between intermittent data-transfer operations. Each sector mark, a permanent physical feature of the disc, causes a transition to state 1. (The Shugart SA901 floppy disc used in our

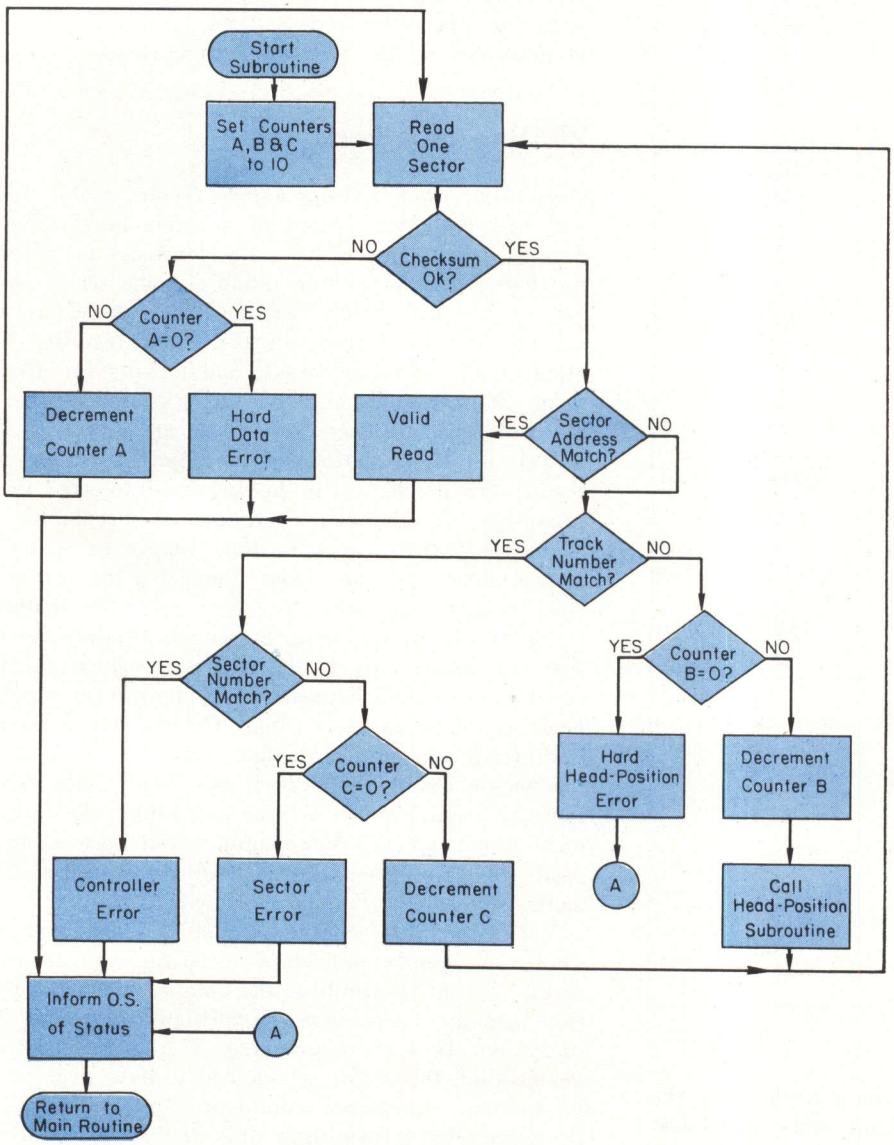


Fig. 5 Error recovery. Any malfunction causes an operation to be retried up to 10 times (any number can be used in the counters). Successful retry or continued failure after 10 retries causes the operating system to take control, with action depending on the controller's current status

project generates 32 sector marks (SMKs) during each revolution, using a light source that shines through holes in the disc onto a photocell. The controller accepts only every fourth mark, thus generating eight SMK signals per revolution.)

Following an SMK and a sector-address match, a write command causes a transition to state 7, in which a preamble of 128 0's is written. After the preamble, a group of 16 1's is written (state 8) as synchronization bits, establishing word boundaries for the sector and effectively fine-tuning the sequence initiated by SMK. The latter can be off-tolerance, especially in a much-used disc, if edges of the holes become worn. After writing the synchronization bits, the controller goes to state 9, where it remains until all data words are written. State 10 transfers the checksum register through the second-level multiplexer to the output shifter, from which it is written during state 11. State 12 sets an interrupt, and state 13 writes 0's until the next SMK, causing a transition back to state 1.

From state 1, a transition is made to state 14 except when the computer has given a write command. State 14 clears a flip-flop called SYNC to prepare for reading the 16-bit sync burst. State 2 counts the 16 bits of 1's, and sets the SYNC flip-flop if the count is correct.

From state 2 any of four transitions can occur:

(1) Error indication flip-flops (state 6) set either because a command is present when the drive is not ready or because SYNC was not turned on during the 16-bit burst. Not ready means any of several conditions—eg, a just-started disc coming up to speed or a seek in progress.

(2) SYNC is turned on, but the sector address does not match, a read command has not been issued, or the drive is not ready, causing a transition back to state 0 to wait for the next SMK. This sequence of states 0 to 1 to 14 to 2 to 0 is executed sequentially, so that the sector counter always contains the current sector number, even when idling. This is called rotational position sensing.

(3) An unused disc that has not been properly initialized could trap the controller in state 2. Therefore an SMK in state 2 guarantees a transition to state 1.

(4) Normal reading of the sector (state 3) followed by reading the checksum (state 4).

States 4 and 6 are both followed by an interrupt set (state 5) and a return to the Wait state.

Our error-recovery scheme (Fig. 5) uses three main memory locations, which are initially set to 10, as counters. (Since these are software constants, any value can be used.) At the end of a read operation, a checksum is computed from the data as read, and compared with the checksum previously written on the sector. If the two are not the same, counter A (CNTA) is used to control rereading of the sector. At the end of 10 read attempts, the operating system concludes either that nothing was ever written on the sector or that it contains an unrecoverable error.

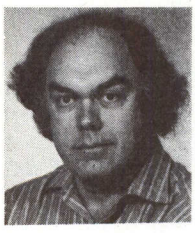
If checksums agree, the operating system assumes that the sector was read successfully. However, it may be the wrong sector, so the first word in the sector, ie, the sector address, is compared with the address sought. If addresses are unequal, software starts to track down the error. First, it determines whether the correct track has been reached; if not, a new seek command is issued, and another attempt is made to read the sector. Counter B allows 10 attempts at head positioning before an unrecoverable track-positioning error is declared.

If the track number checks, a sector-number comparison is made. If this does not check, counter C is decremented and the system again makes 10 attempts to read the sector.

If desired, the contents of the counters after a series of error-recovery attempts can be transferred to tabulation counters to indicate overall disc performance. These and other error statistics can be very important. With good error-recovery techniques, a gradual degradation of performance can occur as disc surfaces and other components become worn; nevertheless, the system continues to limp along, making heroic struggles to move data back and forth to the disc. Error statistics are useful to monitor and halt degradation before things become too bad.

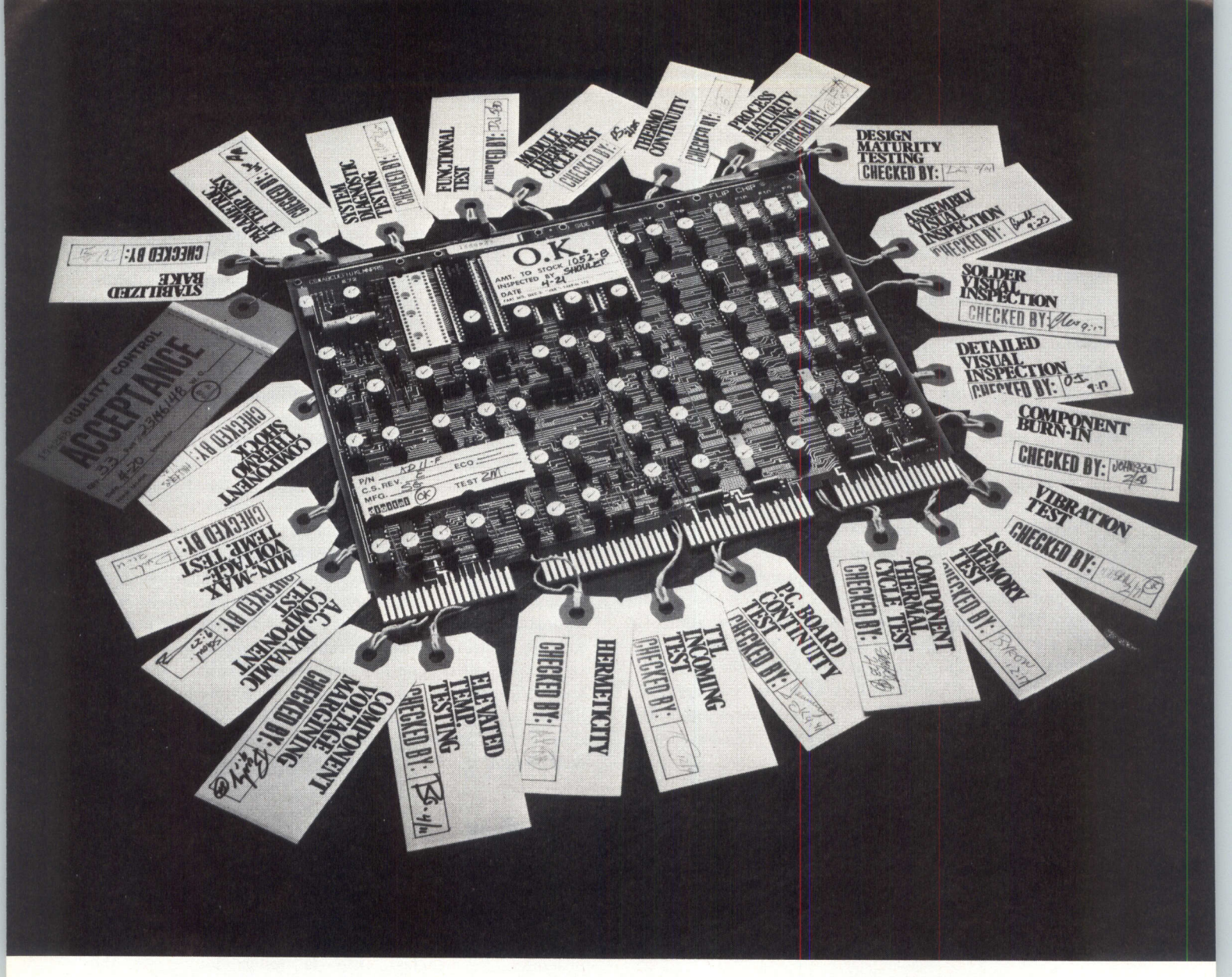
Reliability

Shugart Associates specifies its floppy disc to be good for 2 million passes/track when the head is in contact with the recording surfaces. Cleaning and lubricating material in the disc jacket make this long life possible. Nevertheless, life is much longer if the head is retracted when no commands are being executed. IBM retracts the head after three revolutions without a command; we do the same under hardware control.



Theodore H. Kehl received the BS, MS, and PhD degrees from the University of Wisconsin. Currently an associate professor of computer science and of physiology and biophysics at the University of Washington, his research encompasses microprogrammable modular computer systems, and information retrieval and firmware compiler techniques, directed toward more efficient systems for use in biomedical research.

Lawrence Dunkel, a member of the Physiology and Biophysics Dept of the University of Washington, is engaged in the design and development of digital hardware for microprogrammed real-time computer systems. He holds the BS degree in natural science from Seattle University.



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Protecting Minicomputers From Power Line Perturbations

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Equipment to protect minicomputers against malfunctions in the primary power source has only recently become feasible as a result of new design concepts incorporating integrated circuits and power semiconductors. This equipment gives minicomputers protection similar to that which has long been available for large computers (see *Computer Design*, July 1974, pp 63-79).

While minicomputer malfunctions related to the primary power source may seem mysterious, their causes are relatively few. Most obvious is the blackout, a total power failure that may last for a minute or for several hours. Second cause is the brownout, a planned or unplanned reduction of the line voltage, which may last for hours or days.

Most insidious is the line voltage surge or dip, which may last from a few hundred microseconds to a few seconds. It is easily caused, but difficult to detect. It may be apparent if the lights dim momentarily, or a TV picture is torn or distorted. It is frequently due to a series of transients that may originate in the ignition system of an automobile or an oil-burning furnace, or from an amateur radio transmitter. Other sources are electric typewriters, accounting machines, soft drink vending machines, copying machines, arc welders, electromagnetic cranes—in fact any device that includes a switch or relay, capacitor, or coil. These machines constantly spew noise and transients onto power transmission lines. Such transients are usually picked up by the TV antenna, but are also coupled into power lines, and are likely to end up in the power supplies of minicomputer systems.

For each noise pulse or transient that causes a visible effect on lights or TV pictures, hundreds can happen too fast to produce visible results. They may last 40 or 50 ms, long enough to completely disorient critical electronic circuits, and may be several hundred or even several thousand volts in amplitude.

In many cases, however, the transient is only the beginning. The power line, like any other transmission line, has a resonant frequency, and may oscillate following an abrupt transient. Oscillation creates a train of pulses with a frequency of several megahertz, traveling back and forth along the line at almost the speed of light.

Effects of Power Line Perturbations

Tests have been performed to show which areas within a minicomputer are most likely to malfunction when transients occur. Interruptions lasting from 1 to 2 ms can switch control rectifiers and power transistors, and can generate magnetic fields that make dc power supplies oscillate. Transients coupled into logic circuitry cause undesired switching, resulting in altered word structure, parity errors, changes in memory contents, and nonprogrammed jumps.

Peripherals as well as the computer proper are vulnerable to transients. Tests have shown that disturbances lasting for less than one cycle of the line frequency—16.7 ms—can cause erroneous typewriter printouts, incorrect inputs from card readers, and errors to be generated in the input/output interface. Transients

of sufficient length may cause the computer or one of its subsystems to shut down completely; shorter transients, lasting from one to two cycles—say 20 to 30 ms—will not trigger the shutdown mechanism but may alter the contents of memory. Longer transients may also cause problems with modems, controllers, and scanners. Obviously, ascertaining the causes of such malfunctions is not easy, since they may result from defects in the minicomputer or its peripherals as well as from line voltage fluctuations.

UPS—Solution to Power Line Problems

Uninterruptible power sources (UPS) can eliminate or sharply reduce power line problems such as these. Furthermore, just as the development of semiconductors and integrated circuits (ICs) has dramatically reduced the size and power dissipation of computers while vastly increasing their capabilities, similar developments have produced changes in UPS that are just as revolutionary.

UPS systems are by no means new. They originally came into use after World War II, and have been implemented in several ways. One method used an engine-driven auxiliary generator which was often unsatisfactory because it took 15 to 20 s to reach full operating speed. Another was a generator normally driven by the line that incorporated a huge flywheel. The flywheel was intended to maintain generator speed until an engine reached normal operating speed, but was subject to excessive bearing wear. A modification of this technique used an electromagnetic or eddy-current clutch and a smaller flywheel; however, the clutch was very inefficient, and did not improve reliability. A third approach used a dc motor and a battery source to drive the generator when the ac power failed; short brush life and poor speed regulation doomed it to failure.

The only system that did give satisfactory results used a synchronous motor-generator set to drive the critical load. Driven by a dc-ac inverter powered from a line-driven rectifier when the ac supply was normal, and battery-powered during emergencies, this system was feasible for large loads, but never gained popularity for small installations.

Static UPS systems, which first came into use in the mid-1960s, were principally large systems, because most critical applications at that time required from 40 to 500 kVA. Present-day minicomputers perform tasks formerly requiring much larger installations; as a result the need for small UPS systems has mushroomed.

First of the "small" UPS systems were small only in terms of power output. They were bulky, extremely heavy, and relatively inflexible. Today's more efficient power transistors and rectifiers, and ICs have reduced both size and number of components in rectifier chargers and inverters; large relays and switches have been replaced by solid-state devices. Old-style chassis with point-to-point wire have given way to modular construction with plug-in circuit boards. Thus, standard assemblies and subassemblies can be built and combined into a wide range of off-the-shelf models with negligible customizing. Consequently, modern systems are smaller, lighter, more efficient, and considerably less expensive than earlier ones, especially for output power ratings that range from a few hundred volt-amperes to 30 kVA.

Static UPS System—How It Functions

Basic static UPS consists of a rectifier/battery charger, a dc-to-ac power inverter, and a battery bank or reservoir (Fig. 1). The rectifier/battery charger is driven by the ac line. As long as this commercial power is normal, the rectifier/charger maintains the battery reservoir at full or "float" charge. At the same time, it provides dc input power to the dc-ac inverter, which in turn drives the minicomputer system. If commercial ac power is interrupted (blackout), or drops to a critically low level (brownout), the battery reservoir takes over, maintaining ac to the computer. In addition, during ac line operation, filtering in the rectifier/charger attenuates any transients and fluctuations that might otherwise pass through the minicomputer power supplies to cause ambiguities or errors.

If transients or fluctuations are not a problem, the forward-transfer system (Fig. 2) may be preferable. This system includes a transfer switch; the UPS remains on standby while commercial power is normal.

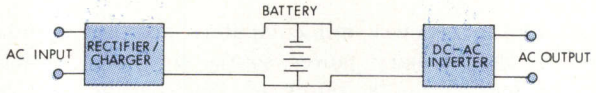


Fig. 1 Continuous UPS system. Rectifier/charger includes filter that keeps transients out of inverter. Charger maintains battery level and furnishes dc input to inverter while ac input is normal. Battery drives inverter when ac line voltage drops or fails

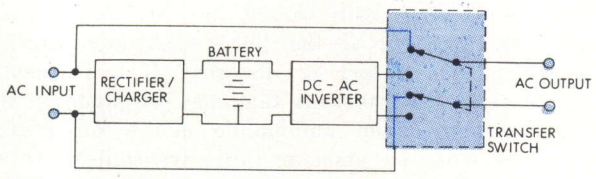


Fig. 2 Forward-transfer UPS. In normal mode (shown), inverter idles while charger keeps battery up; ac line drives load directly. If ac input drops, switch transfers load to inverter until ac line returns to normal

The rectifier/charger maintains the batteries at the float level, and provides idling current for the inverter. If ac line voltage drops excessively, the minicomputer is transferred automatically to the inverter output. The inverter supplies power until line voltage returns to normal, at which time the minicomputer is again transferred to the line.

The forward-transfer UPS has an initial cost advantage because the rectifier/charger unit never has to supply power to inverter and battery reservoir at the same time, and therefore can be smaller. Disadvantages are lack of transient protection and delay in transfer switching, which may itself cause a momentary power interruption.

A third type of UPS is termed reverse-transfer (Fig. 3). Here UPS output is the normal power source; the minicomputer system switches to the ac line only if UPS output falters or becomes overloaded. Consequently, the UPS protects the minicomputer from transients and fluctuations as well as blackouts and brownouts, just as in the continuous type.

All three configurations are subject to the inverter's current-limiting characteristic, typically about 125% of its rated current output at normal voltage. Because this may not be enough to blow a fuse or trip a circuit breaker if a fault develops, the reverse-transfer UPS has an advantage over the other two. When such a fault develops, the transfer switch can go over to the ac line, which delivers necessary current, returning to the inverter when the fault has been corrected.

In this way, reverse-transfer UPS improves overall reliability, since it provides backup power if the UPS should malfunction. To further improve reliability, backup power could be furnished by an auxiliary engine-generator rather than from the commercial line.

Selecting a UPS System

Having determined the nature of his power line problems, the minicomputer user can decide which type of UPS system is needed. Then he must determine the minicomputer system's power requirements. UPS systems are normally rated in terms of output power, measured in volt-amperes (VA) or kilovolt-amperes (kVA). Apparent power is the product of rms voltage and rms current delivered by a source. However, a load consumes real power—the product of rms voltage and rms current actually used by the load, measured in watts or kilowatts. If the load is reactive, voltage and current through it are out of phase, and their rms power product is less than if they were in phase. Difference between the two products is reactive power (VAR), which circulates in reactive circuit elements but does not drive the load. Ratio of real power to apparent power (kW/kVA) is called the circuit's power factor.

Correct UPS rating is the quotient of the minicomputer system's real power requirements (kW) divided by the power factor. Every system component—peripherals and secondary memories as well as the processor—should be taken into account. For each component the "power profile" comprises

(1) Line (or line-to-line) voltage
(2) Rms current per line
(3) Real power in kilowatts
(4) Apparent power in kilovolt-amperes
(5) Power factor
(6) Maximum inrush current and its duration
(7) Estimated future expansion requirements

Usually, the first six items are shown on equipment nameplates; if not, manufacturers can provide them. With this information, UPS manufacturers can determine the kVA rating.

From the amount of backup time needed and the power profile, battery reservoir size can be determined. Most UPS manufacturers provide the system with or without a battery reservoir, depending on user preference.

Rectifier/charger rating is determined by three factors: whether the UPS system is normally online (continuous or reverse transfer), size of battery reservoir, and desired recharge time. A common ratio between recharge and discharge time is 12:1, meaning that a battery discharged in 1 hour would be recharged in 12.

The ideal rectifier/charger operates in a constant-current mode during the initial charge period, automatically switching to constant-voltage mode toward the end of the charge cycle. This type of charger guarantees maximum battery life consistent with fast recharge, and prevents excessive battery outgassing and water consumption. In most cases, the rectifier/charger should provide both a float voltage level for maintaining the normal battery charge and a higher equalizing output with a timer to periodically increase the charge level. This is necessary in some types of batteries because of the chemical reaction that takes place in the battery; even though maintained at a steady float voltage, charge can migrate from cell to cell, causing problems when a load is placed on the battery.

Most critical element from the reliability standpoint is the dc-ac power inverter, since its failure immediately shuts down the UPS system. Rectifier/charger failure is less critical, because battery operation can continue while the charger is repaired. Batteries seldom fail suddenly if properly maintained.

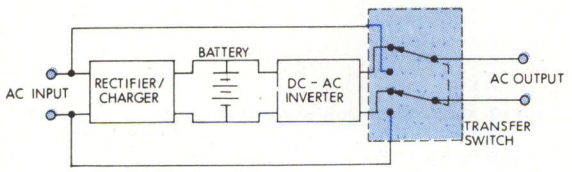


Fig. 3 Reverse-transfer UPS. In normal mode (shown), inverter drives load while ac line connection is available in case UPS malfunctions or is overloaded

Although there are a number of inverter designs to choose from, one has become particularly popular for UPS because of its simplicity and low component count. It is known as the ferroresonant inverter (Fig. 4), and is named for the unique transformer that generates a sinusoidal ac output. It consists only of an oscillator that controls the silicon-controlled rectifier (SCR) switches, ferroresonant transformer, and harmonic filter. It is unique because the transformer has a tuned resonant secondary winding, which produces a regulated output voltage and current limiting. Consequently, complex voltage and current feedback networks are not needed. In spite of or perhaps because of its simplicity, this inverter design has an efficiency of about 70 to 85%, depending on the power level.

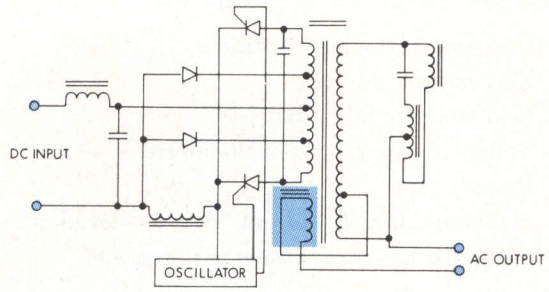


Fig. 4 Ferroresonant inverter. Transformer regulates voltage and limits current. Capacitor across secondary winding is resonant to generate sinusoid output. Voltage regulation is improved by extra transformer winding (colored block)

A quasi-square wave inverter (Fig. 5) creates a variable duty-cycle waveshape which must be filtered by tuned series and parallel inductive-capacitive (LC) networks to reduce harmonic content and form a sinusoidal output. Since the filters are tuned sections, this inverter responds slowly to load transients and its frequency must be fixed. Efficiency is typically about 75%. It requires voltage-regulating and current-limiting networks, which increase the component count and circuit complexity, making it relatively expensive and potentially less reliable than the ferroresonant inverter.

A pulse-width-modulation inverter (Fig. 6) actually consists of two inverters. This circuit regulates by varying the pulse width, causing the output to resemble a sine wave more closely. While this reduces output filter requirements and provides the best transient response and voltage regulation, the extra inverter and the feedback networks make this inverter both complex and expensive. It is usually used at power levels over 50 kVA.

The step-wave circuit (Fig. 7) uses a number of inverters, usually three, but sometimes six, 12, or more; the total is usually an even multiple of three. Inverters are controlled by an oscillator, and their outputs are added in a manner that eliminates harmonics

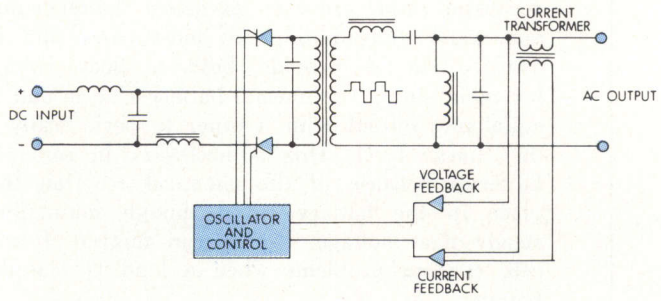


Fig. 5 Quasi-square wave inverter. Oscillator controls SCRs, producing secondary pulses which are filtered and shaped by series and parallel inductive-capacitive circuits

and produces a sine-wave output. Step-wave inverter requires either a separate voltage regulator on its dc bus, or a phase shifter. In the latter case, inverters operate in pairs, one being phase shifted with respect to another; their outputs are then added vectorially. This inverter circuit output can be varied over a limited range of amplitudes and frequencies, and its efficiency at full power can be as high as 85%. It is, however, both complex and expensive and is usually used only in very large, 3-phase UPS systems.

Most UPS systems use one of two types of lead-acid batteries, differing mainly in grid composition. Both are rated for operation at temperatures of 77°F (25°C) ±5°F—a very narrow range, that is important nonetheless. At lower temperatures batteries produce less current, and at higher temperatures their useful life is significantly shortened. Therefore, although the UPS system as a whole can be operated over a wide range of temperatures, commensurate with that specified for most ordinary electronic equipment, batteries should be held to the 10-deg range specified; strip heaters are included in some systems for this purpose.

Of the two types, lead-antimony batteries are least expensive initially, but require periodic equalizing charges. Since they also require more charge current and more water as they age, maintenance costs may offset the lower purchase price. Under optimum conditions, they have a life span of about 20 years.

Although similar to the lead-antimony battery, the lead-calcium battery requires no equalizing charging in most cases, and its charge current and water requirements remain low throughout its life of about 20 years. Initial cost is about 30% more than the lead-antimony battery.

A third possibility, the nickel-cadmium battery may last as long as 30 years, but costs about twice as much for a particular power requirement as the lead-antimony battery. Like the lead-calcium battery, its charge current and water requirements are low, minimizing maintenance costs. In addition, it is suitable in temperatures outside the narrow range cited, since it

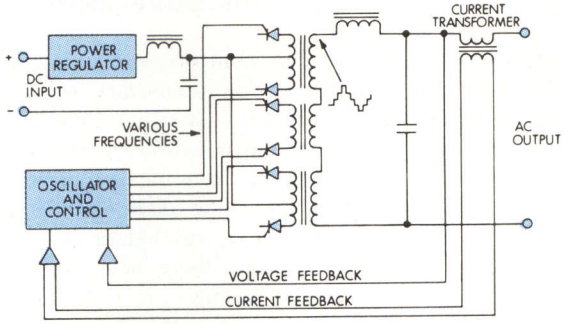


Fig. 7 Step-wave inverter. Large number of series inverters improves output waveform still further, over simpler circuits. This inverter is used primarily in 3-phase systems with high kilovolt-ampere ratings, rarely in UPS for minicomputer systems

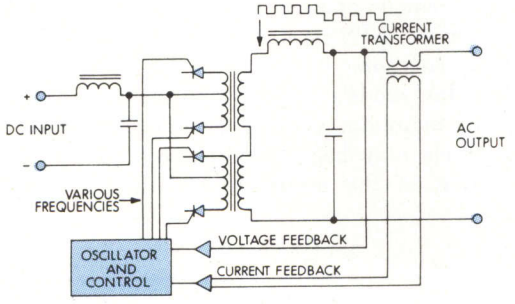


Fig. 6 Pulse-width inverter. Effectively two inverters connected in series, this circuit and varying pulse widths produce an output more closely approximating a sine wave than that of simpler circuits, reducing output filter requirements

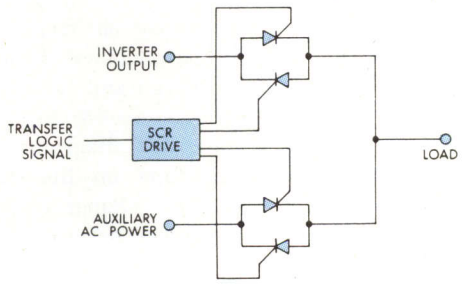


Fig. 8 Static transfer switch. SCRs transfer load between inverter output and auxiliary ac power in a few milliseconds with virtually no interruption

is more efficient and has a longer life than either of the lead-acid types in such a case.

Two types of transfer switches are available for the forward- or reverse-transfer UPS. The electromagnetic switch uses relays to effect the changeover in 50 to 100 ms; the static switch (Fig. 8) uses SCRs instead, and switches in 3 to 4 ms. SCRs form a high speed, single-pole double-throw switch that transfers the load between the UPS output and an auxiliary ac source with virtually no interruption, contact bounce, or arcing.

How Small UPS Systems Save Money

A minicomputer system that controls a manufacturing process may be responsible for thousands of dollars worth of production each hour. A single power line aberration can interrupt that production or result in a batch of substandard products. In some instances, that transient may endanger lives of workers or the plant itself. When such possibilities are balanced against the cost of a small UPS system, there is no reason to hesitate about making the investment.

Typically, a small UPS system costs about $0.75 to $1.00 per volt-ampere, depending on size. The investment can easily be justified by keeping a log of the frequency and duration of outages, brownouts, and transients, and of production losses, wasted manhours, and equipment repair that result. A UPS system often pays for itself in a few months.

Convenience and Reliability

Complete systems, including all necessary switch-gear, basic UPS, and battery reservoir, can be purchased as a package, or the user may provide his own battery reservoir. Basic UPS usually includes protective circuit breakers for individual elements and input and output, and—especially on the continuous UPS, which has no transfer switch—a mechanical bypass switch with which the minicomputer can be transferred to the backup line during UPS maintenance. Front panel status indicators, contact closures, and alarms make operation easy and eliminate the need for constant surveillance. Many systems have flow diagrams on their front panels, with status indicators on the diagrams, allowing the operator to detect any change at a glance. Typically, ac input to the rectifier/charger, its output to battery reservoir and inverter, and inverter ac output are continually monitored. Other critical conditions, such as charge on the batteries, temperature of the power elements, and amount of load current, are also monitored. An audio alarm emits a piercing tone when any out-of-range condition occurs.

In essence, maximum reliability is achieved when failures seldom occur and can be corrected quickly when they do. Reliability is quantified by mean time between failures (MTBF) and mean time to repair (MTTR). Without delving into mathematics, MTBF is best described as a measure of the probability of failure at a particular time; it is computed from the stress on each individual component and the probability of a system failure due to failure of any single component.

MTTR is minimized by cutting troubleshooting and repair time; eg, by using modular chargers, inverters, and transfer switches that can be quickly and easily exchanged, and by putting control circuitry on plug-in circuit boards.

Reliability can be improved in two ways: by reducing the number of components and by reducing the stress on those that remain. Operating power semiconductors and capacitors well below the manufacturer's rating is an important way to reduce stress. Most reliable UPS systems are those that make the greatest use of ICs.

UPS System Installation

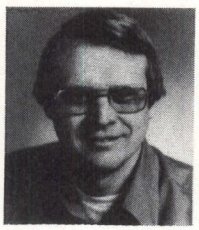
Since the present generation of small UPS systems includes protective circuit breakers at input, output, and critical intermediate points, installation is simple. Users need only provide suitable input power and connect UPS output to the load. In contrast to earlier systems, these operate—except for the batteries—over typical temperature ranges of 32 to 122°F (0 to 50°C).

Although semiconductors and ICs have permitted some size reductions, transformers and chokes contain substantial quantities of copper and iron and are quite heavy; therefore, floor loading must be considered. A UPS may impose a load of 300 lb/ft^2 (approx 1465 kg/m^2) of floor space, and batteries may double that figure, if installed in tiers.

Conclusions

If your minicomputer suffers from mysterious malfunctions, the primary power source may be responsible, and the small UPS system is very likely the only satisfactory solution.

Modern-day models are easy to justify, specify, and install and maintain. Guidelines and suggestions given in this article may help pinpoint your problem, allowing selection of the most suitable UPS system.



Rex M. Teets, vice president of engineering at Deltec, is responsible for design and development of uninterruptible power supplies and associated products. He received a BSEE degree from South Dakota School of Mines, and an MS degree in engineering from UCLA.

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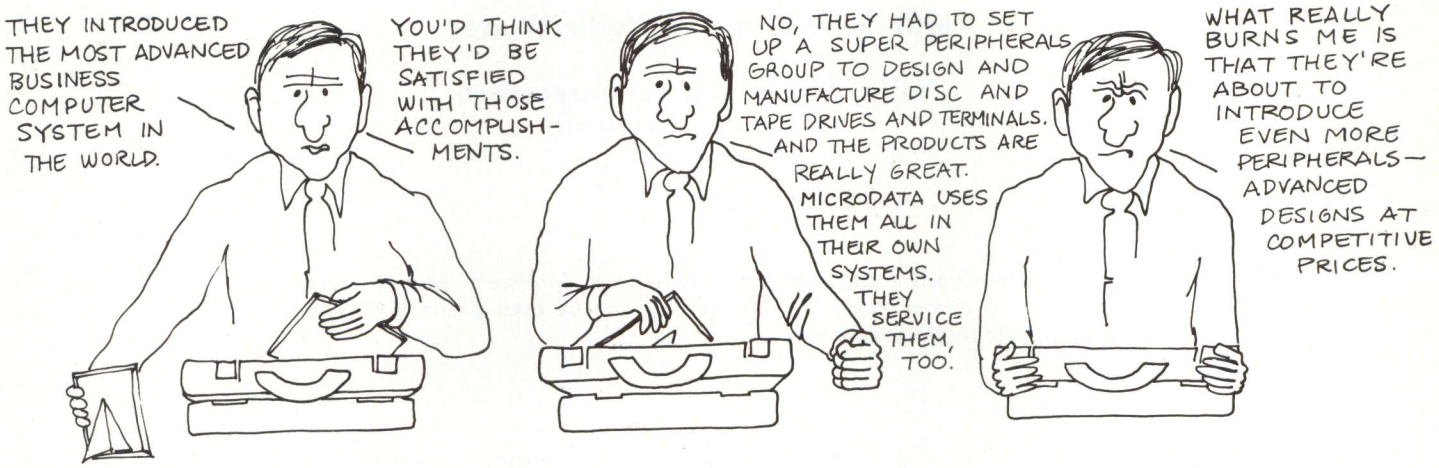

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APPLICATION NOTE

Using a Microprocessor at Speeds Beyond Its Apparent Intrinsic Limit

Milt Schwartz and Keith Winter

National Semiconductor Corporation
Santa Clara, California

When a processor's buses remain unused for a significant part of many instructions' execution times, the idle periods can be used profitably by cycle-stealing peripheral devices

Use of microprocessors in display controllers has been limited by the inherent slower speed of MOS technology. However, an approach using cycle stealing enables the microprocessor to concentrate on program-controlled real-time tasks, such as character-manipulation arithmetic and string processing in parallel with hardware-controlled display generation and refresh.

When a peripheral device steals a cycle, it directly communicates with memory without intervention from the central processing unit (CPU). It can do this when the CPU is not using the input/output (I/O) buses. For the microprocessor used in this application, National Semiconductor Corp's IMP-16, I/O consists of address, data, and control buses. By permitting memory-to-peripheral data transfers concurrently with CPU execution, effective system throughput is increased sufficiently to satisfy real-time demands of a display controller. In this example, the peripheral controls a self-multiplexing group of light-emitting diode (LED) displays, generating and updating the display by directly interrogating a shared memory. The microprocessor computes or manipulates data to be displayed, stores data, and initiates the cycle steal.

Criteria for Cycle Stealing

Cycle stealing can occur if the processor only intermittently uses the data and address buses and if the peripheral can detect when they are idle. In the microprocessor used here, more than 60% of the time is spent performing operations that do not require use of the I/O buses. I/O control flags and timing signals enable the peripheral to recognize this state, use the buses for data transfer, and thereby steal a cycle from the CPU (Fig. 1).

The box "Detect Cycle Steal" in the block diagram (Fig. 1) is principally a D-type flip-flop (Fig. 2). Its D input is conditioned by the output of an OR gate, one of which is labeled "Request Steal." At least one other input is present when the CPU is using the bus; when all inputs are absent (levels down) and Request Steal is present (level also down), the output of the OR permits the flip-flop to be set at the next cycle time T4 (one of eight timing pulses in the microprocessor, each 0.175 μs in duration). If one of the bus-using inputs rises during

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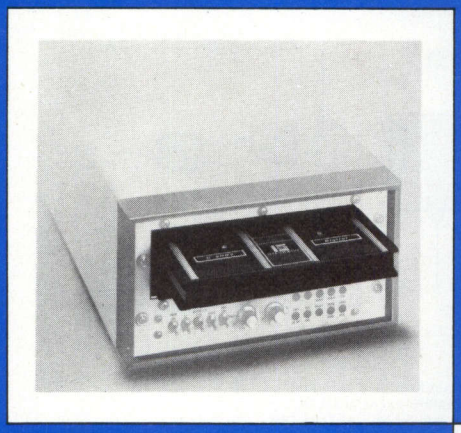

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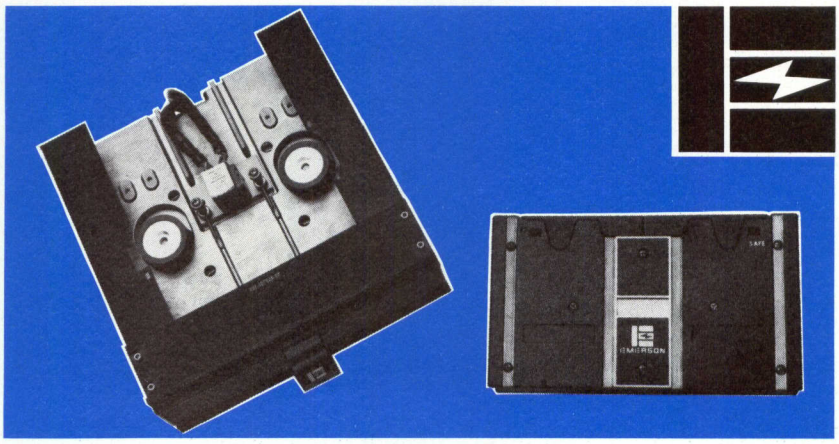

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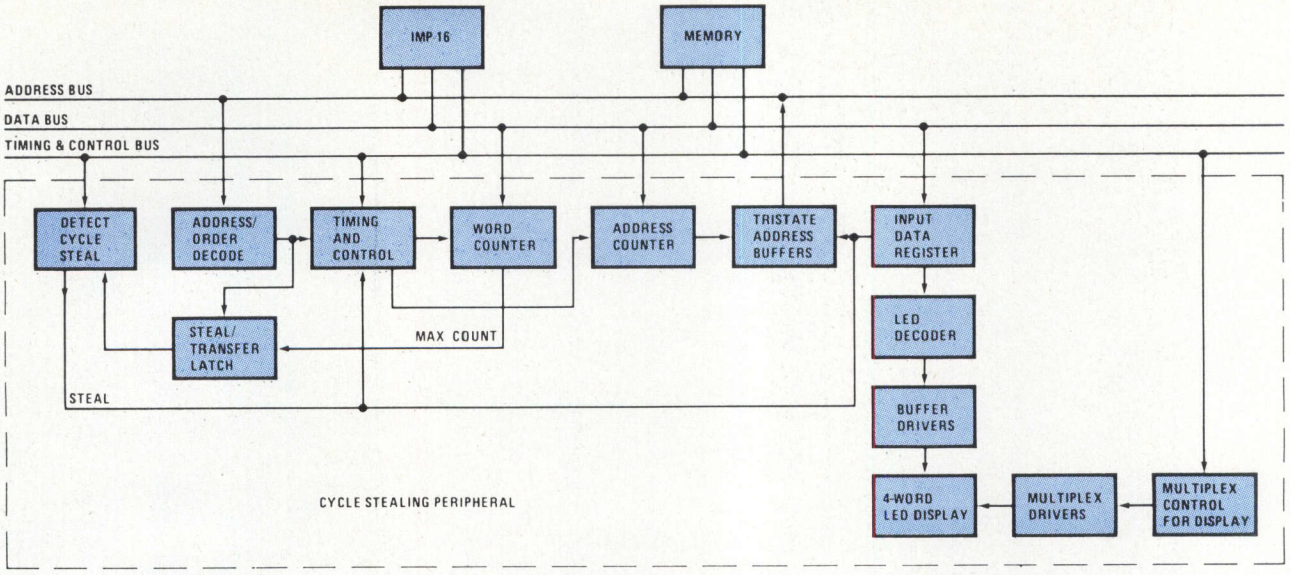

Fig. 1 Communication flow. Controller design shown can steal cycles from microcomputer memory when the processor is not using the buses

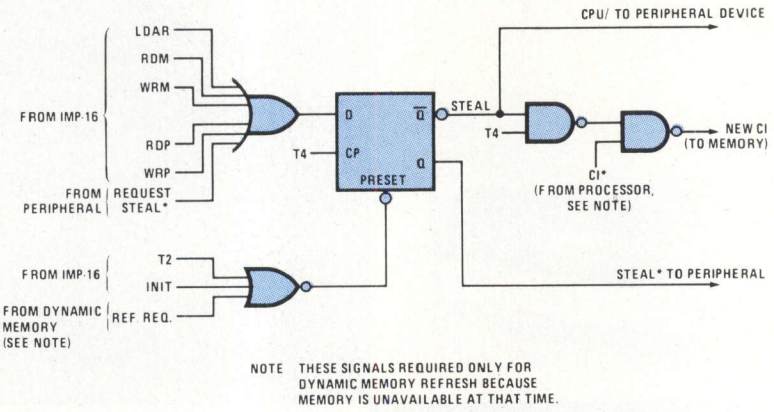

Fig. 2 Key element. Flip-flop turns on when all conditions that permit cycle stealing to occur are met. One condition is result of a command from processor for operation that cycle stealing facilitates

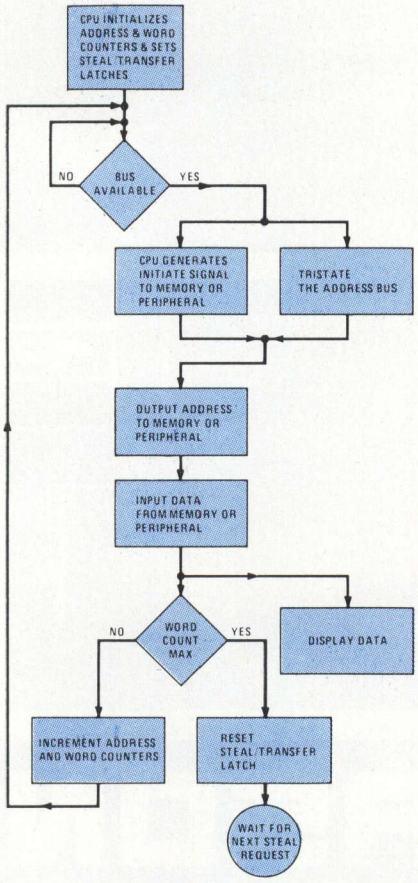

Fig. 3 Cycle stealing sequence. After initialization, I/O process continues independent of CPU until concluded. In some cases the device as well as the process is transparent to the CPU

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a cycle, the flip-flop is reset at the next T4.

For example, if data are to be transmitted from four consecutive memory locations, each containing four BCD digits, to a display made of 7-segment LEDs, the processor can initiate the transfer and then ignore it while attending to other duties. Display controller fetches the 16 digits four at a time in sequence from memory and stores them in a local buffer. From the buffer they are translated to 7-segment form and the display is initially illuminated and then refreshed.

To initiate the transfer, the CPU executes two output commands (Fig. 3). One command initializes the address counter with the starting address of the first memory location to be displayed; the other puts maximum count add, minus four, in the word counter, and sets a latch called Steal/Transfer. The peripheral maintains counters, transfers data, and resets the latch after the transfer is complete. In this way, the real-time program can synchronize successive transfers upon detection of a signal that the operation is complete. Actual data movement is independent of the CPU.

Detailed Description

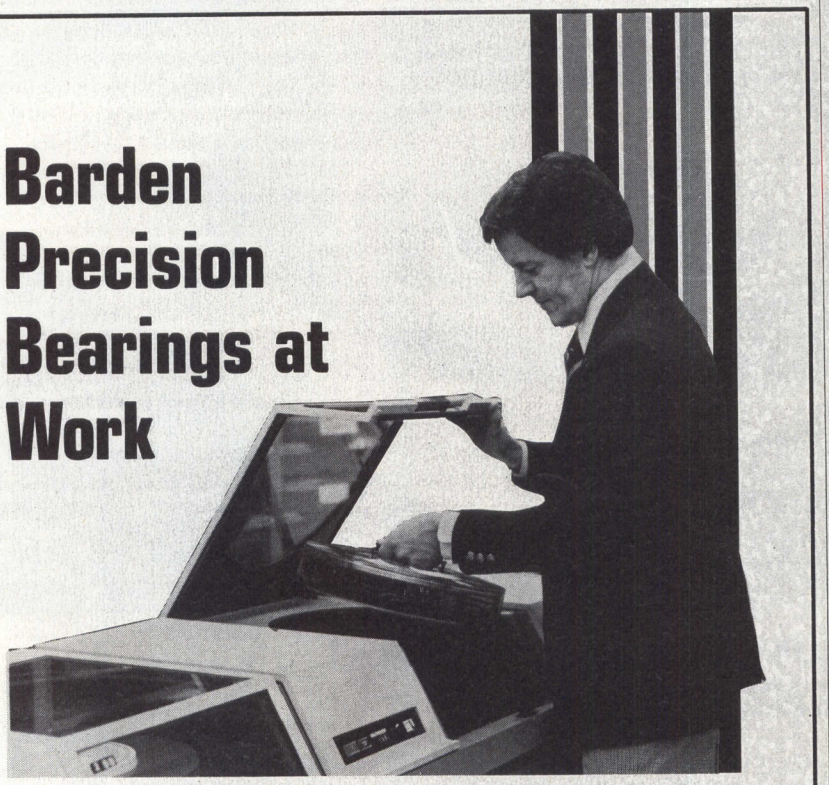
Heart of the cycle-stealing controller is a 16-bit address counter, a 4-bit word counter, and the steal/transfer latch. Address counter contains the address of the next memory location to be displayed; word counter indicates how many locations are to be displayed. Steal/transfer latch is the source of the Request Steal signal; when reset, it indicates to the processor that all transfers are complete.

As soon as the D flip-flop is on, the I/O buses are known to be available. Immediately, the BCD bits at the memory location specified by the address counter are fetched and displayed. The address counter is incremented, the word counter is incremented, and the peripheral waits for another chance to steal. After four memory cycles have been stolen, the last increment makes the word counter exceed the terminal count, thus resetting the steal/transfer latch and inhibiting further steals.

One feature of this approach is that the starting location in memory and the number of locations to be displayed are altered simply by changing the program. A peripheral can even be allowed to steal cycles without the CPU being aware that it exists.

Conclusion

Although this application is based on a simple display, it demonstrates the principles involved in cycle stealing. The basic approach is applicable to much larger displays and to other peripherals. Cycle steal methods along with standard methods of communication enable the user to achieve maximum system throughput by optimizing system resource allocation. This is achieved through I/O and memory communication concurrent with CPU operation. □



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CIRCLE 51 ON INQUIRY CARD

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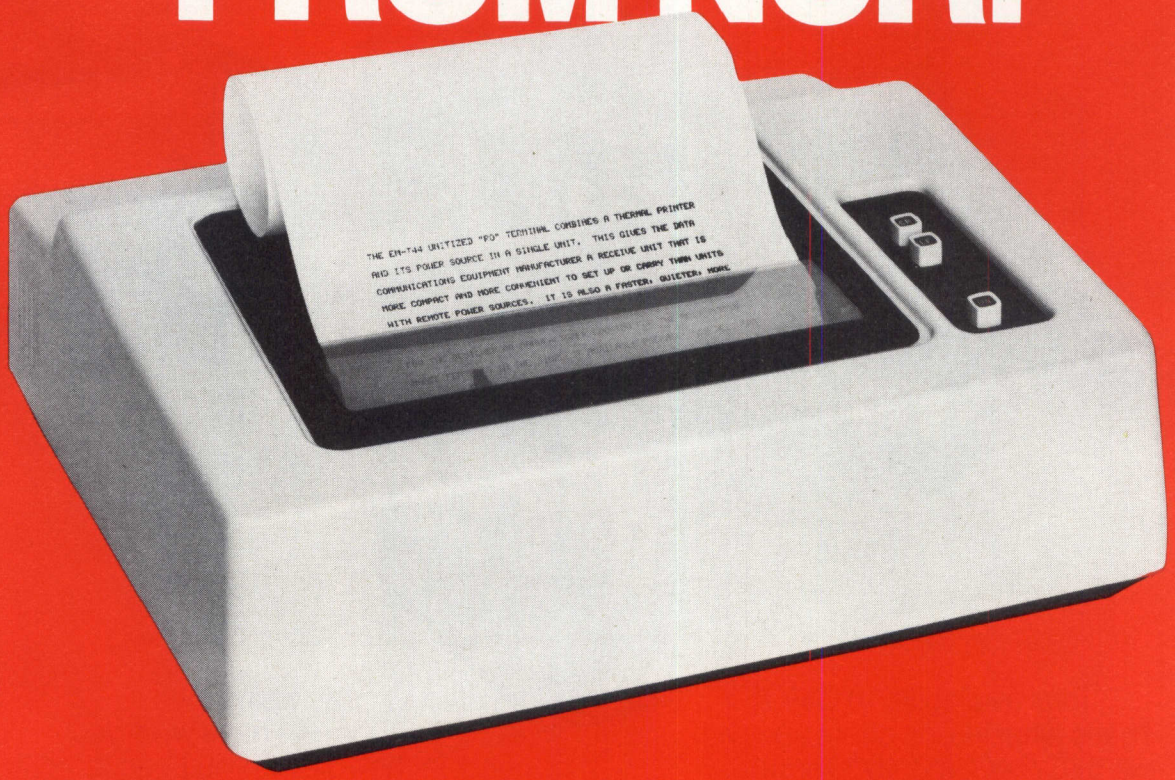

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SPECIFICATIONS

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Electronics: *Single PC board 3.5" x 5.75" (attaches to transport or remote mounting)*

Power: *Less than 1 watt @ 5.0VDC*
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CIRCLE 49 ON INQUIRY CARD

Microcomputer Interfacing: Accumulator I/O Versus Memory I/O

Jonathan A. Titus
Tychon, Inc

Peter R. Rony
Virginia Polytechnic Institute & State University

David G. Larsen
Virginia Polytechnic Institute & State University

When data are transmitted between a microcomputer and an input/output (I/O) device, three actions must occur simultaneously:

(1) The microcomputer must select the specific I/O device that will either receive or transmit eight bits of data

(2) The microcomputer must indicate to the specific I/O device when the bidirectional data bus is available for data transmission

(3) Data must be transmitted between the microcomputer and I/O device in a very short period of time (microseconds)

In previous columns, we discussed accumulator I/O, in which data are exchanged between accumulator and external I/O device. A significant disadvantage associated with such an interfacing technique is that only one origin or destination for data exists. In addition to the accumulator, a typical microprocessor chip, such as the Intel 8080, has a variety of internal general-purpose registers that can exchange information with memory. These include B, C, D, H, and L registers, each of which is an 8-bit register. From a programming standpoint, it would be very useful to be able to exchange data between any of these registers and any external I/O device, which is the subject of this month's column.

If a data exchange between a general-purpose register and an external I/O device is desired, an exciting interfacing technique called memory I/O or memory mapped I/O can be employed. The basic gimmick behind this technique is quite simple: treat the I/O device as if it were one or more memory locations. By doing so, it is possible to employ microcomputer instructions such as MOV, STAX, LDAX, SHLD, LHLD, STA, and LDA in the 8080 microprocessor instruction set. These instructions transfer data between registers and memory locations.

Differences between accumulator I/O and memory I/O can be best understood with the aid of an example of an interface between an 8080-based microcomputer and an external I/O "device." In this case, the device is an Intel Corp 8255 programmable peripheral interface (PPI) integrated circuit chip. This chip has 24 I/O pins (shown as PA, PB, and PC in Figs. 1 and 2) that can be wired directly to any digital device that has TTL-compatible signals.

To an 8-bit microcomputer, an 8255 chip appears as either four different external I/O devices or four different memory locations. Within the chip four 8-bit registers are addressed by the microcomputer:

Port A—8-bit port that can be configured as input, output, or bidirectional I/O port

Port B—8-bit port that can be con-

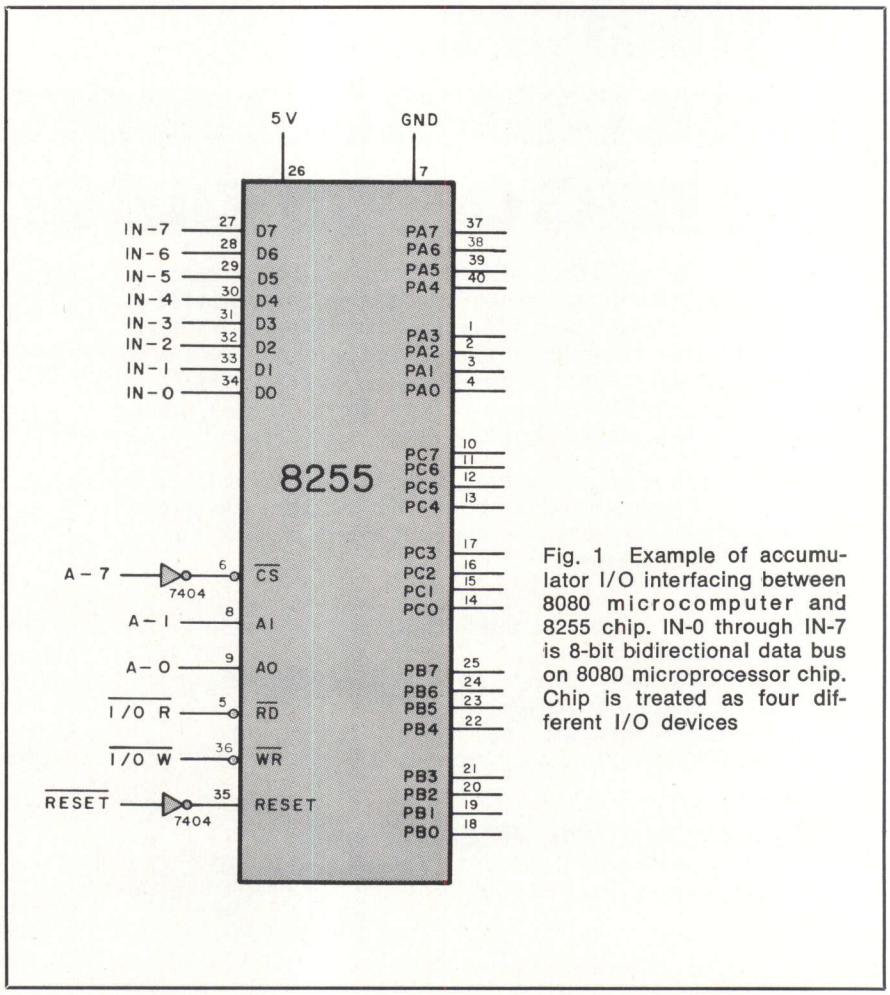

Fig. 1 Example of accumulator I/O interfacing between 8080 microcomputer and 8255 chip. IN-0 through IN-7 is 8-bit bidirectional data bus on 8080 microprocessor chip. Chip is treated as four different I/O devices

Once you make up your mind not to be a follower, there's only one alternative.

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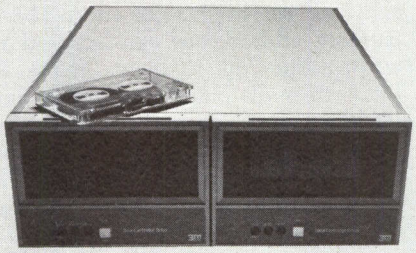

It adds up to this: now the system designer has a reasonably-priced peripheral that delivers both data reliability and data interchange capability. We're certain our competitors are going to be very interested in this new system. And if you are too, just write 3M Company Data Products, Dept. 129, Mincom Division, Bldg. 223-5E, 3M Center, St. Paul, Minnesota 55101.

All our competitors can do is follow us.

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CIRCLE 53 ON INQUIRY CARD

figured as either input or output port

Port C—8-bit port that can be configured as input or output port, or a pair of control ports, one for port A and the other for port B

Internal control register—an 8-bit register which determines specific I/O configuration of 8255 chip and can be altered at any time by the microcomputer

In addition to three I/O ports, the 8255 chip (as shown in Figs. 1 and 2) contains an 8-bit bidirectional data bus (D0 through D7) that communicates directly with the 8080 chip; six control inputs—$\overline{CS}$, A1, A0, $\overline{RD}$, $\overline{WR}$, and RESET; and two power inputs.

Accumulator I/O

In accumulator I/O, $\overline{I/O\ R}$ and $\overline{I/O\ W}$ function pulses are used to read from and write into the 8255 chip*. This chip is addressed with the aid of bits A-0 through A-7 (or A-8 through A-15) on the 16-bit memory address bus of the 8080 chip. In Fig. 1, A-7 is the chip select input and A0 and A1 select one of four registers within the chip. For example, the program

323_8 Enable register for port A and allow it to accept data from accumulator register

200_8 Device code for port A

writes information from the 8080 chip into port A. The port is treated as an I/O device, and an accumulator I/O instruction, 323_8, is employed. A simple change in the control register turns port A into an input port and permits the program

333_8 Enable register for port A and allow it to send data to accumulator register

200_8 Device code for port A

to read information into the 8080 chip from port A.

Memory I/O

In memory I/O, $\overline{MEMR}$ and $\overline{MEMW}$ memory read/write function pulses are used to exchange data between internal registers within the 8080 chip and 8255 registers*. The entire 16-bit memory address bus can be used to address the chip; as shown in Fig. 2, bit A-15 is the chip select input, and bits A0 and A1 are register select inputs. To output data from register B to port A, the necessary program is

041_8 Set the 16-bit memory address pointer register within 8080

200_8 to memory address of port A

160_8 Move contents of register B to port A

Once port A is selected, data can be output successively from other registers in the 8080 chip

161_8 Move contents of register C to port A

162_8 Move contents of register D to port A

163_8 Move contents of register E to port A

167_8 Move contents of accumulator to port A

Each additional transfer of data requires only 2-μs execution time, which is much faster than 5 μs required for successive accumulator I/O data.

We have demonstrated that both accumulator I/O and memory I/O techniques are applicable to the 8255 chip. The specific application in question will determine the best I/O technique. In some cases, accumulator I/O is best; in others, memory I/O simplifies programming and speeds transfer of large quantities of data to or from memory. It should be noted that some microprocessor chips permit only memory I/O interfacing techniques. Such chips frequently possess special memory addressing instructions that speed execution time for memory I/O addressing.

Principal advantage of the 8255 chip is not in programming or execution time, but rather in ease of wiring an interface to an external digital I/O device such as an analog-to-digital converter, digital-to-analog converter, digital panel meter, or digital multimeter. No flip-flops, decoders, or gates are required for interface; they are contained within the 8255 chip. In most cases, only SN7404 inverters are needed to match logic levels between port C, which usually is employed as a control port, and control pins on the external digital I/O device. In the future it is possible that manufacturers will provide I/O interfaces that will permit a digital instrument to be tied directly to a programmable peripheral interface chip.

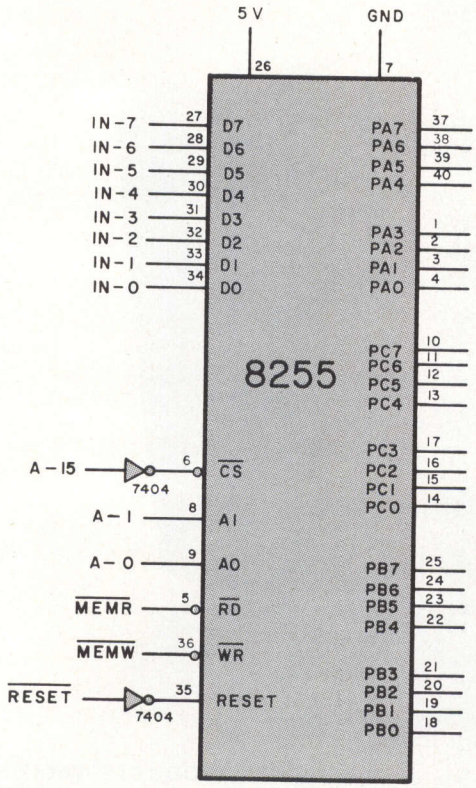

Fig. 2 Example of memory I/O interfacing between 8080 microcomputer and 8255 chip. This chip is now treated as four different memory locations

*Accumulator I/O pulse abbreviations, $\overline{I/O\ R}$, $\overline{I/O\ W}$, $\overline{MEMR}$, and $\overline{MEMW}$, are those employed by Intel Corp, Santa Clara, Calif. $\overline{I/O\ R}$ and $\overline{I/O\ W}$ respectively correspond to $\overline{IN}$ and $\overline{OUT}$, which we have used in previous columns. See D. G. Larsen, J. A. Titus, and P. R. Rony, "Generating Input/Output Device Select Pulses for Microcomputer Interfacing," *Computer Design*, May 1976, pp 196-199

This article is based, with permission, on a column appearing in *American Laboratory* magazine.

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CIRCLE 54 ON INQUIRY CARD

Microprocessor Workshop Provides Material for Digital Systems Education

Presenting fundamentals of and developments in microprocessors, Workshop on Microprocessors and Education will help educators focus on the impact of microprocessors on curricula, and identify what is needed to effectively use them in an educational environment. Scheduled for Aug 16-18 at Colorado State University, Fort Collins, Colo, and sponsored by the Digital Systems Education Committee of the National Science Foundation, the technical program will include sessions on microprocessor architecture, chip design, software, laboratory programs, systems, and applications, as well as panel sessions and discussion groups. Those interested in attending or presenting papers should contact Dr Yaohan Chu, Dept of Computer Science, University of Maryland, College Park, MD 20742. Final date for registration is June 30.
Circle 170 on Inquiry Card

p/ROM Programmer Is Available For System Design Kit

Developed for those who choose to use Intel's System Design Kit (SDK) alone as an experimental bench tool, a p/ROM programmer kit offers expanded capability. This kit, announced by Microcomputer Technique, Inc, 1120 Reston International Center, Office Bldg, Reston, VA 22091, and Cramer Electronics, permits the SDK's unprogrammed p/ROM to be programmed. Only a cable for connecting the 2708 p/ROM programmer Cramerkit™ to the SDK is required.
Circle 171 on Inquiry Card

Fast 16K ROM Meets Speed Requirements of 2-MHz Microprocessors

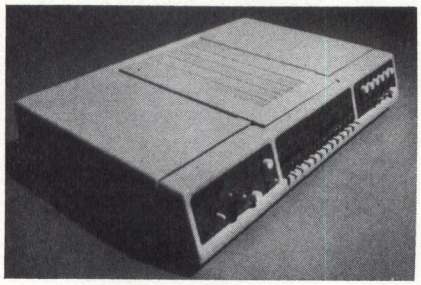
A 16,384-bit static ROM that is claimed to be the fastest 5-V device of its type has been developed by General Instrument Corp's Microelectronics Group, 600 W John St, Hicksville, NY 11802. RO-3-8316B has a worst case access time of 450 ns, nearly twice the speed of the company's other static n-channel 16K ROM. The only other device in this family which matches that speed has 2560-bit size.

Pin for pin compatible with the company's slower 16K ROM (RO-3-8316A) as well as the Intel 2316A and 8316A, the faster ROM is designed specifically for operation with microprocessors such as the 8080A and the 6800 at full 2-MHz speeds. In addition, it can be used in other high speed ROM applications such as character generation and code conversion.

Organization is 2K x 8. The TTL-compatible device is fabricated with a metal gate, ion implanted n-channel process.
Circle 172 on Inquiry Card

Software/Hardware Flexibility Obtained From Prototyping System

"Intercept" prototypes microprocessor-based systems utilizing IM6100 12-bit CMOS microprocessor. The benchtop model duplicates all micro-



processor functions and timing. It provides easy access for I/O devices through built-in Teletype™ interface, as well as plug-in capability for additional memory and complete control panel for man-machine interface.

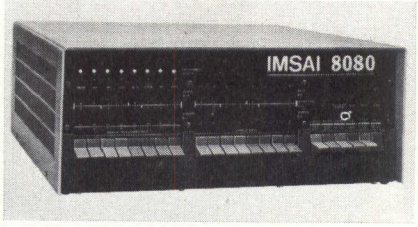
Introduced by Intersil, Inc, 10900 N Tantau Ave, Cupertino, CA 95014, unit will operate with compatible DEC PDP-8/E paper tape programs without software or hardware modifications. It includes a 9-pin interface connector and two uncommitted 25-pin connectors at rear of case. Instrument has fully buffered 3-state TTL compatible bus structure with external access for user options. Power is provided by integral 5-V, 3-A supply providing 1 A for user options.

Instrument has three component parts. Module 6902-CPUTTY contains microprocessor and interface consisting of IM6402 universal asynchronous receiver-transmitter and logic required to transfer data from microprocessor to keyboard-reader and printer-punch. Provisions are included for stopping free running crystal oscillator and introducing external TTL-compatible clock. Second module, 6901-M4KX12, is 4096 x 12-bit unit consisting of 48 nonvolatile CMOS static IM6508 RAMs. Third component is control panel unit, 6900-CONTRL, made up of external housing and front panel controls, plus PC module containing control panel logic and memory.
Circle 173 on Inquiry Card

Low Cost Digital Computer Serves Variety of Needs

The IMSAI 8080 programmable computer is based on Intel's 8080 microprocessor chip and contains all necessary circuitry and power supply to be fully operational. Designed for a variety of applications, including commercial OEM, laboratory prototype, CPU for small standalone systems, and individual use, computer is constructed around anodized aluminum card cage and PC mother board which accommodates front panel and up to 22 plug-in cards for memory and I/O interface devices. Heavy-duty lucite front panel has eight extra program-controlled LEDs and rugged commercial-grade paddle switches backed by debouncing circuits. Power supply produces 20-A current, which powers full system.

System can be expanded to 64K bytes of memory plus floppy disc controller with on-board microprocessor and DOS. Variety of I/O devices including audio tape cassette, printer, video terminal, and teletypewriter can be used. These peripherals will function with 8-level priority interrupt system. BASIC soft-



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CIRCLE 55 ON INQUIRY CARD

ware is available in 4K, 8K, and 12K, obtainable in p/ROM.

Computer, from IMS Associates, Inc, San Leandro, Calif, is available in kit form at $559, and assembled at $931. For dedicated OEMs that do not require front panel, price is $749 assembled, $529 unassembled. Complete set of documentation, including Intel data book, IMSAI 460-page Introduction to Microcomputers, and user's manual, is supplied.
Circle 174 on Inquiry Card

Schottky TTL Interface Functions and Control Element for μProcessors

Three octal registers, two octal bus buffers/line drivers, and an expandable 4-bit slice LSI control element have been announced by Texas Instruments Inc, PO Box 5012, M/S-84, Dallas, TX 75222 as additions to the Schottky TTL family. Two of the octal registers offer digital processor systems designers a choice between transparent latch or clocked D-type flip-flop bus interface, in 20-pin package with pin-row spacing on 0.3" centers. They feature independent 3-state output control line and noise-rejecting hysteresis at synchronous control input. The third register features 3-state bus-interface outputs rated for 3.65-V min high level output to facilitate driving most low threshold MOS loads directly.

Octal bus buffers/line drivers offer inverting or non-inverting logic elements. Providing up to 64-mA sink-current capability, they drive lines having characteristic impedance down to 133 Ω. They also feature noise-rejecting hysteresis loop in input threshold. Two output-enable lines provide individual control over two separate groups each having four buffers.

All Schottky TTL functions feature 3-state outputs to facilitate direct interface with system bus, full parallel access for data inputs and outputs, and low current MOS-compatible pnp inputs. They come in full military temperature (−55 to 125°C) version, in ceramic DIP; or for industrial (0 to 70°C) range, in ceramic or plastic DIP.

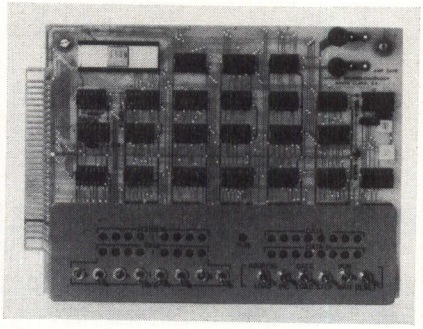
The Schottky TTL control element contains all logic needed to implement low-to-medium intelligent controllers or next-address generator in high performance computer/controller systems. Functional capabilities include increment/decrement by one; offset, vector, or branch; store up to four returns or links; program start or initialize; and on-chip output register. With over 200 equivalent gates, element provides 4-bit wide functions for full adder, 4-word push-pop FILO, 4-wide source-select multiplexer, and microcontrol memory-address/microstate register.

Element features edge-triggered clock and independent asynchronous register clear. Simultaneous 1-clock operations include functions such as increment/decrement, store current microaddress/instruction, and jump to new routine; offset and/or increment current microaddress/instruction, store, and jump to new routine; and hold current microaddress/instruction and store up to four new jump addresses.

Supplied in high-density 20-pin plastic or ceramic DIPs with pin rows on 300-mil centers, it can reduce PC board area up to 60% and can reduce system ROM-access time by up to 44%.
Circle 175 on Inquiry Card

μComputer Card System Is Low Cost Design, Educational Tool

A self-contained microcomputer card system employing the Signetics 2650 microprocessor and 24 ICs, the AMT 2650 allows circuit and system designers to hand load and debug programs using 2650 instruction set. A 62-pin edge connector on card outputs all microprocessor functions plus two fully buffered TTL-compatible 8-bit output data ports for interfacing with user's hardware application.



System includes panel mounted on card with 33 data/address LED displays, data port LEDs, and reset. Programs can be single stepped instruction-by-instruction for program debug. Addresses can be independently incremented by hand and are automatically incremented after each data load. Containing 256 bytes of RAM (additional RAM, p/ROM, and ROM can be interfaced directly via edge connector), system requires 5 Vdc/2 A. Optional 5-V/3-A power supply is available. Developed by Applied Microtechnology, 100 N Winchester Blvd, Santa Clara, CA 95050, system costs $195.
Circle 176 on Inquiry Card

Single Chip μComputer Cuts System Cost For Industrial Applications

A complete one-chip microcomputer, PPS-4/1, containing 1344 x 8 program memory (ROM), 96 x 4 data memory (RAM), and 31 input/output channels with interrupt capability is priced under $10 for quantities of 10,000. It is offered by the Microelectronic Device Div of Rockwell International Corp, 3310 Miraloma Ave, PO Box 3669, Anaheim, CA 92803.

Processing power is enhanced by 8-bit instructions and bidirectional I/O options, which include two 4-bit input channels which can be simultaneously used for testing or comparing data, two 4-bit I/O channels, and 10 discrete I/O lines. Two interrupt request input lines (one of which can automatically trigger echo signal) provide priority input and status capabilities. Another feature is provision of clocked, simultaneous serial I/O capabilities, enabling infinitely expandable I/O options. Pulsed or complex digital waveforms may be easily generated as a variety of serial or parallel outputs. Also permitted is cascading to provide systems utilizing multiprocessors in complex applications.

Other device features are 384-bit RAM data memory, TTL and CMOS compatibility, arithmetic logic unit with five working registers, externally synchronized on-chip resistor controlled clock generator, and single power supply (15 V) requirement. Power dissipation is 70 mW. Applications include instrumentation; electronics for business equipment; peripheral controller in drum and matrix printers, plotters, and similar equipment; and economic system for

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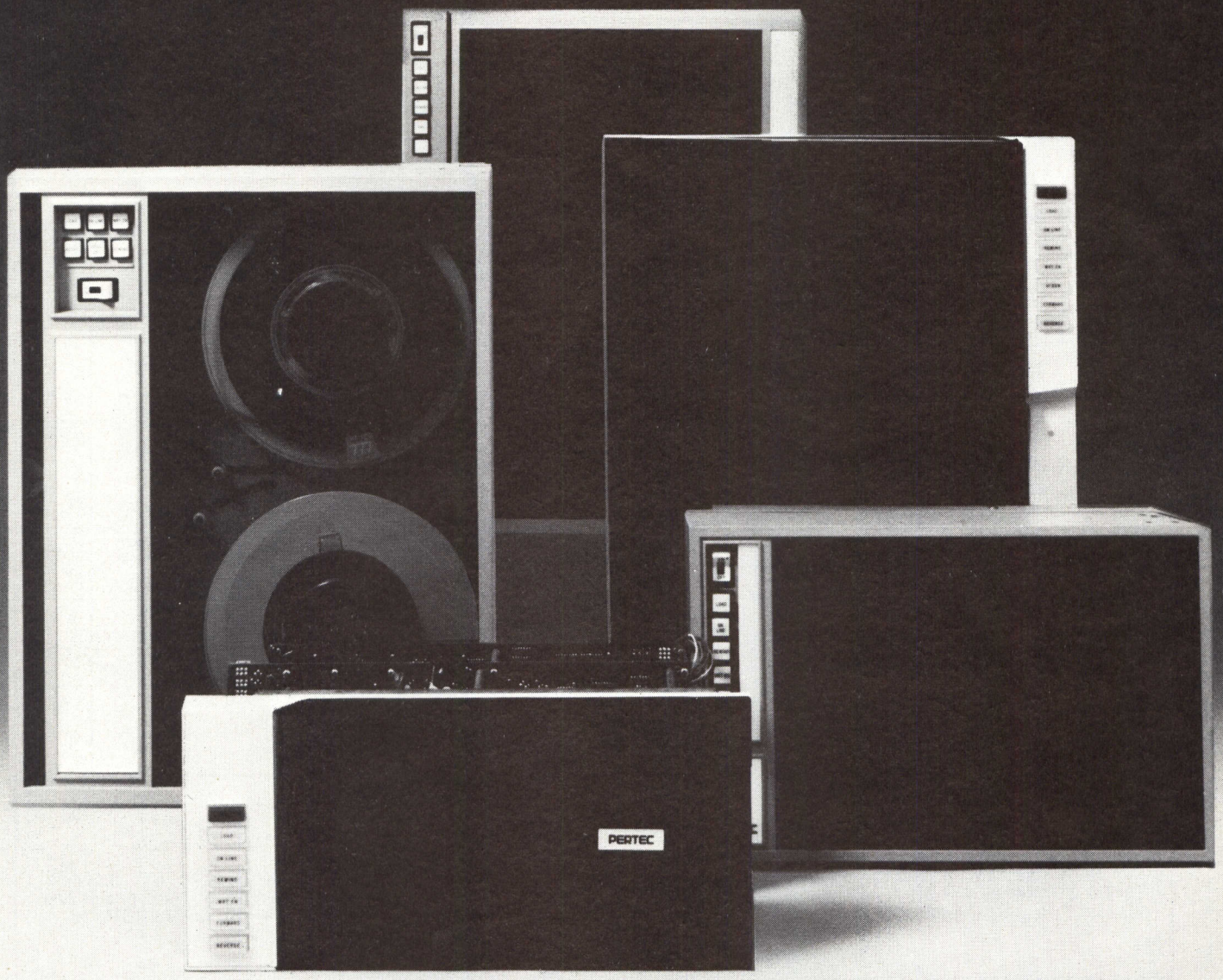


No-fault insurance.

You're looking at five insurance policies. Each capable of lowering your tape-drive operating costs. While reducing down-time. *And* maintenance costs. *And* service costs. *And headaches.*

50,000 tape-drives are in good hands.

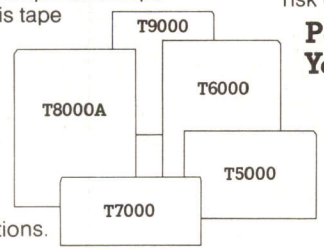
Pertec tape transports are known world-wide: Over 50,000 units have been sold. Making Pertec tape drives the most popular, most successful in the history of independent tape drives. (Today, *every* competitor designs his tape drives to be Pertec interface compatible.)

Our five models work: Day in. Day out.

OEMs know about Pertec tape drives.

Because they work when they're supposed to work.

And they can be configured to offer OEM customers over 400 tape drive variations.



We take the risk out of buying.

Each of the five Pertec tape transports has a solid performance record. (Let's face it, you can't very well make and sell over 50,000 units and have a poor performance record.)

And to top it off, our customers get a service resource that is one of the largest, most available, best-trained *in the world.*

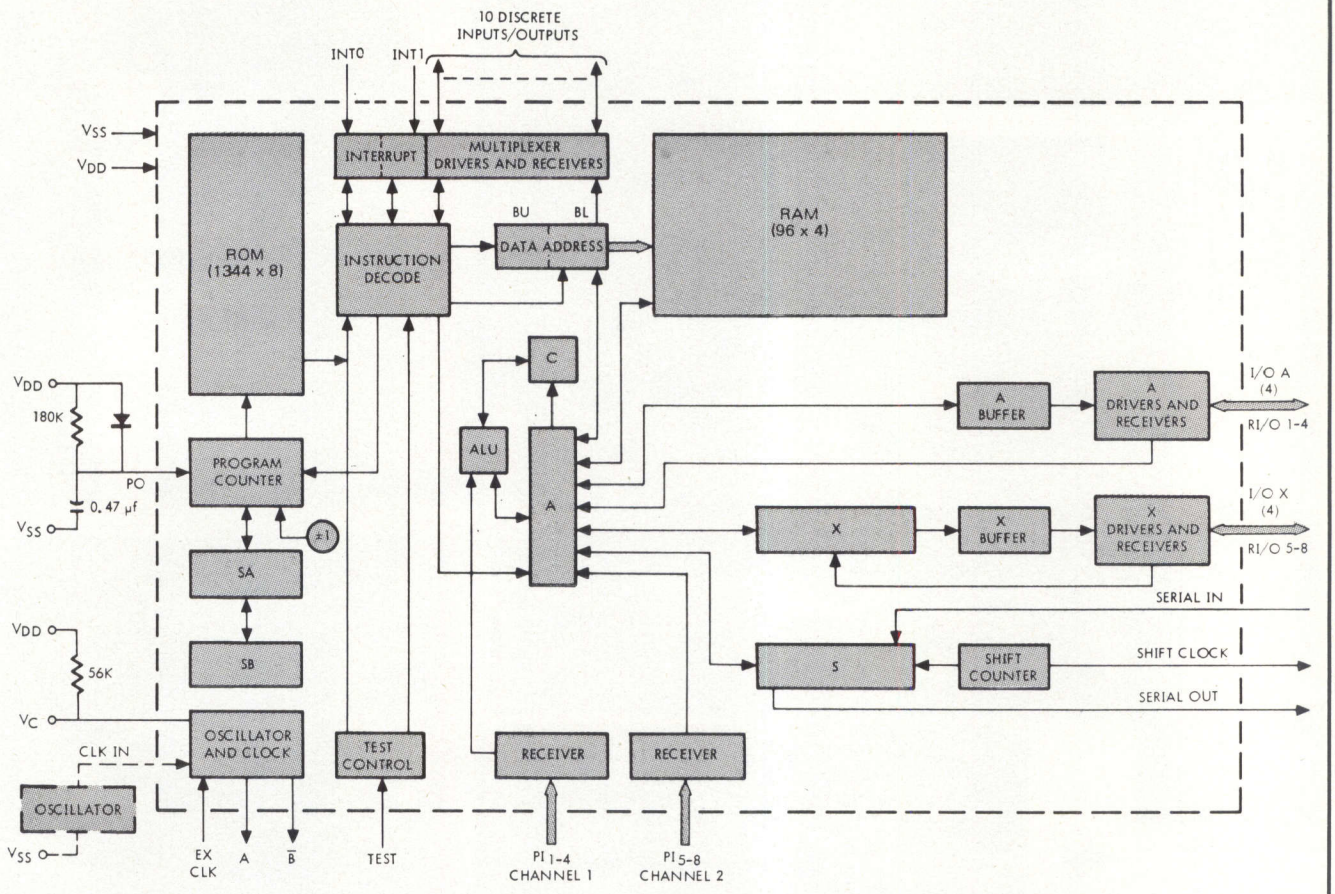
In short, we've taken the fault out of tape drives. And the risk out of buying.

Pertec Tape Drives.
Your no-fault insurance policies.

PERTEC

Call the Pertec regional office nearest you:
Boston (617) 890-6230; Chicago (312) 696-2460; Los Angeles (213) 996-1333; London (Reading) 582-115.

CIRCLE 56 ON INQUIRY CARD



Functional diagram of 1-chip microcomputer. PPS-4/1 evaluation circuit, in 64-pin ceramic DIP, has 31 I/O channels, 1344 x 8 ROM, 96 x 4 RAM, and multifunction instruction set. External p/ROM or RAM eases program development and testing. Production version of chip comes in 42-lead plastic package with program encoded in 10,752-bit ROM

industrial control functions. Full software support permitting development of user's proprietary programs is provided, including assembly and simulation programs on GE time-share network.

Also available is Assemulator, a system development tool which converts program in assembler language code which is interpreted by special evaluation version of microcomputer. This version has address and memory lines bonded to external pins, permitting storage of proposed program in external p/ROM or RAM to allow real-time development and testing.

Circle 177 on Inquiry Card

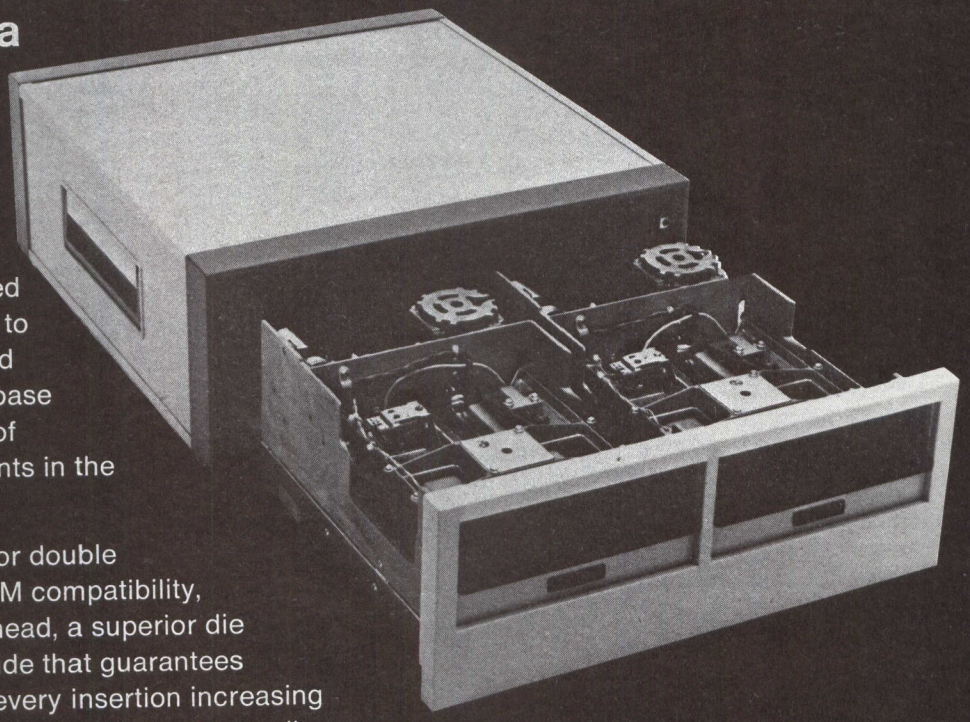
Module Expands Design Aids for Systems Development

Plugging directly into card cage of the company's EXORciser™ development tool, MEX68RR EROM/RAM module provides a flexible repository for user-defined programs. Various combinations of RAM, ROM, p/ROM, and alterable-ROM can be installed in 20 24-pin DIP sockets. Module capacity is 512 bytes of RAM and 16K bytes of ROM or p/ROM. Four sockets are reserved for MCM6810 128 x 8-bit RAMs; the remaining sockets can accommodate MCM68708 alterable-ROMs or other devices with 512 x 8 or 1024 x 8-bit organizations.

When connected to address bus, RAMs occupy the lowest 512 bytes of address space. They can be disabled via jumper wires. ROM section is divided into four arrays, each having max capacity of 4K bytes. Base memory address switches permit arrays to be assigned to various locations within address space. Switches change array locations modulo 4K-bytes. ROM sockets are connected to "read/disable" switch. In read mode, 1K byte of address space

You asked for it... the Skinny Floppy from Shugart!!

Introducing the SA800/801R...the new member of the most popular Floppy Disk Drive family, now available for mounting two units horizontally in a standard 19-inch Retma rack...or desk top, too!!



The SA800/801R, custom designed with the user in mind, is identical to its 20,000 predecessors in the field today except for a new slim line base casting. Just one more example of Shugart's response to requirements in the Floppy Disk marketplace.

The SA800/801R features single or double density recording capabilities, IBM compatibility, a ceramic read/write recording head, a superior die cast base plate and cartridge guide that guarantees positive diskette registration on every insertion increasing overall performance and reliability... all of the outstanding features you receive with our standard SA800/801.

Take a good look at the unique design of the SA800/801R when you plan your next Floppy Disk System. The SA800/801R can be packaged either horizontally or vertically and offers numerous features that our competitors do not have.

For further information regarding the ultimate in Floppy Disk Drives, contact our Marketing Department in Sunnyvale, California. We can stack 'em any way you want them.

CIRCLE 57 ON INQUIRY CARD

SHUGART ASSOCIATES

435 Indio Way, Sunnyvale, California 94086 (408) 733-0100 TWX: 910/339-9355 SHUGART SUVL
Europe: 74 Rue d'Arcueil, Cedex 212, 94518 Rungis, France Telephone: (1) 686 80 01 Telex: 204594

is allocated to socket; when disabled, socket's memory space can be utilized by other devices.

Developed by Motorola Semiconductor Products, Inc, PO Box 20294, Phoenix, AZ 85036, module features operating temperature range of 0 to 70°C, and power requirements of 5, 12, and −12 Vdc, each at 1.0 A max. Unit price is $395.

Circle 178 on Inquiry Card

Software Eases µProcessor Programming

Assembler and simulation software programs developed by Microcomputer Technology, Sunnyvale, Calif to facilitate microprocessor programming and code verification are now available through Control Data Corp, Box O, Minneapolis, MN 55440. The library of programs supports microprocessors made by Intel, Motorola, Fairchild, and their second sources. Included are 8080/8080A, 4004/4040, 6800, and F8 types.

Features of the assemblers include extensive error diagnostics, macro capability, symbolic machine operation codes (op-codes, mnemonics), symbolic address assignment and reference, relative addressing, flexible character codes (binary, decimal, hexadecimal, octal, ASCII, or EBCDIC), and conditional assemblies. The simulators contain extensive error diagnostics, statistical data on instruction distribution and execution time, and trace capability for display of register contents.

Programs are available on Cybernet networks in either time-sharing or batch mode. The company claims that execution of statements with this software averages approximately 2½ cents per card.

Circle 179 on Inquiry Card

Language Compiler Aids in Generating µProcessor Programs

A high level compiler designed by Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94086 for use with the 2650 microprocessor is an extension of Intel's PL/M™. Called PLUS (Programming Language for Micro Systems), the 32-bit compiler permits development of machine language code with fewer statements than assembly language software since a single compiler statement can produce many lines of machine code.

A compiler generated program has more bytes, is more compact and faster to write, and features portability (it can be used for any microprocessor with similar compiler). Inefficiency usually ranges from 10 to 30%, involving a trade-off between faster program development and additional program storage memory. Added features of PLUS include block structuring, procedure calls, byte and address data elements, and micro capability. It generates relocatable code supported by a relocating loader, and allows separate compilation of program modules.

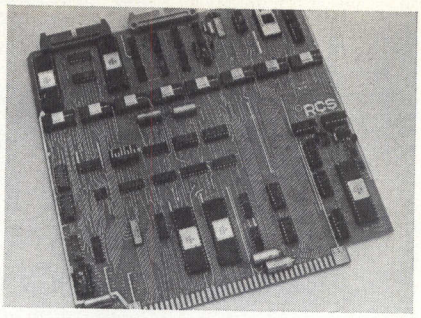
A 16-bit version is also planned; the program will be installed on NCSS and GE timesharing services. Price for either cross-compiler version is $1250.

Circle 180 on Inquiry Card

Microcomputer System Can Be Constructed With PC Board Modules

A full hardware/software microcomputer development system can be constructed with a family of modules built by Revenue Control Sciences, 137 Richmond St, El Segundo, CA 90245. A microcomputer module, based on the Motorola M6800 microprocessor, includes 4K bytes of R/W memory, 1K bytes of erasable p/ROM, four peripheral interface adapters (PIAs), and address/data drivers. It requires only a power supply to operate.

Other modules include main board; regulator board with real-time clock, power fail sensing, and battery backup; p/ROM-COM board with 14K bytes of Intel 2708 p/ROM, current loop async port or EIA port, and integral 300-baud modem; memory board with 4K to 16K bytes of R/W memory and 1K bytes of p/ROM; board to program 2708 UV erasable p/ROMs; and general interface board consisting of PIAs. Wirewrap module and extender card are also available. Available floppy disc system uses one card slot in the main board. Software provided with full system comprises editor, assembler,



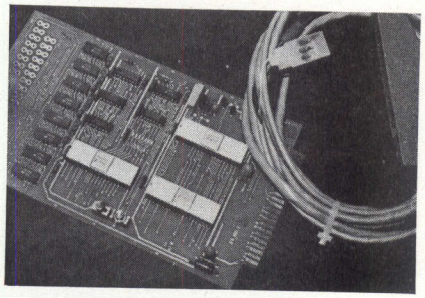
floppy disc operating system, and interactive debugger, as well as utilities, arithmetic, and p/ROM programmer packages.

Circle 181 on Inquiry Card

µProcessor Design/ Evaluation Kit Supplied As Assembled Board

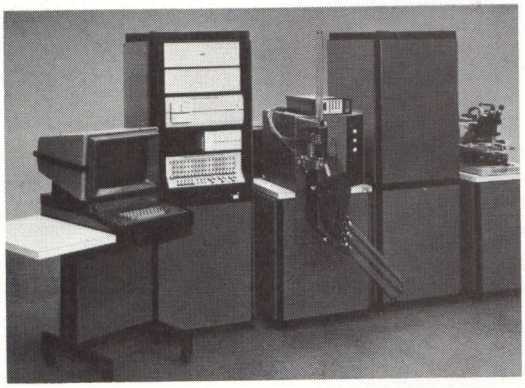
Provided as a fully assembled and tested circuit board, the F8 microprocessor design kit is a complete system. It contains the company's 3850 F8 CPU circuit, 3851 program storage unit circuit, 3853 static memory interface circuit, and eight 2102 static RAMs (1K byte of memory). A wired edge-connector cable is supplied for connection to standard teletypewriter terminal and power supply. Produced by the Microsystems Div of Fairchild Camera and Instrument Corp, 1725 Technology Dr, San Jose, CA 95110, the kit also contains F8 programming manual, data book, and the company's Fairbug program.

Board has 32 I/O bits, two levels of interrupts, and control circuits. No assembly or soldering is required. A series of user-oriented subroutines, the Fairbug program is programmed into the 1K-byte ROM of the program storage unit. A "bootstrap" loader enters program into RAM memory from terminal. Speeds range from 110 to 2400 baud. From terminal, program can examine and alter any register or memory location within the system.



Circle 182 on Inquiry Card

THE J387: WHEN PRODUCTIVITY COUNTS.



Here are seven ways in which the J387 Memory Test System helps increase productivity. Study them closely. When it's time to invest in memory testing equipment, you'll want to remember them all.

REPEATABLE RESULTS WITH HANDLERS or PROBERS.
Because the system was designed to drive devices at the end of cable, test results are consistently repeatable even when wafer probers or automatic handlers are connected to the system.

NO TEST STATION TWEAKING.
The system's software eliminates the need to modify the program every time you change test stations. Once set, the times stated in the test program are always valid.

PROGRAM YOUR OWN PATTERNS.
Teradyne's new programmable pattern generator allows you to produce whatever patterns will exercise your memories best in the least amount of time.

TWO STATIONS MEAN HIGH THROUGHPUT.
The basic J387 arrives with two test stations because experience has shown that two usually offer the lowest cost per device tested. Should you require more, they can be added.

TESTS RAMs, ROMs, EVEN 16Ks.
The J387 will test many different RAMs and ROMs, including 4k devices in 16-, 18-, and 22-pin packages. Even memories with up to 16 address inputs can be handled.

ALL THE DATA YOU NEED.
You're provided with cumulative Schmoo plots, lot summaries, distribution analyses, datalogged parametric values, and all the other data you need to increase yield and improve productivity.

TERADYNE PRODUCTIVITY TURNS UP EVERYWHERE.
You'll find it in hardware optimized for memory testing. And in Teradyne's unique 10-year circuit module warranty. It's why we maintain a seven-day, 24-hour troubleshooting service. And a global service program backed up by local parts stocking centers.

Whether you're a memory user or manufacturer, the J387 delivers what you need. Optimized memory testing that will boost your throughput and increase your productivity. For the full story on the J387 Memory Test System, write: Teradyne, 183 Essex Street, Boston, Massachusetts 02111. In Europe: Teradyne, Ltd., Clive House, Weybridge, Surrey, England.

WE SELL PRODUCTIVITY.

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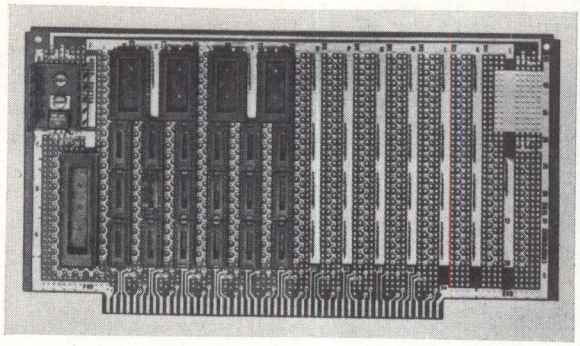
CHICAGO (312) 298-8610/DALLAS (214) 231-5384/NEW ENGLAND (617) 458-1256/NEW YORK (201) 334-9770
SUNNYVALE (408) 732-8770/LONDON (0932) 51431/PARIS 073 16 98/ROME 59 47 62/MUNICH (089) 33 50 61/TOKYO (03) 406-4021

For people with memory problems cut this out and save.

Microprocessor Board Has Wide Range of Mounting Capability



8800V microprocessor board reduces development time for memory expansion and peripheral interface circuits in microcomputers. Large area and 100 I/O terminals allow modular circuit construction and subsequent prototype evaluation in operating system

Universal board permits microcomputer users to increase amount of RAM, ROM, or p/ROM; meet increased peripheral interface hardware requirements; or add I/O circuits such as A-D, D-A converters, multiplexers, and relays. Board has 100 I/O terminals.

Model 8800V from Vector Electronic Co, Inc, 12460 Gladstone Ave, Sylmar, CA 91342 comes prepunched with 0.042" dia holes on 0.1" centers so that DIPs can be placed in any location. Typically, 5.313 x 10" board holds two 40-pin DIPs, eight 24-pin DIPs, and 36 14- or 16-pin DIPs. Alternatively, it can hold 52 14- or 16-pin DIPs, or ten 40-pin DIPs and eight 24-pin DIPs, in any combination.

DIP devices can be used without modifying board, which also has space for discrete devices and ribbon-wire connectors. Column and row DIP zone coordinates as well as column and row hole designators are etched into laminate. Power is distributed to each DIP location by power and ground planes on opposite sides of board; these also give distributed decoupling capacitance. Additional capacitors can be located adjacent to DIPs.

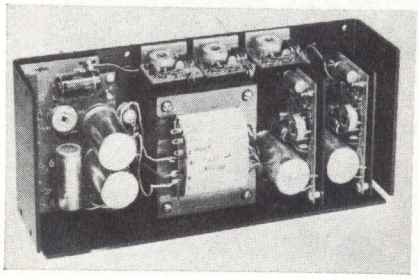
There are two copper heat-sink positions on component side for regulators; one is prewired and predrilled for 7800 series regulators in TO-220-type case, the other is uncommitted. Provisions are made to cut power conductors for special applications. One low profile, finned heat-sink is supplied with each board. Boards are manufactured of blue 0.06" FR-4 epoxy-glass material. Card has 50 connector fingers on each side, spaced on 0.125" centers. Holes are provided for card ejectors. One-to-one layout sheets showing hole and bus location are furnished with each board. Solder tail, wrapped-wire mating and associated sockets, terminals, and tools are also available.

Circle 183 on Inquiry Card

Three-Output Supply Powers Microprocessor and Memory Modules

Designed for microprocessor-based systems, model 3MA-MP provides power for CPU plus peripheral modules, including memories in systems applications. The supply, introduced by Dynage, Inc, 1331 Blue Hills Ave, Bloomfield, CT 06002, furnishes three outputs: 5 V at 6 A, 12 V at 1.5 A, and a third which is usable between 5 V at 1 A and 9 V at 1.5 A.

Each output is provided with independent overvoltage protection and is temperature compensated and adjustable, allowing maximum flexibility in applications. Selectable input is 115 or 230 Vac. Unit has operating temperature range of −20 to 40°C at full rating, with derating to 71°C.



Circle 184 on Inquiry Card

Analysis/Control System Is Designed for Analog Instrumentation

Analog Data Acquisition Analysis and Control System (ADAACS) is a flexible microprocessor-based digital unit for use with analog instrumentation. Major functions are to control instrumentation, provide digital encoding of analog data signals, process data, and supply output data in analog and digital form to peripheral devices (eg, visual alphanumeric display, meters, and data logging printer).

Unit interfaces with Termiflex's HT/2 computer terminal, which provides control switch/keyboard and alphanumeric visual display for operator control and observation. Keyboard contains 20-key pad and three shift keys which allow generation of 128 ASCII characters as control inputs. Visual display has two 10-character lines of full alphanumeric characters, including upper/lower case, control, and status.

A variety of systems are adaptable since controller can be reprogrammed, and up to 16 single-ended, or eight differential analog input signals can be accommodated at input interface. Output interfaces include two EIA standard peripheral output ports, which allow interface to peripheral or communication link. Third EIA interface is dedicated to HT/2 terminal. Two analog output ports are provided to drive devices such as meter and recorder. Processor contains up to 4096 characters of plug-in p/ROM components which can be changed to provide new functions.

Data are provided in analog form for analysis and control, and, if desired, closed loop system control can be provided of process involved with data. Introduced by Lion Precision Corp, 60 Bridge St, Newton, MA 02195, system provides solutions to dimensional analysis through reprogramming with HT/2 terminal, replacing p/ROM set, and adding or deleting analog function modules.

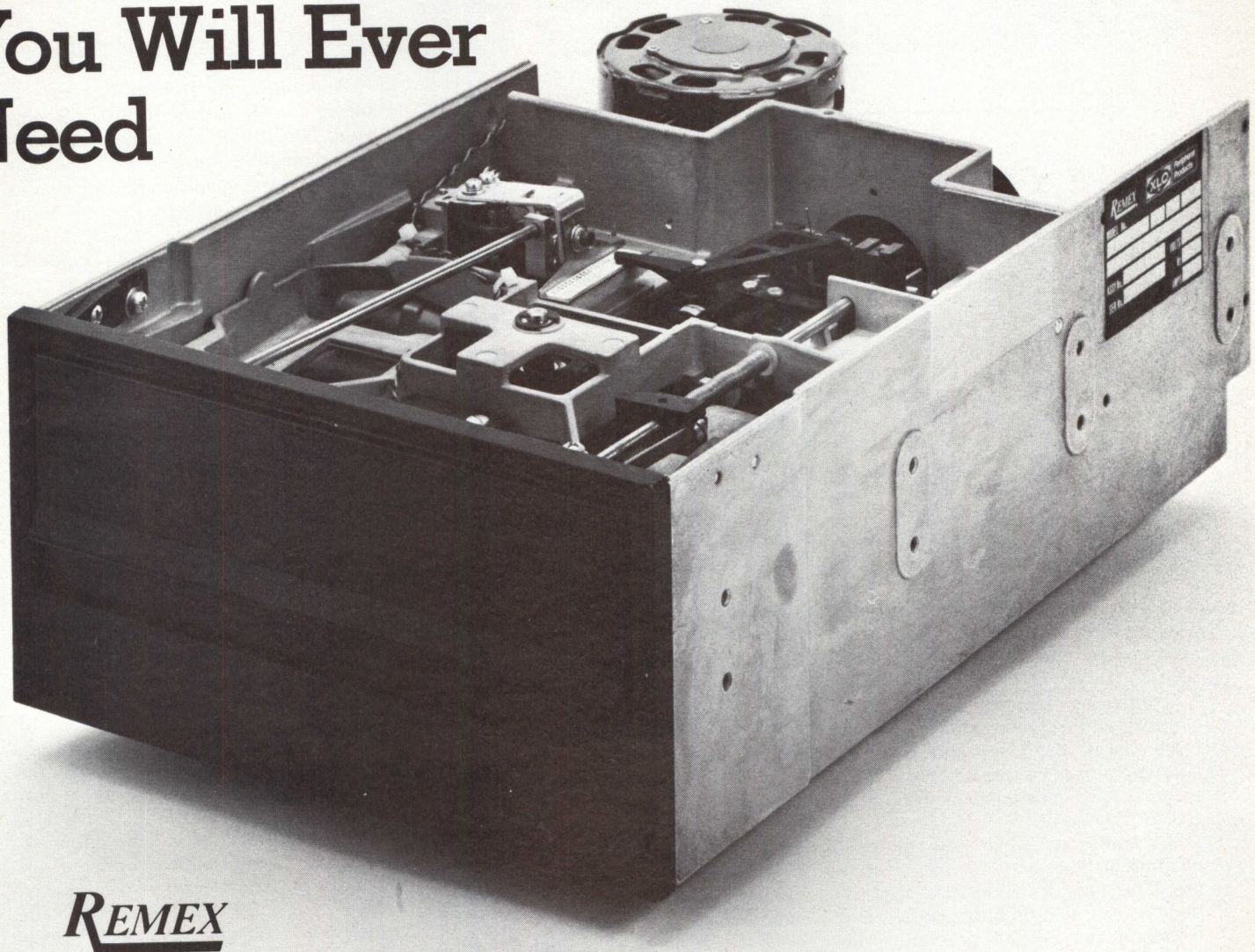
Circle 185 on Inquiry Card

The REMEX RFD 1000—Because It's Versatile. Double or single density with capacity up to 6.4 Mbits...IBM standard or 32 hole hard sectored media without drive modification...IBM compatible or expanded hard and soft sectored formats for application flexibility...Unit select daisy chain capability for maximum controller efficiency...Selectable DC negative voltage for system compatibility...Individual drive housing or two drives horizontally side by side in a 19 inch rack configuration.

The REMEX RFD 1000—Because It's Reliable. Ceramic head for extended life...Precision machined, die-cast construction...Operator interlock and expandable clutch for media protection...Front panel "head in contact" indicator and optional "head in contact" door lock...Optical write protect to assure data security...Stylus ball lead screw positioning system for long-lived accuracy...Optical track 00 sensing for drive carriage protection.

The Remex RFD 1000 is the RIGHT peripheral from Remex.

This Is The Only Flexible Disk Drive You Will Ever Need



REMEX

XLO® Peripheral Products

Ex-Cell-O Corporation

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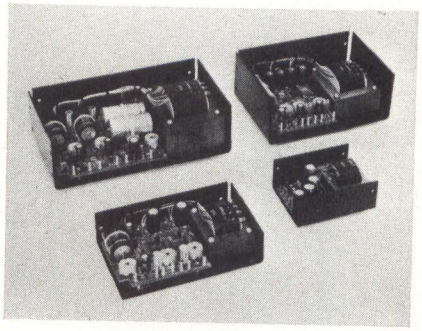
(714) 557-6860, TWX (910) 595-1715. In Europe and the U.K.: SpA, Microtechnica
Via Madama Christina 147, Torino, Italy 10126.

Open-Frame Supplies Meet All MPU System Power Requirements

Micro-Pro series of dc power supplies meet requirements of microprocessors as well as standard triple output 5-, 12/15-V applications. Seven models made by Alpha Power Inc, 9020 Eton Ave, Canoga Park, CA 91304 are claimed to represent the lowest priced and broadest line available.



They are packaged in four industry-standard case sizes. The 1CMP triple output model is designed for small 8080 MPU systems and is rated 5 V at 1 A, 12 V at 0.25 A, and 5 V at 0.4 A. 2CCMP and 2DMP units can power any microprocessor and associated RAMs, ROMs, p/ROMs, FPROMs, clock, and I/O chips.

Units operate from 105 to 125/210 to 250 Vac, 47 to 63 Hz with output fully protected, including current foldback and built-in overload protection on all models. Repairable design features anodized chassis and G10 epoxy board.

Circle 186 on Inquiry Card

Prices of µComputer Evaluation Kit Reduced

Lower prices for its F8 microcomputer evaluation/development package (survival kit), which includes CPU, program storage unit (PSU), static memory interface, 1K x 8-bit R/W memory, FORTRAN IV cross assembler for 16-bit computers, 2.0-MHz crystal, two CMOS buffers, and 6.75 x 5.5" PC board, have been announced by Mostek Corp, 1215 W Crosby Rd, Carrollton, TX 75006. The unassembled MK 79001 was reduced from $197 to $147; the assembled MK 79002 dropped from $250 to $185.

When assembled, the computer has capabilities of 24 bytes of I/O arranged in three 8-bit ports; 1024 bits of R/W memory; full duplex TTY interface (20-mA loop); crystal control clock; automatic power-on reset; hardware reset; and nonvolatile operating system in PSU firmware, called designer development tool 1 (DDT-1).

Kit comes complete with all documentation necessary for its effective use. This includes a detailed application note, programming guide, and listing of the DDT-1 program. Also available for use with the computer are the MK 79003 power supply box, which provides an edge card connector as well as all required power, switch-selectable baud rate, and TTY connector cable.

Circle 187 on Inquiry Card

Bipolar Circuits Provide Support for Microprocessors

Pair of bipolar microprocessor support circuits are designed to implement input/output, clock generation, and timing functions for 8080A-type microprocessors. They allow designers to minimize number of circuits in system, optimizing their speed/power performance.

Available from Advanced Micro Devices Inc, 901 Thompson Pl, Sunnyvale, CA 94086, Am8212 is an I/O port consisting of 8-bit latch and 3-state output buffers, with control and device selection logic. It is supplied in 24-lead molded and hermetic DIPs. Am8224 contains crystal-controlled oscillator, divide-by-9 counter, high level drivers, and auxiliary logic functions. It comes in 16-lead molded and hermetic DIPs.

Both devices are specified for operation over commercial and military temperature ranges. Circuits are also processed to MIL-STD-883 requirements. Prices start at $2.90 for molded unit in 100-piece lots.

Circle 188 on Inquiry Card

Real-Time Multi-Tasking Operating System Serves Microprocessor

The MTOS-68 executive, for the Motorola M6800 microprocessor, consists of 3K-byte control program in ROM, 256-byte scratchpad R/W memory, and adjustable interrupt clock. System is provided as a board which plugs directly into Motorola's EXORciser™. Other configurations, as required for specific applications, are also available.

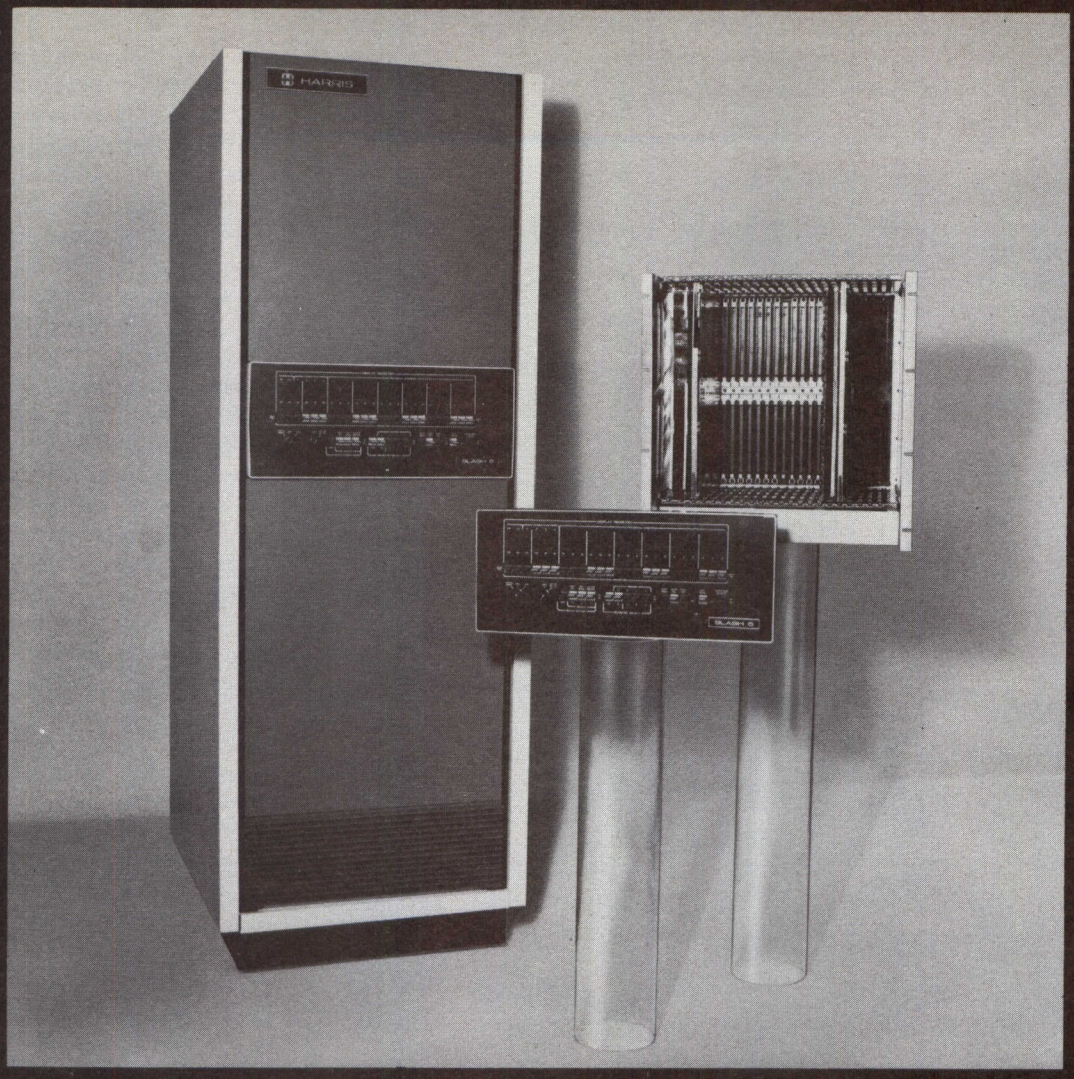
Announced by Industrial Programming, Inc, 9 Northern Blvd, Greenvale, NY 11548, the system provides four categories of service: management of tasks, coordination of shared subprograms, management of time, and I/O of console messages and discretes. A detailed user's guide is available.

Circle 189 on Inquiry Card

Economical Solutions Offered by Ready-to-Use µComputer

For use in both individual and industrial applications, the Micro 68 computer system is built around Motorola/AMI 6800 microprocessor. The system, developed by Electronic Product Associates, Inc, 1157 Vega St, San Diego, CA 92110, contains integral power supply, 16-button keyboard, 6-digit LED display, and 128 words of R/W memory. Content of p/ROM permits loading, inspecting, editing, inserting break points for debugging, and executing programs. Memory can be expanded to 64K and full 16-bit I/O can be obtained. Memory lines can be buffered on board. System is completely assembled in 9 x 16 x 2" hardwood cabinet with transparent smoked plexiglass lid. □

Circle 190 on Inquiry Card



Announcing the Harris Slash 6. Supermini performance. At super minicost.

If you recognize optimum price/performance value when you see it, you should see our new SLASH 6. It outperforms most 32-bit minis, at a price that's better than many 16-bit minis.

The Harris Slash 6 costs only $14,500*. You get 600 nanosecond cycle time; 48KB of MOS memory with error correction; hardware multiply, divide, and square root; 8 priority interrupts; and a turnkey control panel.

You get building-block architecture that lets you expand your systems as your needs expand. And sophisticated real-time software that no other machines offer in this price/performance range.

The Harris Slash 6. The first truly low-cost/high performance computer for all of you who were waiting for optimum price performance value. Harris Computer Systems, 1200 Gateway Dr., Ft. Lauderdale, FL. 33309. Europe: Techmation N.V., Gebouw 105/106, Schiphol-Oost, The Netherlands.

HARRIS

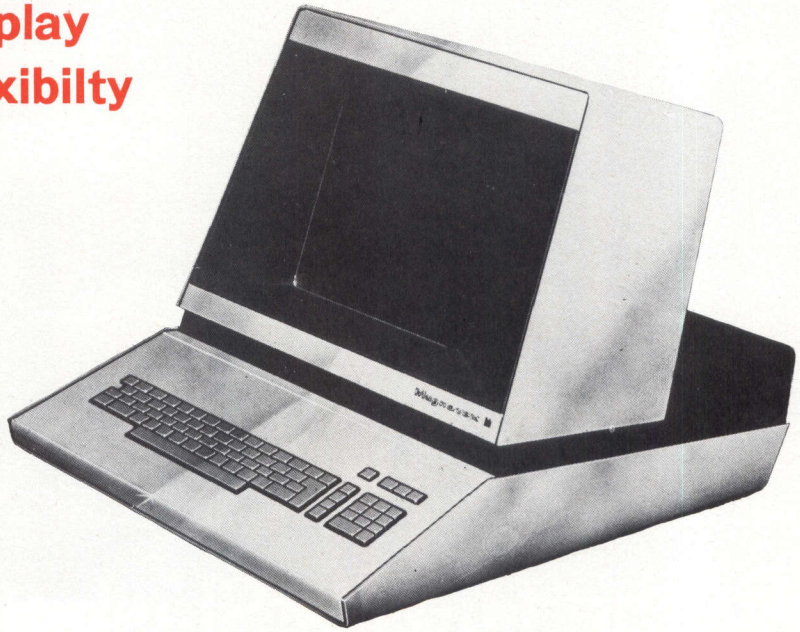
COMMUNICATIONS AND INFORMATION HANDLING

*Volume discounts available.

CIRCLE 58 ON INQUIRY CARD

PRODUCT FEATURE

Microprocessor Control of Graphics Terminal Permits Display Flexibilty



A programmable microprocessor for control of electronics and a plasma panel for display are combined in the Orion 60 terminal to achieve a high level of flexibility. Designed for online operation with a variety of computer systems, Magnavox Co's graphics display terminal communicates with a computer either by direct connection or via long distance telephone lines using external modems.

Highly interactive graphic and alphanumeric presentations are featured. There is no screen jitter or flicker since the display does not need to be refreshed. Displays can be dynamically altered through selective write and erase of each dot. An option permits the user to alter the display by a fingertip entry method, using 256 touch entry points in a 16 x 16 matrix. In addition, the terminal can be used with a variety of rear projection units through a rear port entry connection.

Character generation and vector drawing functions for addressing the plasma panel are provided by the controller electronics. Two basic modes of operation are ASCII—in which the terminal responds to coding on a character-by-character basis for printing and format control functions—and graphics—in which the terminal responds to 3-byte sequences to generate vectors and perform other special functions.

Operational Characteristics

Standard communication interface for the terminal operates in accordance with EIA standard RS-232-C bit serial, asynchronous, full duplex. Baud rates are selectable. Data received through the interface are routed to the microprocessor, which operates on each character to execute a plot function or perform a control function. The microprocessor supervises control of all internal functions; communicates directly with memories, display panel interface, and communications interface sections; and supervises output data control so that only a properly enabled data source—normally the keyboard—will be able to transmit.

Each element of the plasma display is distinguishable with a minimum point luminance of 30 ft-L. The viewing matrix is formed by a grid of 512 x 512 lines defining more than 262,000 picture elements. Active viewing surface is approximately 8.5 in.^{2} with 60 elements/in. Each element may be selectively written or erased using identical timing and control cycles. Individual points, vectors, and characters may be drawn or erased in any combination without modifying the remainder of the display.

Standard alphanumeric characters are formed in a 7 x 9 dot format within an 8 x 16 matrix area, positioned to allow for placement of upper and lower case characters. For instance, a capital letter would be in the area from row 3 down to row 11, while a lower case letter would fill rows 6 to 11—or to row 14 if it had a descender. Whenever the terminal is in ASCII mode, a cursor is written in rows 15 and 16. (An optional 5 x 7 format is available in a 6 x 10 matrix area.)

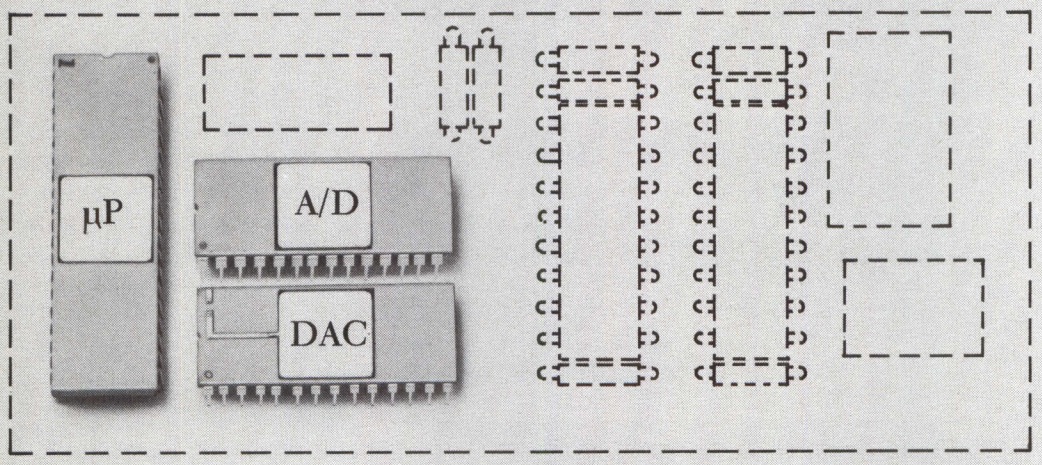
Total screen capacity is 2048 characters at a maximum of 64 char/line x 32 lines. Characters may be offset by subscript or superscript commands or by graphic coordinate locating commands.

All 128 ASCII code combinations are accepted by the terminal (96 printable and 32 for control). Optionally, up to 128 special characters can be loaded into a user programmable random-access character memory via graphic mode. Access can be in either mode.

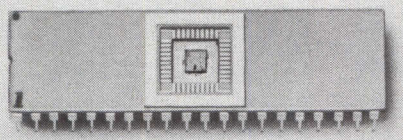
Several internal control functions occur automatically under special conditions without computer or operator command. One of these is anti-wraparound—vertical and horizontal—to prevent any partial character from being written on the panel. This feature is disabled in graphic mode or during cursor movements.

(Continued on p 133)

A lot of microprocessor users wish their analog interface problems would go away.



We made them disappear.



With our monolithic CMOS converters.

10- and 13-bit A/D converters with tri-state output logic that gets you directly onto the microprocessor data bus. And our 10-bit D/A converter with double-buffered inputs direct from the microprocessor. And each communicates in two bytes: the 8 LSB's, and the remaining MSB's.

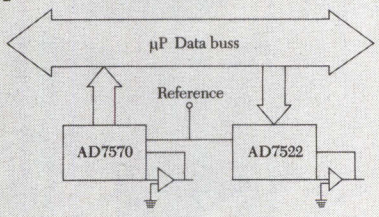
Our AD7550, industry's newest and most accurate monolithic CMOS A/D converter, uses a patented (Analog Devices U.S. Patent No. 3872466) "quad slope" conversion technique to provide 13-bit accuracy, 1 ppm/°C offset and gain drifts, and has its own amplifier, comparator, clock and digital logic.

Our AD7570 is a monolithic CMOS 10-bit successive approximation A/D converter with ratiometric operation and only 20mW of dissipation. Parallel and serial outputs with 20μs conversion time provide excellent application flexibility.

Our AD7522 is a monolithic CMOS multiplying, 10-bit DAC. It's the only such device available with double buffered inputs that can be loaded in parallel or serial mode. Low dissipation, very low feedthrough and drifts of only 1 ppm/°C complement the interface handshaking routine for maximum flexibility and optimum performance.

These I/O peripherals, the AD7550, AD7570 and AD7522 data converters are your only real solutions for interfacing a microprocessor to the analog world.

And these are just three of a complete line of more than 20 IC converters that make a lot of your conversion problems disappear. For more information, write Analog Devices, the real company in precision measurement and control.



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Analog Devices, Inc., Norwood, Massachusetts 02062

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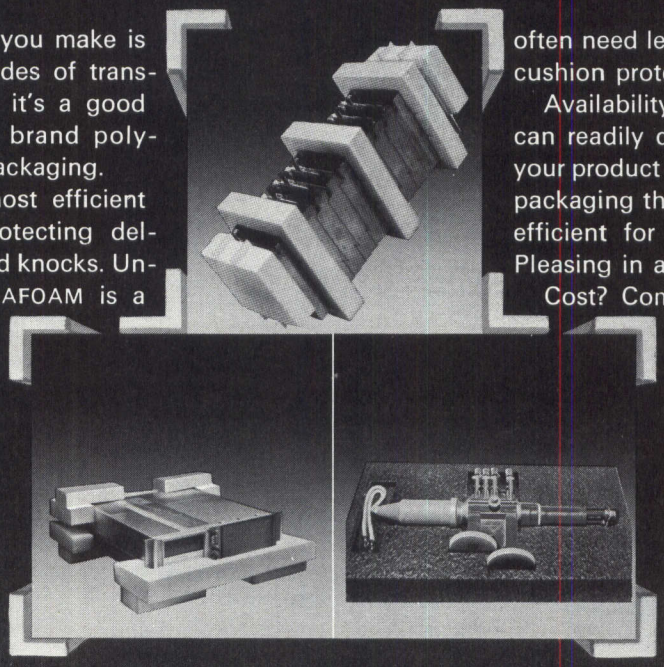
CIRCLE 60 ON INQUIRY CARD

Why cushion packaging for heavy electronics? Because the bigger they are, the harder they fall.

If the electronic equipment you make is subject to all the usual modes of transportation . . . chances are, it's a good candidate for ETHAFOAM* brand polyethylene foam for cushion packaging.

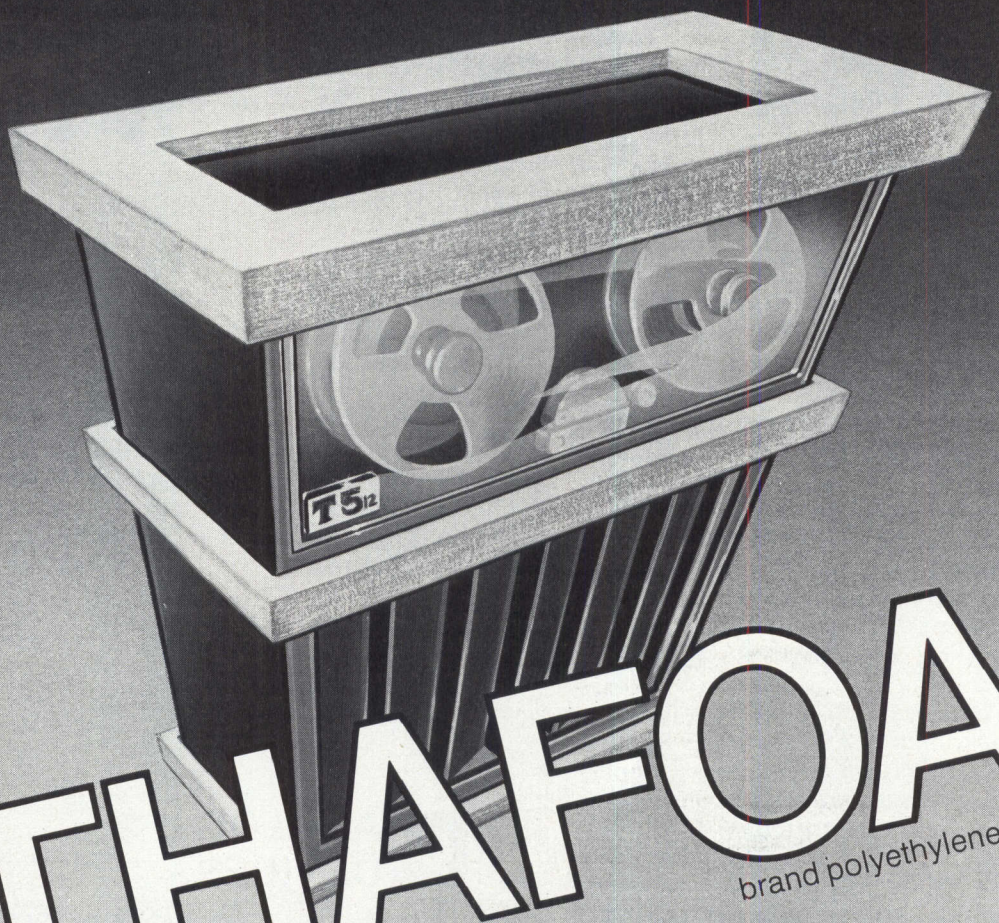
It's by far one of the most efficient packaging materials for protecting delicate electronic gear from hard knocks. Unlike corrugated inserts, ETHAFOAM is a resilient, closed-cell plastic foam. This means it does a better job of protecting from repeated shock, vibration and abrasion. And unlike many molded foam parts, it won't shatter. It boasts excellent recovery, too, returning to shape after impact. Finally, because of its inherent efficiency, you often need less ETHAFOAM for equivalent cushion protection.



Availability? Fabricators of ETHAFOAM can readily design and deliver the parts your product requires. You'll wind up with packaging that's lightweight and volume-efficient for lower transportation costs. Pleasing in appearance, too.

Cost? Competitive in cushioning, but thanks to its design versatility and other cost-cutting features, ETHAFOAM brand polyethylene foam will probably cost you less in the long run. How's that for delivering the goods.

More information? Check with your nearby fabricator of ETHAFOAM. He's listed on the following page.



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Packaging Services, Louisville (502) 778-5565
Prescotech, Louisville (502) 585-5866
Republic Packaging, Lexington (606) 254-7715

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Republic Packaging, Glen Bernie (301) 766-0126

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Can Pak Service, Feeding Hills (413) 734-2146
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GSF, Lawrence (617) 685-1151
Keil Brothers, Mansfield (617) 339-8440
Rogers Foam, Somerville (617) 623-3010
Tainer Tech, Northbridge (617) 234-7301
United Foam, Georgetown (617) 352-2200

MICHIGAN
Creative Foam, Fenton (313) 629-4149
Foamade Industries, Royal Oak (313) 548-5555
Geo. A. Cantrick, Detroit (313) 871-4300
Stephenson & Lawyer, Grand Rapids (616) 949-8100

MINNESOTA
Charles Industries, Minneapolis (612) 535-2225
Federal Packaging, Minneapolis (612) 533-1631

MISSOURI
Foam Products, St. Louis (314) 739-8100

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Crescent Products, Paterson (201) 278-9368
Paramount Industries, Piscataway (201) 755-1400
Rempac Foam, Passaic (201) 773-8880
B. Zeitz & Son, Cherry Hill (609) 663-5504

NEW YORK
Bernel Foam, Buffalo (716) 875-2900
Prescotech, Buffalo (716) 822-2100
Styro Sales, Long Island City (212) 786-1791

NORTH CAROLINA
Hibco Plastics, Yadkinville (919) 679-8856

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Another such function—page-full-break—is switch selectable and provides an automatic interrupt at the computer when a full page of text has been printed on the screen. A space-overwrite latch optional function provides nondestructive spacing in ASCII mode after receipt of a carriage return command prior to a feed command.

Lines can be written or erased in graphics mode at any point at 80 vectors/s (standard 2400-baud operation). Characters can be formed at a rate of 240/s.

Firmware (microprogram) options are available in various combinations if specified at time of purchase. Some of these are dual APL/ASCII character set, incremental vectors, alternate control codes, 4000-character screen format (80 char/line x 50 lines), universal I/O channel, cursor readout, and horizontal tab sets.

Supporting software includes a graphics package (GPAC), interactive graphics software (IGS) for IBM/360/370 computers, and an interactive previewing package for CalComp plotters. Consisting of user-callable subroutines, written in ANSI FORTRAN IV, which support all functions and options of the terminal, GPAC is adaptable to many minicomputers and mainframe systems.

Enabling the terminal to be connected to an IBM/360 or /370 computer, IGS consists of three levels: interactive graphic access, basic support for FORTRAN and GPAC compatibility, and user data support for FORTRAN. The plotter previewing package allows a plot to be examined before it is drawn. This package utilizes functions and concepts of IGS.

Specifications

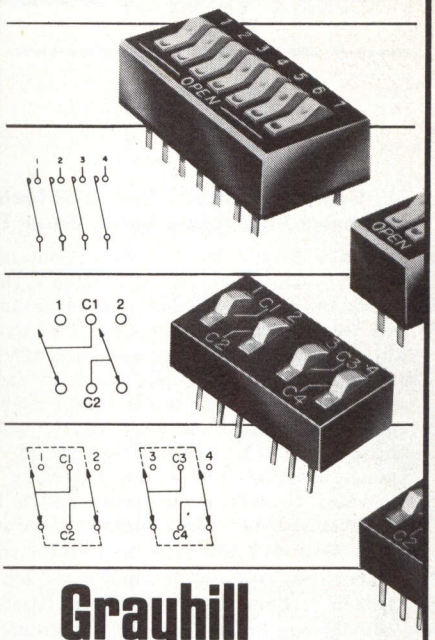
Dimensions of the terminal, including key set, are 26.5 x 19.5 x 20″ (67.3 x 49.5 x 50.8 cm). Weight is 60 lb (27.2 kg). Power requirements are 115 V, 60 Hz, 7 A. The unit operates under standard office conditions.

Price and Delivery

List price for the Orion 60 graphics terminal is not available at press time. Delivery is 60 to 90 days ARO. Magnavox Government and Industrial Electronics Co, Fort Wayne, IN 46804. Tel: (219) 482-4411.

For additional information circle 199 on inquiry card.

Now there are 3 circuitry configurations!



Grayhill Rocker DIP Switches - SPST, SPDT, DPDT

All with exclusive spring loaded, sliding ball contact system...life rated at 50,000 operations.

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Now Grayhill's DOUBLE-DIP™ Rocker DIP Switch (DPDT) joins the DIP-C™ (SPDT) and the plain vanilla SPST, in the industry's most comprehensive line for cost-effective on-board switching. Grayhill's Series 76 Rocker DIP Switches offer the important advantages of IC compatibility, compact high-density design, and ease of mounting by direct wave soldering or insertion into standard DIP sockets. Positive positioning through the exclusive spring-loaded sliding ball contact system provides immunity to shock and vibration and life with 50,000 operations.

Detailed specifications and pricing are available from Grayhill, 561 Hillgrove, La Grange, Illinois 60525 or phone (312) 354-1040 for your free Rocker DIP family literature packet.

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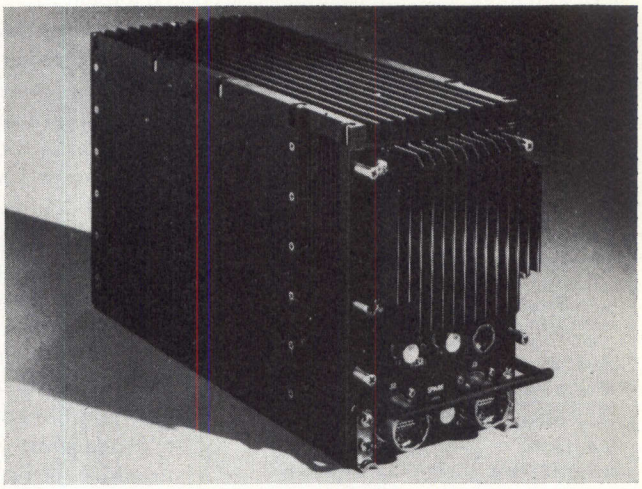
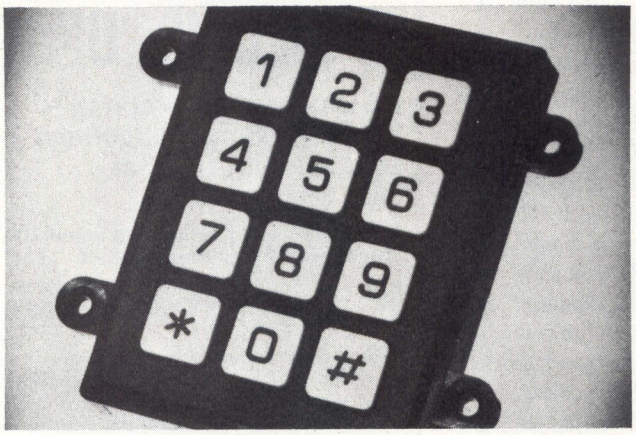
PRODUCTS

Mil-Spec Processor Offers 32K Memory and Extensive Instruction Set in Small Package

Reduction in size and weight without loss of computing power has been achieved in the 1650 severe environment computer by combining microprocessing techniques and LSI technology with a double density core memory. The unit is totally compatible with 1600 series computers and its computing power is equivalent to the 1602 (AN/UYK-19), but both size and weight have been reduced by about two thirds. Single-module CPU, two 16K core memory modules (1-μs cycle time), and 28-Vdc power supply measure 5 x 7¾ x 12½" and weigh <30 lb. The microprogrammed, 16-bit processor uses a Nova™-compatible instruction set based on four accumulators and a hardware stack pointer. It executes 52-bit microinstructions with 150- and 250-ns cycle times. Only 440 words of the 1024-word control store p/ROM capacity are required to implement the instruction set. Three package configurations are offered based on cooling provisions. **Rolm Corp,** 18922 Forge Dr, Cupertino, CA 95014.

Circle 200 on Inquiry Card





Keyboard Meets Environmental Requirements of Microprocessor Systems

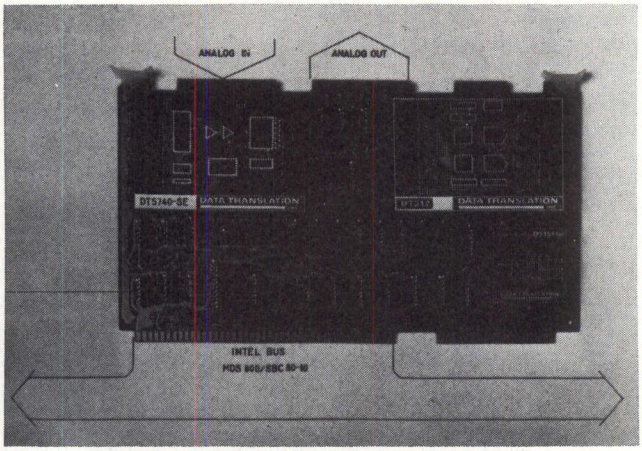
Suited for use with microprocessor-based designs requiring a small keyboard for data input and function selection, this 12-key keyboard incorporates the unique Softac design, and provides a positive response when a button is depressed. Entire contact area is protected environmentally with a plastic film shield. Double-shot molded keytops and a mounting bezel are made from engineering grade thermoplastic. Keyboard is provided with mounting pins for easy assembly onto a printed circuit board and mounting on a panel. 1-of-12 or 3 x 4 matrix circuit is directly compatible with many standard integrated circuits. Products adaptable to this type of keyboard include process control systems, microprocessors, instruments and test systems, and communications equipment. **Clare-Pendar Co,** Post Falls, ID 83850.

Circle 201 on Inquiry Card

Single-Board Analog I/O System Mates with Single-Board Microcomputer

Exactly compatible with Intel's single-board SBC 80/10 microcomputer, the DT1751 offers a 16-channel high speed data acquisition system at the input, two D-A converter channels at the output, and a program I/O and interrupt interface to the SBC 80/10. Application software can be developed in the Intellec™ MDS-800. Interrupt portion of the interface has external trigger capability for synchronizing data measurements with some process event. All analog circuitry utilizes standard DATAX modules. A DATAX II data acquisition module, complete with an over-voltage protected MUX, sample/hold, and 12-bit A-D converter, is at the input. A programmable gain amplifier extends resolution of analog measurements to 14-bit resolution. Analog outputs comprise two channels of high current drive 12-bit D-A converters, capable of driving 50 ft of cable to 0.1% in <1 μs. **Data Translation Inc,** 109 Concord St, Framingham, MA 01701.

Circle 202 on Inquiry Card



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• Economics of Alternative Technologies • Survey of Applications—How to use Microprocessors and LSI • Basic Elements of a Microcomputer System • Case Histories Detailed • Advanced Multi-Microprocessor Configurations • How to get started • The Future

COURSE 134: SOFTWARE/SYSTEM DEVELOPMENT: TOOLS AND TECHNIQUES FOR MICROCOMPUTERS

• Software Fundamentals • System Development Process Overview • System Analysis • Program Design • Program Implementation • Hardware/Software Integration, Testing and Debugging • Future Trends in System Development

COURSE 187: BIT-SLICE MICROPROCESSORS, PLA'S AND MICROPROGRAMMING

• Applications of Microprogramming and Bit-Slice Microprocessors • Microprogramming Techniques • Survey of Microprogrammable Devices • Case Studies in Bit-Slice Microprogram Applications • Programmable Logic Arrays • Implementation of Applications for PLA's

COURSE 102: MICROPROCESSORS/MICROCOMPUTERS: A Comprehensive Technical Introduction and Survey

• Review of Relevant Fundamental Computer Concepts • Basic Elements of a Microprocessor System • Development of a Microcomputer System • How to get started • Estimation of Cost

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☐	☐	Oct. 26-29	SAN FRANCISCO
☐	☐	Nov. 9-12	HOUSTON
☐	☐	Nov. 16-19	WASHINGTON D.C.
☐	☐	Nov. 30-Dec. 3	LOS ANGELES

Course 201 (Day 1 & 2)	Course 187 (Day 3 & 4)		
☐	☐	Sept. 20-23 (just after AOC convention)	WASHINGTON D.C.
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Course 205 (Day 1 & 2)	Course 134 (Day 3 & 4)		
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Course 102 (Day 1)	Course 134 (Day 2 & 3)	Course 187 (Day 4 & 5)		
☐	☐	☐	Sept. 13-17 (at time of WESCON)	LOS ANGELES

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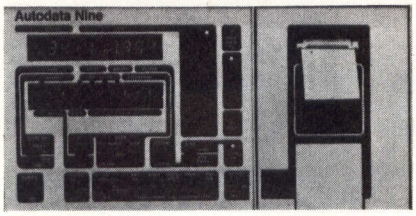
PRODUCTS

DATA ACQUISITION SYSTEMS

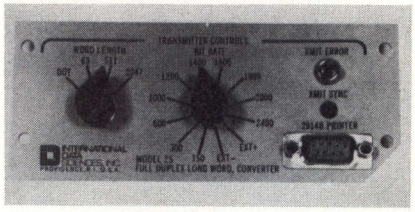


Autodata Nine, a data acquisition system with alarm options for supervisory control, incorporates a microprocessor for computer-like performance. Connecting directly to most sensors, including thermocouples, RTDs, current transmitters, and voltages from microvolts to 120 V, the system converts inputs to engineering units, which are displayed and recorded with proper symbols. An integrating measurement technique provides noise rejection as high as 180 dB with 0.01 or 0.001% resolution, selectable on a per-channel basis. **Acurex Corp,** 485 Clyde Ave, Mountain View, CA 94042.
Circle 203 on Inquiry Card

DC CONTROL MOTOR

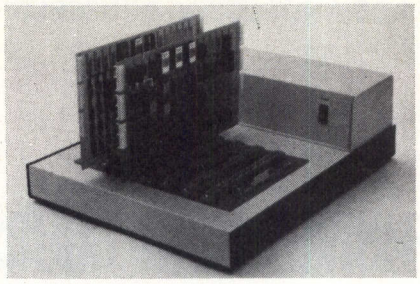
The 22VM, a version of the company's 2VM dc control motor, features a hollow rotor that permits very low inductance and nearly instantaneous start, stop, and positioning response. Other features include high torque-to-inertia ratio, high frequency response characteristics, low ripple content, and freedom from cogging. Unit is available with analog tachometer. **Micro Switch, a Div of Honeywell,** 11 W Spring St, Freeport, IL 61032.
Circle 204 on Inquiry Card

FULL DUPLEX LONG WORD CONVERTER



Designed for installation in WECO 914B or Sierra 1914B data test set, model 25 is a kit consisting of two PC boards and hardware, control panel, harnessing, and switch marking overlay. Installation adds complete 2047-bit test pattern transmitter and receiver, transmit error capability, and printer output connector. Unit extends capability of test set to allow full duplex testing, which is necessary to perform loopback tests and 2-way end-to-end tests of data transmission links. **International Data Sciences, Inc,** 100 Nashua St, Providence, RI 02904.
Circle 205 on Inquiry Card

CIRCUIT PROTOTYPING SYSTEM



Consisting of universal prototyping boards, and motherboard, with sockets, chassis, and power supply, system is available in bundled form, or as parts. Boards are laid out for any combination of 14-, 16-, or 40-pin DIPs. Useful component area is 7 x 10". Chassis is equipped with a bus-structured motherboard and six 86-pin sockets. Double-sided motherboard bus lines each terminate in a male connector at one end of the board; at the other end, power is brought into the bus. **Oxbridge Associates,** 2698 Marine Way, Mountain View, CA 94043.
Circle 206 on Inquiry Card

DATA CARTRIDGE RECORDER SYSTEMS

Model 300-S, a 3M-ANSI-compatible system, features computer-grade dual gap head and synchronous formatter for complete read-after-write and CRC error checking. Intelligent ANSI formatter/controller utilizes parallel I/O structure for simple interfacing to microprocessors and minicomputers. A buffered unit, model 300-B, contains dual 128-char buffer for asynchronous applications. RS-232/TTY, parallel interface, complete edit and search capabilities, and remote and manual controls are std features. **Columbia Data Products, Inc,** 6655 Amberton Dr, Baltimore, MD 21227.
Circle 207 on Inquiry Card

SUBMINIATURE ALTERNATE ACTION PUSHBUTTON SWITCH

Capable of using all toggle terminal and sealing options, 6-A spdt pushbutton switch is alternate action and momentary. Switches have a snap-acting loading spring which gives a behind-panel depth of 0.450". 8161 identifies the push on/push off model, while 8168 is the momentary model. Dimensions are identical for both versions: pushbutton actuator is 0.122" dia and 0.280" long; switch body measures 0.500 x 0.270 x 0.450". **C&K Components, Inc,** 103 Morse St, Watertown, MA 02172.
Circle 208 on Inquiry Card

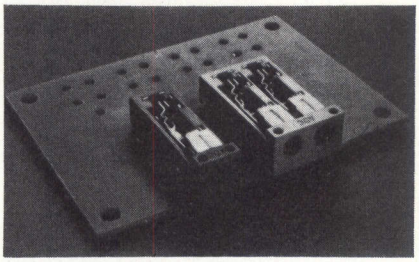
MINIATURE DIP SCRs

Packaged in low-profile 4-pin DIP, VCRC series simplifies PC board layout and is compatible with automatic handling, testing, and inserting equipment. Ratings are 200, 300, 400, and 600 V (V_{DRM}) and (V_{RRM}) with 1.5 A [$I_{T(RMS)}$], 100 A at 60-Hz peak surge on-state current (I_{TSM}). Gate-trigger current (I_{GT}) is 15 mA. With dense glass passivation and shorted emitter construction, SCRs have 200 A/μs di/dt and 200 V/μs (typ) dv/dt ratings. **Varo Semiconductor, Inc,** PO Box 676, 1000 N Shiloh, Garland, TX 75040.
Circle 209 on Inquiry Card

AUTORANGING MULTIMETER

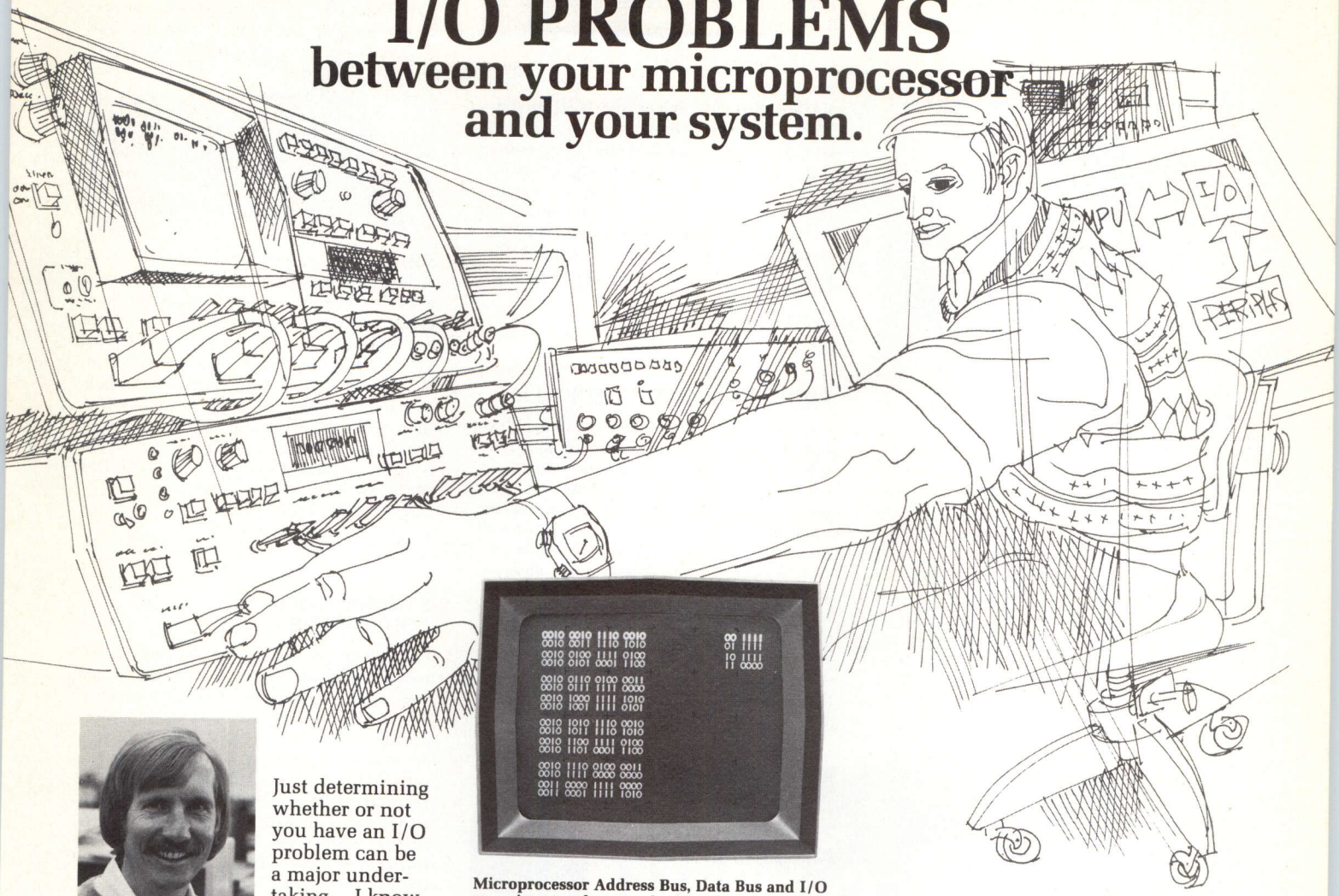
Offering five autoranging functions with hold position on any range, Digitest 350 digital multimeter features autopolarity and bright 11-mm LED display. Measurements of Vdc range from 0.0001 to 1000 V; Vac from 0.0001 to 750 V. A (ac and dc) are from 0.00001 to 2 A, while resistances are from 0.1 Ω to 2000 kΩ. Automatic power saver system cuts off instrument after 3 min. of operation. Other features include low battery indicator and long term stability. **Schneider Electronique,** 27-33 Rue D'Antony, 94533 Rungis-Cidex L 165, Paris, France.
Circle 210 on Inquiry Card

MINIATURE JACKS FOR PCB MOUNTING



PCB-Jacks, designed for PC board mounting, measure 1.25 x 0.435", <½ size of Bantam jacks. Soldered directly to board, 3-conductor jacks eliminate need for motherboards, jack-mounting hardware, and front plates. Jacks are made of WECO #1 gold crossbar contacts and nickel-silver springs. Normal through-jack configuration permits splitting and isolating signal to test and monitor. Six std colors are available to facilitate circuit coding: red, white, blue, orange, yellow, and black. **ADC Products,** 4900 W 78th St, Minneapolis, MN 55435.
Circle 211 on Inquiry Card

Let's talk about solving I/O PROBLEMS between your microprocessor and your system.



Just determining whether or not you have an I/O problem can be a major undertaking...I know, I've been there too. We call communication with the microprocessor "handshaking," but sometimes information transfer, especially across an I/O port, reminds me more of "armwrestling."

Analysis of data transfer across an I/O port can be very tricky. The microprocessor and the peripheral may have independent system clocks, or the peripheral may be asynchronous. There may be a parallel-to-serial data transformation, or vice-versa. The systems may require a common trigger to interact properly. How do you verify all that? And how do you determine that the instructions are being received and executed properly?

About the only way I know that you can really be sure everything is working right (without spending an excessive amount of time) is to look at it on an HP 1600S Logic State Analyzer. Then it doesn't matter whether you have independent system clocks going. Or whether part of the system is asynchronous.

The HP 1600S lets you display two separate tables of data on one screen, so you can look at program flow right alongside the input and output states of the I/O port. That way there's no question about correct sequencing—or about data flow in either direction.

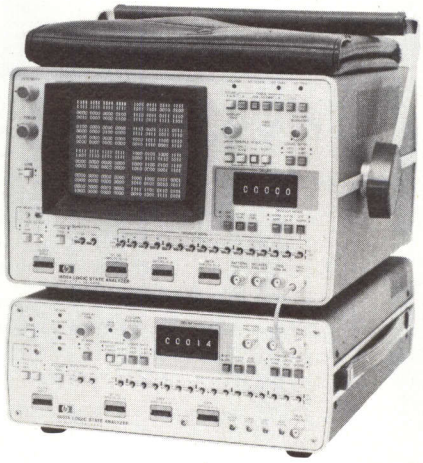
Microprocessor Address Bus, Data Bus and I/O input and output data are displayed simultaneously on the HP 1600S screen.

Confidence in your system design and operation will be high. I mean, when you can actually look at all those data buses, read their information flow, and see that it's all perfect—that's confidence!

What's more, if you do find a problem, the HP 1600S will help you pinpoint it more quickly than any other way I know. It can help you put an end to armwrestling within your microprocessor systems.

The HP 1600S, at $7100*, is one of the biggest timesavers you'll ever find. You should learn more about it. HP has arranged a number of seminars around the country to make that possible. Find out how you can attend the one in your area by calling your local HP field engineer. He can also supply you with complete spec sheets and application notes detailing the use of mapping for troubleshooting minicomputer and microprocessor systems. You'll discover an exciting new concept in digital troubleshooting.

*Domestic U.S.A. price only.



086/6

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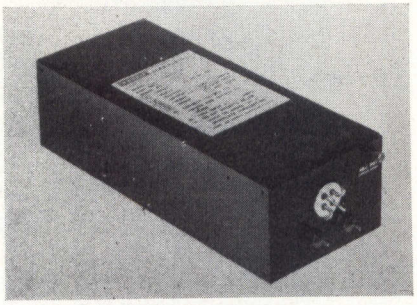
CIRCLE 63 ON INQUIRY CARD

PRODUCTS

POWER CONVERSION MODULE



Converting 115-Vac, 400-Hz input power to 50 W of regulated dc power at voltages ranging from 5 to 50 Vdc, UN50 series supplies operate over the −55 to 100°C mil temp range. Dc input voltages are regulated to 0.3% over the full input range of 115 Vrms ±10%. Load regulation is 0.5% for no load to full load at constant input voltage. PARD (ripple and noise) has been reduced to 25 mV rms, 100 mV pk-pk, over the 25 to 100°C temp range. The unit provides full rated output current over −55 to 85°C, derated to 80% of full load rating at 100°C. **Abbott Transistor Laboratories, Inc,** 5200 W Jefferson Blvd, Los Angeles, CA 90016.
Circle 212 on Inquiry Card

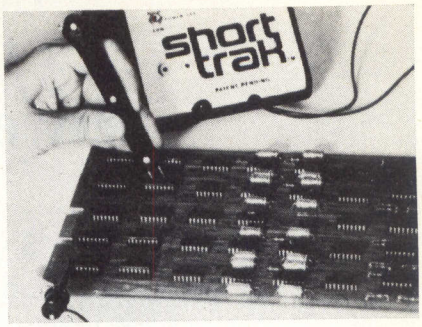
LINE DRIVER, RECEIVER CIRCUITS

For application in data communication and data terminal equipment, the 9636 line driver and 9637 line receiver meet EIA stds RS-422 and -423 as well as requirements of CCITT stds X.26 and X.27. A dual single-ended line driver, the 9636 provides TTL- and CMOS-compatible inputs. 9637 is a Schottky dual-differential line receiver that provides a TTL-compatible output. Both circuits are packaged in 8-pin mini-DIPs, and operate over mil and industrial temp ranges. **Fairchild Camera and Instrument Corp, Linear Integrated Circuits Div,** 464 Ellis St, Mountain View, CA 94042.
Circle 213 on Inquiry Card

PROGRAMMABLE CONTROLLER

Improved MC series offers expanded flexibility, functions, and capacity. Plug-in function modules allow each controller to be enhanced above basic architecture to exact level of performance needed for specific application. Six modules are mini-input/output, sequencer, fault isolator, press control monitor, scaler/quadrature detector, and multiple set-point counter which contains memory for storage of front panel entered preset, control point, and desired on-off control action. **FX Systems Corp,** CPO Box 818, 77 Cornell St, Kingston, NY 12401.
Circle 214 on Inquiry Card

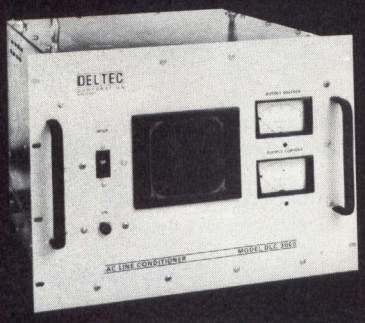
PCB SHORT TESTER



Short-Trak™ pinpoints exact location of etch or solder short on fully loaded printed circuit assembly, without damaging land areas or components. Unskilled operator can typically locate short in seconds, guided by dual-color LED indicator located on dual-tipped, spring loaded probe. Audible continuity tester is included, as well as long line cord. Heavy gauge, 2-tone aluminum chassis measures 9 x 4⅝ x 3". Total weight is 3 lb. **Digital Facilities, Inc,** PO Box 34834, Dallas, TX 75234.
Circle 215 on Inquiry Card

SYNCHRO/RESOLVER TO DC CONVERTERS

Converting 3ϕ synchro or 2ϕ resolver inputs into dc sine and cosine outputs at 400 conversions/s, with peak angular error of ±2 min., series SD-100 converters accept output of std 11.8- or 90-V 3-wire synchro, or 4-wire resolver, and provide two dc voltages: one corresponding to sine of rotor shaft angle, the other to cosine. Input is transformer isolated and balanced line-to-line. Synchro input quadrature is rejected. **Computer Conversions Corp,** 6 Dunton Ct, East Northport, NY 11731.
Circle 216 on Inquiry Card



ELIMINATE NOISE PROBLEMS WITH DELTEC'S

COMPUTER POWER CONDITIONER

5 KVA FOR LESS THAN $1,500

Only One Computer Power Conditioner Eliminates All Noise Problems.

Noise on a computer power line causes data and memory loss as well as mysterious crashes and errors. This noise can pass through voltage regulators and dedicated power lines.

Deltec DLC Series computer power conditioners eliminate noise and regulation problems. Unique shielding provides 120 dB (1,000,000:1) reduction for: Transients—Voltage Spikes—Ground Loops—Line Noise caused by RFI or EMI (radiated noise).

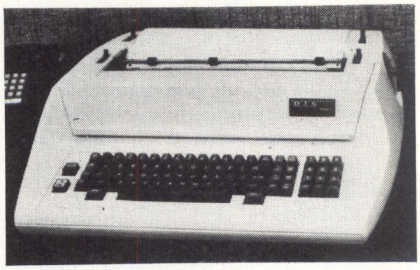
The DLC regulates voltage within 3% over a 30% input voltage range.

For more information, call or write:

DELTEC, 980 Buenos Ave.,
San Diego, CA 92110
Phone (714) 275-1331

DELTEC CORPORATION

HARD COPY DATA TERMINAL



DTC-302 Hy-Writer KSR uses the Diablo HyType II printer and a microprocessor controller to offer flexibility in data rate, error checking, and terminal interlock features. In either desktop or pedestal version, the unit is capable of 45-char/s print speeds. A buffer optimization and monitor technique allows the device to operate at optional data rates to 1200 baud. Other features include a long life ribbon cartridge, additional levels of print hammer intensity for better print quality, and ribbon out/paper out interlocks. **Data Terminals & Communications,** 1190 Dell Ave, Campbell, CA 95008.
Circle 217 on Inquiry Card

THE MATCHMAKER

Telefile introduces the only disk system flexible enough to match any minicomputer with any of the hot, new 3330-type drives. Big disk storage at a mini price.

Telefile now has available the most flexible large capacity disk system for minicomputers on the market today. The Matchmaker. It comes two ways:

As a disk system for users (DS-16-C) where we match your minicomputer with *any* of the latest 3330-type technology drives you want. Telefile supplies the complete package.

As an OEM disk controller. You can order just controllers alone (DC-16-C) and mix and match minicomputers and drives to satisfy your customer's whims and storage requirements.

Either way, disk system or controllers alone, you are assured of flexibility, performance features, and price no one else can match.

Each system stores up to 1.2 billion bytes.

You can match just the right drives to meet your storage capacity needs all the way from *13.3 million to 1.2 billion bytes per controller.* Each DC-16-C Matchmaker controller handles up to four drives. Minicomputers never had it so good.

Choose any of the latest drives.

You've seen them announced one-by-one and they're coming on strong. CalComp's Trident. Control Data's Storage Module. Diablo's 400 Series. The Ampex 9000's and Memorex 677's. Each builds upon IBM 3330 technology, which means higher storage densities and new circuitry for superior reliability.

To switch drives, simply change one controller circuit board. We've timed it at 63 seconds flat!

Compatible interfaces to eleven minicomputers.

We're designing a complete line of compatible interface boards to match up to many minis: Data General, DEC, Interdata, Keronix, D.C.C., Microdata, Honeywell, Lockheed, H-P, Varian, and Cincinnati Milacron. Simply fit our tailor-made computer interface module inside your computer chassis and you're in business. If you have another type mini, we'd be glad to design one for you.

Or you can design your own interface.

Your designers may want a piece of the action. Our general interface board makes it easy. Your board will tie in directly, bringing big disk storage to *any* 16-bit minicomputer.

A controller so small you can even hide it.

The Matchmaker is our smallest controller yet. It is totally self-contained right down to its power supply and cooling system. It's small enough to tuck away in a drive housing or in a rack above, below, or even *behind* the computer. Out of sight.

We'll even make you a faceplate.

If you want to show the Matchmaker off, we'll make a bezel to match your computer panel. Private label it and call it yours. There's no end to the flexibility.

Easy "front door" maintenance.

Five circuit boards slip right in from the front of the DC-16-C Matchmaker. A disk interface board, a general interface board, a command/timing board, a memory/address board, and an optional maintenance board for offline disk pack formatting and test exercising.

Unmatched features

- Contains 512-byte buffer for data rate matching
- Variable data search and read
- Block transfer of data up to mini-addressing capacity
- Offset positioning and data strobe controls
- Write protection to the sector level
- Sequential or staggered sector addressing
- Defective track relocation and alternate track addressing
- Overlapping seek capability
- Multi-sector operations across head and cylinder boundaries

We wrote the book on disk controllers, and you can get it free.

For years, we've helped minicomputer users grow their disk capacities. Now our Matchmaker system is a quantum leap forward. A new in-depth, hot-off-the-presses Matchmaker technical manual gives you all the facts. Write for it. Prove to yourself that this is one disk controller no one else can match.

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Please send me your Matchmaker book.
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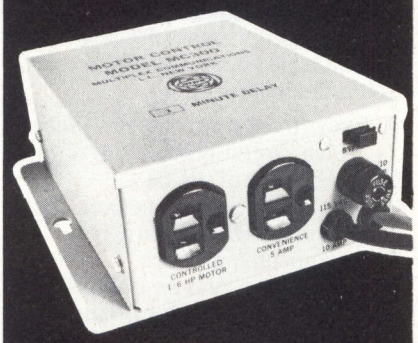

MC 300/350 FULL DUPLEX HALF DUPLEX MOTOR CONTROL

Do you own a Teletype Terminal?

If so, then ask yourself the following questions:

1. Does the terminal ever waste energy by running when it's not transmitting or receiving data?
2. What is the yearly maintenance bill on the terminal?
3. Am I willing to spend a nominal amount,* one time to *save up to 40%* or more of that *maintenance bill* every year?

The MC300/350 Motor Controls turn the terminal *on* when data is being sent or received and *off* when data stops. It thereby *prolongs the life of the terminal, reduces downtime, saves maintenance costs* and *saves energy.*

- Ideal for use on ASR and KSR Terminals.
- Excellent for computer applications.

* Price quote available on request. Call us today or write for our free brochure.

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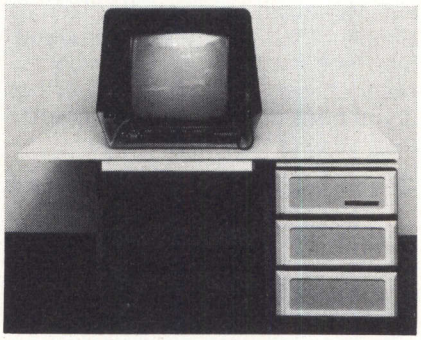
123 Marcus Boulevard
Hauppauge, New York 11787
(516) 231-5350

PRODUCTS

TRANSIENT VOLTAGE PROTECTORS

Expanded LVP series for low voltage dc circuits is designed for printed circuit mounting. Ten std models have preset clamping voltages from 6.2 to 51 Vdc. Devices provide nanosecond reaction to presence of overvoltages, clamping harmful transient voltages to safe levels with min of voltage overshoot. Shunt capacity is 15 μF; temperature range is -55 to 85°C. These 1-J units give peak power surge capability ranging from 5-kW peak at duration of 0.1 μs to 40 W peak at 10 ms. **Dale Electronics, Inc,** Dept 860, PO Box 609, Columbus, NE 68601.
Circle 218 on Inquiry Card

3D INTERACTIVE GRAPHICS DISPLAY SYSTEM

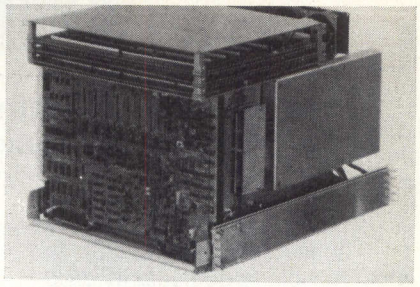


Direct-writing system capable of displaying 3D graphics and alphanumerics, and generating up to 20K 0.1" vectors at 30 Hz, the 3400 employs a proprietary vector generator unit which operates with buffer registers to minimize data access delay time. It features graphics processing unit (microprocessor) for data transformations. Std firmware includes perspective, windowing, clipping, and zooming. Other features include small-element discard, and VGAM (Vector Graphics Access Method) software. **Vector General, Inc,** 21300 Oxnard St, Woodland Hills, CA 91364.
Circle 219 on Inquiry Card

FAST A-D CONVERTERS

4130 family of 8-, 10-, and 12-bit binary converters features monotonic operation, excellent stability, and max nonlinearity of $\pm\frac{1}{2}$ LSB for 8 bits and ± 1 LSB for 10 and 12 bits. Conversion rates of 1.33 MHz for 8 bits (model 4130), 1 MHz for 10 bits (4131), and 0.285 MHz (4132) or 0.400 MHz (4133) for 12 bits are guaranteed. 4130 has 750-ns max conversion time. Monotonic operation is from 0 to 70°C for 8- and 10-bit units; 1 to 49°C for 12 bits. Units are stable over the full op temp range. **Teledyne Philbrick,** Allied Dr at Rt 128, Dedham, MA 02026.
Circle 220 on Inquiry Card

DRUM MEMORY SYSTEM



Random access head-per-track system interfaces with DEC PDP-11 minicomputer. Model 4401 drum memory, functionally equivalent to DEC RC11/RS 64 memory, has memory capacities up to 2M 16-bit words, and avg access time of 8.5 ms. All electronic and mechanical adjustments can be made from front, sides, or top of slide-mounted unit; there are no filters to change or clean. Unit fits 19" EIA or DEC racks and has panel height of 15¾" (40 cm). Operating temp range is 10 to 45°C. **Vermont Research Corp,** Precision Pk, North Springfield, VT 05150.
Circle 221 on Inquiry Card

1500-LINE/MIN. PRINTER

LP7000 prints at speeds from 1240 to 1500 lines/min. using 48-char set on 132 col. Other char fonts include 64, 96, or 128 char, ASCII or EBCDIC coded; numeric, alphanumeric, or symbolic. Fonts may be changed from 48 to 96 char, or from 64 to 128 char, by exchanging chain modules. Chain printer is available with "Grand Slam" configuration option, which prints 15 char/in. rather than 10 char/in., thereby providing 132 column output on 8½ x 10⅝" paper. **Potter Instrument Co, Inc,** 151 Sunnyside Blvd, Plainview, NY 11803.
Circle 222 on Inquiry Card

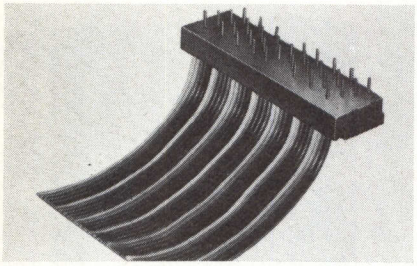
16-CHANNEL DATA LOGGER

Generating cassette tapes for later analysis on Wang Laboratory's 2200 series computers, 200W series accepts up to 16 channels of 0- to 10-V analog signals, converts them to binary digital data, formats the data, and writes them on std Philips cassettes. Plug-in circuit card construction provides versatility: by removing multiplexer and A-D converter cards, unit becomes digital recorder accepting 8 bits of parallel data; by adding input expander card, 40 bits of parallel data can be accepted. **Memodyne Corp,** 385 Elliot St, Newton Upper Falls, MA 02164.
Circle 223 on Inquiry Card

TRANSFER SWITCH

Containing 256 channels divided into eight sets of 32 channels/set, Transfer Switch, a mass switching device, allows any 32-line set to be selected to interconnect with any other set by application of straight binary address code. Simultaneous switching of all 32 lines is accomplished by LSI CMOS transmission gates; they are bi-directional/bilateral and pass 30 V pk-pk up to 1 MHz. Switch features complete address decoding and retention, and is compatible with any addressing system. **Counterscan Systems, Inc,** PO Box 536, E Hwy 6, Sutton, NE 68979.
Circle 224 on Inquiry Card

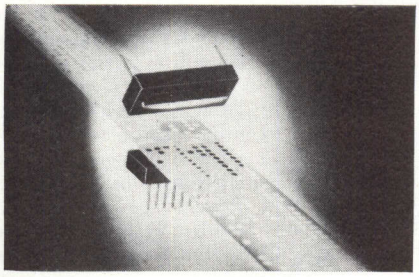
ROUND WIRE FLAT CABLE PCB CONNECTOR



CF006 series is intended for use with ribbon cable having 20, 26, 34, 40, or 50 round conductors on 0.050" centers. Termination is fast and simple since cable does not have to be stripped and all connections are made simultaneously. Connector features built-in strain relief. Assembly is by means of simple tool; pretwisted contact tines are forced through cable conductors to achieve multi-contact, secure connection. Reaction forces assure continued firm contact of tines against conductor. **CW Industries,** 550 Davisville Rd, Warminster, PA 18974.
Circle 225 on Inquiry Card

INFRARED LED LIGHT BAR

Packaged array of solid-state LED, complete and ready-to-use bars include reverse voltage blocking diode. Light level (min to max) is externally adjusted by user. Std is 1" length for 9-channel readers; custom lengths are available to user's specs. The low cost bars have solid-state reliability and cool operation, provide long trouble-free life, and are built to resist shock and vibration. There is a spectral match to silicon detectors. **Opto Technology, Inc,** 1001 E Touhy Ave, Des Plaines, IL 60018.



Circle 226 on Inquiry Card

TAPE LABEL PRINTER

Printer eliminates costly posting mistakes by replacing manual or semi-automatic methods of label preparation for computer tapes. At rate of 20 labels/min., unit automatically prints external labels, on line, whenever dismount message occurs for newly created output tape. Manual posting by the user is eliminated. Tape-labeling process is simplified; the operator dismounts tape, peels pressure-sensitive label from continuous form, and puts it on tape reel, assuring accuracy. **Scientific Measurement Systems, Inc, an Inductotherm Co,** 26 Olney Ave, Cherry Hill, NJ 08003.
Circle 227 on Inquiry Card

INCANDESCENT DISPLAY

The 7-segment Pinlites® MD-4 with ¼" char height is housed in mini-DIP package with 0.2 x 0.1" DIL pins. Display combines features of high contrast ratio of filament type displays with ultra-mini LED packaging. Package size is 0.312 x 0.375 x 0.275". MD-430, 3-V unit, draws 8 mA, delivering 1400 ft-L at rated voltage; 4-V MD-440 draws 12 mA and gives 9000 ft-L; and 5-V MD-450 is rated at 9000 ft-L and draws 12 mA. MD-430 can be ac or dc driven, multiplexed, and withstands military environments. **Refac Electronics Corp,** PO Box 809, Winsted, CT 06098.
Circle 228 on Inquiry Card

PORTABLE p/ROM PROGRAMMER

Fully automatic model VIII is designed specifically to meet requirements for field service and microprocessor applications. Programming is accomplished using keyboard, master ROM, or RAM-PAK™ memory cube as input data source. Operating features include hexidecimal keyboard, address and data displays, mode control switches with supporting indicators, and capability to select a special address or a data field using upper and lower address limits. Programming or verifying initiates the automatic sequence of illegal bit test—program—verify. **Data I/O Corp,** 1297 NW Mall, Issaquah, WA 98027.
Circle 229 on Inquiry Card

DISPLAY PANELS

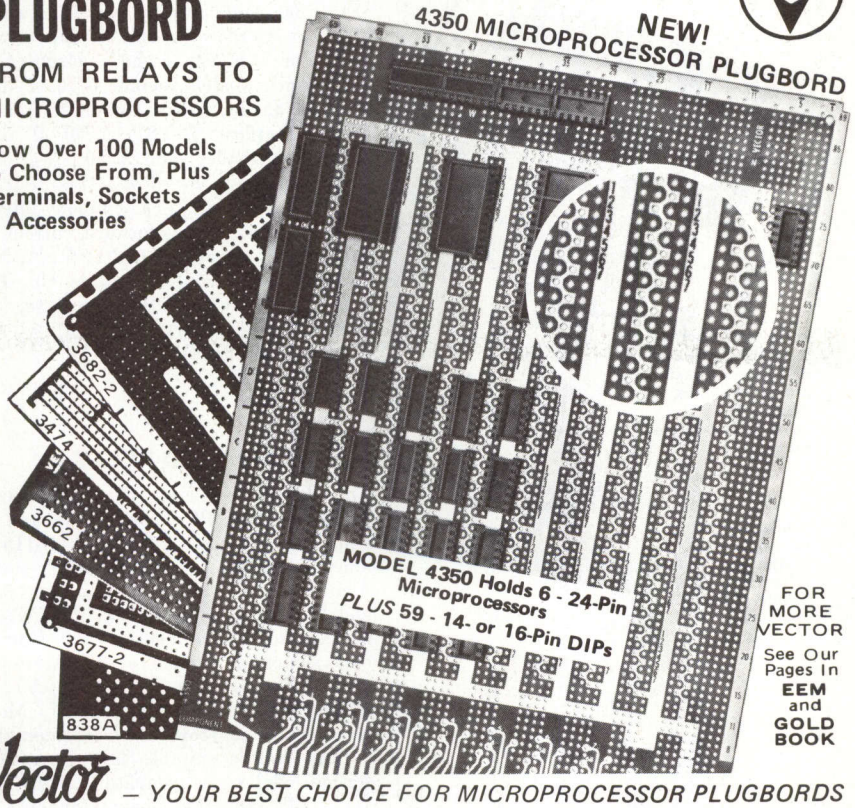
Nine models of DP-10 series display data in vertical, horizontal, rectangular, or square matrices presenting 10 to 100 points of data in ½ x 1" legend modules, and 20 to 100 legends in ½ x ½" modules. Options include choice of legends that are permanently visible, partially visible, or invisible when not illuminated; display film without legends, to add or change later as needed; and legends and symbols displayed in any of six colors, which can be changed easily. **Data Panel, Inc,** 7313 S Washington Ave, Edina, MN 55435.
Circle 230 on Inquiry Card

MOUNT ANYTHING ON A VECTOR PLUGBORD —

FROM RELAYS TO MICROPROCESSORS

Now Over 100 Models to Choose From, Plus Terminals, Sockets & Accessories

NEW! 4350 MICROPROCESSOR PLUGBORD



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Vector — YOUR BEST CHOICE FOR MICROPROCESSOR PLUGBORDS

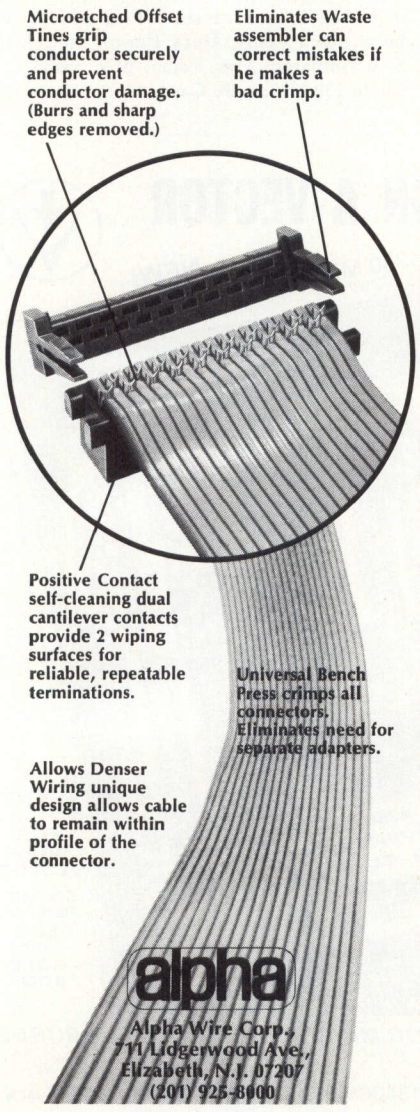
ELECTRONIC COMPANY, INC.
12460 Gladstone Avenue, Sylmar CA 91342 (213) 365-9661 - TWX (910) 496-1539 46476

New ideas from a new source for flat cable and connectors

The source: Alpha Wire, one of the oldest full-line wire and cable manufacturers.

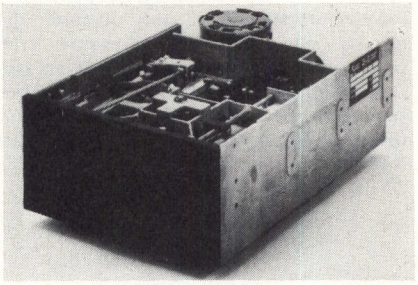
Our cable is compatible (matches all flat cable connectors designed for 0.050 in. conductor spacing). It has excellent teardown characteristics, is ultra-flexible, and UL listed. Exclusive footage indicator on the reel shows how much cable is left.

Our complete line of connectors (female sockets, headers, DIPs and PCBs) also offer some new ideas:



PRODUCTS

DOUBLE DENSITY FLOPPY DISC DRIVE



Featuring versatile design configuration for easy system integration, in double density, RFD 1000 provides up to 6.4M bits of data storage with MFM encoding recommended. Transfer rate is 500K bits/s. Single density (up to 3.2M bits) data storage with transfer rate of 250K bits/s is possible. Format and media are user selectable. Unit is IBM compatible, accepting 3740 formatted and 32-hole hard sectored diskettes. Drive features "enhancement" status connector, maximizing efficiency and flexibility in daisy-chain configurations. **Remex Div of Ex-Cell-O Corp,** 1733 Alton St, Santa Ana, CA 92705.
Circle 231 on Inquiry Card

RED LED DISPLAY

With two 0.6" digits on a single module, MAN6700 configurations provide two full digits or overflow capability, and common anode or common cathode electrical requirements. Models include 6710—2 digits, common anode; 6730—1½ digits, common anode, overflow (±1.8); 6740—2 digits, common cathode; and 6750—1½ digits, common cathode, overflow (±1.8). All have right-hand decimal. Typ luminous intensity is 500 μcd at 20-mA forward current, 210 μcd at 10 mA, and 125-μcd at 5 mA. **Monsanto Commercial Products Co, Electronics Div,** 3400 Hillview Ave, Palo Alto, CA 94304.
Circle 232 on Inquiry Card

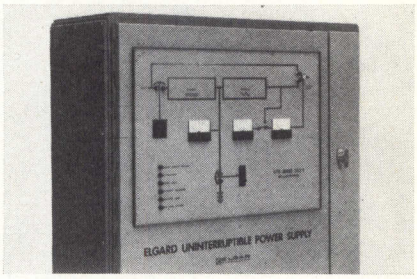
3-POLE DIP REED RELAY

An addition to series 83 line, relay reduces required PC board space and per-pole cost. It uses std 8-pin TO-116 terminal grid to fit all std DIP sockets. Available coil voltage ratings are 5, 12, and 24 Vdc. Contact rating is 10 W, with max switching voltage of 100 Vdc and max switching current of 0.5 A. Coil resistance values are 150 Ω (5 V), 450 Ω (12 V), and 750 Ω (24 V). Molded epoxy package provides environmental immunity and is suitable for automatic insertion. Relay is compatible with RTL, DTL, TTL, and HTL logic. **Gordos Corp,** 250 Glenwood Ave, Bloomfield, NJ 07003.
Circle 233 on Inquiry Card

SILICON VOLTAGE REFERENCE CHIPS

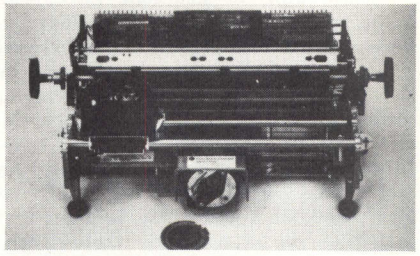
Unencapsulated chips feature long term stability and have controlled tempcos at currents as low as 500 μA. Mechanically, they are of rugged 1-piece construction, and are meant to be either eutectically bonded or attached with conductive epoxy pastes to substrate material. Anode metallization is aluminum, facilitating either gold thermo-compression or aluminum ultrasonic bonding. Chips can be supplied with ribbon leads for applications requiring solder attachments. **Codi Corp,** Pollitt Dr, Fair Lawn, NJ 07410.
Circle 234 on Inquiry Card

5-kVA UNINTERRUPTIBLE POWER SYSTEM



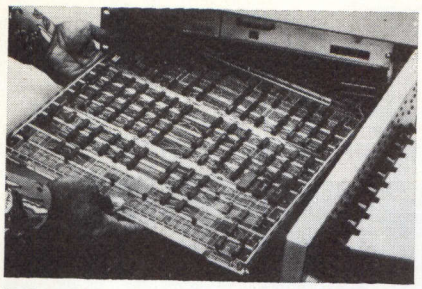
Combining battery charger, battery bank, solid-state inverter, and bypass switch, the 502-1 provides clean continuous power to critical loads. Battery charger converts ac line power to dc, which normally float-charges the battery bank and powers the inverter. On loss of input ac, the inverter continues to furnish the critical load with uninterruptible ac power by drawing energy from the battery bank. Dimensions of the unit are 60.5" high x 43" wide x 17.5" deep; weight is 1200 lb. **Elgar Corp,** 8225 Mercury Ct, San Diego, CA 92111.
Circle 235 on Inquiry Card

WORD PROCESSING PRINTER MECHANISM



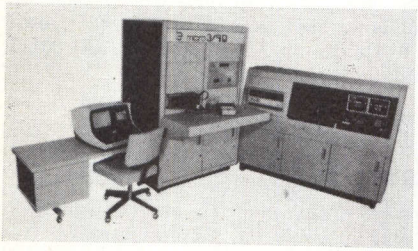
Model 1355WP, totally ASCII compatible and offered with a std HyType II interface, is a HyType mechanism improved to provide better char registration through increased hammer energy. It is offered with a selection of 16 type styles on steel-clad daisy printwheels, which assure finer print quality than conventional plastic printwheels. Cartridge-loaded ribbons for the unit include multistrike film, cloth (in black and red/black), and single-strike carbon types. **Diablo Systems Inc, a Xerox Co,** 24500 Industrial Blvd, Hayward, CA 94545.
Circle 236 on Inquiry Card

MICROPROGRAMMABLE PROCESSOR



Enhancing computing power of any Nova™ type computer, Micro-N provides microprogramming capability, implementing user-defined, procedure-oriented macros. The device occupies one slot in the computer chassis and includes high speed processor with four accumulators, up to 4K words of p/ROM to hold microprograms, and up to 64 words of RAM for temporary scratchpad storage. The processor is driven by a 20-MHz clock, and most operations take only 100 ns, including instruction fetch and execution. **Educational Data Systems,** 17981 Sky Park Circle, Irvine, CA 92707.
Circle 237 on Inquiry Card

MICROPROCESSOR TEST SYSTEM



A multi-test-head/multi-terminal system, the Micro 3/90, in std configuration, is an 80-pin system capable of simultaneous megahertz data rates on all pins. Incorporating minicomputer, 96K bytes of core memory, and dual 5M-byte disc, system covers digital testing requirements, including high speed testing of PC boards containing microprocessors, and other types of LSI circuits. System includes high speed digital test capability and ATLAS language-controlled analog test hardware. **Instrumentation Engineering, Inc,** 769 Susquehanna Ave, Franklin Lakes, NJ 07417.
Circle 238 on Inquiry Card

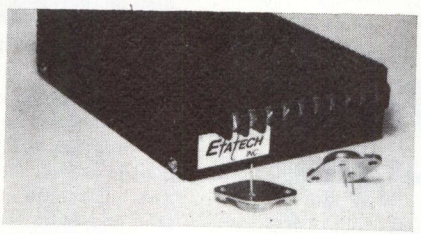
DIGITAL MATRIX SWITCH

EIA RS-232 8 x 8 switch provides connection flexibility, fallback switching, and monitoring for complete digital interface management between eight modems, eight online terminals (or computer ports), and eight standby terminals (or ports). Device combines functions of 8 x 8 crosspoint matrix, 8-channel fallback switch, and digital patch/monitor panel in one package. For each channel, switch handles full-duplex EIA RS-232 interface, including data and control leads (15 leads total). **Cooke Engineering Co,** 900 Slaters Lane, Alexandria, VA 22314.
Circle 239 on Inquiry Card

MINICOMPUTER DATA PROCESSING SYSTEM

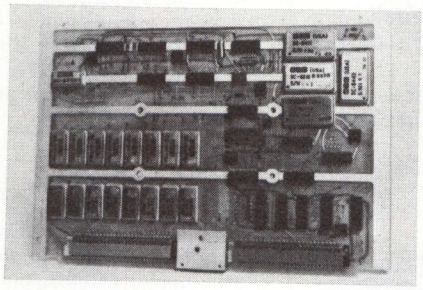
ACE-000/40 control system consists of Texas Instruments' 16-bit minicomputer with 8K of semiconductor memory, including 98 basic instructions, double-precision arithmetic instructions, and I/O control boards for special applications. Tri-Data dual deck digital recorder reads and writes 250K 16-bit words on self-contained tape cartridges. TEC-450 computer-controlled video terminal provides system control and special features. Output "hard copy" is obtained with Centronics 306 matrix printer. **Automation Control Engineering,** PO Box 11709, Winston-Salem, NC 27106.
Circle 240 on Inquiry Card

SWITCHING POWER SUPPLIES



Patented Univerter™ power transfer circuit has been combined with practical packaging techniques to produce fully regulated series B (B5R00S10) module, which provides 5 V at 10 A, and features 70,000-h MTBF at 80°C baseplate, 75% min efficiency, remote sensing, and complete overload/short circuit and overvoltage protection. B12R0S5, 12 V at 5 A, and B15R0S4, 15 V at 4 A, operate over a 95- to 130-Vrms, 47- to 440-Hz, single-phase line range and provide ±10-mV max line regulation, 10-mV load regulation, and 250-μs transient response. **Etatech, Inc,** 187-M W Orangethorpe Ave, Placentia, CA 92670.
Circle 241 on Inquiry Card

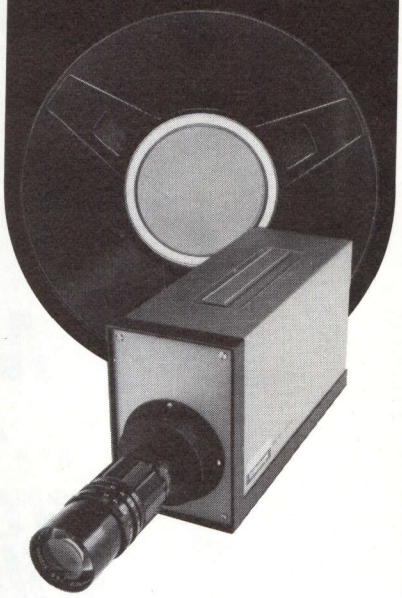
PLUG-IN S-D CONVERTER



CAT 6325 is 14-bit, 8-channel, multiplexed converter which plugs directly into AN/VYK-19 Rugged Nova mainframe. Containing all I/O logic, unit is compatible with most programming methods (eg, priority chain, program interrupt). Three different references are accommodated; it can be expanded to 32 channels. Features include simultaneous sampling, 150-μs conversion time, ±6-min. worst case accuracy over temp (−55 to 105°C), and integral cold plate thermal design. **ILC Data Device Corp,** Airport International Plaza, Bohemia, NY 11716.
Circle 242 on Inquiry Card

EMR OPTICAL DATA DIGITIZER

PROVIDES DIRECT COMPUTER INPUT FROM A VISUAL SOURCE



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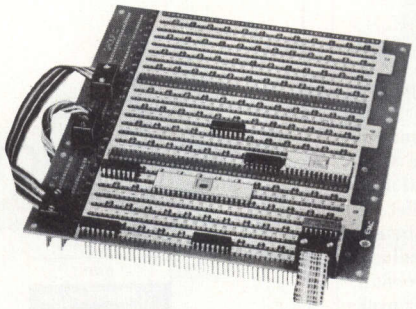
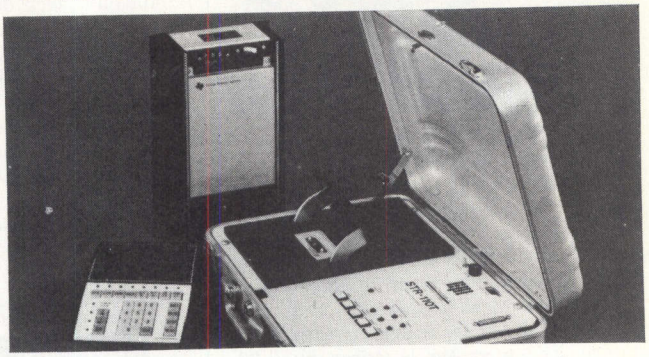


EMC

Interconnection Specialists

PRODUCTS

PORTABLE CASSETTE PROGRAM LOADER



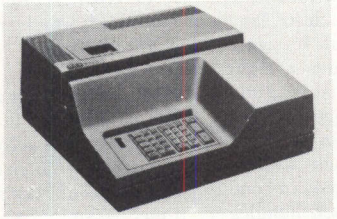
Directly compatible with TI's 5TI programmable control system, the STR-110T can load those sequencers in as little as 4 s. Initial programs are loaded into the sequencer's memory using the 5TI programmer. Permanent records can be made by plugging the program loader into the sequencer's auxiliary port and pushing the read-memory switch. The loader automatically records program data onto cassette tapes—up to 8192 16-bit words per 50-ft tape and more than 100K bits on each side of a 300-ft data cassette. To program a sequencer, the loader is plugged into the connector and the enter switch is pressed. Loading time is 4 s for a 256 x 16 memory, 16 s for 1024 x 16, plus 8 s to clear the tape leader. Bit error rate is <1 hard error in 10^8 bits. **Electronic Processors, Inc,** 1265 W Dartmouth Ave, Englewood, CO 80110.
Circle 243 on Inquiry Card

CARTRIDGE TAPE SYSTEM

DataPacer magnetic tape system is completely interfaced to PDP-8/E and -11, ready to plug-in. Using the 3M data cartridge, the unit can store 2.8M bytes on a 4-track cartridge. Construction is modular, with three drives across in the 19″ rack. The device reads and writes at 30 in./s, with a transfer rate of 48K bits/s. Searches and rewind, backward or forward, occur at 90 in./s. Each module has its own switch panel for track selection, online/local selection, and offline rewind. Tape position indicators show the mode and position of each module at any given time during data operations. Software includes load and dump routines, DEC operating system drivers, keyboard utilities system, interpretive language I/O library routines, and diagnostics. **Tennecomp Systems Inc,** 795 Oak Ridge Tpk, Oak Ridge, TN 37830.
Circle 244 on Inquiry Card

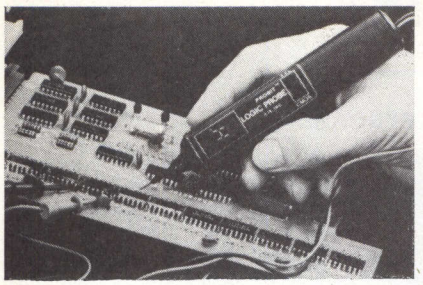
DESKTOP DOCUMENT ENCODER

Microprocessor-based 7740 utility encoder provides encoding for all fields on documents in either MICR or OCR fonts. The 7740 proof encoder, incorporating a journal printer and four totals including an adding-machine feature, can be used as a utility encoder as well as for low-volume proof applications. Key to device flexibility is its programmable read-only memory which allows the user to specify field formats, type fonts, and other variables. Each field may contain up to 16 char, with a limit of 70 per line. Operator may enter any or all fields for encoding. An automatic field entry feature allows an entire field to be encoded by depressing a single preprogrammed key. **NCR Corp,** Dayton, OH 45479.



Circle 245 on Inquiry Card

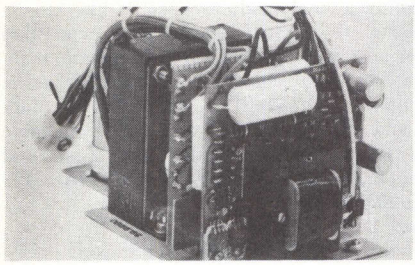
LOGIC PROBE



Testing both TTL/DTL and CMOS logic systems, Probit can detect pulses down to 30 ns, and can accurately check valid and abnormal logic levels. No loading is added to circuit under test due to probe's high input impedance (200 kΩ). Protection against over-voltage inputs is provided along with reverse voltage protection to 100 V. Seven segment display indicates "H" for logic high, "L" for logic low, and a "period" for pulse detection. Display is blank for abnormal logic level. **Control and Information Systems, Inc,** 10 Spring Valley Village, Richardson, TX 75080.

Circle 246 on Inquiry Card

18-W UNINTERRUPTIBLE POWER SYSTEM



Controlling up to 18-W power and providing five output voltages: 1.8 A/5 V ±0.3%, 0.3 A/−14 V ±0.3%, 0.6 A/15 V, 0.03 A/26 V, and 0.4 A/1.7 Vac, the low cost UPS permits the number of outputs and specific voltages and currents to be readily modified, within a total output power of 18 W. Backup may be provided by any 12 V/18 A-h lead-acid or gel-cell battery. Complete on a 4 x 4 x 8" open-frame chassis, the unit features a precision power supply/charger circuit. **Elexon Power Systems,** 3131 S Standard Ave, Santa Ana, CA 92705.

Circle 247 on Inquiry Card

DC POWER SUPPLIES

Black Knight line EAPS series modular OEM supplies operate from 115/230 V, 47 to 420 Hz ac line. Units are available in ratings of 5 V at 10 A, 12 V at 7 A, 15 V at 6 A, 24 V at 5 A, and 28 V at 4 A. Voltage adjustment is ±5% and the units are regulated ±0.1% for line and load. Ripple is 1 mV rms. Protection features include automatic foldback current limiting, overload and short circuit protection, IC regulator protection, reverse polarity protection, and inductive load protection. **Adtech Power, Inc,** 1621 S Sinclair St, Anaheim, CA 92806.

Circle 248 on Inquiry Card

MEDIUM SPEED A-D CONVERTER FAMILY

High resolution model A-855-13 converts 13 bits in 25 μs; the -14 converts 14 bits in 30 μs. A form of successive approximation is used to convert seven uni- and bipolar voltages to user-selected digital output codes. The low profile modules require no external adjustments or components to meet rated specs from 0 to 70°C. Busy output is provided with a fanout of five TTL loads for system synchronization with multiplexers, sample/holds, and output registers. **Intech/Function Modules Inc,** 282 Brokaw Rd, Santa Clara, CA 95050.

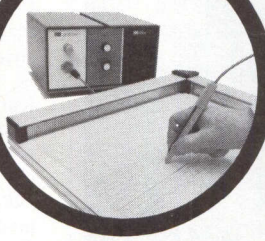
Circle 249 on Inquiry Card

BUS CONVERTER

Allowing conversion to LSI-11 and PDP-11/03 computers without redesigning PDP-11 controllers already in use, the 10001 Univerter, offered as an LSI-11 option, converts the LSI bus to a Unibus™ structure and permits full bidirectional communication between the two. A pseudo-status register returns control to the user over all four Unibus interrupt levels, and an extended memory map provides a virtual memory scheme that extends addressing to 512K words. **Able Computer Technology,** 1538-E E Chestnut St, Santa Ana, CA 92705.

Circle 250 on Inquiry Card

Super. because it's sonic



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It's the supersonic digitizer. It uses sound as its ranging medium. Which makes it more flexible to use. And more reliable.

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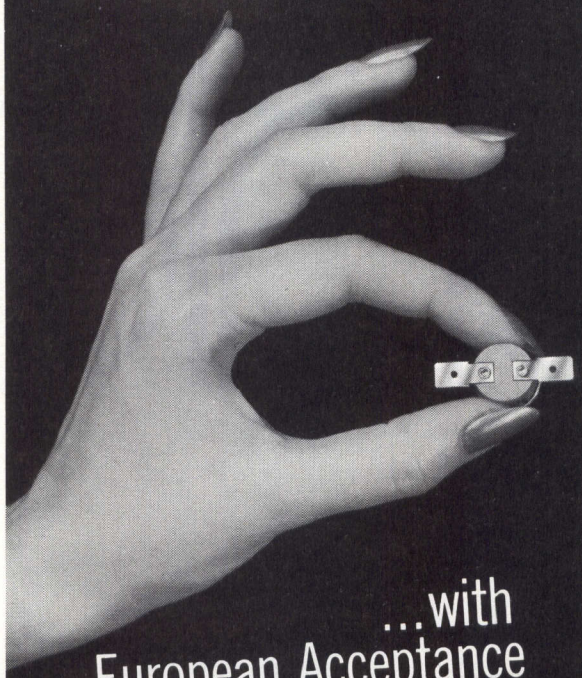
CIRCLE 70 ON INQUIRY CARD

New Hi-Temp Thermostat



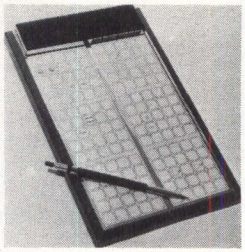
...with European Acceptance

Ideal for a variety of high temperature applications! Elmwood's new snap-action RC thermostats include a glass-bonded mica (ceramo-plastic) base that allows set points to 550°F (290°C). The patented metal sleeve insert and rivet construction permit listings by European agencies as well as U.L. and C.S.A. The RC's are SPST, pre-set, tamperproof, and available with mountings, terminals and brackets to suit. Want more? Call or write Elmwood Sensors, Inc., 1659 Elmwood Ave., Cranston, R. I. 02907. Phone 401/781-6500. European Div., Elmwood Sensors Ltd., North Shields, England.

ELMWOOD SENSORS

PRODUCTS

MULTIFUNCTION KEYBOARD

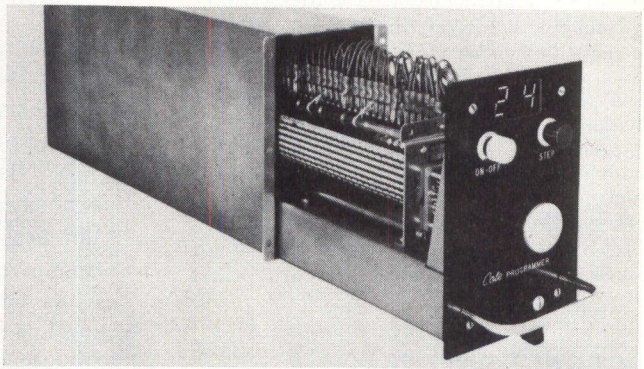


Extending capabilities of the Auto-Draft™ interactive design and drafting system, the ACTEC keyboard provides a human-engineered keyboard library of symbols and system commands. By depressing the appropriately coded key, the operator can call any user-defined symbol or system command from the system's memory for insertion in the drawing. Extending or replacing the system's menu, the keyboard provides capability for 150 symbols. Each digitizer input station will handle multiple keyboards allowing a wide range of library choices. The device is readily detachable and completely interchangeable between digitizers, allowing users to develop symbols and commands tailored to a particular application and to interchange keyboards among digitizers as required. **Auto-trol Corp,** 5650 N Pecos St, Denver, CO 80221.
Circle 251 on Inquiry Card

LOGIC ANALYZER WITH HARDCOPY OUTPUT

Logicorder 8, a compact plug-in unit, provides direct 8-channel readout of logic timing diagrams from an integral miniaturized stripchart recorder. It also has an oscilloscope output that can be used independently or simultaneously with the hardcopy feature. Designed to occupy a dual module space within a Tektronix TM 500 mainframe, the unit is completely compatible electrically and mechanically with the 500 system. Features include 10-MHz sample rate on eight channels at 256 bits/channel (40-MHz sample rate on two channels in a 1024-bit memory mode), scope output, and full 8-bit word trigger. Switchable data resolution provides the user with a detailed look at the total timing waveform on the hardcopy output. **Scanoptik Inc,** PO Box 1745, Rockville, MD 20850.
Circle 252 on Inquiry Card

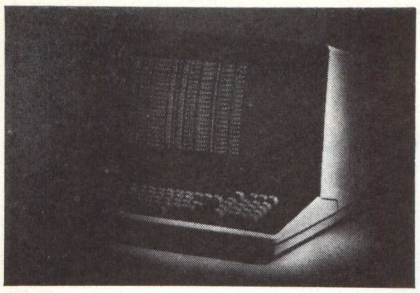
PLUG-IN PROGRAMMER



Process control package can be completely replaced in 15 s to minimize process downtime. A stepping-switch/drum programmer is mounted on a drawer assembly and prewired to a zero-force connector at the rear of the drawer. The drawer slides into a panel-mounted case, with a mating connector at the back end. A lever on the front of the drawer releases the connector, allowing it to be withdrawn for easy program changes or complete replacement. Units can control 30 solenoid valves, timers, or other electrical devices through a 24-step sequence; a digital readout indicates the program sequence in process. Rotating drum assembly of the stepping switch can be furnished with any number of individual drum sections, each having 24 snap-up programming tabs built into its periphery, which actuate enclosed 5-A load switches. **Cole Instrument Corp,** 2034 Placentia Ave, Costa Mesa, CA 92627.
Circle 253 on Inquiry Card

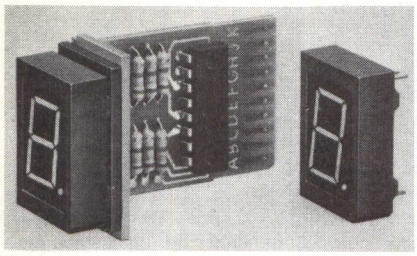
CIRCLE 71 ON INQUIRY CARD

CRT TERMINAL WITH U/LC DISPLAY



Offering 20-line x 50-char format with 96-char ASCII code set, 2050 terminal is available in KSR and RO versions. Written on 7 x 9 dot matrix in 10 x 12 dot field, characters measure approx 0.13 x 0.25" on 14" diag screen. Command functions include erase screen, line feed, and carriage return. Cursor positions are right, left, up, down, home, and X-Y positioning. Std KSR version has RS-232 interface; baud rates are 110 through 9600. RO terminal has parallel TTL interface at up to 1200 char/s. **Ann Arbor Terminals, Inc,** 6107 Jackson Rd, Ann Arbor, MI 48103.
Circle 254 on Inquiry Card

HIGH BRIGHTNESS LED READOUT



With char height of 0.600", 730 series provides low powered 7-segment GaP red readout with decimal point (model 730-6001) that draws ≤10 mA/segment and operates with std IC power supply levels. Digit is visible from 35 to 40 ft, having high contrast ratio and wide viewing angle. Design maximizes package density and includes filter for contrast enhancement. 730-6007 consists of GaP readout mounted on PC board, complete with current-limiting resistors and decoder/driver. **Dialight, a North American Philips Co,** 230 Harrison Pl, Brooklyn, NY 11237.
Circle 255 on Inquiry Card

SINGLE TRACE OSCILLOSCOPE

With bandwidth from dc to 5 MHz, instrument features conveniences found in high-priced test equipment. Triggered sweep and pushbuttons enhance ease of operation. Standard on the model 5040 is one touch TV-V mode. Sensitivity of the vertical deflection system is 20 mV/cm; horizontal deflection system provides sweep range from 1 μs/cm to 10 ms/cm. **Dumont Oscilloscope Laboratories, Inc,** 40 Fairfield Pl, West Caldwell, NJ 07006.
Circle 256 on Inquiry Card

6250 BIT/IN. TAPE TRANSPORT

Packaged in a 19 x 24.5" OEM configuration, 3400/3600 series transports provide tape speeds ranging from 45 to 125 in./s, with data transfer rates from 36K to 781K bytes/s. Both long (0.6") and short (0.3") gap operation is accomplished with no program restrictions. The package incorporates technical breakthroughs in tape path, reel servo, and capstan control design (patents are pending), which permit high performance in the compact size. **Gulliver Technology Corp,** 1728 21st St, Santa Monica, CA 90404.
Circle 257 on Inquiry Card

POWER DARLINGTON TRANSISTORS

In 100-, 150-, and 225-W power levels, units are said to be the only 200°C operating junction temp transistors available. All are true hermetic sealed, and continuous duty. 100- and 150-W units are resistance-welded; 225-W units, solder constructed. Features include thermal resistance of 0.67°C/W; second breakdown current ($I_{s/b}$----SOA); leakage current stability at 200°C junction temp, I_{cer} 5 mA; and higher current gain vs collector current, h_{FE} of 1000 at 4, 6, and 10 A. **Lambda Electronics,** 515 Broad Hollow Rd, Melville, NY 11746.
Circle 258 on Inquiry Card

TERMINAL SYSTEMS DIVISION
CAMBRIDGE, OHIO

DIGITAL LOGIC DESIGN ENGINEERS

To design complex state-of-the-art logic circuits Point-of-Sale including initial design, prototype construction, initial checkout and manufacturing follow-up. Applicants should be experienced in one or both of the following specific areas:

1. **Logic design involving microprocessors, and associated LSI devices.**
2. **Logic design of memory systems involving NMOS RAMS.**

In addition, expertise or background should include some of the following areas: microcomputer applications, minicomputer design, computer I/O controller design, OCR interface design, and high speed logic design.

Candidates should have a BS/MS degree or equivalent plus 3-6 years experience in the above areas.

LOGIC DESIGN

Point-of-Sale-Terminals Next Generation

Will perform logic design of peripheral and I/O circuits and plan/design electronic interface from peripheral and I/O devices to microprocessors.

Should possess diversified experience in digital logic design with emphasis on signal processing techniques and a broad knowledge of digital hardware. Should have knowledge of timing, coding/decoding, formating, data transfer and control logic including worse-case analysis. An engineering degree and 4-7 years design experience.

This is a more senior level professional position with good visibility and excellent growth opportunity, situated in an attractive, rural east central Ohio community.

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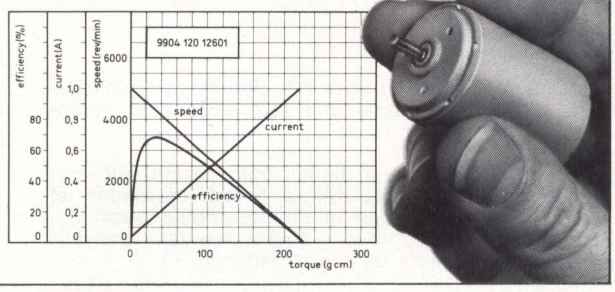

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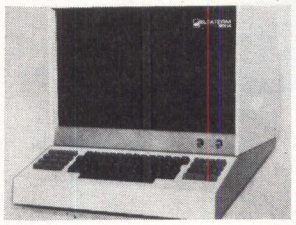
PRODUCTS

MICROPROCESSOR-BASED COMPUTER TERMINAL



An alphanumeric display, incorporating an LSI microprocessing unit, the Eltaterm 8504 presents letters, numbers, and symbols entered from the operator's keyboard or received online from remote computer or data communication terminal on a CRT screen. Display monitor consists of CRT tube and electronic control circuits; effective screen size is 9.5 x 7.0". Memory stores all displayed char and refreshes them to provide a flicker-free image. Data can be read from memory for online transmission to remote computer or terminal, or for transmission to an auxiliary storage device or printer. Typewriter-like keyboard contains 52 alphanumeric and 24 special keys; controller electronic circuits provide sequence, timing, and operational signals; and communication interface matches speed and data structure of the terminal with those of the computer. **Elta Electronics, Ltd,** c/o Commodore Aviation, Inc, 505 Park Ave, New York, NY 10022.

Circle 259 on Inquiry Card

MAGNETIC TAPE—DIGITAL LOGIC INTERFACE

The MC3467 preamplifier actually contains three independent preamps, each with an electronic gain control input; the MC3468 read amp is a subsystem which, when used with the preamp, provides the interface between magnetic tape heads and digital logic. Preamps have differential inputs and outputs, allowing operation in balanced systems. Typ bandwidth is 15 MHz; gain control range is from essentially 0 to approx 100 V/V. Devices may be used in combination or the read amp alone for open reel and cassette cartridge tape systems. Read amp LSI circuit performs active differentiation, peak detection, and threshold detection functions for NRZI, PE, and GE recording formats. Gain can be set between 0 and 7.5 V/V; bandwidth is 15 MHz. Both devices are packaged in 18-pin plastic DIPs. **Motorola Semiconductor Products, Inc,** PO Box 20294, Phoenix, AZ 85036.

Circle 260 on Inquiry Card

PORTABLE DATA COLLECTION AND ENTRY SYSTEMS

Completely self-contained, including solid-state memory, Ni-Cad battery pack, keyboard, and LED display, Infopac terminals are rated at 15,000-h MTBF. Model I½ weighs only 3 lb. Memory has 4K-char capacity std and can be expanded up to 64K within the terminal. Battery pack provides 10 h of continuous operation, and can be removed and replaced in the field. Data in memory are protected against loss by an integral, second battery with associated retention circuitry that automatically takes over during battery changes or if power is depleted. Data can be entered using an optical wand-type reader for std bar codes, or from the keyboard. Memory is accessible, forward or backward, allowing the operator to put any unit record on display at any time. **AzurData Inc,** 1305 Mansfield Ave, Richland, WA 99352.

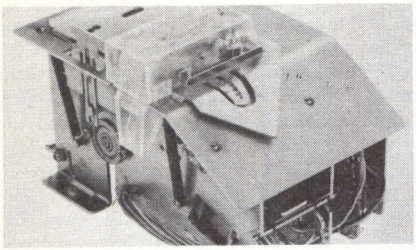
Circle 261 on Inquiry Card

PROCESS COMPUTER

Model 340, hardware and software compatible with other model 300/16-bit systems, uses virtual addressing via high speed associative memories. Main memory expansions of up to 512K words are possible. High computing capacity of CPU is obtained with list of 321 instructions, including complete fixed-point and floating-point arithmetic. High system throughput is result of simultaneous operation between CPU and I/O processors. Ultra-fast buffers (cache memories) increase processing capacity. **Siemens AG,** Postfach 3240, D-8520 Erlangen 2, Federal Republic of Germany.

Circle 262 on Inquiry Card

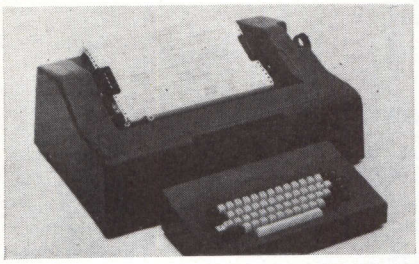
PAPER TAPE PUNCH



Model 6110 features 4 x 4 x 6" size and rugged construction. A brushless dc motor contributes high reliability and low power consumption. The solid-state transistorized motor provides power for all tape-feed operations, allowing trigger magnets to perform triggering only. Operating at 50 char/s, the device is adjustable to accommodate five, six, or eight channels of 1, 7/8, or 11/16" ANSI std paper tape. Control circuit requirements are easily integrated into data I/O peripherals. **Epson America, Inc,** 2990 W Lomita Blvd, Torrance, CA 90505.

Circle 263 on Inquiry Card

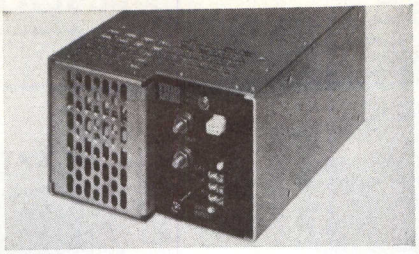
MEDIUM SPEED MATRIX PRINTERS



Plotter version of the series 900 printer allows a dot to be printed anywhere on the paper with horizontal resolution of 60 dots/in. and vertical resolution of 72 dots/in. Features include horizontal and vertical tabulation, forward and reverse 1/6-, 1/2-, or full-line feed, expanded char, internal 320-char buffer, and controllable automatic line feed from carriage return. Printer is available as KSR or RO terminal with switch-selectable rates of 110, 300, and 1200 baud. **Applied Computing Technology, Inc,** 17961 Sky Park Circle, Irvine, CA 92707.

Circle 264 on Inquiry Card

SWITCHING POWER SUPPLY



With power/unit volume up to 2 W/in.^{3}, 682 series can operate at full load for 20 ms after ac power is cut off, and delivers full load with input line voltages as low as 95 Vac (or 188 Vac). Various models provide dc output voltage from 2 to 48 V. Typ efficiency of 750-W, 5-V unit is 75%, increasing with higher voltage versions. Output regulation is ±0.2% for worst combination of line and load. Spikes and conducted interference have been virtually eliminated. **Trio Laboratories, Inc,** 80 Dupont St, Plainview, NY 11803.

Circle 265 on Inquiry Card

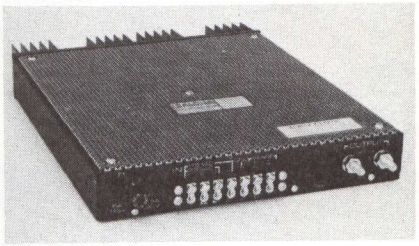
DC SERVOMOTORS

High torque model 6083-103, measuring 1.555 dia x 2.380 long, has stall torque of 23.8 oz-in. when excited with rated voltage of 24 V. Current at stall is 4.0 A; no load speed is 5050 rpm. Modifications in windings and mag circuit provide several other ratings as std. Either self-aligning sleeve or ball bearings are available. Replaceable brushes are a std design feature. The unit is available with integral dc tachometer where velocity feedback is necessary for close control. **Transicoil, Inc, Commercial Products Div,** Worcester, PA 19490.

Circle 266 on Inquiry Card

SWITCHING POWER SUPPLY

Low profile Flat-Pak 250 series, measuring 9 x 12 x 1½" high, is available in ratings of 5 V at 50 A, 12 V at 21 A, 15 V at 17 A, 20 V at 13 A, and 24 V at 11 A. Convection-cooled units feature full rated output at 40°C without base-plate cooling. Specs include wide range dual input of 98 to 132/196 to 264 Vac at 47 to 63 Hz, regulation of ±0.075% max, ripple and noise spikes of 50 mV pk-pk max, typ efficiency of 75% foldback current limiting, and remote sensing. **Alpha Power Inc,** 9020 Eton Ave, Canoga Park, CA 91304.



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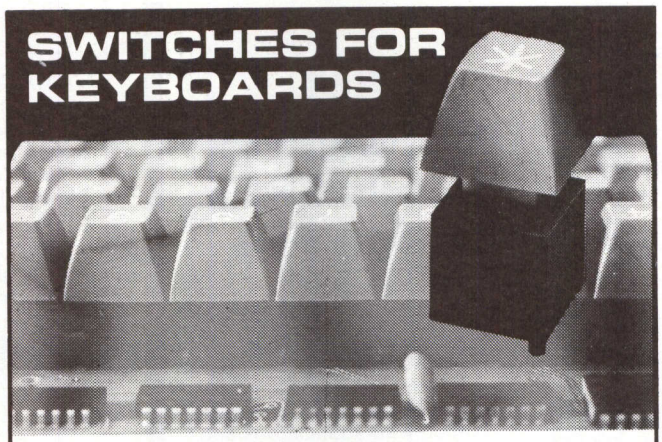

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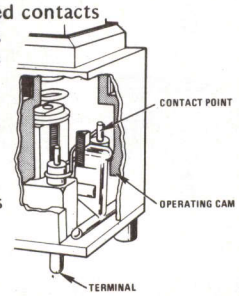

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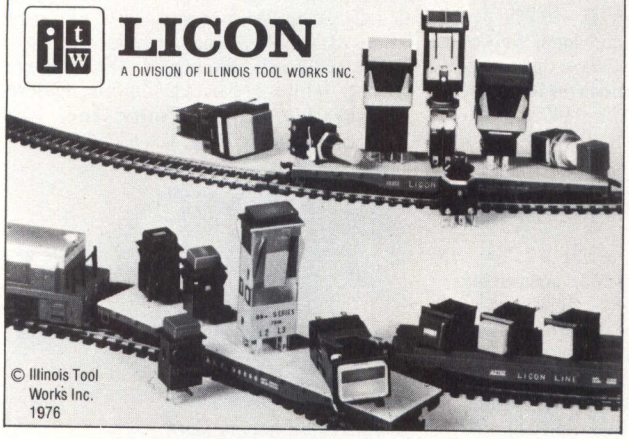

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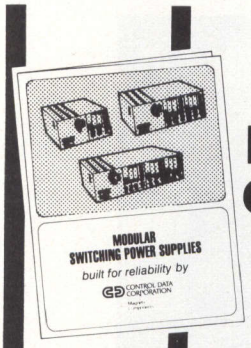
CIRCLE 75 ON INQUIRY CARD



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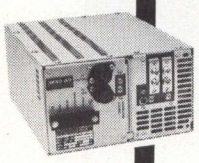

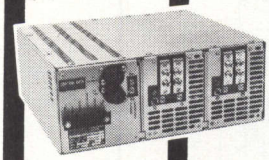

These compact, modular power supply switchers simplify design in 300-600 watt applications and keep costs down too. (They're priced at less than 90¢ per watt!) Benefits to the end user include **low EMI noise levels** (we are designed to meet VDE STD 0875) and **highly reliable operation** plus convenient maintenance and easy add-on capability up to 1200 watts in a single, 19 in. rack. Get specs, prices and feature details today from:

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CIRCLE 76 ON INQUIRY CARD

PRODUCTS

DATA SET/DATA AUXILIARY SET

The T201C/829 is a std Western Electric-compatible 2400-bit/s T201C data set with an integral C829 data auxiliary set. The C829 circuit assembly terminates and conditions the 4-wire private line, voiceband data channel, and mounts in place of the 2-wire line card used in DDD applications. Installation is simplified to connecting the 4-wire private line cable and EIA interface connector cable to only one unit. Test and monitor jacks on the C829 card, plus self-test functions and diagnostic lights on the T201C, reduce installation time to a min, and provide complete system testing from one location. The device can be converted for 2-wire private line operation by removing the C829 card, and for 2-wire DDD operation by replacing it with a 2-wire line card. **Rixon Inc,** 2120 Industrial Pkwy, Silver Spring, MD 20904.
Circle 268 on Inquiry Card

CONNECTORIZED BUS CABLE ASSEMBLIES

In 1-, 2-, and 4-m cable lengths (3-, 6-, and 12-ft), passive, completely insulated Amphenol[R] cable assemblies are designed in accordance with latest specs of IEEE Std 488 to facilitate interconnection of programmable electronic measuring instrumentation systems. Cable consists of 24 conductors—16 for signal lines and eight for logic ground returns and overall shield. Of the 16 signal lines, eight carry coded data and commands to and from interconnected devices, and eight are held in reserve for critical control and status messages. Stackable 24-contact rack-and-panel male plug and female receptacle connectors are used to connectorize the cable on each end. Voltage rating is 200 Vdc, current rating is 5-A/contact. **Bunker Ramo Cadre Div,** 20 Valley St, Endicott, NY 13760.
Circle 269 on Inquiry Card

FRONT PANEL DIP SWITCHES

Designed specifically for front panel application, the Toggle-Dip™ is life-rated at 50,000 operations at logic levels, and 25,000 operations at 125 mA, 30 Vdc. Long life is attributed to its spring-loaded, sliding ball contact and detent system. Switches with one to four stations are available with spdt configurations; one or two stations with dpdt circuitry. Several switches may be stacked side-by-side to create multistation front panel arrays. Toggle-type actuators are on 0.200″ centers in the spdt version, 0.400″ for dpdt. Toggles extend 0.200″ from the mounting surface, and switch terminals are located on std DIP centers of 0.100 x 0.300″. **Grayhill, Inc,** 561 Hillgrove Ave, La Grange, IL 60525.
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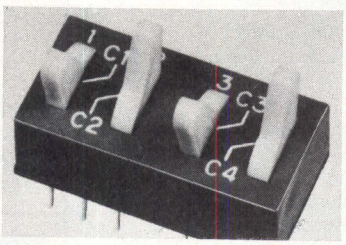


MAGNETIC STRIPE CARD ENCODER

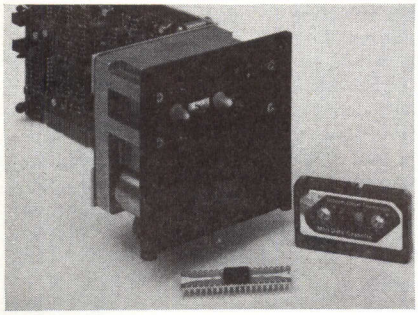
Operating under control of an 8-bit microprocessor, MT-75 encoders are programmed to encode cards to ABA, ANSI, IATA, ISO, and Thrift Industry stds. Manual entry of information is simplified by retaining constant (fixed) information in memory, and by machine formatting of data. Automated entry of information can be accomplished by use of optional inputs from punched paper tape or punched tab cards. Read/write card transport used in the unit has an RS-232 interface and is available as a subsystem. **Mag-Tek, Inc,** 1513 E Del Amo Blvd, Carson, CA 90746.
Circle 271 on Inquiry Card

SOLDERLESS BUS

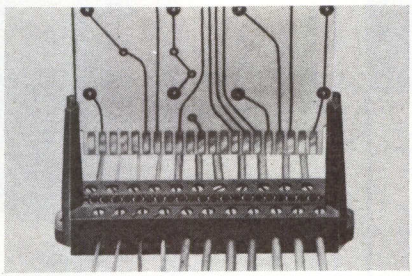
Bus offers higher current-carrying capacity, easier insertion and removal, and lower installed cost, where interconnections of higher density are required on wire wrappable pin arrays and PC socket boards. Quik/Strip provides more complete insulation than other products. Comprised of barrier strip, conductor, and insulating layer, bus carries current equivalent to that of 18-gauge copper wire. Programmable during manufacture, component has bimetallic conductor with beryllium copper in the contact finger area. **Rogers Corp, Electro Components Div,** Rogers, CT 06263.
Circle 272 on Inquiry Card

MINIATURE TAPE RECORDER

Measuring 3 x 3 x 1.8", and weighing 16 oz complete with electronics, model 6409 is designed for the MI-50 Information Terminals mini data cassette. Capacity of 64K bytes/side (unformatted) with packing density of 800 bits/in. and data transfer rate of 2400 bits/s are provided. Unit consumes <2 W of power, operating at 5.0 Vdc; <0.25 W in standby mode. Specifically designed for use with microprocessors, unit includes end-of-tape and load point sensing, and write inhibit. **Raymond Engineering Inc, Raycorder Products Div,** 217 Smith St, Middletown, CT 06457.
Circle 273 on Inquiry Card



PCB CONNECTOR



PCB1B and PCB1B-G, designed for boards with 0.156" center-to-center contact spacing and 6 to 43 contacts, incorporate patented design which eliminates need for wire termination or soldering. Unterminated wire can be interfaced with PCBs using a screwdriver. Board contacts are protected from stubbing by barrier slots in entry socket. Wire entry holes, located on both sides of connectors, are funneled; captive wire-clamping screws, adjacent to PC board entry socket, are backed out to speed installation. **Amerace Corp, Control Products Div,** 2330 Vauxhall Rd, Union, NJ 07083.
Circle 274 on Inquiry Card

LOGIC MONITOR

Incorporating fully isolated power supply and selectable trigger threshold which matches precise characteristics of logic family under test, LM-2 consists of connectors/display unit, which clips over IC, and power supply module, which contains reference power supply and logic family selector switch. 16 channels of information are displayed simultaneously. Self-contained power supply assures no loading of circuit under test, avoiding logic level shifts and false triggering. **Continental Specialties Corp,** 44 Kendall St, Box 1942, New Haven, CT 06509.
Circle 275 on Inquiry Card

MAGNETIC TAPE CLEANER

Operating at 300 in./s, 10½" reel of computer tape makes full cycle in slightly over 3 min. Model 422 achieves >90% cleaning efficiency with long life sapphire blade and automatically advancing tissue wipes, which wipe both sides of tape four times during cycle. Pack wheel squeezes air out of tape stack and guides tape onto center of reel, eliminating protruding layers. Electronic brakes never need adjusting and are automatic at power interruption, end of tape, and appropriate reflective markers. **BOW Industries Inc,** 5819 Seminary Rd, Bailey's Crossroads, VA 22041.
Circle 276 on Inquiry Card

SURVEY OF MICROPROCESSOR/ MICROCOMPUTER BUYERS

The publishers of COMPUTER DESIGN and the leading industrial market research company INTERNATIONAL DATA CORPORATION announce a significant new market research report entitled:

Survey of Microprocessor/ Microcomputer Buyers

7000 COMPUTER DESIGN readers were surveyed to determine:

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- the µP/µC models selected and the criteria for the selection
- the memories selected and the criteria for the selection.
- peripherals used with the equipment.
- various aspects of software and test.
- opinions on current µPs/µCs and peripherals.
- recommendations for their improvement.
- future plans for using µPs/µCs

and much more.

The 150 page report contains more than 50 tabulations of data from the survey, many of them correlating use factors and selection criteria with type of equipment. Each table is accompanied by an explanation of its meaning and an interpretation of its significance.

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THE COMPUTER AND DATA PROCESSING PRINTER MARKET

The environment of the computer and data processing printer industry is intensely competitive and complex - - a circumstance brought about by the substantial number of manufacturers in the field (some 110) offering a total of 500 different models. The printer manfacturers are not only prolific but they have managed to produce some highly sophisticated and complex devices — that work and work reliably. A recent study showed that of all the segments of the independent computer peripheral area, printer manufacturers with a profitability of 9.3% (profit as a percentage of sales) were second only to interconnect equipment manufacturers, and that single-product line companies fared better on the average than the multi-product line companies.

Frost & Sullivan has completed a 175-page analysis of the market for computer and data processing printers and a forecast of the nature, size and opportunities of the market. Specific forecasts to 1985 are furnished by end user (10 types); non-impact vs. impact printers; printer speed; and non-captive vs. captive. Trends in competition, applications, pricing and technology are covered. Printing techniques are assessed, and equipment comparisons are tabulated.

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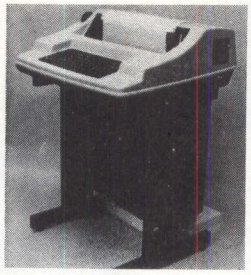
PRODUCTS

30-CHAR/s MATRIX IMPACT PRINTERS



Designed for unitized compactness, reliability, and flexibility, general purpose series 30 printers incorporate a printhead that is moved by a digital servo system. Char formation and spacing are totally independent of the speed of the head. Dot pattern for each char is stored in memory and is addressed by the specific code for that char. For local and remote I/O applications, the terminal is available in RO, KSR, and ASR versions, all featuring full 128-char ASCII keyboard, and switch-selectable line lengths of 80 or 132 col. The desktop version is easily loaded from the rear; a pedestal version from the bottom or rear. The printer is switchable from the full 30 char/s to 10 or 15 char/s; its FIFO buffer has a 68-char capacity with a dump burst speed of up to 90 char/s. **Di/An Controls, Inc,** 944 Dorchester Ave, Boston, MA 02125.
Circle 277 on Inquiry Card

NARROW BAND NOTCH FILTERS

585 series filters are specifically designed to permit accurate measurements of noise on telephone message circuits. Active filters exhibit sharp, notch-like reject characteristics which virtually eliminate test or holding tones from the input of noise measurement equipment. −3 and −50 dB bandwidths conform with Bell System specs. The 3-pole-pair, stagger-tuned, band-reject filters, packaged in low profile, plug-in modules, exhibit 0 ±0.3-dB pass band gain, 20-kΩ constant input impedance, <±5-mV offset voltage, and 50-μV/°C offset voltage drift over the 0 to 70°C op temp range. All models provide rated specs with ±15-Vdc power supplies and operate from supplies ranging from ±5 to ±18 Vdc. Model 585-1 has 50-dB attenuation from 995 to 1025 Hz; -2 has 50-dB attenuation from 2785 to 2815 Hz. **Frequency Devices, Inc,** 25 Locust St, Haverhill, MA 01830.
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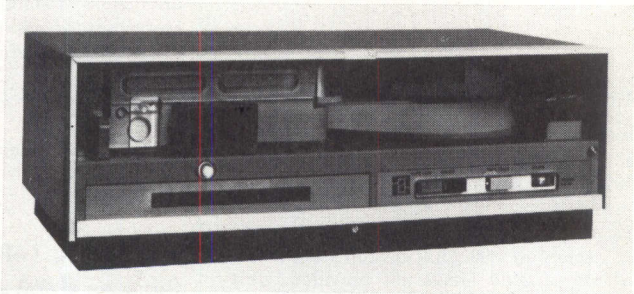
TAPE PUNCH UNIT



An independent punch unit designed for data registration, the model 3406 is a desktop or rackmounting paper and mylar tape punch station containing a complete spooling system which eliminates tape handling problems. Insert a roll of unpunched tape, push a button, and tape winds itself automatically. The device provides MOS/TTL/DTL handshaking interface; the punching mechanism is the reliable model 34 which punches 70 or 40 char/s, 5-,6-/7- or 8-level tape without adjustment. Advance feedhole is available. The unit consists of two or three main sections: punching unit, tape supply and take-up, and control circuitry. Options include punch without backspacing function; without parity check; and without power supply and interface electronics. **GNT Automatic Inc,** 440 Totten Pond Rd, Waltham, MA 02154.
Circle 279 on Inquiry Card

LITERATURE

Circular Connectors

Color catalog of MIL-C-83723 series II includes electrical data; fluid and fuel resistance parameters; contact arrangements; cable, wall, and box mounting receptacle specs; and accessories. **ITT, Cannon Electric Div,** Santa Ana, Calif.
Circle 300 on Inquiry Card

Mini/Microcomputers and Turnkey Business Systems

Published annually and updated biannually, *Microcomputer Review* lists all available minicomputers and spec information on manufacturers and equipment. Annual subscriptions are $48 (overseas $60). **GML Information Services,** Lexington, Mass.
Circle 301 on Inquiry Card

Self-Locking Fasteners

Comprehensive booklet contains four sections on descriptions, types, and applications of fasteners, along with other products. **Long-Lok Fasteners Corp,** Cincinnati, Ohio.
Circle 302 on Inquiry Card

Switches

Two brochures providing charts and drawings introduce spdt slide and dpdt power switches and termination styles, plus pushbutton switch. **C&K Components, Inc,** Watertown, Mass.
Circle 303 on Inquiry Card

Screened Image Displays

Describing advantages of displays, leaflet contains table of specs, and offers reply card for users' requirements. **Beckman Instruments, Inc, Information Displays Operations,** Scottsdale, Ariz.
Circle 304 on Inquiry Card

Over/Undervoltage Protectors

Specs and technical information included in brochure describe std available models of electronic protectors, and applications. **Heinemann Electric Co,** Trenton, NJ.
Circle 305 on Inquiry Card

Learning Aid/ Development System

Complete with block diagram and photo, product information bulletin presents features, specs, and options of μPrimer 4/8. **Technitrol, Inc,** Philadelphia, Pa.
Circle 306 on Inquiry Card

Alarm/Control System

Schematics and specs are provided in application, engineering manual which covers interfacing and operation of 2711 system. **ADC Telecommunications, Div of Magnetic Controls Co,** Minneapolis, Minn.
Circle 307 on Inquiry Card

OEM Modular Power Supplies

Illustrated catalog provides needed information to help designers select single/triple output switching regulated, and single/dual output linear regulated supplies. **Hewlett-Packard Co,** Palo Alto, Calif.
Circle 308 on Inquiry Card

Synchro Converters/ Displays/Encoders

Offering 21 models and instruments, short-form catalog provides photos and specs on the solid-state, TTL-compatible devices. **Computer Conversions Corp,** East Northport, NY.
Circle 309 on Inquiry Card

Analog Input Controller

Bulletin outlines features, application information, options, and technical specs of RTP7480 wide-range controller. **Computer Products, Inc,** Fort Lauderdale, Fla.
Circle 310 on Inquiry Card

Electronic Wire and Cable

Consisting of charts describing electrical and physical characteristics, 100-page catalog features positive UL identification, metrication, and application-oriented products. **Belden Corp, Electronic Div,** Richmond, Ind.
Circle 311 on Inquiry Card

TDC Vupak Systems

Full-color photos highlight brochure presenting features of system's software, hardware, applications, and specs. **Honeywell Process Control Div,** Phoenix, Ariz.
Circle 312 on Inquiry Card

Remote Multiplexing

Detailed application note for designers of data acquisition systems explains advantages of digital transmission and multiplexing, and some considerations of installation and protection. **Burr-Brown,** Tucson, Ariz.
Circle 313 on Inquiry Card

DC Servo Motors and Tachs

Photos, graphs, drawings, performance curves, and data points for design and applications of direct drive control components are furnished in 162-page full-line catalog. **Magnetic Technology, Div of Vernitron Corp,** Canoga Park, Calif.
Circle 314 on Inquiry Card

Cassette Recorder Products

Features of incremental and continuous digital recorders, data loggers, and recording systems are highlighted in product guide which provides applications, specs, and comments, as well as introduction to recording. **Memodyne Corp,** Newton Upper Falls, Mass.
Circle 315 on Inquiry Card

Transform Processor

Descriptions of AP-120B peripheral array processor, its applications in digital signal processing and vector/matrix operations, and available software are presented in brochure. **Floating Point Systems, Inc,** Portland, Ore.
Circle 316 on Inquiry Card

DC Micromotors

Data which include complete specs, dimensional drawings, principles of operation, and information on comparable reduction gearheads are furnished in guide covering line of "escap^{R}" micromotors. **Portescap U.S.,** New York, NY.
Circle 317 on Inquiry Card

Power Supplies and Line Conditioners

Through illustrations, charts, and tables, designer's handbook and catalog concentrates on technical descriptions, applications, and problem solutions. **Tele-Dynamics, Div of AMBAC,** Fort Washington, Pa.
Circle 318 on Inquiry Card

Terminal System

Applications, technical specs, peripherals, and detailed description of features of 40+ data display system are covered in full-color, illustrated booklet. **International Communications Corp, A Milgo Co,** Miami, Fla.
Circle 319 on Inquiry card

Memory Products

Complete with application notes, and cross-reference and production status guides, data book contains 544 pages of specs, characteristics, and diagrams of memory components, systems, and interface devices. Send $3 check to Marketing Services Dept, **National Semiconductor Corp,** 2900 Semiconductor Dr, Santa Clara, CA 95051.

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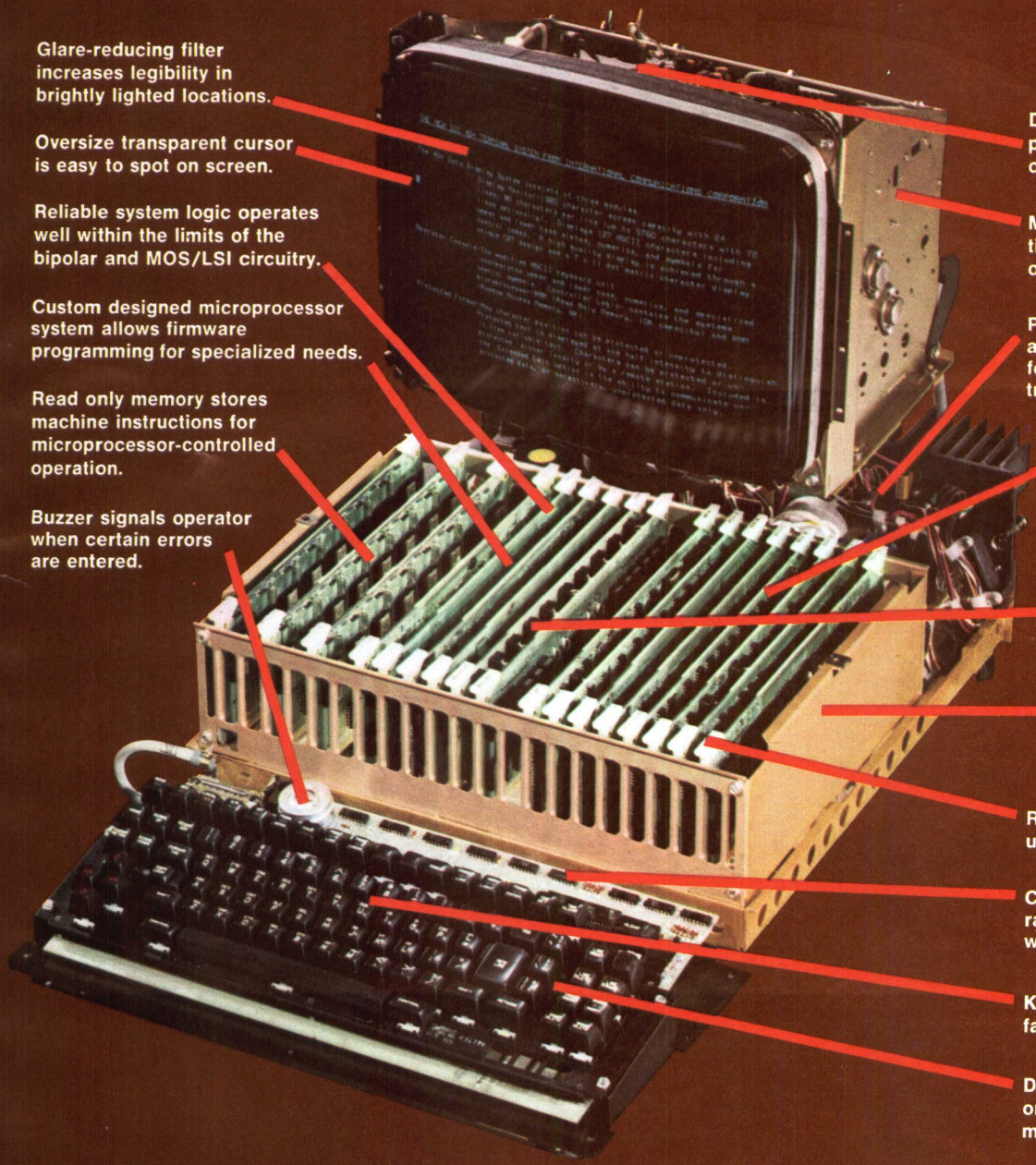
The 40+ Data Display System.

More than just a pretty case.



Glare-reducing filter increases legibility in brightly lighted locations.

Oversize transparent cursor is easy to spot on screen.

Reliable system logic operates well within the limits of the bipolar and MOS/LSI circuitry.

Custom designed microprocessor system allows firmware programming for specialized needs.

Read only memory stores machine instructions for microprocessor-controlled operation.

Buzzer signals operator when certain errors are entered.

Dynamic CRT focusing provides uniform legibility over full screen.

Movable display monitor tilts and swivels for operator convenience.

Power supply designed and built by ICC specifically for the 40+ facilitates trouble-free operation.

Gold-plated connectors assure positive electrical contact even after long service.

Special circuit switches allow on-site changes in key functions and data format.

Convection cooled chassis eliminates use of troublesome fans.

Random access memory stores up to three pages of data.

Custom encoder circuit accepts rapid typing speeds without losing characters.

Keyboard switches have familiar typewriter touch.

Dependable solid state switches on each key withstand millions of depressions.

Users of ICC's 40+ Data Display System are pleased with the appearance of their terminals. But, more important, they're impressed with their operation. Because, inside the sculptured case of every 40+ Data Display Terminal is a superbly designed electronic system. It offers a wide selection of built-in and optional features, and a choice of configurations to fill changing needs. It's the optimum terminal for many of today's business applications. Our new 12-page brochure tells why. Send for your copy.

ICC

International Communications Corporation

8600 N.W. 41st Street, Miami, Florida 33166 Telephone (305) 592-7654

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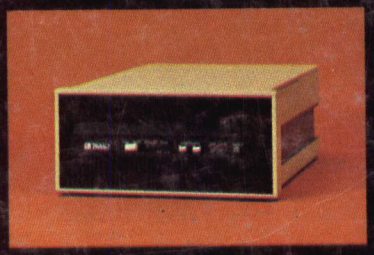
CIRCLE 78 ON INQUIRY CARD



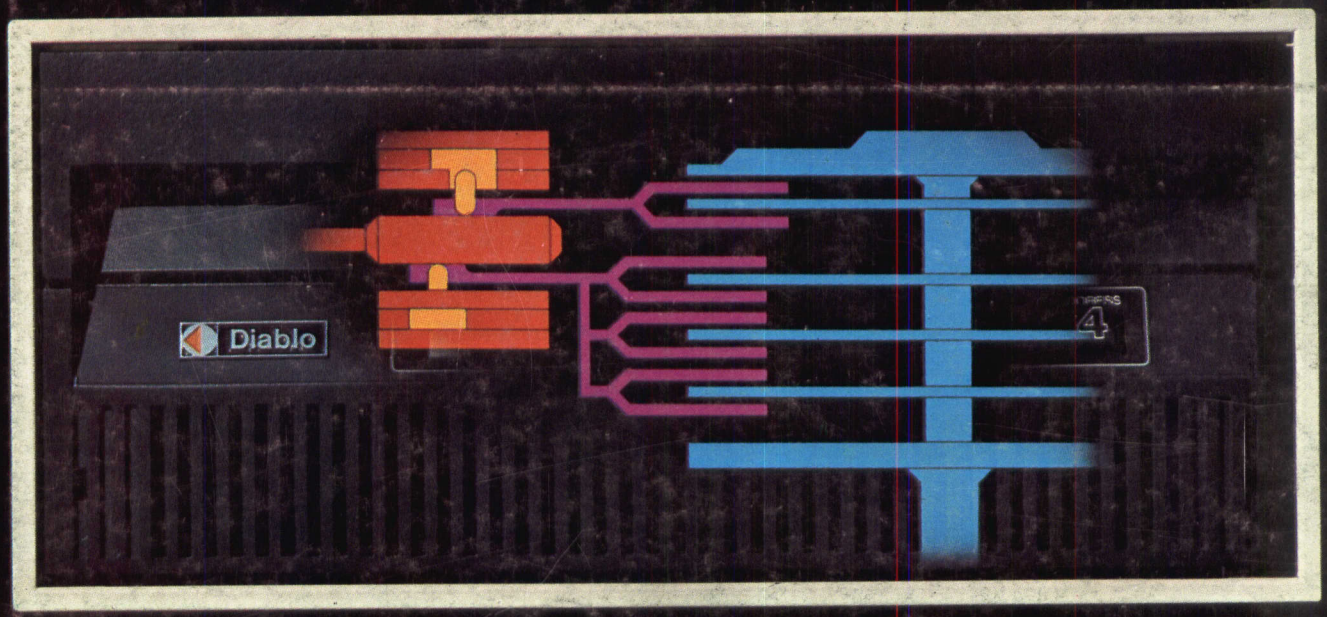
When you buy a Series 400 disk drive in 26.6, 40 or 53.3 megabyte capacity, you get two drives in one compact package! The first has a removable 13.3 Mbyte cartridge; and the second has 13.3, 26.6 or 40 Mbytes of fixed capacity. It's only possible with our exclusive inertial actuator that gives our Series 400 drives two independent head positioners. That means you can be reading or writing with the upper unit, seeking with the lower unit. And, of course, all the inherent Series 400 features are there: power interrupt protection, data track servo following, common dimensions for all models, 100% common spares, interface compatibility in all models and proven Diablo disk drive performance dependability and reliability. For a complete presentation of the new Diablo Series 400 disk drive family, call or write Diablo Systems, Inc., 24500 Industrial Blvd., Hayward, CA 94545 or Diablo Systems, S.A., Avenue de Fre, 263, 1180 Brussels, Belgium.

Diablo

Diablo Systems, Incorporated
A Xerox Company

CIRCLE 79 ON INQUIRY CARD

2 disk drives for the price of one



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