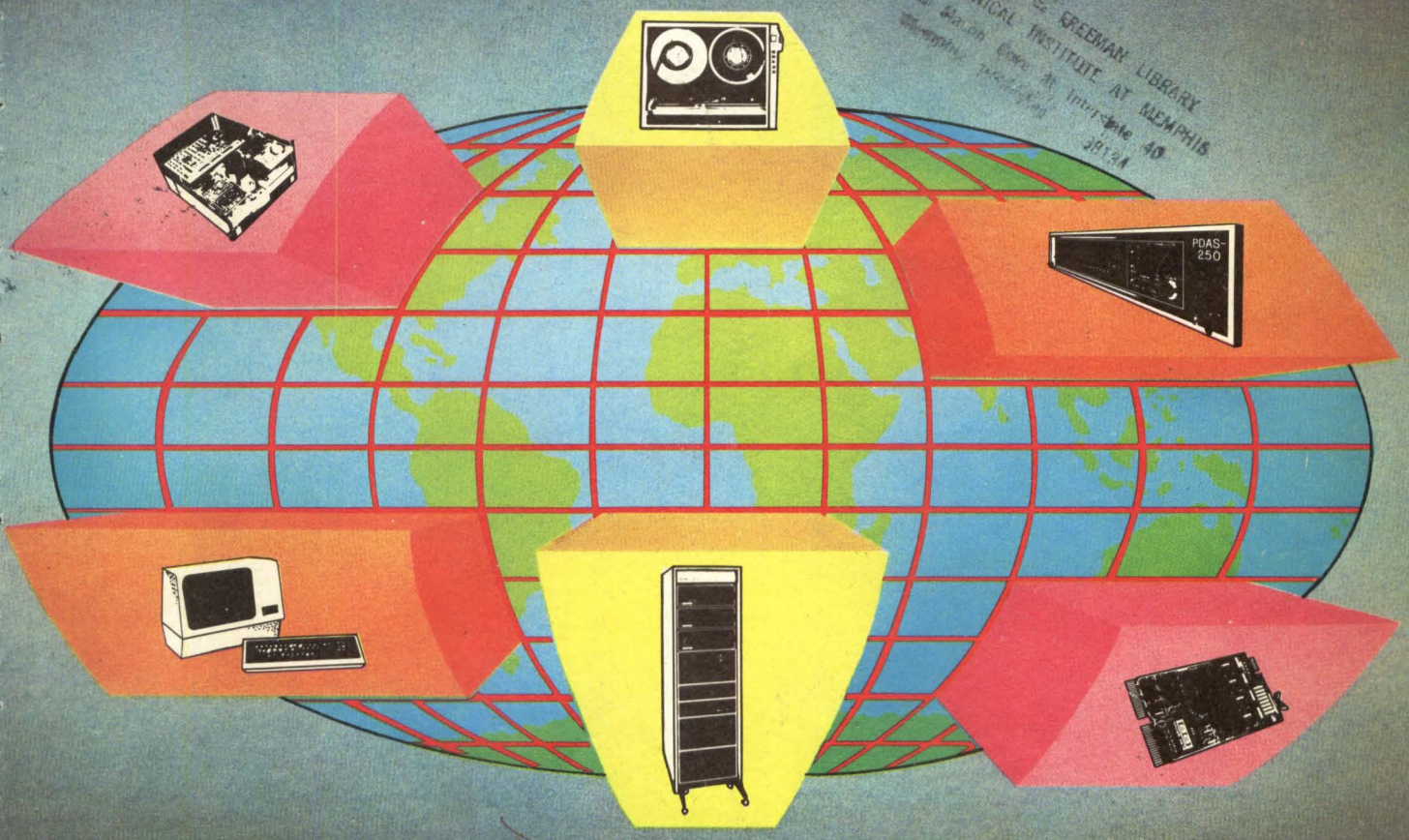
VOLUME 11, NO. 1

JANUARY 1981

Digital Design

Computers • Peripherals • Systems

The World of DEC Compatibility



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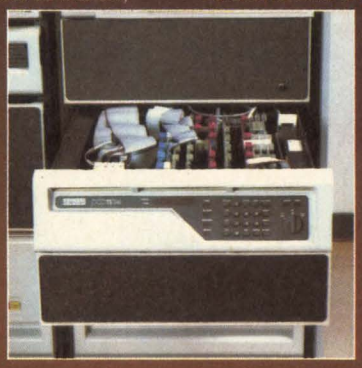

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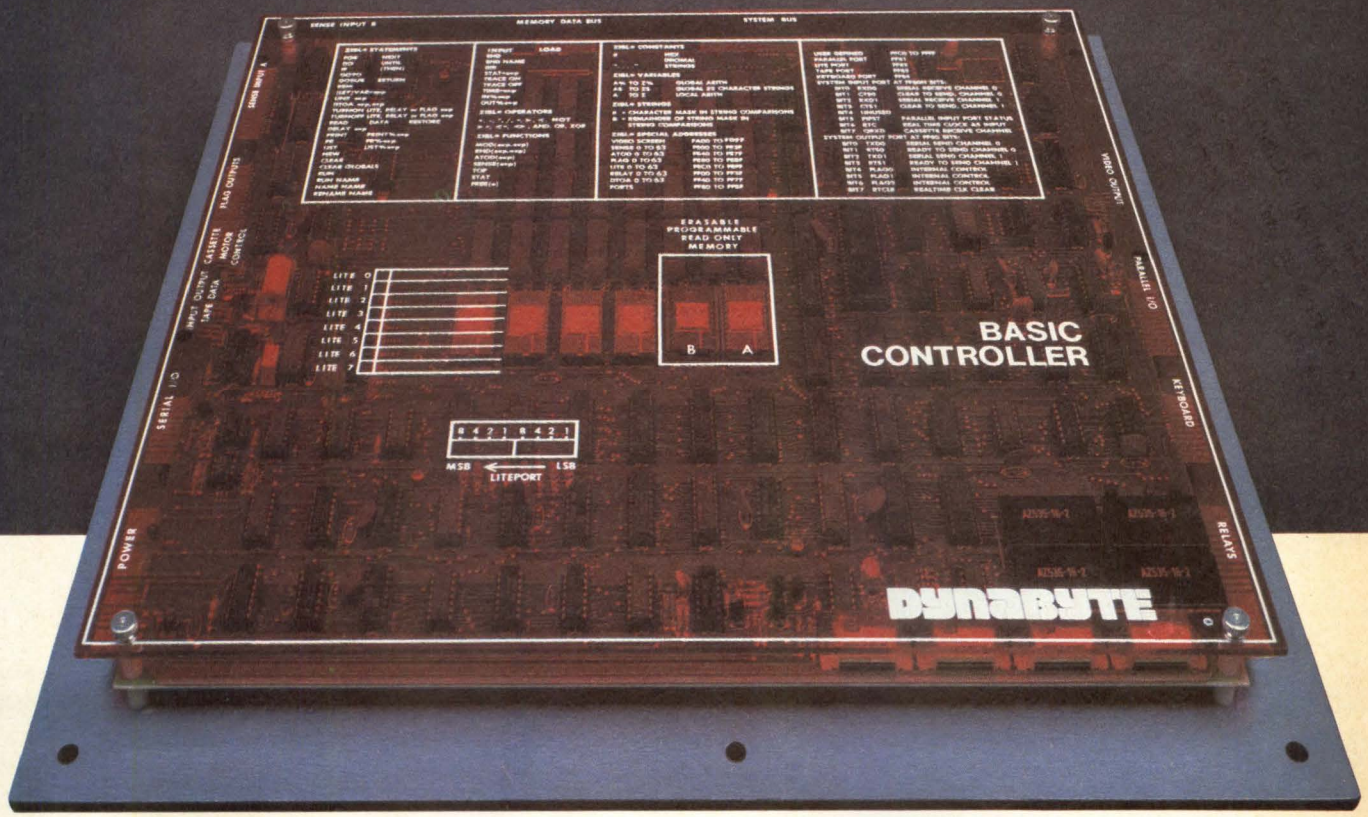

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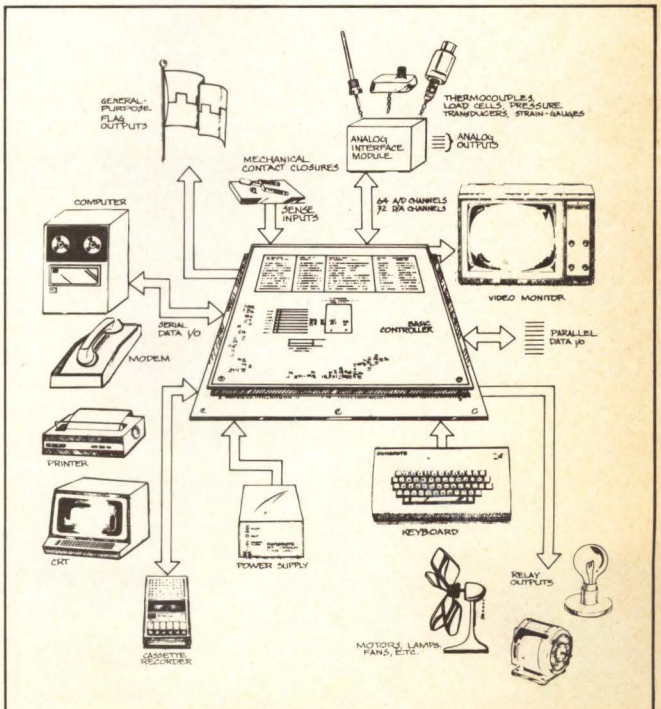

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Digital Design

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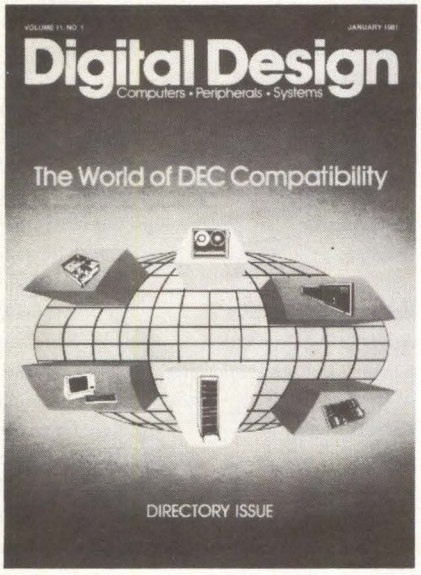

ON OUR COVER

With thousands of computer-compatible products offered for DEC micro and minicomputers, it's truly a DEC-compatible world. Photos courtesy of: Digital Engineering; TDX; Burr-Brown; Charles River Data; Datel; DCA.
Cover illustration by Josh Randall.
Concept by Richard Sarno.

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Faster deliveries, wider selection, better specs, lower costs, compact packaging — these and other factors offered by DEC-compatible manufacturers enable OEM system integrators to reach the market sooner.

32 DEC-Compatible Directory

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62 Acquiring Data At High Speed With A Minicomputer System

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Selection of the optimum switcher for a given application depends upon the specifics of the particular application. This article provides guidelines for the system builder.

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DIGITAL DESIGN
Publication number: USPS 407-010
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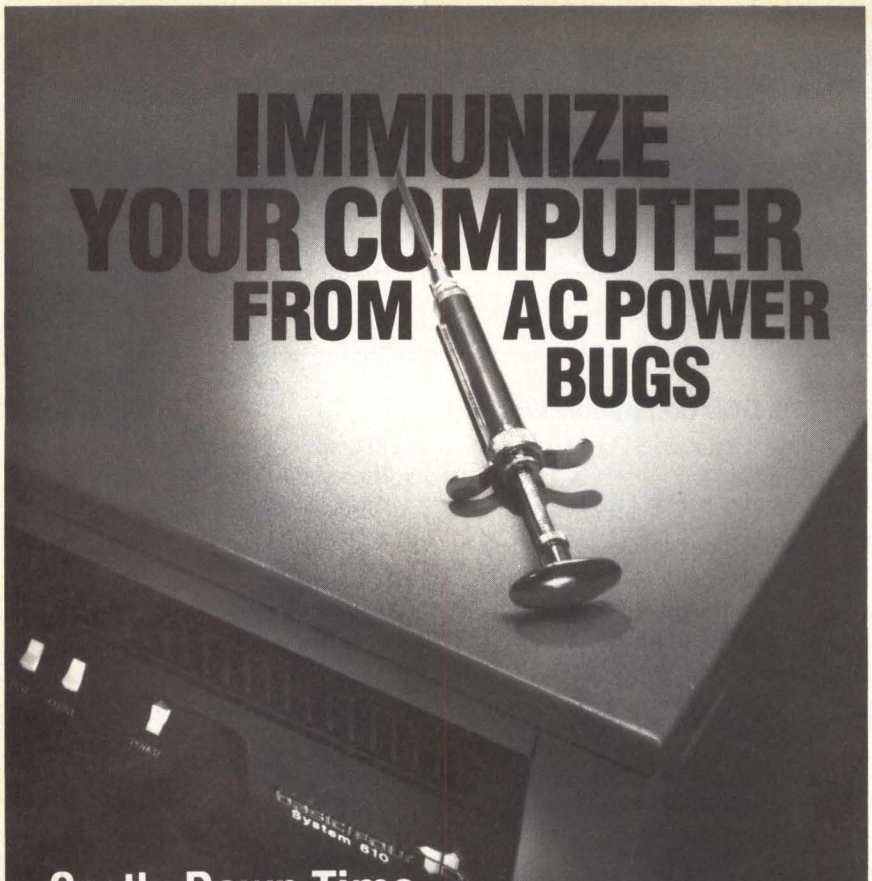
IMMUNIZE YOUR COMPUTER FROM AC POWER BUGS



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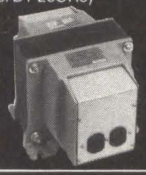

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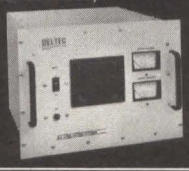

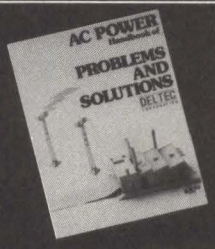

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Editor: Main Office
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Letters

Non-degreed EEs

Dear Editor:

This is in defense of non-degreed EEs, who Feerst disdains. I've had no formal electronic training, yet I've designed analog and digital products which are doing quite well. Does this make me less of a designer? No. I observe negative tendencies among my degreed colleagues; among them a disdain for good ideas originated by younger or less educated personnel.

We non-degreed electronic designers have positive characteristics: we work harder to prove ourselves, are cheaper, are less likely to tolerate politics and have learned not to look down our noses at others. We start as test technicians and work our way into design past many obstacles. We are denied admission into professional societies – such as IEEE – and are just as prone to get shafted by our employers when we come up with an idea that makes money (for them). Feerst would do well to embrace everyone who designs electronic circuits for a living in his CCEE. To argue that electronics should be a caste into which admission should be selectively unavailable to the non-degreed is undemocratic.

I have worked in companies where non-degreed people are ostracized and I've had it. We need a standard test for competence in the various disciplines.

Michael B. Stone
Alexandria, VA

Discovers XTHL

Dear Editor:

As I pointed out to Tim Quilici last November, the format in which I first presented MSGXP was designed to be most easily understood, and no attempt to optimize code was made. I was therefore pleased that *Digital Design* subsequently printed his optimization techniques. Now you have gone us both one better!

Since almost all "Designers' Notebook" articles had been directed to hardware designers, and I have worked with a number of them taking their first steps as micro programmers, I was trying to pass on a time saving technique in as straightforward a manner as possible. My own software seems to echo that simplistic, straightforward simplemindedness! I almost hate to admit that I have been writing 8080 code for almost five years – and have never used XTHL (eXchange Top of stack with HL). The reason is simple: when I started with the 8080 I couldn't imagine what the hell XTHL was good for, so I promptly forgot it! When I first started using MSGXP (I did invent the technique, to the best of my knowledge), I should obviously have made use of XTHL, but because by then I was an "expert" on the 8080 (and never used the instruction), it obviously did not exist!

It is because of exactly this kind of "mental programming" that I think articles such as Tim's are valuable to us and to less experienced engineers. All too often we find ourselves in a situation where the governing principle is "Don't make it neat, make it NOW." This tends to stifle imagination and learning, and my own is a perfect example.

Hopefully, *Digital Design* will continue to publish such "Designers' Notebook" articles, which help to eliminate stagnation.

Ken Barbier
Borrego Engineering

Digital Tape's Birth

Dear Editor:

I enjoyed reading about Wilvred (Bill) Wetzel in your May issue and your recognition of his contributions to the magnetic recording art. I was working on a system for recording FM data for telemetering purposes on magnetic tape for a new base that was to be built at Cape Canaveral in 1951. In the telemetering recording system a pilot channel was recorded together with the multichannel data, recovered and used to provide corrective signals for removing tape stretch and flutter and wow errors. The problem that I was working on was that of overcoming the delay in the bandpass filters. It caused the corrective signals to arrive too early. I designed a pile of electronics to delay the corrective signals through RC lattice networks to arrive in time for theoretical perfect synchronization. The signal did not fully correct because of a strange residual 3000 cps FM noise. The highest mechanical flutter and wow frequencies could not extend beyond 100 cps. Most of the problem resided in the tape itself – high frequency flutter had just been discovered.

We had the recorder and signal analysis equipment: 3M had the tape making facility. Bill Wetzel would make up test tapes, changing parameters in the manufacturing process, and send them to us. We would then tell him which tapes were better – and which worse. Most of the problem was tied down to small clumping on the surface – which we called "teaties" in our correspondence in deference to their conical shapes. Under the microscope he found the nature of the troublemaking inclusions and began to appreciate the importance of cleanliness in the manufacturing process. He found how to reduce the number and frequency of these teaties and pushed 3M into manufacturing a special tape just for us – deteatified tape. Someone in 3M asked the question: "What does the word 'deteatified' mean?" It was simply too risque for the early 1950s, so it emerged as 3M's Instrumentation Grade Magnetic Recording tape, with later versions used for digital magnetic recording.

I believe that the sales of this special grade tape eclipsed that for conventional audio tape and evolved as a significant factor in 3M's profitability and growth. I always like to think that 3M's leadership in high performance tapes was partially as a result of Bill Wetzel's feeling that national defense was important enough to take a gamble on creating a product for a market that didn't exist in the minds of two out of three in the business.

Paul Baran
President
Cabledata Associates
Palo Alto, CA

Line Disturbance Analyzers

Dear Editor:

We are looking for a piece of equipment which will connect to our AC line and detect and display anomalies in voltage and phase. It must also have a printer to record permanently such faults, and have a built in time clock so we can correlate the line anomalies with other equipment cycling. This was discussed in the February 1980 issue's "Evaluating Power Line and Power Supply Performance In Computer Systems" (by S. Tharp of Dranetz), but I would like to see a total listing of units. Is such a product available? Or, would the function be implemented using a larger instrument? Any help will be appreciated.

Michael Neidich
UP Systems, Inc.
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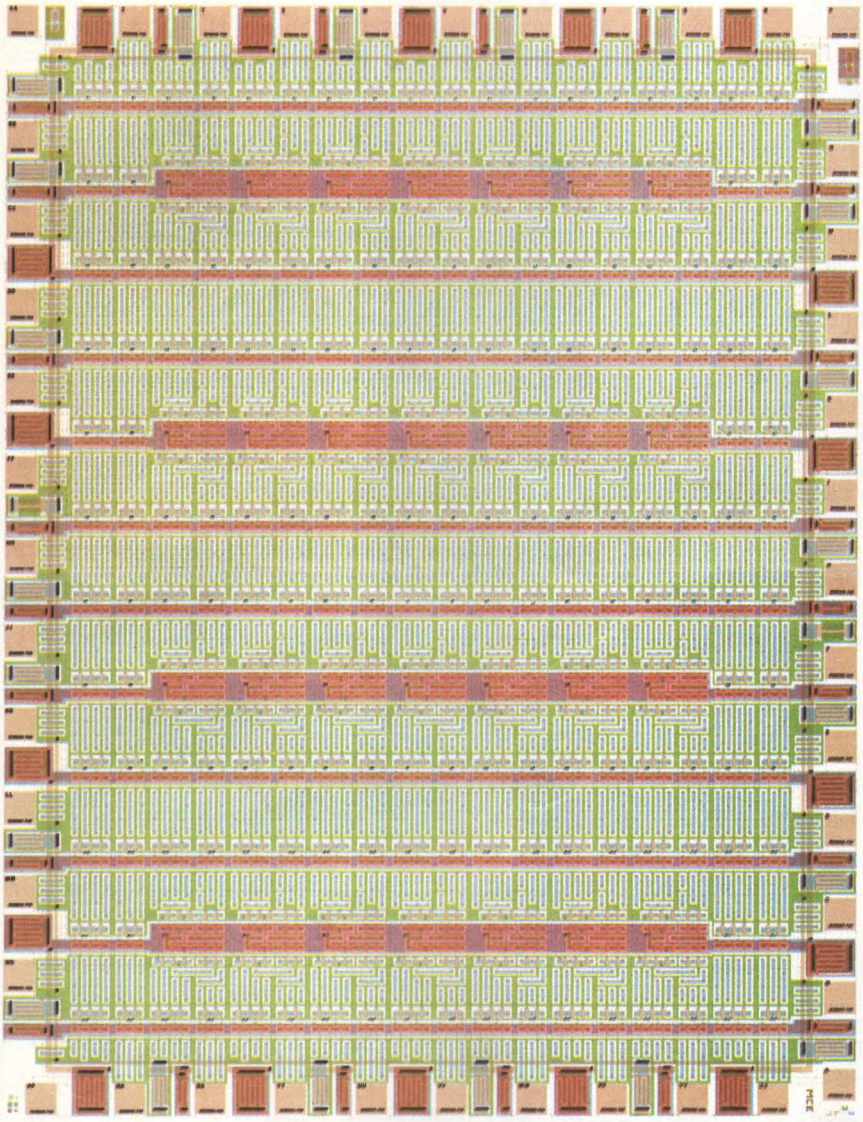

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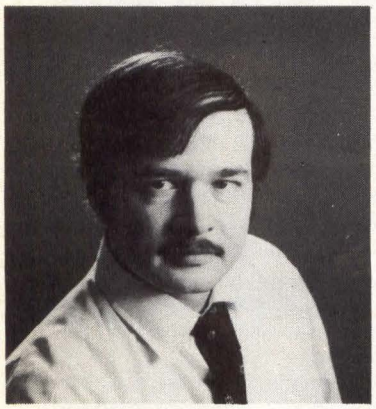
Speakout

Paul Snigier, *Editor*

The Magazine For DEC Compatible Products



Digital Design this month offers a comprehensive DEC-compatible Directory. An important industry milestone, it is the first DEC-compatible directory published by any electronics/computer trade-press publication. Last August we had the first DEC-compatible issue ever devoted to this subject. This current issue is the second of our on-going series in this important field.

This directory is designed to meet your needs as well as those of OEM integrators and system designers. In August we wrote: "Searching for compatible memory and peripherals for DEC computers can be a hassle. Where do you look? We understand that many system designers scan through **Digital Design**'s pages and look at the advertisements; some save back issues or tear out ads. Since most major manufacturers of DEC (and Data General and other) compatible boards and peripherals advertise in **Digital Design** often, at least once each six months, this is a workable solution. However, we want to do more for you and publish DEC-compatible equipment directories and directory listings of firms that manufacture/service compatible memory and peripherals."

DEC-compatible-manufacturers' responses to our August Speakout questionnaire were more than we expected: they were overwhelming! Strong, favorable reader response hinted that this issue might become a collector's item. Many called or wrote to say they would be willing to pay (a lot) for such a directory. Naturally, we thought of publishing it separately and charging (a lot) for it. We then decided that the best way to serve our advertisers (who pay our bills and make it possible for you to receive DD, and other computer magazines, free) was to first serve our reader's interests.

We plan to expand this directory. Our third DEC-compatible issue will appear in July. We will publish descriptions of new devices that will have been introduced by then and will include those manufacturers who missed last August's questionnaire. If you were left out and want to be listed in the expanded directory, then please fill out this questionnaire. Use photocopied forms for each product. Don't take the easy way out and write: "See spec sheet." (We cannot reprint spec sheets.) Include in your mail-back, press releases, photos, manuals, literature, articles, etc. Also, let us know whom to contact for more information.

Remember, if your firm manufactures DEC-compatible products, this is an excellent opportunity to be listed in a directory that will reach 65,000 direct (173,000 total) readers – leading computer system integrators throughout the industry. This directory issue will be saved by system integrators and designers, and will be actively referred to over the next 12 months and beyond.

If your firm manufactures, buys, sells, trades, writes software for DEC-compatible memories, peripherals or equipment, then let our 65,000 direct (173,000 total) readers know. Send us all the product literature you've got. Please place one product per page (make photocopies as desired). See *Speakout* above for more directions.

Product Name/Model No. _____

Description/specs _____

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Do you: manufacture ☐ ___ buy ☐ ___ sell ☐ ___ trade ☐ ___ service ☐ _____ (check all that apply)

Is vendor maintenance available? _____

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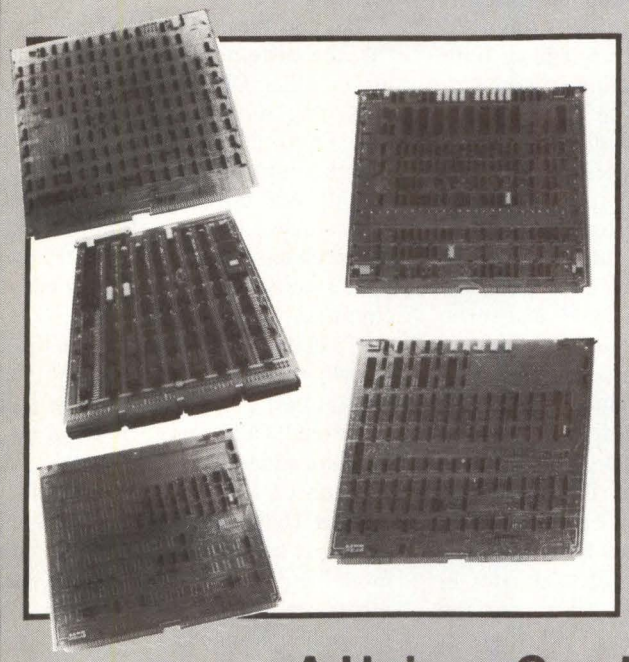
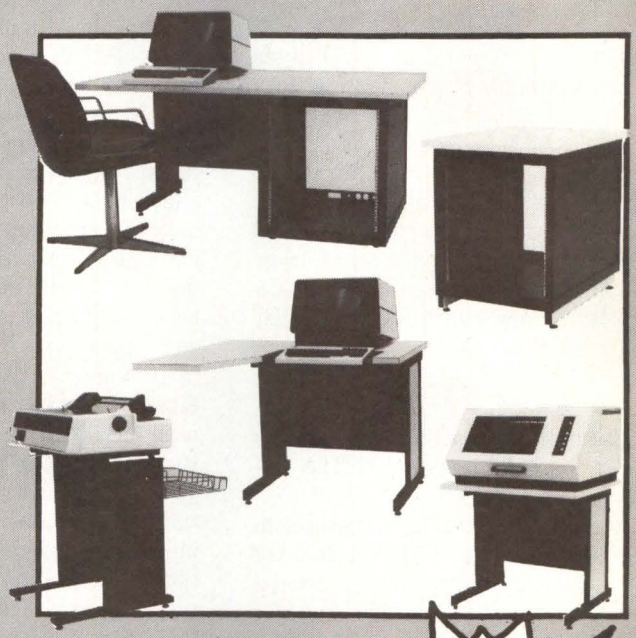
From *mini-computer systems* Peripheral Products Division





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Technology Trends

Multiplexer Systems Aid Communications

Users of DEC's DH11 multiplexer need improved line-handling capabilities in a smaller package and at a lower cost. Such a communications multiplexer would allow PDP-11/VAX-11 users to connect as many as 64 asynchronous communications line devices to a single controller board housed within the CPU backplane. Additional lines could be connected through a communications controller card to the CPU; and line adapter cards to external distribution panels. Such a multiplexer would use a single hex-size circuit board for the communications controller connected by a 34-conductor ribbon-cable to as many as four distribution panels. Each panel contains its own integral supply and either one or two eight-channel line adapters. The CS-11/H is such a unit.

Line adapters provide data/modem interface circuitry plus UART circuitry for serial-to-parallel/parallel-to-serial conversions for parallel data transfer between adapters and controller. The UARTs also contain a baud rate generator. The line adapters may be configured initially for either RS-232C or current-loop interface.

Flexibility

"This unique system organization gives users flexibility where it is needed," said Phillip Begich of Emulex. "Channels may be added in eight – not 16 – line increments; and types of interfaces can be changed, mixed or matched.

"Since all line interfacing variations are outside the CPU, users never restructure the CPU chassis or add expansion boxes for additional lines, as with other multiplexers requiring multiple boards in the host CPU," Begich continued. "If more than 64 lines are needed, only one additional standalone board is inserted on the Unibus to handle a second group of up to 64 lines."

CS11/H exceeds DZ11's low performance and DEC's comparable DH11 systems. "It offers all of the DH11 features – such as DMA output transmission, FIFO input and adaptability of line interfacing, speed and format selection," stated Begich, "and individual byte count and address registers are provided for each line for DMA of characters transmitted from CPU memory. This procedure reduces both CPU and Unibus loading in comparison to interrupt-driven multiplexers, which have programmed output operations." Begich also noted that it offers added benefits with optimized packaging: higher total performance, automatic self-test and reduced power requirements. All these standard and enhancement features have diagnostic and operating software transparency.

It supports asynchronous line interfaces of all types, including RS-232C, with full DM11 compatible modem control and current loop. It provides for program selection of individual line speeds to 19,200 baud using all commonly-used baud rates (plus split line speeds for handling different rates in transmit and receive). Character size from 5 to 8 bits and stop bits are 1, 1.5 or 2 bits in size. Transmission modes include half duplex, full duplex or echoplex.

The CS11/H firmware PROMs directly emulate DH11 functions, allowing transparent execution of standard DEC diagnostics and OS software.

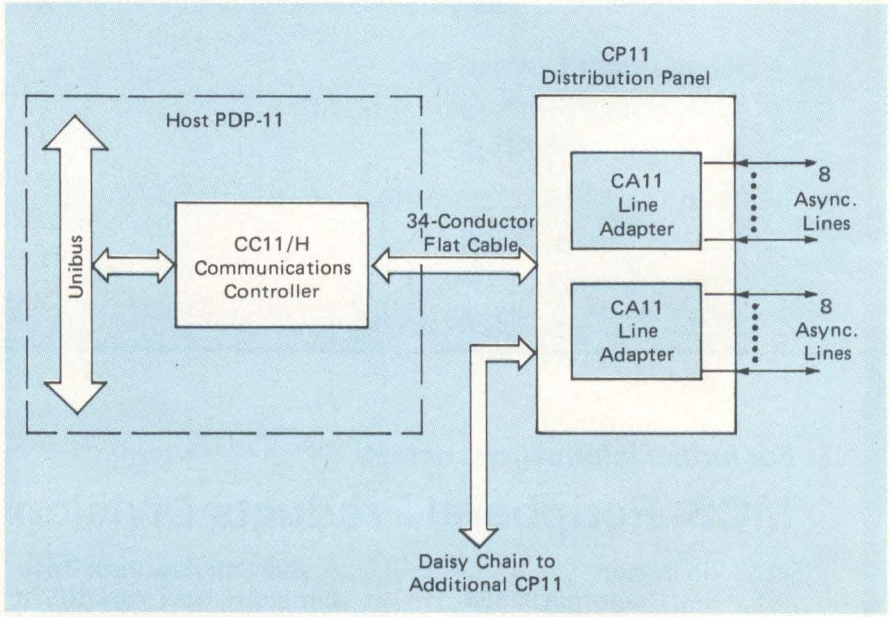
Beyond these standard DH11 benefits, the system provides features lacking in other DH11 systems. Compact packaging puts all basic communications controller functions on one board plugging into a single Unibus SPC slot as only one unit load on the Unibus. The single 34-conductor flat cable daisy chains up to four distribution panels containing the line adapter circuitry.

CS11/H requires 4 A from the internal +5-V computer supply. Each distribution panel has a supply, so no additional CPU power is required as lines are added.

Each CC11 controller emulates up to four 16-line DH11's in eight-line increments up to 64 lines. All operating mode and special firmware enhancements are selectable by slide switches for each eight-line group.

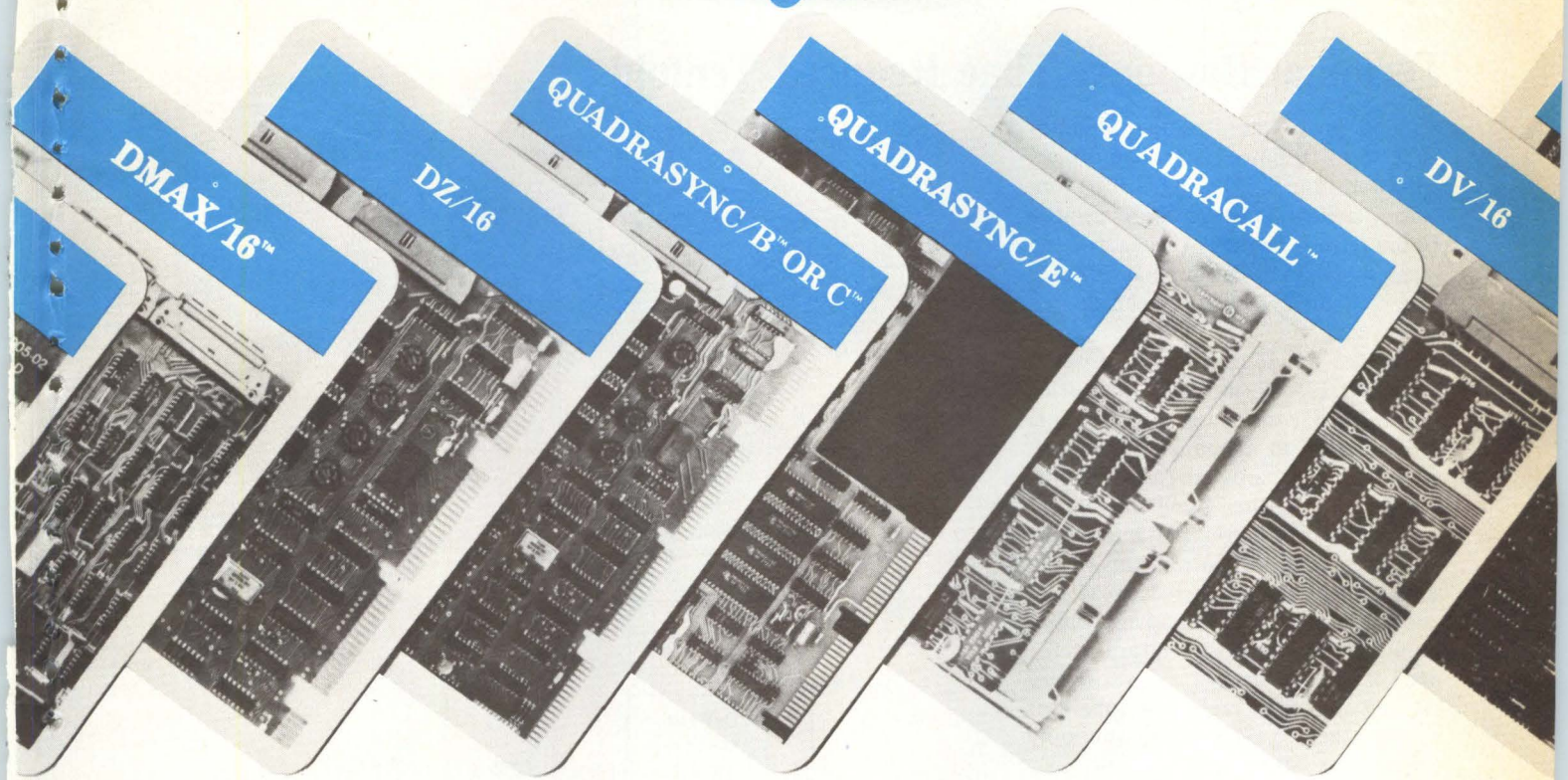
Want further information? Contact **Emulex Corp**, 2001 E. Deere Ave., Santa Ana, CA 92705. (714) 557-7580.

Circle 196



The basic element of the CS11 Multiplexer is the CC11/H communications controller: it emulates the functions of the multiple cards found in the DH11 and occupies one STC slot on the Unibus and represents just one unit load to the CPU.

Hotline to your PDP-11



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DMAX/16™
(16-LINE DH11 REPLACEMENT)

INSTALLS IN: <half DH11 space. **DATA RATES:** All standard baud rates **plus** 19.2K baud and one user programmable rate (16 baud rates). **PROCESSING ADVANTAGES:** Word transfers (in lieu of byte DMA) cut processing overhead by half! **OPERATING MODES:** Full or half duplex with full modem control via DM/16 option. **CAPACITY:** Up to 256 lines on a single PDP-11 at 2 bus loads per 16-lines.

DZ/16
(16-LINE DZ11-E REPLACEMENT)

INSTALLS IN: VAX or PDP-11 in half DZ11-E space at 1 bus load. **UNIQUE OPERATING ADVANTAGES:** On-board LED self-test pinpoints malfunction area. Built-in maintenance aid (staggered loop-around) provides only way to effect total parity/framing error check. On-board address/vector pencil switches assure complete configuration control.

QUADRASYNC/B™ OR C™
(4-LINE DL11 REPLACEMENT/EIA OR CL)

INSTALLS IN: 1 SPC slot, 4 lines at 1 bus load. **DATA RATES:** 7 selectable rates for any of the 4 lines (150-9600). **ELECTRICAL:** EIA standard RS232C or 20 MA current loop (send/receive). **VECTOR/ADDRESS SELECTION:** Vector and address values to be set on boundaries of 00, to 40,. 16 continuous word address for Vector or Address.

QUADRASYNC/E™
(4-LINE DL11-E REPLACEMENT)

INSTALLS IN: 1 SPC slot, 4 lines at 1 bus load. **DATA RATES:** 7 selectable rates for any of the 4 lines (150-9600). **ELECTRICAL:** EIA standard RS-232C with modem control. **VECTOR/ADDRESS SELECTION:** 16 continuous word address for Vector or Address—starting values selected on any boundary.

QUADRACALL™
(4-LINE DN11 REPLACEMENT)

INSTALLS IN: 1 SPC slot, 4 lines at 1 bus load. **PERFORMANCE:** Interfaces up to 4 Bell 801 ACU's with Unibus for autodial link-ups. **INPUT/OUTPUT:** 5-input signals from ACU are handled by EIA RS-232 receivers. 6-output signals are transmitted using EIA RS232 drivers. **VECTOR/ADDRESS SELECTION:** Allows selection of device address and vector by use of pencil switches.

DV/16
(8, 16, 24 or 32-LINE DV11 REPLACEMENT)

INSTALLS IN: <half DV11 space providing byte protocol handling for sync/async communications such as DEC DDMCP, IBM BISYNC, etc. **OPERATING ADVANTAGE:** User may mix sync and async lines in combinations of 4 or 8 lines by on-board switch selection with modem control. Fully software compatible with all DV11 performance features.

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Terminal Response-Time Reduced Tenfold

Want a smart terminal that updates screen 5 to 10 times faster than typical μP-based units? The IQ 135, from Soroc, achieves fast response using a 16-bit refresh memory (instead of the usual 8-bit) in a design that accesses two characters for the screen at one time.

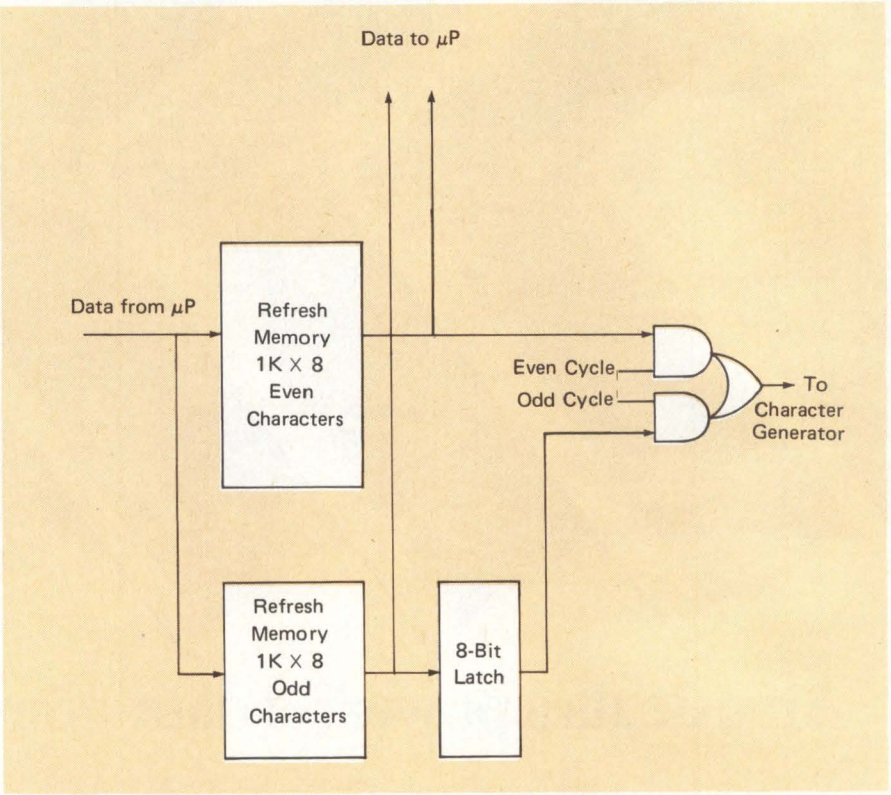
Besides providing reduced response times, IQ 135 allows the computer or operator to easily alter the terminal configuration to maximize compatibility with system hardware requirements. This is accomplished by changing control codes used during data transmission to delimit certain portions of the screen (such as protected areas and ends of lines). If, for example, a printer requires only a carriage return at the end of a line instead of a carriage return and line feed, the operator changes the control code to send only the carriage return.

System flexibility includes human factors and hardware requirements. A 36-character user message line is independent of screen data, allowing the system to maintain constant messages on the screen for the operator even while the rest of the screen data is being scrolled. The right-hand margin is adjustable in increments as small as one character, and blinking fields can be set by adjusting the length of time the blinking characters are on and off.

The 2-k screen memory is supported by a 750-character FIFO buffer that uses space compression to extend capacity. Up to 128 continuous spaces can be compressed into a single byte of FIFO memory – a useful capability in text-oriented applications like WP where data often contain many continuous spaces.

IQ 135 displays the full ASCII 128-character set in upper and lower cases on a screen with a capacity of 80 characters by 24 lines. Standard communications interface is RS-232C. An optional 20-ma current loop interface is available, and data transmission is switch selectable in rates from 110 to 19,200 baud.

Want more information? Contact **Soroc Technology, Inc.**, 165 Freedom Ave., Anaheim, CA 92801. (714) 992-2860. **Circle 197**



The μP accesses refresh memory much more frequently than possible in μP-based terminals. The video section accesses two characters/time in the 16-bit-wide refresh memory, saving one character for the next character time. The Z-80 can have a memory cycle between character accesses, and maximum delay between memory cycles is only one character time (about 600- to 700 ns).

Trend To Conditioned Power Grows

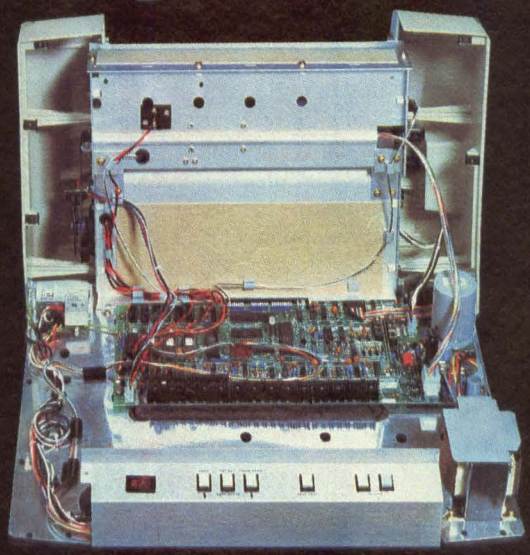
The future will see increasing emphasis on power conditioning. Noise disturbances, voltage variations and outages were always a problem for computers. IBM's 1974 two-year study found that the typical computer site experienced 130 error-producing power anomalies per month. Matters haven't improved much since then; indeed, they may be worse. Certainly, the spectre of lower-quality power due to oil shortages and nuclear plant construction slowdowns are not reassuring to OEMs. With the invasion of microcomputers and minicomputers into unprotected industrial and business environments, the question of conditioned power becomes one of increasing concern in 1981.

What can OEMs do? The answer to that question was recently discussed by Patrick K. Hallinan of Topaz in San Diego, CA. Hallinan's recommendations to system integrators were as follows.

Getting rid of noise

For low-gain circuits or insensitive loads, transformer isolation is adequate. If powering a high-gain circuit, sensitive instrumentation, DP systems, communication systems or telemetry equipment, primary noise must be blocked to prevent degraded or inaccurate performance. Greater physical separation of coils produces less noise coupling, but it increases leakage in-

Say Ahh....



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Not that is comes up often, but want to get inside? Simple. Just remove a few screws and the clam-shell case swings open exposing all major components. This easy access plus built-in self-test and minimum component count yields an MTTR of one-half hour. The 9-wire print head replacement's even simpler . . . two screws and it's out. Without opening the case. And without a service call.

Performance Plus

The DP-9000 Series prints the full ASCII 96 character set, including descenders and underlining, bi-directionally, at up to 200 CPS. Number of columns can go up to 80 or 132, depending on character density—switch or data source selectable from 10 to 16.7 characters per inch. And all characters can be printed double width. The print head produces razor-sharp characters and high-density graphics with dot resolutions of 72X75 dots/inch under direct data source control.

Interface Flexibility

The three ASCII compatible interfaces (parallel, RS-232-C and current loop) are standard, so connecting your computer is usually a matter of plug-it-in and print. Also standard are: a sophisticated communications interface for printer control and full point-to-point communications, DEC PROTOCOL, and a 700 character FIFO buffer. An additional 2K buffer is optional.

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ductance and reduces power transfer. A grounded single-turn of conductive foil between coils diverts much primary noise current to ground. Capacitance around the Faraday shield couples enough noise from primary to secondary to cause problems. A box shield, completely enclosing the winding with conductive foil, provides a ground path for primary circuit noise. Smaller capacitance exists between primary and secondary coils. The ultra-isolator stops noise currents from crossing the transformer in either direction. Each coil is enclosed in a wrapped foil-box shield. Enclosure and separator plates provide a second level of box shielding. Coils are separated. This protects against 88.5% of all error-producing power anomalies.

Undervoltages and overvoltages account for 11% of significant power line disturbances. These are due to normal transmission line voltage drops, intra-building voltage drops, brown-outs, and voltage sags and surges.

The most common solution to voltage variations is the AC line-voltage regulator. Incoming voltages rise 13% above nominal and fall 25% below nominal. They regulate to around ±7% of nominal. Today OEMs have turned to power conditioners, which combine an ultra-isolator with a voltage regulator to produce the best counter-weapon against noise and voltage variations. They come in a wide variety of shapes and sizes, and in power ratings to suit virtually any computer. Power conditioners can solve 99.5% of all power disturbances. Approximately 0.5% of power line disturbances are power outages – devastations that erase entire programs in milliseconds. The most common solution to blackouts is the Uninterruptible Power System (UPS). They can be either on-line or off-line (see Digital Design, February 1980). Power conditioners, best for most computer applications where cost is primary, cost $.45 per VA; UPS cost $2.50 per VA. The selection is one of weighing the cost of data that could be lost: if invaluable, the added cost of UPS is a bargain.

OEMs Urged to Scrutinize DEC-Emulating Video Terminals

Rick Brechtlein, *Cobar, Inc*

Many VT-100 type terminal makers jumped temporarily into the market to capitalize on DEC's recent terminal delivery woes. Lock into one of these "here today, gone tomorrow" terminals and your woes may be just starting. Asked what the OEM system designer can do to protect himself, Rick Brechtlein of Cobar offers some advice in the following report.

DEC's headache

The DEC terminal emulation "gold rush" began more than a year ago when DEC incorrectly anticipated a slowdown in business but was soon overwhelmed with orders. The VT-100's unique design, detached keyboard (arranged similarly to the IBM Selectric), set-up modes (allowing operators to configure systems through the keyboard) and overall good performance made the VT-100 into a defacto terminal standard. Soon, DEC fell 14 months behind on deliveries! The gold rush was on.

Some companies recoded the micro program in general purpose terminals and offered these as emulators that functionally duplicated the VT-100. Others carried emulation farther: their terminals were designed to look and feel like the VT-100. Some even added extra features. One had some qualities that even DEC's VT-132 lacked!

DEC will begin a major marketing push for its VT-132, the latest generation terminal, early this year; and it could trigger a greater demand than the VT-100.

Because DEC increased its manufacturing capability three-fold within the last year and greatly reduced delivery time, some terminal emulators felt the VT-100 market was too volatile: they modified their VT-100 emulators as general purpose terminals. Still, even though DEC is catching up with its VT-100 deliveries, there is a good market for DEC terminal emulator makers who offer a quality product, good service and provide hardware for the small OEM systems designers with unique applications.

Buyer criteria

Emulating terminals sell for 20-45% below DEC's prices. But when DEC reduces prices, some suppliers will bail out, leaving their customers behind.

Rule 1: the capability of expanding a system should be near the top of your checklist for evaluating DEC terminal emulators. Those most totally committed have terminals designed for today and tomorrow. It should have VT-132 features, plus more. Expect a great demand for the VT-132; it fits perfectly into DEC's marketing pattern of concentrating on the commercial business-forms management, word processing, distributed processing and off-line applications – that are terminal-oriented.

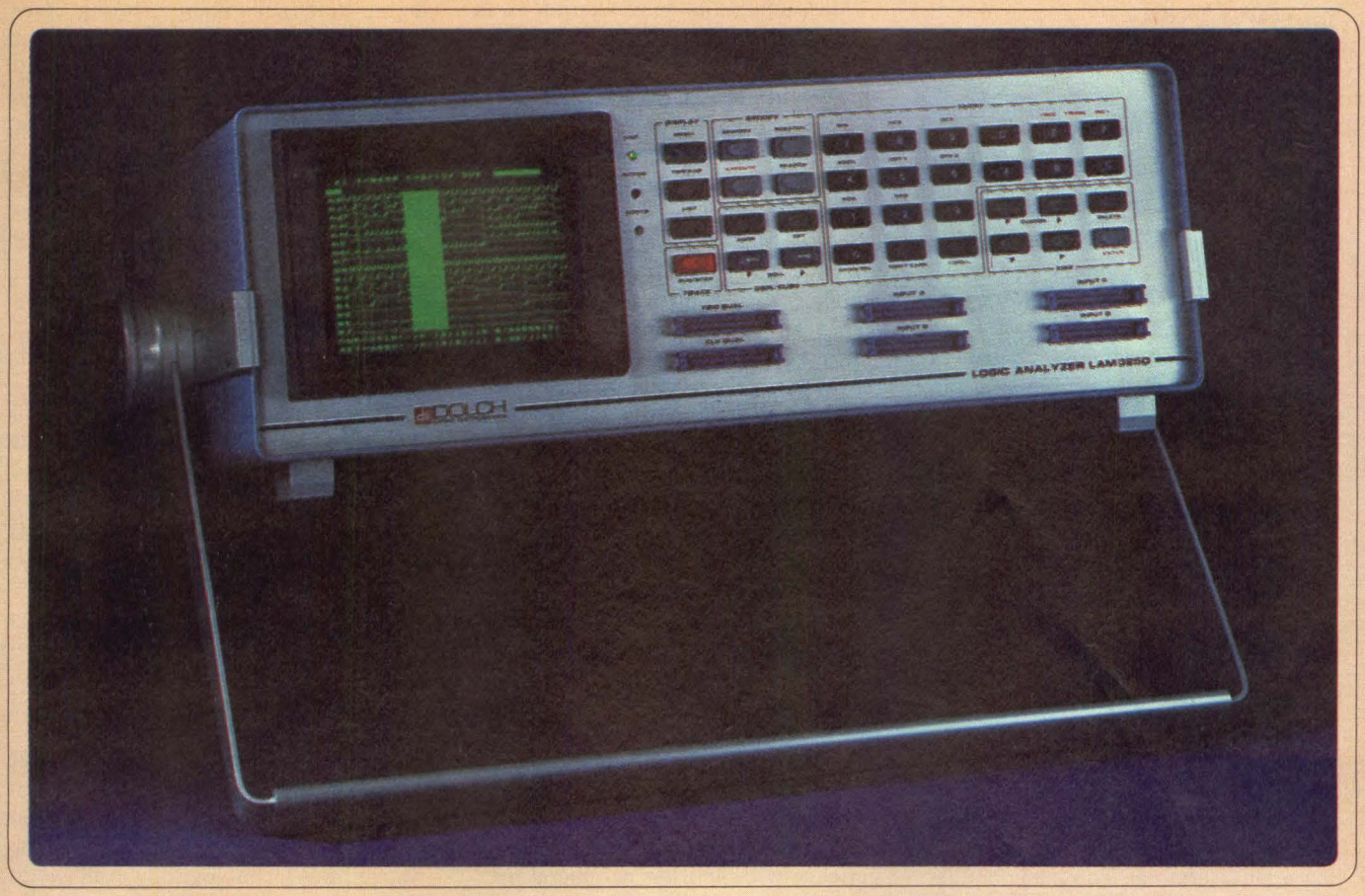
The VT-132 hit the market before software could support it. Late last year, there was still no DEC software to support the terminal, even though it had already been in limited production for about 18 months. However, there are quite a few large DEC OEM software houses that are writing their own I/O drivers to take advantage of VT-132 features.

Rule 2: an emulating terminal should at least equal VT-132 performance. One common complaint from VT-100 users is the data overrun problem. Most emulators have expanded buffers and improved scrolling mode to help solve this problem. For example, look for a data buffer larger than the VT-132's, (twice the size of the VT-100 buffer,) and scroll speed controlled automatically by a μP to virtually eliminate data overruns (a frequent and costly problem in heavily-used DEC systems).

Internal memory size will determine a terminal's versatility and expandability. It takes 8K of PROM to duplicate the VT-100's, and approximately an additional 4K to add VT-132 capabilities. Insist on at least that much more internal memory. It's a good idea to have expansion capability of about 32K to handle future requirements.

The terminal should have a bidirectional auxiliary port, which will permit adding nearly any type of peripheral with an RS-232C interface. (This is a must for system expansion.)

Also important for expandability and flexibility is data and control char-



32 TO 64
Channels...with a Battery

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Since it incorporates dual 16-channel X 1000-bit recording blocks, the LAM 3250 can accept up to two independent external clocks for sampling data, letting you independently monitor both address and data on a multiplexed bus.

Powerful triggering.
Four-level sequential triggering, each level with an independent pass counter ranging from 1-255 counts, lets you debug programs containing nested subroutines. There's even a Restart function to guide you through data on the bus. All of this is easily programmed in a separate trigger menu.

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acter arrangement. If data and control characters are in a table, users change the character sets by merely changing the table, thus permitting redefining keyboard layout (an important feature if users need special requirements, such as foreign languages).

Operator convenience enhancements, such as transmitting multiple character sequences through a single key stroke, can be implemented with the "set-up" procedure. For example, a command sequence repetitively used during an editing session could be invoked with a single key.

A few emulators have features such as controllable cursor (operators can stop it from blinking) and non-glare screen (a characteristic not available in VT-100s and VT-132s).

Consider ergonomics

Most emulators probably don't emulate enough. It is important for a terminal to look, feel and even sound like a DEC terminal. Too many emulators fail on the human engineering aspects.

Most emulators deliver terminals in 30 days; some factory-direct manufacturers do better. But service is important – although much less critical for VTs than other devices because VTs are simpler. Will a terminal require significant maintenance during its life? Unlikely. Most don't have adjustments to check; and some, like the VT-132/VT-100, don't even use mechanical switches to set up operating parameters. Thus, most offer substantial warranties. A few offer one-year warranties. Other common warranty periods are for six months and 90 days. Some even offer loaner terminals when a CRT needs factory repair. Rule 3: deal with a factory-direct emulator to speed response when service is required.

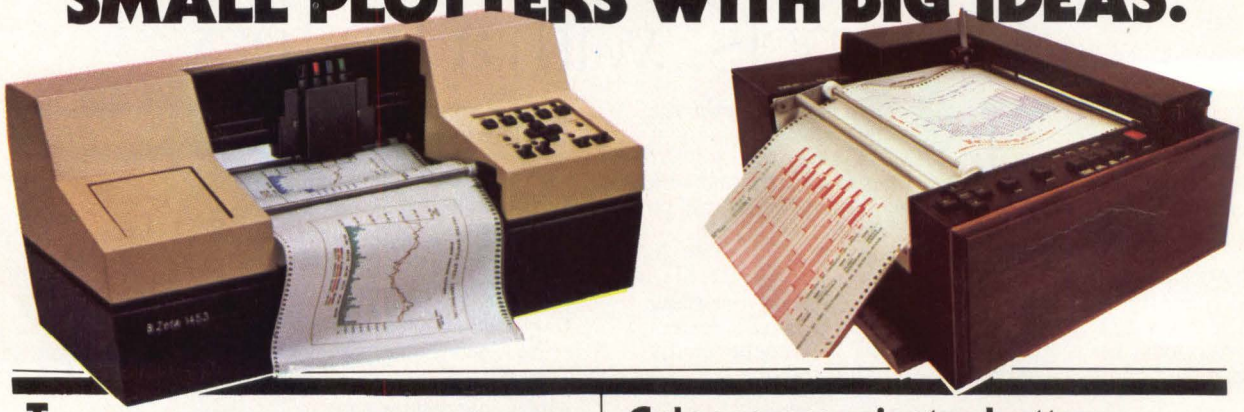
Many OEM's question the viability of terminal manufacturers. Will the company you buy from be around to service and supply more terminals in the future? Are start-up companies less likely to survive than large established companies? Although percentage of failures among new companies is great, the computer peripheral industry is unique: most got a lot of experience with another peripheral manufacturer – before starting their own companies. Few novices organize computer peripheral manufacturing companies! You can learn a lot about a new company's financial stability by checking his vendors for credit references. Look also, at the background of the company's principals.

Advantages exist in dealing with a start-up company. If ordering fewer terminals – or terminals for special applications – you may be better off dealing with a newer, smaller company that is eager to get your business. But, be sure there is a degree of commitment to the DEC marketplace.

Finally, look for the terminal maker whose marketing approach is similar to yours. You are committed to a market and designed a system for what is probably a vertical market. Most emulators produce quality products. Several firms that make VT-100 emulators include: Visual Technology, Datamedia, Cobar, Plessey, C. Itoh (Japanese), Volker-Craig (Canadian), Microterm, Direct, Datagraphix and Teleray.

But firm commitment and product selection are not the only selection factors. In choosing, select the video display terminal that maximizes the capabilities technologically available to fulfill the requirements of your particular market.

COLOR GRAPHICS FROM TWO SMALL PLOTTERS WITH BIG IDEAS.



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NEW

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The 900 Series uses built-in Z-80 intelligence and far simpler mechanical design to provide total closed loop control for gentle tape handling. You get your choice of 45, 75 or 125 inch per second speeds in NRZI/PE recording formats.

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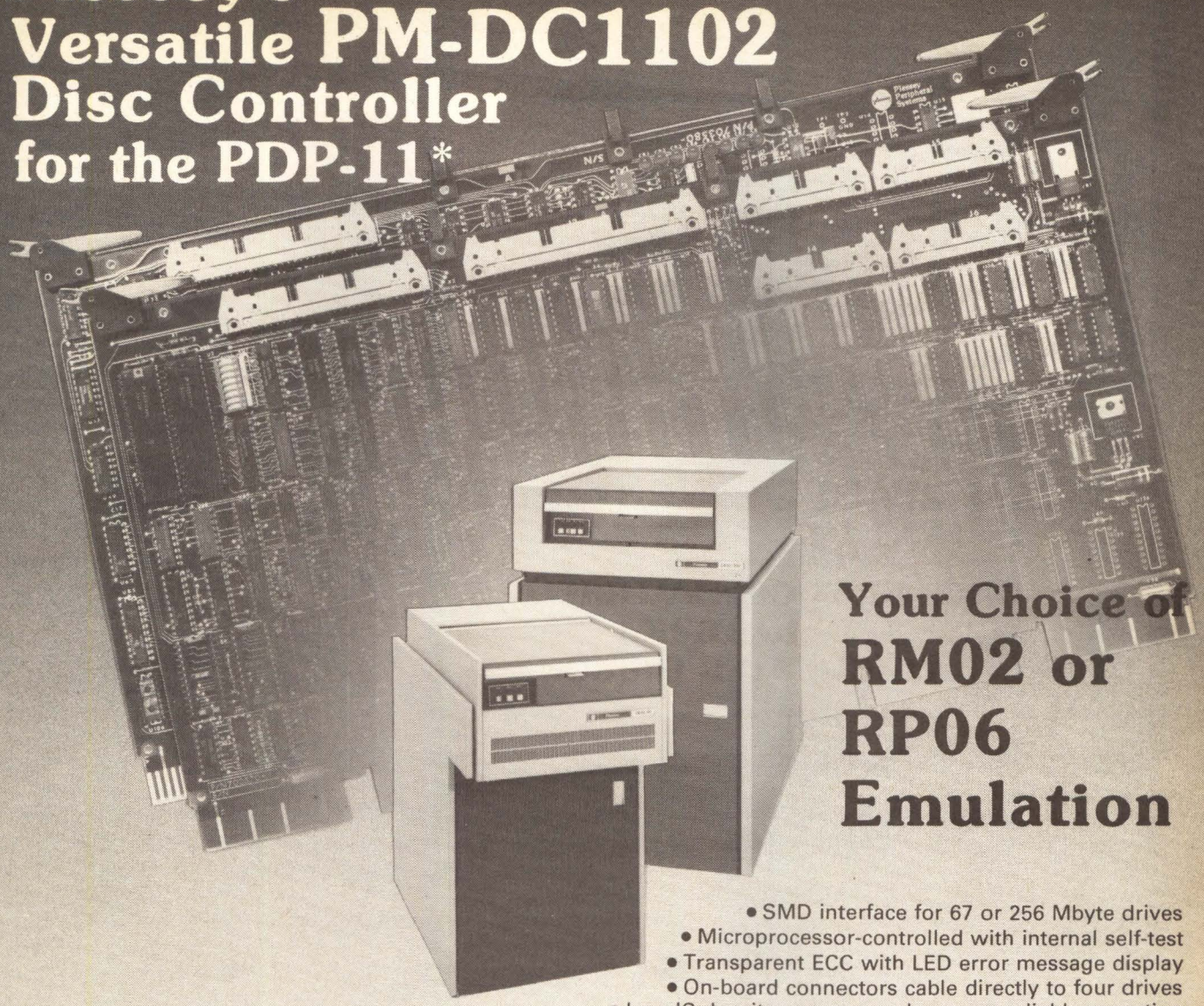
Plessey's Versatile PM-DC1102 Disc Controller for the PDP-11*



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PM-DS02D (RM02 emulation)

Plessey's PM-DS02D disc subsystem consists of the PM-DC1102 controller and one 67 Mbyte PM-DD11/80 SMD drive that has a proven history of reliability and data integrity. The PM-DS02D subsystem provides complete software and media compatibility with DEC's RH11/RM02 subsystem. The PM-DC1102, in this configuration, can directly support four 67 Mbyte disc drives for a total system capacity of 268 Mbytes. Disc pack files created on either the PM-DS02D or the DEC RM02 can be used interchangeably.

PM-DS06E (RP06 emulation)

The PM-DS06E consists of the PM-DC1102 disc controller and one 256 Mbyte PM-DD11/300 SMD disc pack drive with cables. The PM-DS06E provides for expanded capacity RP06 emulation (256 instead of 176 Mbytes) and, by use of minor software patches, is compatible with RSTS*/RSX11M* system software and diagnostics for DEC's RP06 disc subsystem. Up to four 256 Mbyte PM-DD11/300 disc drives may be cabled directly to the controller for a maximum system capacity in excess of 1000 Mbytes.

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Plessey Peripheral Systems

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Innovative Design

Touch and Go With Optical Video Controls

It's widely recognized that engineers prefer electronics components with at least as many buttons as the average accordian, whereas businessmen generally begrudge a single on/off switch. In recent years, circumstance has favored the engineer, due to the explosive development of complex features for what were previously simple machines. And with smaller and smaller units performing more and more functions, merely finding enough square inches of surface area to aesthetically locate the controls became a task in itself.

With Xerox's model 5700 electronics data processing printer, it became more than a task; in fact, unless they wanted their printer to look "like the cockpit of a 747," as manager of software display Anthony Ciuffini puts it, it was impossible. For although the 5700 is far from small, its list of functions and features – wordprocessor printing, electronic mail, remote computer printing and direct copying – is quite extensive. "We looked at the features we were trying to incorporate," says Ciuffini, "and we decided we couldn't do it with a conventional approach – period."

Xerox's unconventional solution is an 8″ X 11″ touch-control video screen that serves as both control panel and operator's manual for the 5700. When you turn on the printer, a diagrammatic control panel, along with key function questions, appears on the screen. All the operator need do is answer the questions by actually touching the "buttons" represented on the screen. If the operator is unsure about something, there is a touch button marked "help" near the bottom of the screen. Touching it calls up more detailed information and instruction.

Via what Xerox calls "progressive disclosure," the 5700 guides the operator, who guides the 5700 through its operations. "The operator turns on the machine," explains Ciuffini, "and chooses a mode from the three that come up on the screen (PRINT, COPY, or COMMUNICATE). From there on, everything's self-explanatory – training is minimal."

Beyond its use as control panel and operator's manual, the 5700's video display also serves a diagnostic function: should a simple mechanical problem occur, the screen displays a drawing of the 5700 with a blinking light indicating the problem's location. If the 5700 believes its problem to be beyond the ken of its owners, it asks that a service rep be called.

Ciuffini claims that the 5700 is the first optical touch-control screen on the market. It senses finger location by use of infrared light-emitting diodes (LEDSs) and light-sensing transistors, occupying four one-inch-wide printed circuit boards that frame the video screen. Infrared LEDs line two of the circuit boards (one vertical and one horizontal), while light-sensing transistors populate the two opposing boards. The entire frame of pc boards lies under a red polycarbonate bezel, made by GE, that shields out most of the ambient light, while allowing transmission in the infrared band.

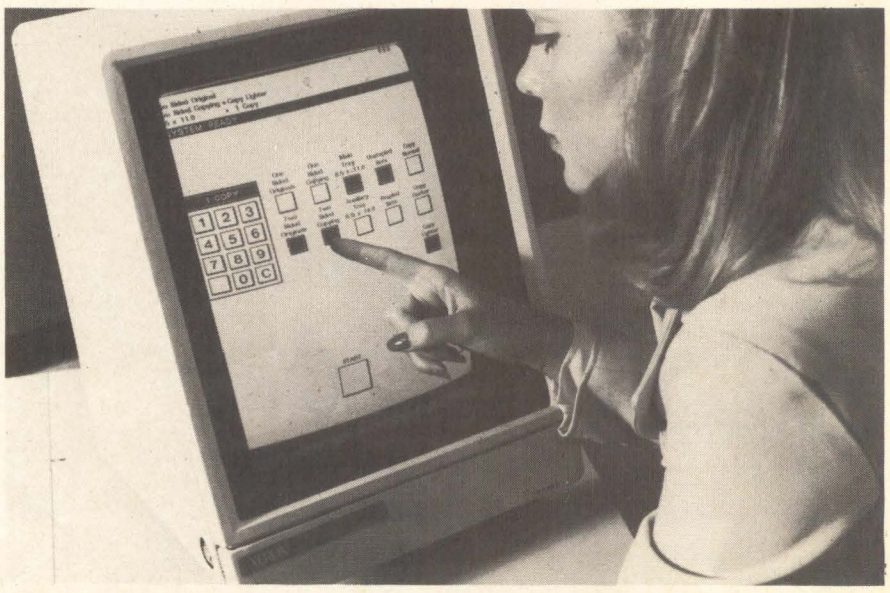
"Opposite each LED," explains Ciuffini, "we bias a photo-transistor to the ambient, room light, just before we fire the photo-diode. Then, the transistor looks for the firing of the diode. If we see it, we then claim there's no interruption; if we don't see it, we know we have a hit

Starting in the lower, right-hand corner and moving up and across, the diodes scan the screen forty times each second. Each diode occupies .216 inches, so the average-sized finger will intercept two or three beams in each dimension. "So even if you lose a diode," says Ciuffini, "the system will still work."

Although some consider the video control screen a little "Hollywoodish," Ciuffini claims that it's the best possible solution to their design problem. "The only other possible answer I could imagine would be voice-feedback and recognition," he says, "and that's still three to five years down the line."

Purchase price of the Xerox 5700 electronic printing system varies according to what features are specified. The lowest cost system available costs $66,300 or $1,440 per month on a one-year lease agreement. A typical system runs in the vicinity of $90K. Xerox Corp, 701 S Aviation Blvd, El Segundo, CA 90245. **Circle 198**

– Bob Hirshon



Instead of pushing buttons, operator of Xerox 5700 electronic printing system just touches screen to control system. Different displays appear for each kind of office operation – printing for word processors and remote computers, electronic mail or copying.

OUR SMART TERMINAL IS ONE TOUGH COMPETITOR.

It's not easy buying a terminal today. There's a lot of names to choose from. So consider the facts, then make your decision.

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We're confident we have the right terminal. From our Dialogue 80 to our Dialogue 30, one of the best priced terminals on the market today.

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Call Harvey Hirsch today at Ampex Corporation, Memory Products Division, 213/640-0150, 200 North Nash Street, El Segundo, CA 90245.

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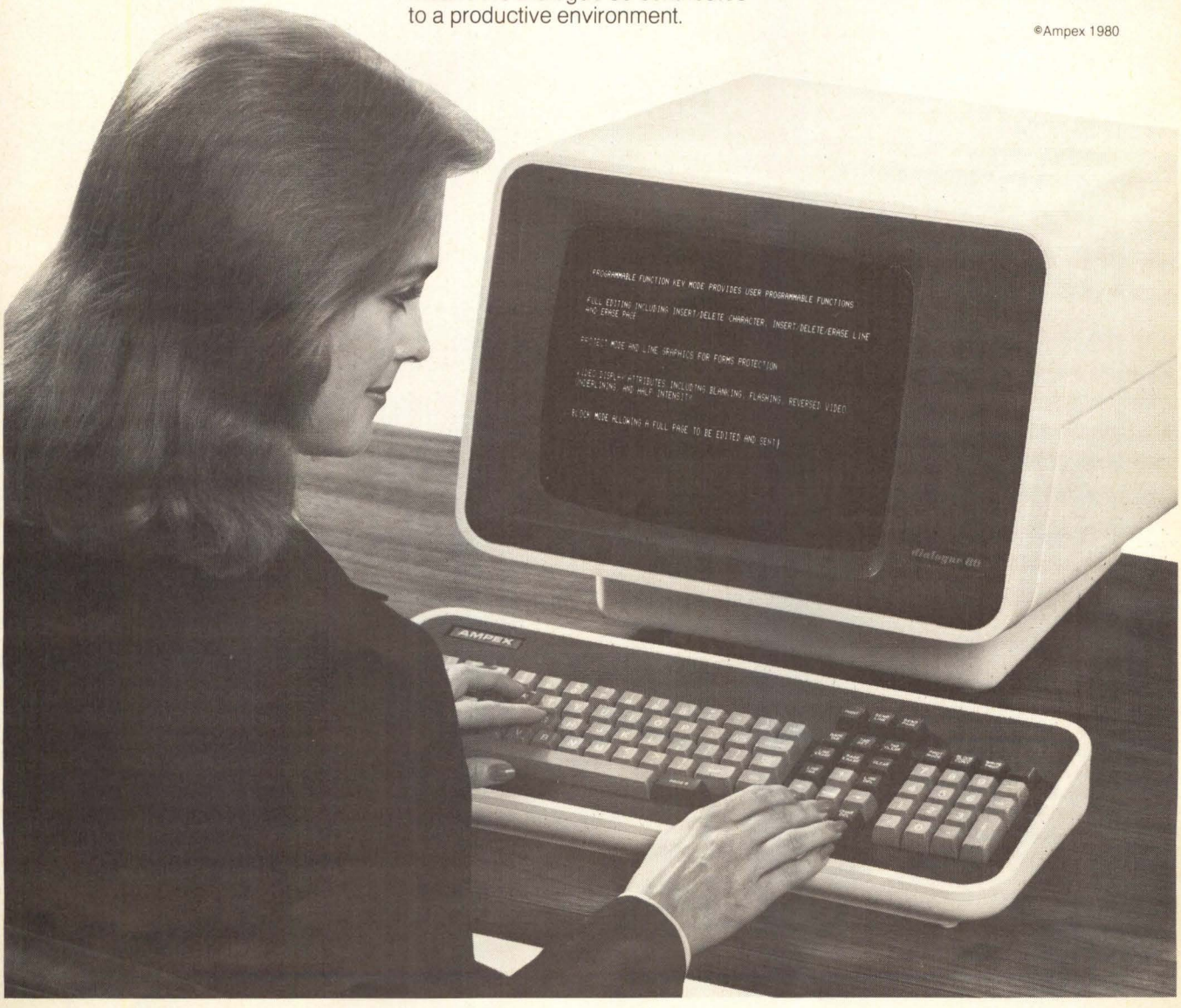


Circle 14 on Reader Inquiry Card

Steel Belt Styli Deliver Electrostatic Hard Copy

For inexpensive hard copy from storage tube or raster scan displays, Tektronix introduced the model 4611 and the 4612 copy devices. These units offer several notable features, the most important of which, from a marketing aspect, if not a design aspect, is the use of a dielectric paper that looks, feels, and acts like regular bond paper. According to the manufacturer, it provides archival-quality hard copy that doesn't fade. And the copies can be written on with pen or pencil.

Rather than the usual liquid toner, the 4611 and 4612 use a dry, powder-like toner that doesn't seep, leak, or smear. It consists of carbon and wax that's heat-fused to the dielectric paper. Total paper and toner cost for an 8-1/2″ X 11″ copy is about 3 cents.

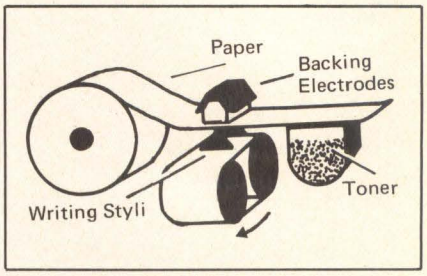
Design-wise, the 4611 and 4612 depart considerably from conventional electrostatic hard copy devices. Instead of a stationary row of print heads, Tektronix uses six writing styli on a rapidly rotating stainless steel belt. Above this belt passes the dielectric paper; above that are two backing electrodes that apply a voltage difference and, through the styli, place a small point of charge on the paper. Two of the belt's six styli are in contact with the paper at any instant. Switching each of the two electrodes on and off precisely determines placement of each electrical point.

After passing between the styli and electrodes, the paper travels over the toner applicator. Here, the points of electrical charge applied by the writing styli magnetically attract charged particles of carbon/wax toner. Finally, a hot metal band heat-fuses the black toner particles to the paper.

Resolution is 256 dots per inch horizontally and 170 dots per inch vertically. Because there is considerable dot overlap (67% horizontally, 40% vertically), lines drawn on the 4611 and 4612, although somewhat ragged, are more continuous than the dotted lines characteristic of other electrostatic printers.

Model 4611 copies from storage tube displays, while model 4612 works from raster scan video sources. Neither will set any speed records for delivering hard copy; they each require about 24 to 30 seconds per page. But they both produce copy that's high enough in quality and permanence to save, yet low enough in cost to throw out. **Tektronix, Inc**, P.O. Box 1700, Beaverton, OR 97075. **Circle 199.**

– Bob Hirshon



Instead of using stationary print heads, Tektronix employs six stainless steel writing styli on a rapidly rotating belt.

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25 ips standard and 100 ips streaming for only $3815.*

Get the only tape subsystem in the world that works with ANY Data General CPU or DG emulator, at a price you would expect to pay for only a tape drive. It's the most cost-effective tape backup available for Winchester disc drives, giving you maximum storage in the shortest possible time.

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Circle 15 on Reader Inquiry Card

DILOG INTERFACES DEC 11*

10 intelligent hard disc and magnetic tape controllers offer LSI-11,* 11/2, 11/23, and PDP-11* single quad slot compatibility with up to 60% power saving.

Only DILOG (Distributed Logic Corporation) exclusive automated design, common proprietary architecture and sophisticated bipolar μPs give you • all single board quad size products requiring no external power or chassis . . . just a cable to connect the drive . . . *you don't need anything else* • high reliability • automated self-test including data base protect feature and indicator. And at cost savings of 50% or more.

LSI-11 MAGNETIC TAPE CONTROLLER, Model DQ 120, interfaces 4 industry standard reel-to-reel drives • emulates TM11* • handles 7 and/or 9 track NRZI drives to 112.5 ips • selectable DEC or IBM byte order formatting • data error checking • RT-11/RSX-11* compatible • extended addressing to 128K words.

LSI-11 MAGNETIC TAPE COUPLER, Model DQ 130, interfaces dual density (NRZI/PE) formatted drives • emulates TM11 • handles up to eight 9 track 800/1600 bpi industry standard drives at speeds from 12.5 to 125 ips • "streamer" mode capability • software or switch selectable density • RT-11/RSX-11 software compatibility.

LSI-11 MASS STORAGE DISC CONTROLLER, Model DQ 200, interfaces any two SMD flat cable interface compatible hard disc drives for up to 500 MB on-line storage • mix or match compatible Winchester, SMD or CMD • variable sector size • automatic media flaw compensation with bad sector flagging • optimized logical to physical unit mapping • implements Winchester fixed head option.

LSI-11 SHUGART SA4000 WINCHESTER DISC CONTROLLER, Model DQ 201, emulates DEC RK* • runs drivers under RT-11 and RSX-11M* systems • compatible with 14.5 MB SA4004 or 29 MB SA4008 drives • automatic media flaw compensation.

*Trademark Digital Equipment Corp.

LSI-11 DISC CONTROLLER, Model DQ 100, interfaces 2.5, 5, 10 or 20 MB cartridge and fixed platter drives in combinations to 80 MB • RKV-11/RKO5* emulator • handles front load (2315) and/or top load (5440) drives • automatic power fail/power down media protection • RT-11/RSX-11 compatible.

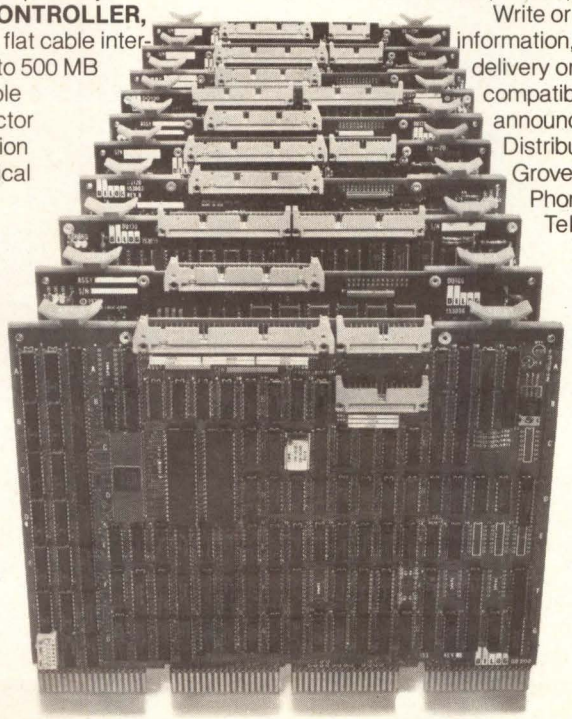
LSI-11 EMULATING MASS STORAGE CONTROLLER, Model DQ 202. Cost effective interface of two 8 and/or 14-inch Winchesters, SMD or CMD hard disc drives without changing controller . . . 8 to 300 MB capacity • RP emulator • automatic media flaw compensation.

PDP-11 MAGNETIC TAPE CONTROLLER, Model DU 120, emulates TM-11 and has same features as Model DQ 120 (LSI unit) • software compatible with RT-11, RSX-11, RSTS, IAS and MUMPS.

PDP-11 MAGNETIC TAPE COUPLER, Model DU 130, offers features of Model DQ 130 (LSI unit) • RT-11, RSX-11, RSTS, IAS and MUMPS software compatible.

PDP-11 DISC CONTROLLER, Model DU 100 includes features of Model DQ 100 (LSI unit) • RT-11, RSX-11, RSTS, IAS and MUMPS compatible • emulates RK-11.

PDP-11 EMULATING MASS STORAGE CONTROLLER, Model DU 202, offers same features as Model DQ 202 (LSI unit).



Write or call for detailed product performance information, OEM quantity pricing, stock to 30 day delivery or warranty data on these DEC 11 compatible products . . . or several soon to be announced new DILOG products.

Distributed Logic Corp., 12800-G Garden Grove Blvd., Garden Grove, CA 92643
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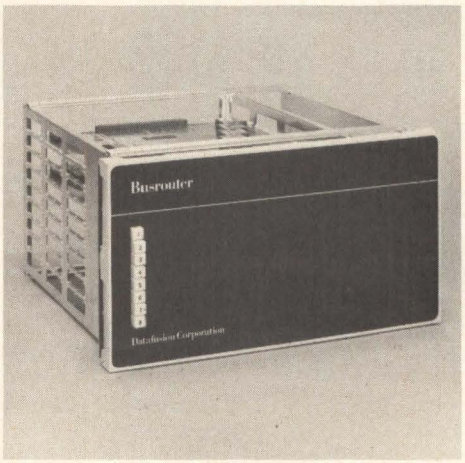
Circle 12 on Reader Inquiry Card

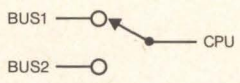
Reconfigure your PDP11 Unibus* with the push of a button.



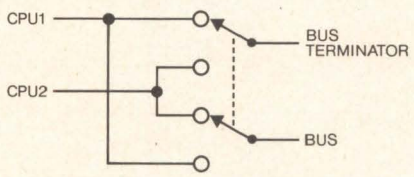
Do you need to share peripherals? Do you have multiple cpu's with a limited number of peripherals? Do you need to selectively choose which peripheral is on the bus?

If so, Datafusion Corporation's OSR11-A Busrouter can help. It is a passive, manually operated device to perform the physical and electrical switching of the Unibus* for PDP11 series computer systems: up to eight switching planes (i.e., configurations); electromechanical switching relays (simple, high reliability, minimal electrical loading).

Essentially, each Busrouter switching plane can be viewed as a single pole, multiple throw switch.



The application shown here is a situation opposite the first, where one peripheral bus can be switched between two cpu's with the cpu not selected being terminated.



Many more configurations are available such as sharing multiple peripheral devices between multiple cpu's and then selectively choosing to switch each one or all to one cpu or another.

Other PDP11 products available are a bus repeater, bus cable tester, and an associative processor for high speed text search – a hardware approach.

We also have some ideas for the application of our products which might not have occurred to you. If you can't get the performance that you would like from your PDP11 system, maybe we can help. Please telephone our Marketing Manager at (213) 887-9523 or write to Datafusion Corporation, 5115 Douglas Fir Road, Calabasas, California 91302.

*TRADEMARK OF DIGITAL EQUIPMENT CORPORATION

Circle 16 on Reader Inquiry Card

Innovative Design

And the band plays on and on and.....

In the mid-1950's, computers came out of university research labs and exploded into the commercial world. Since then, the computer industry has expanded faster and with more vitality than any other industry in all the chronologies of science. No other newly-developed technology ever enjoyed a quarter-century of undiminished growth. How long will it continue before leveling off? Will 1981 be another year of increase in both technology and sales? Stephen G. Jerritts, President of Honeywell's Information Systems sees no early end to the rainbow:

"Honeywell expects 1981 trends in the computer industry," he declared recently, "to parallel those of 1980. The industry will exhibit steady growth, possibly impacted by uncertainty of the US and international economies.

"Demand for systems to help users improve productivity will continue.

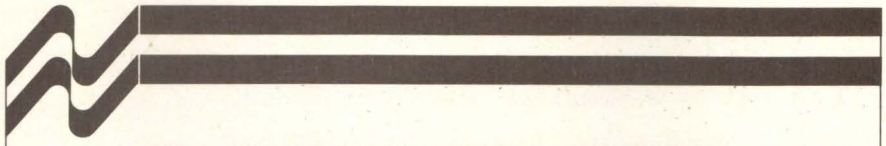
"There are, however, some potential areas of difficulty for the whole industry in 1981. The present trend towards record high interest rates, if prolonged, could negatively impact the industry because of the high cost of leasing. Also, international markets may not maintain the strength displayed during 1980."

(Meanwhile the industry continues to welcome in every new year with the same song it has sung the past 25 years and hopes to sing again during the forthcoming 25: "Happy days are here again!") *–H. Shershow*

DEC-Compatible Winchester and Floppy Storage

The DEC compatible LSI-11 "Flinchester" storage system, FWT01172 system includes 8.9M bytes of fixed 8" Winchester storage plus 1M byte of double sided floppy disk storage. Also available for the PDP-11, the "Flinchester" systems include disk drives, controller, interface, power and cabling in a low profile 5 1/4" rack or table top enclosure.

"Flinchester" storage systems are compatible with standard DEC operat-



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ing systems RT-11 and RSX-11M. Operating with floppy diskettes, standard DEC RX01, RX02 and IBM 2/2D formats are automatically recognized for data input and output. The double sided floppy disk provides over 40% faster average access compared to DEC single head RX02 floppy disk drives.

Winchester disk operation increases performance of DEC LSI-11/PDP-11 floppy based systems. Average access to 8.9M bytes of storage is 70 msec with greater than 500K bytes per second data transfer rates. System throughput improvements of up to 8 times that of DEC RX02 floppy based systems are achievable.

SMS has solved the Winchester backup problem through the use of 1M byte floppy disk drives. Reliable and low cost floppy diskettes require less than 60 seconds to transfer 1.2M byte of data to or from the Winchester disk. The SMS "Minute per Megabyte" solution allows an operator to backup 8.9M bytes in less than 8 minutes including insertion and removal time. Alternatively for many partial backup or selective file backup applications only a single convenient diskette may be required.

A proprietary SMS "Flinchester" controller is included in the FWT01172 to interface between the LSI-11 Q-Bus and both floppy and Winchester disks. Two modes of operation are possible. Compatible mode provides complete DEC RX02 hardware, software and media compatibility. Standard DEC software will run on "Flinchester" systems without any modification to device handlers. To access the Winchester disk and IBM compatible floppy disks, the controllers' extended mode can be utilizied with an appropriate device handler. SMS offers device handlers for RT-11 and RSX-11M operating systems.

The extended mode also increases system throughput due to high performance DMA interface operations. Rather than transferring only one disk sector per command, up to a 65K byte data block may be transferred in a single command. The LSI-11 is not interrupted until a transfer completes since the SMS "Flinchester" controller automatically steps to successive tracks or cylinders. Up to (2) floppy disks and (2) 8″ Winchester disks are supported by the SMS controller. Each device is addressed independently by the same SMS RT-11 or RSX-11M handler.

Additional features of "Flinchester" systems include extensive test and diagnostic support. Resident controller self-test automatically performs basic CPU, memory, controller and drive test after each power up or bootstrap operation. Additional tests may be executed via software selected maintenance commands or via on board switches. LED indicators display basic system malfunction via error code display. More extensive test and utility operations are easily performed through a special SMS Installation and Test diskette. The diskette automatically boots a stand alone program which provides a convenient and easy to use terminal-to-operator interface. A menu driven display with operator selection allows testing, drive alignment, copying, formatting, scanning and Winchester backup and load functions. Prices start at $6700.

Scientific Micro Systems, 777 East Middlefield, Rd., Mountain View, CA 94043.

WINCHESTER DISKS
FLOPPY DISKS
DEC® RX02 COMPATIBILITY
LSI-11® Q-BUS

IN A SINGLE ENCLOSURE!

COMPATIBILITY . . .
Add 10M bytes of Winchester disk and 1M bytes of floppy disk storage to your LSI-11 computer with the SMS DSX01172 Disk System 11X. Plug any configuration of LSI-11 modules (including LSI-11/23) into the Disk System 11X's 8 quad slot Q-Bus backplane. Enough power is provided for up to (13) dual height cards and the SMS dual height "Flinchester" controller.

The single dual head floppy disk is hardware, software and media compatible with the DEC RX02. Software selectable IBM 3740, 2/2D formats provide diskette interchange with IBM and other non-DEC systems. On-board bootstrap loads (from Winchester or floppy) and runs your RT-11, RSX-11M and other software automatically at power up. All this plus resident diagnostics in a single 10-1/2" package.

AND MORE PERFORMANCE . . .
The latest 8" Winchester disk technology gives you up to 20% faster data transfers than DEC's RL01. Extended mode operation allows multiple sector and contiguous across track block transfers during Winchester or floppy access. The DSX01172 also runs floppy disk fill and empty buffer operations over 34% faster than RX02. Automatic error retry and automatic flaw mapping are standard features during Winchester disk data transfer.

PLUS GROWTH
For storage needs beyond 10M bytes, the SMS WIN 1426 add-on Winchester disk provides up to 26.4M bytes for Disk System 11X. Choose either a DSX01172 resident 10M bytes Winchester disk or an add-on 26.4M byte 14" Winchester in a low profile 5-1/4" enclosure. The WIN1426 cable connects directly to the SMS "Flinchester" controller resident in the Disk System 11X. And the WIN1426 provides twice the data transfer performance and five times the storage capacity of DEC's RL01.

AVAILABLE SOON!
PDP-11 or LSI-11 Winchester plus floppy disk add-on storage in a single 5-1/4" package!

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The New Standard For PDP-11 Disk System Technology

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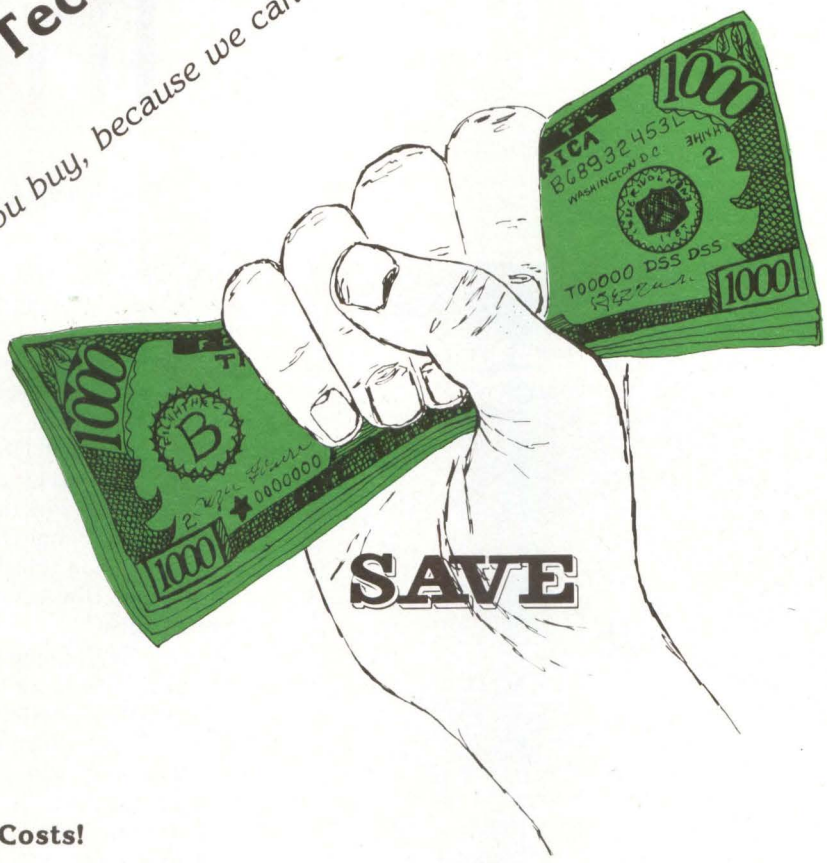

Know All the Hidden Costs!

Only System Designed Just for PDP-11 Family
Designed exclusively for DEC's UNIBUS or MASSBUS CPU's. On the UNIBUS, it's just one card that plugs into any spare SPC slot. On the MASSBUS, four cards plug into any spare existing RH70 standard back plane.

Same Disk Drive as DEC RM02-03, RP06 and RM04-05
We use the same disk manufacturers as does DEC. The RM02-03 is the 9762 CDC 80MB and the new RM04-05 300MB is the CDC 9766. Only the LOGO is different.

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You bet! Use your existing Software. . . no change needed. Runs all DEC's Diagnostics plus has its own. Fully emulates DEC disk Drivers.

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Through Data Systems Services, maintenance and installation is provided via CDC for both Drive and Controller. We also offer full PDP-11 system support.

Full Media Compatible?
That's right! You can read or write on our drives. Put it on DEC's and it will play or vice versa. TRULY MEDIA COMPATIBLE.

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DRJM02 80MB + Controller	DRWP06 200MB + Controller
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DRJM04 300MB + Controller	DTU125
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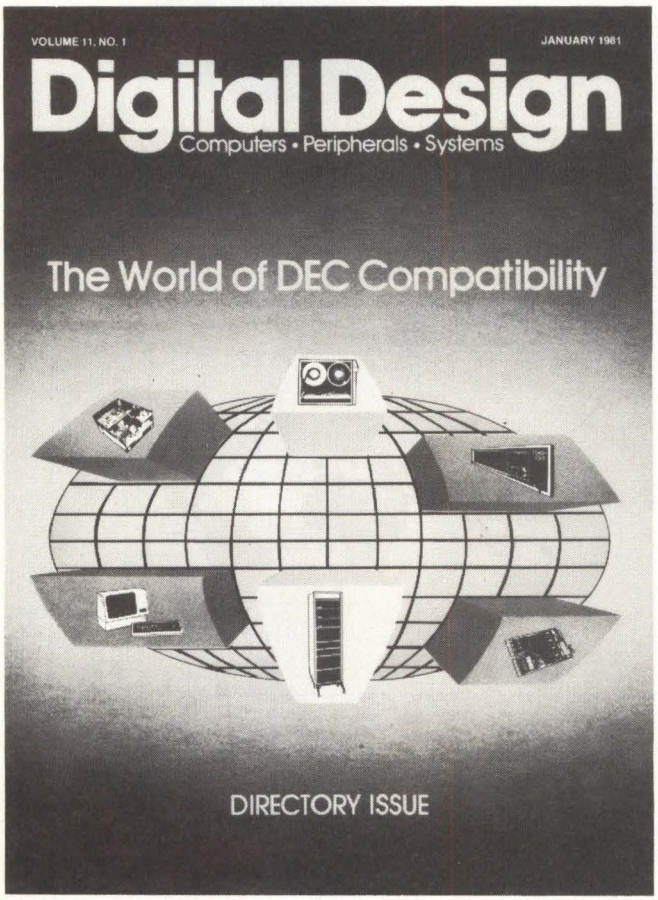
Circle 20 on Reader Inquiry Card

The DEC

Paul Snigier, *Editor*



Digital Design's "DEC-Compatible Directory" is the first such directory published by any electronics/computer tabloid or magazine. Prior to publication, it generated unusually strong reader and manufacturer interest. We suspect it might go on to become a collector's item that will be saved and referenced over the next 12 months (and beyond).

This is our first DEC-compatible directory, but it does not mark the beginning of *Digital Design*'s coverage of this specialized field. For the past four years, *Digital Design* has published more on DEC-compatible products than any other publication. Finally, last August we published the industry's first DEC-compatible issue, "The World of DEC-Compatibility."

Future "DEC-Compatible Directories" will expand coverage to include more firms and products. Do you produce DEC-compatible devices or offer compatible software or services? If your firm and products are not listed in this issue, then we would like to add your name to an updated directory scheduled for July. (That directory will also describe new products and services introduced in the interim. So, if you want your new products included in the next directory, then simply refer to "Speakout," in this issue, and complete the "DEC-Compatible Questionnaire." One product per page, please (make photocopies as necessary.) Mail to *Digital Design*'s Directory Editor.

Your listing will be seen by *Digital Design*'s 65,000 direct (173,000 total) readers – system designers, OEM integrators and system builders. A sizeable segment of these readers design and integrate DEC-compatible products into their systems.

Meeting OEM/user needs

Makers of DEC-compatible equipment will experience continued growth. Any recessionary trends will not be felt to any extent; even if lead times of DEC equipment were to lessen, users will continue to seek DEC-compatible peripherals and boards to extend their existing systems capability. In fact, in recessionary times, or in times when upward movement to a superior system is difficult due to long lead times, the tendency is to upgrade existing computer systems. For DEC-compatible equipment makers, this spells a bonanza.

Two sides

The coin has two sides. For DEC users, the bonanaza for DEC-compatible manufacturers translates into more competitive systems from the numerous firms, all to the advantage of DEC users. The cross fertilization of product developments from this hotbed of activity promises to maintain DEC's commanding lead over its competitors.

Compatible World

Foreign peripheral vendors also offer technologically superior boards, peripherals and products DEC can't (or doesn't want to) produce. In many cases, they incorporate the latest available devices into their products before DEC will. If DEC's long lead times are due to a lack of computers being shipped, that's one thing (usually bad for add-in/on vendors); if due to a memory shortage, as we've seen recently, this is good for the DEC-compatible makers. For the growing 32-bit VAX market, which has yet to hit in full force, lack of mass memory promises to lure more plug-compatible vendors into this arena. Unlike the PDP-11 field, vendor reputation and commitment are even more critical with the VAX. Once suffering from a "here today, gone tomorrow" reputation, the plug-compatible vendor market is respectable: it has come of age and past reputation no longer will prove a deterrent to users seeking to increase the capability of their VAX systems.

Users last summer were shipped VAX systems with only 256 kB out of the original 768 kB that was originally promised. They had to wait several months. Since the VAX can address 32 MB, this add-in/on memory market shows great promise for the independents.

Delivery woes

Whenever a manufacturer like DEC can't meet demand (or fails to anticipate demand accurately), distributors and users alike take it on the chin. The LA120 teleprinter last spring is just one example that comes to mind. When DEC discovered deliveries would slip, it failed to notify dealers; the dealers did not discover it until two months later, putting them behind the eight ball. Firms that leased such products were worse off. For those who couldn't wait, purchase of a TI820 or other unit was the only option left.

The scenario has been repeated again and again. VT-100 deliveries fell far behind and emulators jumped in.

Vendor strategies differ

Vendor approaches are interesting. If a vendor can retrofit an existing product for DEC-11 compatibility, he has opened new markets. Plessy Microsystems did just that; it took its MIPROC-16 high-speed 16-bit computer and configured it to operate as an Associate Processor to DEC's PDP-11s.

Dilog (Distributed Logic) is one firm offering a number of DEC-11-compatible products. To capitalize on the growing mass memory market, Dilog introduced a quad-size LSI-11 compatible intelligent Magnetic Tape Couple that includes TM-11 emulation circuitry and exclusive built-in circuitry that handles tape product advances such as "Streamer" mode operation.

Sometimes, an unmet need expressed by DEC users creates a market. For example, system builders and users required "system units" and/or "expansion chassis" used with the currently available controllers which occupy two to four slots. With this need in mind, Avid (Woburn, MA) designed what was believed to be industry's first dual density (800/1600 bpi-NRZI/PE) single hex board mag tape controller for PDP-11 and VAX-11 computers.

DEC-compatible manufacturers have found it pays to minimize the system integration problems for the customer – whether the customer is an OEM or end user. AED (Sunnyvale, CA) accomplished this for each of three controllers by utilizing a technology and architecture reducing component requirement while providing functionality capable of yielding emulation of a DEC disk system.

The above are just a few vendor strategies. Each firm positions itself in what it perceives as an advantageous marketing niche. If the vendor succeeds in correctly evaluating the market, he's in clover; if not, he goes hungry and may not support that line properly. And, if you miscalculate when selecting a vendor who's not totaly committed to a given product line, then you're also in trouble. The bottom line is this: check the firm's staying power and commitment to that given product line. *Digital Design*'s "DEC-Compatible Directory" will help you make comparisons between the many vendors. The Directory can help you select optimum companies for particular needs.

Directory acronyms

All product models/numbers in the Directory are boldfaced with heavy type, as are company names. Each new product begins on a new line. To prevent redundancy, names of firms that submitted several products were listed only once – after their last product. (Due to numerous products offered in some cases, we did list a company's name more than once, to avoid confusion.)

A brief description follows the product name/number. The next entry is a word code, indicating the type of vendor maintenance available. "FO" signifies that the firm has field offices; "3rd party", that it uses third party maintenance; and "None" may mean that the firm has a return-to-factory repair – generally the address listed at the end. The acronym "1-yr. RTFW" signifies there is a one-year return-to-factory warranty. The term "RTFR" means return-to-factory repair. Warranty period, if not mentioned, was not listed by the company. "W" and "w/o" mean "with" and "without." "MUXer" stands for "multiplexer." "Comp." is "compatible." "HW/SW-comp." is "hardware/software-compatible." "V" means "vendor maintenance available."

DEC-Compatible Directory

LSI-11/2/23-based 20-MB Winchester/tape cartridge backup. "Dekchester" includes business software. LSI-11/2-based floppy WP system, "Minichester," has CRT, 64 kB, 1-MB dbl. density RX02-compatible floppies, printer.
PDP-11 business software. Includes WP for RT-11.**ABC Computers, Inc.,**Box 7529, 500 Tonopah, Tahoe City, CA 95730. (916) 583-5562.

DMAX/16 10048. Replaces the DEC DH11-AE and DH11-AD. The DH11-AE Equivalent is 2 hex-sized PC boards plus a distribution panel. The DH11-AD equivalent is 3 hex-sized PCBs and the panel. PDP-11 & LSI-11. Maintenance handled on RTFW. $5200 to $6300 for qty 1. Rev. due 1/1/81.
Quadrasync/E 10028-1. Equivalent to 4 ea. DEC DL11-E; RS232 and full modem control. The QUAD/E is an extended-width QUAD PC Board. PDP-11 & LSI-11. $1300 for qty 1.
Quadrasync/B (10015) Quadrasync/C (10022). QUAD/B is equivalent to 4 ea. DEC DL11-B, RS232, no modem. QUAD/C is equivalent to 4 ea. DEC DL11-C, current loop. The QUAD/B and QUAD/C are single quad-sized PC Boards. PDP-11 & LSI-11. $950 for qty 1.
Quadracall 10045. Replaces DEC 4 line DN11. This is a single quad-width board that connects up to 4 auto call units to a PDP-11. PDP-11 & LSI-11. $1400 for qty 1.
DZ/16 10090-1. PDP-11 & LSI-11. $3500 for qty 1.
DV/16. PDP-11 & LSI-11. 8 channels is $7500 for qty 1.
SCAT/45 10019. PDP-11 & LSI-11. $12,000 for qty 1 of basic set.
CACHE/45 10006-2. PDP-11 & LSI-11. $4500 for qty 1.
Emuloader 10047. PDP-11 & LSI-11. $500 for qty 1.
Qniverter 10067. PDP-11 & LSI-11. $750 for qty 1.
Univerter 10001. PDP-11 & LSI-11. $675 for qty 1.
Rebus 10014. PDP-11 & LSI-11. $1400 for qty 1.

Dual I/O 10039. PDP-11 & LSI-11. $950 for qty 1.
Buslink.PDP-11 & LSI-11. $2100 to $3600 for qty 1. Dir. of Marketing, **Able Computer** 1751 Langley Ave., Irvine, CA 92714 (714) 979-7030.

AR-2100 VHS Digitizer. A/D conversion for real time analysis of wide band signals. DEC. Sell, service. V. $100K-$200K. Dean A. Strack,**Adams-Russell Co. Stein Div.** 280 Bear Hill Rd., Waltham, MA 02154 (617) 891-4700.

PDQ-3 high-speed, stack oriented computer system. It directly addresses 128kB of memory and executes Pascal and other higher level language statements directly by executing UCSD "P" code. It operates on "defacto" standard bus, DEC-11/23 "Q" Bus with variety of interfaces for disk drives, mag tapes, A/D, communications, etc. Advanced Computer Design. Sell, service. Terminals: Zenith Z-19, Sorac and most video terminals currently available. Add-in/add-on memory: "Q" Bus compatible memory, core, etc. Floppy disk drive: CDC, Shugart & Shugart Compatible Drives. Hard disk drive: CDC and Storage Module (SMD) compatible drives 12-300 MB's/Drive. Controllers: Emulex, Dilog. I/O analog boards: A/D, D/A, IEEE, Digital I/O. Others: Mag Tape Interfaces, graphics interfaces, communications mux. FO. TP. High Performance 16-bit stack-oriented computer system executes UCSD Pascal P-Code directly. Supplies with UCSD O.S., Pascal compiler, screen-oriented editor and linker. Fully Interrupt. $6,495 (board only, $3,195) Includes 2 double-density floppies & controller drives.
DM45. Emulex TC/11-P, Cipher 900X 75 IPS tape drive, 15 feet cable, 800/1600 IPS. Controllers: Emulex. $9,600.
DM77. Emulex TC11/P, Cipher 900X 125 IPS Tape Drive, 800/1600 BPI, 15 feet cable. Controllers: Emulex TC11/P. $10,995.
DM80.CDC 9762 80MB Disc Drive, "A" Cable 20′, "B" Cable 20′. Hard disk drive: CDC 9762 80MB Disk Drive. $8,550.
DM300. CDC9766 300MB Disk Drive, "A" Cable 20′, "B" Cable 20′. Hard disk drive: CDC 9766 300MB Disk Drive. $14,500.
DM02/70 (Massbus Disc Subsystem). Emulex SC70 Controller, CDC 9762 80MB Disc Drive, "A" & "B" Cable 20′ each, Terminator (Drive). Hard disk drive: CDC 9762. Controllers: Emulex SC70. $16,500.
DM02 (Unibus Disc Subsystems). Emulex SC11 Controller, CDC 9762 80MB Disc Controller, "A" & "B" Cables 20′ each. Hard disk drive: CDC 9762 80MB. Controllers: Emulex SC11 Controller. $14,550.
DM06/70 (Massbus Disc Subsystem). Emulex SC70 Controller, CDC 9766 300 MB Disc controller (SMD), "A" & "B" Cables 20′ each, Data & Signal. Hard disk drive: 9766 300MB Disc Drive. Controllers: Emulex SC70 Controller. Emulex SC70/B2 Massbus Controller, Disk Drive Avg. Access time 80ms, 1.2 MB/sec transfer rate, 3000 RPM. $22,500.
DM06 (Unibus Disc Subsystem). 300MB Disc Drive 9766 CDC, Emulex SC11 Controller, "A" and "B"' Cable 20′ each, Terminator (Drive). Control Data. Hard disk drive: CDC 9766. Controllers: Emulex SC11. $20,500. Vincent Maturo/Herb Allaire/Gary Noonan, **Advanced Digital Products,** 7584 Trade St., San Diego, CA 92121 (714) 578-9595.

AED 512 Graphics Terminal. Full color imaging and graphics capability for your DEC system. 256 simultaneous colors (full video memory). Select from a pallette of 2^{24}. 16K dynamic MOS, organized in m = 1 to 8 Picture planes of 512 by 512 bits. Colors = 2 to the nth. DEC (and interface for DG). FO. Controller $8875 (1-9); monitor $2500 (1-9).
AED Flex-02. Floppy Disk controller for LSI-11 Q-Bus, providing emulation of the RX-02. LSI-11. Controllers, FO. $1220 (1-9).
AED Storm-02. RM 02 emulator for storage module disks. Disk pack interchangeability with DEC. Controllers. $4325 (1-5).
AED Winc-01. RL01 transparent controller for Winchester-type drives. LSI-11/2, /23. Sell, service. Hard disk drive, controllers. $6495. Gary Wilson, Nat'l Sales Mgr., **Advanced Electronics Design, Inc.,** 440 Potrero Ave., Sunnyvale CA 95014 (408) 733-3555.

Cartridge Tape Subsystem DP-8000. The DP-8000 is a Tape FORMATTER intended to make the DEI Transport look like a FORMATTER 9-trk Open Reel Transport. In particular, it is Connector Compatible as a PERTEC FT-7000/8000. DEC. Sell. Controllers. Return basis. 6400 BPI, 4-track serial, 13.4 MB/cartridge @ 8K record length. DP-8000 Subsystem $3400. Ron Richard/Dick Gorgens, **Alloy Engineering Co., Inc./Computer Prod. Div.,** 85 Speen St., Framingham, MA 01701 (617) 620-1710.

M/Core. Solid state add-on core memories for computers with controller for Unibus I/O on PDP-11 computers. Add-on memory, controllers, HO. Un limited capacity. 750-ns avg. access time. PDP-11 Unibus computer controller. $15,000/MB in qty.
Model Eighty. Head/track disk add-on memory for computers with controller for Unibus I/O on PDP-11s. Add-on memory, hard disk drive, controllers, HO. 1 to 8 MB capacity head/track disk memory. 8.5 ms avg. access time. PDP-11 Unibus controller. $7,000 to $17,000 in qty. L. T. Lincoln, **Alpha Data Inc.,** 20750 Marilla St., Chatsworth, Ca 91311 (213) 882-6500.

Ampex Megastore 11. Non-volatile memory replacement for fixed head disks on Unibus systems. RJS03, RUS04, RF11 compatible. PDP-11. Sell, FO. Capacity: 512 KB to 8 MB. Transfer rate: 500,000 B or 1 MB. $22,000/MB.
Ampex ARM-1170 Mainframe Memory. Plug compatible mainframe memory for PDP 11/70 computers. Alternative to MJ-11 and MK-11 memory. Sell, FO. 345 ns effective cycle time. 275 ns memory module access time. 650 ns memory module cycle time. 64K to 512K capacity.
Ampex ARM-20S Expanded Mainframe Memory. 256K to 2048K replacement and add-on semiconductor memory. DEC System 20. Add-on semiconductor memory. 36 bits plus parity. 256K to 2048K words in 256K increments. Access time:

550 ns max - 32MHz CPU clock/660 ns. Max - 25 MHz CPU clock.

Ampex ARM-1100P Parity Memory. Add-on parity memory for PDP-11s employing Unibus structure. Add-on parity core memory. 32K words × 18 bits module capacity. 275 ns access time. 650 ns cycle time. System capacity: 32K to 128K words. DATO/DATI/DATIP/DATOB operating modes.

Ampex ADC-01 Intelligent Disk Storage Module Controller. Disk controller that interfaces all PDP-11 computers utilizing Unibus interface to 1 or 2 storage module drives. Ampex 900 and 9000 series. Storage capacity 40 to 6000 MB. Transfer rate: 0.806 or 1.209 MB/sec. $3580. Gary Owen, **Ampex Memory Products Div.,** 200 N. Nash St., El Segundo, CA 90245 (213) 640-0150.

DP-9500 DEC Printer. Alphanumeric/Graphic printer, 16.8 inch paper, 3 char. fonts standard. Sell, service. V. 14 FO. 150 to 200 cps, 1.75 to 16.8" paper width. Full hor. and vert. format control. 60 × 72 dots/in. resolution in Graphics. DEC Protocol or STX/ETX Protocol. $1,830. J.W. Knox, **Anadex Inc.** 9825 De Soto Av., Chatsworth, CA 91311 (213) 998-8010.

RSX-11M DCL. Digital Command Language Interpreter for RSX-11M OS. English commands such as COPY, RENAME, ASSIGN. Easy to use. Supplements but does not replace MCR routines. 1-yr. support. SW also runs under VAX/VMS. **Andrew Rubel & Assoc., Inc.,** One Soldiers Field Park 605, Boston, MA 02163 (617) 876-7993.

LSI-11 Video Display Generator. (VDC II), LP-11 line printer interface, FDC-11 floppy controller, 8 × 4 Q-bus card cage, etc. **Andromeda Systems,** 9000 Eton Ave., Canoga Park, CA (213) 709-7600.

Ann Arbor Ambassador. A CRT terminal which implements the ANSI X3.64 std., including full editing, erasure, formatting, print/copy and transmission parameters. Capable of displaying 18 to 60 lines of 80 char., selectable from host or KB. Includes detached 92-key KB with 15-programmable function keys. TTY-compatible. Sell, service. Factory maintenance only. $1300-1430.

Model 400S. A compact CRT terminal with 2000 character memory, available in 25 × 80 (24 lines displayed), 50 × 40 (24 lines displayed), and 50 × 40 (12 lines displayed) formats. Includes direct cursor addressing; blink, dim and reverse-video accents; detached 72-key KB with separate numeric pad/cursor controls (up to 36 function keys optional); 15" non-glare screen. All TTY-compatible equipment. From $1220.

Model VT52-COMPAT. A CRT terminal which emulates the VT52 in function and command structure. Includes 24 line × 80 character display format, upper/lower case, blink accent for highlighting, cursor addressing, erase to end-of-page/end-of-line, and detached keyboard with 3 programmable function keys; 15–in. non-glare screen. All TTY-compatible equipment. Factory maintenance only. $1450. Sarah Freeman, **Ann Arbor Terminals, Inc.** 6175 Jackson Rd., Ann Arbor, MI 48103 (313) 663-8000.

2301 Line Printer Controller. PDP-8, 11 series. Centronics/Printronix compatible. $700. **Deskware Computer Furniture.** Printer Stands/CRT Workstations/System Cabinetry. **Ardent Computer Products.** 399 Fairview Dr., Elmsford, NY 10523 (914) 347-3922.

Model 8900. Programmable IBM Channel-to-DEC Q-bus interface. OEM version consists of 3 Quad-height modules. Terminals: SOROC IQ-120. Floppy disk drive: DSD and DEC RX01/2 types. Controllers: DSD/DEC. Emulates std. IBM control units.Transfers data at up to 1 MB/sec. Data transfer via DMA (NPR). Hardware/Software compatible with LSI-11/02/23. $4,994 (1); $2,995 (50+).

Model 8911. Programmable IBM channel adapter standalone interface that provides channel speed interface between an IBM channel and a DEC computer (also other non-std. devices). Buy. Factory or on-site repair. Emulates standard IBM control units. Data transfers on the channel up to 1 MB/sec. Contains LSI-11/02, 32-K RAM, tape drive, 2 serial ports, 4 user available quad-slots. $12, 995(1); $10,995 (50+). **Austron Data Systems,** 1915 Kramer Ln., Austin, TX 78758 (512) 836-3523.

NTDS Interface Model Nos. 14190-501 & 14192-501. Rockwell's NTDS interfaces provide the communications link between PDP-11/VAX computers and U.S. Navy std. tactical computers or NTDS peripherals with fast, slow or Anew channels. Sell, service. $7,000-$9,000. John G. Burlinggame, **Autonetics Marine Systems Div.,** 3370 Miraloma Av., Anaheim, CA 92803 (714) 632-4995.

Disk Drive Exerciser, Model 113B or Model 108. Portable, hand-held disk drive exercisers for field maintenance of floppy/hard disk drives. DEC (RK05). Allan Hughes, **Ava Instrumentation, Inc.,** 9672 Manzanita Av., Ben Lomond, CA 95005 (408) 336-5048.

Tape File Controller Model TFC-812. Dual density 800 NRZI/1600 PE bpi mag tape controller for PDP-11/VAX-11 systems. FO; 3rd Party. Imbedded controller, IBM/ANSI compatible, daisy chain up to 8 tape drives, large data buffer for ease of system config., checks VRC, LRC, CRC, read after write parity check, software compatible with DEC O.S. using TM-11 handler, compatible with industry std. tape drives. $3400.

Tape File Controller Model TFC-912. Dual density 800 NRZI/1600 PE tape controller for LSI-11, -11/2, -11/23. Imbedded controller-occupies one Q-bus slot, fits all LSI-11s, IBM/ANSI compatible, daisy chain up to 8 tape drives, operates with tape drives from 12.5 to 125 ips, large data buffer for ease of system config., checks VRC, LRC, and CRC, read--write-parity check, software compatible with DEC O.S. TM-11 handler, compat. with industry std. tape drives. $3,500.

Tape File Controller Model TFC-822. Single Board Dual Density 800 NRZI/1600 PE Tape Controller for PDP-11/VAX-11. Sell, service. Hardware/software compatible with PDP-11/VAX-11 that use TM-11 Handler. Requires only 1 hex SPC slot. ANSI/IBM-media compatible, automatic threshold control and read retry mode, multi-word transfer across the Unibus, large FIFO data buffer, word and byte transfer, self-test on power turn on, daisy chain up to 8 tape drives, mixing two tape speeds and mixing single- and dual-density drives and multi-drives configuration. $3,000 (OEM qty.).

Tape File Subsystem Model TFS-804-1075 GCR Tape Subsystem. Dual density 1600 PE/6250 GCR bpi GCR tape subsystem for PDP-11/VAX-11. System uses a STC GCR tape drive at 75 ips. Dual density 6250 GCR/1600 PE bpi is standard, 4K FIFO data buffer, fits all PDP-11/VAX-11 computers, controller occupies one SPC slot, ANSI/IBM media compatible, software compatible with DEC operating systems, multi-word transfer, IBM or DEC packing via byte swapping, tape auto thread/load μP controls. $31,950.

Tape File Subsystem Model TFS-805-1125 Tape Subsystem. Dual-density 1600 PE/6250 GCR or tri-density 800 NRZI/1600 PE/6250 GCR bpi recording densities with tape speeds at 75 or 125 ips. System software compatible with PDP-11/VAX-11 systems. Dual-density 1600 PE/6250 GCR bpi industry std., 4K FIFO data buffer, controller occupies one SPC slot, ANSI/IBM media-compatible, software compatible with DEC operating systems, multi-word transfer, IBM or DEC packing via byte swapping, tape auto thread/load, μP control. $34,500.

Tape File Subsystem Model TFS-806-1075 & TFS-806-1125. GCR tape subsystem with dual density 1600 PE/6250 GCR bpi or tri-density 800 NRZI/1600 PE/6250 GCR bpi for operation at 75 or 125 ips. System interfaced and software-compatible with PDP-11/VAX-11. Sell, service. Dual-density 1600 PE/6250 GCR, bpi industry std., 4K FIFO data buffer, controller occupies 1 SPC slot, ANSI/IBM media compatible, software compatible with DEC O.S., multi-word transfer, IBM or DEC packing via byte swapping, tape auto thread/load, μP control. $34,500. John S. Connolly, VP-Sales, **AVIV Corp.,** 6 Cummings Park, Woburn, MA 01801. (617) 933-1165.

BD50-1,2 BD80-1,2,3 BD 160-3 BFM90 BFM160 3255. 50, 80-MB disk drives with Trident or SMD interface. 160-MB SMD interface. 90 & 160-MB Winchester disk drives. DG intelligent controller for all above disk drives. For any and all who use Trident or SMD. Terminals, add-in/add-on memory, floppy disk drive, hard disk drive (50-80-160 removable 90-160 Winchester), controllers (3255 DG intelligent), I/O analog boards. No vendor maintenance available. Mr. Richard Bravo, **Ball Computer Products,** 860 E. Arques, Sunnyvale, CA 94086 (408) 733-6700.

B

DECSystem Controller. LPC-20 plug-compatible controller/printers handles printers (300, 600, 900, 1200, 1500, or 1800 lpm). SW comp. w/TOPS-10, TOPS-20 OSs. Quad-board (10.5″ H by 9″ W by 0.875″ T). Hex-board (5.062″ H by 9″ W by 0.875″ T). Power (+5Vdc @ 4.5A). $6,500. Printer systems (w/LPC-20), from $10,250 (300 lpm) to $33,500 (1800 lpm). **BDS Computer Corp.** (Line Printer Systems), 1120 Crane St., Menlo Park, CA 94025. (415) 326-2115.

PC design. Design and documentation of PCBs compatible with DEC, etc. for terminals, add-in/add-on memory, floppy disk drive, hard disk drive, controllers, I/O analog boards, processors. Price quoted, based on complexity/density. Bill White, **Bill White Printed Circuit Design,** 1106 So. Ambridge St., Anaheim, CA 92806 (714) 778-1477.

BIZCOMP 1022 Intelligent Modem. Auto-dialing, auto-answer, FCC-registered, Bell 103-compatible controlled by 3-wire RS-232 interface. Can write comm. software in BASIC or COBOL. Compat. w/ any RS-232-equipped computer. Terminals: buy. Modems: sell, service, V. $595.
BIZCOMP 1030 Series Intelligent Modem. Auto-dialing, auto-answer, auto-repeat-dial, Bell 103 compatible, FCC registered. Intelligent Modem controlled by ASCII chars. sent over same RS-232 port used for data comm. $395; 1031, $495. Marketing Mgr., **BIZCOMP Corp.,** Box 7498, Menlo Park, CA 94025. (415) 854-5434.

VT-100 Type Terminal. BT-100 Video Display Terminal includes complete VT-100 emulation, advanced video package, printer port. Double-size, reverse video characters; user-selectable 80/132 char./line; split screen, smooth scrolling capabilities. $1995. Larry Howell, **The BRAEGEN Corp.,** 3340 East LaPalma Ave., Anaheim, CA 92806 (714) 632-5245.

PDP-11 Interactive project control programs. Predicts potential engineering/architectural project problems prior to overruns. **BST Consultants, Inc.,** Box 23425, Tampa, FL 33623. (813) 961-3902.

MP1104. Analog output for LSI-11. Specialized terminals. I/O analog boards. No vendor maintenance. 4-output ch.; 12-bit resol.; ±0.025% acc.; 10μs conversion. $550.
MP1216. Analog Input for LSI-11. 16 DIF/32 SE input channels; 12-bit resol; ±0.025% acc; 40μs conversion; ±10V to ±10mV range. $550.
MP1216-PGA. Analog input for LSI-11. 16 DIF/32 SE input ch.; 12-bit resol; ±0.025% acc.; 350-μs conversion; ±10V to ±10 mV range. $675. C.R. Teeple, **Burr Brown Industrial Systems Products,** 3631 E. 44th St., Tucson, AZ 85713. (602) 747-0711.

C

Printer/VAX Interface. Installed on VAX-11/780 Unibus, this word-buffered interface permits access to Calcomp's 5000 series of 6 electrostatic printer/plotters (11″/22″ wide, 0.72-3.25 ips). $2260. **California Computer Products, Inc.,** 2411 W. La Palma Av., Anaheim, CA 92801. (714) 821-2541.

PDP-11 semiconductor memory. Expanda Stor-11 appears as fast secondary or main memory expansion, swapping disk or fixed-head disk replacement compatible w/ RK-11 controller SW. 350 ns access. Add-in: 256 kB, $8577; to $11,720/MB. Add-on: $9512-$14,750/MB. **Cambex Corp,** 360 Second Av, Waltham, MA 02154. (617) 890-6000.

FD211. Dual floppy system, RX02 equiv., for PDP-11, LSI-11/2, LSI-11/23. Complete SW/media compat. w/DEC RX02. Sell, service. Floppy disk drive: Shugart SA800 (single sided), SA850 (double sided). Controllers: CRDS FC202. FO (at CRDS). Complete RX02 compatibility with single or double-sided drives. $3250.
MF-211. Combines LSI-11/2 or LSI-11/23 w/RX02 equival. floppy system within 10.5″ enclosure. Also w/ double-sided drives. SA800; SA850. CRDS FC202. Functionally equiv. to DEC 11V03L, w/ single-sided or double-sided drives. $5980-$9255.
HD11/T 20.8-MB Winchester Disk with Cartridge Tape. SW equiv. to 4 RL01s, plus optional 3M Cartridge Tape backup. Hard disk: Shugart. Controllers: CRDS HC300. $8700, w/ tape option; w/o cartridge tape, $6500. William Nimee, **Charles River Data Systems Inc.,** 4 Tech Circle, Natick, MA 01760. (617) 655-1800.

CI-103. Desktop μC w/ LSI-11/2 or LSI-11/23 CPU. Sell/buy: terminals, floppy drive, hard disk drive, controllers. Sell: semi memory bds. Vendor maintenance: DEC. $4500, LSI-11/2 Base; $8995, LSI-11/23 Base.
CI-S100. Add-in expansion memory for S-100 bus. 1-yr. warranty. $750 for 64K×8.
CI-1103. Add-in expansion memory for LSI-11, LSI-11/2, LSI-11/23, PDP-11/03, PDP-11/23 and Heathkit H-11. $750 for 32K×16. John Ross, **Chrislin Industries,** 31352 Via Colinas #102, Westlake, CA 91361. (213) 991-2254.

MARS-232. MARS — Modular Array Processing System. MARS is modular, high-speed array processor. Allows designers to configure multiple processor systems. Applications: arithmetic processing, FFTs, digital filters table look-ups. Sell, service. Array processor arithmetic peripherals. Vendor maintenance from home office. 1K complex FFT 1.05ms for a single processor; I/O bus rates 30 MB/sec. $20-$60K for single processor systems. Dr. Peter Alexander, **CNR Inc, Computer Products Div.,** 220 Reservoir St, Needham, MA 02194. (617) 449-4906.

Model 3132. Emulating video terminal for VT132, VT100 & VT52 users. DEC's AVO (advanced video option) and printer port option are std. on 3132. RTFR. Same specs as VT-132/VT-100. Model 3132's enhancement features improve cost/performance. $1995. Rick Brechtlein, VP Sales, **Cobar Inc.,** 699 S. State College Blvd., Fullerton, CA 92631. (714) 992-4345.

QD 11-10F. Q Bus Disk Subsystem, disk drive, 512-bytes/sector format, 10′ cabling, Q Bus interface, preformatted pack, slides and full maintenance docum. 3rd party. $5,995.
QB 11/00-12-00. Q Bus Integrated Terminal — 12″ CRT monitor (P4 phosphor), 80-char. × 24-line alphanumeric display, LPV 11 I/O, audible alarm, line time clock, keylock front panel, full ASCII KB, 15-func. keys, 18-slot Q Bus backpanel, (4) switched AC receptacles, LSI-11 CPU, and full maintenance docum. $2,995 (OEM qty. only).
QB 11/00-9-00. Q Bus Integrated Terminal — 9″ CRT monitor (P4 phosphor), 64 char. × 16-line alphanumeric display, LPV 11 I/O, audible alarm, line time clock, keylock front panel, full ASCII KB, 15 func. keys, 18-slot Q Bus backpanel, (4) switched AC receptacles, LSI-11 CPU, and full maintenance docum. $2,895 (OEM qty only). Charles S. Breen, **Comark Corp.,** 257 Crescent St., Waltham, MA 02154. (617) 894-7000.

RK05 Controller Kit. Interfaces RK05-J disk cartridge drives to LSI-11. Allows users to operate RK05 subsystems, previously installed on PDP-11/23. Interface up to 8 drives daisy-chained together, for total capacity of 20-MB online storage. SW compatible with RKV11/RK11; operates under RT-11, RSX-11, RSTS, UNIX, TSX operating systems. LSI-11s/LSI-11 compatibles: free "systems catalog" lists complete line. $1800. **CompuMart, Cambridge Digital Co.,** 270 Third St, Cambridge, MA 02139. (617) 491-2700.

PDP-11 Software. Version 2 handles small-medium manufacturing control functions of materials inventory, job costing maintenance, factory scheduling and capacity planning. $20,000. **Computer Covenant Corp.,** 790 Farmington Av., CT 06032. (203) 677-6563.

PDP-11 Array Processor. MSP-3X is on 2 stand. hex-size (8.4″×15.7″) boards. Plugs into SPC (small peripheral controller) slots of host computer. Performs signal analysis operations at 20 to 50 times speed of PDP-11. 1204-point real FFT in 14.3 ms. 52.5 W. $4950. 90-day warranty. **Computer Design & Applications Inc.,** 377 Elliot St., Newton, MA 02164. (617) 964-4320.

DEC ASYNC Multiplexer (DZ-11 A, B,E). DEC Async. interface (DL-11 A,B,C,D,E)., DEC 128KB MOS memory (CMS-11), DEC DD 11-DK DD-11CK backplanes. All of above are DEC compatible. Zee V. Rote, **The Computer Group,** Box 17960, Irvine, CA 92713. (714) 551-4001.

NTDS to PDP-11 Unibus IF/NPF 1-1. This interface allows data transfers between devices with a NATO std. I/O port (such as AN/UYK-20, AN/USH-26, etc) and DEC Unibus. Data transfers are DMA and can be 16- or 32-bit parallel words. NPF was an outgrowth from internal needs. FO: factory. MIL-STD-1397 (SHIPS). D.W. Thompson, VP Mktg., **Computing Devices Co. (a div. of Control Data Canada),** Box 8508, Nepean, Ontario K1G 3M9. (613) 596-3050.

DEC-11/i SBC/80 coax link. "11-0016 Megalink," a Unibus-compatible interface, permits

AND UP TO 3 MONTHS LATER, YOUR RAM DATA'S STILL INTACT ON THIS CMOS MEMORY EXPANSION BOARD FOR THE LSI-11.®

Introducing the RRS-008, the newest member of our family of memory expansion modules for the LSI-11. Combining 4K of CMOS RAM, up to 12K of ROM, plus battery back-up on a single board, the RRS-008 offers designers a convenient way to expand memory capacities for either stand-alone or bank-switching applications. Without worrying about RAM data loss when power's shut off.

Like our other LSI-11 memory modules, the RRS-008 functions identically to standard DEC memory. But when you reach the LSI-11's 28K memory space limit, you're no longer left high and dry. By simply adding a Bank-Switching Controller, you gain up to two million bytes of storage. When you add another controller, you get four megabytes.

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For even more economical memory expansion, we offer substantial quantity discounts. And these modules are also available without memory chips, for additional cost savings. To get further information on our memory expansion products for LSI-11 or PDP-11® computers, call or write Digital Pathways, 1260 L'Avenida, Mountain View, CA 94043. Telephone (415) 969-7600.

RRS-008	RAM/ROM Module 4K by 16-bit RAM (CMOS) Up to 12K by 16-bit ROM Includes on-board NiCad batteries	$890 (single qty)
RMA-032	32K by 16-bit RAM On-board refresh	$750 (single qty)
RMS-032	32K by 16-bit ROM (Intel 2716-type or TI 2532-type)	$300 (single qty)
BSC-256	Bank-Switching Controller For up to 2 megabytes	$300 (single qty)

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DMA block transfers at Mbps between 255 PDP-11s over one 32,000′ coax. 8.5 × 12″ quad board plugs into PDP-11 backplane. $4520(10). **Computrol Corp.,** 15 Ethan Allen Hwy., Ridgefield, CT 06877. (203) 544-9371.

DEC Memory Tester, T-119. RAM board tester. Stand-alone Benchtop unit. Fixtures for LSI-11/PDP-11 memories. $13,400 (complete).

Product design services. Disk controllers (SMD), cartridge, Winchester tape controllers (NRZI, PE, GCR), Memories (16-bit thru ECC capabilities). Add-in/add-on memory: LSI-11, LSI-11/23, PDP-11, VAX. Controllers: disk & tape. Also: memory test equip. No vendor maintenance. Martin Bock, **Concept Development, Inc.,** 3198 G Airport Loop Dr., Costa Mesa, CA 92626 (714) 557-1811.

94178 Semiconductor Memory. VAX add-in memory. FO. Full cycle time, 400 ns; full access time, 250 ns. 32K × 72, $1790 (100).

94170 Semi memory. PDP-11/70 add-on memory to 4 MB. FO. Full cycle time, 600ns; access cycle time, 460 ns. 256 KB to 4MB capacity, 256KB, $6120 (100).

94134P Semi memory. PDP-11/04 to 11/55 add-in memory includes parity, to 256K × 18 capacity by using double-density (32K) chips. Full cycle time, 500 ns; access time, 350ns. 16K × 18 to 256K × 18 capacity. 48K × 18, $1240 (100).

94134 Semi memory. PDP-11/04 to 11/34 add-in memory to 128K × 18 capacity. Full cycle time, 500 ns; full access time, 350 ns. 32K × 18 up to 128K × 18. 48K × 18, $1035 (100).

94123 Semi memory. LSI-11/2 to LSI-11/23 add-in memory up to 64K × 16/18 capacity. Full cycle time, 500 ns; full access time, 240 ns. 32K × 18, $595 (100). Len Muehleisen, **Control Data Corp., Computer Memory Div.,** 8001 E. Bloomington Freeway, Bloomington, MN 55420. (612) 830-6135.

LSI-11 8-K EPROM module/programmer CCS-1220. Also: process control computers. $460.

Micro-tape TU-58. RS-232 dual drive cartridge tape system connects to minis/micros. To 0.5 MB on-line storage. Also: process control computers. $2550. David Ivex, **Control Logic Inc.,** 9 Tech Circle, Natick, MA 01760 (617) 655-1170.

Corvus 11L and Corvus 20L. 10 and 20 plug-compatible Winchester disk drives for LSI-11. FO. $5,950 & $6,950. Thomas A. Browne, **Corvus Systems,** 2029 O'Toole Av., San Jose, CA 95131. (408) 946-7700. TWX No: 910-338-0226.

MAP200, MAP300, MAP6400. 32-bit and 64-bit floating point array processors. Controllers: digital & analog I/O interfaces (scrolls). I/O analog boards: ADAM and AOM intelligent processors. Also: Array Processors. FO. MAP200: 32-bits, 7.5 MFLOPS, MAP300: 32-bits, 15 MFLOPS, MAP6400: 64 bits, 3 MFLOPS. All 36 MB/s. MAP200 @ $23,800; MAP300 @ $36,400; MAP6400 @ $89,000. E. Arsenault, **CSPI,** 40 Linnell Circle, Billerica, MA 01821 (617) 272-6020.

500 MUTT (MultiUse Terminal Translator). MUTT permits owner of computer system to connect via phone circuits to remote data terminal device and have this terminal appear to computer as system console. DG, DEC. No vendor maintenance. $765. Paris J. Campbell, Jr., Mktg. Mgr., **Custom Systems, Inc.** 2415 Annapolis Lane, Minneapolis, MN 55441 (612) 553-1112.

OSR11-A. Unibus Router. Allows Unibus reconfigured easily w/ push of button. Flexible, w/ many configurations possible. RTFR. 1-yr. warranty. Allows 2 CPUs to share one or more peripherals. More CPUs can be added. Price depends on configuration. Std. 2 CPU, 1 bus is $2900.

OSB11-A. Unibus Repeater. Repeats Unibus signals. Allows 50′ more cable and 19 more loads to be added to Unibus. $1250. Bill Dilfer, **Datafusion Corp.,** 5115 Douglas Fir Rd, Calabasas, CA 91302. (213) 887-9523.

Bm-1 Computer System. Bulk Mini is combination of LSI-11 and core disc emulator. RTFR. 15-3/4″ chassis with supply, interface, 11 quad-slot Q-Bus-backplane and 256KB to 1.0MB of RF11 disc emulation.

BM-2 Computer System. Bulk Mini is combination of LSI-11 and MOS/ECC disc emulator. 15.75″ chassis with supply, interface, 11-quad-slot Q-Bus-backplane and 512KB to 4.0MB of RF11 disc emulation dual port version available.

DR-115 16K × 16. Core Memory for LSI-11. RTFR. Single quad-board (equiv. to 4 MM-11A) $1540.

DR-115S 32K × 16. MOS Memory for LSI-11. Single dual-board (equiv. to MSV11-DD). Also, parity vers. equiv. to MSV11-ED. $850.

DR-113S 128K × 18. MOS Memory for LSI-11/23. Single quad-board work w/ or w/o Dataram's PO3 parity controller. (Non-Parity) $2575.

BS-417 Memory system. 512KB to 4096KB MOS/ECC Memory Expansion for PDP-11/70. RTFR. 7″ or 15-3/4″ chassis with supply/cables in 512KB incr. $10,600.

DR-114S 128K × 18. MOS Memory for PDP-11. Operates with M7850 parity control module (equiv. to 2 MS11-JS). $3045.

DR-114SP 128K × 18. MOS Memory for PDP-11. On-board parity generate/check circuitry. Equiv. to MS11-LD). $3145.

DR-114 32K × 18. Core Memory for PDP-11. Single board add-in memory (equiv. to MM11-DR). $2495.

DR-120S 64K × 43. MOS Memory for DECSystem 2020. Single-extended hex-array board (equiv. to M8629). $5600.

DR-118A 32K × 12. Core memory for PDP-8A. Single hex add-in memory board. Also as 16K × 12 add-in memory. $2545.

DR-118 16K × 12. Core memory for PDP-8E, F, or M. Single quad add-in memory board. $1925.

DR-178S 64K × 72 (512KB).

MOS/ECC Memory for VAX-11/780. Replaces 2 M8210 array boards. $5660.

C-202 Memory Sys. 251KB to 4.0MB Core Disc Emulator for PDP-11. 7″ or 15.75″ chassis with supply, interface, cable. Emulates RF11 in 256KB increments. $8,100.

BS-204 Memory Sys. 512KB to 8.0MB MOS/ECC Disc Emulator for PDP-11. 7″ or 15.75″ chassis with supply, interface, cable. Emulates RJS03/04 in 512KB increments. $10,100.

BC-204 Memory Sys. 512KB to 8.0MB Core Disc Emulator for PDP-11. 7″ or 15.75″ chassis with supply, interface, cable. Emulates RJS03/04 in 512KB increments. Self-test. $13,100.

BS-202/3/4 DP Memory Sys. 512KB to 8.0MB Dual Port MOS/ECC Disc Emulator for LSI-11/PDP-11. Emulates RF-11 or RJS03/04 FHD. Acts as common data bank between 2 CPUs or CPU and custom I/O. Each port independently interfaces to LSI-11, PDP-11 or custom I/O. 512KB increments. $13,500.

BC-202/3/4 DP Memory Sys. 256KB to 8.0MB Dual Port Core Disc Emulator for LSI-11/PDP-11. Emulates RF-11 or RJS03/04 FHD. Acts as common data bank between 2 CPUs or CPU and custom I/O. Each port independently interfaces. 256KB increments. $12,500.

B04 Chassis Assembly. 7″ LSI-11 System chassis with 8 Quad-slot backplane, supply, dual TU58s, controller. Moving head disc, SMD and tape controller. RTFR. Front loading, backplane carriers LSI BUS on A & B and C & D connectors; provisions for RL01-type controller. $2900.

B03 Chassis Assembly. 5.25″ LSI-11 System Chassis with 8-quad-slot backplane & supply. Front loading backplane carries LSI-Bus on A & B and C & D connectors; provision for RL01-type controller. $1300.

DR-414 5-1/4″ Expansion Chassis. 5.25″ PDP-11 Expansion Chassis contains double system unit/supply. +5V @ 16A, −15V @ 6A and +15V @ 3A. $1485.

BC-205 Memory Sys. 512KB to 2.0MB Core Disc Emulator for PDP-15. 15.75″ chassis with supply & interface. Emulates RF15 in 512KB increments. Interface has offline self-test. $24,875.

BS-203 Memory Sys. 512KB to 4.0MB MOS/ECC Disc Emulator for LSI-11. 7″ or 15.75″ chassis with supply, interface, cable. Emulates RF11 in 512KB increments. μP-controlled interface has off-line self-test. $10,300.

BC-203 memory Sys. 256KB to 4.0MB Core Disc Emulator for LSI-11. 7″ or 15.75″ chassis with supply, interface and cable. Emulates RF11 in 256KB increments. Offline self-test. $8300.

BS-202 Memory Sys. 512KB to 4.0MB MOS/ECC Disc Emulator for PDP-11. 7″ or 15.75″ chassis with supply interface, cable. Emulates RF11 in 512KB increments. $10,100.

BC-202 Memory Sys. 251K to 4.0MB Core Disc Emulator for PDP-11. 7″ or 15.75″ chassis with supply, interface, cable. Emulates RF11 in 256KB increments. $8,100.

PDP-11/T34 Tape Controller. When interfaced with 1-4 ind. std. R/R tape transports emulates RU10/TM11. Plugs into PDP-11 backplane. Dual density controller operates to 1600 bpi, 125 ips. PE or NRZI. $3600.

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CONTROLLERS. Single board floppy and cartridge disc controllers for LSI-11 series CPU.

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transports emulates TU10/TM11. Plugs into LSI-11 backplane. Dual density controller operates to 1600 bpi, 124 ips PE or NRZI. $3600.

LSI-11/T03 Tape Controller. Emulates TU10/TM11. Unit plugs into LSI-11 backplane. Operates to 800 bpi, 75 ips, NRZI $2340.

PDP-11 S33 Disc Controller. Storage Module Drive Disc Controller. RM02, RK07, RP06, other emulations. Plugs into PDP-11 backplane. Operates with industry std. SMDs. $4900.

LSI-11 S03 Disc Controller. RM02, RK07, RP06, other emulations avail. Plugs into LSI-11 backplane. Operates with SMDs. $5400.

PDP-11 C33 Disc Controller. Moving head Cartridge Disc Controller, when interfaced with 1-4 disc drives, emulates RF11/RK05 disk system. Plugs into PDP-11 backplane. Operates with 100 or 200 TPI, 1500 or 2400 RPM and 2200 or 2040 bpi drives to 20 MB. $1860.

LSI-11 C03 Disc Controller. Movinghead cartridge Disc Controller. When interfaced with 1-4 disc drives, emulates RK11/RK05 Disk System. Plugs into LSI-11 backplane. Operates with 100 or 200 TPI, 1500 or 2400 RPM and 2200 or 2040 bpi drives to 20 MB. $1860. Pete Yeatman, Customer Services Mgr., **Dataram Corp.,** Princeton Rd.,Cranbury, NJ 08512. (609) 799-0071.

DLP-11. Printer controller for PDP-11/04 thru 11/70, VAX 11/780, LSI-11/24. Software compatibility: RT-11, RSTS, RSX-11, IAS, UNIX, VMS, TSX. 3rd party maintenance. $625. (All cables ordered separately.)

DLP-1100. Line printer controller for LSI-11, LSI-11/2, LSI-11/23, PDP-11/03. Software compatibility: RT-11, RSX-11, Mini-UNIX. $375. (Cables ord. sep.)Jim Marshall/Stan Leopard. **Datasystems Corp.,** 8716 Production Av., San Diego, CA 92121. (714) 566-5500.

DSD 480. Double-sided floppy disk system has double capacity of DECs RX02. No patch needed for RSX-11 users. Simple OS patch adds capacity for RT-11 users. Can interchange data between all IBM and DEC formats. FO. Onboard diagnostics identify faulty module. Service "Hot Line" for assistance. Replacement module airshipped 24 hrs of call. $4495.

DSD880. Combination Winchester/floppy disk system. Winchester emulates RL01; floppy emulates RX02. Has several additional features including an easy access control panel and exlusive DSD "Hyperdiagnostics". $7495.

DSD 440. Floppy system emulates RX02. Additional features, including "Hyperdiagnostics". On-board diagnostics identify faulty module, service "hot line" for assistance, replacement module air shipped within 24 hrs of call. $3695. Jack Margolis. **Data Systems Design.** 3130 Coronado Dr., Santa Clara, CA 95051. (408) 727-3163.

LAB-DATAX. Lab. data acq. computer sys. LSI-11/2 CPU with 64K Bytes RAM, fixed & floating point instructions, dual drive double density IMB floppy drive, 4 RS-232 serial I/O ports, RT-11, FORTRAN & DTLIB subroutines plus choice over 100 analog I/O boards. $9210 to $20,230. Nick Baran, **Data Translation, Inc.,** 4 Strathmore Rd., Natick, MA 01760. (617) 655-5300.

ST-LSI-RLY. A/D peripheral board; 8 differential A/D channels; relay multiplexer to accommodate differential voltages to 250V RMS; a memory-mapped peripheral; with diagnostic program formatted on paper tape. LSI-11/2, LSI-11, PDP-11/03, PDP-11/23. 12 bits; 126 dB CMR; Linear to ±1/2 LSB; 30 samples/sec, throughput. $695.

ST-LSI Series. A/D, D/A peripheral brd; compat. w/LSI-11, PDP-11/03, PDP-11/23; 32 SE or 16 diff. A/D on master brd; 32SE or 16 diff. A/D on slave; 2 D/A opt. on master; slave brd has 4 D/A chans; A/D master has opt. P.G.A.; Pacer clock; EOC EOS interrupts; a memory-mapped peripheral; w/diagnostic program on paper tape; full quad. size. LSI-11, PDP-11/03, PDP-11/23. 12 bits A/D, D/A; A/D: accuracy within ±0.025% FSR ±1/2 LSB; throughput period, 20 μS; D/A: linear within ±1/2 LSB max. From $657. (16 SE A/D chans. only).

ST-LSI2 Series. A/D peripheral boards; compatible w/LSI-11/2 (half-quad); 16 SE or 8 diff. A/D ch., master board; 48 SE, 24 diff. A/D on slave board; DMA board available; pacer clock; a memory-mapped peripheral; with diagnostic program on paper tape, half-quad size. LSI-11/2. 12 bits; accuracy within ±0.025% FSR ±1/2 LSB; throughput period 20 μs. $625. (Master Board). Ted Petit. **Datel-Intersil, Inc.,** 11 Cabot Blvd., Mansfield, MA 02048. (617) 339-9341.

Tape Controller/1520. Embedded PDP-11 compatible tape controller interfaces to 4 drives (any speed) and compatible with DEC software. A dual density controller is 2 boards — one hex, one quad size. DEC-11/04-60. Controllers: sell & service tape subsystems. FO. Densities 200 — 1600 BPI; 7 or 9 track, speed 12.5 — 125 ips. 2 board embedded controller. $3400. Stu Reile/Jeff Strief, **Datum Inc./Peripheral Products,** 1363 S. State College Blvd., Anaheim, CA 92806. (714) 533-6333.

VISACOM/23 computer and display system. Built around LSI-11/23. Provides for image display of 256 × 256 × 16 or 512 × 512 × 16 bit image memory using 16K RAMs. May have up to 112K words of Q-bus memory to support with RT11 or RSX11M. Stand-alone or DEC interface; other interfaces. Terminals: Televideo — TV 1-912. Floppy drive: SMS FT/FD 0100 I floppy. 1-yr RTFW. 256 × 256 × 16 or 512 × 512 × 16-bit image memory. Top 4 bits for overlay. Zoom 2:1, 4:1, 8:1 on image and overlay independently. Full scroll capability. 16K MOS RAM. Compatible with complete line of LSI-11 Q-bus devices. $30,000-$50,000.

VISACOM — both a computer and a display system (LSI 11/02-based). 256 × 256 × 16 bit or 512 × 512 × 16 bit image memory with 320 × 256 or 640 × 512 viewable matrix. Configured either color, monochrome, or both, plus 4 bits dedicated to 4 overlay planes configured as stand-alone with floppy, CRT or peripheral to host computer. 256 × 256 × 16 bit image memory or 512 × 512 × 16 bit. Top 4 bits for overlay. Zoom 2:1, 4:1, 8:1 on image and overlay independently. Compatible with complete line of DEC Q-bus devices. Full scroll capability. 16K MOS RAM chips for image memory. $15,000-$30,000.

ID1100. 1K × 1K × 4 up to 1K × 1K × 24 image display system. Suitable for ultra-high resolution, monochrome or color display. DEC interface std; other interfaces available. 1K × 1K × 4 or 8 bits/image memory plus 1K × 1K × 4 bits for overlay per memory controller, 3 memory controllers for color, 16K MOS RAM chips for image; options include joystick, trackball, lightpen. $40K to $100K.

IP5000. Up to 4 channels of 512 × 512 × 8 bit image memory. Optionally 512 × 512 × 4 or 8 bit overlay memory. System has digital video processor for allowing channel arithmetic or boolean operations at video frame rates. DEC interface std, plus most popular mini interfaces avail. Internal digital processor, to 4 512 × 512 × 8 bit memory ch. 4 or 8 bit overlay, split screen and pseudo color support, ASCII overlay, zoom 2:1, 4:1, 8:1 on each memory or overlay ch, full scroll capability all ch. 16K MOS RAM chips for image memory. $40,000-$65,000.

ID5000. 512 × 512 × 8 bit or 512 × 512 × 12 bit systems supporting either color or monochrome image display. Addressable/viewable matrix of 512 × 512; point plot mode, ASCII overlay, 50 char. by 25 lines; joystick/cursor optional. 12-bit systems have 1 or 2 bits for graphic overlay. 16K MOS RAMs for image memory. $13,000-$20,000.

ID2000. 256 × 256 × 8 or 256 × 256 × 12 bit sys. supporting color or monochrome image display. Addressable/viewable matrix of 256 × 256; point-plot mode ASCII overlay-64 ASCII subsets arranged as 80 char. × 25 lines; joystick & cursor optional. 12-bit systems have 1 or 2 bits for graphic overlay. $8,000-$12,000. Phil Cleveland. National Sales Mgr., **DeAnza Systems, Inc.,** 118 Charcot Ave., San Jose, CA 95131. (408) 263-7155.

RTP Series. Analog-Digital I/O Cards and Subsys. for Process Control/Instrumentation. PDP-11 & LSI-11, DG, Intel, Texas, Motorola, Computer Automation, PE (Interdata) Harris. 3rd party maintenance. G. Readman, **Di-An Data Systems Ltd.,** Mersey House, Battersea Road, Heaton Mersey, Stockport SK4 3EA England. Phone: 061-442-9768.

Diagnostic Engineering. Diagnostic products for DEC-compatible products. OS drivers for DEC-compatible products. Russell Wheeler, **Dice Systems, Inc.,** 7 1/2 Harris Rd., Nashua, NH 03062. (603) 888-6700.

PDP-11-compatible reel-to-reel tape systems. Has: single hex-width plug-in interface board; transport-embedded formatter; complete line tape transports (reel sizes: 7″, 8.5″, 10.5″; speeds: 12.5 to 75 ips; formats: NRZI, PE, NRZI/PE; densities: 800, 1600 bpi for 9-track & 200, 556, 800 for 7-track.) Terminals: 150-200 CPS matrix teleprinter with RS-232C interface. Controllers: Model UCI — Unibus-compatible interface. Vendor maintenance at factory. 3rd party. **Digi-Data Corp.,** 8580 Dorsey Run Rd., Jessup, MD 20794. (301) 498-0200.

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System 105 Statistical Multiplexor. System 105, an 8-port max. statistical multiplexor for point-to-point or multipoint application, has 2 sizes: 105-400, a 4-port max. unit and 105-800, a 8-port max. unit. FO; 3rd party. 105-400, $1295; 105-800, $1495.

System 115 Statistical Muxor. System 115 is a 2-32 port statistical muxor for p-p or multipoint. $2450.

System 150 Network Processor. Provides network management w/centralized control, ability to perform host selection, port contention/network reconfiguration. Is a 64-port unit for p-p or multipoint use. $13,500.

System 205 Unibus Interface Statistical muxor. This single PCB replaces up to 128 ports in p-p or multipoint use. $4250.

System 210 Terminal Control Unit. Terminal communications system for DEC system-10 similar to DEC DC10, DC68, or DC76. Includes all hardware and software to support 2-128 local asynch terminals or dial-up modems of 50-9600 baud speeds. $11,000.

System 250 — Network Processor. Centralized statistical muxor controls overall routing functions, port contention, host selection and multipoint muxing for DCA's networks. Also a front-end processor for DEC system-10s. $21,500.

System 355 Master Network Processor. Bus-oriented processor that supports 62 high-speed trunk lines, 126 ports and provides terminal users access to 255 host computers in p-p, multipoint and multinode data use. Also has built-in diagnostics. $8,750. William L. Goldstein, VP Mktg./Sales, **Digital Communications Associates, Inc.,** 135 Technology Park/Atlanta, Norcross, GA 30092. (404) 448-1400.

MEGACORE. Add-on systems interfaced to any computer, including DEC, NOVA, HARRIS etc. We sell & service add-on systems and repair all equipment sold at our factory.

DEC, NOVA and ECLIPSE memory boards. Brand new memory boards 100% compatible w/ all DEC, NOVA and ECLIPSE memory boards. 1-yr warranty. Alfred Gomez, **Digital Data Systems, Inc.,** 1396 NW 65 Terrace, Plantation, FL 33313. (305) 792-3290.

Retro-Graphics, model VT-640 PCB. Mounts inside VT-100. Provides high-powered computer graphics capability. Vendor maintenance from DEC distributor. 640 × 480 resolution, 8 modes plus user programmable modes, green toned screen, compatible with most graphics software, including Tektronix Plot 10 and ISSCO's DISSPLA and TELLAGRAF terminal plus retro-graphic: $3495. Lee Ambrosini, **Digital Engineering, Inc.,** 630 Bercut Dr., Sacramento, CA 95814. (916) 447-7600.

DBL 2.0. Enhanced version of Dibol-11. Compiles/executes programs written in DISC's DBL 1.3 or DEC's Dibol-11. DBL spans RT-11, RSTS/E, RSX-11M, and TSX and TSX-PlusM (by S&H Computers, Nashville, TN). **Digital Information Systems Corp.,** 6247 Fair Oaks Blvd., Carmichael, CA 95608. (916) 485-4849.

TCU-150. Battery-supported calendar clock for PDP-11 Unibus. FO. Continuously maintains year, month, day, hour, min, sec. Batteries support for 3 mo., but recharge automatically when computer power restored. $460.

RMA-032. 32KW RAM board for LSI-11. Supports bank-switching to 2MB in LSI-11/2. Dual-width board. 450 ns access time. Up to 32 RMA-032s controlled by single BSC-256 bank switch controller. $990.

BSC-256. Bank-switch-controller. Controls up to 2 Megabytes of RAM or ROM using the RMA-032 and RMS-016 memory boards. Vastly expands LSI-11/2 memory space. Dual width board appears as registers in peripheral space. Contains 32 word prom bootstrap. $300.

RMP-116. EPROM Programmer/Memory Board. DEC PDP-11 Unibus. Holds 16K words of Intel 2716 or TI 2516 EPROMs. Programs and executes from any socket. $895.

TCU-100. Time-of-day Calendar Clock, battery-supported. PDP-11 Unibus. Continuously maintains month, day, hour, min, sec. Batteries good for 3 mo., recharge automatically when power restored. Programmable interrupts. $495.

TCU-50D. Battery-supported time of day calendar clock for LSI-11 QBUS. Dual-width board maintains hour, min, sec, mo, day. Battery supported (self-recharging) time is continuously available. $325.

RMS-016. 16 KW EPROM board. Compatible with BSC-256 Bank switch controller. LSI-11. FO. 300 ns access time EPROM board. Uses Intel 2716s or TI 2516s. Dual-width board. $300. Marie Stokes, **Digital Pathways, Inc.,** 1260 L'Avenida, Mountain View, CA 94043. (415) 969-7600.

VP 800/A Video Processor. Software based, table driven CRT display. Human eng., 80 or 132 cpl, 32K of packed display memory, user-definable character sets, smooth scroll (2 rates), split screen, printer port. DEC, DG, Interdata, Varian. FO. HP 2645 and VT-100 compatible. $2250 includes 8K of display RAM & printer port. Larry Strober, VP Mktg., **Direct Inc.,** 1279 Lawrence Station Rd., Sunnyvale, CA 94086. (408) 734-5504.

Mag Tape Coupler/DILOG Model DU130. Interfaces up to 2 industry std. formatted tape drives with 3 slave drives each to PDP-11 Unibus. 12.5 to 125 ips. Drives either single or dual density. Software-compatible with RT-11, RSX-11, RSTS, IAS, Mumps via std. tape drivers. CEC PDP-11 Unibus. Factory maintenance. TM-11 media/software compatible, single quad-size board draws under 3.5A from 5V supply. Occupies 1 SPC slot; interfaces to ind. std. 0.5″ streamer tape drives. $1,695.

LSI-11 Disk Controller/DILOG DQ100. Single board, quad size. Emulates RK05 Disk Controller. RT-11, RSX-11 software-compatible. LSI-11, 11/2, 11/23. Addressing capability to 128K words, RK05 software & media compatibility. Handles to 80MB total capacity. Draws under 3.5A from 5V supply. $1,995.

LSI-11 Mass Storage Disk Controller/DILOG DQ200. Interfaces LSI-11 to disk drives w/ flat cable SMD interface; handles to 500MB of on-line storage. Has modified DEC RK Software Driver. DEC LSI-11, 11/2, 11/23. Single board, quad size. Addresses to 128KW memory, R/W in block sizes to 64KW. Has automatic bootstrap, media flaw compensation & self-test feature, draws under 3.5A at 5V & 300 mil & 12V. $2,950.

LSI-11 Tape Controller/DILOG DQ120. 0.5″ tape controller. Single board, quad size. Emulates TM-11 tape controller. RT-11 RSX-11 software-compatible. LSI-11, 11/2, 11/23. Addressing capability to 128KW., TM-11 compatible, handle to 4 ind. std. tape drives to 112.5 ips. Draws under 3.5A 5V. DEC or IBM media compatible. $2,295.

LSI-11 Tape Coupler/DILOG DQ130. DQ130 interfaces to 2 ind. std. single or dual density formatted tape drives to LSI-11. 12.5 to 125 ips. Emulates TM-11 controller, software-compatible w/ RT-11 and RSX-11. LSI-11, 11/2, 11/23. Addressing capabilities to 128KW., TM-11 media & software compatible. Single board, quad size, draws under 3.5A at 5V. Interfaces to ind. std. 0.5″ streamer tape drives. $1,695.

Shugart SA4000 Winchester Disk Controller/DILOG DQ201. Interfaces Shugart SA4000 to LSI-11, 11/2, 11/23. Single quad size, address. to 128KW memory, R/W to 64KW blocks. Software compatible to RT-11 or RSX-11, using RK05 device driver, draws under 3.5A from 5V. $2450.

Mass Storage Disc Controller/DILOG Model DQ202. Mass storage Disc Controller for interfacing 8″ & 14″ Winchester or similar drives with flat ribbon cable (SMD) interface. Emulates DEC RP02 device drivers used in RT-11 & RSX-11 software systems. LSI-11, 11/2, 11/23. Single card, quad size, draws under 3.5A at 5V, and 300 mA at +12V. Controller std. w/ on-board bootstrap loader, diagnostics & automatic media flaw compensation. $2,450.

PDP-11 compatible Disc Controller/DILOG DU100. Single-board, quad-size board occupying 1SPC slot. Controller software-compatible to RT-11, RSX-11, RSTS & IAS via FK05 software drivers. PDP-11 Unibus. RK05 media compatible (when using properly aligned 2315 disk drive), handles to 80 MB capacity. Auto self test. $1,995.

PDP-11 Tape Controller/DILOG DU120. 0.5″ tape controller on single, quad size board, software-transparent to RT-11, RSX-11, RSTS, IAS and Mumps software systems via TM-11 tape driver. TM-11 software-compatible, handles to 4 ind. std. tape drives. To 112.5 ips. Card draws under 3.5A from 5V. Occupies 1 SPC slot. $2,295.

Mass Storage Disk Controller/DILOG DU202. For interfacing 8″ & 14″ Winchester or similar disk drives w/ flat ribbon cable (SMD) interface. Runs RP02 software driver in DEC software systems. Single card, quad size board, uses under 3.5A at 5V; 500 mA at −15V. Controller comes std. w/ on-board bootstrap loader, diagnostics & auto media-flaw compensation. $2,495. Les Alberts/John Frassel, **Distributed Logic Corp.,** 12800-G Garden Grove Blvd., Garden Gr., CA 92643. (714) 534-8950.

We led the way with disc storage systems for DEC and other minicomputers.

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We can help you maintain the high throughput of data you expect from your VAX. That's because our Computroller V minimizes the error potential that exists with the increased densities of the new 600 M/byte drives. We do it through our unique 7-byte ECC (error correction code) on both header and data fields. It calculates and corrects for burst errors up to 11 bits on-the-fly — and does it all internally, without bugging the CPU.

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D

DD8200 plug card compatible mass disk storage. Has our Computroller V coupled w/ 200MB Memorex 677-02 drive(s), Ampex 200MB 9200 drive(s). VAX 11/780. Hard disk drive: 200MB Memorex 677-02, 200MB Ampex 9200. Controllers: Computroller V. 3rd party vendor maintenance (CDC & Others).

DD8600W plug compatible mass disk storage. Our Computroller V is coupled with 600MB Winchester CDC drive(s). VAX 11/780. Hard disk drive: 600 m/byte CDC 9775. Controllers: Computroller V.

DD8300 plug compatible mass disk storage. Computroller V coupled with 300MB SMD drive(s). CDC 9766, 300 m/byte Ampex 9300. VAX 11/780. CDC & Others.

DD886W plug compatible disk storage. Computroller V with 80MB Winchester drive(s). CDC 9730. VAX 11/780.

DD880 plug compatible mass disk storage. Computroller V with 80MB SMD drive(s). CDC 9762, 80MB Ampex 980. VAX-11/780.

DD7300 plug compatible mass disk storage. Computroller V w/ 300MB SMD drive(s). CDC 9766, 300 m/byte Ampex 9300. PDP-11/70.

DD7200 plug compatible mass disk storage. Comp. V w/ 200MB drive(s). Memorex 677-02, 200MB Ampex 9200. PDP-11/70.

DD786 plug compatible mass disk storage. V w/ 80MB Winchester drive(s). CDC 9730. PDP-11/70

DD780 plug compatible mass disk storage. V w/ 80MB SMD drive(s). CDC 9762, 80MB Ampex 980. PDP-11/70.

DD46W plug compatible mass disk storage. V w/ CDC 9775 600MB Winchester drive(s). DEC-11/04-11/60, Interdata (32 bit machine).

DD43 plug compatible mass disk storage. V w/ 300MB SMD drive(s). CDC 9766, Ampex 300MB 9300. DEC-11/04-1160, Interdata (32 bit machines).

DD42 plug compatible mass disk storage. V w/ Memorex 200MB 677-02 drive(s) and Ampex 9200. DEC-11/04-11/60.

DD56W plug compatible mass disk storage. V w/CDC 9730 80MB drive(s).

DD52 plug compatible mass disk storage. V w/ CalComp T-50 drive(s). DEC-11/04-11/60, DG (Nova-Eclipse).

DD54 plug-compatible mass disk storage. V w/ CDC 80M/byte SMD drive(s) for DEC-11/04-11/60, DG (Nova-Eclipse) Interdata 32-bit machines. James Harrison, **Diva, Inc.,** 607 Industrial Way West, Eatontown, NJ 07724. (201) 544-9000.

Series 2001/9001. IEEE-488 0.5" tape systems. Variety of reel sizes, recording densities, tape transport speeds. Buffer memory to 16K. Data thruput exceeds 100,000 B/s. PDP-11 & LSI-11 w/ IEEE-488 option, DG Nova w/ IEEE-488 option. Factory service. $8,895-$13,195. Joseph O'Loughlin, **Dylon Corp.,** 3670 Ruffin Rd., San Diego, CA 92123. (714) 292-5584.

E

SECS 2. Ruggedized 16-bit mini I/O & software-compatible to PDP-11. Floppy drive: ruggedized floppy disc SEDS-1. Controllers: tape system controller, 1553 bus controller. I/O analog boards: Serial I/O for RS-232/422. Also: supply, adaptors, extenders, half, full ATR chassis. MIL E5400, MIL E16400, MIL E4158B. Factory maintenance. Dean Knutson/Nelda Seifert, **EMM, Severe Environment Systems Co.,** 20630 Plummer St., Chatsworth, CA 91311. (213) 998-9090.

TC11. Tape controller for integration of ind. std. reel-to-reel tape drives — NRZ, PE and dual density — to 125 ips to host PDP-11. CDC 3rd-party maintenance. Performance for high-speed/high-density operations; complete diagnostic/operating software compatibility; extensive controller self-test/subsystem diagnostic operations executed by controller firmware. TC11/N, $3000; TC11/P, $3600.

TC01. Tape controller for r/r tape drives. To 75 ips to host LSI-11, 11/2, 11/23. $3000.

SC70. PDP-11/70 disk controller emulates RH70 Massbus controller. Std. vers. implemented by microcode, support SMD-type disk drives of 80, 160, 200, 300, 600 MB. Integrates SMD and Winchester-type mass storage devices to host PDP-11/70. $7950.

SC21. Single-board, embedded large disk controller for PDP-11 in 3 models. Emulates RP11, RH11, RK611 controllers. $5000.

SC11. Disk controller for use with PDP-11 in 3 models. Emulates RP11, RH11, RK611 controllers. $6000.

SC01. Disk controller for use with LSI-11s in 3 models. Emulates RP11, RH11, RK611 controllers. $5000. Phillip Begich, Dir., National Sales, **Emulex Corp.,** 2001 Deere Ave., Santa Ana, CA 92705. (714) 557-7580.

PDP-11 Report Writer. "General Reporting System" is on-line query language/report writer; handles reports from RMS-11 files in nonsophisticated use, but can adapt to another filing system. Overriding faults allow preparing customized reports. Licensed, 1-yr. support, $12,000. **Enterprise Technology Corp.,** 305 Madison Ave., New York, NY 10165. (212) 972-1860.

RPO-2 disk drive file tester. The "Mark VI" tests Memorex 660s and DEC RPO-2s. Modes: find/rev, alternate, R/W, (de)select, restore, etc. $2995 (1-4). **Essar, Inc.,** 2486 N. Glassell St., Orange, CA 92665. (714) 998-8572.

G

SRF-System Reporting Facility. SRF improves PDP-11 performance/capacity planning. Identifies programs using excessive resources, pinpoints bottlenecks, measures component usage. Improves system thruput, monitoring capacity, planning upgrades. PDP-11s with RSX-11M or M-PLUS. Also: software. FO in MD and Los Angeles. Required: PDP-11 with RSX-11M or M-PLUS. $2995.

ARSAP. Provides total control of PDP-11. Resource management, chargeback, system accounting essential for multi-user system. PDP-11s with RSX-11M or M-PLUS. $2995.

SAL-11. PDP-11 productivity tool. Fortran/assembly language programmers use SAL-11 to produce structured, maintainable, reliable MACRO-11 programs. Prerequisites: PDP-11 with RT-11, RSX-11M or M-PLUS. $1295. Susan H. Kalichstein, **Gejac, Inc.** Box 188, Riverdale, MD 20840. (301) 864-3700.

LSI-11 Hi-Density Universal Wire-Wrap Modules/Model 2140. Flexibility in IC choice number/size. Low-profile sockets with component-side Wire-Wrap pins permit 0.5" slot spacing. Mounting-holes for additional I/O connectors/trimpots provided on some top edges. V. From $63.

Disk Cartridge Controller/Model 2153. HW/SW compatible w/ RKV11/RK05. Operates w/ 2.5 to 20 MB drives 2315 front-load or 5440 top-load removable cartridge disk drives interfaceable. With full 18-bit ext. address of LSI-11/23. Selectable address, interrupt vector, bus priority level, 1500 or 2400 RPM disk drives. Optional: bootstrap loader, self-diagnostic, a Q-bus terminator, to 80 MB. From $1750.

PDP-11 High-Speed, Paper-Tape Punch-Controller/Model 2023. Similar to PA611-series "Typeset-11" paper tape punch controllers used w/ BRPE Punch Models 11, 18, 21 to 110 cps. Complete system unit. W/ or w/o supplies/punches. From $1350.

PDP-11/Line Printer Controller/Model 2024. For: LP11, LA11, LS11 line printers; LXY11, LV11 printer/plotters. With std. DEC software, it interfaces to dot matrix, impact, electrostatic (to 1000 lpm) line printers. From $575.

Card Reader Controller/Model 2025. HW/SW-C w/ CR11/CM11/CMS11. Operates w/DEC, Documation, Cardamation, PDI, GDI, similar card readers. Reads punched or marksense cards to 600 cpm. $700.

PDP-11 Async. Serial Line Interface/Model 2031. Full/half-duplex communication between PDP-11 & serial data communication device. Single quad board has DL11-A — E features. Compatible w/ teletypewriters, Bell series 103, 113, 202-type modems; other async. serial-data devices. From $550.

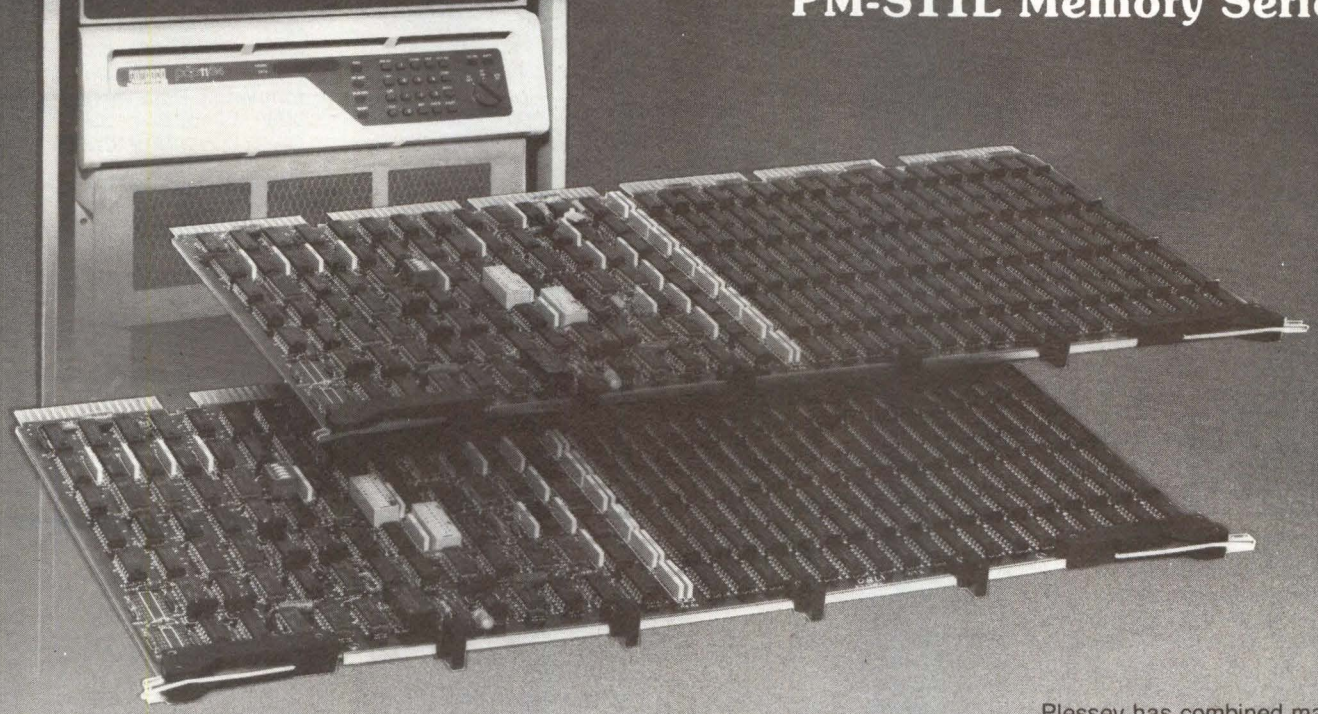
Async. Multiplexer/Model 2033. Program-controlled muxer connects PDP-11 to 8 or 16 async. serial lines. Exceeds DZ11. Auto. config. for RS-232 or current-loop operation, split tran./receive baud rates, RS-423/RS-232 drivers and 19.2 KBaud capability, special test-mode connectors. From $1450.

Hi-Density Universal Wire-Wrap Modules/Model 2040. Flexibility in IC choice number/size. Low-profile sockets. Component-side Wire-Wrap pins permit 0.5" spacing. Mounting-holes for extra I/O connectors. From $63.

General Device Interface/Model 2041. General-purpose parallel interface between PDP-11 Unibus/peripheral device. Compat. w/ DR11-C O.S. & dagnostic SW. Parallel trans. of 8- or 16-bit data out, 16-bit data in, and 6 bits of control/status info. $425.

Plessey's 256 Kbyte Add-In MOS Memories for the PDP-11*

PM-S11L Memory Series



Plessey has combined many years of experience in the design and manufacture of computer memories with the field-proven technology of 16K RAMs to produce the reliable PM-S11L Memory Series for the PDP-11. The SINGLE hex board 256 Kbyte MOS memories are compatible with DEC's* operating systems and diagnostics and are completely hardware, voltage, signal and pin-to-pin compatible with Unibus* backplanes. These memories offer refresh cycling and can be supported by battery backup. All electronic components of the PM-S11L Memory Series are mounted on a stable, rugged base that is reinforced with a metallic brace to ensure safe shipment and ease of installation and maintenance in any systems environment.

Plessey's PM-S11L Series is designed to replace DEC's MS11L. The PM-S11L and PM-S11L/F are available in 256, 192, 128, and 64 Kbyte versions, with or without on-board parity controller. Variable switch settings allow starting and stopping on any 8 Kbyte boundary within the extended addressing range of 0 to 4 Mbytes. LED indicators are included for visual display of parity error.

The PM-S11L has a cycle time of 500ns and read/write (R/W) access time of 385/235ns. Model PM-S11L/F is configured for a cycle time of 425ns and R/W access time of 300/200ns for improved PDP-11 performance.

Plessey's reputation for quality, service, delivery, competitive prices, and worldwide support has made us the largest independent producer of DEC-compatible equipment. All Plessey products withstand strict quality control procedures of the highest commercial standards. Add-in memories are subjected to dynamic "burn-in" at elevated temperature, and inspected for error-free operation in the user's environment via bench tests and computer diagnostic procedures.

Plessey's product line includes add-in/add-on core and semiconductor memories; cartridge, disc pack, floppy, mag tape controllers and subsystems; microcomputer and minicomputer systems; DEC-compatible software; and a wide variety of backplanes, expansion chassis and other accessories. All Plessey products include applicable hardware and software documentation, plus warranty with maintenance/installation options.

Contact your nearest regional sales office for more information on the PM-S11L Memory Series or any Plessey product.

*Registered trademark of Digital Equipment Corp.

Return this form for more information on Plessey's PM-S11L Memory Series.

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G

Parallel Communication Link/Model 2081. Multiprocessor communications. Interconnects multiple PDP-11s under RSX-11M or DECNET in distributed processing. Features of PCL-11B computer link. Max. bus bandwidth of 1 MB and error-free comm. w/ HW parity/CRCC error det. From $4500.

PDP-11 Interface Hardware/ Model 2099-BC11A. UNIBUS Cable. From $115. Gerald E. Nutter, **Gen/Comp Inc.,** 6 Algonquin Rd, Canton MA 02021 (617) 828-2008.

DUALTAPE DT-58. Dual cassette drive and controller. Factory maintance. 256KB/ cassette; 2 drives; 9.5-sec av. access time to any block of 512B. RS-232 interface. $1,200.

DUALDRIVE 800/DD-800. Dual Shugart 801 or 850 floppy drives + chassis + supply + controller for Q-Bus. $2,995. Philip R. Moore, **General Digital Corp., Inc.** 3322 S. Memorial Parkway, Suite 81, Huntsville AL 35801 (205) 883-1700.

DEC-11, VAX data base management software. "Sequitur" runs under all PDP-11, LSI-11, VAX O.S. **General Eclectics,** 2608 8th St., Berkeley, CA 94710. (415) 848-2693.

Tri Star. 3 drives, double-sided, double-density floppy systems w/ LSI-11/2 or LSI-11/23, 64-KB RAM to 256-KB RAM, serial I/O port. Floppy drive: 3 1.25-MB drives. Hard disk drive: Super Tri Star 10-MB Winchester. Controllers. Also: single or quad serial I/O port. Western union maintenance. $11,000 to $19,000.

Pegasus. RK05-compatible 20-MB cartridge-based system. Reads RK05 removable cartridges & dual density packs. LSI-11/2 or LSI-11/23, 64-KB RAM to 256-KB RAM, serial I/O port. Hard disk drive: 20-MB (3 fixed & 1 removable). Controllers. Also: single or quad serial I/O port. $17,500 to $22,500.

Super Pegasus. 90-MB fixed & removable-based system with LSI-11/2 or LSI-11/23, 64-KB RAM to 256-KB RAM, serial I/O port. Hard disk drive: 90 MB (3 fixed & 1 removable). Controllers. Also: single or quad serial I/O port. $22,500 to $27,500.

Gemini. Dual-drive, double-sided, double-density floppy disk system w/ LSI-11/2 or LSI-11/23, 64 KB-RAM to 256 KB-RAM, serial I/O port. Floppy drive: 2 1.25-MB drives. Hard disk drive: Super Gemini 10-MB Winchester. Also: single or quad serial I/O port. $9,500 to $18,500. Donald D. Woelz, **General Robotics Corp.,** 57 N. Main St., Hartford WI 53027 (414) 673-6800.

H

All DEC Microboards, LSI-11/2, -11/23. Only authorized stocking distributor for DEC. Buy, sell: Terminals, add-in/ add-on memory, floppy disk drive, hard disk drive, controllers, I/O analog boards, CPU, SW. DEC-Standard prices. 1-day delivery. Jim Christian, **Hamilton/Avnet** 10950 W. Washington, Culver-City CA 90230 800-421-3210. (In Cal.) 800-252-0627.

DEC-11-type, interrupt-driven O.S. HA-SP/68000 command-level syntax, resembling DEC-11 O.S., provides device-independence via peripheral interchange program. ROMable. O.S. may reside anywhere in memory. OEM license, $25,000. Jack Hemenway, **Hemenway Assoc., Inc.,** 101 Tremont St., Boston, MA 02108. (617) 426-1931.

Universal Extender Card, Models 8010ET, Z80ET, 6800ET DE2ET, DE4ET, DE6ET. Models for popular μP card cages, unique gold-plated TPs allow TPs to hang at any angle, staggered test contact pts. eliminate test probe cluttering, side strips for positive-ground clip retention. DEC, Intel, Zilog, Motorola, DEC compatible. Terminals: Hybricon P/N's CP-1-2; NP-1-2; SP-1-2; W-01; JW-02, etc. Others: full in-house wire wrapping service, pick up, delivery. Smallest board $65 to $165.00 for largest one.

Low Profile Series, No. 2-DE6-SS, 3-DE6-SS. Compatible with DEC low-profile, mounts on 1/2″ centers, handles all sizes of DIPs. Single-sided board permits stacking on 1/2″ centers. Comes pinned or loaded with 16-pin DIP sockets, tantalum caps. Terminals: Hybricon P/N's CP-1-2; NP-1-2; SP-1-2; W-01; JW-02, etc. 2-DE6-SS, $175; 3-DE6-SS, $253.

Socket Pinned Boards-Models 4-DE2-VHF; 4-DE6-VHF. Dual, Quad and Hex-type boards: compatible with DEC HW. These are 2-format boards loaded with screw-machined socket pins, factory installed. Pin level can be low profile (1.5), 2-level or 3-level pins. Teminals: P/N's CP-1-2; NP-1-2; SP-1-2; W-01; JW-02, etc. 4-DE2-VHF, $146.95; 4-DE4-VHF, $287.45; 4-DE6-VHF, $395.

High Frequency Series, Model 2-DE2-VHF; 2-DE4-VHF; 2-DE6-VHF. Dual, Quad and Hex-type boards, compatible with DEC HW. Extended freq. range, to 500MHz for high-speed logic, continuous ground plane, high density, very low noise, crosstalk. 2-DE2-VHF-$55.20ea; 2-DE4-VHF-$94.75ea; 2-DE6-VHF-$139. Janis Parker/Sales; Jim Williams/Wrapping Service, **Hybricon Corp.,** 410 Great Rd., Box 206, Littleton MA 01460 (617) 486-3174 or 486-8102.

I

PDP-11/70 Memory System. "Maxiram-11/70 HS" solid-state, non-rotating equiv. of RS04/RS03 fixed-head disc drives attaches to PDP-11/70 cache bus. 19″ rack-mounted chassis. 512KB to 8 MB. **Imperial Technology, Inc.,** 831 S. Douglas St., El Segundo, CA 90245. (213) 679-9501.

Dibex operating system. Dibol-compatible O.S. is plug-compatible with CTS-300 O.S., but offers re-entrancy and will be operational on 8086 early in 1981. $1000. **Information Access Systems,** Box 835, Sparta, NJ 07871. (201) 729-7581.

Clear Signal Cables & Connectors. Cables & Connectors to interface virtually any HW with any peripheral. Jim Karo, **Inmac,** 2465 Augustine Dr., Santa Clara, CA 95051. (408) 727-1970.

MTS 1050/130. PDP 11 mag tape sub-system, including controller, formatter, cabling and 1/2″ tape transport. FO; 3rd party. Dual mode (NRZI) 800 cpi and (PE) 1600 cpi, 10.5″ reels operating at 45 ips — Controller supports 4 additional tape drives. $7,850 each; daisy chain drive, $4,850.

Model MTS 1050/150. 1/2″ tape sub-system for LSI-11. Controller, formatter, 10.5″ reel tape transport. IBM compatible. 9 tracks — dual mode (NRZI) 800 cpi, (PE) 1600-cpi operating at 45 ips. Stores over 40 MB of data on 2400′ reel. $7,500; slave, $4,850.

Model TDC 3000/180. PDP-11 Cartridge drive sub-system. Emulates TM 11/TU 10 0.5″ tape system. Computer with SW device, diagnostic — single or multi-drive systems. Digital cartridge recorders per ANSI ×3.56 Std. 1976. Over 3.35 MB on DC 300XL cartridge. Used for program load on archival storage. $4,680 single drive; $6,180 dual drive.

TDC 3000/160. LSI-11 cartridge drive sub-system. Emulates TM 11/TU 10 0.5″ tape system — with SW driver, diagnostic. Single or multiple drive systems. Over 3.35 MB of data storage for program load or data archival — table top or rack mount. $4,680 single drive; $6,180 dual drive. Aldo Falossi, Tech. Support Mgr., **Innovative Data Technology,** 4060 Morena Blvd., San Diego, CA 92117. (714) 270-3990.

Peripheral Interface Controllers. Std. and special controllers for printers, disc drives & all tape drives (paper, mag, 1/4″, 1/2″ cassette) for minis and μCs. STD models for Nova, Rolm, Data General, PDP-11, LSI-11, etc. and S-100. Controllers: For printers, disc and all tape drives. I/O analog boards: Data acquisition and data processing modules. Others: special digital interface modules for any computer. Rick Fay, **Instrumentation Technology Systems,** 19360 Business Center Dr., Northridge, CA 91324. (213) 886-2034.

K

MOT11A. Plug-in Motorola M6800 System for the LSI-11 Q-Bus (Dual Slot) with serial, parallel Interface. $1,560.

MM05. Memory Switch for the LSI-11 Q-Bus. $480. **Kaiser & Dr. Damm GmbH,** Computertechnik u. CAD-Anlagen, Gerh.-Hauptmann-Str. 74, 6052 Muhlheim/M. Phone: 0 61 08/20 65-20 66.

L

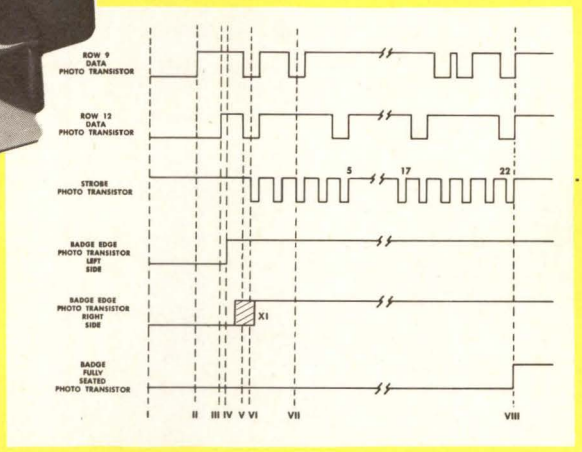
Lexidata System 3400. Image & graphics display processor. Raster refresh technology. DEC, DG, Interdata, HP, Prime. Terminals: to 1280 × 1024 resolution for imaging & graphics applications. From $7510. Carole Swan, **Lexidata Corp.,** 37 N. Ave., Burlington, MA 01803. (617) 273-2700.

FOR DATA ENTRY . . .

DSR-100

BADGE READER

A compact, low cost, completely solid state badge reader for Hollerith coded badges. Provides every function for any type of interfacing. Used in time clock, controlled access, and data collection terminals. The one reader that meets every requirement and is exceeding everyone's expectations in actual use.



- ★ Completely solid state for maximum reliability and long life.
- ★ Provides complete readout of numerical and alpha numerical data up to 22 columns.
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- ★ Compact. Lightweight. Low cost.

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FOR PROGRAMMING . . .

SEALECTROBOARD

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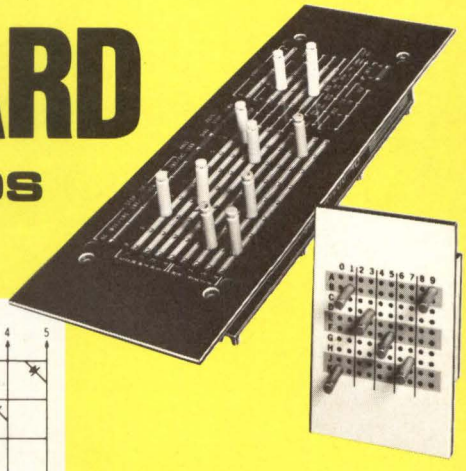
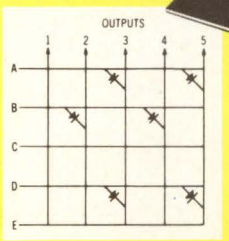


The reliable, common-sense method to switch and program any process or sequence of events. The ideal man-to-system interface affording instantaneous read-out or program changes anytime, anywhere.



- ★ Multiple switching from any input to any output.
- ★ Non-polarized or diode connections.
- ★ Instant readout and program changes.
- ★ No patch cords.
- ★ Available in 2, 3, 4, 5 or more switching planes.
- ★ Matrix available in .250", .100", or 4 mm spaced. hole patterns.
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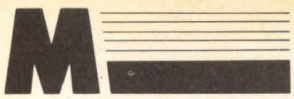
Circle 25 on Reader Inquiry Card



UFG-01. High-speed video frame grabber for PDP-11 bus. Factory maintenance. Companion to URGB-256. American/European std. Three-version 4/6/8 bits per pixel. Conversion rate at 30 MHz. Ext. sync to video source. Full SW control. $795 (1-4).

URGB-Alpha. Color Alphanumeric Video Controller for PDP-11 bus. Programmable character density. Blinking/Inverse/double height. From 10-128 characters per line. Hardware scroll & light pen. Up to 60 lines. Ext/Int sync. American/European std. $845 (1-4).

QRGB-Alpha. Color Alphanumeric Video Controller for LSI-11 bus. Programmable character density. Blinking/Inverse/double height. From 10-128 char./line. Hardware scroll & light pen. Up to 60 lines. Ext/Int sync. American/European std. $845 (1-4).

QRGB-GRAPH. Variable Resolution Color Graphic Controller for LSI-11 bus. Support zoom, pan & scroll. Ext/Int Sync. Variable Resolution 256 × 256 × 4. American/European standard. 512 × 512 ×4, 1024 × 1024 plus more. Single command erase. $1500 (1-4), APR/81.

URGB-GRAPH. Variable resolution color graphic controller for PDP-11 bus. Support zoom, pan & scroll. Ext/Int sync. Variable resolution 256 × 256 ×4, 512 × 512 × 4. American/European standard. 1024 × 1024, plus more. Single command erase. $1500 (1-4), APR/81.

URGB-256. 256 × 256 Color Graphic Video Controller for PDP-11 bus. 256 × 256 × 4 resolution. Optional companion frame grabber. 16-level color grey scale. Ext/Int sync. Two boards for 256 level color. American/European std. $1595 (1-4).

QFG-01. High-speed Video Frame Grabber for LSI-11 Bus. Companion to QRGB-256. American/European Std. Three version 4/6/8 bits per pixel. Conversion Rate at 30 MHz. Ext. sync to video source. Full SW control. $795 (1-4).

QRGB-256. 256 × 256 color graphic video controller for LSI-11 bus. 256 × 256 × 4 resolution. Optional companion frame grabber. 16 level color grey scale. Ext/Int sync. Two boards for 256 level color. American/European std. $1595 (1-4).

MDC-512. Variable resolution graphics controller for PDP-11 bus. Variable resolution. Ext/Int sync. 256 × 256, 512 × 256, 512 × 512, 1024 × 256. American/European std. Single command Erase. Vertical scroll. $1295 (1-4).

MDC-2480. 24 × 80 alphanumeric video controller for PDP-11 bus. U & L graphic character set. Acces time 500 ns. Support blink/inverse video. American/European std. Transparent memory. Ext/Int sync. $495 (1-4).

MLSI-2480. 24 × 80 alphanumeric video controller for LSI-11 bus. Support blinking/inverse video. Access time 500 ns. Upper/lower/graphic character set. American/European std. Transparent memory. Ext/Int sync. $495 (1-4).

MLSI-512. Variable-resolution graphic controller for LSI-11 bus. Variable resolution. Ext/Int sync. 256 × 256, 512 × 256, 512 × 512, 1024 × 256. American/European std. Single command erase. Support vert. scroll. $1295 (1-4). **Matrox Electronic Systems, Ltd.,** 5800 Andover Ave., TMR, Quebec, H4T 1H4, Canada. (514) 735-1182.

PDP-8 (MDB-LE8) Line printer controller. For Centronics, Dataproducts, GE Terminet, Printronix, most printers that emulate Centronics/Dataproducts interface. 15′ cable furnished with board. For PDP-8, E, A, F, M. 1-yr. RTFW. $650.

MDB-11B general purpose DMA wire-wrap board. General purpose DMA interface on single quad board. 12 IC positions of user logic. Includes 2 connector positions, up to 50 conductors each for cable-to-peripheral devices or to wire-wrap modules. All those are for PDP-11 & VAX-11/780. All 1-yr. RTFW. $1,195.

MDB-11C G.P. bus foundation module with W/W. $390.

MDB-1710 G.P. bus foundation W/W module. General purpose parallel bus foundation module with all logic for bus interface/interrupt service. Universal wire wrap portion for user logic, 40 sockets of any DIP configuration. $225.

MDB-11 WWB Quad W/W module. Quad wire wrap module for use with PDP-11, PDP-8, LSI-11. Up to 70 DIP sockets or ICs. 4 connector positions up to 50 conductors each for cable-to-peripheral device or to wire wrap modules for expansion. $125.

MDB-W9500 Hex W/W module. Universal hex wire wrap module with pins inserted for almost any combination of up to 96 sockets or ICs from 14 to 40 pins. Two I/O buses are provided. 130 pins on the side and the other, 250 pins across the top to be used with any configuration edge connectors. $195.

MDB-LP11 line printer controller-Dataproducts. Line printer controller for all speed versions of Dataproducts or Dataproducts interface emulating printers. Compatible with DEC operating and diagnostic software plus optional long-line operation adapter available. 15′ std. cable included; optional lengths up to 3,000′. All 1-yr RTFW. $750.

MDB-LP11A line printer controller- data printer. Line printer controller for all speed versions of Data Printer or Data Printer interface emulating printers. Compatible with DEC operating and diagnostic software plus optional long-line operation adapter available. 15′ std. cable included; optional lengths up to 3,000′. All 1-yr. RTFW. $1,250.

MDB-LS11 line printer controller- Centronics. Line printer controller for all speed versions of Centronics/G.E. Terminet/LA180 or Centronics/G.E. Terminet/LA180 interface emulating printers. $650.

MDB-CR11 card reader controller. Card reader controller for all-speed versions of Documation/other popular card readers. $875.

MDB-PC11 paper tape reader/punch controller. High-speed paper tape reader/punch controller for Remex/other popular paper tape reader/punch devices. $750.

MDB-XY11 incremental plotter controller. Incremental plotter controller for Houston Instrument, Calcomp/other popular devices. $1,250.

MDB-LV11 electrostatic printer/plotter controller. High-speed electrostatic printer/plotter controller for Versatec/similar interface emulating devices. $1,450.

MDL-11 async. serial line interface. With combined EIA/20-ma loop on quad board allowing switch-selectable modes of DL11-A, B, C, D or E with 16 selectable rates from 50 to 19.2K baud. Switch-selectable addressing interrupt vectoring, trans./receiver clock sources and baud rates. Full dataset control is std. Compat. with DEC operational/diagnostic software. Cable for connection to terminal or dataset. PDP-11 & VAX-11/780. 1-yr. RTFW. $630.

MDL-11W async. serial interface. Serial line interface with line freq. clock and EIA/20ma loop capability allowing DL-11WA or WB mode. Operation with either line frequency or ext. clock. 16-std. switch-selectable rates from 50 to 19.2K baud. All features of MDL-11. $630.

MDB-MDU11 sync. serial interface. Full/half duplex high-speed sync. program controlled data interface on a single quad board. Features of DU-11 plus speeds to 650 bytes/s. Complete modem control, 5 registers, double buffered interrupt, switch selectable address and interrupt vector, EIA level convertors and processes sync. and isochronous data. $1,443.

MDB-DUP11 sync. serial interface with protocols. Full/half-duplex high-speed sync. interface on single quad board. Provides all features of DUP-11-DA plus bit oriented protocols SDLC, ADCCP and HDLC, and byte control protocols BISYNC and DDCMP. Programmable character length 1 to 8 bits for BOP or 5 to 8 bits for BCP. $1,200.

MDB-DZ11A 8-line async. multiplexer. Async. 8-line EIA mux provides features of DZ-11A plus each line has programmable char. formats and data rates from 50 to 19.2K baud. Includes dataset control. $1,950.

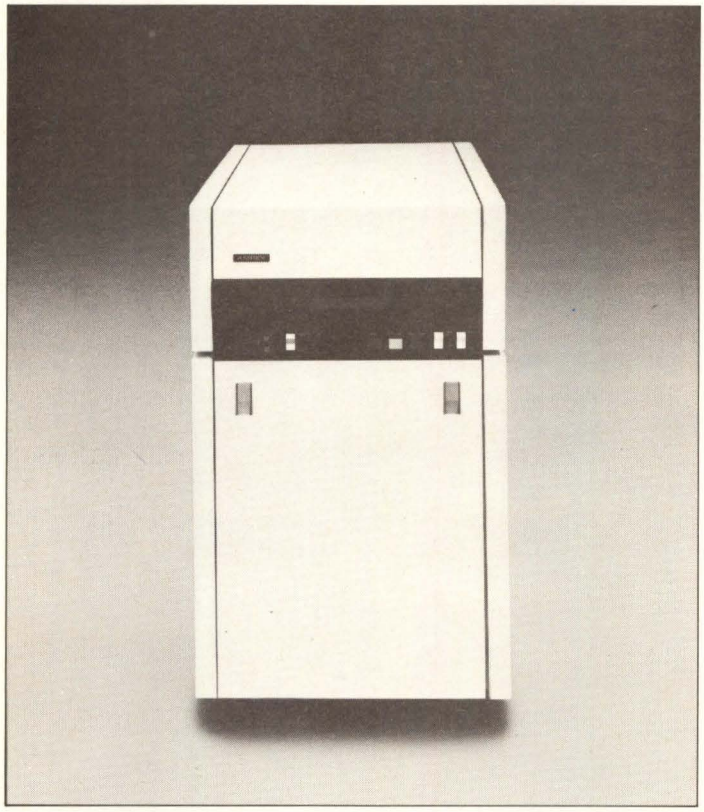
MDB-DZ11AC 8-line mux with current loop/RS-232. Async. 8-line mux with EIA/20 ma on per line basis (provides features of DZ-11A and DZ-11C on single board). Each line programmable from 50 to 19.2K baud. $1,950.

MDB-DZ11E 16-line async mux. Async 16-line mux provides features of DZ-11E plus individually programmable char. formats and data rates for each EIA line from 50 to 19.2K baud. $3,110. **MDB Systems, Inc.** Orange, CA.

MDB-DA11BJ Unibus interprocessor link. High speed parallel DMA interprocessor link links 2 PDP-11s with differ. drivers/receivers. Operates to 3,000′. Allows data transfers across 32K boundaries in blocks of up to 32K words. Data transfer speeds to 500K wps. Selectable address, interrupt vector and bus levels provided, preset to DEC std. assignment 77241X. Compatible with DR11B and DA11B operating and diagnostic software. All 1-yr RTFW. $4,875.

MDB/MLSI-DABOI Unibus-Q Bus interprocessor link. High-speed parallel DMA interprocessor link used with PDP-11, LSI-11/2 or 11/23 with differential drivers and optically-isolated receivers. All features of MDB-DA11BJ and DA11BOI. 50′ cables included; optional to 1,000′. $4,050.

TOTAL CDC COMPATIBILITY AND GREAT DELIVERY, TOO!



The only thing worse than not having enough disk storage, is not being able to get enough disk storage.

Fortunately, the Ampex DM-9300AQ solves both problems. With 300 megabytes of reliable disk pack storage and off-the-shelf delivery.

But the advantages of the DM-9300AQ don't stop with delivery. It's completely compatible with CDC's 300 megabyte drive. So disk packs can be interchanged, written on, or read by either drive. Of course, the industry standard SMD interface, and power sequencing of both units are also compatible.

DM-9300AQ disk pack swapping is as easy as using them. Its large front opening has been designed with the convenience of a top loader, and human engineered for minimal lifting. So even a 20-pound pack is easy to insert and remove. It's such a good idea, we're surprised somebody didn't think of it sooner.

But then, the DM-9300AQ is full of good ideas. Like highly reliable on-track servoing, and a single port daisy-chain interface with ribbon cable that can be converted—in the field—to an internal dual port.

And the same goes for maintenance. Service requires only front, rear, or top access. Side access is eliminated, so you can arrange the units side by side. What's more, the logic chassis in the rear of the unit swings out to provide easy access to all test points and connections. And extensive use of LEDs simplifies trouble-shooting.

The DM-9300AQ has a lot to offer. But what's even better, is that it's all offered right now. With delivery that's ready when you are.

The DM-9300AQ. Just one of a complete line of Ampex plug compatible disk drive memories for nearly any CPU.

For more information, contact Gary Owen at Ampex Memory Products, 200 North Nash Street, El Segundo, California 90245. If you're really in a hurry call him at 213/640-0150. Or contact your local sales office.

Either way, we won't keep you waiting.

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INTRODUCING THE $324* WE DO-IT-FOR-YOU WINCHESTER CONTROLLER.

Until now if you needed an inexpensive Winchester controller board, you were in big trouble.

They didn't exist.

Then we designed 5 chips that take the place of about 75 on an ST500/SA1000 interface. Which means it's now possible to fit a complete controller on one 6" x 9" board with about 40 chips instead of 150.

BIG ON RELIABILITY. Our WD1000 board gives you everything you need in a Winchester controller. Features like: a choice of 128, 256 or 512 byte buffers; a 5 MBITS/SEC transfer rate; control for up to 4 drives; control for up to 8 R/W heads and much more. All for about one-third the price of previously available controllers. The WD1000 is just $324 in quantities of 250.

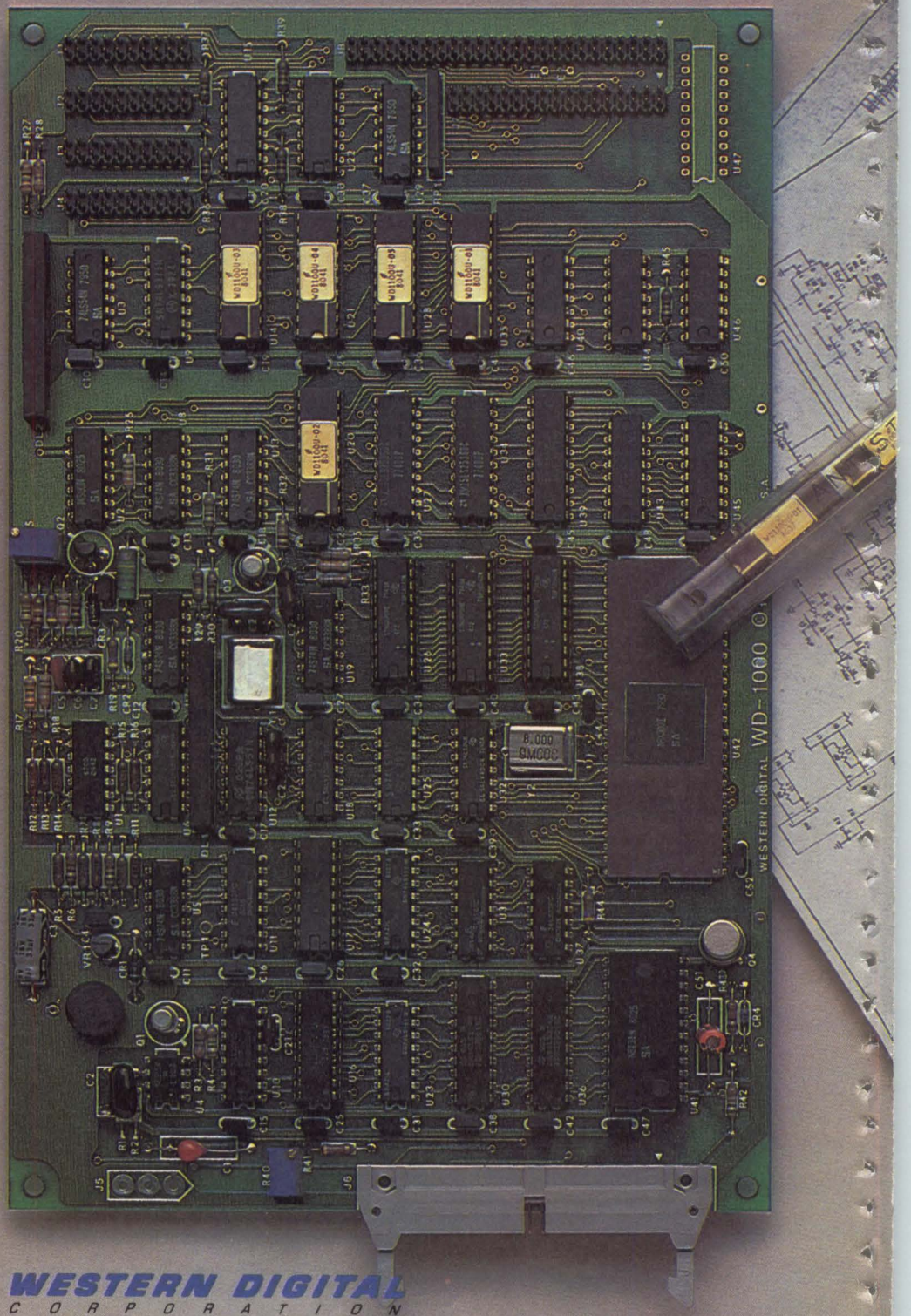
So suddenly you have greater design flexibility and the opportunity to create a system that's more reliable, less expensive and programs just like a floppy.

BIG JUMP ON THE MARKET. The WD1000 can save you up to 50% on your complete Winchester system and months of development time. Now's your chance to get a better product on the market, fast enough to make it very profitable.

For more information, including specifications on the WD1000 board, call (714) 557-3550 or mail in our coupon today.

With our boards, it won't be long before you're in the chips.

*Quantity 250.



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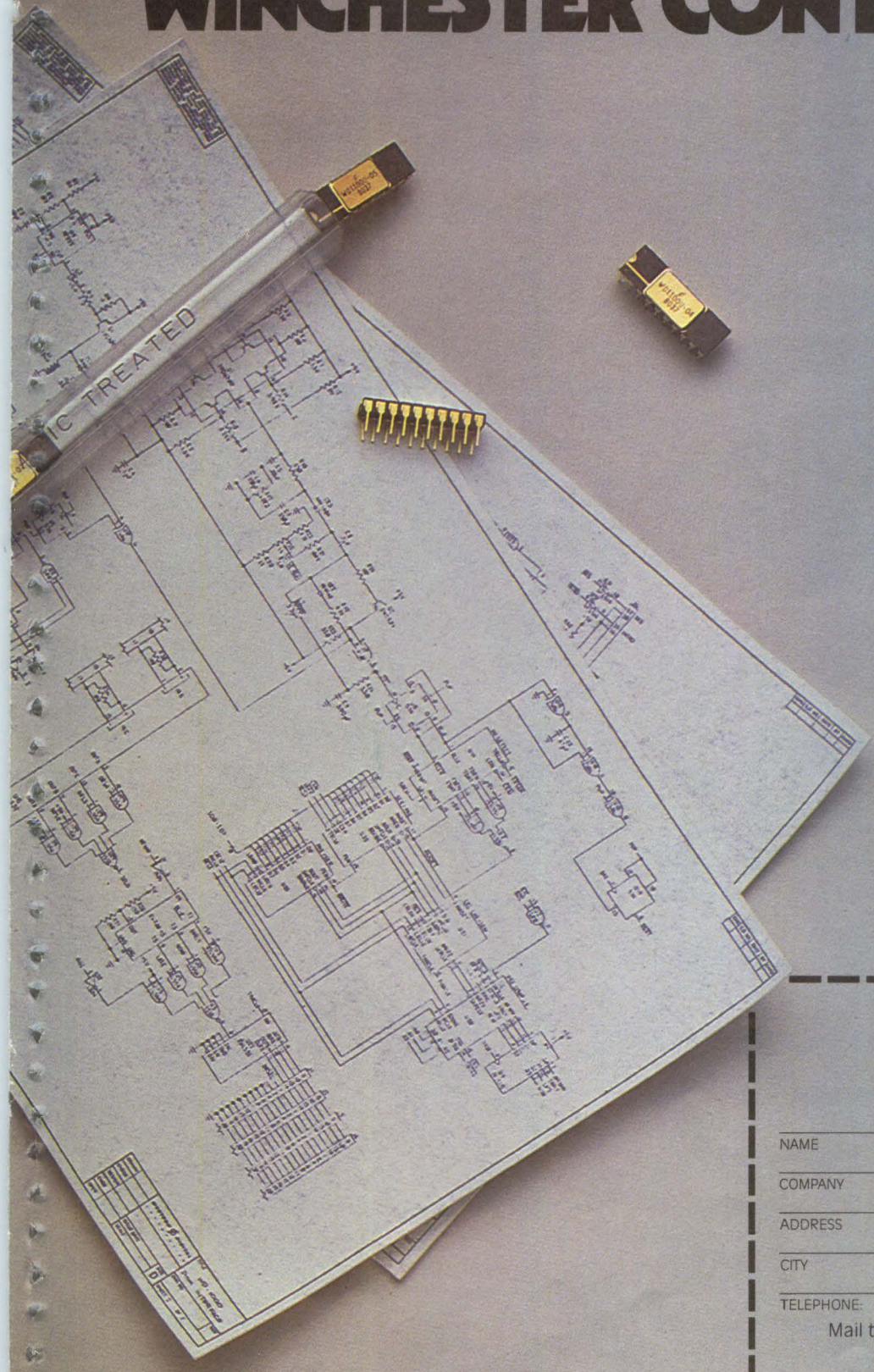
INTRODUCING THE $48* OEM DO-IT-YOURSELF WINCHESTER CONTROLLER.



Until now Winchester controllers had to be big, complex and very expensive.

SMALL WONDER. We've taken 75 discrete components from the usual Winchester controller and replaced them with 5 MSI chips (address mark detecter, CRC generator/checker, MFM generator, serial/parallel converter, parallel/serial converter) that can fit on a single board. And cost $48 per set.

Think what that means to you.

SMALL PACKAGE. An ST500/SA1000 interface for your system that's small, inexpensive, a lot less complicated and very reliable.

When you order the WD1100 5-chip set, we include complete instructions on how to design your controller board to make it work the way you want it too.

So not only will you save cold hard cash and months of development time, you'll be able to design a more compact, more reliable product. And get it into production while it's still new and exciting.

For more information, including specifications on the WD1100 chip set, call (714) 557-3550 or mail in our coupon today.

And it won't be long before you're in the chips.

Yes, I'm interested in saving money on my next Winchester controller.

☐ Call me. ☐ Send literature

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3128 Red Hill Ave.
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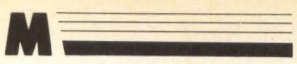


MDB-DA11BOI DMA interprocessor link. High-speed parallel DMA interprocessor link between two PDP-11 Unibus computers with differential drivers. Features of MDB-DA11BJ. $5,275.

MDB-DA528 program-controlled interprocessor link. Parallel buffered program controlled interprocessor link for use with PDP-11. Programmed control of 16-bit parallel data transfer between two PDP-11 computers. Compatible with DEC DR11C operating and diagnostic software. $2,495.

MDB-DR11B DMA interface module. Compatible with DR11B on single quad module. $1,450.

MDB-DR11C general-purpose parallel interface. Replaces DR11C. $440.

MDB-TA528 G.P. digital module. I/O interface with external bus control provides bus-to-bus interface to 100'. Line drivers/receivers; buffered I/O. $615.

MDB-MR004 G.P. PROM programmer module. On-board PROM programmer. Accommodates 2716, 2732 and 2758 type devices. Sockets for 8 device positions. $995.

MDB-MR11A bootstrap loader/restraint module. Features of DEC 873, 793 and MR11 on single quad module. Connector for independent quad module. Connector for independent ext. bootstrap control/watchdog timer. $795.

MDB-PDI11 byte-parallel bi-dir. DMA interface with RS-422. EIA RS-422 protocol driver/rcvr. compatible. For plasma display/high-speed-copy output devices. $2,150.

MDB-MR005 PROM/RAM module. For 2704, 2708, 2716, 2732 and 2758 type PROMs and 4118 and 4016 type RAMs. Sockets for 16 devices. $575.

MDB-IB11A IEEE/488 instrumentation bus controller. Interface between PDP-11 and programmable instruments that conform to ANSI std. MC 1.1-1975/IEEE std. 488-1975. Operating/programming as described for DEC's IB11 and IBV11A. 12' cable, connectors for first instrument. $1,425.

MLSI-LP11 line printer controller. All popular line printers. Compatible with LP11 or LS11 diagnostic and operating software. Multiple line printer address selection standard. 15' cable, mating connectors. LSI-11, LSI-11/23. $475.

MLSI-CR11 card reader controller. For all speed versions of Documation/other popular card readers. Multiple card reader address selection std. Compatible with DEC CR11 operating and diagnostic software. 15' cable, mating connector. $775.

MLSI-LV11 electrostatic printer/plotter controller. For Versatec/similar emulating device. 15' cable. $975.

MLSI-XYV11 incremental plotter controller. For Houston Inst. or CalComp XY plotters or equiv. Multiple plotter address selection/diff. drivers. Comp. with DEC XY-11 operationg/diagnostic software. $675.

MLSI-PC11 paper tape reader/punch controller. For popular paper tape reader/punch devices. Comp. with DEC PC-11 op. and diag. software. 15' cable, mating connectors. $675.

MLSI-DLV11 async. serial interface. EIA/20 or 60-ma loop. All data rates from 75 to 19.2K baud w/o crystal change. Switch-selectable UART parameters/baud rates. Multiple serial line address selection std. Comp. with DEC op./diag. software. $275.

MLSI-DLV11-E async-serial interface. All data rates from 75 to 19.2K baud w/o crystal change. Switch select. baud rates/ UART parameters. EIA and RS-232 rcvrs/drvrs for complete dataset control. Multiple line address selection. Comp. with DEC op/diag. software. $275.

MLSI-DLV11F async. serial interface. Serial line interface with programmable/switch-selectable baud rates from 75 to 19.2K baud. Switch selectable char. format, address, interrupt vector. Four level interrup. Buffer ready/printer busy monitor circuit. Dual size board. $290.

MLSI-DUV11 sync. serial interface. Program selectable USART parameters. Switch-selectable multiple serial line address. Bell 201 or 303 modem compatible. $700.

MLSI-DUPV11 sync. serial interface. Full/half duplex. Features of DEC DUP11-DA. Hardware CRC or LRC checking, generation for bit oriented protocols SDLC, ADCCP and HDLC. Byte control protocol BISYNC and DDCMP. $950.

MLSI-MRV-000 PROM module. 8 sockets for 2704, 2708, 3624 PROMS. Switch selectable memory area allocation. LSI-11, -11/23. $175.

MLSI-MRV-001 PROM module. LSI-11, -11/23. $175.

MLSI-MRV-002 PROM module. 32 sockets uses 5623, 5624 or equiv. PROMS. LSI-11, -11/23. $175.

MLSI-MRV-003 PROM Module. 32 sockets hold 3625 or equiv. PROMS. LSI-11, -11/23. $175.

MLSI-MRV-004 Programmable PROM Module. 8 sockets. On-board programmer. Uses 2716 and 2758 or equiv. PROMs. Programmer/memory area allocation switch selectable. Programming: memory-to-memory transfer with 55 ms wait loop. LSI-11, -11/23. $495.

MLSI-MRV-005 PROM/RAM Module. Comb. module. 8 sockets. Uses 2716, 2732, equiv. PROMs or 4016 RAMs. LSI-11, -11/23. $225.

MLSI-DRV11P Quad-Size Bus Foundation Module. General purpose bus foundation module. Basic Q-bus programmed I/O interface, address decode circuitry and multiple interrupt vector priority selection. Multiple external I/O provisions on module. Pinned for 56 wirewrap IC positions for user-designed logic. Wirewrap pins on component side. Accommodate any .300", .400", .600" center DIP. LSI-11, -11/23. $275.

MLSI-1710 General Purpose Bus Foundation Module. Dual size module. Basic Q-bus programmed I/O interface, address decode circuitry/ multiple interrupt vector priority selection. Multiple external I/O provisions on module. Pinned for 20 wirewrap IC positions for user-designed logic. Wirewrap pins on component side. Accommodate any .300", .400" or .600". Center DIP. LSI-11, -11/23. $175.

MLSI-DRV11C Parallel Line Interface. Parallel line interface module with multiple address selection and multiple interrupt vectors. Provides 16-bit word programmed data transfers. 4 control lines to peripheral units. Comp. to DRV11 operating/diagnostic SW. LSI-11, -11/23. $240.

MLSI-KW11-P Programmable Real Time Clock. 4 clock rates, program selectable (ext., 60Hz, 10KHz, 100KHz). 60-Hz crystal-controlled oscillator. Crystal control is with external inputs in 3 modes of operation (single interrupt, repeat interrupt, external input). Comp. with KW11-P operating/diagnostic SW. LSI-11, -11/23. $650.

MLSI-DR11B DMA Interface. Comp. with DEC operating/ diagnostic SW. Provides interrupt request/bus master control for bi-directional exchange of 16-bit data from LSI-11 bus to external device. Plug comp. with MDB-DR11B. DEC LSI-11, LSI-11/23. $575.

MLSI-DA11BOI Interprocessor Link Subsystem. Optically-isolated parallel DMA interprocessor link between two LSI-11s. High-speed differential drivers coupled with optically-isolated receivers maximize circuit isolation/provide ground loop current elimination for data transfer rates to 500K words/s. Data rate adjustments provided for optimum system operation to 1,000'. $3295.

MLSI-IBV11 IEEE/488 Instrumentation Bus Controller. Provides interface between LSI-11/programmable instruments that conform to ANSI IEEE 488-1975. Operating/ programming considerations as for IBV11-A. Includes 12' cable w/ connectors for first instrument. $700.

MLSI-BA11-30X LSI-11 Expansion Chassis. 5.25" RETMA rack-mountable expansion chassis assembly w/ blank front panel, BPA84 backplane/card guide assembly. Triple output regulated switching supply: +5v @ 25a, +12v @ 5a and −12v @ 1a. $1550.

MLSI-BPA82 Dual Size Backplane & Card Guide. 8 LSI-11 Q-bus dual slots. Compact assembly fits into 5.25" RETMA chassis. Provides removable 120-ohm bus termination. $275.

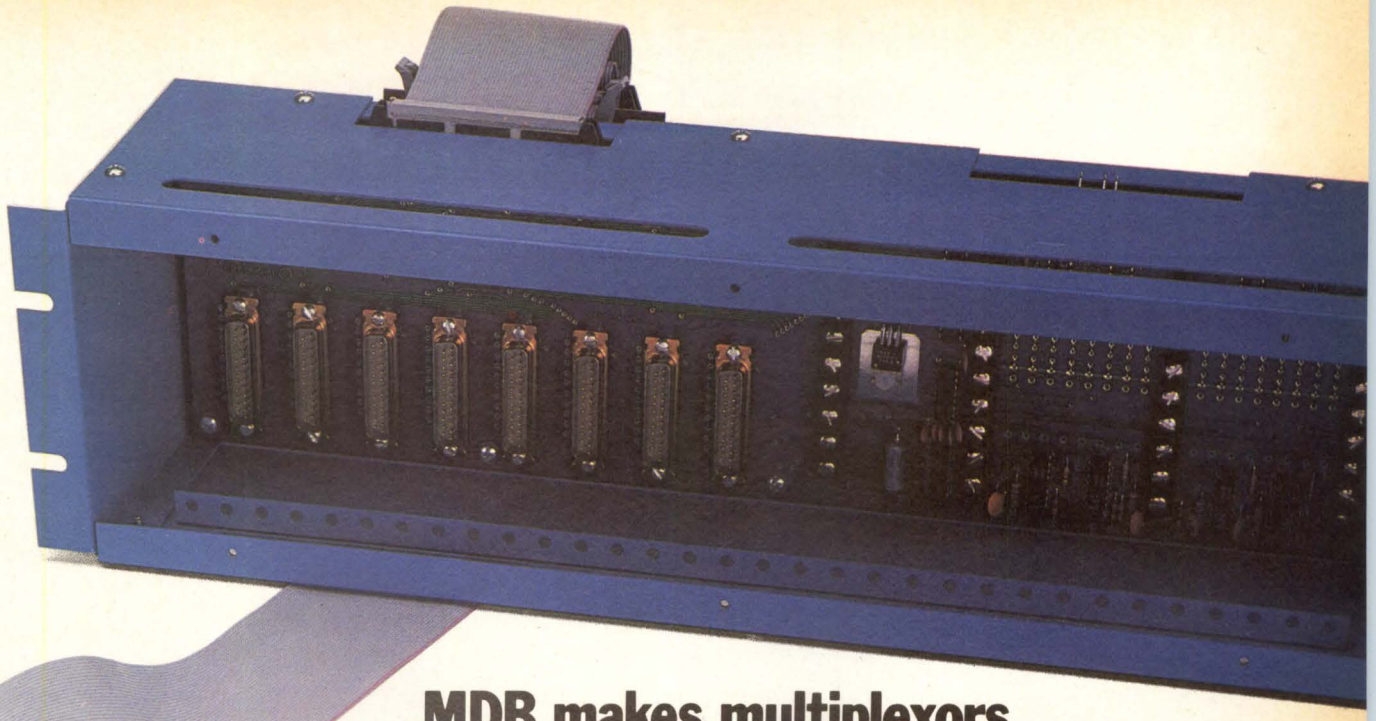
MLSI-BPA84 Backplane/ card guide assembly. 8 quad or 16 dual LSI-11 Q-bus slots. Assembly fits into 5.25" RETMA chassis. $425.

MLSI-H984 Roll-Around System Cabinet. 30" H, 31" L. 24.5" internal rack height, 29" D. Wood-grained top working surface. Internally mounted A/C power strip. External on/off circuit breaker. Two sets vertical mounting rails, RETMA space, baked enamel finish. $550.

MLSI-BA11-58X TU58 System Chassis. 5.25" RETMA rack mountable chassis assembly. BPA82 8 slot dual-width backplane/card guide assembly. Removable 120-ohm termination. Triple-output regulated switching supply: +5v @ 25a, +12v @ 5a and −12v @1a. Dual front loading TU-58 cartridge tape drives/controller w/ combined storage capacity 500K bytes. Self-contained power on/off/ failure sequencing. $3395.

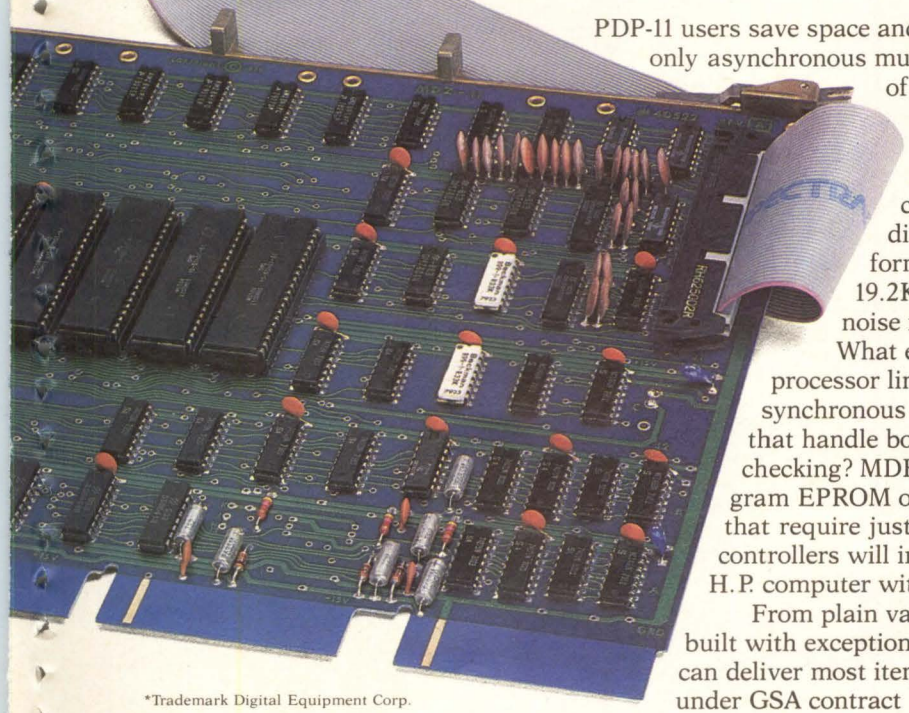
MLSI-11/03-LHBX Box System. LSI-11/2, async. serial ports, line time clock, bootstrap, 32KB RAM, EIS/FIS instruction set. 5.25" H. RETMA rack mountable system box. 8 quad or 16 dual Q-bus slots. Triple output regulated switching supply. Power on/off/ failure sequencing. $3855.

MLSI-11/03-58X Box System. LSI-11/2, 2 async. serial ports, line time clock, bootstrap, 32KB of RAM memory plus



MDB makes multiplexors for the PDP*-11 that let you combine RS232 and current loop on one board.

Imagine what else we can do!



PDP-11 users save space and save money! MDB's DZ11AC is the first and only asynchronous multiplexor that lets you combine up to eight lines of RS232 and current loop in any configuration on a single hex board. No more doubling up on boards, distribution boxes, rack spaces or price. The MDB DZ11AC is fully compatible with DEC DZ-11 operating and diagnostic software and, at the same time, performs at 16 standard data rates from 50 to 19.2K baud with optical isolation for enhanced noise immunity.

What else can MDB do? Have you seen our interprocessor links for LSI*-11 as well as PDP-11? Or MDB's synchronous communications interfaces for Q-Bus* that handle both bit and byte oriented protocols and error checking? MDB makes PROM modules that let you program EPROM on the board and foundation modules that require just one card slot. Our famous line printer controllers will interface your DEC, DG, P-E, IBM Series/1 or H.P. computer with most of the major line printers in the world.

From plain vanilla to state-of-the-art, all MDB products are built with exceptional quality. We warranty them for one year, can deliver most items in 30 days or less and offer them under GSA contract #GS-00C-02423.

Call or write and tell us what we can do for you.

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MDB SYSTEMS INC.
1995 N. Batavia Street
Orange, California 92665
714-998-6900
TWX: 910-593-1339

Circle 70 for PDP-11, 71 for LSI-11, 72 for DG, 73 for P-E, 74 for IBM.

M

dual TU-58 cartridge tape units with combined storage capacity of 500KB. $4995.

MLSI-BA11-20X LSI-11 System Chassis. Front panel, BPA84 backplane/card guide assembly. Front panel switches and indicators for user-selected LTC or KW11L. $1,990.

MLSI-11/23 AAX 11/23 System. LSI-11/23 with memory management, 128KB of RAM memory, 4 async. serial ports, bootstrap, line time clock and bus termination. $6,750. **MDB Systems, Inc.** 1995 N. Batavia St., Orange, CA 92665. (714) 998-6900.

MXV21 Floppy Disk Controller. DEC RX02 compatible floppy controller. Provides automatic firmware bootstrap loading from single or double density floppies, IBM 3740 formatting, power fail protection, write current switching, double sided control, write precompensation. Controllers: manufacture, market, sell MXV21. Factory maintenance. Dual-height card, LSI-11, LSI 11/2, LSI-11/23 compatible, single or double density, single or double sided, alternate address vector selection, four-level device-interrupt priority. $1260. W. A. Williamson, **Micro Development Assoc.,** 2192 Martin St., Suite 210, Irvine, CA 92715. (714) 851-2120.

MM-1103/2. 16-K word × 16-bits core memory for LSI-11. Factory service. $1350.

MM-1103. 8-k word × 16 bits core memory for LSI-11. $990. Bob Lepore, **Micro Memory, Inc.** 9436 Irondale Ave., Chatsworth, CA 91311. (213) 998-0070.

MK-16 microcomputer/ MkTRAN software. Mk-16: 16-bit μC. High-speed, low-power. MkTRAN: translation software for PDP-11 programs to run on Mk-16. 3rd party. Charles A. Sereno, VP Marketing, **Mikros Systems Corp.,** 845 Central Ave., Albany, NY 12206. (518) 489-2561.

HSP3609-212A Printer. Weighs less than 65 lbs. & provides 64-char. ASCII alphanumeric subset plus graphs up to 400 lpm. Qualified to MIL-E-5400, MIL-E-4158 & MIL-E-16400. Switch selectable 80 col. & 132 col. printout on multiple copy - up to four part - fanfold paper. Std. interface is serial by char. and parallel by bit including full line buffer. Unit includes off-line built-in test capability. 9.5″H × 14″W × 19″D. Controllers: PDP-11M/ Rolm 1602/NTDS/RS-232C/ MIL-Std-188C. Vendor maintenance. Fully MIL qualified: MIL-E-16400, MIL-E-5400, MIL-E-4158. $14,500.

LP3036 Line Printer. The lightweight (12 lbs.), multifunction, μP controlled line printer provides 36 or 42 col. printout to 240 lpm. Meets MIL-T-21200, MIL-E-16400, MIL-E-5400, NACSEM 5100. LP3036 internally stores to 150 sheets of 4.25″ wide, single or multipart fanfold paper. 64 ASCII char. set is std., 96 or 128 char. optional. $5000.

TP2000 Thermal Line Printer. TP2000 thermal printer is designed to meet the environmental requirements of MIL-T-21200, MIL-E-16400, MIL-E-5400. 7 lbs. Internal storage for a 150′ roll of 4.25″ wide thermal paper. Automatic paper take up optional. TP2000, a 10 cpi, 40 col. printer, operates at 160 lpm print speed. For greater page density, a 66-col. (17 cpi) version available. $5000.

CR600 Mag Tape Cartridge Recorder. Reel-to-reel cartridge recorder offers cartridge operation and reel interchangeability with IBM compatible transports. Utilizing 7″ reels with 600′ of storage, supply reel within cartridge readily removed for loading & processing on any IBM compatible mag tape unit. Processes data at 25-ips tape speed in IBM compatible 556/800-bpi NRZI format or optional 1600-bpi PE format. Rewind at 50-ips. $11300.

CR300 Compact Cartridge Recorder. The compact CR300 (5.5″ × 8.5″ × 8.5″) provides record/playback of digital data on DC300A (1/4″) data cartridge. 30-ips tape speed with 90-ips search/ rewind. 1600-bpi PE recording the CR300 utilizes a completely sealed, interchangeable SUPER PAC cartridge. Reliable in severe military environments and operator-proof data security. $5000.

DD400 Flexible Disk Drive. Over 3 million bits of 'on line' storage on interchangeable floppy disk media (over 6 million bits with optional double density). Media compatibility with IBM3740; each diskette provides 77 data tracks with 3200 bits/inch data packing (6400 bpi double density). Any addressable position on the diskette can be accessed in random sequence. Data transferred at a peak rate of 250 KC (500 KC double density). Track-to-track access within 6 ms. Slave $4700; Master $8850.

AT-1161 Tape Transport. (Auto Threading) operates to 130 ips with 200/556/800 bpi NRZI format. Optional 1600 bpi PE. Complies with MIL-E-16400/MIL-T-21200. Built-in test equipment. Unit is interfaced to NORDEN (DEC) and ROLM (Data General), Litton 3050, CDC 560124A μP (ANEW interface), Varian 620, Honeywell RL-6, others. $23,500. R. Ceonzo, **Miltope Corp.,** 9 Fairchild Ave., Plainview, NY 11803. (516) 349-9500.

EDC24. Singleboard emulating disk controller interfaces LSI-11 Q-bus computers to SMD-compatible disk drives. Emulates several DEC disk subsystems, including RK06/07 and RM02/03, with no modification to system SW. No vendor maintenance. $4,900.

SMV15. Singleboard disk controller interface VAX-11/780, PDP-11 series Unibus computers to SMD-compatible disk drives. Features automatic DMA throttle, dual access capability, 32-bit ECC. Supports VMS, RT-11, RSX-11, RSTS/E OS. $3,900.

SMC11. Singleboard disk controller interfaces any PDP-11 series Unibus computer to SMD-compatible drives. Automatic DMA throttle, dual full-sector RAM buffering and 32-bit ECC. Supports RT-11, RSX-11, RSTS/E OS. $3,900. Bill Berkman, VP Mktg., **Mini-Computer Technology,** 2470 Embarcadero Way, Palo Alto, CA 94303. (415) 856-7400.

MK8001. Add-in semiconductor memory for PDP 11/04, 05, 10, 34, 35, 40, 45, 60. To 64K words × 18 bits (2 Parity). 350 ns access; 16K, 32K, or 64K words/board; 16K bit dyn. RAM technology. 8.8″ × 15.69″ × 0.4″ (hex-wide board). 1-yr RTFW. 64K Memory, $1610.

MK8005. PDP-11/03, LSI-11/2, to 32K word × 18 bits (2 Parity); or board refresh for 16K dyn. RAMs. 140 ns write access, 375 ns read access; 16K, 32K words/board; Mostek 16K bit dynamic RAM technology; 9″ × 5.2″ × 0.4″ (dual wide) size. 32K × 16 memory, $850.

MK8009. PDP-8 A, E, F, M; to 64K words × 12 bits; compatible with system (sync.) timing; uses Mostek 16K bit dynamic RAM chip technology with on-board refresh. Fully compatible with PDP-8 timing; 16K, 32K, 48K and 64K words/board; Quad-, 5-, and 6-wide board sizes available; 16K RAM chip technology. 64K memory, $2790.

MK8011. PDP 11/04, 05, 10, 34, 35, 40, 45, 60 up to 64K words × 18 bits (2 Parity); On-board parity controller obliviates necessity for DEC 7859 Parity controller. 150 nsec access time; 16K, 32K, 64K words/board; hex-wide size (15.9″ × 8.8″ × 0.4″); on board parity generator/checker; 16K bit dynamic RAMs with on-board refresh. 64K memory, $1725.

MK8012. PDP11/04, 05, 10, 34, 35, 40, 45, 60; up to 128K words × 18 bits (2 Parity); 16k dynamic RAMs — on-board refresh. 350 nsec access time; 64K, 80K, 96K, 112K, 128K words/board; on-board refresh for 16K bit dynamic RAMs; hex-wide size. 128K memory, $2410.

MK8015. PDP 11/04, 05, 10, 34, 35, 40, 45, 60; up to 128K words × 18 bits (2 Parity); On-board parity controller; 16K bit RAM chips. 100 nsec write access time; 64K, 96K, 112K, 128K words/board; on-board parity controller; on-board refresh; hex-wide size (15.69″ × 8.8″ × 0.5″). 128K memory, $3150.

MK8016. PDP 11/780 VAX; to 64K words x 72 bits (8 ECC); on board refresh. Compatible with VAX memory controller; 32K or 64K words/board; 16K bit dynamic RAMs with on-board refresh; 15.69″ × 11.93″ × 0.56″. 64K memory, $5500.

MK 8070. PDP-11/70. For up to 64K words x 39 bits (7 bits ECC). Mostek 16K dynamic RAM technology with on-board refresh. 15.69″ × 8.8″ × 0.56″. In 16K, 32K, and 64K words/ board. Mostek 16K Dynamic RAM technology. Gary Anderson, **Mostek/Memory Systems,** 1215 W. Crosby Rd., Carrolton, TX 75006. (214) 323-6000.

DEC-11/VAX Semiconductor memory. Add-in memory boards for PDP-11, LSI-11, VAX. **Motorola, Inc.** 3501 Ed. Bluestein Blvd., Austin, TX 78721. (512) 928-6776.

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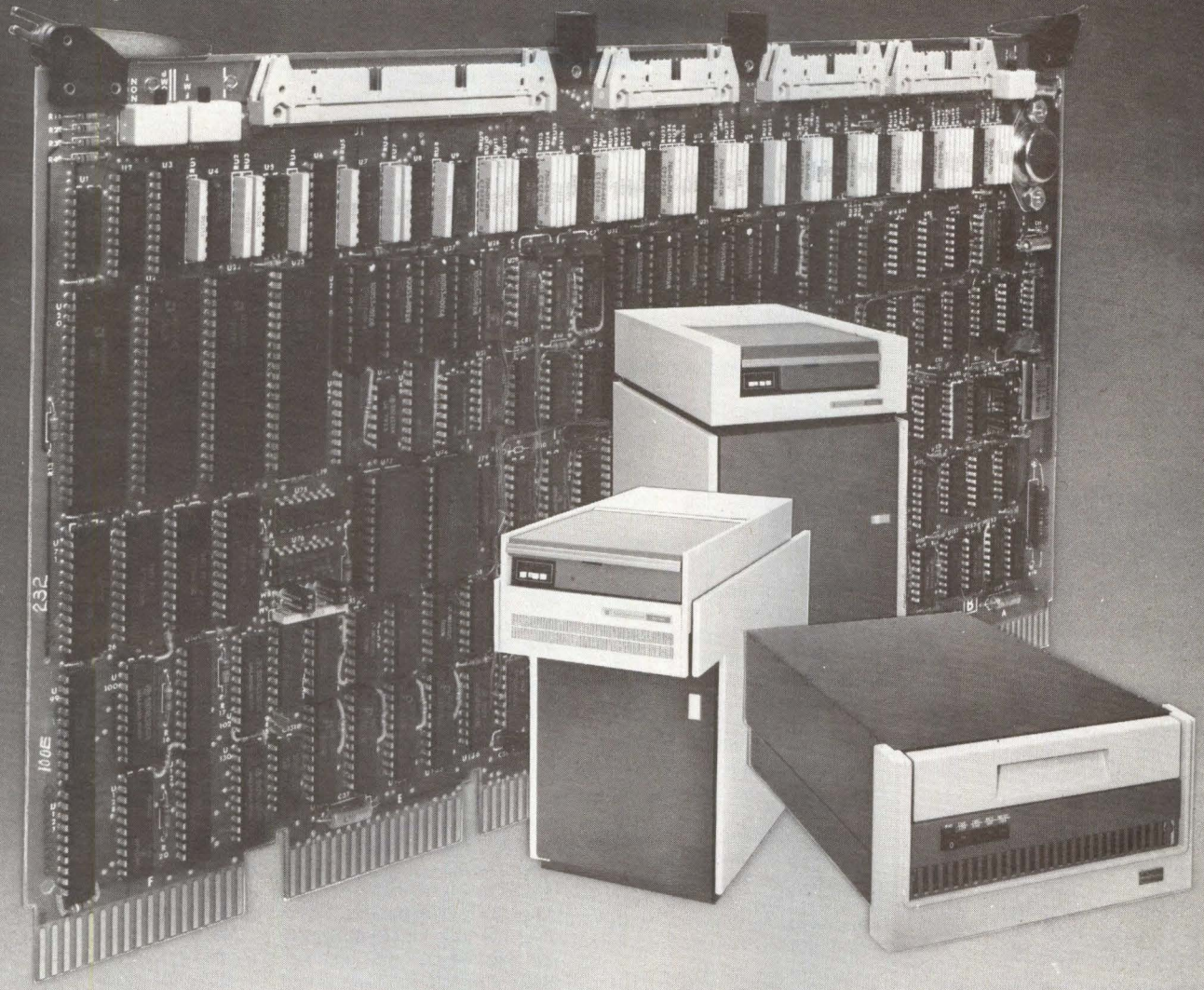
GPIB11-1. PDP-11 to IEEE std. 488-1978 interface card. Maintenance: home office. $1295.

GPIB11-2. PDP-11/IEEE 488-1978 std. high-speed DMA interface card. $1995.

GPIB11V-1. LSI-11/IEEE 488-1978 std. interface card. $695.

GPIB11V-2. LSI-11/IEEE 488-1978 std. high-speed DMA interface card. $1295. Kim Hosen, **National Instr.,** 8900 Shoal Creek Blvd., Austin, TX 78758. (512) 454-3526.

NEW SMD CONTROLLER for
Plessey's family of disc subsystems for the PDP-11*



PLESSEY'S PM-DC1100 disc controller provides a reliable interface between your PDP-11 and a wide range of drives with industry standard, SMD-type interfaces, including the latest Winchester minimodule devices. The low-cost PM-DC1100 is designed for realistic expansion of your present RP02/RP03* series subsystem data base to more than 538/2000 Mbytes of hard disc storage. For PDP-11 users without an RP series subsystem, the PM-DC1100 is available with selected drives, cables and DEC*-compatible software as a complete subsystem. Model numbers and formatted capacities are:

PM-DSA11/32	27 Mbyte	(1 removable, 1 fixed disc)
PM-FS11/33	25 Mbyte	(1 fixed, Winchester)
PM-DSA11/80	67 Mbyte	(1 disc pack)
PM-DSA11/300	256 Mbyte	(1 disc pack)

The PM-DC1100 controller is completely transparent to your operating systems and diagnostics that support the RP series controllers. It's also pin-to-pin, signal, and power compatible with DEC backplanes. Just plug the SINGLE hex board into your PDP-11 computer, and cable directly to one or two drives. With a multidrive interface chassis and minor software patches, the controller can support up to eight drives.

The microprocessor based controller features a high transfer rate of 1.2us/word, transparent ECC, multiword DMA transfer, and many other benefits you expect from the leading producer of DEC-compatible peripherals.

Contact your nearest regional sales office for more information on the PM-DC1100 controller, subsystems, or any Plessey product.

Return this form for more information on Plessey's PM-DC1100 disc controller.

Plessey Peripheral Systems

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Irvine, CA 92714
ATTN: Marketing Dept.
800-854-3581 or
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NS11L. Add-in memory for PDP-11 modified-std. or special bus, 22-bit addressing. +5V-only on-board parity-density 256KB (128 × 18), on-board CSR. Factory maintenance/optional 24-hour replacement maintenance. 1-yr. warranty.

NS11E. Add-in memory: PDP11 modified-special-std. Bus-on board ECC 128 kB (64K × 26). +5V-only, on-board CSR.

NS780. Add-in memory for VAX 11/780 CPU. 512KB density 64K × 64 + 8 ECC, 225 ns access/425ns cycle. FO. Installation/field service avail.

NS23L. Add-in memory: LSI-11, 11/2, 11/03, 11/23. Density 32K × 18, 190ns read access/490 read cycle. Battery back-up. Std. factory maint./ optional 24-hr. replacement maint.

NS23Q. Add-in memory for LSI-11/23 256KB (128 × 18) on single quad-card, on-board parity. Don Johnson, **National Semiconductor/Memory Systems,** 2900 Semiconductor Dr./7C265, Santa Clara, CA 95051. (408) 736-6994.

New/used DEC & DG equipment. PDP11, PDP8, VAX, ECLIPSE, NOVA systems, processors, peripherals. Buy, sell. Warranty service only. 90-day warranty; most items eligible for manufacturer maintenance. Discounts to 50% off list on late-model equipment. Minicomputer Sales Dept., **Newman Computer Exchange,** Box 8610, Ann Arbor, MI 48107. (313) 994-3200.

Zeta Plotters. Full line of high peformance digital drum plotters/electrostatic printer-plotters. Also: computer output plotters. FO; 3rd party. 12″ to 54″ high performance drum plotters. From $6,000. Mike Higgins, **Nicolet Zeta Corp.,** 2300 Stanwell Dr., Concord, CA 94520. (415) 671-0600.

NVM05. VAX 300MB disk drive subsystem utilizing SBI/supporting full DEC diagnostics. 3rd party. $28,900 drive, controller, cables; $16,900 slave drive & cable.

Power Plus 11/70. Utilizes PDP 11/70 CPU. Terminals: NVT-100. Add-in/add-on memory: 128KB - 2048KB. Hard disk drive: 80MB, 200MB, 300MB, 600MB. Controllers: Massbus and Unibus. $120,000 — 200,000.

NWM05. 300-MB disk drive subsystem for PDP-11/70 Massbus-Cache interface. $22,900 drive, controller, cabling; $15,900 drive & cabling. Seth Basker, **Nordata,** 4433 27th Ave. West, Seattle, WA 98199. (206) 282-1170.

MCC-Z Portable MicroChassis. Portable, table-top package for up to 4 dual-height DEC-type μC modules. 5v @ 8A, 12v @ 1.5A supply w/ front-panel controls, fan, pre-wired Q-bus backplane. Terminals, add-in/ add-on memory, floppy drive, hard disk drive, controllers, I/O analog boards, others. FO; 3rd party. $690.

SBC-1 Shoe-Box Computer. Portable desk-top computer w/ front panel controls & indicators, supply, fan. LSI/11-2 CPU w/ multi-function module, 8K RAM, 60Hz crystal clock, 2 RS-232 I/O ports. 2 Q-bus slots for expansion. $1980.

MCC-3 System MicroChassis. 19″ Rack-mount. chassis for up to 16 quad-height or 32 dual-height DEC-type micro modules. +5V @ 12A & 12V @ 2.5A supply w/ front-panel controls. Modules are front-mounted vertically for easy access & cabling. Includes 2 cooling fans. $1395 w/ Q-bus backplane for 8 double-height or 4 quad-height cards.

MCC-1 System MicroChassis. 19″ Rack-mountable chassis for up to 20 dual-height DEC-type micro modules. +5V @ 12A & +12V @ 2.5A supply w/ front panel controls. Modules are front-mounted vert. for easy access & cabling. Includes 2 fans. $1195 w/12-slot Q-bus backplane, supply, 2 fans: 20 slots add $200. Ken Salz, **North Atlantic Industries/ACS Div.,** 60 Plant Ave., Hauppauge, NY 11787. (516) 582-6500.

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Unibus Status Monitor PDM-U1. PDP-11 Unibus-compatible status monitor presents state of each of 56 Unibus lines onto individual LEDs. Has one-level built-in-latch for ea. signal so last bus cycle stored/displayed. Contained on dual-wide board, extra height. $350.

ZIF TENDER PDX-2, 4, 6. PDP-11 & LSI-11 compatible extender boards with std. PC connector or ZIF. In dual, quad, hex vers with build-on card guide. $80, dual w/ZIF; $110, quad w/ZIF; $150 w/ZIF. Pat Dawson, **Pacific Digital Systems,** 878 Hollenbeck Av., Sunnyvale, CA 94087. (408) 732-0656.

MBB-11/MBC-11 Bubbl-Board/Bubbl-Pac. Magnetic bubble memory modules for LSI-11. 46K bytes per module, 7.5 ms access, non-volatile. $947 (10). R.L. Nelson, **PC/M Inc., Bubbl-Tec Div.,** 6800 Sierra Court, Dublin, CA 94566. (415) 829-8705.

MEccVII. Semi error-correcting memory system. Battery back up. 32KB encrements to 256KB on one controller; 2 ea. 128KB memory array boards. LSI-11/2, 11/23. No vendor maintenance. Bill Sayre, **PEBX, Inc.,** 501 Vandell Way, Campbell, CA 95008. (408) 866-7838; Non CA: (800) 538-3112.

WINRS-11. LSI-11, PDP-11 Winchester storage system. 21-280MB cap'y. Lo-profile enclosure. $6550.

VRC-VII. High-perform. color video display interface for PDP-11/04-11/70, VAX. Floppy drive, hard disk drive, controllers, others.

FDI-L11/D. DMA dual-density programmable floppy disk interface for the LSI-11. $1190.

HEX-L11. Multi-processor linking system for the LSI-11. $1596.

VRL-11. Direct access video interface for LSI-11.

VRQ-11. Programmable direct-access video interface for LSI-11/2, 11/23. 22-bit addressing.

VRU-11. Programmable video interface for the PDP-11/04 - 11/70, VAX.

VRG-Q11. Alphagraphic 512 × 512 & 32 × 64 video display interface for LSI-11/2 - 11/23. $995.

DMA-L11. High-perform. DMA/ PIO interface for LSI-11/2, 11/23. No vendor maintenance. $495. **Peritek,** 3014 Lakeshore Av., Oakland, CA 94610. (415) 465-9000.

PM-RFV11. Fixed-head disc emulator, for fast swapping on TSX OS or RSX-11M. 500 KB/s. transfer rate w/ 4-ms access time. Quad-wide controller board w/ 256-KB memory board can interface with max. 7 PM-RMV11 memory modules for 2MB capacity. FO.

PM-DSW 11/E. 254-MB disc storage system for PDP-11/70. PM-DCW11 controller interfaces direct to RH70. Emulates RH70 w/ RP06 drive.

PM TS11. Mag. tape subsystem for PDP-11 is direct replacement for TM 11/TV 10 tape system. Compatible w/ all DEC SW diagnostics.

TSX-PLUS (Software). Allows true time sharing under RT11 OS. Up to 30 users access what apears independent RT-11 single job monitor.

PM XS 21. 1MB, rackmountable, dual floppy subsystem has two 512KB double density floppy disc drives, μP-based controller. Single density encoding (IBM 3740 FM) or double density (DEC-modified MFM) RX11, RX211 compatible SW, diagnostics.

PM XS31. 2-MB, rack-mount, dual floppy subsystem: 2 1MB double-density, double-sided drives, μP-based controller uses single-density encoding (IBM 3740 FM) or double density (DEC Modified MFM) RX11 and RX211 compatible.

PM XSV 31. Double-density floppy subsystem w/ double-sided drive, PM-XCV31 controller. Write precompensation, transparent firmware, bootstrap, 4 level interrupt priority. 1MB w/ single drive or 2MB w/ two drives.

PM1132A. 64KB core memory module operates on Unibus of PDP-11.

PM-8A16. 16,384-word by 12-bit random access core memory module for PDP-8/A. Plug-in replacement for MM8-AB core memory. Operates with (or in place of) MM8-AA(8K) — or MM8-AB(16K) core memories.

PM-1132. 64-KB core memory module operates on Unibus of PDP-11.

PM-DSA 11/32. Cartridge disc subsystem contains DC1100 controller with PMDD 11/32 CMD Disc Drive. One 13.4-MB fixed; one 13.4-MB front-loading cartridge.

PM-Rev 11/2. Dual-height console bootstrap ROM loader compatible with LSI-11, Plessey's Micro I & Micro II.

PM-KK 11A. High-speed, 2KB cache memory for PDP-11/34A central processor. Cache memory has required data for 85% of data requests that occur during typ. program operation.

PM-FS11G. 14″ Winchester disc subsystem for PDP-11s has single hex-wide PM DC1100 controller board, FD11G fixed-disc drive w/ 25.3-MB formatted capacity. Compatible with RP 11/C controller & SW.

PM-DS11/300 C. DEC RH11 replacement. Complete mass storage disc system. Expandable to 8 drives.

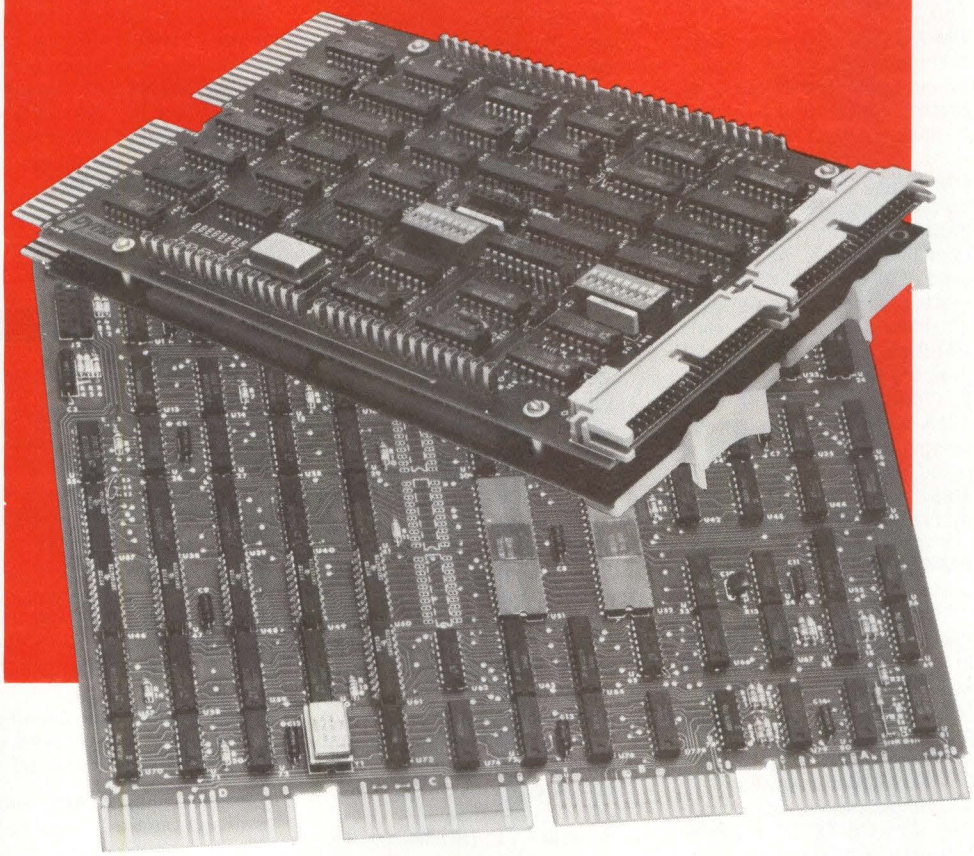
PM-DSA11. 5 & 10-MB cartridge disc subsystem for PDP-11.

PM-XS11. Floppy disc drive subsystem for PDP-11. Emulates RX11. (Rack mount).

PM-RF11. Replaces RF-11A. High-performance, disc emulator. Utilizes 16K MOS memory in place of mag disc unibus systems.

PM-TS11. TM11/TU10 equivalent mag tape subsystem for PDP-11.

DEC®-COMPATIBLE PERIPHERAL CONTROLLERS



Now, from the company that delivers the industry's widest range of DEC-compatible memory products, a family of peripheral controllers that's second to none. From comparatively simple cartridge disk controllers to complex 300MB storage module drive (SMD) controllers.

An impressive array of state-of-the-art controllers, all built around high-speed bipolar microprocessors. All software compatible with the host LSI-11® or PDP®-11 minicomputer...and all available now.

And Dataram's controllers are designed to save you money, and a lot more. Like space — our controllers typically occupy half the space required for the comparable controller from DEC. Doing it with a level of performance that makes any member of this family worth looking at.

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Cranbury, New Jersey 08512
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DATARAM CONTROLLER	Magnetic Tape Controller			Cartridge Disk Controller		SMD Controller					
	T03	T04	T34	C03	C33	S03/A	S03/B	S03/C	S33/A	S33/B	S33/C
MINI	LSI-11	LSI-11	PDP-11	LSI-11	PDP-11	LSI-11	LSI-11	LSI-11	PDP-11	PDP-11	PDP-11
COMPATIBILITY	TM11/TU10			RK05		RM02	RK07	RP06	RM02	RK07	RP06

Circle 23 on Reader Inquiry Card

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PM-DSV21L. RLO2 equiv. disc cartridge subsystem for LSI-11.
PM-XSV-21. Dual density floppy subsystem for LSI-11/2, LSI-11/23.
PM-DCV11A. Cartridge disc controller for LSI-11 based systems.
PM-DSA11/300. 256 MB disc pack subsystem for PDP-11.
PM-CSV11. Minicartridge tape backup subsystem for LSI-11.
SYST-34. Line of mini systems offer sophisticated computing applications.
SYST-23VX. Micro systems for sophisticated computing applications in small systems environment. LSI-11/23-based system has 10 MB dual-platter cartridge disc subsystem, dual floppy disc subsystem. Expansion to large data base. Protects HW/SW. Integral memory management for max. of 256 KB of addressable memory, four-level interrupt protocol, parity check, optional floating point.
SYST-13V. Line of disc cartridge micro systems. 128 KB MOS memory. Marketing, **Plessey Peripheral Systems,** 1691 Browning, Irvine, CA 92714. (714) 557-9811.

SYST-2VX. General purpose μC systems for small system applications. Terminals: PT-100.
SYST-1V. LSI-11/2 systems.
PM-DSA 11/80. Disc subsystem consists of DC1100 controller board (fully software transparent to DEC software) & DD 11/80 disc drive. Single board controller directly supports 2 drives, 8 drives can be added to upgrade the subsystem to a maximum formatted capacity of 538.4 MB.
PM-DC 11/300C. Mass disc storage control unit consists of PM-DC 11/300 disc controller, supply, fans. Replaces RH11-based systems. DEC SW compatible. 2000 MB per system when extended to full capacity of 8 drives.
PM-DC 1100. Completely transparent to DEC OS & diagnostics that support RP series controllers. For realistic expansion of RP02/03 series subsystem data base to over 538/2000 MB hard disc storage. Supports up to 8 drives. Disc controller interfaces PDP-11 and wide range of SMD drives — including latest Winchester minimodule drives. Single hex-wide board pin-to-pin, signal and power compatible with DEC backplanes. Transparent to OS and diagnostics that support RP Series controllers. Transfer rate of 1.2μs/word, transparent ECC and multi-word DMA transfer. With selected drives, cables, DEC-compatible SW as complete disc storage subsystem.
PM-DC 1102. Disc controller for use w/ high performance CDC 9762 (or equiv.) storage module drives. PM-DC 1102 emulates; totally SW and media comp. w/ RH11/RM02 disc subsystem. 4 drives can be connected directly to DC 1102 controller for max. formatted capacity of 269.2 MB.
PM-DC 11A. Controller board replaces RK11D controller for RK05. Transparent to DEC OS diagnostics. Support std. 2.5; 5; 10 MB drives for max. formatted capacity of 20 MB storage.
PM-KG11A. Communications arithmetic option is programmable polynomial calculator providing error detection capabilities for data communications.
PM-7850. Dual-wide parity controller for PDP-11 contain parity memory. Odd parity checking detects memory failures of all 0's on the Unibus, a more probable failure than all 1's. Insures memory integrity.
PM-S8A. High density add-in memory for PDP-8/A. Addresses located anywhere from 0-128K words in 4K increments using a DIP switch module located on memory card. Operates with KT8A memory management unit for addresses above 32K.
PM-SJ11. High speed memory system for the PDP-11/70 has 256KB storage; to 1.5MB.
PM-S11L & PM-S11L/F. Memory board replaces MS11L & provides 256 KB of MOS memory and on-board parity controller. SW transparent to DEC's OS & diagnostics. 256 KB MOS memory for PDP-11. Single hex-board compatible with DEC's OS/diagnostics. HW, voltage, signal, pin-to-pin compatible with Unibus backplanes. Refresh cycling. Supported by battery backup. Variable switch settings permit starting/stopping on any 8 KB boundary within extended addressing range of 0 to 4 MB.
PM-S11E/64. 128KB MOS board ECC.
PM-S11E. Compact system has 2 boards of 256KB of memory. ECC.
PM-1132W/JE & PM-1132W/J. 128 KB parity core memory provides nonvolatile R/W storage for PDP-11/70. Is a 64-KB add-in memory for MJ11 memory chassis. Single unit space for PM-1132W/JE.
LSI/PDP-11 WP/list processing software. PWS-1 permits unlimited changing of formatting of copy, sorts/merges names list, etc. PWS-1 is written in assembly Macro-11 used w/RT-11 OS. w/ or w/o TSX time-sharing facilities. $2300, w/OEM discounts.
PT-100 VT-100 Alternative. 80 or 132 col. by 24 lines, reverse video/blink fields on per-char. basis, variable intensity (bold to half-bright). Parity, baud rate, underlining, tabs KB-selectable. Detached KB. Switch-selectable 20mA/EIA interface, printer port (RS-232 interface).
PM-RF11. Fixed head disc emulator provides high-speed, bulk storage (to 1.5 MB). 16K MOS RAMs. ECC. No moving parts. For interactive applications, use as a swapping file (increases throughput). Data transfer speed: 1 to 2 μs/word; access time, under 1 μs. **Plessey Peripheral Systems,** 17466 Daimler, Irvine, CA 92714. (714) 540-9945.

Diskos 3350. Winchester disc drive. DEC, DG, Intel, TI-990, Interdata. Hard disc drive, controllers: joint selling approach. Factory FO. Capacity: 10-160 MB; access: 45 ms; 8" & 14". $1650 to $2250. Carol Manning/Kathy Smith, **Priam,** 3096 Orchard Dr., San Jose, CA 95134. (408) 946-4600.

VIDIO/11 (VIDeo I/O). Software package: subroutine library for doing CRT I/O in application programs. Provides CRT model independence with cursor control etc. PDP-11/VAX. Vendor maintenance thru SW maintenance agreement from vendor. Supports most CRTs & video attributes, cursor control, partial screen scrolling. Configures at runtime for CRT used. Provides "protected fields" for CRT input. About 2.5KB of code (sharable). OEM license: $1,500 (1 CPU) & royalty on sales of OEM product.
SCRNIO/11 (SCReeN I/O). SW package: subroutine library & screen format editor for using predefined screen formats in application programs. Includes field attributes for input processing/error checking. PDP-11/VAX. Requires PSI's VIDIO/11. Supports most CRTs. Field attributes include fill/justify, mask, range, legal values, mendatory/optional, default values, etc. Multiple formats/screen. About 3.5KB of code (sharable). OEM license: $2,000 (1 CPU) & royalty on sales of OEM product.
SPEEDSORT/11. General-purpose sorting utility SW package; usable as standalone utility via user command or callable from application program. Fast sorting w/minimum workfile space. PDP-11. Requires RSX-11M/M+/D or IAS OS. SPEEDSORT-11 task requires 64KB memory to run. Sorts all FCS file types, including RMS sequential. To 15 keys: char., binary, floating point, or unsigned. $600/yr. rental (end-user, 1 CPU); discounts for add'l CPUs. Stephen F. Heffner, Pres., **PSI (Pennington Systems Inc.),** 65 S. Main St, Bldg C, Pennington, NJ 08534, (609) 737-2727.

Q

1200, 2200, 2710, 5100. Cartridge tape storage systems. PDP-11 & LSI-11, DG, Intel. Floppy drive, hard disk drive, controllers, I/O analog boards. FO. From $2,330. Leon Malmed, Sales Dir., **Qantex Div of North Atlantic Industries,** 60 Plant Ave, Hauppauge, NY 11787. (516) 582-6060.

R

VT-100-compatible video display generator. LSI-11 bus resident. Comes as board set or w/ KB and monitor as console or workstation. **RDA, Inc.,** 5012 Herzel Pl., Beltsville, MD 20705. (301) 937-2215.

Real-time image processor RIP-260. Image processor. Q-bus, Unibus, IEEE-488. FO. RIP-261, $13,370; RIP-262, $15,870; RIP-263, $18,370; RIP-264, $20,810. Richard Pizza, **Recognition Concepts Inc.,** 916 Forbes St, Lakeport, CA 95453. (707) 263-6869.

Cassette cartridge mass storage unit — RDS-58. Random access, low-cost data storage w/controller allows unit function much like disk. Incorporates DEC TU-58 tape subsystem in package ready for mini or micro interface. 90-day warranty on parts/labor; after warranty, return to factory for repair. $1,425. John Heikkinen, **Remtech, Inc.,** 2603 Artie St, Suite 21, Huntsville, AL 35805. (205) 536-8581.

The banker. Memory bank switch allows any LSI-11 to use up to 256KB. Usable with any memory that is DEC comp.
RSI 16. Multiple processor system features multi-user capability. Uses DEC Q-Bus std. DEC comp. peripherals. Up to 16 independent processors. Mix a variety of CPUs in same system. Supports any DEC LSI-11 or 68000.
Pascal development software. Allows user to create

The Power Paradox:

The AC power your computer needs in order to operate is also a major cause of computer error, malfunction and damage.

The computers that control your operations (and therefore your profits) are designed to operate from a clean, steady supply of ac power.

This ac power *must* be kept within manufacturer-specified tolerances in order for the computers to operate properly and safely.

In fact, the U.S. Department of Commerce states that "if a computer's voltage exceeds 120% [of the rated voltage] for a duration as short as 1 to 10 milliseconds, the computer will make errors."[1] Unfortunately, interruptions and disturbances of this nature are commonplace occurrences within most computer facilities.

A comprehensive study of power line disturbances which affect sensitive computerized equipment was conducted by two IBM researchers. They concluded that such disturbances occur on an average of 128 times each month.[2] For users of computer-based equipment, power disturbances can and do create a variety of costly problems.

Effects upon data processing computers.

When these power disturbances occur in your data processing center they can cause entry errors, program changes or loss, head crash, data loss, the generation of false or garbled data, the need to rerun programs, and computer downtime.

Effects upon computerized process control equipment.

Process control equipment is also vulnerable to power disturbances. Common problems created by these disturbances include improper batch termination and even program changes. The program changes can result in the repetition of process errors and in downtime while equipment is being reprogrammed.

Effects upon energy management systems.

Most energy management systems use small computers to make energy-saving decisions, but their effectiveness can be offset by these same disturbances. Program changes and errors may prevent useful operation of these systems as energy savers.

Thus, the computers your company depends on to reduce operating costs actually may be increasing them.

Topaz power peripherals can protect all of your computers.

Topaz can provide the power peripherals specifically designed to keep your company's data processing, process control and energy management computers from making costly power-related errors.

And if you manufacture computers or computerized equipment, Topaz peripherals can make your product more reliable as well as reduce the requirements for needless service calls.

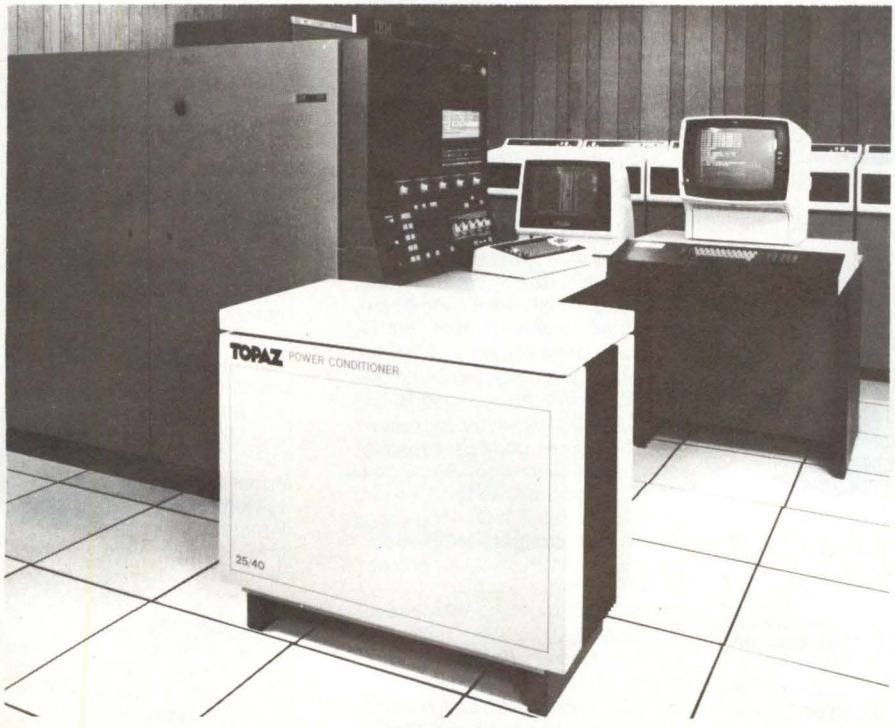
Immediate delivery and guaranteed solutions to power problems have made Topaz the leading computer power peripheral company in the world.

For more information about Topaz and its products:

1. Tear out this ad and mail it to us along with your business card; or
2. Circle the reader service card; or
3. Call us:

References:

1. *U.S. Department of Commerce, "The Effects of Electrical Power Variation Upon Computers: an Overview."*
2. *George W. Allen and Donald Segall, IBM Systems Development Div., "Monitoring of Computer Installations for Power Line Disturbances," presented to the IEEE Power Engineering Society.*



Topaz peripherals solve the power paradox by conditioning normal ac power for your computer and computer-based equipment.

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executable native code files from Pascal and/or RSI Macro assembler source files. Programs include: RSI Pascal Compiler, Pascal-to-Native Code Translator, RSI Macro Assembler, Object Code Linker, Mixed Code Listing Generator, Run-time Support. ROS runs on LSI-11, 370, 8086 or RSI 68K.

RSI 68K. 68000 systems uses DEC Q-Bus and std. DEC compatible peripherals. **Renaissance Systems, Inc,** 10639 Roselle St., San Diego, CA 92121. (714) 457-2700.

Line Printer Controller Model 1200. 120X line printer controller connects a Data Products or Centronics (or equiv.) line printer to Unibus of PDP-11. Add-in/add-on memory, hard disk drive, controllers, also tape drives. 3rd party. 1200, $800.

Mag. tape adapter, Model 1300. 13XX mag tape adapter interfaces industry std. formatted tape transports to PDP-11/04 thru PDP-11/70. Adapter logic completely contained on one quad board that plugs into one SPC slot of CPU. 13XX, $1,600.

Mag tape adapter, Model 3300. 33XX mag tape adapter interfaces ind. std. formatted tape transports to LSI-11s. Adapter logic on 2 dual boards. 33XX, $1,600.

Multiplexer Model 1116/1116A. 16 ch. asynchronous MUXer. 1116, 1116A, w/ modem control. PDP-11. 1116, $5,100; 1116A, $6,000.

Cartridge disc controller Model 1400. Provides PDP-11 users the ability to control cartridge class disc drives from manufacturers other than DEC while restraining compatability with DEC OS SW. 14XX, $2,500.

GCR (6250 bpi) tape systems, Model 1939. Provides an ind. std. Pertec NRZI/P.E. formatter plug-compatible interface to CPU interface port so existing CPU adapter designs can have high performance 50 to 125-ips "dual density" PE (1600 CIP/GCR 6250 CPI) mag tape subsystems easily added. DG, DEC, SEL, etc. Pertec NRZI/PE formatter compatible. 1939 tape subsystem, $35,000. Dick McCormick, **Rianda Electronics, Ltd.,** 2535 Via Palma, Anaheim, CA 92801. (714) 995-6552.

Graphic 7. Vector stroke, intelligent graphics display system. DEC, Interdata, SEL, Harris, HP, DG, Honeywell, Norsk. Terminals: graphics terminals, monochrome/color. Home & FO.

Graphic 8. Raster graphics display system. Arnold Schumacher/Chuck Hafemann, **Sanders Assoc. Inc., Information Products Div.,** Daniel Webster Hwy, S., Nashua, NH 03061. (603) 885-5280.

DU-11 trigger trace diagnostic memory. Special Quad-height trigger trace diagnostic memory card. Senses trigger conditions entered by ODT or program control/locks latest stored bus transaction info for readout thru console ODT. Uses include SW debugging, development, system diagnostics. PDP-11/34 etc. (Unibus). Diagnostic memories. Factory maintenance. Size Quad; trace memory 240 words; trigger/command memory 16 words; trigger levels 3; selective trace. $975.

DQ-11/23 trigger diagnostic memory. Special dual-height trigger trace diagnostic memory card. Senses trigger conditions entered by ODT or program control/locks latest stored bus transaction info for readout thru console ODT. Uses include SW debugging, development, system diagnostics. LSI-11, -11/2, -11/23, -11/03. Size dual; trace memory 240 words; trigger/command memory 16 words; trigger levels 3; selective trace. $890.

DM-11 diagnostic memory. Special dual-height "Flight Recorder" memory card. Buffer-stores latest bus transaction info until locked by computer's spurious or programmed halt. Data read-out thru system console ODT. LSI-11, -11/2, PDP-11/03. Dual size; trace memory 256 words; bus transactions caputed, DATI, DATO, DATIO, Interrupt. $650. Jerry L. Shumway, **Scanoptik, Inc.,** Box 1745, Rockville, MD 20850. (301) 762-0612.

Bus Control Unit Model BCU-11LA. MIL-STD-1553A interface is plug compatible with LSI-11 Q-Bus minis. Terminals, add-in/add-on memory, floppy drive, hard disk drive, controllers. $6,000 (4). Jerry Blevins, **SCI Systems, Inc.,** P.O. Box 4000, 8600 S. Memorial Pkwy., Huntsville, AL 35802. (205) 883-4800 ext. 251.

FWT0122, FWT0127. RX02-compatible floppy storage system w/ Winchester add-on capability. Low profile 5 1/4" enclosure allows direct connection to 14" WIN1400 26.4 MB Winchester disk option. Includes self-test, resident diagnostics, IBM double density format support, dual-head drive option. LSI-11 or PDP-11 interface. Factory warranty/service. $3900 (1); $2650 (50).

Disk System 11X D5X0122 or D5X0127 or D5X01172. Complete LSI-11 computer system w/ choice of (2) floppy disk drives or (1) 8.4 MB 8" Winchester and (1) floppy disk. Includes power, 8-quad slot Q-bus backplane, disk drives, enclosure in attractive 10 1/2" table top package. LSI-11/2 or LSI-11/23 optional. D5X0122 $5600; with computer, $7400. Michael A. Liccardo, **Scientific Micro Systems,** 777 E. Middlefield Rd., Mountain View, CA 94043. (415) 964-5700.

Graphics 100. Add-in printed circuit card gives VT-100 full graphics capability. Has light pen, hardcopy, support SW options. FO. 1220 × 240 dot screen resolution; ASCII, APL, GREEK, RAM char sets standard; 3 rotations for labels; boldface, doublewidth type; separate graphics memory; light pen option, printer dump port to DECwriter II with Graphics II. $1200 for Graphics 100. Thomas M. Seitzler, Dir. Marketing. **Selanar Corp.,** 2403 De La Cruz Blvd., Santa Clara, CA 95050. (408) 727-2811.

LSI-11/2/23 Floppy Controller Board. SCD-RXV21 supports 1 or 2 dual-density, single- or double-sided floppy disk drives. Single, dual-wide board replaces RXV21 control logic. SW compat. w/ DEC OSs and diagnostics for RX02. Compat. w/ RX01/RX02 media, IBM 3740 format, Shugart interface. Pin-to-pin, signal, power-compat. w/ Q-bus backplanes. $666.66. 6-mo. warranty; a 24-hr. replacement. Also: 8- and 16-line EIA or 20mA async. muxers w/ EIA/20mA combo; expander chassis with 4- or 9-row hex-wide backplane for LSI-11s; 64KB-128KB Q bus and Unibus compat. MOS mem., 256KB-512KB VAX compat. MOS mem.

SA-BA11N Processor Chassis. 5.25" rackmount chassis with operator console and Q-bus compatible supply. 4 or 9-row backplane supports LSI-11, LSI-11/2, LSI-11/23, associated Q-bus devices.

SA-BA11N-1 Expander Chassis. 5.25" rackmount chassis w/ operator console, Q bus-compatible supply. 8-row, quad-wide backplane support, LSI-11, LSI-11/2, LSI-11/23.

SCD-DZ11 Async. MUXers. Buffered, program controller interface between PDP-11 & multiple local or remote async. terminals. 8 or 16-line EIA or 20mA and 8-line each EIA and 20mA combo. Programmable baud rates, data set control.

SA-H100 Backplane/Cardframe Assembly for LSI-11. 8-row, quad-wide backplane/cardframe assembly has 16 dual Q-bus slot backplane w/ etched PCBA bus structure/cardframe for module protection/positive alignment.

SDC-RKV11 Cartridge Disc Controller for LSI-11. Single quad-wide controller board replaces DEC's 4-board RKV11 controller for RK05. Supports combos of 2.5-MB, 5-MB, & 10-MB drives w/ max capacity of 20 MBs. SW comp. w/ DEC OSs & diagnostics designed for RKV11.

MOS Memories: Q-bus, Unibus and VAX Compatible. National Semiconductor memories. **Sigma Sales, Inc.** 6505C Serrano, Anaheim Hills, CA 92807. (714) 974-0166.

Model 2290 Line Printer System. 900-lpm Line Printer with 132 columns, 64 char. 6/8 lpi, form length select switch, static eliminator, self test, active ribbon control, paper motion detect, interface, I/O cable assembly. DEC, DG, HP, TI, Burroughs, Perkin Elmer. Controllers: included with line printer. FO; 3rd party. $18,000.

Model B-300 Line Printer System. 300 lpm Band Printer, 64 or 96 char., 132 col., 6/8 lpi, form length select switch, pedestal, diagnostic display, with computer interface, I/O cable. DEC, DG, Perkin Elmer, HP, Burroughs TI and most other processors. $6,000.

Model 2260 Line Printer System. 600 lpm Line Printer System with 136 col., 64 char., 6/8 lpi, form length select switch, static eliminator, self test, paper receptacle, controller, I/O cable assembly. $12,000.

Model B-600 Line Printer System. 600 lpm Band Printer, 64 or 96 char., 132 col., 6/8 lpi, form length select switch, pedestal, diagnostic display, with computer interface, I/O cable assembly. $8,000.

B-900. 900 lpm Line Printer System with 64 or 96 char., 132 col., 6/8 lpi, form length select switch, quietized cabinet, paper puller, diagnostic dis-

play, with computer interface, I/O cable assembly. $12,000.

Model M200 Line Printer System. 200 lpm matrix line printer with 128 char., 132 col., form length select switch, diagnostic display, 10 & 16.7 cpi, self test with computer interface (parallel or serial), I/O cable. $2,995.

Model 2550 Line printer System. 1500 lpm charaband line printer system with 64 and 96 char. set, 132 col., 12 ch. VFU, self test, static eliminator, paper puller, active ribbon control, 6/8 lpi, with controller, I/O cable assembly. $33,000.

Model 2230. 300 lpm line printer system, with 64 char., 136 col., 6/8 lpi, form length select switch, static eliminator, paper receptacle, self test, controller, I/O cable. $9,000. Donald Dooley, **Southern Systems, Inc.,** 2841 Cypress Creek Rd., Ft. Lauderdale, FL 33309. (305) 979-1000 or (800) 327-5602.

Model 109PTS EyeCom II. Picture digitizer & display terminal for image processing. Unibus or Q-bus interface Digitizer 640 × 480 by 8 bits grey scale, display A/N 80 columns × 24 lines, graphics 640 × 480, image display 640 × 480 × 8 bits & color. From $14,500. M. Stanley Schlosser, **Spatial Data Systems Inc.,** P.O. Box 978, 508 S. Fairview Ave., Goleta, CA 93017. (805) 967-2383.

SPECTRA 21. Multifunction disk/tape controller which emulates DEC RM02/RM05 disk and TU10/TM11 tape subsystems when attaching up to 4 SMD disk and 8 formatted tape drives. It offers single board design, DEC SW transparency and ability to support data transfers concurrently from 2.0 MB/sec disks and 1/2″ tape drives. 3rd party. Separate buffers allow simultaneous disk and tape data transfers, supports "start/stop" or "streaming" 1/2″ tape drives, 32 bit ECC, automatic diagnostic self-test. $4800 (25-49/yr).

SPECTRA 11. Emulating DEC PDP-11 compatible disk controller which attaches up to 4 SMD disk drives. Provides emulation of DEC RM02 (80 MB) and RM05 (300 MB) disk subsystems allowing SW transparency to RSX11M, RSTS/E and other DEC OSs. Full software transparency, 32-bit ECC, single command multiple sector transfers, 3 sector RAM buffer eliminates "data lates", single board design, overlapped seeks, automatic diagnostic self-test, supports any SMD disk drive. $3600 (qty 25-49). Steve Roberts, **Spectra Logic Corp.,** 2316 Walsh Ave., Santa Clara, CA 95051. (408) 496-6100.

DEC-Style Concept/DSC. Small peripheral controller compatible to DEC. Controllers: DSC-DD11-CK,-DK,-PK. Factory maintenance. OEM Jean Littrell, **Stanford Applied Engineering, Engineered Products Div.,** 3530 De La Cruz Blvd., Santa Clara, CA 95050. (408) 988-0700.

DEC-Compatible backpanels. PDQ Backpanel packaging system offers PC board/edgecard circuit connector integration in single, double-sided, true multi-layer assemblies. Complete wire-wrap services, full testing, total in-house backpanel construction. DEC-comp. backplanes PDQ/DSC offers prewired, pretested unit in 4- and 9-slot systems & custom configs. Pin grid patterns in .125 × .125 and .125 × .250. Connectors can be assembled to any length. **Stanford Applied Enginering** 340 Martin Ave., Santa Clara, CA 95050. (408) 727-7552.

STEP-3 Firmware Integration & Test Station. User reworks microcode on most minis to yield enhanced instruction set for special applications. Is an integrated unit/ helps generate, test, edit, debug microcode for added/modified or code commands. DEC or any micro-coded computer. FO. Simulations: 40ns & up; microcode width: 8 to 192 bits, depths to 24K; built-in terminal, logic analyzer, debug panel, powerful micro-code editor, and multiple-breakpoint test facility. $11,000 to $19,000 depending on array size and assembler needed. Steve Drucker, Technical Applications, **Step Engineering, Inc.,** 757 Pastoria Ave, P.O. Box 61166, Sunnyvale, CA 94086. (408) 733-7837 in CA, (800) 538-1750, -1751 elsewhere.

LASERSCAN 100. Gun-type bar-code laser scanner. Hand-held laser gun for supermarket price file verification, inventory control, direct store delivery, POS Scanning. Manufacturer programmable to read most commercially available bar codes (UPC, EAN, Code 39, Codabar, Code 2 of 5). Aggressive decoding of printed symbol on all substrates. DEC, DG, INTEL, UNIVAC, Motorola, IBM. RS232C Communications Interface. FO.

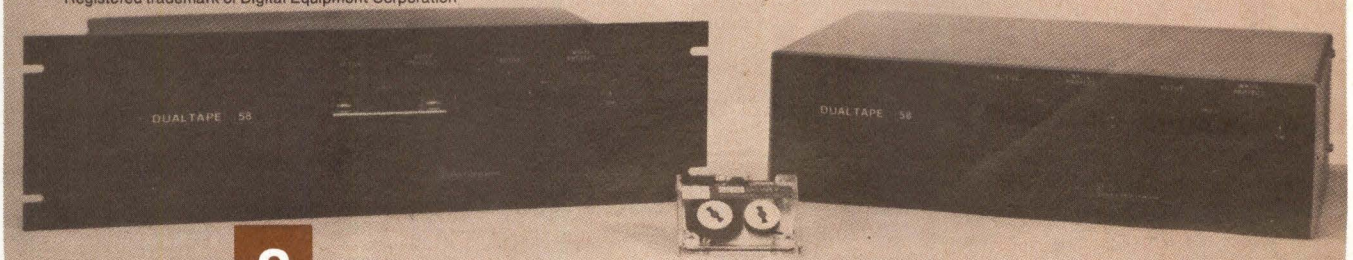
The drive for DEC economy comes from General Digital Industries

GDI's DUALTAPE-58 brings real economy to most DEC* operating systems. Each of two cassettes holds 256K bytes for a total of 512K bytes of economical, removable storage.

Thanks to an integral intelligent controller, the tape functions as a random access device, giving your computer the same random access to any of 1024 storage blocks as if they were on disk. Interfaces are standard RS-232C or RS-423. All current DEC operating systems support the DUALTAPE-58 as a standard, file-structured device.

Get added performance from your DEC system for only $1200. Write or phone for specifications on GDI's DUALTAPE-58.

*Registered trademark of Digital Equipment Corporation



GDI

General Digital Industries, Inc.

500 Wynn Drive ● Huntsville, Alabama 35805 ● 205/837-8305

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S

LASERSCAN 410. Blood product identification scanner — desktop laser scanner for fast, accurate identification, processing of blood bags/ tubes via scanning linear bar code symbols.

LASERSCAN 550/500. High speed laser scanning data terminal. Unit is a Scan-Above portable work station designed for unsold returns processing applications for UPC and EAN. For the processing of magazines, paperback books, newspapers, records, tapes, damaged goods, perishables; including baked goods, dairy, salads (among others). RS232C Communications Interface. FO. S. Richard Rausch, VP/Sales, **Symbol Technologies, Inc.,** 90 Plant Ave., Hauppauge, NY 11787. (516) 231-5252.

T

PDP-11 Data entry/forms management programming aid. "Screen Builder" interactive software decreases repetitive coding of screens/ forms. Written in Basic,Plus-2 and Macro-11, it runs under RSX-11M O.S w/ RSM-11K on PDP-11s. $3200 on RL01 media.**Tallant Associates, Inc.**Suite 308, S. 3010 W. 16th Ave., Denver, CO 80204. (303) 623-4999.

VT-100-Compatible "Model 100". Code- and performance-compatible "100" uses VT-100 set-up mode, but also displays text describing each entered operating parameter. Several ergonomic enclosures: 2 detachable KBs; 2 tiltable CRTs. $1790. **Teleray Div. of Research, Inc,** Box 24064, Minneapolis, MN 55424. (612) 941-3300.

LSI-11/23 96-KWord Modules. TM10000 Series. 64KW or 96 KW, optional parity, Std. "dual" DEC board; 5-V MOS dyn. RAMs.

PDP-11/34, -11/44 256 KW/ 128 KW Modules. TMM20000 Series. Error-det., error-corr. transparent to OS, comp. w/ PDP-11/34, -11/44, addressing 2MW. Programming options: modified or extended Unibus, I/O page size, control status ref reg. address location/error status reg; 5-V MOS dyn. RAMs. **Texas Instruments, Inc.,** Semiconductor Group, Box 1443, M/S 6958, Houston, TX 77001. (713) 490-3746.

BUSCOMM-11. Add-on memory (core) system for use with PDP-11s. FO: 24. $3800 (64 kB).

ECOM 70/127. Add-on core memory system for use with PDP-11/70. 1 MB $15,000.

PINCOMM PS. 128 kB, 96 kB, 64 kB, 32 kB semiconductor add-in memory for use in PDP-11. 128 kB with internal parity. $2050.

PINCOMM 70S. 256 kB semi add-in memory for use in PDP-11/70. $3995.

PINCOMM 780S. 256 kB semiconductor memory (add-in) for use in VAX-11/780. $3995. Miles S. Efron — V.P. Mktg., **Trendata Corp, Standard Memories.,** 3400 W. Segerstrom Ave., Santa Ana, CA 92704. (714) 540-3605.

U

Industrial Drive Control System. Drive card plugs into PDP-8, provides control signals to positioning *DC motor* systems in 1 to 500 HP range for use in industrial positioning, velocity control applications. Unico purchases terminals and sells to Unico customers. FO. Russell A. Grothus, Ad Manager, **Unico, Inc.,** 3725 Nicholson Rd., Franksville, WI 53126. (414) 886-5678.

V

Head-per-Track Drum 4016/ 4401. High-reliability, high-performance add-on memory for PDP-11. 1 to 4 MB, 8.5 ms avg. access, 16-word buffer controller interfaces PDP-11 via Unibus (OEM). MTBF exceeds 25,000 hrs. Others: head-per-track drum with controller. FO. Storage capacity 4.7 MB unformatted; storage

LSI-11 SYSTEMS FROM ANDROMEDA

Any size you want.

No matter what your LSI-11 system needs are, Andromeda can satisfy them.

For example, the 11/M1 system shown on the right weighs only 14 pounds yet contains 102kb of mini disk storage (expandable to 389kb), 64kb of RAM, space for up to 16kb of EPROM, 4 serial ports, and the LSI-11/2 CPU. All of this for less than $4000. While the 11/M1 will run the RT-11 operating system, it is best suited for dedicated applications where its small size but large processing power are needed.

Near the other end of the scale is the 11/H23-DDF system shown at the left. The mobile enclosure includes the LSI-11/23 processor, 256kb main memory, 10mb of storage on the double density RK-05 cartridge disk and 1.2mb on the double density floppy disks. This system also has 4 serial ports and 7 empty dual width slots for additional interfaces. The $22,500 price includes the video terminal shown, a 150 CPS matrix printer, and the RT-11 operating system.

These are just two examples of the many LSI-11 based systems available from Andromeda. And the standard systems are just starting points; we will provide any combination of package, processor, memory, interfaces, and peripherals to meet your requirements. In addition to general purpose systems, we also have turnkey packages for word processing, time-sharing, data acquisition, and graphics.

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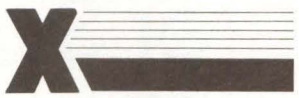

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PDP-11/Z8000 cross-software. This package develops Z8000 code and runs under version 7 of UNIX O.S. on a PDP-11/45 or 11/70. Package includes C compiler, compiler code optimizer, Z8000 assembler, linker, up/download program. $10,000. **Zilog, Inc.,** 10340 Bubb Rd., Cupertino, CA 95014. (408) 446-4666.

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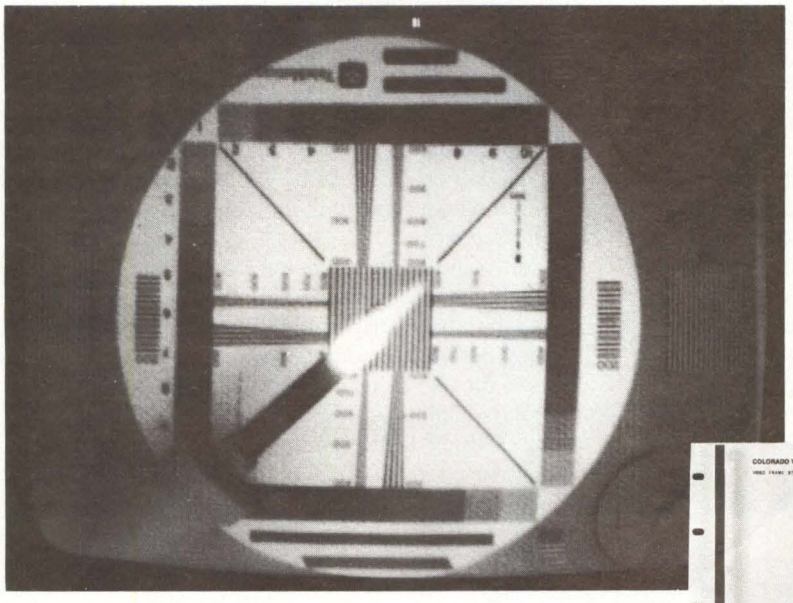

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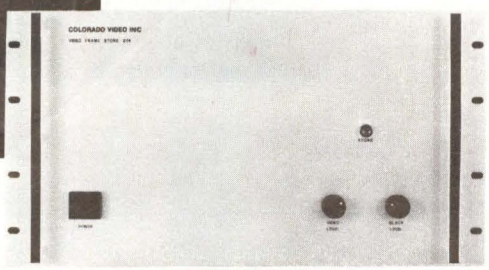

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Acquiring Data At High Speed With A Minicomputer System

Robin B. Lake, Ph.D.
Case Western Reserve Univ.

Bus bandwidth, operating system overhead or instruction execution time often limits the rate at which a minicomputer can operate in data acquisition applications. However, a peripheral high-rate data acquisition subsystem can elevate the performance of an ordinary minicomputer into the performance range of a specialized mainframe computer with data rates approaching a million samples/second. Multiple high-rate subsystems attached to the same mini can acquire data at rates exceeding 10 million samples/second. Key to this performance is a system based on a dual-port Extended Memory Unit (EMU) **(Ref 1)** described in the September 1977 issue of *Digital Design* **(Ref 2)**.

When combined with sophisticated signal- and image-processing techniques, minicomputers can perform services of great value in many industrial, research and medical applications. However, such applications as image-processing or multi-channel signal analysis require aggregate signal bandwidths beyond the real-time capabilities of even larger minicomputers. Cost-effective mini-based systems for these applications must be able to acquire and analyze high bandwidth signals better than heretofore.

Signal acquisition limitations of the typical minicomputer arise in part from the computer's architecture **(Fig 1)**. The processor's bus provides the communication pathway for the computer system's components. Transfer of acquired data into main memory must arbitrate bus use during the transfer of instructions from main memory into the processor and the transfer of blocks of acquired data from main memory into mass storage peripherals. In a typical PDP-11 (3) minicomputer, the processor's UNIBUS (3) offers a bandwidth of approximately 1.7 megabytes/second (4). By utilizing tight stand-alone assembly language coding and efficient direct memory access data transfers in a PDP-11/45, we were previously able to achieve sustained data acquisition rates of only approximately 60,000 samples/second.

The operating systems also limits high data acquisition rates. Even a real-time operating system may require execution of thousands of instructions within the operating system code to effect transfer of a single data block from main memory to mass storage. Since delays of 1 msec/512 samples are not uncommon, they severely limit the data rate, when a user wants the convenience of the operating system, its utilities and its file-structured mass storage.

The language used to code the data acquisition application also dramatically affects acquisition rates. With DEC's older DOS Fortran system, we were able to obtain only 3000 samples/second with Fortran; with Focal, only 72 samples/second!

Additional hardware complications may hide in a manufacturer's data acquisition peripherals. Early versions of DEC's laboratory peripheral system required real-time clock stopping before it could be read. This halt led to the loss of absolute time when recording the time that events occurred. Other data acquisition devices may only be capable of transferring 32K or 128K samples before requiring register reloading which usually takes longer than the intersample time. This extra time causes a loss of a sample or of syn-

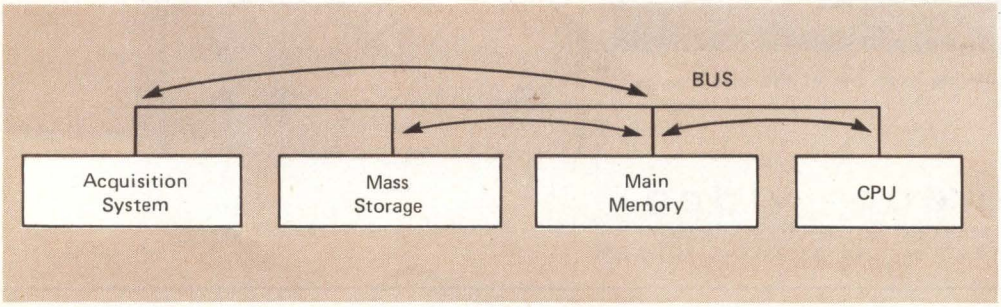


Fig 1 Information transfers occur on the computer bus in the manner shown.

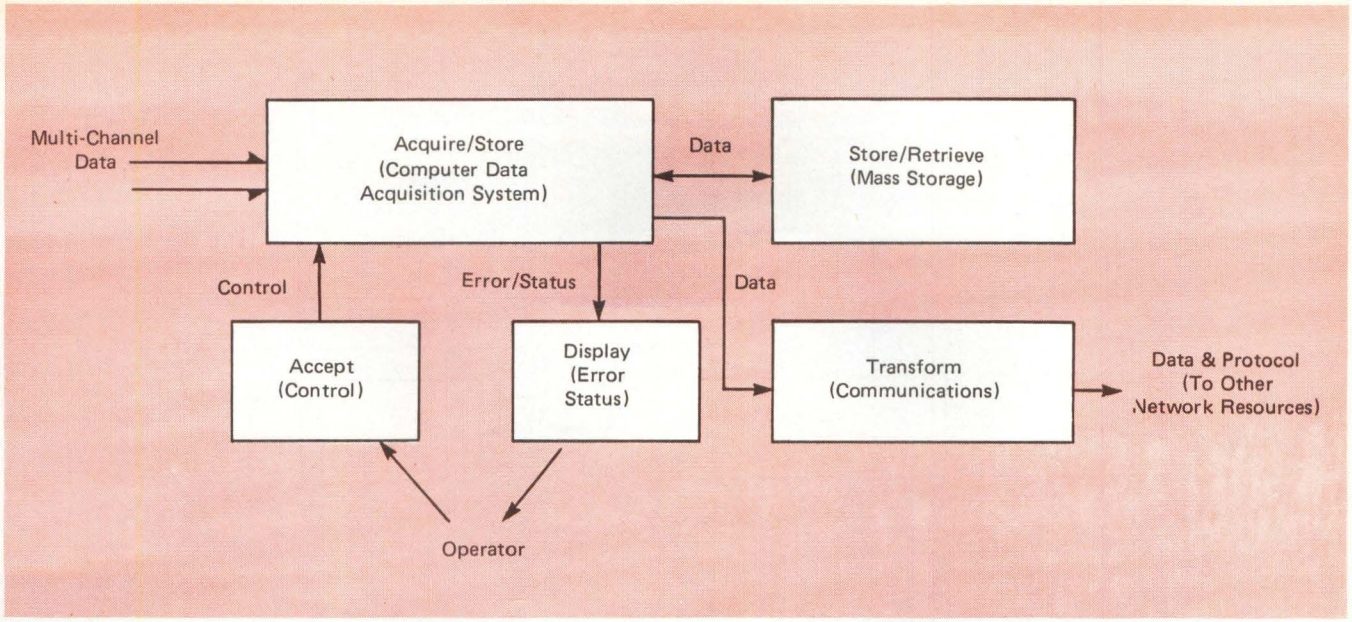


Fig 2 Information flows in the complete acquisition system as shown.

chronous sampling. Even experienced users have found difficulty in obtaining the data rates expected from so-called "real-time" hardware and software.

We solved all these problems by designing a distinctively high-rate data acquisition subsystem around the dual-port EMU.

Functional specification

We needed our first system for high-speed laboratory data acquisition specified to perform the following functions of: (1) Acquiring transient data with 12-bit resolution at 125,000 samples/second, (2) Transferring acquired data into mass storage and/or over a data communications network, (3) Providing processor control at the onset of sampling, (4) Informing the processor of the completion of sampling, (5) Multiplexing the data acquisition over from 1 to 32 channels, (6) Sampling-and-holding which need not be simultaneous over all multiplexer channels, (7) Providing a very accurate adjustable time base (1 part in 10^6) for sample intervals, and (8) Providing a simple hardware and software interface to the processor.

The person who would operate the computer was expected to possess no detailed knowledge of the hardware or software underlying the system. The operator could initiate software tasks via the operating system, could observe changing light patterns, could set switches, and could report, but not diagnose, software and hardware errors.

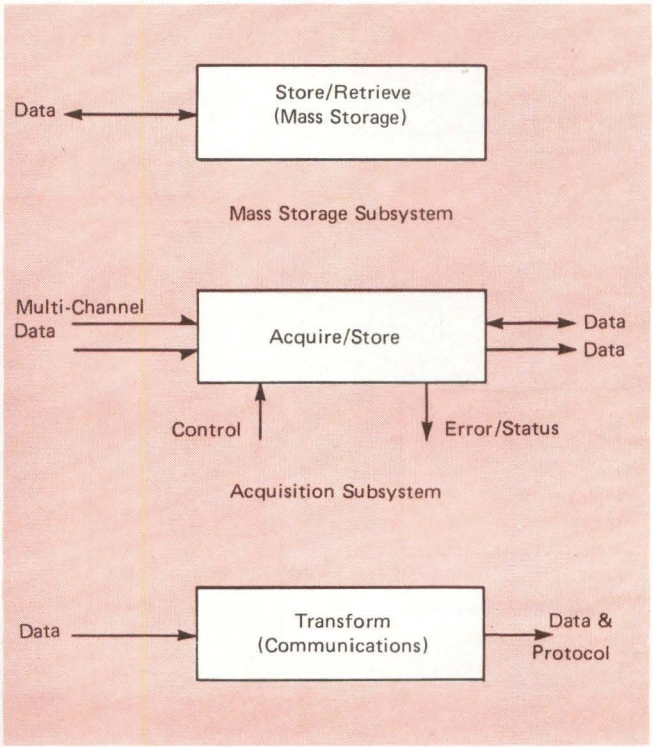


Fig 3 Complete data acquisition systems consist of acquisition, mass storage and communications subsystems.

Information flow

Our design discipline breaks any computer system into five primitive functions: ACCEPT/ACQUIRE INFORMATION, STORE INFORMATION, TRANSFORM INFORMATION, RETRIEVE INFORMATION and DISPLAY INFORMATION. From the functional specifications, the information flow diagram for the complete system appears in **Fig 2.** The overall information flow diagram breaks into the functional subsystems shown in **Fig 3.**

Structural design and implementation

We decided to implement this subsystem by using as much off-the-shelf commercial equipment as possible. The Analogic AN5800 A/D subsystem met the functional specifications for the multiplexor and A/D converter; it provides a straightforward general-purpose TTL interface. A Comstron/SEG precision oscillator with TTL square-wave output met the clock specifications. A PDP-11 with an RP-04 disk, DR-11-C digital interface, and a DECNET (**Ref 3**) communications interface was available. The storage for the acquisition system is a Monolithic Systems Model 3601 dual-port EMU.

These design decisions produced a data acquisition subsystem (**Fig 4**). We implemented the mass storage subsystem with the RP-04 disk and the data communications subsystem with DECNET communications.

We also implemented the RUN and INITIALIZE signals with the DR-11-C interface. The software for operating all three subsystems, except the DR-11-C, was inherent in the

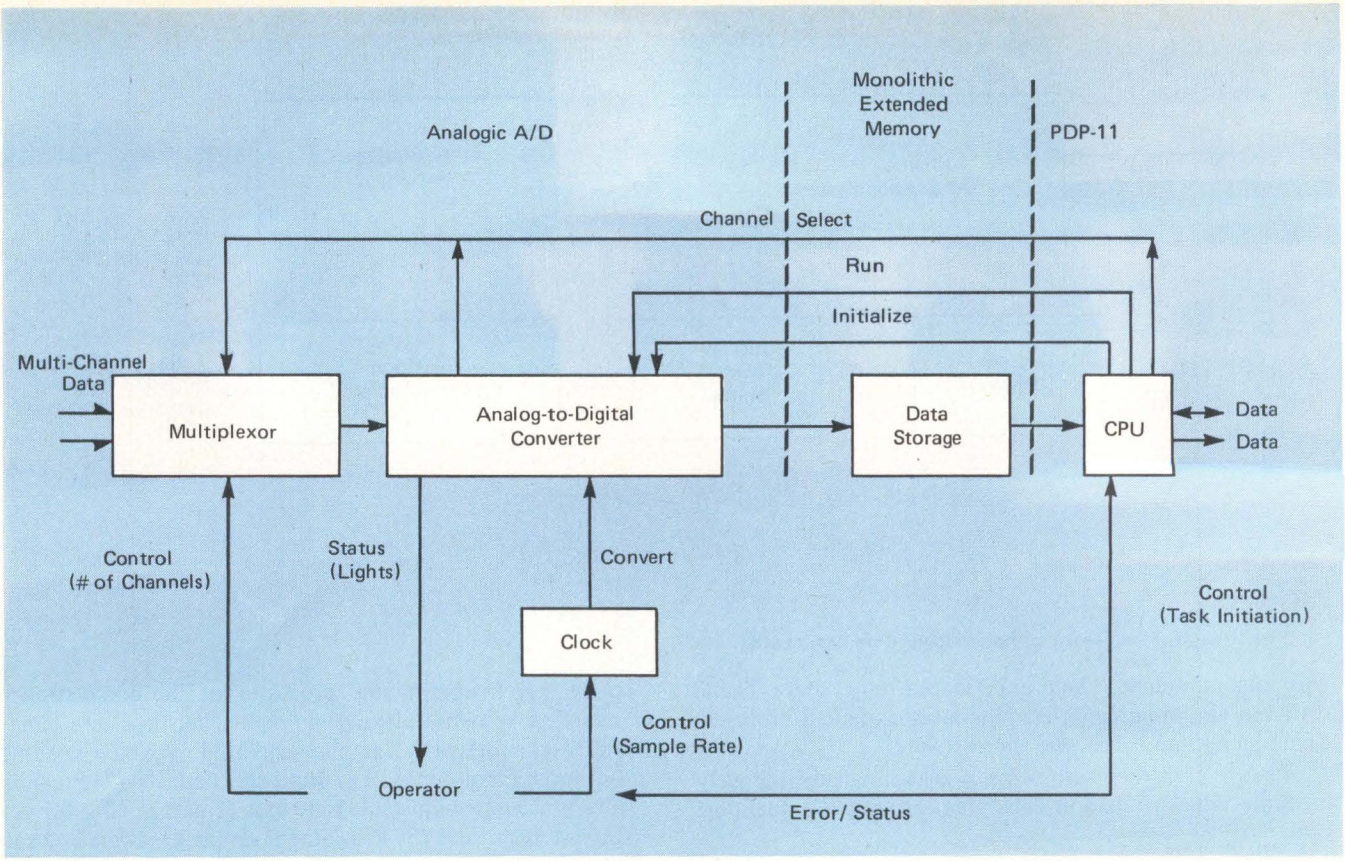


Fig 4 Structural diagram and implementation of the acquisition sub-system.

RSX-11-M operating system. We wrote a simple MACRO program to set and clear bits in the DR-11-C and installed it within the RSX operating system.

The concept of a bigger storage via a large dual-port memory unit proved the key to the success of the acquisition system design. One port of the Monolithic EMU appears to the processor as a fixed-head disk (**Fig 5**). The modular design of the EMU permitted a simple and straightforward modification to the EMU's second port by changing to interface boards within the EMU to: • Match the timing and control signals of the Analogic A/D, • Accept RUN and INITIALIZE signals from the DR-11-C, and provide SAMPLE CLOCK and DONE signals to the DR-11-C, and • Generate the storage addresses and data parity for the EMU.

All acquired data is stored without using the processor's bus. Moreover, the processor is free to proceed with compu-

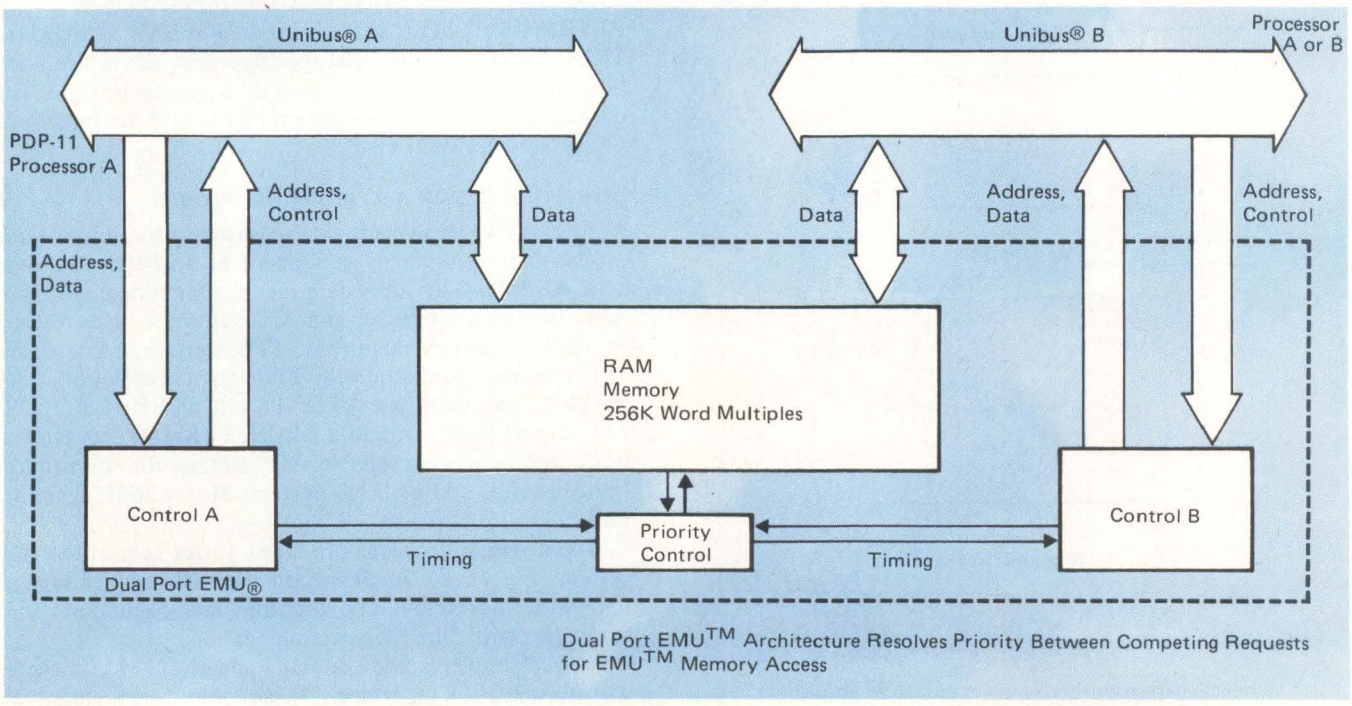


Fig 5 Dual port configuration of the EMU.

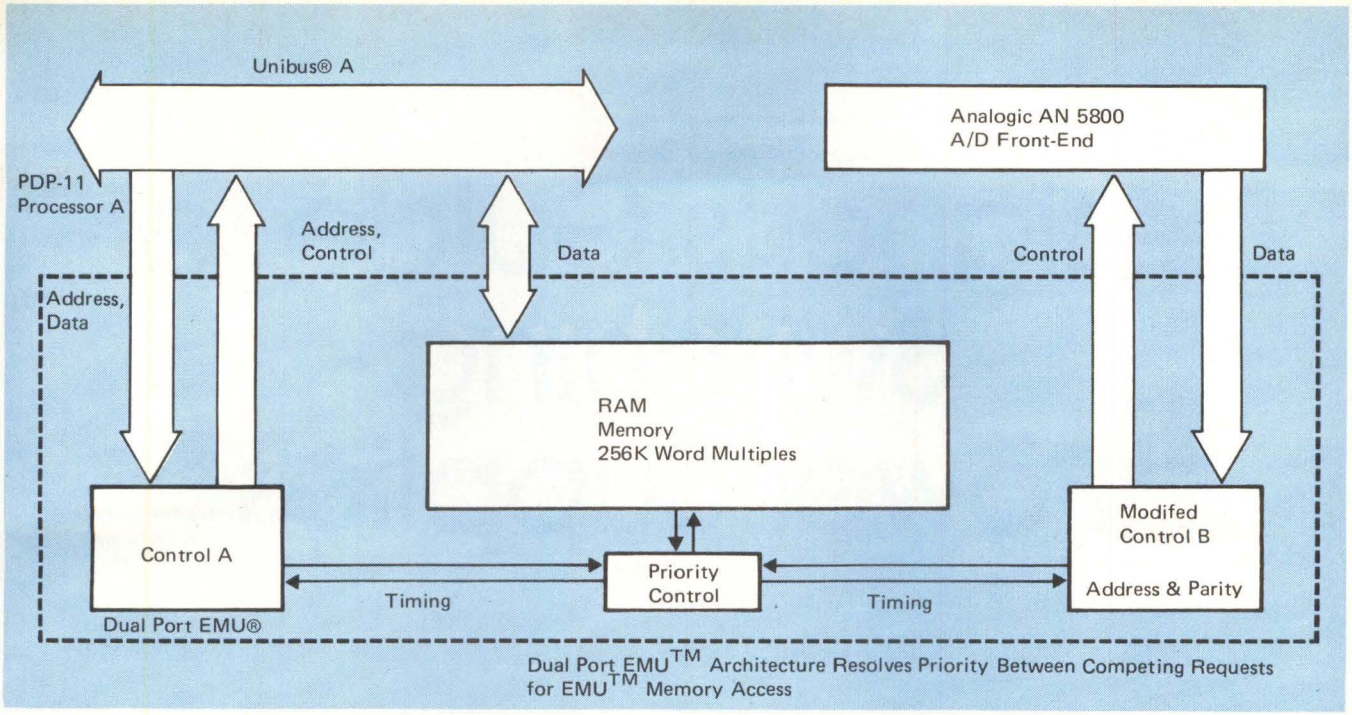


Fig 6 The EMU in the A/D configuration.

tation and display during acquisition. Once started by the processor, the data acquisition subsystem operates autononomously for the duration of the acquisition epoch.

The chosen EMU very happily provides immediate hardware and software compatibility with the processor. All operating system device drivers work directly and all DEC's diagnostics are compatible. The hardware interface between the EMU and the CPU consists of only a UNIBUS cable. We finished the complete system integration, debugging and testing within 10 man-days.

Operation

The system performs its functions in either of these two modes:

(1) As a fully buffered autonomous data acquisition subsystem, it can handle up to 125,000 samples per second for epochs up to 5 seconds. With a different A/D frontend, rates up to one million samples/second are possible for epochs of up to 2 seconds. Data acquisition continues until the buffer memory has been filled (256K-2M samples). The processor then transfers the acquired data to mass storage.

(2) As a fully buffered subsystem, the buffer memory operates in a circular fashion. As each "block" of acquired data accumulates in the buffer memory, the processor transfers it to mass storage. Here, the average transfer rate of the mass storage device or the data communications network determines the maximum data rate.

Evaluation

We have designed and built a high rate data acquisition subsystem that overcomes the bus limitations inherent in the processor. Our first systems acquire data via a 125,000 sample/second A/D converter; rates of one million samples/second are possible with other, faster converters. Multiple high rate systems attached to the same processor operate simultaneously, and provide aggregate bandwidths exceeding 10 million samples per second. The first application uses four systems on a single processor and offers 128 differential channels, 12-bit resolution and an aggregate acquisition rate of 500,000 samples/second.

The key component in the design is a dual-port solid-state memory unit. In addition to meeting and exceeding our functional specifications, the EMU provides these additional performance features: (1) The ability to do real-time acquisition, even though it uses non-real-time operating systems, such as RSTS and UNIX, (2) Use of all operating system and utility software directly with no additional programming, (3) The ability to attach multiple acquisition systems to one processor, (4) A 1 μsec/word transfer rate into the processor's main memory, with none of the rotational latency found in disk memories, (5) Straightforward adaptation to the D/A as well as A/D conversion, (6) The ability to analyze the acquired data while it resides in the EMU, which operates as a directly addressable large array storage and (7)The ability to add a battery back-up unit and transport the acquisition subsystem to the experiment site, as if it were a 32-channel FM tape recorder.

The design has proven to be a useful and convenient solution to the problem of acquiring data at high rates with a minicomputer.

Information on availability of a new, fully integrated EMU A/D subsystem may be obtained from Mr. Reed Ahlquist, Monolithic Systems Corp., 14 Inverness Dr. East, Englewood, CO 80112.

References

(1) EMU is a trademark of Monolithic Systems Corp.

(2) "Enhancing Mini Capabilities: EMU", *Digital Design*, September 1977, pg. 32-41.

(3) PDP, UNIBUS and DECNET are trademarks of Digital Equipment Corp.

(4) Bell, C. Gordon, et al., *Computer Engineering*, Digital Press, Bedford, MA, 1978, Chapter 11.

(5) The writing of this paper was supported in part by a grant, LM 07001, from the National Library of Medicine.

Designer's Guide to Switching Power Supplies

Staff Report
Signetics Corp., Sunnyvale, CA

From the system designers' concept, there exist three basic approaches to obtaining regulated dc voltages from raw ac power sources. The three basic sources have a common denominator; they require a rectification media when operating from an ac line, in order to obtain raw unregulated dc voltage. The three sources of obtaining dc regulated voltages are: shunt regulators, series linear regulators and series-switched mode regulators. The series switched mode regulators will be referred to as switched mode power supplies (or SMPS) in this article.

Briefly stated, if all three types of regulation can perform the same function, following are some of the key parameters to be addressed: (1) from an economical point of view, cost of the system is paramount, (2) from an operations point of view, weight of the system is critical and (3) from a design criteria, system efficiency is the first order of business.

The series and shunt regulators operate on the same principle of sensing the DC output voltage, comparing to an internal reference level and varying a resistor (active device) to maintain the output levels whithin prespecified limits.

Switched mode power supplies (SMPS) are basically DC-to-DC converters, operating at frequencies in the 20kHz and higher region. Basically, the SMPS is a power source which utilizes the energy stored during one portion of its operating cycle to supply

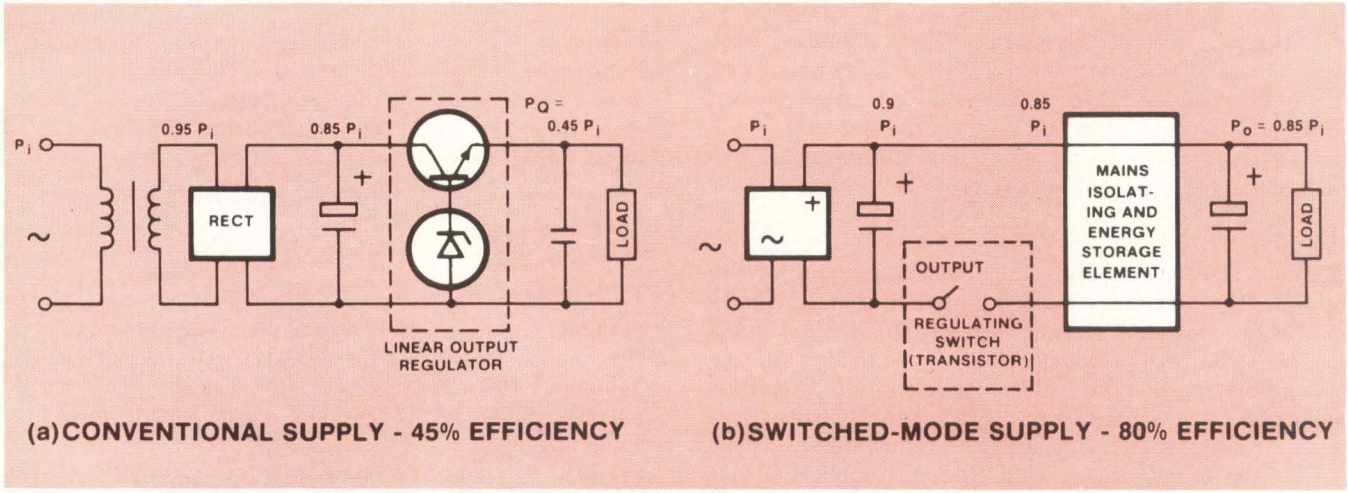


Fig 1. The use of switched-mode power supplies can increase efficiency from around 50% to 80%.

power during the remaining segment of its operating cycle.

Linear regulators, both shunt and series, suffer when required to supply large currents with resultant high dissipation across the regulating device. Efficiency suffers tremendously. (Efficiencies less than 40% are typical.)

Switched mode power supplies operate at much higher levels of efficiency (generally in the order of 75% to 80%), thereby reducing significantly the energy wasted in the regulated supply. The SMPS does, however, suffer significantly in the ripple regulation it is able to maintain as opposed to a much higher degree of regulation available in series (or shunt) linear regulators.

The linear regulators obtain improved regulation by virtue of the series

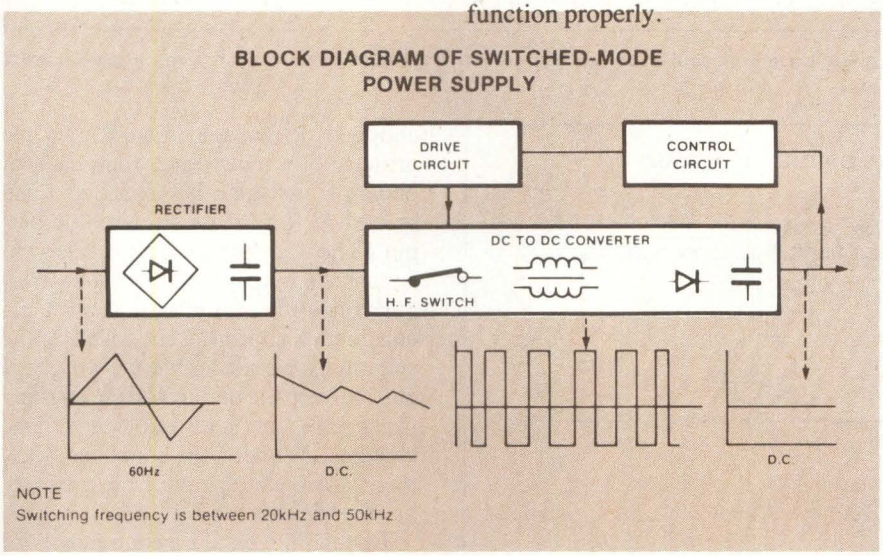


Fig 2. The principle of the a.c.-fed SMPS.

pass elements always conducting, as opposed to SMPS devices having their active devices operative only during a portion of the overall operating period.

Before proceeding, let's look at some definitions and comparisons between linear regulators and switched mode power supplies.

Regulation

Line Regulation, sometimes referred to as static regulation, refers to the changes in the output (as a percent of nominal or actual value) as the input AC is varied slowly from its rated minimum value to its rated maximum value (i.e., from 105VACRMS to 125VACRMS).

Load Regulation, sometimes referred to as dynamic regulation, refers to the changes in the output (as a percent of nominal or actual value) when the load conditions are suddenly changed (i.e., no load to full load.) Note that the combination of static and dynamic regulation are cumulative; care should be taken when referring to the regulation characteristics of a power supply.

Thermal Regulation are changes due to ambient variations or thermal drift.

Transient Response

The ability of the regulator to respond to rapid changes in either line variations, load variations, or intermittent transient input conditions. (This parameter can often be referred to as "recovery time.")

AC Parameters

Voltage Limitings is the regulator's ability to "shut down" in the event that the internal control elements fail to function properly.

Current Limitings often referred to as "fold-back" where the amplifier segment of the regulator folds back the ouput current of the device when safe operating limits are exceeded. Thermal Shutdown is the regulator's ability to shut itself down when the maximum temperature is exceeded.

General Parameters

Power Dissipation is the maximum power the regulator can tolerate and still maintain its operation within the safe operating area of its active devices.

Efficiency is the ratio (in percent) of the usable versus total power being dissipated in a regulated supply. (The losses can be ac as well as dc losses.)

EMI/RFI is the generation of radio frequency interference signals and magnetic field disturbance especially in SMPS devices. (Transformer and choke design available which reduced both RFI & EMI to safe acceptable regions.)

The balance of this section will be dedicated to the discussion of the general operation of Switched Mode Power Supplies (SMPS) with emphasis on the Signetics (NE5560 Control and Protection Module.

Switched-mode power supplies (SMPSs) have gained much in popularity in recent years because of the benefits they offer. They are now used on a large scale in desk calculators, computers, as instrumentation supplies, etc., and it is confidently expected that the market for this type of supply will grow.

The advantages of SMPSs are low weight and small size, high efficiency, wide AC input voltage range, and low cost.

Low weight and small size are possible because operation occurs at a frequency beyond the audible range; the inductive elements are small.

High efficiency because, for output regulation, the power transistor is switched rapidly between saturation and cut-off and therefore has little dissipation; this eases heatsink requirements, which also contributes to weight and volume reduction. Conventional linear-regulator supplies may have efficiencies as low as 50%, or less, but efficiencies of 80% are readily achievable with SMPSs; see **Fig 1.**

Wide AC input voltage range because of the flexibility of varying the switching frequency in addition to the change in transistor duty cycle makes voltage adaptation unnecessary.

Low overall cost, due to the reduced volume and dissipation, means that less material is required and smaller semiconductor devices suffice.

Switched-mode power supplies also have slight disadvantages in comparison with linear regulators, namely, somewhat greater circuit complexity, tendency to r.f.i. radiation, slower response to rapid load changes, and less ability to remove output ripple.

How SMPSs operate

The switched-mode power supply is a modern version of its forerunner, the electromechanical vibrator, used in the past to supply car radios. But the new concept is much more reliable because of the far greater lifetime of the transistor switch. **Fig 2 shows the principle** of the ac fed SMPS. In this system the ac voltage is rectified, smoothed, and supplied to the electronic chopper, which operates at a frequency above the audible range to prevent noise. The

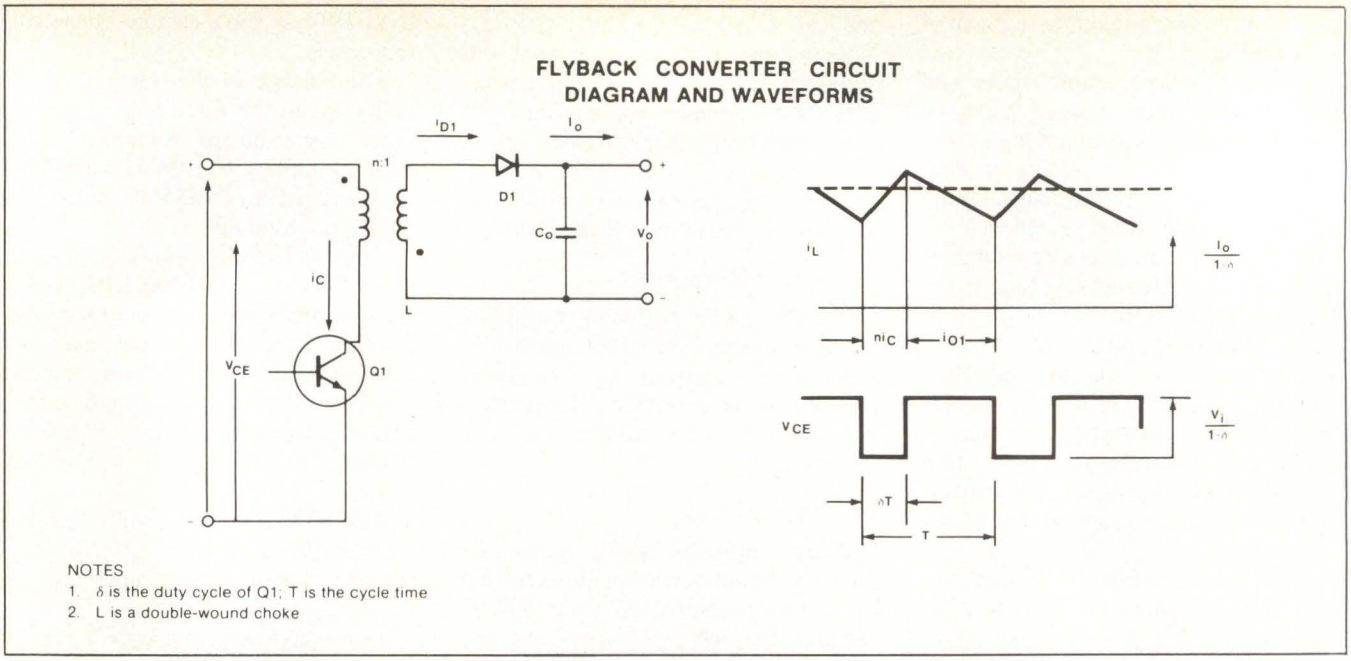


Fig 3. Flyback converter circuit converts input voltage waveform, applied across the transistor's collector-to-emitter junction through choke to the current waveform shown at upper right.

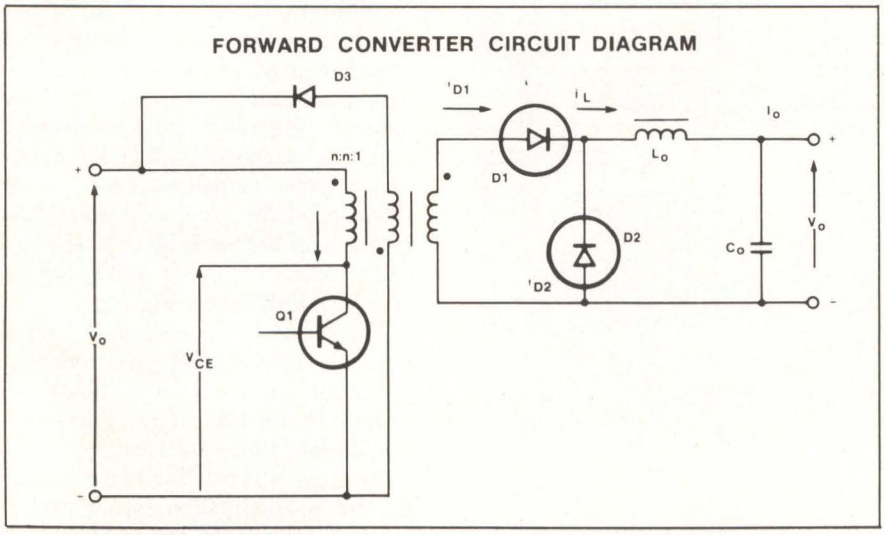


Fig 4. Forward converter circuits, like this one, place the choke in series with the output. This minimizes high-frequency output ripple.

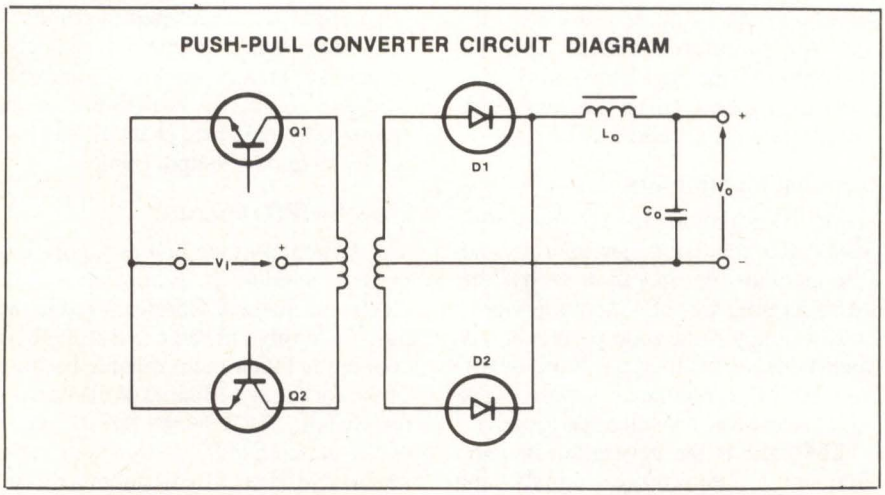


Fig 5. Push-pull converters provide greater output power and double the ripple frequency, thus reducing output ripple voltage. Unfortunately, this type requires a complex base drive (not shown).

chopped dc voltage is applied to the primary of a transformer, and the secondary voltage is rectified and smoothed to give the required dc output. The transformer is necessary to isolate the output from the input. Output voltage is sensed by a control circuit, which adjust the duty cycle of the switching transistor, via the drive circuit, to keep the output voltage constant irrespective of load and line voltage changes. Without the input recitifier, this system can operate from a battery or other dc source.

Depending on the requirements of the application, the dc-to-dc converter can be one of the three basic types: flyback converter, forward converter, or push-pull (balanced) converter.

The flyback converter

Fig 3 shows the flyback converter circuit, and the waveforms of transistor voltage, V_{CE}, and choke current, i_L, reflected to the primary (choke double-wound for line isolation). Cycle time and transistor duty cycle are denoted T and δ, respectively. While Q_1 conducts, energy is accumulated in the choke magnetic field (i_L rising and D_1 reversed biased), and it is discharged into the output capacitor and the load during the flyback period, that is, while Q_1 is off (i_L falling and D_1 forward biased.) During Q_1 conduction, C_o continues delivering energy to the load so providing smoothing action. It will be noted that only one inductive element is needed, in distinction to the converter types discussed below, which require two. As the V_{CE} waveform shows, the

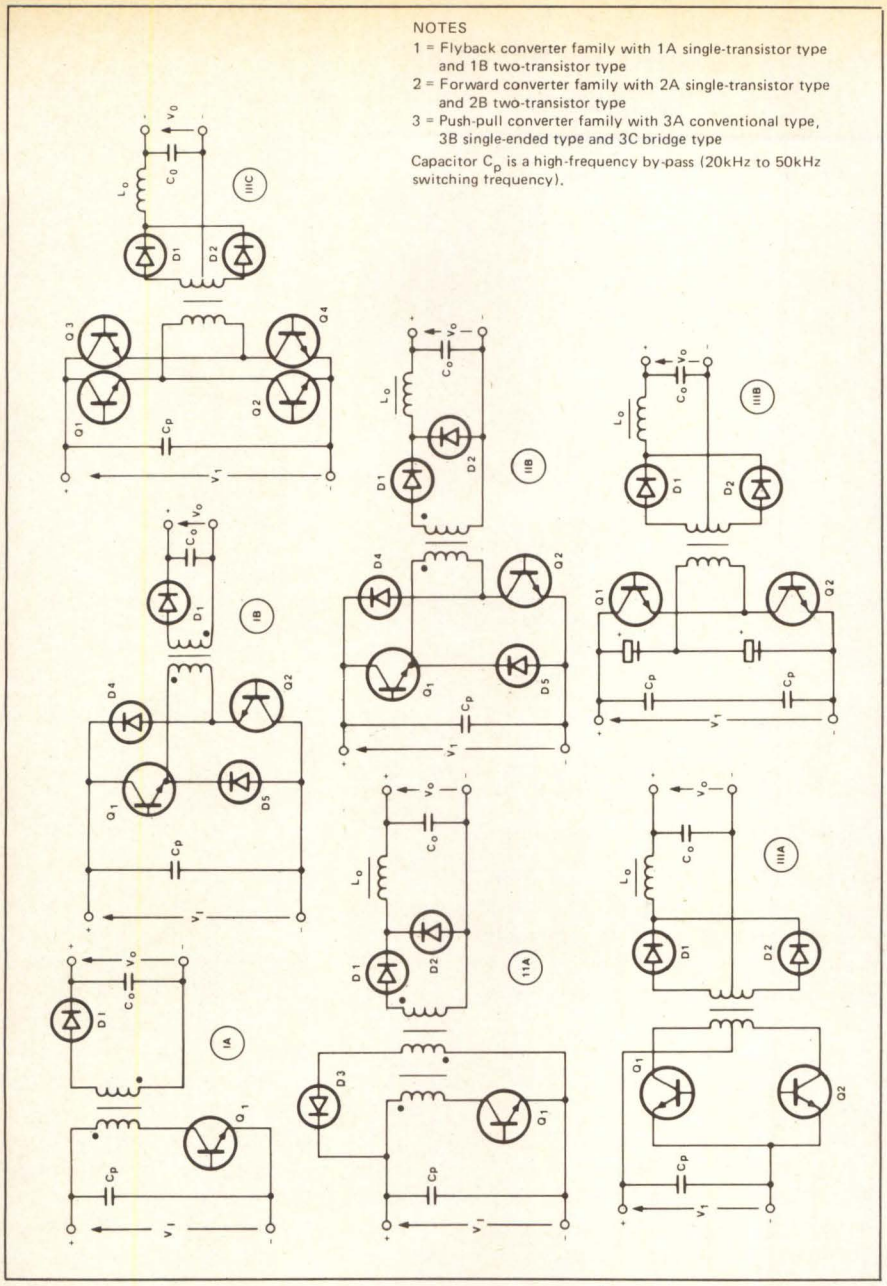


Fig 6. The three basic circuit configurations — fly back, forward, and push-pull converters — come in many variations. Here are seven variations of these three basic circuits. Which is best? It all depends on criteria of performance, complexity and cost.

peak collector voltage is twice the input voltage, V_i, for δ equal to 0.5.

The forward converter

A major advantage of the forward converter, particularly for low output voltage applications, is that the high-frequency output ripple is limited by the choke in series with the output. **Fig 4** illustrates the circuit. During the transistor-on (or forward) period, energy is simultaneously stored in the choke L_O and passed via D_1 to the load. While Q_1 is off, part of the energy accumulated in L_O is transferred to the load through free-wheeling diode D_2. Output capacitor C_O smoothes the ripple due to transistor switching. After transistor turn-off, the magnetic energy built up in the transformer core is returned to the dc input via the demagnetizing winding (closely coupled with the primary) and D_3, so limiting the peak collector voltage to twice the input voltage V_i.

The push-pull converter

This converter type, given in **Fig 5**, consists of two forward converters operating in push-pull. Diodes D_1 and D_2 rectify the rectangular secondary voltage generated by Q_1 and Q_2 being turned on during alternate half cycles. Push-pull operation doubles the frequency of the ripple current in output filter. L_OC_O and so reduces the output ripple voltage. The peak transistor voltage is $2V_i$.

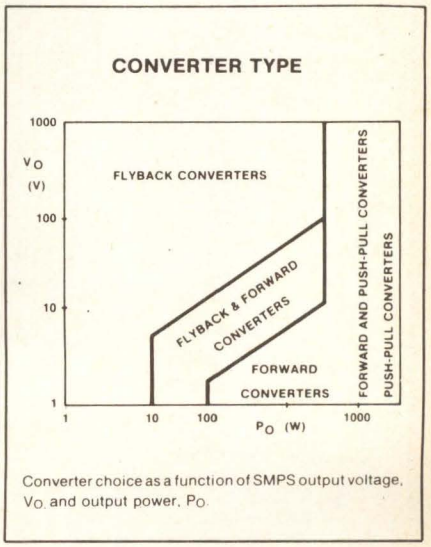
The "best" choice

There exist several versions of the three fundmental circuits described earlier.

These are shown in **Fig 6.** Circuits IA, IIA and IIIA are the basic types. In the two-transistor circuits, IB and IIB, transistors Q_1 and Q_2 conduct simultaneously and diodes D_4D_5 limit the peak collector voltage to the level of DC input voltage V_i. Similarly in the push-pull circuits IIIB and IIIC, the collector voltage does not exceed V_i. In circuit IIIB, Q_1 and Q_2 are turned on during alternate half cycles; in circuit IIIC, Q_1 and Q_4 are turned on in one half cycle and Q_2Q_3 in the next.

Converter choice depends on application and performance requirements. The flyback converter is the simplest and least expensive; it is recommended for multi-output supplies because each output requires only one diode and one capacitor. However, smoothing may be a problem where ripple requirements are severe. The push-pull type has the most complex base drive circuit but it produces the lowest output ripple with given values of L_O and C_O.

Fig 7 is a general guide for the choice of converter type, based on output voltage and power. In the case of the flyback converter, it becomes more and more difficult to keep the percentage output ripple below an acceptable level as the output power increases and the output voltage decreases; for reasons of circuit economy, however, the flyback converter is the best proposition if the output power does not exceed about



Converter choice as a function of SMPS output voltage, V_O, and output power, P_O.

Fig 7. To decide which converter type to select, first determine output voltage and power, then locate which zone this follows into.

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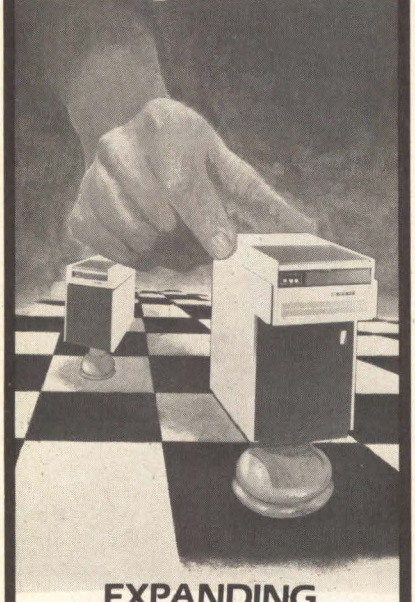

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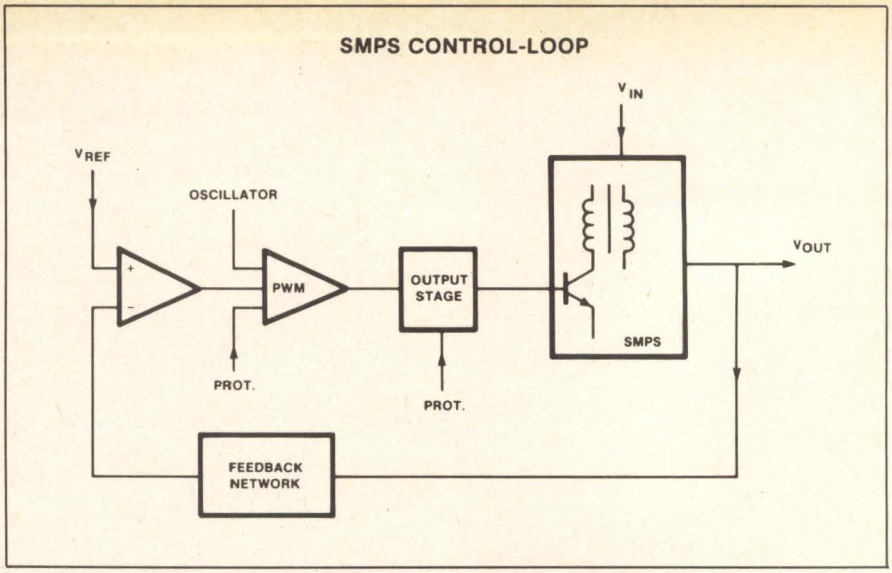

Fig 8. SMPS control-loop action is critical to maintain proper output with varying loads. By comparing output voltage with the reference voltage, the variation from the norm will alter the pulse width.

10W. For output powers higher than about 1kW, the push-pull converter is preferable.

Control and protection

In addition to providing adequate output voltage stabilization against line voltage and load changes, the control module must give fast protection against overload, equipment malfunction, and the effects of switch-on immediately following switch-off. In addition the following features are desirable:

(1.) Soft start: that is, a gradual increase of the transistor duty cycle after switch-on causing a slow rise of the output voltage, which prevents an excessive inrush current due to a capacitive load or charging of the output capacitor.

(2.) Synchronization: to prevent interference due to the difference in free-running frequencies (for example, in a system in which a low-power SMPS supplies the base drive circuit of the output switching transistor in a high-power SMPS).

(3.) Remote switch-on and switch-off: essential for sequential switching of supply units in, for instance, a computer supply system.

The control and protection circuitry of a SMPS is a crucial and complicated part of the whole supply. Integration of this circuitry on a chip will therefore ease the design of an SMPS considerably.

For example, the NE/SE5560 is a control circuit for use in switched mode power supplies. This single monolithic chip incorporates all the control and housekeeping (protection) functions required in switched mode power supplies including an internal temperature compensated reference source, internal Zener reference, sawtooth generator, pulse width modulator, output stage and various protection circuits.

SMPS control-loop

Fig 8 shows the principal control-loop of a regulated SMPS. The output voltage V_0 is sensed and, via a feedback network, fed to the input of an error amplifier, where it is compared with a reference voltage.

The output of this amplifier is connected to an input of the pulse-width modulator (PWM).

The other input of this modulator is used for an oscillator signal, which can be a sawtooth or triangle. As a result, a rectangular waveform with the frequency of the oscillator is emerging at the output of the PWM. The width of this pulse is dictated by the output voltage of the error amplifier. After passing through an output stage, the pulse can be used to drive the power transistor of the SMPS.

When the width of the pulse is varied, also the on-time of this transistor will vary and consequently the amount of energy taken from the input voltage V_i.

So, by controlling the duty cycle δ of the power transistor, one can stabilize the output of the SMPS against line and load variations. The duty cycle δ is defined as t_{on}/T for the power transistor. Protections for overvoltage, overcurrent, etc., can be realized with additional inputs on the PWM or the output stage.

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Design Guide To Data Acquisition

Ed Sliger
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The interface requirements between the data acquisition system and a micro has three functional building blocks making up the parallel interface. These are the differential amplifier, address decode and handshake/control circuitry.

Differential amplifier

In applications that require removing low-level transducer signals from a noise path, the differential amplifier becomes an essential part of the DAS. For several different types of transducers, the complexity of this block may vary from as little as a single op amp buffer to the complexity of a software programmable signal conditioner.

Before deciding on the circuitry needed for a particular application, the differential amplifier must be configured to meet several parameter requirements, no matter how simple or complex this block of the DAS may turn out to be. First, the differential amplifier circuitry following the multiplexer must have a high input impedance. This impedance eliminates the effects of unpredictable multiplexer channel on-resistance, which varies with voltage, current and temperature. However, it must not be a part of the overall data acquisition function, in other words, if some effect were to double the resistance of the on-channel, no noticeable change must appear at the output of the differential ampli-

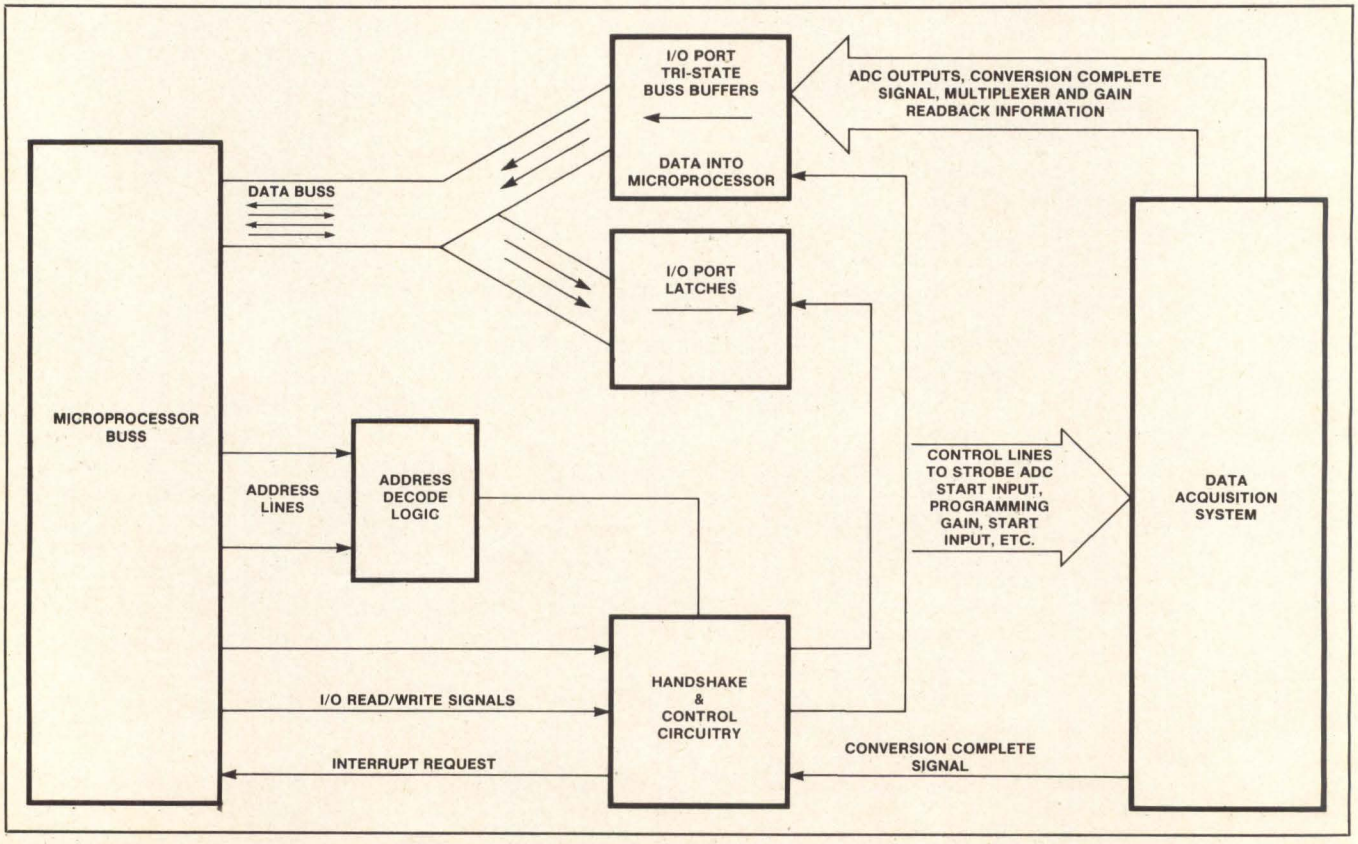


Fig 1 Block diagram of a microprocessor-to-data acquisition system interface.

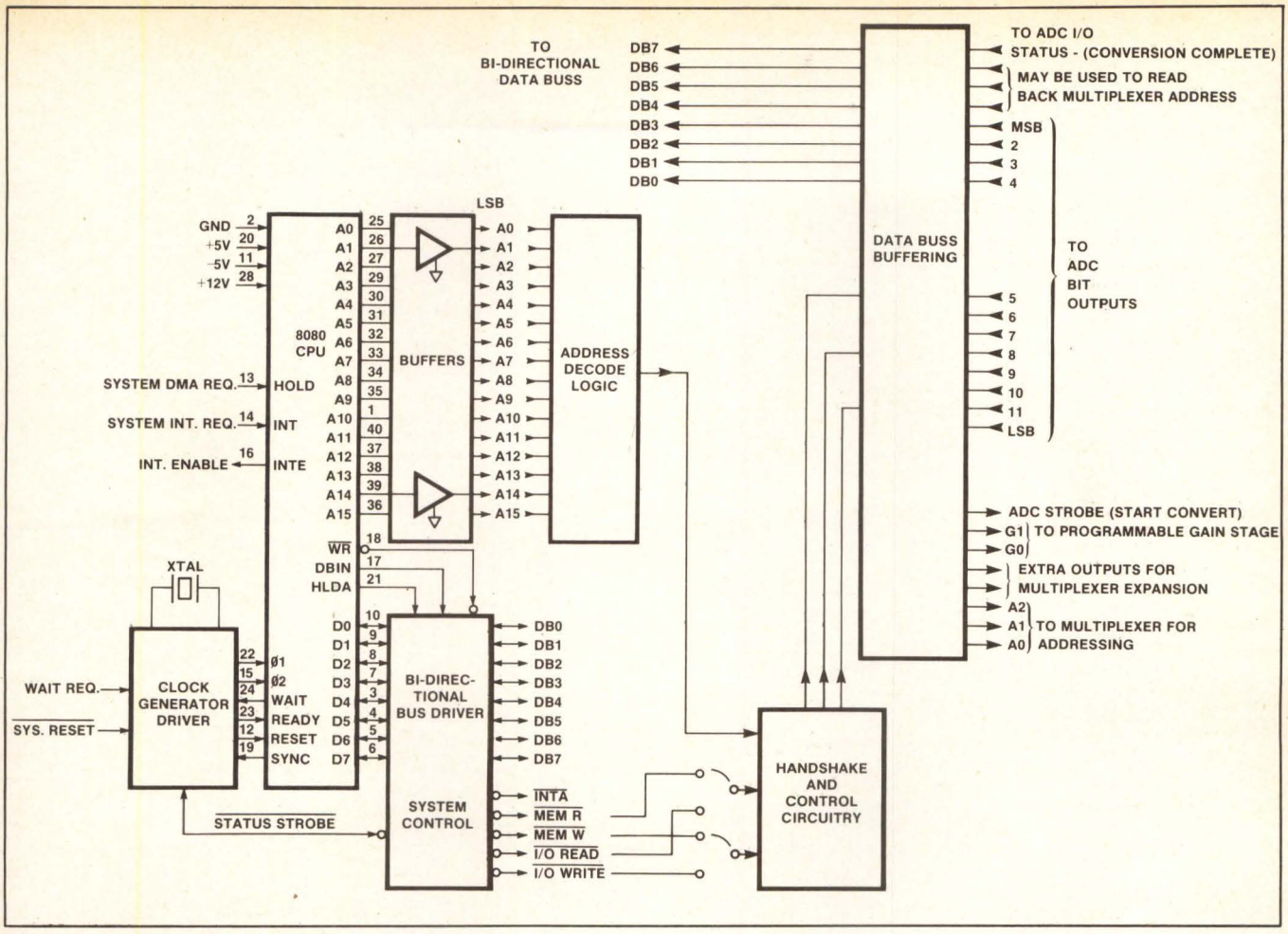


Fig 2 Block diagram of an interface between a data acquisition system and an 8080 CPU.

fier. Second, the common mode rejection ratio of the 12-bit differential amplifier should exceed 80 dB to be certain that for ±10 V of common mode input, noise of only 1m V could slip through to the output. A third and most important factor, especially in data acquisition systems of 12 bits or better, involves the stability of critical components over temperature. Because maintaining this level of accuracy over any reasonable temperature range can be very expensive, this aspect of the system's design must be thoroughly examined before specifying any critical components.

Analog section as a whole

There is the analog of the 12-bit binary two's complement DAS, and the timing and control necessary to interface the analog components to one another and to a μP. The differentially configured front end of the DAS uses a two-of-eight IC multiplexer (IH6216) and three LM156 op amps. A programmable gain stage with a low pass filter on the output which feeds an IH5110 sample and hold amplifier follows the differential amplifier. The IH5110's output is connected to the comparator input (LM301) through the internal R-feedback 10K ohm resistor of a laser-trimmed, ICL7112 multiplying D/A converter.

Programming the multiplexer and programmable gain stage, before strobing a 74123 dual one-shot, initiates a conversion. Outputting one word to the port of the μP, which is responsible for the control of the DAS, starts the conversion. The time delay created by the 74123 allows the front end of the DAS to settle before the strobing of the A/D converter. Implementing the same delay via software eliminates the need for the 74123 as soon as the A/D converter is strobed.

The conversion complete signal of the 2504 SAR commands the 5110 S/H to the hold mode, and the conversion process begins. After allowing for the set-up of the conversion complete signal, the μP monitors for the end of the conversion by using its interrupt facilities. At the end of conversion, the digitized analog signal is available for the μP to input by tri-stating the outputs of the 2504 SAR onto the μP's bus.

μP interfacing

The interface requirements between the DAS and any μP consist of three basic building blocks which make up the parallel interface: the data bus buffers, the address decode logic, and the handshake and control circuitry **(Fig 2)**. To communicate effectively with the DAS, the microprocessor always needs these three blocks, implemented by merely using a single LSI parallel interface elements (provided by each μP manufacturer) or by using several MSI discrete logic packages **(Fig 3)**. Regardless of the method chosen, the interfacing is relatively easy, provided that the designer possesses some prior knowledge of the μP to be interfaced.

Data bus buffering

The dynamic flow of data into and out of the μP requires a data bus buffered in both directions for data flowing to and from external devices. This means that an external device must latch data from the bus at the appropriate time and enable data onto the bus at the appropriate time. Tri-state buffers to enable the flow of data onto the bus and D-type latches to remove data off the bus permit this type of data

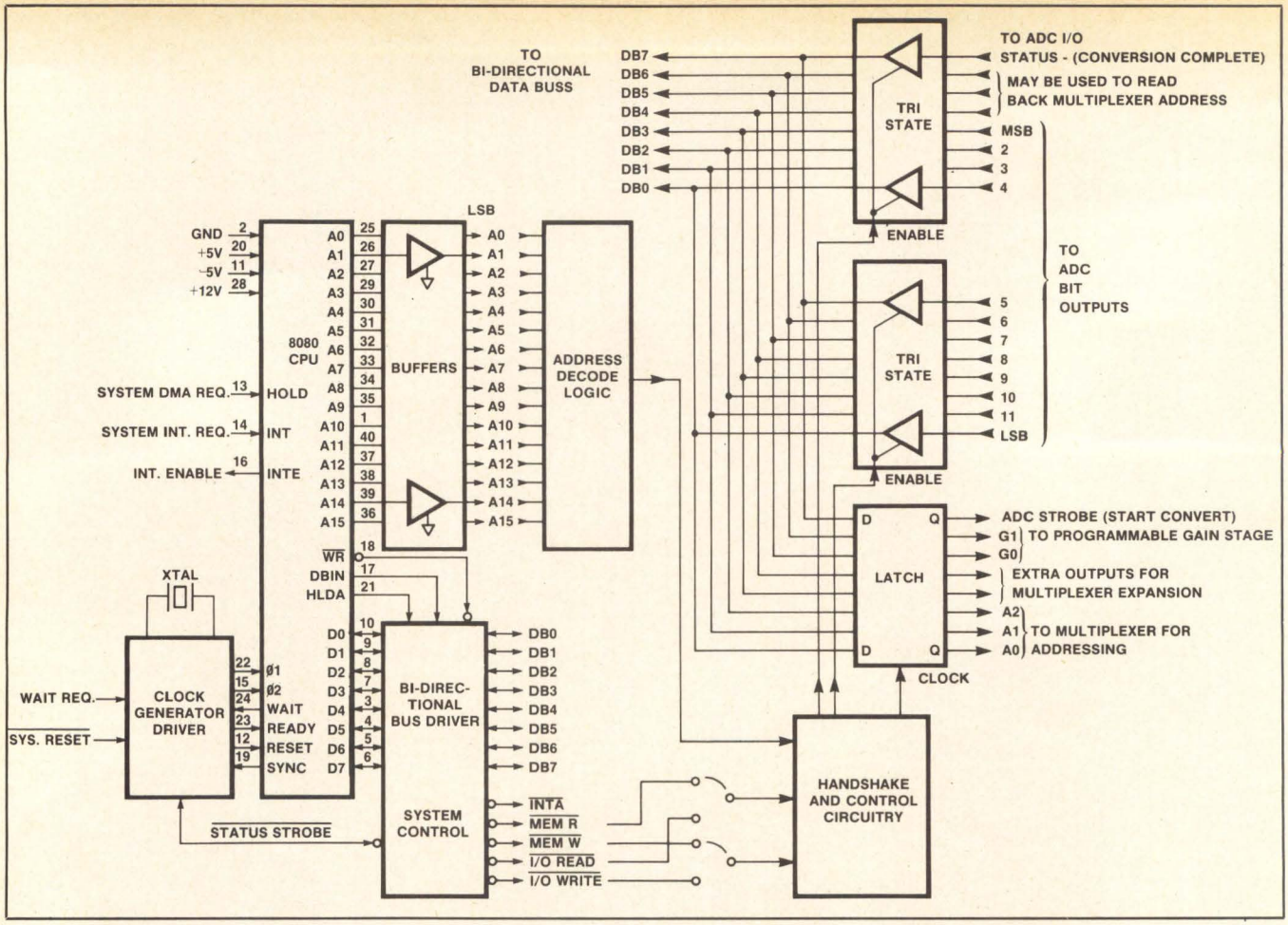


Fig 3 This interface between the DAS and the 8080 shows the circuitry necessary for data bus buffering. Note in the upper right-hand corner the two sets of octal tri-state buffers and the octal latch through which the CPU communicates with the DAS through the bi-directional data bus, DB0-DB7. The CPU executes a data transfer by supplying the handshake and control circuitry of the interface with the proper signals to allow for enabling the selected buffer or latch.

transfer, if the respective enable and clock control lines are activated at the right times by the handshake and control circuitry. The type of logic used in the μP system and the number of loads on the bus determine the logic family to use in the DAS interface. **Fig 4** contains the first part of the design of a discrete logic interface for interfacing the DAS to an Intel 8080.

A few examples of tri-state buffers include the Signetics 80T9X series, the TI and National 74LS36X series and the CMOS 80C9X series available from National Semiconductor. All have six buffers per package in different polarities and tri-state configurations. National also markets 8-bit CMOS latch/buffers, 74C373 and 74C374 (74LS374 also available), which are very attractive for 8-bit CMOS applications.

Address decoding

In a system that uses a single μP to control many processes, the μP must communicate with several different I/O devices over the same data lines. When interfacing hardware to a data bus with this type of structure, the μP must have the ability to enable or "address" a specific I/O device for data transfer through the bus. This capability brings about the need for address decoding hardware at the interface itself. The type or quantity of circuitry for this task depends primarily on the architecture of the overall system. Since the addressing capabilities of this type of μP may overwhelmingly exceed the actual number of unique addresses used within a system, the amount of discrete logic necessary for address decoding at each interface can be minimized by initially allocating only that number of μP address lines actually needed to satisfy the system's I/O requirements.

Two basic techniques for I/O addressing exist: programmed I/O and memory-mapped I/O. Programmed I/O refers to specific instructions and μP signals used by the interface. The manufacturer sets them aside for the special purpose of communicating with I/O devices. For example, the Intel 8080 contains an I/O instruction which uses the eight lower address lines (A0-A7), plus two special Read (I/OR) and Write (I/OW) signals to control all I/O access to the CPU.

Address decoding **(Fig 5)** uses exclusive-OR logic to buffer the address lines into an eight-input NAND gate. Since the exclusive-OR gates can be programmed for polarity (inverting or noninverting), jumper-selectable addressing of the particular device onto the μP data bus is possible. Note that the two signals which control the Read (I/OR) and Write (I/OW) operations from the μP are active only during the execution of the input or output instruction of the 8080 instruction set. Therefore, the memory addressing capabilities of the μP are not affected; the memory R/W control is initiated with two completely different control signals: Memory Read (MEMR)/Memory Write (MEMW).

Memory-mapped I/O does not occur in the same way. The same control lines control memory access (again

continued on page 79

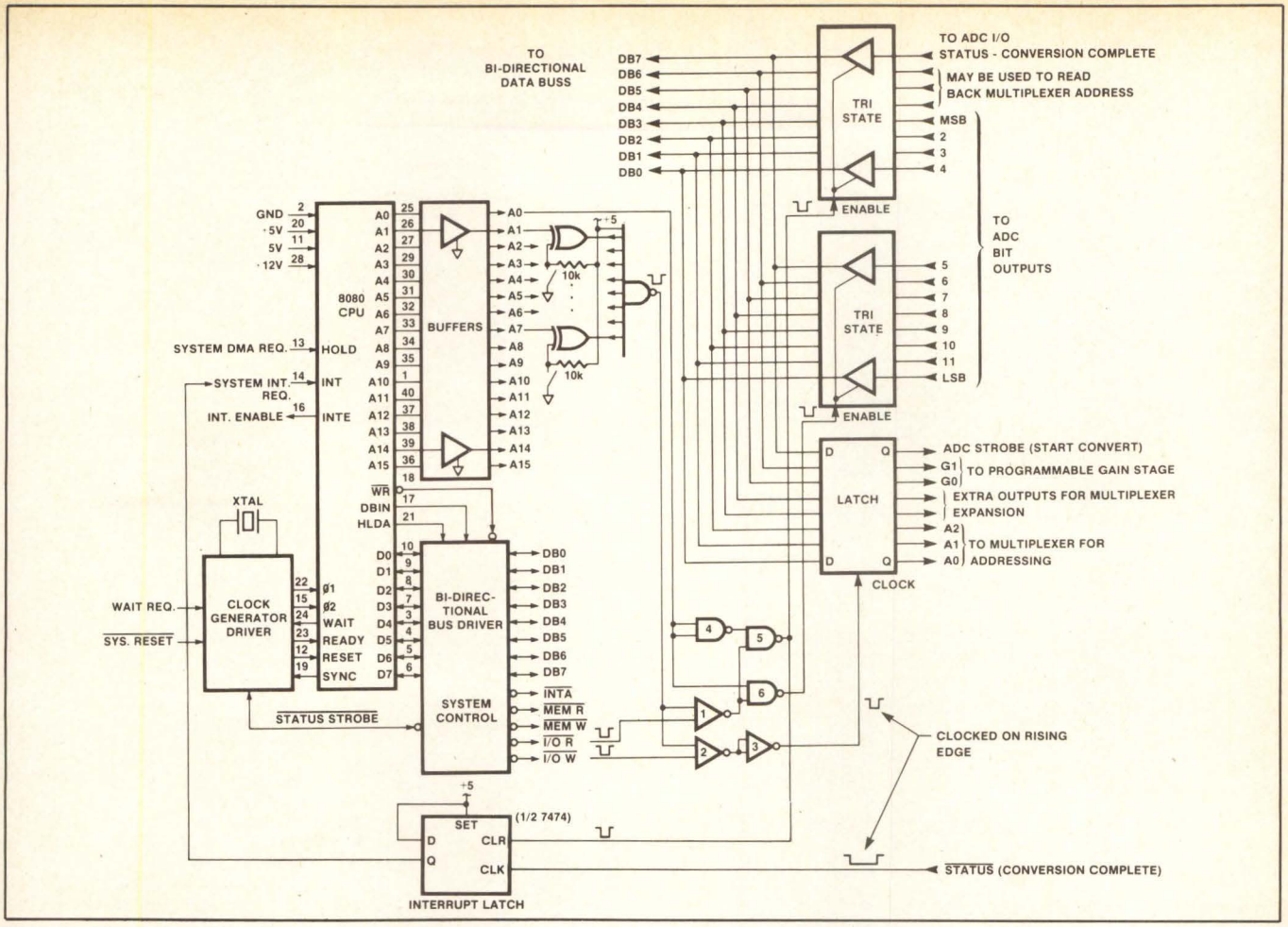


Fig 4 Block diagram illustrates the different circuitry necessary for data bus buffering and address decoding for programmed I/O and memory mapped I60.

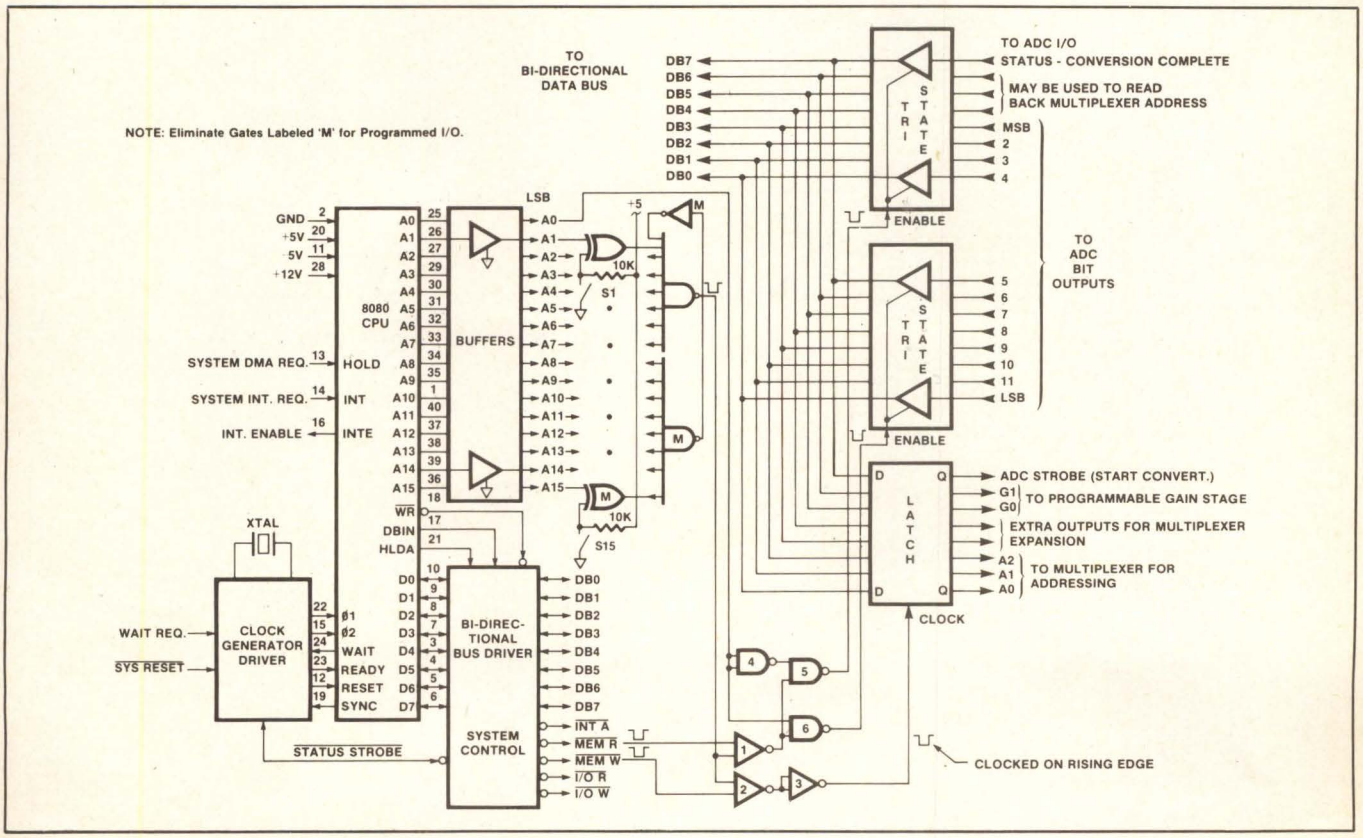
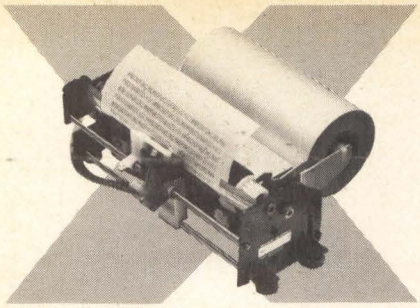


Fig 5 Block diagram illustrates how the complete interface between the DAS and the 8080 CPU differs for programmed I/O from memory mapped I/O.



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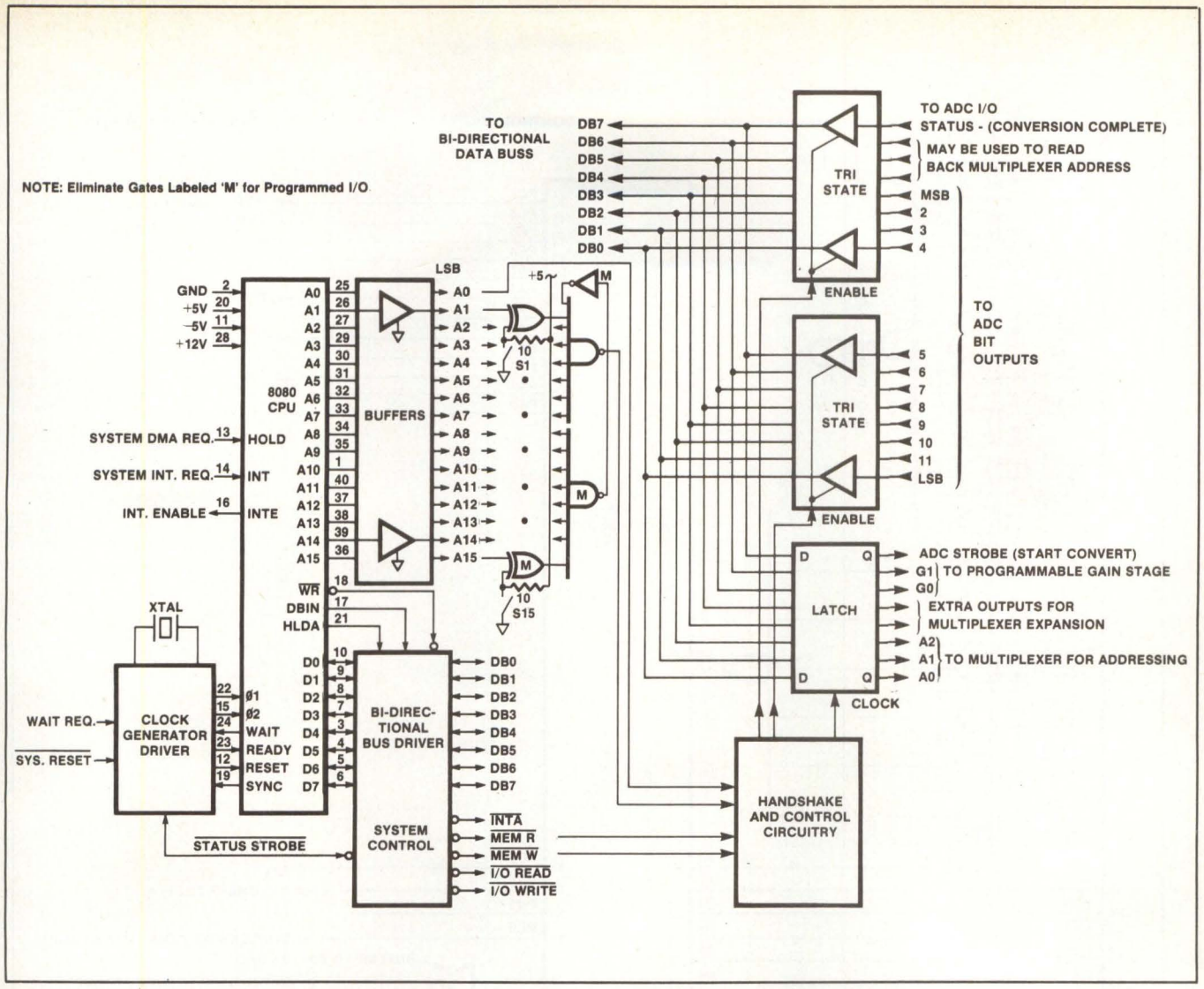


Fig 6 Block diagram depicts the complete interface of a DAS-to-8080 with programmed I/O and an interrupt driver.

continued from page 74

MEMR and MEMW) I/O transfer. The address decoding shown just extends the previously described decoding and differs only in the number of address lines decoded. The extra address lines are needed, because the I/O address now looks like a memory address to the CPU. The normal μP is memory-mapped in the lower addresses of the usable addressing range, and the I/O addresses are partitioned at a staring point greater than the highest memory address.

The advantages of memory-mapped I/O over programmed I/O appear in the software required to access the I/O device under each configuration. In programmed I/O, only two instructions are available to access the device; in memory-mapped I/O, all of the memory reference instructions are available. In an 8080 CPU, this accessability means that the two 8-bit ports or both 8-bit words which form the ADC and control information may be read directly into the H and L registers with a single LHLD instruction. The significance of this feature is obvious. Software I/O transfers can be made to operate faster and more efficiently. Such operations as incrementing multiplexer address can be completed directly with one instruction instead of three or four as required in programmed I/O. This key efficiency comes to passs because data to and from the I/O device does not have to pass through the accumulator when communicating with the I/O device as it does in programmed I/O.

Handshake and control circuitry

Handshake and control circuitry can be implemented in one of two ways: with a programmed I/O interface or a memory-mapped I/O interface **(Fig 6)**. The circuitry required for the handshake and control block consists of only a few gates and is identical for either interface. The operation differs only in this respect: Either two R/W signals $\overline{I/OR}$ and $\overline{I/OW}$ for the programmed I/O interface or $\overline{MEMR}$ and $\overline{MEMW}$ for the memory-mapped I/O interface feed NOR gates 1 and 2. The signals enable either a Write into the latch or a Read from one of the two tri-state buffer groups, but only if the output of the address decode circuitry is enabled or gate D's output is at a logic low level. During a Read instruction, the selected interface, by using the A0 address line, selects the tri-state group controlled by gate 6 (if A0 = high level) to enable data onto the data bus. The use of the least significant address lines for control (in this case, A0) provides an easy way to select between multiple ports on the same interface.

Interrupts

Accompanying diagram shows the previously described programmed I/O interface with the necessary circuitry for an interrupt-drive in interface. Even though the interrupt structure illustrated is a very simple, single-level structure, the idea behind it is very important.

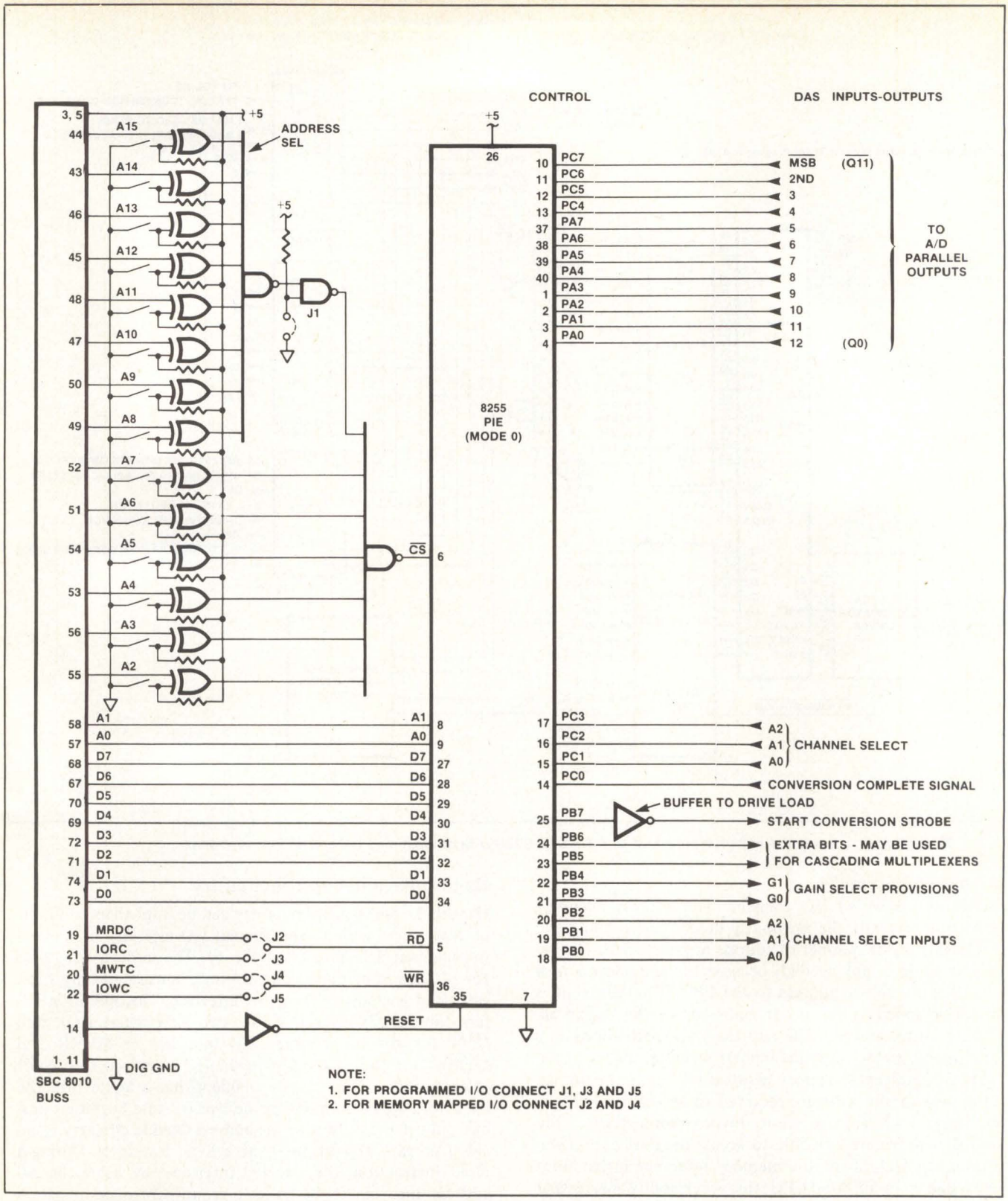


Fig 8 Interface for an SBC 80/10 bus.

First of all, a single-level interrupt means that only one interface to the μP is interrupt-driven in a system that may contain several I/O devices processing data. In the system shown in diagram, single-level interruption occurs because the 0 output of the interrupt latch is tied directly to the interrupt request input (INT) of the 8080. To configure a system with several interrupt-driven interfaces, additional hardware between the interrupt latch output of the interface and the interrupt request input of the 8080 is needed. As it is generally agreed that multiple interrupts call for multiple interfaces, the investigation of the interfaces is left to the designer.

The steps for generating an interrupt request in the system illustrated in diagram occur in the following manner. As soon as the STATUS signals makes the transition to a logic high state (positive transition) to signify an end of conversion of the DAS's ADC, the Q output of the interrupt latch is clocked high. This step immediately generates an inter-

rupt request at the 8080 INT input. Assuming that the μP strobed the ADC some time earlier and is now currently executing an instruction for some other routine in memory, program execution jumps to the interrupt service routine for the interrupting device at the end of the current instruction execution.

Usually, the interrupt routine is set up to service a device when the CPU cannot afford to spend the time monitoring the data ready flags. During the service routine for the interface in the system, the uppermost group of tri-state buffers are enabled for gate 5 to read the status information and the most significant ADC MSB and, at the same time, to clear the interrupt request to the 8080 before the interrupt service routine is over. This clearance step is important because if the interrupt request is not removed before a return to normal program execution occurs, the interrupt service routine will be immediately re-entered.

Interfacing the SBC-80/10 bus

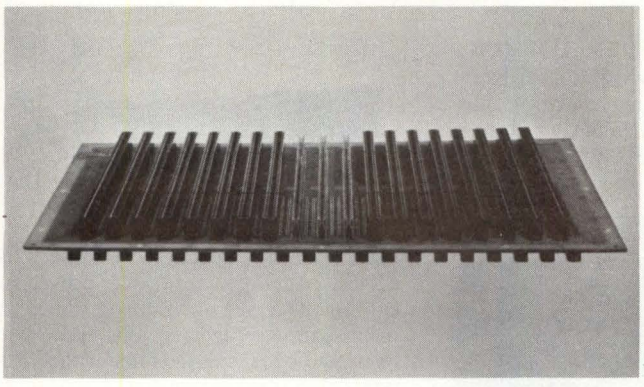
A complete interface for a DAS with an 8255 parallel interface element can be designed to plug directly into the 80/10 bus. When used in mode 0, the 8255 can replace the tri-state buffers and the latch and handshake control circuitry to provide the simplified interface. When using the 8255 or any other parallel interface element to drive a data bus directly, care must be taken not to overload the tri-state drive capability of the parallel interface element. Otherwise, the interface cannot drive the bus and improper data transfers will occur. When connecting the data lines directly to a bus heavily loaded with three TTL loads the 8225 must be buffered with tri-state devices. The same R/W signals which enter the 8255 at pins 5 and 36, respectively, would then drive the enable lines for the tri-state buffers. Initializing the 8255 with a control word of 231_8 in mode 0 programs the I/O pins with PB0-PB7 as output and all others as input.

Finding a common ground

When designing the interface between a data acquisition system and a μP, analog and digital ground routing in the DAS, and noise emissions from the μP-based system are often overlooked. Since the DAS depends on highly accurate voltage levels, maintaining that accuracy in an environment of large digital ground currents and noise is imperative. Not only must care be taken when laying out the PC board, but the analog section must be isolated as much as possible from its digital neighbor. This can be done by physical separation and considerable amounts of ground plane – analog and digital.

The analog and digital ground touring should consist of two separate networks originating at the system power supply as one common ground. The analog ground path back to the system power supply must contain little or no varying currents. At the same time, it should be as mechanically short and as thick as possible to keep a constant analog ground reference throughout the entire system. The separation between the two ground networks should not stop at the system bus, but should continue through every card in the system. Clamping diodes, installed between the two grounds on cards containing the analog and digital circuitry, prevent damage to circuitry in the event of accidental separation (excess potential difference) between the two grounds. ■

Backplanes



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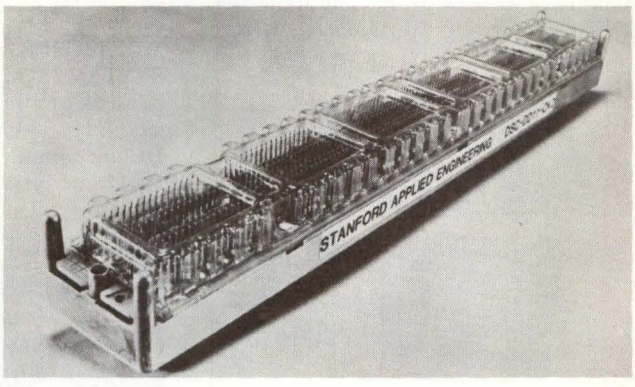
DEC Compatible



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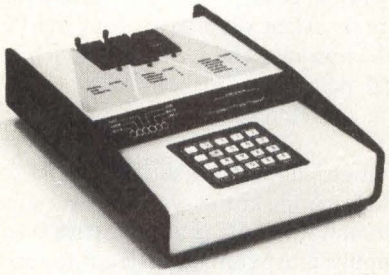
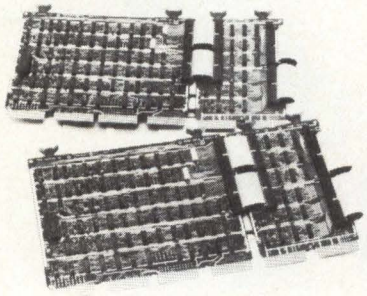
New Products

PORTABLE EPROM PROGRAMMER programs single- and 3-voltage MOS EPROMS and EEPROMS. The ZAP 80A has 8K X 8 (64K bits) data RAM and a built-in 8K X 8 PROM/ROM simulator. Serial interface includes RS232C,



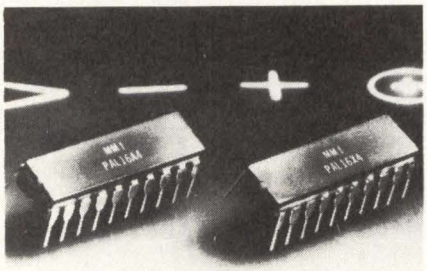
a 20ma current loop for teletype and a full modem handshake. An RCA 1802 COSMAC μP controls the sequencing, pinouts, voltages and timing with software controlled programming of all devices. The 20-key keyboard allows for selection of EPROM types, interfacing formats, baud rates from 50-1200, parity, programming and control functions and system self test. In the battery mode, the battery is first tested and continuously monitored. The ZAP 80A is $1695; the ZAP 80B (4K x 8 RAM, single-voltage) is $1395. **Sunrise Electronics,** 524 S. Vermont Ave, Glendora, CA 91740 **Circle 129**

DEC NETWORKS. Networks of PDP-11, VAX 11/780 and LSI-11/2 or 11/23 computers can be formed using the Interprocessor Subsystem Links. For linking of two PDP-11 computers, the DA11BJ provides differential driver/



receiver modules for high speed parallel data transmission up to 3,000 ft., the DA11BOI provides differential receivers and optically isolated receiver modules for up to 1,000 ft. For LSI-11 applications, the MLSI-DA11BOI links a PDP-11 computer with an LSI-11/2 or 11/23. The fourth system links between two LSI-11 computers. Both of these subsystems feature optically isolated receivers. Common features include compatibility with DEC DA11B operating and diagnostic software; cables for operation of two computers up to 50 ft, a selectable feature allows data transfer across 32K boundaries in blocks of up to 32K words. From $3295 to $5275, 60 days ARO. **MDB Systems Inc,** 1995 N. Batavia St, Orange, CA 92665 **Circle 171**

PROGRAMMABLE ARRAY LOGIC. Two new PAL Series 20 devices perform arithmetic functions such as: +, −, >, <, between limits and equality. With other PAL devices, arithmetic PALs can replace 90% of the 5400/7400 series TTL logic functions. Ad-



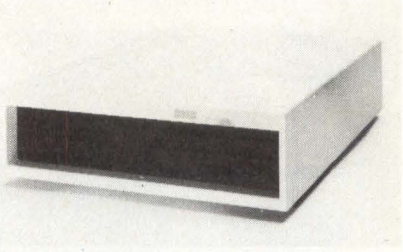
ditional features include input gated feedback, exclusive-OR, and parallel carry. Applications include 4-bit up/down counters with shift, program counters and between limits comparators. PAL16X4 and 16A4 are $39/100. **Monolithic Memories,** 1165 E. Arques Ave, Sunnyvale, CA 94086 **Circle 174**

MULTIUSER μP DEVELOPMENT SYSTEM. The basic system hardware consists of an EXORmacs 15-slot chassis, an MC68000 MPU/MMU module, a DEbug module, two 128 kB Dynamic RAM modules, and a Universal Disk

Controller module. Software includes the VERSAdos multitasking operating system, CRT Editor, Structured Assembler, Linkage Editor, PASCAL Compiler and Symbolic DEbug. Peripherals include a 32MB hard disk and an EXORterm 155 display console. Additional memory, display consoles, and Multi-Channel Communications Modules (MCCM) may be added to the system to accommodate up to 8 users. An optional line printer is also available. The M68KMACSH1 system is $35,995; the M68B600LPI printer is $11,400. **Motorola,** Box 20912, Phoenix, AZ 85036 **Circle 170**

VIBRATION ISOLATORS. These low cost, low frequency, low profile isolators provide isolation in both the horizontal and vertical planes. They offer a wide load range for application in a variety of equipment. The Duo-Plexx 7820 isolators are made of lightweight, high strength plastic. The design requires little space resulting in overall package size reduction. They provide excellent vibration isolation to minimize the transmission of structure-borne noise either to or from supported equipment. Available in two sizes with three load ranges in each size, and are operational over a temperature range of −18°C to +50°C and can be stored under load from −32°C to +50°C. No special tools or mounting hardware are required. **Barry Controls,** 700 Pleasant St, Watertown, MA 02172 **Circle 173**

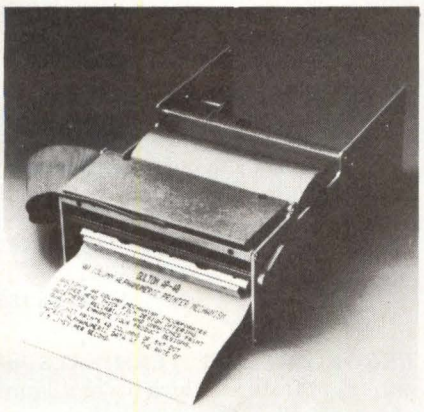
WINCHESTER/FLOPPY STORAGE. This DEC compatible system includes 8.9MB of fixed 8″ Winchester storage plus 1MB of double sided floppy disk storage. Available for the LSI-11 or



PDP-11, the systems include disk drives, controller, interface, power and cabling in a 5 1/4″ rack or table top enclosure. Average access is 70 ms with over 500 kB/sec data transfer rate. The controller's compatible mode provides complete DEC RX02 hardware, software and media compatibility. The extended mode can access the Winchester disk and IBM compatible floppy disks and also increase system throughput by transferring up to a 65 kB data block in a single command. The FWT01172, LSI-11 Flinchester system *is from* $6700. **Scientific Micro Systems,** 777 E. Middlefield Rd, Mountain View, CA 94043 **Circle 189**

New Products

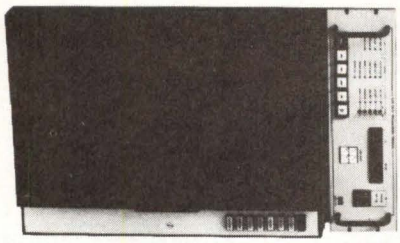
ALPHANUMERIC PRINTER MECHANISM provides data output in log format with 40 columns of hard copy printing utilizing 2 fixed 20-column dot matrix printheads and a paper drive



system. There are no electronics included and it interfaces with any μP-based system. Forty columns of normal height 5 X 7 characters, .11″ X .08″ or 5 x 14 double height characters, .22″ x .08″ are obtainable. The mechanism can also display half size and bold characters at normal size. Print speed is 150 lpm. The AP-40 LM is $375. **Gulton,** MCS Div, East Greenwich, RI 02818 **Circle 178**

KEYBOARD. MPNK-72 Word Processor Keyboard is a replacement equivalent of Keytronic's L1660 Keyboard. It is a solid-state capacitance, low profile solderless-contact, key-switch keyboard with μP control, 2-slot molded sculptured keytops, 100 million keystroke reliability, rigid frame mounting and electronic shift lock to insure mechanical reliability. **Amkey, Inc,** 220 Ballardvale St, Wilmington, MA **Circle 179**

TAPE TRANSPORT. This off-line system is designed for high speed transmission of IBM format compatible digital



magnetic tape data via DDD, WATS, leased or private line links. The μP-based system is fully compatible with terrestrial and satellite channels provided by domestic and international common carriers. All formatting, error protocol, modem signalling and tape transport control is directed by a single chip LSI μP. An extensive built-in self-test validates system operation. The Series 7300 System can connect to a variety of data terminals via an EIA RS-232C compatible I/O port with error protecting line protocols. **Quad Systems, Inc,** 16021 Industrial Dr, Gaithersburg, MD 20760 **Circle 177**

FLOPPY DISK SUBSYSTEM. This dual-sided, double-density floppy disk subsystem for the SCOUT NAKED MINI 4/04 computers, has a formatted-data capacity of 1 MB per drive. Full software support includes the 10S4 driver, ISOLITE (self-test) diagnostic and autoload diagnostic formatter. The subsystem includes a universal floppy disk controller, a single SCOUT board that interfaces with the SCOUT I/O bus, rack-mountable chassis with power supply, and cables. Diagnostic/formatter software enables the user to format diskettes with sequential sectoring for both single and double density. ($3950). **Computer Automation, Inc,** 2181 Dupont Dr, Irvine, CA 92713 **Circle 180**

Put video display capability into your Multibus system using this simple instrument.

Phone DataCube today for the industry's only off-the-shelf interface modules for Multibus/keyboard/video display, Multibus/video camera/video display, and Multibus/digital input/strip chart video systems.

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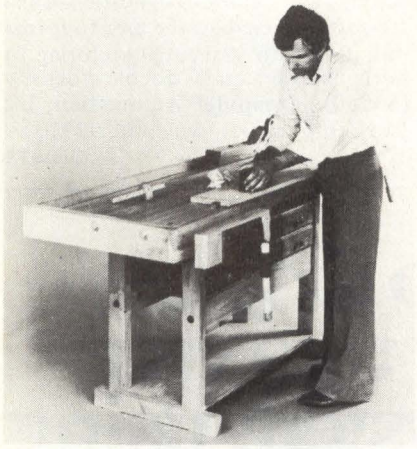
670 Main St., Reading, MA 01867

Circle 44 on Reader Inquiry Card

New Products

WORKBENCH FOR PROTOTYPES. A fine cabinetmaker's workbench, ideal as a place to construct prototypes or "dummys", is one of 70 projects that have appeared in past



issues of this journal. The magazine is ideal for engineers working in their home basements. Although confined to wood crafting, these fine magazines offer tips and techniques that are time-proven and valuable. A hobbyist engineer will find them extremely useful. **Woodworker's Journal,** Box 1629, New Milford, CT 06776 **Circle 134**

DATA MONITOR. This portable, completely ruggedized data communications diagnostic tool for field use can be used by anyone to diagnose a majority of line problems. It interfaces with Encore 100. Two languages are

available: ASCII and EBCDIC (with HEX conversion), with speeds from 50 to 9600 band. Either async or sync operation can be selected, and both half- and full-duplex communication modes can be utilized. Data Monitor 200, including monitor, tape recorder and scope is $5000. **Digitech Data Industries Inc,** 66 Grove St, Ridgefield, CT 06877 **Circle 156**

FORTRAN, COBOL FOR APPLE II. FORTRAN-80 can compile several hundred statements/minute in a single pass and needs less than 25 kB of memory. The FORTRAN compiler creates true Z-80 machine code and supports double precision, integer X 4 and integer X 1 data types. It is supplied with a library of floating point, math and I/O routines. The FORTRAN-80 package includes compiler, LINK-80 linking loader and complete reference manual. It runs on an Apple II with SoftCard, 48K and one disk drive. ($195). COBOL-80 includes 4 kinds of data files – sequential, line sequential, relative and indexed sequential. Screen definition permits full-screen I/O and editing. Program segmentation brings individual program sections into memory as needed. The COBOL-80 package includes compiler, LINK-80 linking loader, MACRO-80 assembler, LIB library manager, CREF-80 cross reference assembler and complete reference documentation. It requires an Apple II with SoftCard, 48K and 2 disk drives. ($750). **Microsoft,** 400 108th Ave NE, Suite 200, Bellevue, WA 98004 **Circle 165**

ERGONOMIC CRT TERMINALS incorporate features which make it more adaptable to human interface requirements. The detached keyboard has a typewriter layout with 79 keys, auto repeating, 6 function keys for generating 16 two character code sequences, separate cursor control and edit cluster, and software controlled lock/unlock. Display characteristics include a 12" diagonal screen with non-glare (anti-reflect) display, 25 lines of 80 characters and 96 displayable ASCII codes. Switch selectable features include: 8 data transfer rates from 110 to 9600 baud; 10 or 11 bit serial async ASCII data with odd, even or mark parity; EIA RS-232C interface; and line, page and partial page transmit. The std. Series 630 Data Screen terminal is $1100. **TEC, Inc,** 2727 N. Fairview Ave, Tucson, AZ 85705 **Circle 184**

ELECTRONICS. News – including behind-the-scenes coverage of significant professional events in the electronics/computer industry – is covered in this free (supported by donations) newsletter. **Committee of Concerned EEs,** Box 19, Massapequa Park, NY 11762 **Circle 141**

PROGRAMMERS

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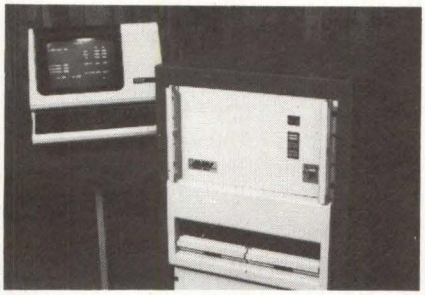
EQUIPMENT & SOFTWARE BARGAINS

New Products

MODULAR ARRAY PROCESSORS. This series of high-speed programmable array processors, in the most basic configuration, can perform 1K complex Fast Fourier Transform in 1.05 ms. They are controlled by a minicomputer as programmable peripherals. The Data Processor (DP) module is available in 2 versions: the DP-R, which can carry out a single 32-bit multiply and two 32-bit adds in 200 ns; or, the DP-C, which is capable of 4 multiplies and 6 adds in 200 ns. The DP includes dual parallel 16-bit



data paths and arithmetic units, and a set of 4 high-speed memories which may be populated with up to 64K, 32-bit words each. The Interface Processor (IP), controls data flow in a system. It handles prioritized device interrupt request arbitration and I/O transfers at a 20MB/sec rate. Different packaging options are available for both. The MARS DP is $20K, complete development systems are $40K, 90 days ARO. **CNR. Inc,** 220 Reservoir St, Needham, MA 02194

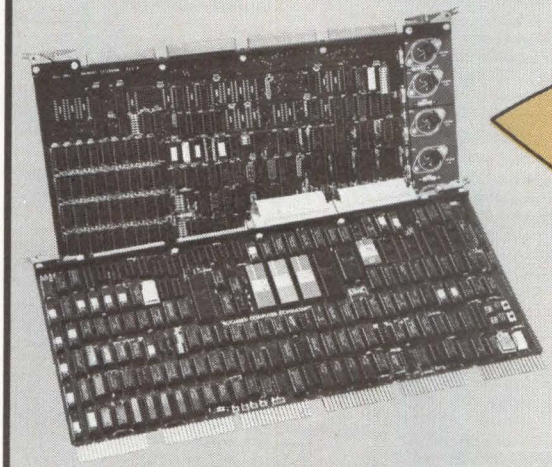
Circle 126

LOW COST 8086 SBC. This user oriented single board computer has an 8086 CPU and conforms to the IEEE P796 Bus (formerly Intel's Multibus) standard. In addition, the CUSTOM 86 provides two breadboarding areas for the user to add circuitry for a specific application. For additional memory, the 20-bit address and 16-bit data-bus lines, are brought out to wire wrap stakes. The breadboard area is designed for easy wirewrapping and will accept any standard .3 or .6 inch wide sockets. The C86 board also will accept two user installed 50-pin flat ribbon cable connectors for interfacing to other devices or boards. CUSTOM 86 prices start at $995 in single quantities and are available from stock. **Microbar Systems Inc.,** 1120 San Antonio Rd., Palo Alto, CA 94303. **Circle 205**

COMMUNICATIONS FOR 300 LPM PRINTER, based on the Teletype Model 40 printer mechanism, offers numerous interfaces. ASCII serial async communications protocol support includes XOn/XOff, ENQ/ACK ETX/ACK, and Break When Busy, which is also available with the current loop option. Power turn on diagnostics check the microcomputer data paths, including ROM, RAM, communications interface, and printer control. Print speed is 300 lpm (400 lpm with the 48 character set), 132, 80, and 80 columns forms access (ticket) models are offered. The Innovator 202 is $4995. **Innovative Electronics Inc,** 15200 NW 60th Ave, Miami Lakes, FL 33014 **Circle 166**

SINGLE-CHIP DIGITAL CORRELATOR. This chip is capable of comparing a stored 64-bit reference word with similar incoming data at a 20-MHz rate. A first-of-a-kind device, it provides a binary-weighted output representation of the number of bits that are in agreement. Correlation is widely-used to detect a desired signal in the presence of other signals or noise, to reorganize specific signal patterns, and to measure time delays through various mediums, such as the body, RF paths, electronic circuits, etc. Price of the TDC1023J is $85 in 100 quantities (US OEM). **TRW LSI Products,** 2525 E. El Segundo Blvd., El Segundo, CA 90245. **Circle 211**

Grab a star



X.25

Link your PDP-11 to today's networks

With ACC's latest network packages, you can grab X.25 for your PDP-11. Use them to send messages to remote sites via Telenet or Tymnet. Or to sites within your own corporate-wide packet-switched network.

IF-11/X.25

Our IF-11/X.25 package consists of two circuit boards, shown above, plus software. The first three X.25 levels are supported. Up to 32 network connections called virtual circuits are handled simultaneously.

The IF-11/X.25 is microprocessor based. Its two boards fit into two PDP-11 backplane slots. And since all X.25 protocol processing is done within the IF-11/X.25, your PDP-11 is free to perform other tasks.

User Mode X.29

This terminal-handling software runs in your PDP-11. It serves as packet assembler/disassembler (PAD) for up to 32 independent PDP-11 users accessing the network.

With User Mode X.29 conjoined with IF-11/X.25, you've linked your terminals right to the network. And the end result? The X.25 network is effectively rendered invisible: you can send network messages in a direct and simple manner. Now how's that for stargrabbing?

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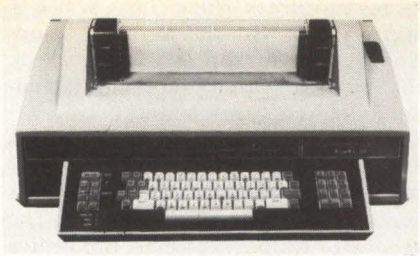
PDP is a registered trademark of Digital Equipment Corp.

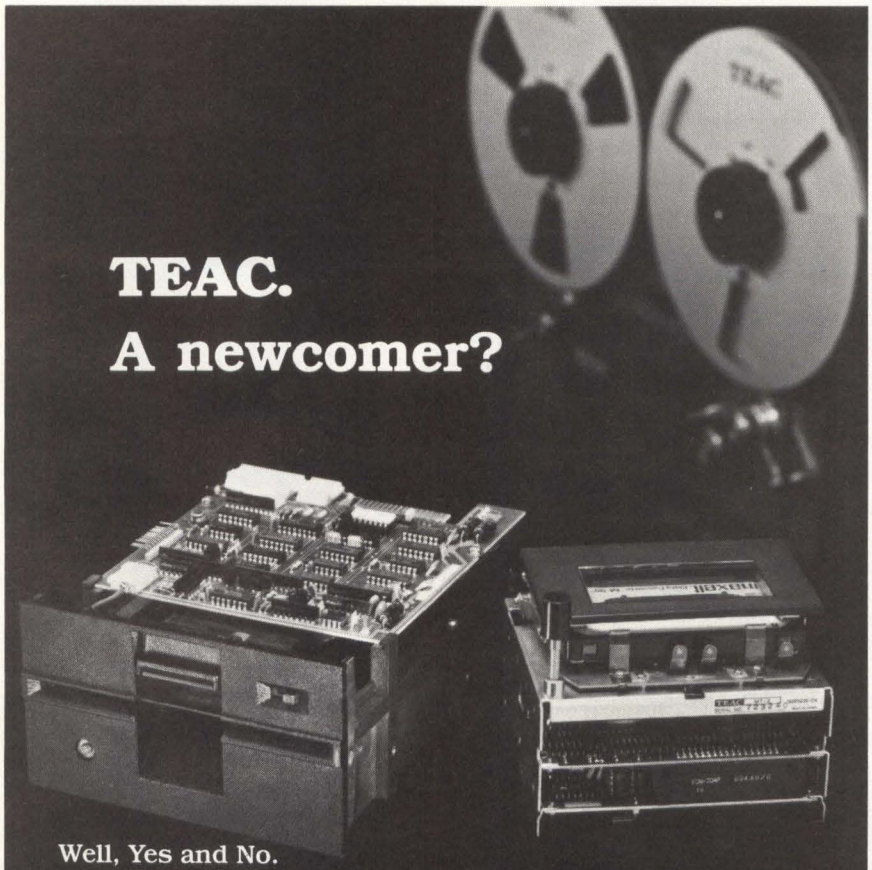
Circle 47 on Reader Inquiry Card

New Products

ENHANCED PRINTER. New options for the TermiNet 200 units include APL/ASCII keyboard. With this option, the printer has 188 printable characters; 94 for the ASCII code set and 94 for the APL code set. The 9-wire printhead option prints lowercase letters with descenders and provides true underlining. The alternate font option allows users to define their own character set(s). Special symbols can be created for various applications.



TermiNet 200 printers can produce up to 9 copies at 200 cps with a paper slew rate of 20 ips. Print compression is switch or code-controllable at 10, 13, 15, and 16.5 cpi. **General Electric Co,** Waynesboro, VA 22980 **Circle 132**



Well, Yes and No.

YES, we are introducing 5¼" floppy disk drives.

NO, we are not new in the digital recording field; in fact we are a leader in digital cassette recorders with over 200,000 units already sold.

And with a solid 25 years of expertise in magnetic recording technologies – digital, analog, video, and of course our popular stereo tape decks – we *know* how to design and build recorders (to put it modestly).

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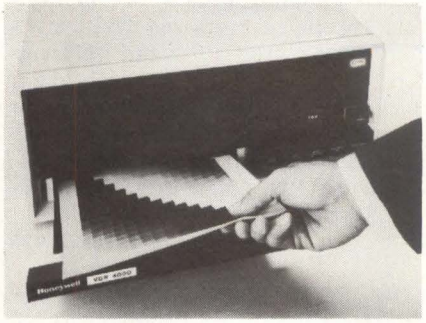
Circle 48 on Reader Inquiry Card

DISPLAY STATIONS increase charactor screen capacity on the Display Station from 1920 characters (Model 2) to 2560 (Model 3), 3440 (Model 4) and to 3564 characters (Model 5), 132 character line. Consisting of a display monitor and separate keyboard, the 2078 models are available with 5 keyboard options: 75-key data entry, 75-key EBCDIC or ASCII typewriter, and 87-key EBCDIC or ASCII typewriter. Features include non-glare and tilt screen, a line and column indicator, and status display of the system, cluster and terminal. From $2431 (Model 1, 75-key data entry); to $3565 (Model 5, 87-key EBCDIC typewriter). Also available is the 2076 Remote Cluster Controller. It supports up to 8 Category A communications devices in BSC mode. It is also separate from the display station for configuration flexibility and will support all 4 models of the 2078. ($4494). **Memorex Corp,** San Tomas at Central, Santa Clara, CA 95052 **Circle 127**

VIDEO GRAPHIC HARD COPIER. In 14 secs, this unit produces crisp, 81/2 × 11" pictures with high resolution and up to 16 shades of gray. The VGR 4000 can be desk top or rack mountable. Features including built-in test

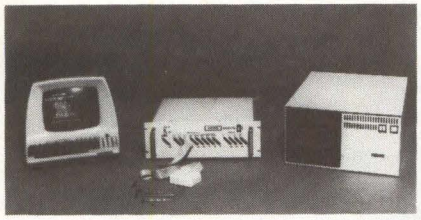


and diagnostic capability, multiplex and copy counter. It is platen-less and uses only 100 W on standby. From $5000 to $7000, OEM discounts available. **Honeywell,** Box 5227, Denver, CO 80217 **Circle 142**

DISKETTE DRIVE. This double-sided, double-density diskette drive for Datapoint 1800 dispersed processors can store over 2 MB of data. Four dual drive units can be configured with an 1800 for over 8 MB of storage. The 1413 includes a dual diskette drive with internal controller. A 256 byte buffer in the diskette controller is randomly accessible by the processor and provides access to stored data. The 1812, with 64K user memory and the 1413 Diskette Drive, is $12,770. The 1814, with 120K user memory and a 1413 Diskette Drive, is $14,070. Add-on 1413 Diskette Drive modules are $5,795. **Datapoint Corp,** 9725 Datapoint Dr, San Antonio, TX 78284 **Circle 195**

New Products

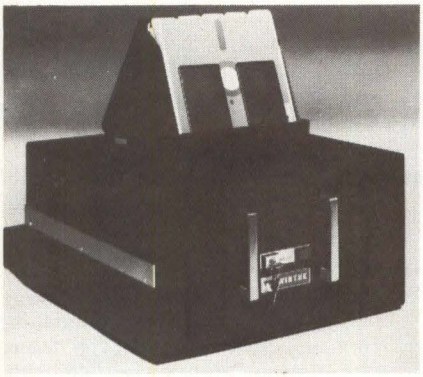
MICROPROGRAMMING DEVELOPMENT SYSTEM has a resident computer system with 64 kB of memory, 2 floppy (dual density) drives, and



a CRT terminal. The processor is a 4 MHz Z80. The PROM Emulator/Logic state analyzer also contains a 2901 based processor and is tied to the computer as well as the CRT terminal. The logic state analyzer offers a 20 MHz trace, 1023 deep, and expandable to 80 channels wide. An unlimited break/trigger feature offers simultaneous and independent arming, conditional and/or unconditional break/trigger of any number of addresses within an 8192 addressing space. The DS500 starts at $15,900. **Hilevel Technology, Inc,** 14661 Myford Rd, Tustin, CA 92680 **Circle 151**

VAX 11/780 300MB Drive System uses the faster SBI rather than the UNIBUS and runs full DEC diagnostics. The NVM05 can support 8 additional drives. Transfer rate is 9.7 Mbit/sec. The drive system is spindle compatible with DEC RM05. The basic drive with controller is $28,900, additional drives are $16,900. **Nordata,** 4433 27th Ave. W., Seattle, WA 98119 **Circle 149**

UCSD PASCAL compiler is available for the SPRINT 68 microcomputer. The UCSD system includes an inter-



active operating system, PASCAL compiler, screen-oriented editor, macro assembler, linker, P-code interpreter, and a library of utilities. The software package is $675. **Wintek Corp,** 1801 South St, Lafayette, IN 47905 **Circle 140**

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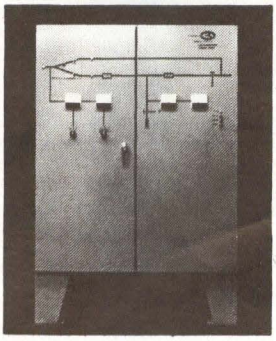

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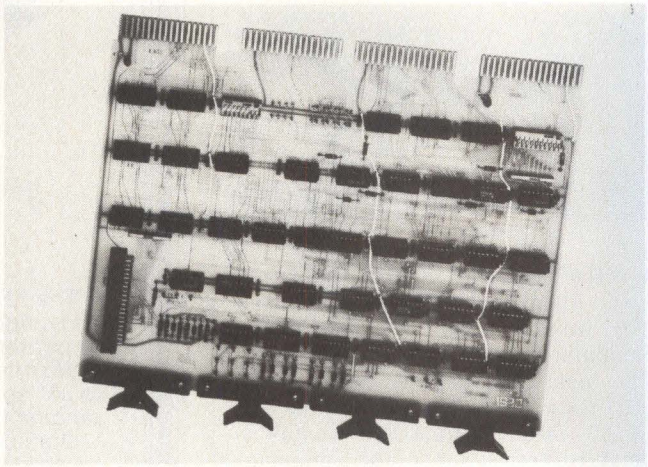


selection of address and vector locations. The LPC 11, with a 25′ cable is $525. **Computer Extension Systems, Inc.,** 17511 El Camino Real, Houston, TX 77058. **Circle 200**

N/C WIRE WRAPPING SYSTEM features a 20 X 20″ wiring area, 10 ips traverse speed, high resolution stepper-motor design with .0025″ increment, full operator display complement and a rugged 40-tube wire bin. The system also has a smart paper tape transport that contains its own μP and buffer to ensure fast accurate data transfer. The SW-101 offers software flexibility. It reads tapes in either ASCII or EIA code, and can read tapes prepared either for absolute or incremental positioning. The SW-101 is $4995. The SW-101F with a fanfold (Z-fold) reader in place of the tape transport is $4495. **OK Machine and Tool Corp,** 3455 Conner St, Bronx, NY 10475. **Circle 201**

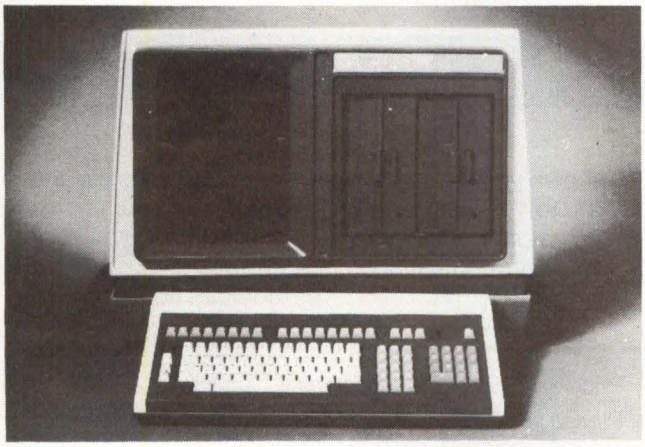
MEMORY BOARD is a 64 kB "dual wide" LSI-11 compatible memory card. Configured as 32K by 18 bits, the dynamic NMOS RAM has on-board parity generation and parity check circuits, internal or optional external refresh functions, battery back-up provisions and expanded address-space operation. The NS23L, has a read access time of 190 ns, a read-cycle time of 490 ns, a write access time of 90 ns/word or byte, a write-cycle time of 390 ns, and a read/modify/write access time of 700 ns/byte with a R/M/W cycle time of 1000 ns. Optional configurations are 32K by 16 bits without parity, and depopulated versions are 16K by 18 bit or 16K by 16 bit. Operating power requirements are 1.5A at +5V and 0.4A at +12V. From $550 to $750. **National Semiconductor,** 2900 Semiconductor Dr, Santa Clara, CA 95051. **Circle 203**

SOFTWARE BROCHURES. The diskette based operating system (Ontel MDOS/80) and the disk based operating system (Ontel HDOS/80) provide a powerful set of commands to control data movements and processing directly from any OP-1 display computer. Various features simplify and generalize data handling operations. Both provide dynamic link space allocation/deallocation for max. utilization of disk and diskette space. They support sequential and random file structures. Up to 64 private user file catalogs are supported in HDOS/80 as well as a single shared catalog. Both systems are mutually compatible. **Ontel Corp,** 250 Crossways Park Dr, Woodbury, NY 11797. **Circle 204**

COMMUNICATIONS MULTIPLEXORS for DG Nova and Eclipse computers running under DOS, RTOS, RDOS and AOS. Model 4111 is software transparent to the ULM series and Model 4311 is software transparent to the ALM series. Both single board devices require only one slot in the CPU and contain 8 async ports, one sync port, 2 EIA teletype ports and a real time clock. The teletype ports are jumper selectable to handle RS-232 printer devices. Both multiplexors accommodate data speeds from 50 baud to 38.4K baud under both hardware and software control. An optional data speed of 45.5 baud can be supported for military applications. The sync port is compatible with IBM's BYSYNC protocol and supports transparent or non-transparent communications over serial EIA lines. **Quentin Research, Inc.,** 19355 Business Center Dr, Northridge, CA 91324. **Circle 208**

STORAGE MODULE CONTROLLER also functions as a formatter. The SMD 2180 makes Storage Module technology available to the microcomputer user. Single board Intel MULTIBUS compatible controller/formatter controls up to four 40-300 MB Storage Module drives. 20-bit addressing, two powerful addressing modes, and a software selectable 8 or 16 bit wide data bus makes the device compatible with SBC 80, SBC 86, and other Multibus compatible CPUs and Memories, in all operating modes. An on-board microprogrammed bipolar processor gives the SMD 2180 powerful macro level commands with automatic error recovery and self-diagnostic reporting. **Interphase Corp,** 13667 Floyd Circle, Dallas, TX 75243. **Circle 209**

CP/M INTELLIGENT TERMINAL. As a stand-alone μC or workstation in a distr. processing network, Piiceon Information Processing System – said to be the first 8086-based μC to use a CP/M OS – consists of an ergonomically-designed full-page video display, 64 KB of RAM/8 KB of PROM. It has screen-labeled function keys and two opt. dual-sided, double-density floppy disk drives with 1.2 MB of storage each. Full-page video display has a 66-line-by-80-char. format w/ a 7-by-9 dot matrix in a 9-by-15 field. Any combination of 128 ANSCII U&L char. and descenders are displayed in high/low intensity, with blinking, reverse,



blank and underline. Detachable keyboard has a full alphanumeric set of 107 keys, with N-key roll over. Features include: full cursor control w/ home key, V/H scrolling, justified print out, auto repagination, screenviewing of a full page document. It has two RS-232C ports for communications and printer. Optional auxiliary interface is for multi-terminal applications. Selectable baud rates (8) are 110 to 19.2K. Transmission mode is conversational or block. Power consumption w/o drives: 120 W; w/ drives, 230 W. $4,995, w/o diskette drives; $6,522, w/ drives. Includes CP/M 86 OS and WP software. **Piiceon Inc.,** 2350 Bering Dr., San Jose, CA 95131. **Circle 210**

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1	30B-010	30W-010	30Y-010	4.88	28B-010	28W-010	28Y-010	5.25	26B-010	26W-010	26Y-010	5.75
1.5	30B-015	30W-015	30Y-015	5.19	28B-015	28W-015	28Y-015	5.63	26B-015	26W-015	26Y-015	6.23
2	30B-020	30W-020	30Y-020	5.50	28B-020	28W-020	28Y-020	6.00	26B-020	26W-020	26Y-020	6.68
2.5	30B-025	30W-025	30Y-025	5.82	28B-025	28W-025	28Y-025	6.38	26B-025	26W-025	26Y-025	7.13
3	30B-030	30W-030	30Y-030	6.13	28B-030	28W-030	28Y-030	6.75	26B-030	26W-030	26Y-030	7.60
3.5	30B-035	30W-035	30Y-035	6.44	28B-035	28W-035	28Y-035	7.13	26B-035	26W-035	26Y-035	8.05
4	30B-040	30W-040	30Y-040	6.75	28B-040	28W-040	28Y-040	7.50	26B-040	26W-040	26Y-040	8.50
4.5	30B-045	30W-045	30Y-045	7.07	28B-045	28W-045	28Y-045	7.87	26B-045	26W-045	26Y-045	8.98
5	30B-050	30W-050	30Y-050	7.38	28B-050	28W-050	28Y-050	8.25	26B-050	26W-050	26Y-050	9.43
6	30B-060	30W-060	30Y-060	8.00	28B-060	28W-060	28Y-060	9.00	26B-060	26W-060	26Y-060	10.35
7	30B-070	30W-070	30Y-070	8.63	28B-070	28W-070	28Y-070	9.75	26B-070	26W-070	26Y-070	11.25
8	30B-080	30W-080	30Y-080	9.25	28B-080	28W-080	28Y-080	10.50	26B-080	26W-080	26Y-080	12.18
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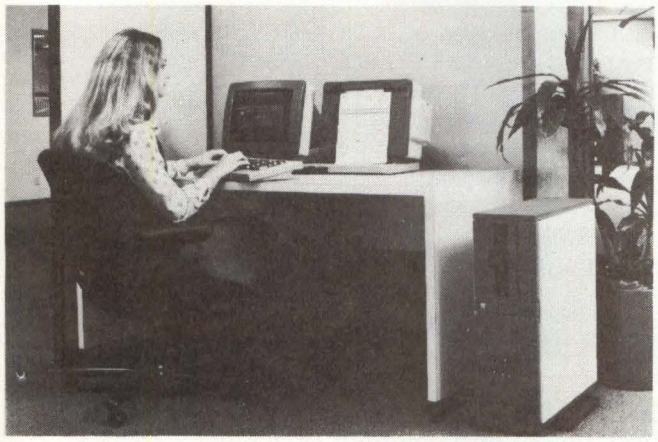
POWER SUPPLY CATALOG is a 20 pg description of Kepco's voltage and current stabilized power supplies, digital programmers and associated mounting and hardware accessories. Among the power supplies are unipolar and bipolar programmable low and high voltage units, employing linear feedback technology. There are high-efficiency switchers with single and multiple outputs ranging from 10 to 300 W. Also listed is the ferroresonant power supply design. **Kepco, Inc.**, 131-38 Sanford Ave, Flushing, NY 11352. **Circle 218**

NEW COMPUTER CONCEPT. Designed around a 16-bit μP, this family of information processing systems concentrates all processing power in multifunction workstations. The system allows true multifunctionality – data processing, word processing, numerical processing and graphics capabilities – in a compact, ergonomically sound unit. The single-station system Model 1121-1, has a minimum of 128kB of RAM; its deskside mass storage subsystem consists of one 10 MB, 8″ Winchester disk and one floppy disk. In cluster configurations to be available first quarter



1981, up to 16 workstations can be combined, utilizing a Shared Resource Processor (SRP) to access up to 116.5 MB of combined Winchester and floppy disk mass storage. The family consists of 6 standard versions with unlimited configurability in 3 dimensions between the various levels of the system, including upgrade of individual workstation power; upgrade of system power through addition of workstations and mass storage capacity; and reallocation of system capabilities through assignment of workstations from a mini- or large-cluster system to standalone configurations. System single-unit begins at $11,990. The largest packaged configuration presently defined, the 16-station resource-sharing cluster with 58 MB of Winchester disk storage, 0.5 MB of floppy disk and streaming tape cartridge back-up, is $133,500. **Convergent Technologies,** 2500 Augustine Dr., Santa Clara, CA 95051. **Circle 219**

SOFTWARE EXCHANGE SERVICE. A free software exchange service has been established for DEC PDP-11 computer users. This service allows PDP-11 users to submit their software for software exchange credits which may be used to obtain any software listed in the "Quarterly Software Exchange Bulletin". Also available via a dial-up line is the electronic magazine "Digital Digest". **PDP-11 Software Exchange,** 3169 Holcomb Bridge Rd, Suite 307, Dept. 1216, Norcross, GA 30071. **Circle 220**

WORK STATION. Desk top Integrated Work Station includes intelligent terminal with video features, built-in card cage, holding a number of Multibus or LSI-11 Q-Bus cards and optional two 5.25″ floppy drives. From $3195. **Callan Data Systems,** 2637 Townsgate Rd., Westlake Village, CA 91361. **Circle 214**

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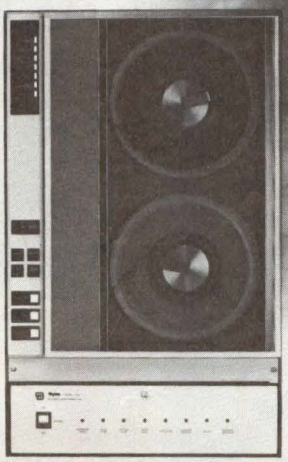

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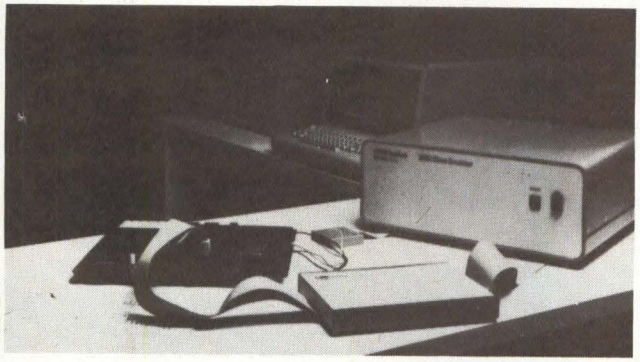
CAD/CAM REFERENCE BOOK. This 306 pg. handbook is intended for both experienced and novice CAD/CAM users. It is composed of articles from educators, consultants, and Computervision CAD/CAM users from such institutions and companies as MIT, Harris Corp., General Electric, General Dynamics, and Reliance Electric. Among the topics covered are: "What is CAD/CAM?"; "How is CAD/CAM Justified?"; "How to Select a CAD/CAM System"; "How to Get Started"; "How to Organize and Manage a CAD/CAM Facility"; "Formulation of System Cost Effectiveness". The handbook also includes papers on using a CAD/CAM system for PCB design, IC design, wiring diagrams, mapping, piping design, numerical control, and the design of complex 2D and 3D structures. **Computervision Corp.**, 201 Burlington Rd., Bedford, MA 01730. **Circle 221**

PASCAL COMPILER AND SUPPORT FOR 68000/8086 The PASCAL compiler is the first of a family of GenRad high level language compilers. It produces assembly source code as its output and conforms to ISO international PASCAL standards. Additional software support includes object program linker, powerful screen-based editor, interactive debugger with disassembly and symbolic debugging, and command control language. Hardware support for the



two 16-bit processors includes 2302 Slave Emulator and logic analyzer. Emulation is at full processor speed. The slave logic analyzer provides 3 breakpoints and a trace qualifier, each 48 bits wide. Trace memory is 64 bits wide and will store 256 events. Support is compatible with both the 2300 Series single user and the 2301 network configurations, with either floppy disk or combination hard/floppy disk mass storage systems. **GenRad Development Systems Div.**, 5730 Buckingham Pkwy, Culver City, CA 90230. **Circle 222**

MATRIX PRINTER combines 200 cps print speed with intelligent, bi-directional printing and variable print densities for versatile, high-speed output. Features of the PM-LC11 printer terminal include: 9-wire, bi-directional print head with shortest distance sensing logic; parallel, RS232, or current loop interface; 600-character FIFO buffer storage (2,000 character buffer optional); adjustable width tractor paper feed with complete forms control, horizontal and vertical tabs, and 132, 158 or 176 columns; 10, 12, or 13.3 char./in. with either 6 or 8 lines/in. vertical spacing; underlining and double-width character; graphics mode (1X6 dot matrix); full ASCII character set; and long-life cartridge ribbon. The PM-LC11P desktop, dot matrix line printer, including PM-7258 parallel interface, and 25′ cable is $2307, OEM discounts available. Configurations are also available for the Q-bus and as a stand-alone. **Plessey Peripheral Systems,** 1691 Browning Ave, Irvine, CA 92714. **Circle 207**

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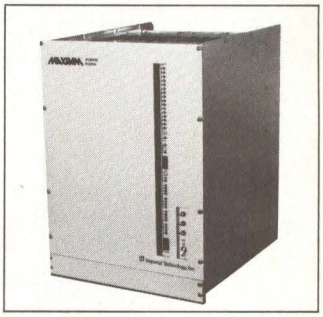

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Designers' Notebook

Varactor-Controlled Hybrid PLL Aids Micro-Winchester Disk Drives

Finis F. Conner
Shugart Technology,
360 El Pueblo Rd,
Scotts Valley, CA.

Data separators used in disk drive applications employing soft sectoring and MFM encoding usually consist of circuits to do: start logic, PLL, data separator, address mark detection. This low-cost PLL uses a varactor (hyperabrupt) tuning as the oscillator controlling element. Here are some considerations if you're scaling an existing circuit from one frequency to another or designing a circuit from scratch.

The oscillator is a series resonant circuit (CR_1, C_2, L_1 and C_3). The gain and feedback elements are Q_1, Z_1 and R_4. One major advantage of this oscillator is the ability to stop the oscillator (holding the frequency information),

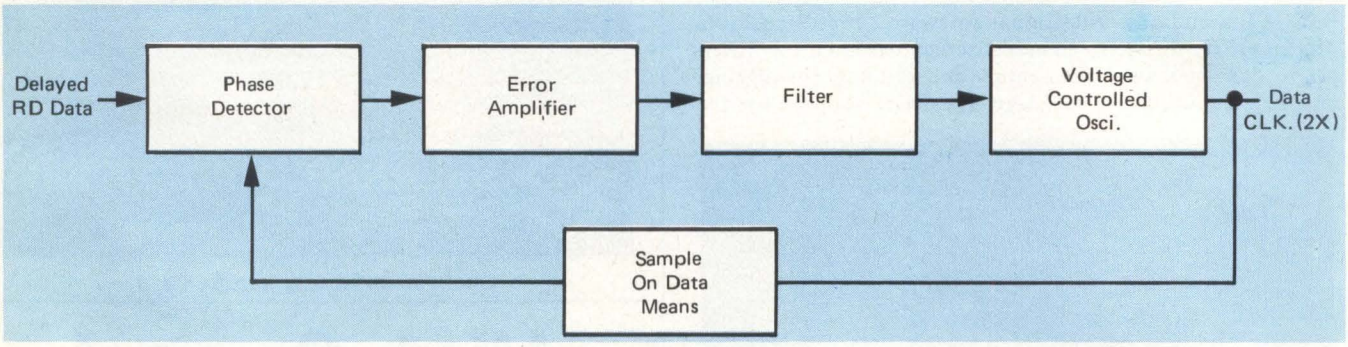

Fig 1 Block diagram of basic PLL.

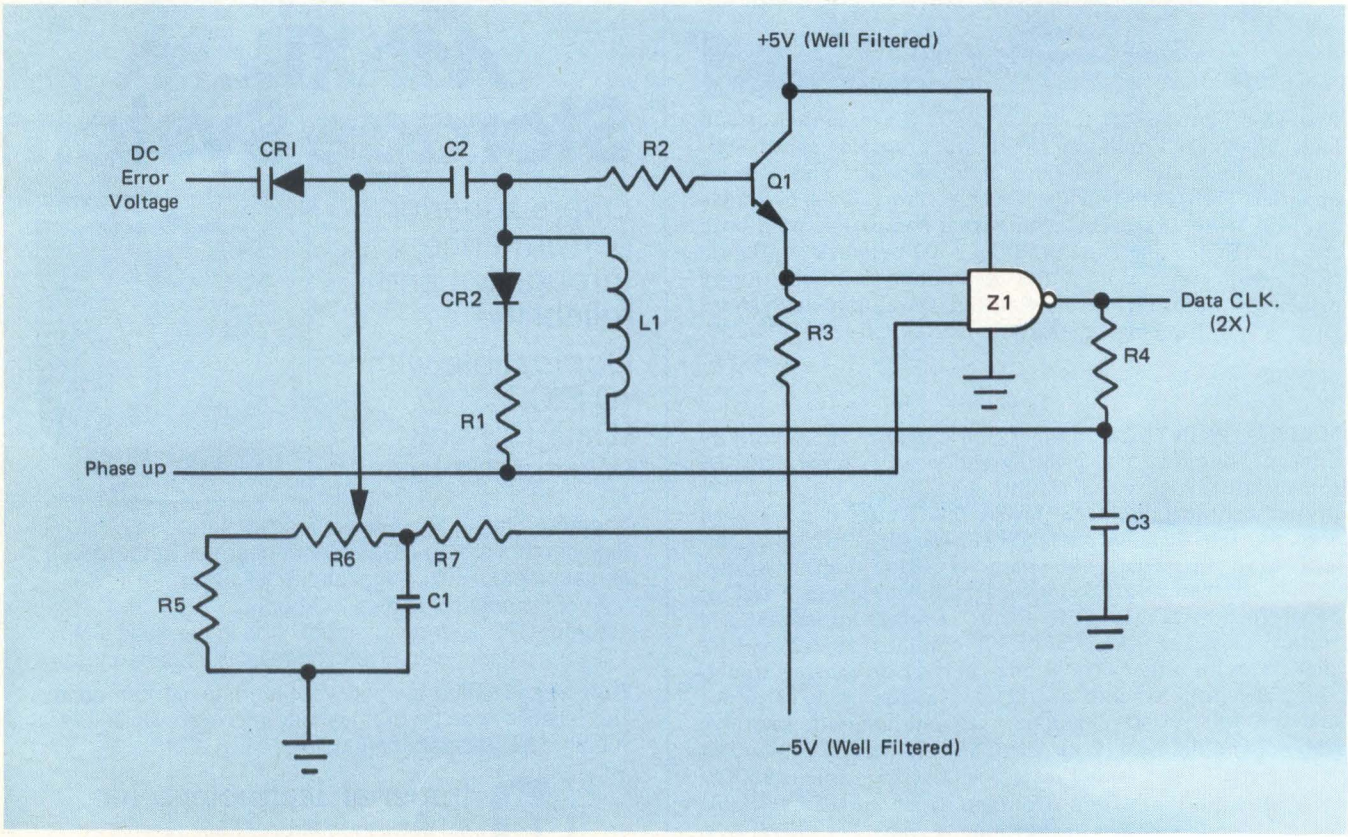

Fig 2 Voltage-controlled oscillator (CR1, C2, L1, C3) uses a varactor.

and then restart it with a known phase relationship to the gating signal. The circuit elements that accomplish phasing are R_1, CR_2 and one of the inputs to Z_1.

CR_1 is the varactor diode. Capacitance change is a function of applied voltage change (dC/dV) and is the controlling element of the oscillator output frequency. Care is a requisite when choosing the varactor, and the normal bias to be used, so that operation is maintained on the steep portion of the "diode capacitance vs. reverse voltage curve." In this application, DC ERROR VOLTAGE is designed nominally to be 0 Volts, and the nominal bias chosen is –3 V. To select a varactor, refer to the family of curves for a diode with nominal capacitance at –3 V bias equal to approximately two times the total capacitance (C_{tot}) required for the inductor chosen. Also, select a diode that has good linearity above and below the nominal operating bias (straight line dC/dV, and the steeper the better). In this example, the lower curve of the set represents a Motorola MV 1404 or a DSW Electronics KV 1502 (which are both similar). The Q of the varactor is important only in a negative sense. If the Q is significantly below 100 at the operating frequency then the effects must be included when modeling the circuit tolerancing ($Q = 1/R_S \times C_{varactor} \times 2\pi f$) so R_S should be $\leq 1\Omega$; –3 V bias). Finally, the temperature coefficient of the chosen varactor at the operating bias is important because the PLL will only acquire over a given range in the manner desired (phase acquisition only). As the varactor capacitance changes with temperature, a portion of the acquisition range is lost and inevitably some non-linearities of oscillator gain characteristics occur.

C_2 is used as a DC blocking capacitor only. As a general rule it is the most commonly used decoupling capacitor found on the board as long as it is 100 times greater than C_{tot} or more. L_1 is used to set the free running frequency for the oscillator. It is chosen for: $Q \geq 50$ at the operating frequency (OF), $Fr \geq 10$ times the OF, and magnetically shielded to minimize noise. C_3 completes the circuit and is selected so that C_{tot} equals the desired value.

An example using the Motorola MV 1404 for a disk drive with 5×10^6 bits/second transfer rate: $C_{varactor}$ at 3.5 V ≅ 58 pf; 3.0 V ≅ 76 pf; 2.5 V ≅ 94 pf. $F_{osc} = 2 \times$ Bit rate = 10 MHz. L_1 is chosen for resonance at 10 MHz with $C_{tot} < C_{varactor}$. Assume C_{tot} (3.0 V) = 60 pf. $L1 = (2\pi f)^2 \times 60\text{ pf})^{-1} \rightarrow 4.22\ \mu H$.

Keeping in mind the required Q and self resonant frequency goals, a Nytronics inductor mode: Wee – Wee –3.9 μH is chosen. SRF = 91 MHz. Q min. @ 7.9 MHz = 40. $C_{tot} = ((2\pi f)^2 \times 3.9\ \mu H)^{-1} = 65$ pf. $C2 = ((C_{tot})^{-1} - (C_{varactor})^{-1})^{-1} = 449$ pf → 470 pf.

The gain of the oscillator is calculated by first calculating C_{tot} for the three voltages, C_{tot}: 3.5 V = 51.63 pf; 3.0 V = 65.42 pf; 2.5 V = 78.33 pf. Fr: 3.5 V = 11.22 MHz; 3.0 V = 9.96 MHz; 2.5 V = 9.11 MHz. K_{osc} = (F(3.5 V) – F(2.5 V)) /1V = (2.11 MHz/V)/s.

The integration indicated in the denominator of the above equation (K_{osc}) arises because the gain is constant over each increment of frequency. Therefore, as the frequency increases, the gain as a proportion decreases at a slope of –6dB/octave. This circuit has been found to be effective, and it is time-proven in applications.

uC Controls Four-Phase Stepper Motor

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This digital circuit controls a 4-phase stepper motor using a software solution. At the time of our design, other hardware implementations existed to control a 4-phase stepper motor; but, because the added software would not cause the μC to be "compute-bound", we implemented stepper motor control in software. The function MOTOR sets up registers B, C and E with the half-step full-step flag, clockwise counter-clockwise flag and motor position index, respectively. These values are stored in R/W RAM and can be modified by the program that calls MOTOR. MOTOR then calls function MVMTR which requires as input the appropriate values in registers B, C and E as described above. MVMTR computes the next motor position index, which is a pointer to an element in a look-up table. Access to the look-up table provides the next motor pattern, which will cause the motor to move clockwise or counter-clockwise at half-step or full-step. MVMTR outputs are the next motor pattern in register A (low-

```
;
;*****************************************************************************
;
        TITLE   'MVMTR STEPPING MOTOR PROGRAM MOD 1.0'
;
;*****************************************************************************
;
        ORG     0000H
;
;*****************************************************************************
;
;FUNCTION:  MOTOR
;INPUTS:  NONE
;OUTPUTS:  NONE
;CALLS:  MVMTR
;DESTROYS:  A,B,C,E,H,L,F/F'S
;DESCRIPTION:  SETS UP REGISTERS USING RAM STORAGE TO
;              INDICATE HALF STEP OR FULL STEP, CW OR CCW AND CURRENT
;              MOTOR POSITION INDEX.  FUNCTION MVMTR IS CALLED TO
;              CALCULATE NEXT MOTOR POSITION INDEX AND MOTOR PATTERN.
;
MOTOR: LXI     H,MTRTB         ;POINT TO TOP OF THE DATA TABLE
                               ;FOR THE STEPPER MOTOR
       MOV     C,M             ;MOVE CW-CCW FLAG TO REG. C
       INX     H
       MOV     B,M             ;MOVE HALF STEP-FULL STEP FLAG TO REG. B
       INX     H
       MOV     E,M             ;MOVE MOTOR POSITION INDEX TO REG. E
       CALL    MVMTR           ;GET NEXT MOTOR PATTERN
       MOV     M,E             ;SAVE CURRENT MOTOR POSITION INDEX
       OUT     P8255           ;STEP STEPPER MOTOR
       RET
;
;*****************************************************************************
;
;FUNCTION:  MVMTR
;INPUTS:  B - HALF STEP = 1   FULL STEP = 2
;         C - CW = 0   CCW = 1
;         E - CURRENT MOTOR POSITION INDEX
;OUTPUTS:  A - NEXT MOTOR POSITION (LOWER NIBBLE)
;          E - NEW MOTOR POSITION INDEX
;CALLS:  NONE
;DESTROYS: A,E,F/F'S
;DESCRIPTION:  GIVEN HALF STEP OR FULL STEP, CW OR CCW, AND CURRENT
;              MOTOR POSITION INDEX; COMPUTES NEW MOTOR POSITION INDEX
;              WHICH IS USED IN COMPUTING THE APPROPRIATE ELEMENT IN
;              A LOOK UP TAPLE TO GIVE THE NEXT MOTOR POSITION
;
```

er nibble) and the new motor position index in register E. Function MOTOR then saves the motor position index in R/W RAM. The motor position is changed via the next motor pattern output to an 8255 PPI or equivalent. The appropriate driver circuit must be provided between the 8255 and the stepper motor windings.

A hardware version, using digital ICs, was designed by Vikram Mannja of India and published earlier in Digital Design. His four-phase stepper overcame the need for a separate start/stop switch and inhibit controls. Two independent step/jog controls provide less complexity and save two ICs. Clock generated by the timer is twice the frequency of the internal clock (INT CLK). This stepper motor was used in process control systems as a control drive. The input signals are direction control and digital pulses only, thereby overcoming the need of a DAC and other analog circuits. A simple 2-line-to-1-line multiplexer can be inserted at the dotted line to enable the user to select either internal or external clock and direction control.

```
MVMTR: PUSH    H               ;SAVE RP HL
       LXI     H,MPOS1         ;POINT TO TOP OF MOTOR POSITION LOOK UP
                               ;TABLE
       MOV     A,C             ;MOVE CW OR CCW TO REG A
       ORA     A               ;SET FLAGS
       MOV     A,E             ;MOVE CURRENT MOTOR POSITION INDEX TO REG A
       JZ      MVMT1           ;IF CW, THEN JUMP; OTHERWISE CCW, NO JUMP
       SUB     B               ;SUBTRACT STEP SIZE
       JMP     MVMT2
MVMT1: ADD     B               ;ADD STEP SIZE
MVMT2: ANI     07H             ;SAVE LOWER 3 BITS ONLY
       MOV     E,A             ;MOVE NEW MOTOR POSITION INDEX TO REG E
       ADD     L               ;ADD REG L TO A AND
       MOV     L,A             ;MOVE REG A TO L.  RP HL POINTS TO
                               ;NEXT MOTOR POSITION
       MOV     A,M             ;MOVE NEXT MOTOR POSITION TO REG A
       POP     H               ;RESTORE RP HL
       RET
;
;*************************************************************************
;
;MVMTR TABLE                   TABLE CANNOT CROSS A 256 BYTE BOUNDRY
;
MPOS1: DB      0AH             ;EIGHT-STEP (HALF-STEP) INPUT SEQUENCE FOR
MPOS2: DB      08H             ;STEPPER MOTOR.  ODD NUMBERS ARE
MPOS3: DB      09H             ;FULL STEP SEQUENCE.
MPOS4: DB      01H
MPOS5: DB      05H
MPOS6: DB      04H
MPOS7: DB      06H
MPOS8: DB      02H
;
;*************************************************************************
;
; STORAGE AREA
;
MTRTE:
CWCCW: DS      1               ;CW=0 CCW=1 DIRECTION DETERMINED BY
                               ;LOOKING FROM REAR OF STEPPER MOTOR
HSFS:  DS      1               ;HALF STEP = 1 FULL STEP = 2
MPI:   DS      1               ;MOTOR POSITION INDEX
       END
```

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