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ComputerCraft

THE PRACTICAL MAGAZINE FOR PERSONAL COMPUTERS & MICROCONTROLLERS

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Our Hard Drives are inittialized, partitioned and formatted. Each drive is then tested for integrity, to ensure you get a first class product! Included with your drive you get disk management as well as speed caching software. Also included are many other programs such as games, utilities and many others. You will have hours of enjoyment from your new hard drive and free software!

Model	Size	Brand	Speed	Dimension	Bare	XT/Tandy	16 Bit Kit
ST225	21M	Seagate	48ms	5.25	183.	224.	234.
ST125	21M	Seagate	28ms	3.5	224.	255.	265.
KL320	21M	Kalok	39ms	3.5	144.	196.	206.
ST238R	32M	Seagate	40ms	5.2	193.	237.	257.
ST138R	32M	Seagate	28ms	3.5	226.	254	278.
KL330	32M	Kalok	39ms	3.5	163	225.	234
ST251	42M	Seagate	28ms	5.25	245.	286.	295.
ST151	42M	Seagate	24ms	3.5	336.	367.	376.
SN2040	42M	Samsung	35ms	3.5	197	257	267
KL343	42M	Kalok	28ms	3.5	234.	N/A	254.
CP3044	42M	Conner	28ms	3.5	286.	N/A	315.
WD2044	42M	Western Digital	18ms	1.0	294.	N/A	325.
ST157R	48M	Seagate	28ms	3.5	266.	316	326.
ST157A	48M	Seagate	28ms	3.5	235.	N/A	287.
PT1357R	48M	PTI	28ms	3.5	257.	314	334.
MK134A	68M	Toshiba	22ms	3.5	307.	356.	375.
ST1277R	62M	Seagate	28ms	5.25	257.	304.	326.
MC8085	85M	Microscience	40ms	5.25	326.	387	424.
ST296N	85M	Seagate	28ms	5.25	317	356.	385.
ST1096N	85M	Seagate	28ms	3.5	394.	455.	486.
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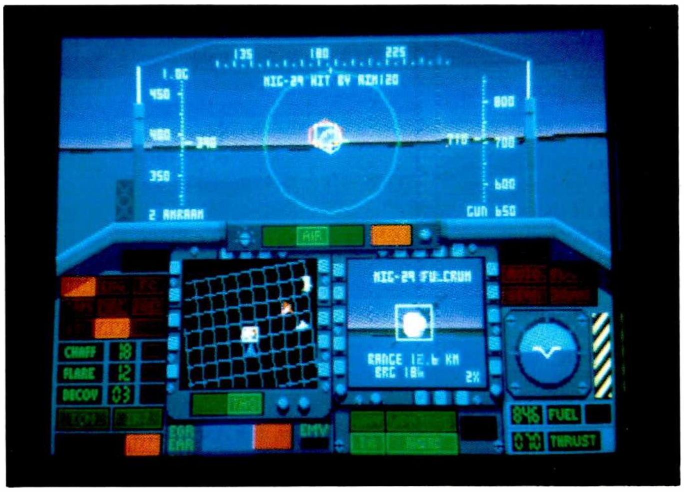
ComputerCraft

Volume 2, No. 5 May 1992



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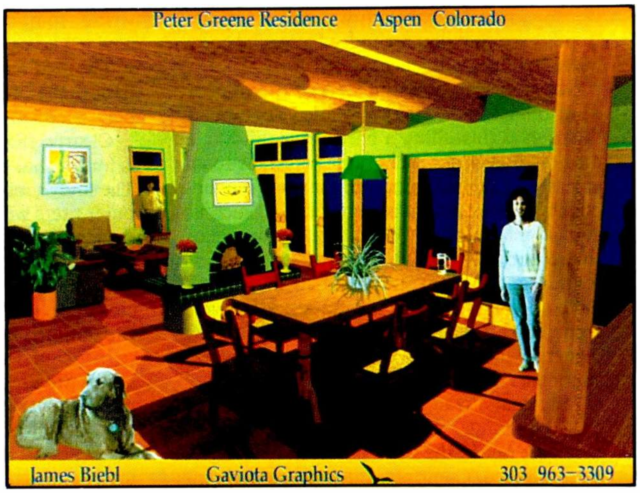

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ON THE COVER: Removable mass-storage SCSI cartridge drives can eliminate the problem of constantly running out of hard-disk space for storing applications and files. They also provide a convenient means for transporting files from one computer to another and for safeguarding data by storing the cartridges in a locked safe.

Reader Profile

Our recent readership study was very revealing. It indicated that you are indeed a special computer-involved audience.

Not surprisingly, some 87% of the respondents observed that they upgraded a computer themselves (installing a hard drive, adding a memory board, etc.). The same percentage own at least one PC, while most of the small remainder own other microcomputer types, such as Amiga or MacIntosh. What's more, two out of five respondents own a PC with a 386SX-or-better microprocessor, although half of you still have an AT (80286-CPU) model. However, some of the latter are had by multiple PC owners, who number about one-third of respondents.

Less than 4% of you personally own a 486-CPU computer, though a number of respondents use one in the work place. Interestingly, a StoreBoard/Computer Intelligence study indicates that about 3% of all PCs sold in 1991 were 486 types (386DX and SX machines led with about 58). As I expressed in my March editorial, I feel that the 486 is the way to go if you're planning to buy a new system, even if it's only a 486SX. Just be sure that your motherboard has a processor enhancement socket (Intel is pressing board makers to include one in their new board designs).

I know that when one lays out personal rather than corporate money, there's a tendency to stay safely behind the leading technical edge in order to reduce your outlay. For sound investment reasons, though, I'd advise you to weigh options carefully because the 50-MHz and faster 486DXs are coming up, not to mention the 586 microprocessor. With a 386, you won't easily be able to play catch-up without dumping costly entire boards. Although prices of 486DX 25-MHz computers have dropped dramatically, I'd hold out for a 33-MHz one.

Nearly one-fifth of PC owners who filled out our reader survey questionnaire already have non-impact printers (laser or ink-jet), while about one-third own a 24-pin model. I expect more and more of you will choose to own the former since selling prices have dropped considerably. Trading off speed for better output quality and lower operating noise will win the day, I believe.

VGA or SVGA video monitors dominate among our readers, with about 70% of you indicating you have one. It's obvious from computer system types cited on the survey that many of you upgraded your systems to this higher standard.

Given the technical orientation of *ComputerCraft*, it's natural that many readers carry a technical title in either the computer or electronics industry. Indeed, the study reveals that more than half do—engineers, technicians, programmers, LAN administrators, system developers, etc. Corporate executives, business owners, educators and students account for another quarter. And nearly 15% are computer resellers, professionals (physicians, accountants, etc.) or craftsmen (mostly plant electricians). The remainder bear such titles as CAD draftsmen, computer sales/service representative, technical writer, computer operator, armed forces, and a wide variety of others.

The median age of respondents is estimated to be in the late thirties, the largest group being between 35 and 44 years.

Clearly, the core of *ComputerCraft* readers is unlike that of most computer publications. The study substantiated that they're active computer users who open the cases of their equipment to improve or expand its operation and who constantly seek new ways to apply their PCs and microcontrollers at work and at home. How closely do you fit into the average reader profile outlined here?

In the software world, word-processing programs are used by most respondents, which is natural. But other applications are heavily used, too. More than half of you also employ telecommunications, database, spreadsheet and graphics packages, while computer-aided design (CAD) and Microsoft *Windows* are used by 41% and 40% of respondents, respectively. Desktop publishing, too, has a strong user base among our readers, with almost one-third of respondents using the software.

Most respondents said they are involved with computer languages, led by BASIC with nearly three-quarters. This is followed by assembly language with 45%, QuickBASIC with 37%, C with 35%, Turbo Pascal with 20% and C + + with about 15% of readers who do programming.

About three-fourths of respondents who use telecommunications software also subscribe to an on-line service, led by CompuServe with 39%. Prodigy follows with 30% and GEnie with 18%, Farther down are America Online with 12% and Delphi with 8%.

As we already know, the microcontroller field is increasingly popular among our readers. Approximately three out of five respondents indicate they use or plan to use a microcontroller or SBC, while nearly this number say the same for an EPROM programmer or emulator. Some 33% of you use test products, software or hardware, to repair computers. About 33% reported they were involved in computer networking.

Mail-order purchases represent the largest buying source, with three out of five respondents indicating this for hardware and a nearly equal number for software. About 15% noted they also purchase products from computer shows and swap meets. Extrapolating the study's results on computer buying plans for the next 12 months, the average reader is expected to spend $2,694 on hardware and software.

ComputerCraft readers are heavily involved with computers at their work, with better than two out of five in the study indicating they're employed in the computer or a related field. A similar number note that they are responsible for selecting computer equipment at their worksite, while another one-third report that they do this informally.

Art Salsberg

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LS33	.25	LS162	.45	LS348	.75
LS37	.24	LS163	.36	LS353	1.00
LS38	.24	LS164	.45	LS357	.80
LS42	.35	LS165	.60	LS363	.75
LS51	.15	LS166	.75	LS364	.75
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LS73	.33	LS173	.60	LS367	.35
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LS75	.25	LS175	.35	LS373	.50
LS83	.30	LS181	1.25	LS374	.45
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8228	1.75	8749	7.00
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8243	1.75	80286-8 PLCC	8.50
8250	2.95	80287-8	125.00
(16450)	6.50	80287-10	135.00
(16550)	13.00	V-20-10MHZ	6.50

SEND FOR FREE CATALOG! OVER 150 NEW ITEMS!

TERMS: (Unless specified elsewhere) Add $3.25 postage, we pay balance. Orders over $50.00 add 85¢ for insurance. No C.O.D. Texas Res. add 8¼% Tax. 90 Day Money Back Guarantee on all items. All items subject to prior sale. Prices subject to change without notice. Foreign order - US funds only. We cannot ship to Mexico or Puerto Rico. Countries other than Canada, add $9.00 shipping and handling.

CIRCLE NO. 54 ON FREE INFORMATION CARD

Michelangelo Virus Spreading. Discovered in mid-1991, the Michelangelo virus is said to have infected many products. Among them are Leading Edge Products, which shipped 6000 infected machines, and 600 demo disks from DaVinci Systems. The virus uses the same efficient replication process found in the Stoned virus, the most common one in the U.S. It presents no warning until triggered on March 6 of any year, when it overwrites the hard disk with random information found in memory. It infects master boot records of hard disks and boot sectors of floppy disks.

According to the National Computer Security Association, the virus occupies about 2K of memory when resident, decreasing what DOS reports as available memory by that amount. When resident in memory, any action that accesses a floppy disk via interrupt 13h will infect the disk. Some reports indicate that the virus misinterprets a 1.44M floppy's Disk Parameter Block, returning a message, "Invalid Media," when accessed again.

The virus is said to be easy to remove. Call NCSA at 717-258-1816 for free help in removing it and any other virus.

Multimedia Messaging. A software add-on developed by Bellcore Labs enables Internet users to send and receive high-quality pictures and sound bites. Called Metamail, it's being given free by Bellcore to subscribers to Internet, the information network widely used around the world by universities, national laboratories, and the like. Metamail is the first program to be run under a new proposed multimedia e-mail standard called MIME. The interactive program can be adapted to any computer that uses the UNIX operating system. Since pictures and sound take much more time on phone lines that text data, the system is presently efficient only for users of high-speed phone links, not the relatively slow modems employed with most PCs.

Jobs. The employment situation in the electronics industry remains steady, says Management Recruiters, Cleveland, OH search/recruitment specialists. Based on its 28th poll, nearly 80% of executives contacted said they either plan to increase or maintain their staff levels....According to Department of Labor numbers reported last September, however, the industry had lost 90,000 jobs. Only programming/software employment exhibited an increase, +8.9%, while total employment in other computer and electronics areas dropped 6.3%....JOBHUNT software by Scope International (704-535-0614; orders only, 1-800-843-5627) can assist job-seekers in a work search. It provides names, addresses, phone/fax numbers and brief company profiles of leading potential employers nationwide. It features search and display by region and/or job function in computer science, engineering and other fields. You can type a sample cover letter for a resume into the program's word processor and automatically mail-merge it with addresses you selected. It also prints mailing and return-address labels. JOBHUNT, for IBM/compatible computers, uses 256K RAM and comes with both 5-1/4" and 3-1/2" disks. $49.95 includes one free update.

Regarding CAD/CAM Employment

• I read your piece on CAD/CAM Employment in the "What's Happening!" section (January) and am interested in the National Association of CAD-CAM Operators. Could you provide me with the mailing address for this organization?

Ed Francisco
Salem, VA

NACO is located at 10801 Hammerly, Ste. 216, Houston, TX 77043; tel.: 713-932-8473.—Ed.

Work of Fiction

• This is to advise you that Lexmark [an IBM Alliance company] has withdrawn a radio ad that referred to a fictional "Needleman Report." We apologized to Ted Needleman for any misconceptions by listeners that the ad may have been referring to him personally. In no way was this the intended effect of the ad.

S. Brent Beckwith
Manager
Printer Market Development
Lexmark International, Inc.
Lexington, KY

Article Updates

• In "Experimenting With the Z8" (December 1991), the pinout for the 2K EEPROM/EPROM/RAM/NVRAM is incorrect. The correct pins and signal names are: pin 9 I/O1; pin 10, I/O2; pin 11, I/O3; pin 13, I/O4; pin 14, I/O5; pin 15, I/O6; pin 16, I/O7 and pin 17, I/O8.

Jan Axelson

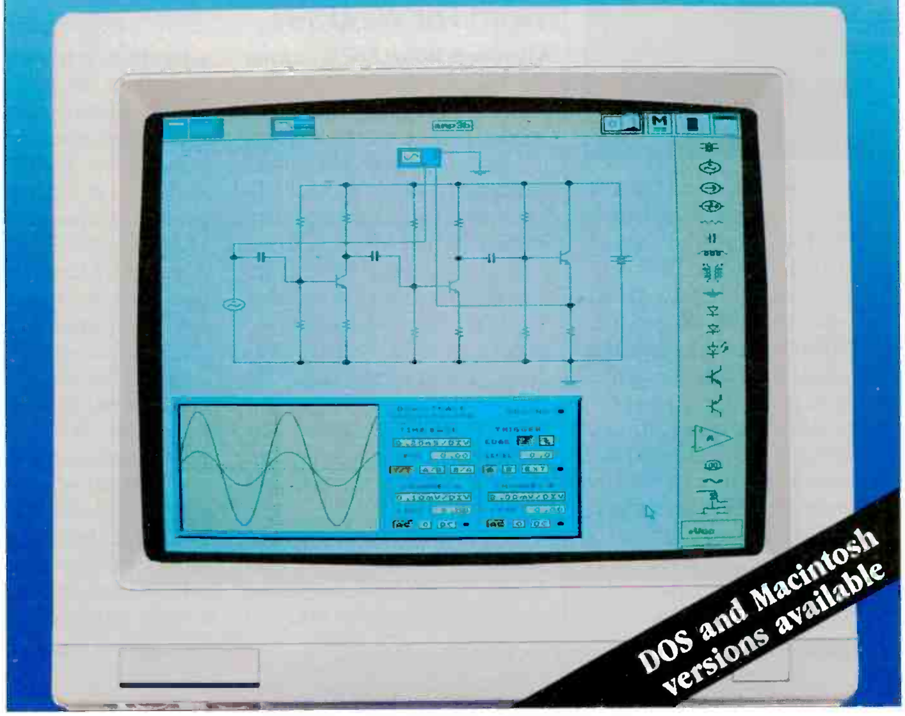
• In "Add Write-Protect Switches to PC Floppy Drives (March), the sentence in line seven, column three on page 50 should read: "Connect the + lead of your ohmmeter to the +5-volt red wire in the power cable and the other lead to terminal Z of switch Sa."

A.A. Mangieri

• The source (Magicland—see address below) for a ready-to-wire pc board for the MAG-11 SBC wasn't given in the March issue of *ComputerCraft*. Readers can obtain the following from this source: double-sided pc board, No. MAG-11BDb, with plated-through holes (includes Parts List, schematic and wiring and construction guides) for $25; partial kit, No. MAG-11PKT/b, consisting of pc board, all ICs that aren't optional (including choice of MAG-11DIAG or BUFFALO firmware in EPROM), 7.32K resistor, IC sockets, PC-compatible program disk (3½-inch or 5¼-inch diskette and documentation in three-ring binder for $65. For other MAG-11-related parts and kits, please write for details.

I also discovered an error in the pc guide for the MAG-11 in the March issue. It concerns the ground pin of *J6*, which is shown incorrectly connected to pin 20 of *U1*. There are several ways to fix this. (1) Leave position 4 of *S2* set to ON to ground the appropriate pins of *J6*, but bear in mind that doing this prevents the AN/D4 from being used for A/D conversion. (2) Cut the component-side trace from pin 19 of *J6* on the component side of the board and jumper from pin 20 of *J6* to the nearest ground. (3) On a single-sided board, simply move the jumper from its present position to ground. (4) modify the pc artwork in Fig. 7.

Tom Fox
Magicland
4380 S. Gordon Ave.
Fremont, MI 49412



What's New!

By Peter R. O'Dell

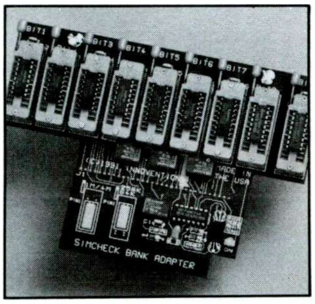
No-Slot Hard Drive

The Backpack hard-disk drive is the latest addition to the Backpack line of no-slot peripherals from Micro Solutions. The drive is easy to install. You just plug it into the parallel port and run the automatic installation program. It requires no interface card because data transfers go through the printer port. The drive has a printer port to enable a printer or another backpack to be attached. The Backpack hard drive works on all DOS versions 3.0 and later and isn't limited to 32M partitions under DOS 3.0. Two models are available: 40M at $625 and 100M at $795. *Micro Solutions, 132 W. Lincoln Hwy., DeKalb, IL 60115; tel.: 815-756-3411; fax, 815-756-2928.*

CIRCLE NO. 1 ON FREE CARD

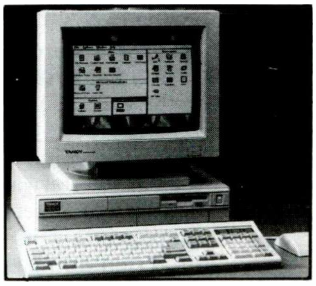
New SimCheck Adapters

Aristo Computers has a series of new adapters for the SimCheck Memory tester. They're for ZIP Memory chips, PLCC and SOJ memory chips, banks of up to nine individual DRAM chips and Apple Macintosh IIfx SIMMs. SimCheck tests all standard SIMMs and SIPs with eight or nine bits of 64K, 256K, 1M, 4M, or 16M. A two-line LCD display provides instructions and test results. Defective modules are analyzed to provide explicit fault indications, including identification of defective bits and open/short wiring problems. $995; adapters, $99 to $345. *Aristo Computers Inc., 6700 SW 105 Ave., Beaverton, OR 97005; tel.: 503-626-6333.*



CIRCLE NO. 2 ON FREE CARD

New Radio Shack Computer



The Tandy 2500 SX/25 HD, the latest offering from Radio Shack, features a 25-MHz 386SX with 2M of RAM (expandable to 16M), one 3½" drive, an 85M "Smartdrive" hard disk, on-board SVGA with 256K (expandable to 512K), eight-bit bi-directional sound circuitry, MS-DOS 5.0, *Windows* 3.0, three 16-bit ISA slots, mouse and keyboard. Built-in ports include serial, parallel, mouse, microphone and headphones. The 2500SX/25 also features automatic software upgrade for any new version of *Windows* released before June 30. There's also one 5¼" open bay in the low-profile 15½" × 15" × 4¼" case. Other versions are available as special order items from Radio Shack. $1,300. *Radio Shack, 700 One Tandy Center, Fort Worth, Texas 76102.*

CIRCLE NO. 3 ON FREE CARD

Fast SX Coprocessor

IIT has a new 33-MHz math coprocessor for fast 386SX-based computers. The IIT-3C87SX is targeted at high-performance portable computers and the growing 386SX desktop market. To serve the portable market, IIT offers the 3C87 coprocessors in space-saving PQFP packages. Like all its current products, the 33-MHz IIT-3C87SX carries a lifetime warranty and is guaranteed to provide 100% compatibility with 386SX systems and software. $199. *IIT, 2445 Mission College Blvd., Santa Clara, CA 95054; tel.: 408-727-1885; fax, 408-980-0432.*

CIRCLE NO. 4 ON FREE CARD

Phone-Usage Monitor

CALLCOST from CMP automatically tracks incoming and outgoing phone calls for professionals and small businesses. The CALLCOST package comes with a small hardware buffer box, software for a DOS computer, documentation and necessary cabling. Once connected, it stores information about phone activity on the line such as on-hook/off-hook status, numbers dialed, call duration and time/date of the call. The buffer box tracks and stores all phone activity whether the computer is on or not. Periodically, information in the buffer box can be easily uploaded to a PC using the CALLCOST software program. Phone data can be printed in a variety of report formats, to be used for client billing, corporate reimbursement or general business management. CALLCOST has a facility to set up a client database and account codes. Each package monitors activity on one or two phone lines. $289. *CMP Inc., 2150 W. 6 Ave., Unit N, Broomfield, CO 80020. tel.: 800-245-9933.*

CIRCLE NO. 6 ON FREE CARD

Word For Windows

Microsoft *Word For Windows* 2.0 focuses new features on making everyday word-processing tasks easier. The company made extensive use of its "Usability Lab" to identify tasks most often used and then minimized the effort to activate them. Most needed features are now found on the customizable Toolbar. Cut-and-paste is replaced with a "drag-and-drop" feature that greatly facilitates editing text. An automatic envelope generator lifts the address from a letter and places it in the proper position on an envelope.

Microsoft created a new visual Print Merge Helper that guides the user through the mail-merge process. You can select bullets from a palette of more than 100, including standard business bullets and more specialized symbols like hearts and arrows. *WFW* 2.0 comes with a new fully integrated grammar checker based on Houghton Mifflin technology. A new graphical File Finder lets you see long file names, the subject or content of a document before opening it.

WFW 2.0 simplifies the process of creating and manipulating tables. WordArt lets you manipulate text and fonts create special effects such as curved, rotated and even upside-down text. Columns can be activated instantly with a mouse. You can choose from a wide variety of borders and shading and present data in 3D charts, using the same charting capabilities as those of Microsoft *Excel*. A new drawing feature lets you create and enhance visuals for a document. A special on-line help facility is available for users who are familiar with *WordPerfect* 5.1.

WFW 2.0 requires *Windows* 3.0 or later, 286/386/486 based computer, 2M of RAM, EGA or greater-resolution monitor and 5M of hard-disk space for the minimum installation (maximum installation requires 15M!). $495, program; $129, upgrade. *Microsoft Corp., One Microsoft Way, Redmond, WA 98052-6399; tel.: 206-882-8080; fax: 206-883-8101.*

CIRCLE NO. 5 ON FREE CARD

UNICORN ELECTRONICS

10010 Canoga Ave., Unit B-8
Chatsworth, CA 91311

SINCE 1983 — YOUR I.C. SOURCE — AND MUCH MORE!!
NO SHIPPING CHARGES ON PRE-PAID ORDERS!*
NO CREDIT CARD SURCHARGE!
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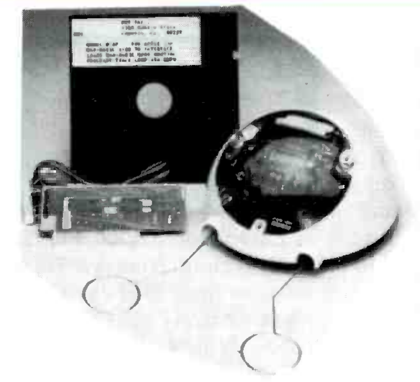
LASER DIODES

STOCK #	MFG.	WAVE-LENGTH	OUTPUT POWER	OPER. CURR.	OPER. VOLT.	1-24	25-99	100+
LS9220	TOSHIBA	660nm	3 mW	85 mA	2.5 V	129.99	123.49	111.14
LS9200	TOSHIBA	670nm	3 mW	85 mA	2.3 V	49.99	47.99	43.19
LS9201	TOSHIBA	670nm	5 mW	80 mA	2.4 V	59.99	56.99	51.29
LS9211	TOSHIBA	670nm	5 mW	50 mA	2.3 V	69.99	66.49	59.84
LS9215	TOSHIBA	670nm	10 mW	45 mA	2.4 V	109.99	104.49	94.04
LS3200	NEC	670nm	3 mW	85 mA	2.2 V	59.99	56.99	51.29
LS022	SHARP	780nm	5 mW	65 mA	1.75 V	19.99	18.99	17.09
SB1053	PHILLIPS	820nm	10 mW	90 mA	2.2 V	10.99	10.44	9.40

WAO II PROGRAMMABLE ROBOTIC KIT

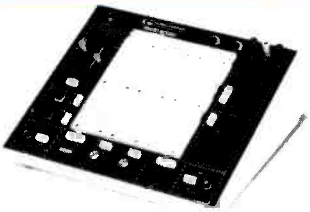


The pen mechanism included with the robot allows it to draw. In addition to drawing straight lines, it can also accurately draw circles, and even draw out words and short phrases. WAO II comes with 128 x 4 bits RAM and 2K ROM, and is programmed directly via the keypad attached to it. With its built-in connector port, WAO II is ready to communicate with your computer. With the optional interface kit, you can connect WAO II to an Apple II, IIe, or II+ computer. Editing and transfering of any movement program, as well as saving and loading a program can be performed by the interface kit. The kit includes software, cable, card, and instructions. The programming language is BASIC.

- Power Source - 3 AA batteries (not included)

STOCK #	DESCRIPTION	1-9	10-24	25+
MV961	*WAO II Programmable Robotic Kit*	79.99	75.99	68.39
WIIAP	*Interface Kit For Apple II, IIE, II+*	39.99	37.99	34.19

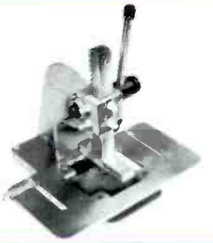
PROTOBOARD DESIGN STATION



- The total design workstation - including expanded instrumentation, breadboard and power supply.
- Ideal for analog, digital and microprocessor circuits
- 8 logic probe circuits
- Function generator with continuously variable size, square, triangle wave forms, plus TTL pulses
- Triple power supply offers fixed 5 VDC supply plus 2 variable outputs - +5 - 15 VDC and -5 - 15 VDC
- 8 TTL compatible LED indicators, switches
- Pulsers
- Potentiometers
- Audio experimentation speaker
- Multiple features in one complete test instrument saves hundreds of dollars needed for individual units
- Unlimited lifetime guarantee on breadboard sockets
- **Fixed DC output**
  +5 VDC @ 1.0 amp, ripple - 5 mV
- **Variable DC output**
  +5 - to +15 VDC @ 0.5 amp, ripple - 5 mV
- **Variable DC output**
  -5 - to -15 VDC @ 0.5 amp, ripple - 5 mV
- **Frequency generator**
  frequency range: 0.1 Hz to 100 KHz in 6 ranges
  output voltage: 0 to ± 10V (20 Vp-p)
  output impedance: 600 (except TTL)
  output current: 10mA max., short circuit protected
  output waveforms: sine, square, triange, TTL
  sine wave: distortion 3% (10 Hz to 100 KHz)
  TTL pulse: rise and fall time 25ns drive 20 TTL loads
  Square wave: rise and fall time ± 1.5 s
- **Logic indicators**
  8 LED's, active high, 1.4 volt (nominal) threshold, inputs protected to ± 20 volts
- **Debounced pushbuttons (pulsers)**
  2 push-button operated, open-collector output pulsers, each with 1 normally-open, 1 normally-closed output. Each output can sink up to 250 mA
- **Potentiometers**
  1 - 1K , 1 10K , all leads available and uncommitted
- **BNC connectors**
  2 BNC connectors pin available and uncommitted shell connected to ground
- **Speaker**
  0.25 W, 8
- **Breadboarding area**
  2520 uncommitted tie points
- **Dimensions**
  11.5" long x 16" wide x 6.5" high
- **Input**
  3 wire AC line input (117 V, 60 Hz typical)
- **Weight**
  7 lbs.

STOCK #	DESCRIPTION	1-9	10-24	25+
PB503	*Protoboard Design Station*	299.99	284.99	256.49

IDC BENCH ASSEMBLY PRESS



The Panavise PV505 1/4 ton manual IDC bench assembly press is a rugged, practical installation tool designed for low volume, mass termination of various IDC connectors on flat ribbon cable.

- Assembly base & standard platen included
- Base plate & platen may be rotated 90° for maximum versatility
- Base plates & cutting accessories are quickly changed without any tools required
- Additional accessories below
- Size - 10" W x 8.75" D x 9" H
- Weight - 5.5 lbs.

STOCK #	DESCRIPTION	1-9	10-24	25+
PV505	*Panavise Bench Assembly Press*	149.99	142.49	128.24

COLLIMATING LENS

This economical collimating lens assembly consists of a black anodized aluminum barrel that acts as a heat sink, and a glass lens with a focal point of 7.5 mm Designed to fit standard 9mm laser diodes, this assembly will fit all the above laser diodes. Simply place diode in the lens assembly, adjust beam to desired focus, then set with adhesive.

STOCK #	DESCRIPTION	1-9	10-24	25+
LSLENS	*Collimating Lens Assembly*	24.99	23.74	21.37

POWER SUPPLY

- Input: 115/230V
- Output: +5v @ 3.75A
  +12v @ 1.5A
  -12v @ .4A
- Size: 7" L x 5¼" W x 2½" H

STOCK #	PRICE
PS1003	$19.99

COLLIMATING PEN

A low power collimator pen containing a MOVPE grown gain GaAlAs laser. This collimator pen delivers a maximum CW output power of 2.5 mW at 820 nm.

The operating voltage of 2.2-2.5v @ 90-150mA is designed for lower power applications such as data retrieval, telemetry, alignment, etc.

The non-hermetic stainless steel case is specifically designed for easy alignment in an optical read or write system, and consists of a lens and a laser diode. The lens system collimates the diverging laser light .18 mrad The wavefront quality is diffraction limited.

The housing is circular and precision manufactured measuring 11.0 mm in diameter and 27.0 mm long. Data sheet included.

As with all special buy items, quantity is limited to stock on hand.

STOCK #	DESCRIPTION	1-9	10-24	25+
SB1052	*Infra-Red Collimator Pen*	49.99	47.49	42.74

DUAL MODE LASER POINTER

New slimline laser pointer is only ½" in diameter x 6¼" long and weighs under 2 oz., 670 nm @ less than 1 mW produces a 6 mm beam. 2 switches, one for continuous mode, and one for pulse mode (red dot flashes rapidly). 2 AAA batteries provide 8+ hours of use. 1 year warranty.

STOCK #	DESCRIPTION	1-9	10-24	25+
LP35	*Dual Mode Laser Pointer*	199.99	189 99	170.99

ROBOTIC ARM KIT

Robots were once confined to science fiction movies. Today, whether they're performing dangerous tasks or putting together complex products, robotics are finding their way into more and more industries. The Robotic Arm Kit is an educational kit that teaches basic robotic arm fundamentals as well as testing your own motor skills. Command it to perform simple tasks.

STOCK #	PRICE
YO1	$43.99

LASER DIODE MODULE

The LDM 135 integrated assembly consisting of a laser diode, collimating optics and drive electronics within a single compact housing. Produces a bright red dot at 660-685 nm It is supplied complete with leads for connection to a DC power supply from 3 to 5.25 V.

Though pre-set to produce a parallel beam, the focal length can readily be adjusted to focus the beam to a spot

Sturdy, small and self-contained, the LDM135 is a precision device designed for a wide range of applications 0.64" diam. x 2" long.

STOCK #	DESCRIPTION	1-9	10-24	25+
LDM135-.5	*5 mW Laser Diode Module*	179 99	170 99	153.89
LDM135-1	*1 mW Laser Diode Module*	189.99	180.49	162.44
LDM135-2	*2 mW Laser Diode Module*	199.99	189.99	170.99
LDM135-3	*3 mW Laser Diode Module*	209 99	199.49	179 54

He-Ne TUBES

New, tested 632nm He-Ne laser tubes ranging from .5mW to 3mW (our choice). Perfect for hobbyists for home projects. Because of the variety we purchase, we cannot guarantee specific outputs will be available at time of order. All units are new, tested, and guaranteed to function at manufacturers specifications.

STOCK #	DESCRIPTION	1-9	10-24	25+
LT1001	*He-He Laser Tube*	69.99	66.49	59.84

AVOIDER ROBOT KIT

An intelligent robot that knows how to avoid hitting walls. This robot emits an infra-red beam which detects an obstacle in front and then automatically turns left and continues on.

STOCK #	PRICE
MV912	$43.99

ORDER LINE — (800) 824-3432 • INTERNATIONAL ORDERS — (818) 341-8833
FAX ORDERS — (818) 998-7975 • TECHNICAL SUPPORT — (818) 341-8833

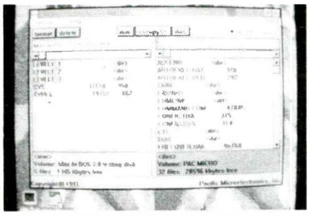
• 15.00 MINIMUM ORDER • UPS BLUE, RED & FEDERAL EXPRESS SHIPPING AVAILABLE • OPEN MON-FRI 9:00 AM - 6:00 PM, SAT 10:00 AM - 3:00 PM PDT • CA RESIDENTS ADD 8¼% SALES TAX • CALL FOR QUANTITY DISCOUNTS • CALL FOR FREE CATALOG (FOR 1ST CLASS DELIVERY OR CATALOGS DELIVERED OUTSIDE THE U.S. — SEND $2.00) • WE CARRY A COMPLETE LINE OF ELECTRONIC COMPONENTS

*NO SHIPPING CHARGES ON PRE-PAID ORDERS DELIVERED IN THE CONTINENTAL U.S.

CIRCLE NO. 140 ON FREE INFORMATION CARD

Windows/Macintosh File Transfer

The *Windows* version of Pacific Micro's *Mac-In-DOS* allows for transfer of Macintosh files to and from an IBM/compatible computer via the IBM floppy disk drive (1.44M only). The main screen of *Mac-In-DOS*



shows Mac files on one side and PC files on the other. Files are copied from one side to the other, with conversions taking place automatically. Function keys perform the main DOS file handling functions like changing of directories, deleting files and copying files. $99. *Pacific Micro, 201 San Antonio Circle, Mountain View, CA 94040; tel.: 415-948-6200; fax, 415-948-6296.*

CIRCLE NO. 7 ON FREE CARD

Shortest-Route Trip Plotting

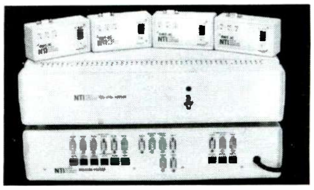
Sky Shepard Software has four new programs of interest for small businesses and individuals. *TRIP* and *PRO-TRIP* function as map/dispatching programs for travelers and businesses that want to route and track mileage. Users simply designate a starting and ending point, and *TRIP* plots the shortest route via interstates and major US highways. *TRIP*'s database contains 2,500 locations. *PRO-TRIP* features an expanded database with 7,000 locations. $60 for *TRIP*; $250 for *PRO-TRIP.*

Mailsaver is a sophisticated duplicate-elimination program for mailing lists. It finds phonetic as well as exact matches, common nickname matches, transposition errors, same-household/same-address records and same individual with multiple addresses. $395.

General Manager is a new sports card inventory program designed for serious collectors. The program generates 10 reports designed to help collectors quickly discover the value of their collections, total amount invested and percentage of increase or decrease in value. The program also incorporates scanning capability, making it possible for collectors to see a specific card on-screen. $50. *Sky Shepard Software, P.O. Box 49, St. Marys, IA 50240; tel.: 515-255-9300/800-397-0924.*

CIRCLE NO. 8 ON FREE CARD

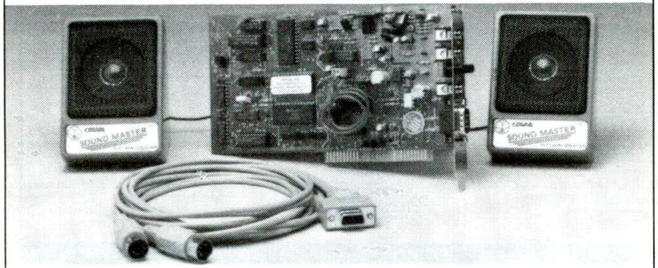
Console/Computer Switch

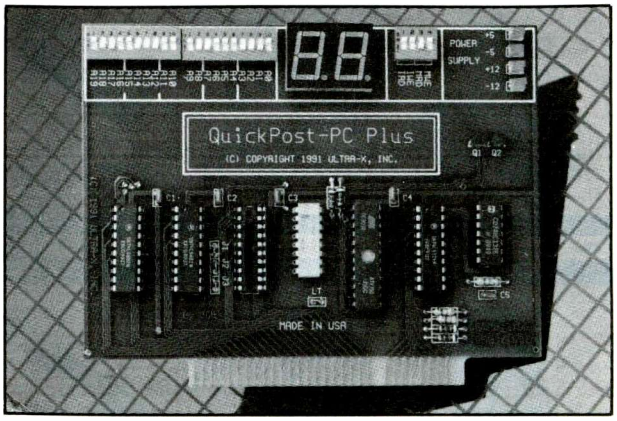


The SC-6X3-15V6M from Network Technologies is a six-console (keyboard and monitor)-by-three-computer matrix switch that permits up to six consoles to be connected to up to three computers. It supports VGA monitors and keyboards with six-pin mini-DIN connectors and operates remotely when the RMT-3C control unit is used with a console. The remote-control unit has a seven-segment display for showing what keyboard is connected to each computer. Only one keyboard can be attached to each computer at a time, but all six monitors can be connected to a single computer.

The SC-6X3-15V6M console switch is housed in a plastic case that measures 5.5″ × 11.5″ × 19″ and requires 117 or 220 volts ac. $2,700, switch; $105, remote. *Network Technologies Inc., 7322 Pettibone Road, Chagrin Falls, OH 44022; tel.: 216-543-1646; fax: 216-543-5423.*

CIRCLE NO. 9 ON FREE CARD





Learn to troubleshoot and service today's computer systems as you build a powerful 386sx/20 MHz computer!

NEW!
386sx/20 MHz
computer, 40 meg
hard drive!

Train the NRI way—and learn to service all computers as you build your own powerful West Coast 386sx/20 MHz computer, now with 1 meg RAM, 40 meg IDE hard drive, and exciting new diagnostic hardware and software!

Jobs for computer service technicians will almost double in the next 10 years according to Department of Labor statistics, making computer service one of the top growth fields in the nation.

Now you can cash in on this exciting opportunity—either as a full-time industry technician or in a computer service business of your own—once you've mastered electronics and computers the NRI way.

Get real-world skills as you train with and keep a powerful 386sx-based computer system plus Microsoft® Works software

Only NRI gives you hands-on training with the finest example of state-of-the-art technology: the powerful new West Coast 386sx/20 MHz computer. As you assemble this fully IBM PC/AT-compatible machine, you actually see for yourself how each section of your computer works.

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Your hands-on training continues as you install a powerful 40 meg IDE hard drive—today's most-wanted computer peripheral—now included in your course to dramatically increase your computer's data storage capacity while giving you lightning-quick data access.

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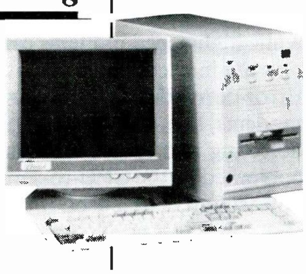

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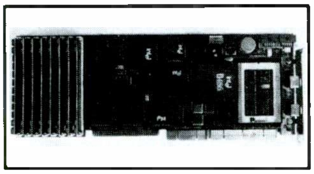
4-052

Single-Board EISA 486 CPU Card

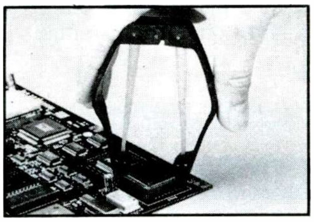
Diversified Technology's ESP-2000 i486-based EISA CPU card is designed for passive backplane architecture. Operating at 33 MHz, it incorporates Intel's 82350DT chip set and uses a CPU-to-memory protocol that allows the memory subsection to operate independently of the CPU clock for a smooth transition to 50-MHz operation. Up to 64M of system memory is supported via SIMMs. The card supports an optional Intel Turbo cache module (both 64K and 128K). The EISA-bus DMA channels can operate in both 8- and 16-bit modes with EISA/ISA bus slaves and masters and 32-bit mode with EISA slaves and masters. $2,595 (0K memory). *Diversified Technology, PO Box 748, Ridgeland, MS 39158-0748; tel.: 601-856-4121.*



CIRCLE NO. 10 ON FREE CARD

PLCC Extraction Tool

OK Industries has a new PLCC extraction tool for the SMT assembly and rework market. The EX-5 is designed for single-handed extraction of 20- to 84-pin PLCCs from any socket. The tool's spring-loaded one-hand design requires no pulling. By simply squeezing the handle, the EX-5 lifts the chip from the socket. It features ESD-safe plastic and metal construction for safety and durability. $20. *OK Industries, 4 Executive Plaza, Yonkers, NY 10701; tel.: 914-969-6800.*



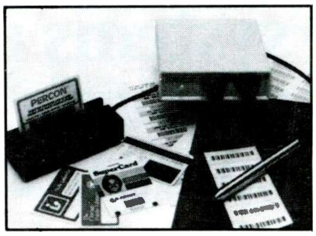
CIRCLE NO. 11 ON FREE CARD

Quick-Connect Barcode Reader

The newest model PERCON Series 20 Universal barcode and magnetic-stripe decoder uses quick-release front-panel jacks to connect any two barcode input devices at once. Barcode input devices offered by PERCON include a selection of wands, CCDs and laser scanners, plus ID-badge scanning heads. The sophisticated decoder automatically differentiates between input from two barcode devices and multiple magnetic-stripe readers, all of which can be connected at the same time.

Universal decoders permit programming parameters to be entered in any of four ways: downloading programming files in a batch mode, scan in from PERCON-supplied barcodes; scan in from user-printed Code 39 labels or set through an interactive on-screen menu. Percon Series 20 decoders provide for data input editing, auto-host recognition, full keyboard support and automatic detection among 13 different bar code symbologies. $735.

The PocketReader, also from PERCON, is a 12-ounce shirt-pocket-size portable barcode reader that includes up to 1M of memory, a *Windows* programming environment and the strength to withstand 5-foot drops onto concrete. PocketReader is easily programmed with PERCON *Program Generator* software. The standard wand tip is suitable for even marginal bar code labels and for narrow bar widths down to 0.007″ (7 mils). A 4-line × 16-character LCD display provides operator prompts and messages, and users can scroll through and review up to 24 lines of data held in an internal display buffer.



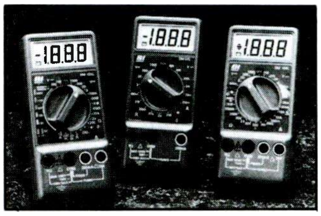
Nineteen splash-resistant keys enter both numeric and alpha data, and four user-programmable function keys are included. Audible feedback is provided through an adjustable-volume speaker. The decoder is compatible with a variety of data-collection networks and uses an RS-232C interface and flexible menu-driven communications protocols. $735, Series 20; $490, PocketReader. *PERCON, Inc., 1710 Willow Creek Circle, Ste. 37, Eugene, OR 97402-9153; tel.: 800-873-7266; fax: 503-344-1399.*

CIRCLE NO. 12 ON FREE CARD

Low-End DMMs

Beckman's new DM5XL joins the DM15XL and DM10XL in the company's line of low-end DMMs. The line features 0.7″ LCD numerals, 10-ampere current fusing, warning beeper when test leads are placed in the wrong input jacks, safety test leads with shrouded input plugs and test points and increased battery life.

Model DM10XL (replaces DM10) includes a continuity beeper and a "Safety Tester" feature. It detects and displays commonly encountered ac and dc potentials from 6 to 220 volts. This special safety feature works even when the DMM's battery is dead, ensuring that the user can always safely detect the presence of live voltage levels.

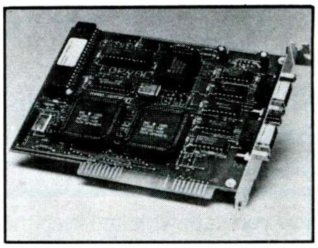


Model DM15XL (replaces DM15) has all features of the DM10XL and adds a logic measurement function that indicates the presence and polarity of TTL pulses up to 10 MHz in frequency. All three meters measure dc to 1,000 volts, ac to 750 volts and resistance, and all feature a diode-test continuity beeper. $35, DM5XL; $45, DM10XL; $60, DM15XL. *Beckman Industrial Corp., 3883 Ruffin Rd., San Diego, CA 92123-1898; tel.: 619-495-3200.*

CIRCLE NO. 13 ON FREE CARD

High-Speed Serial Card

The FORVAL Turbo Interface is a multi-purpose serial adapter card for PC communications. It is a proprietary high-speed, two-port, serial communication board in a half-card format. It can ensure data integrity at speeds up to and exceeding 114 Kbps. The Turbo Interface works with all vendors' high-speed serial peripherals to protect PCs against dropped data. The PC's ability to accept data from the serial port is the limiting factor in high-speed serial communications with limits of around 19 Kbps, while high-speed modems can operate in excess of 56K bps. Error-correcting transmission modems are not capable of detecting and correcting data corrupted by the CPU-to-serial-port link. The Turbo Interface solves this problem. $275.



Forval America, Inc., Modem Div., 28241 Crown Valley Pkwy., Suite F-440, Laguna Niquel, CA 92677; tel.: 714-347-0100; Fax: 714-347-0200.

CIRCLE NO. 14 ON FREE CARD

Hand-Scanner Image Stitcher

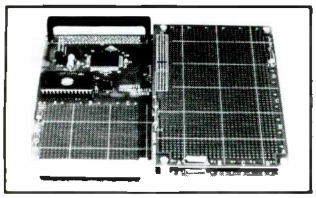
The *CAT Image Enhancer 256* software package gives you the ability to seamlessly combine two halves of one image to produce professional gray-scale-quality digital images. Additionally, it converts dithered hand scanners into true 256-gray-scale scanners. It also offers sophisticated control over contrast, brightness, aspect ra tio, cropping and more and automatically corrects images that are skewed, compressed or uneven in brightness.

The package includes procedures for customizing T-shirts and creating poster-size images. Automatic Contrast Control Enhancement (ACCE) automatically sets the upper and lower contrast limits for output. Format conversions for TIF, TIF 16 Gray, TIF 256 Gray, Pallet.TIF, PCX, CUT/PIC, GIF and BMP are included. The program supports Epson/IBM graphics, HP Inkjet and HP LaserJet printers. Scanners supported include GeniScan GS-2000 Plus/4000/4500/B105G, Logitech ScanMan/ScanMan Plus/ScanMan 32/ScanMan 256, Marstek Mars 105/105 Plus/800 Hand Scanner, Mouse Systems PageBrush/32 and numerous others. Minimum requirements are: VGA or SVGA, DOS 3.1 or later, 640K RAM and hard disk with at least 3M free (recommended). $129. *Computer Aided Technology, Inc., 10132 Monroe Dr., Dallas, TX 75229; tel.: 214-350-0888; fax: 214-904-0888.*

CIRCLE NO. 15 ON FREE CARD

SBus Interface Chip

Accurite Technologies has a new SBus interface IC and a corresponding eight-bit SBus developer's kit. Using the IC and kit, developers can save time and cost while maximizing efficient usage of printed-circuit board "real estate." It features a 32-bit SBus data path, eight-bit peripheral data path, up to 15M byte-per-second throughput, burst-mode data transfers and 13-bit buffered peripheral address lines that can be held or incremented with each byte transferred.

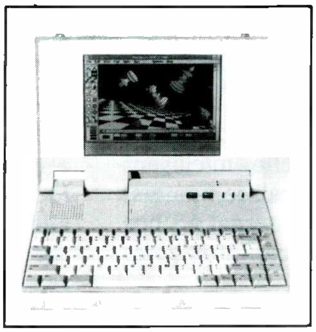


This highly integrated 100-pin PQFP IC package occupies 0.7 sq. in. of board area for its interface, compared to the approximately 29 devices needed for a simple PAL implementation. $695, developer's kit; $30, SBus IC. *Accurite Technologies, Inc., 231 Charcot Ave., San Jose, CA 95131-1107; tel.: 408-433-1980; fax: 408-433-1716.*

CIRCLE NO. 16 ON FREE CARD

Notebook Computers

Dauphin Technology is covering both ends of the notebook type-computer spectrum with its new 500 series notebook computers. The 500-88 is configured with an Intel 8088 microprocessor, 1M RAM, and a 3½" 1.4M drive. A 20M hard disk is optional. The Dauphin 500-SX features a 20-MHz 386SX, 1.4M floppy, 2M RAM, and either a 20M or 60M hard drive. Each unit includes a built in KeyMouse and weighs in at under seven pounds with battery. The case measures 11" × 8½" × 4". *Dauphin Technology Inc., 1125 E. St. charles Rd., Lombard, IL 60148; tel.: 708-627-4004; Fax: 708-627-7618.*



CIRCLE NO. 17 ON FREE CARD

Shareware From PC-SIG DOS Shareware Utilities

By Ed DiGiovanna

(Windcrest/McGraw-Hill. Soft cover. 204 pages. $29.95.)

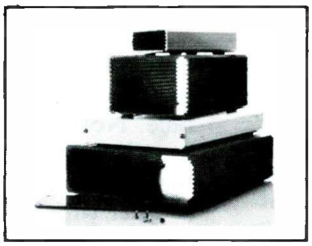
This book and disk package presents an easy-to-read, easy-to-understand description of 18 of the more popular DOS utilities offered as shareware by PC-SIG. A handful of the utilities covered are included as evaluation copies on a 360K disk included with the package.

The utilities are divided into seven chapters, covering memory management, disk utilities, graphics, user interface, catastrophe insurance and printer utilities. Each covers several utilities falling into the category. Enough information is included to allow the reader to "get a feel" for how the program works.

The author also includes registration information for each program. Among the programs detailed, Reconfig permits storing several different configurations of your AUTOEXEC.BAT and CONFIG.SYS files for selection during boot-up; OnSide is a "sideways" printing utility for spreadsheets and similar programs; VMS40 is a utility that uses disk space to emulate EMS; CMOS-RAM is a utility that reads and stores setup data from an AT-class computer for simplified reconfiguration when the backup battery fails; Zip is a compression utility; and Viruscan covers virus detection and removal. But with details on how to use programs that you don't have, the book is in part self-promotional, with software order forms included. As such, its value would be limited to novices who want to get insight into a variety of program types available as shareware (and regular commercial equivalents).

Electronics Enclosure

Extrusion Technology has a new line of extruded aluminum enclosures that are suitable for prototyping, beta testing, and full production. Tech-Box is available in four sizes ranging from 3" × 1" to 6" × 2½". Boxes are available with circuit card slots for card widths of 3.00" to 6½". Numerous off-the-shelf lengths are available as are custom lengths from ½" to 12'. The boxes are supplied with matching panels containing custom hole patterns and a choice of finishes. $5.15 and up. *Extrusion Technology, 80 Trim Way, Randolph, MA 02368; tel.: 617-963-7200; fax: 617-963-7203.*



CIRCLE NO. 18 ON FREE CARD

Cross Assemblers

Logisoft has a new line of DOS-compatible Professional Optimized Cross-Assemblers written in assembly language, resulting in fast assembly. Powerful two-pass relocatable macro assemblers and absolute version are available. Relocatable assembler packages feature a two-pass Linker to resolve forward references between modules. The linker can handle an unlimited number of modules. An independent "Locate" utility allows you to relocate without relinking. All packages include an object code format conversion utility, to provide system compatibility.

Cross-assemblers are available for 8051, 8048, 8080/85, 68000, 6800, 6805, 6809, 68HC11, 6301/03, 6502/65C02, Z80/180, 9900 and other compatible manufacturers' families of microprocsessors and microcontrollers. $99 and up. *Logisoft, PO Box 61929, Sunnyvale, CA 94086; tel.: 408-773-8465; fax: 408-773-8466.*

CIRCLE NO. 19 ON FREE CARD

(continued on page 83)

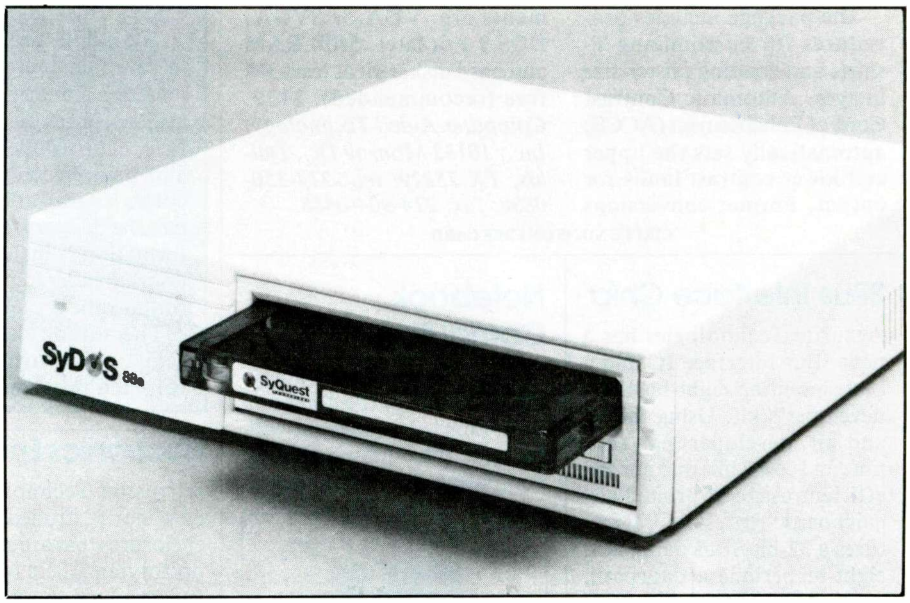
Removable Mass-Storage SCSI Cartridge Drives

Relieves the perennial problem of running out of hard-disk space

Even after purchasing that 200M hard drive you've been wanting for a long time, why is it that the total amount of your file space always exceeds the capacity of your hard drive? If you find yourself in this dilemma often and have given up on compression software and floppy disks, look into virtual mass storage. Combining an efficient SCSI (Small Computer Systems Interface) host adapter, pronounced "scuzzy," with a removable disk cartridge drive may change your view of personal computing.

With virtual mass storage you'll no longer fret and fuss, spending long hours backing up files on floppy disks. Nor will you constantly sort through and decompress files on floppies or hard drives. Adopting removable mass storage can lower your level of frustration and increase your efficiency and organization, and an added benefit is that you'll establish sound data security.

Installing a SyDOS Removable Cartridge Drive kit may be your easiest option in this area, though it isn't likely to be the least-expensive way to go. SyQuest drives—the basic cartridge drive units—are readily available from distributors and retailers, as are SCSI host bus adapters (HBAs). SyDOS and several other vendors offer this basic drive unit bundled with an SCSI host adapter, cables, software and documentation.



SCSI Defined

Before we get into the mechanics of installing a removable cartridge drive kit in your computer, it's a good idea for you to become acquainted with the world of SCSI. Basically, SCSI is a standard bus for connecting intelligent peripheral devices to small computers. It isn't the same as the internal AT bus over which the CPU communicates with memory.

Shown in Fig. 1 is a comparison of systems that use an SCSI system-level interface and ST506 device-level interface. Notice that ST506 functions found on the controller are located on the intelligent SCSI device. An SCSI adapter with its own BIOS provides the interface with the CPU and RAM. Thus, the intelligence of peripheral operations is moved from the CPU to the peripherals.

Of the two electrical (pin-assignment) options available, the single-ended driver/receiver option depicted in Fig. 2 is the more common. The differential driver/receiver is the other option. The asynchronous protocol, similar to the IEEE-488 bus used by Hewlett-Packard, has a nine-bit parallel bus, handshake protocol using the I/O signal line (direction signal), request (REQ) and acknowledge (ACK). Each command or data byte transferred uses these signals. Detailed information on this standard is contained in the "Small Computer System Interface" published by and available from the American National Standards Institute.

Several Drive Options

SyQuest drives come in 44M and 88M versions. SyDOS, a division of SyQuest, offers drives of both capacities as internal and external upgrade kits. It also offers a dual-drive external unit for these two storage capacities. Several other third-party vendors offer similar configurations.

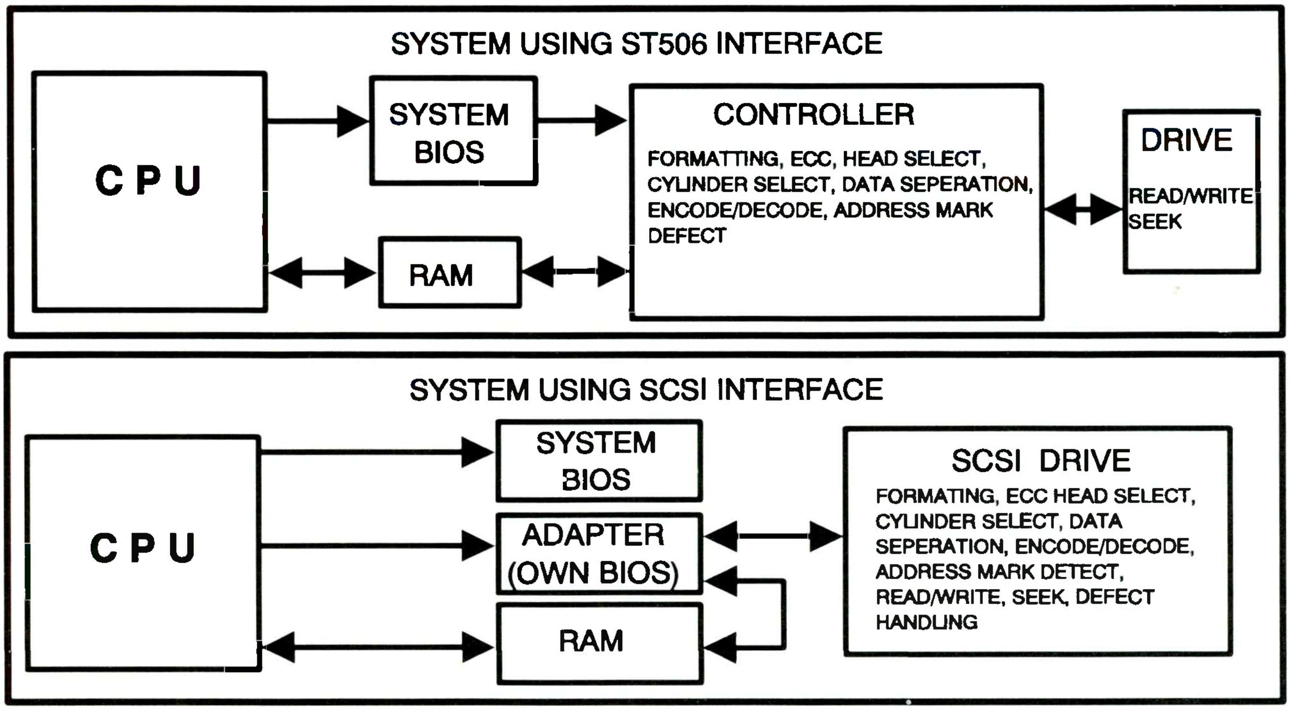


Fig. 1. An SCSI bus moves the intelligence from CPU to SCSI device. This device-independence offers flexibility by not requiring additional controllers when adding new devices.

Giving up some of this pre-packaged convenience to save a few hundred dollars, you'll find several alternative solutions. However, none is as convenient, flexible and affordable as the combination of a 16-bit Always Technology IN2000 SCSI host adapter with a SyQuest Removable Cartridge Disk Drive.

Street prices vary, but you can set up a 44M drive for well under $600 or an 88M unit for less than $800. Cartridges sell for as little as $69 for 44M (SQ400) and $119 for 88M (SQ800) units. If you decide on a single 44M drive, an eight-bit adapter can save you another $100. Thus, you have two basic installation options—third-party kits and purchasing a drive and adapter separately.

I installed a SyDOS 88e (the drive kit numbers have an "e" suffix for external and an "i" suffix for internal units) and a SyQuest SQ555 (44M internal) in two '386 computers. One computer is a run-of-the-mill clone housed in a standard AT case; the other is a Northgate Slimline computer. The former had a 200M SCSI hard drive, the latter a 120M IDE drive. Both installation options took less than an hour to complete, including reading directions.

SyDOS Installation

The SyDOS 88e kit comes complete with everything needed for successful installation. In addition to the SCSI host adapter card, cartridge drive, one cartridge and 50-pin Centronics cable, SyDOS provides utility software for diagnosis, cartridge formatting and *Super PC-Kwik* disk caching.

Installation consists of just four almost-foolproof steps, as follows:

(1) Using the SYPREP utility, you obtain a drive table that provides a ROM map of addresses for existing devices. Most address conflicts can be determined using this utility, allowing you to set jumpers on the host adapter to resolve any conflicts.

The host adapter is compatible with most standard hard-disk controllers, including ST506/412, IDE, ESDI and, of course, SCSI. I had a problem with a DTC RLL controller card in a 286 and was unable to rectify the conflict. If you run into a problem with any of the few 16-bit VGA cards that do cause conflicts, you can give SyDOS technical support a call at 800-43SYDOS to obtain a list of recommended cards.

When running SYPREP, you have the option of installing the SYDRIVER.SYS device driver and updating you CONFIG.SYS file. If you prefer to do this yourself, copy the driver to an appropriate directory and add "device=x: \ x \ SYDRIVER.SYS" to your CONFIG.SYS file.

(2) Next, power down your system and disconnect all power sources. Then remove the cover from the system unit and locate an available 16-bit expansion slot. Remove the cover plate from the rear access panel for this slot, and plug the Adaptec 1540 SCSI host adapter into the slot. This done, secure the adapter with the bracket-retainer screw and replace the cover on the system unit.

(3) Connect the external drive to the adapter via the Centronics cable. If you're installing a single drive (only one SCSI device), set the SCSI ID number to 0 (read the "recession option" for more details on SCSI ID). Power up your system and cartridge drive, reboot, and you're in business.

(4) You'll need to format a cartridge using SYPREP or DOS FORMAT, the difference being that SYPREP copies the device driver to the cartridge if you decide to format it as a bootable disk. You can make this your boot drive, which is very convenient if you run under multiple environments,

such as DOS, OS/2, *Windows*, UNIX or any unique configurations of any one of these.

Installing an internal unit is exactly the same, with the exception that you need a 5¼" half-height bay in which to physically mount the drive, a 5-volt connection and an internal SCSI cable. Install internal units just as you would a floppy-disk drive. Make sure you get a 50-pin SCSI cable when you purchase the drive or adapter, since such cables can be hard to find.

If you install two or more drives internally or externally, you must "daisy-chain" them. This requires a cable with a 50-pin connector for each additional drive.

Recession Option

If you have more time than money, installing individual components offers real savings. You can save $200 or more by going this route.

The IN2000 SCSI adapter provides excellent performance. Like the Adaptec 1540, it'll handle up to seven SCSI peripherals, including tape drives, CD-ROMs and scanners in a daisy-chain scheme. Additionally, this device supports two floppy drives, as does the Adaptec 1542B adapter.

When you daisy-chain several devices, you must assign logical device numbers from 0 to 7. These ID numbers have no effect on non-SCSI device numbers used by your computer (the ones established in your CMOS Setup procedure). External units provide a convenient pushbutton switch on the back of their cases for selecting ID numbers. Internal drives require you to place a jumper plug over the proper pins at the rear of the drive. SyDOS and SyQuest documentation provides clear illustrations for this procedure.

You must also install terminator resistors in the last logical drive and on the adapter. These resistors are supplied with these devices. If you install more than one device, remove the resistor packs from all logical drives, except the last one.

Installation of a SyQuest drive and IN2000 adapter is identical to that for the SyDOS kits. Just make sure you have all components: SyQuest drive unit (44M SQ555 or 88M SQ5110) with rail kit or external power supply with case, adapter card and internal or external cables. Don't forget the cartridge, SYPREP software and device driver. If you connect an external drive to the IN2000 adapter, the cable must have 25-pin (DB-25) and 50-pin Centronics interface connectors.

Performance

Moving data at 5M/s, these SCSI cards kick sand in the face of standard hard-drive interfaces. Of course, the AT bus can't move this fast, and few ESDI or SCSI hard drives reach half this speed; most transfer at around 1M/s. Depending on block size, the cartridge drives will perform at only about 600K to 800K/s, and transfer speed can be as low as 300K/s for small block sizes.

These cartridge drives maintain respectable average seek times of 20 ms, which compare favorably to many hard drives. Effective seek times are even better. Overall, the performance of these drives seems like lightning compared to floppy drives, but it's somewhat sluggish when compared to ESDI and SCSI hard drives.

Reliability, Security & Mobility

The 44M and 88M drives have an MTBF (mean time before failure) of 30,000 and 60,000 power-on hours, respectively. My two years of experience with the cartridges have been without a single problem (the drives carry a five-year warranty).

Since the cartridges aren't hermetically sealed, they can be subject to dust contamination. Taking a brave step a year ago, I tossed a cartridge through the air—data and all—across a 12-foot room to have it land on a carpeted floor. I certainly don't recommend that you attempt this. I was just trying to ascertain if the cartridge could survive such rough handling. It did.

Another point to consider is compatibility between the two formats, as well as with the Apple Macintosh. The SQ5110 (88e/i) reads only 44M car-

SCSI 50-Way Bus Single-Ended Pin Assignments

SIGNAL LINE	PIN	GROUND RETURN PIN	SIGNAL NAME
-DB(0)	2	1	DATA BUS
-DB(1)	4	3	
-DB(2)	6	5	
-DB(3)	8	7	
-DB(4)	10	9	
-DB(5)	12	11	
-DB(6)	14	13	
-DB(7)	16	15	
-DB(P)	18	17	DATA BUS PARITY
GROUND	20	19	
GROUND	22	21	
GROUND	24	23	
TERMPWR	26	25	TERMINATOR POWER
GROUND	28	27	
GROUND	30	29	
-ATN	32	31	ATTENTION
SPARE (GROUND)	34	33	
-BSY	36	35	BUSY
-ACK	38	37	ACKNOWLEDGE
-RST	40	39	RESET
-MSG	42	41	MESSAGE
-SEL	44	43	SELECT
-C/D	46	45	CONTROL/DATA
-REQ	48	47	REQUEST
-I/0	50	49	INPUT/OUTPUT

Fig. 2. Pin 25 should be left open, while all other odd pins should be connected to ground. A minus sign indicates active low.

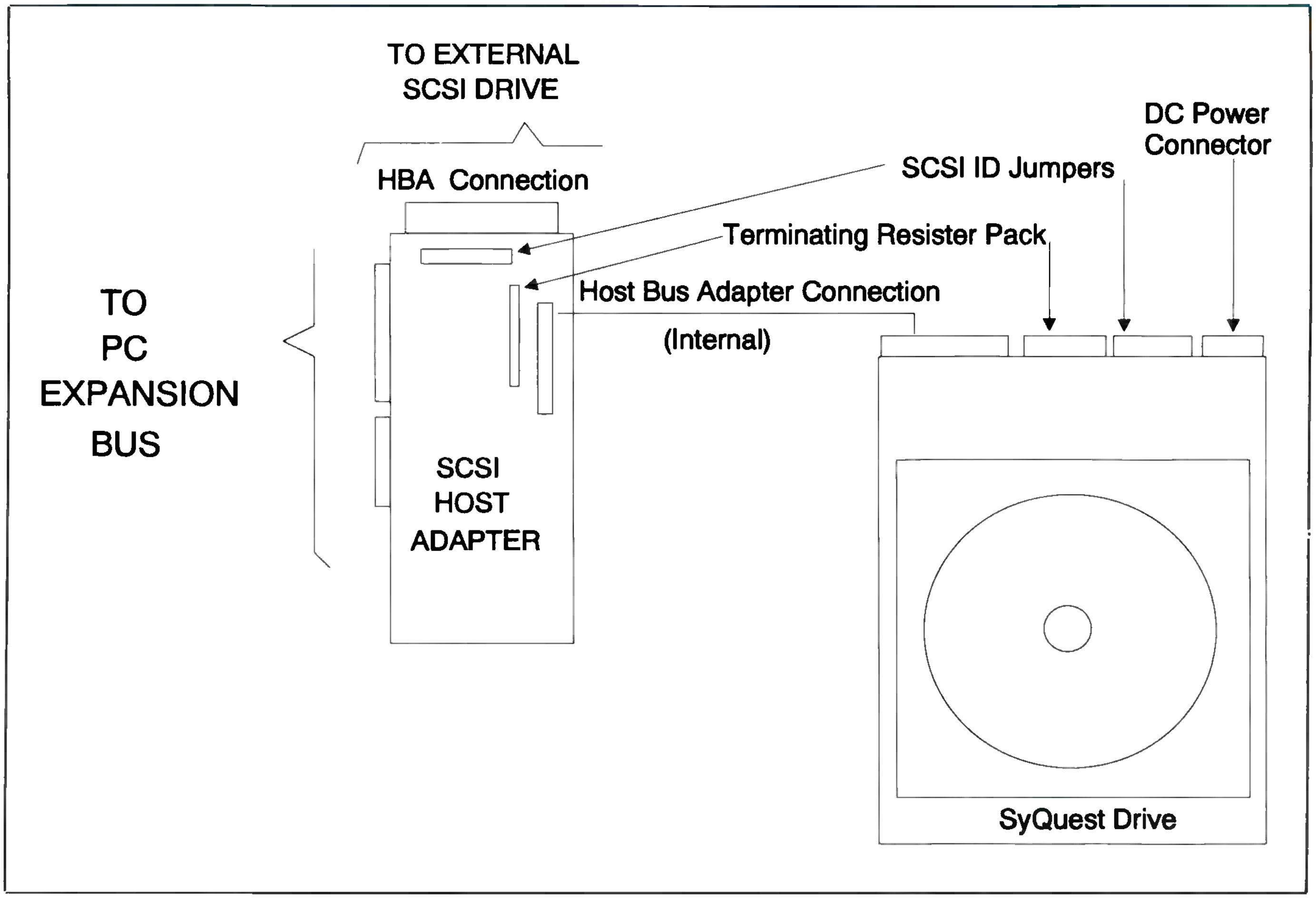


Fig. 3. Installation requires a 16-bit slot for the SCSI host adapter and a 5¼″ half- height bay for an internal SyQuest drive.

tridges. The drives used for the PC and Mac are identical. In fact, I can plug the same drives I installed in my PC compatibles into the SCSI port on a Mac. Of course, for the Mac to read from and write to the cartridges, they must be formatted for the Mac environment. Thus, these drives offer a great deal of flexibility.

When you consider the ability to easily remove a cartridge that contains important data or a backup of your hard disk and keep it secure in a vault or other safe place, the extra cost compared to a conventional hard drive is easy to rationalize.

If you can't be without a laptop computer, SyDOS has announced a new parallel-to-SCSI adapter to meet your needs.

The ease-of-use, straightforward installation and affordable price of a SyQuest removable cartridge drive makes this an option worth considering when you're faced with not enough hard-drive space for all your applications and utility software. Because the cartridges are removable and you can buy extra ones at any time, you can easily back up your hard disk in a convenient manner.

Another benefit of using removable cartridge drives is the ability they give you to organize your work area for better efficiency. Using separate cartridges, you can group together related applications on separate cartridges so that all the applications you need at a session can be "on-line" when you need them. For example, if you're into DTP, you can place on one cartridge desktop-publishing, font-generating, clip art-library and word-processing packages. On another cartridge, you can have your paint and draw programs. On yet another cartridge, you can have all the software you need for desktop video, and on still another cartridge you can have the different types of CAD programs you routinely use. Needless to say, the possibilities are limitless. ■

Names & Addresses

SyDOS 44i, $799
SyDOS 44e, $1,039
SyDOS 88i, $1,439
SyDOS 88e $1,539
SyDOS
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Memory Management

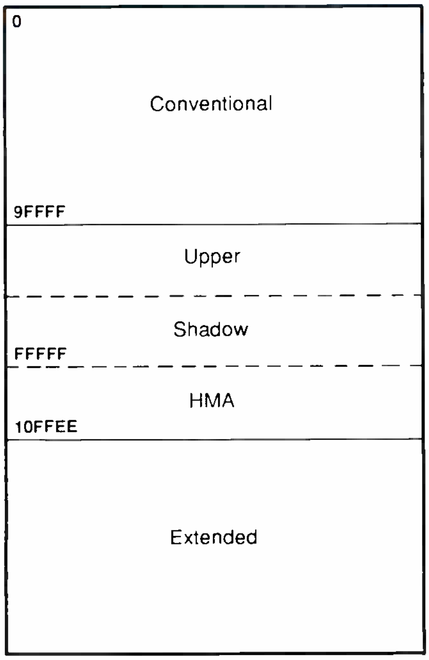
Part 1

Techniques that fit large programs into the user RAM from 0 to 640K by moving as many resources as possible into high memory beyond 1M

Your personal computer is clever enough to work all of its tricks in only one relatively small corner of its brain. In earlier days, there was one memory area in which it would put all the programs you run (your applications), all your pop-up utilities (resident programs) and all operating-system extensions (installable device drivers). A later strategy for increasing the computer's performance is to conserve that speck of memory for running only the code that can't go anywhere else: your applications. To do this, all drivers and resident programs must be put into areas where they won't bump into each other, but where they're conveniently accessible when needed.

This takes memory management. If you're planning to buy many new applications for your personal computer, you'll also need to get a utility or operating system that can manage every byte, bit and ephemeral wisp of memory you've got. Otherwise, your spiffy new applications may run not very well, or not at all. You'll likely use a memory manager because with today's powerful programs, you can't just squeeze everything into the 640K memory box allotted to you.

What is memory management? It's the technique whereby vastly overambitious programs are fit into the grossly inadequate random-access memory (RAM) resources available on commodity personal computers. This constant directly results from structural constraints imposed by both the Intel processor family (the 8086 and 80X86 chips used in IBM/compatible microcomputers) and the Disk Operating System (DOS) that was designed and built within its confines.



Hardware Model 1. 80286 with Chips & Technologies ChipSet, Compaq TOPS384, Micronics, Trillion, etc. This is the first of eight such memory models. Find the model that corresponds to your hardware configuration. The corresponding memory maps will help you determine how to configure the memory in your computer.

All DOS memory-management techniques and products are basically kludges that have been developed to overcome the limitations inherent in personal computers. In short, it's a wonder that the whole thing works at all. But it does—sometimes, it does so rather well.

Knowing how memory managers work is, fortunately, not a requirement. However, you'll be better able to select from among management utilities, and get much more out of one, if you're familiar with their abilities. It helps to know about your computer, too: its memory and limitations, the memory services a manager can make available with it and which programs work with each.

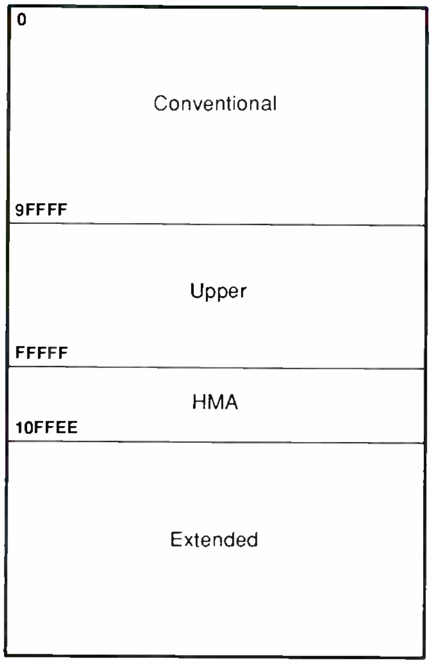
This month, we focus on the various means for efficiently managing memory. Next month, we'll conclude with descriptions of Microsoft MS-DOS 5.0 and Digital Research DR DOS 6.0 and review a variety of products that improve upon the basic resources included in these two operating systems.

Processors

While Intel microprocessors are ultimately responsible for most of our memory-management headaches, problems vary with the specific chip used in a given computer. Early ones defined a troublesome nonlinear address space. Later chips maintained the ability to confound and befuddle us, mostly to ensure compatibility with software designed for earlier ones. But later chips also have advanced features that new operating systems and memory managers can use to advantage.

The 8086 (and 80186, 8088, 80188, NEC V20 and V30 variations) is the dull sibling to which all the other chips in the Intel family must conform, and the one by which they're limited. The 8086 was the first 16-bit chip in the Intel processor line. Its 16-bit register size, instruction set's addressing scheme and 20 address lines limit it to addressing 1 megabyte (1M) of user RAM memory.

At the time it was designed, no one imagined that a personal computer



Hardware Model 2. Computers with 80386 or i486 CPU and RAM installed at upper addresses.

would ever need as much as a million bytes for temporary storage of programs and data and the operating system. After all, the eight bits in just a single byte can store quite a lot of data: a fairly large integer (65,536), eight switch settings or any one of 256 characters. Selecting 1M as the extent of memory space must have seemed like an extravagance. (Note: Extended memory isn't available for 8086 and 8088 CPU-based systems, not even with the help of a memory manager.)

The 80286 and Beyond

When the 80286 was created, its designers included the ability to address up to 15M of memory beyond the first megabyte—an area called "extended memory." Assuming it has been installed, the addition of extended memory would seem to offer a vast total of 16M to any program that needs it. Unfortunately, there are a couple of catches. The 80286 and later processors can address this memory only in a special "protected mode." But to run in protected mode, an AT-class 286 computer needs software written to a new standard that isn't compatible with any of the old software programs for the PC.

The 80286 operating mode that mimics operation of the 8086 is called "real" mode. In real mode, software requires an installable driver to access extended memory. Without the help of a driver, ordinary software running on 286 and later processors can only nibble from the same megabyte as the first-generation 8086.

The 80286 can also address up to 1 gigabyte (1G) of virtual memory—approximately a billion bytes. However, virtual memory isn't memory at all. It's yet another convention that requires some form of memory management to be implemented.

The 80386DX (and 80386SX, 80386ELS, 386SLC, i486DX, i486SX and variations) was Intel's third try. Intel corrected some problems the 80286 had in switching to protected mode, added some built-in memory management and finally got it right. The 80386 and its i486 fraternal twin address memory spaces of up to 4G. They can also access 64 terabytes (64T)—over 64-trillion bytes of virtual memory. All memory-management features supported for the 386 also apply to the 486.

The only trouble with all of the younger children in this family is that they maintain compatibility with the 8086. This is good because it lets the same software run on any of these chips. But it's also bad because it resulted in very little software being written to take full advantage of advances in memory addressing. To do so would shackle the developer's software to only the latest chips, and they represent the smallest market.

Memory Types

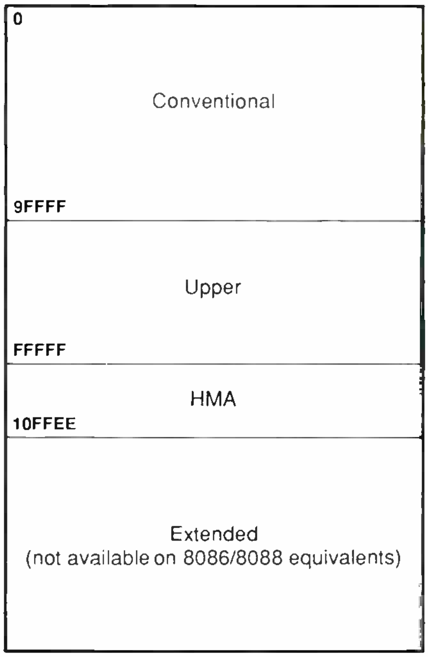
The memory available to software running on these Intel processors varies with its location in the memory space and how it's managed and can be used. Various types of memory are used by operating system drivers, applications, terminate-and-stay-resident (TSR) pop-ups and memory-management software itself.

Note that there are important differences between memory and a memory-address space. Although there are many ways to add memory to computers, a processor's memory-address space is fixed. The memory spaces described below are available on all machines with appropriate processors. However, a given memory space can't be used unless memory chips are physically installed there or are mapped there by a memory manager.

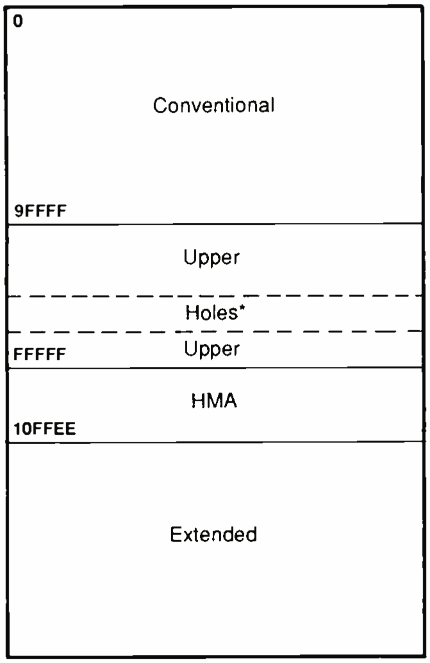
Mapping simply means that a logical address (the place where you need memory) is applied to some corresponding piece of physical memory (actual integrated circuits), not necessarily at the same physical address. Mapping is like giving a group of memory chips different names at different times, depending on the job you want them to do.

Processors without built-in memory-management circuitry, like the 8086 and 80286, are confined to using memory at the physical addresses where chips are installed. (This handicap can be overcome by adding circuitry with an adapter or, for the 286 only, by adding external system logic chips.) But in most cases, a memory address refers only to a space, not to a particular chip, one of its cells, nor its contents.

- *Real Memory*. Other than the awkward "first megabyte," or even more ungainly "DOS memory space," there's no widely-used term for the aggregate memory area addressable by DOS. Here, the term "real" memory is used to refer to this area because the 80286, 80386 and i486 are restricted to



Hardware Model 3. Computers with 8086, 80286, 80386 or i486 CPU with EMS 3.2, or EMS 4.0 or EEMS board installed.



*No physical memory installed

Hardware Model 4. Computers with no chipset, no EMS board and no upper RAM.

it only while running in real mode. 80286 and later processors can also add, with some prohibitions, an extra "high-memory area" to their DOS-addressable domains.

- *Conventional DOS Memory.* Intel architectures and DOS divide real memory into low and high areas. The bottom 640K can be called "low" memory, but the term has nothing to do with its binary social status. It's just the coincidence that memory is numbered from zero, and this most-important memory was mapped first.

This memory can also be called "conventional" or "main" memory because it's the area originally envisioned as all the memory a microcomputer would ever need for programs and data. That view lasted about a week, maybe two, but all processors since have had to honor the misconception for reasons already cited.

- *Upper Memory.* Upper memory lies in the area of real memory between 640K and the DOS limit of 1M. This area is sometimes referred to as "high memory," and program code running here is said to be "loaded high." These terms can lead to confusion with the "high-memory area" (HMA), which begins just beyond the upper-memory addresses at hexadecimal 100000.) In the Intel design, the upper-memory area is addressable by the processor, but it's intended for ROM-memory chips that contain parts of the operating system and for mapping onto device-controller buffers and other modifications to, or extensions of, the operating system. Early machines didn't have physical memory installed at these addresses, unless it was a ROM (read-only memory) for firmware or RAM on an adapter card.

The most universal use of upper memory by an adapter is for video buffers. That area begins just after the 640K low-memory area, at A0000, and can extend as far as BFFFF. The highest upper memory, F0000 through FFFFF, is reserved for addressing the computer's basic input/output system (BIOS) that resides in ROM chips. The area between these two is reserved for more BIOS memory and the input/output requirements of other adapters. These I/O buffers are a common source of conflicts when they overlap.

Overlapping typically occurs when local-area network (LAN) adapters, caching disk controllers and other cards are added to an industry-standard architecture (ISA) personal computer. In fact, if too many adapters with conflicting memory requirements are added to a system, the discord may not be resolvable. Microchannel (MC) and extended industry standard architecture (EISA) machines can arbitrate these addresses automatically. (The EISA bus will also accept ISA adapters that aren't subject to arbitration.)

Wherever an adapter or BIOS isn't installed, this address space remains unused. And any such real estate that can be directly addressed by processors running in real mode is clearly valuable. As a result, several management techniques have been developed to make use of it. Most use it to map resident software and drivers into RAM. It can also be combined with conventional memory under the proper circumstances.

One use for upper memory began when AT-class machines were designed with RAM installed in the upper-memory address space. These computers have system-logic chip sets, frequently from Chips and Technologies, that incorporate a narrow range of memory-management abilities. Such systems can switch between their upper-memory RAM and BIOS ROMs with a technique called "shadowing." The RAM is, therefore, known as shadow RAM.

To implement shadow RAM, system BIOS contents and/or video-card BIOS ROMs are first copied to fast RAM residing at the same address as the ROMs. The copy is the "shadow," and the system-logic code switches memory lines to it from the ROM. When subsequent calls are made to the firmware, they're handled by swift shadow, rather than by the real firmware in slow ROM.

A more prevalent use today is to map upper-memory addresses into other memory locations at which RAM is installed. Memory-management utilities make unused, but adequately large, upper-memory address spaces available to applications. They can place 16K frames there for "expanded memory," or use them for 4K segments known as "upper memory blocks" (UMBs).

- *Upper Memory Blocks.* UMBs are those parts of upper memory that aren't allocated to system use, such as BIOS ROM and controller buffers. As they aren't used by the system, UMB addresses can be allocated to running programs that would otherwise require conventional memory. RAM needn't be installed at UMB addresses for them to be used.

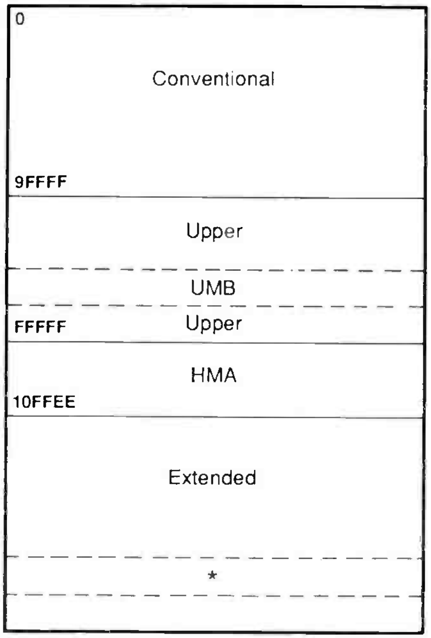
One technique is to use these addresses to give programs access to physical memory at extended-memory addresses, but they can sometimes also access hardware that supports the expanded-memory specification (EMS) or physical shadow RAM. Whether they can be allocated to XMS, EMS or shadow memory depends on your memory manager. It must be able to store programs in RAM to which the UMB addresses refer.

With available memory, UMBs can be used to run just about any resident software—installable drivers, system resources, network re-directors and TSR pop-up programs. Drivers and buffers are usually loaded high by modifying statements in DOS's CONFIG.SYS file, a text file that tells the operating system how to configure itself in memory. TSRs are often loaded high by similar modifications to DOS's AUTOEXEC.BAT start-up batch file. Programs then address the UMB or run from it, just like any other real memory—without bumping into video, BIOS or adapter memory.

To create this safe world for applications, though, the memory-management utility itself must vie for upper-memory space, just like an adapter or BIOS chip. Conflicts must be resolved before the manager can be installed. The trend here is for the memory manager to accomplish detection and resolution of these conflicts automatically.

Not all memory utilities have this feature, however, and some conflicts are still undetectable, even by those managers that do. The conflicts that remain are resolved, whenever possible, by excluding or including regions of memory with special statements. Many utilities require you to manually edit these statements into the CONFIG.SYS file.

- *Extended Memory.* As mentioned earlier, extended memory lies above the 1M address reach of the original 8086 processor family, and the 80286 and later processors can address at least 15M of it by switching to a special protected operating mode. However, programs must conform to certain criteria before they can run in this mode. Most currently don't, unless they use a "DOS extender." Microsoft's XMS convention provides extended memory to these applications in the form of extended-memory blocks (XMBs).



*Remap extended memory to UMBs in upper memory

Upper memory for Hardware Model 4 (only with 80386 or i486 CPU). Also for Hardware Model 3 if EMS board is configured as extended memory. Some computers can remap replace physical memory in Hardware Model 2 into extended address space, creating the equivalent of Hardware Model 4.

DOS extenders are a type of memory software that manages access to extended memory by switching between protected and real modes. They access extended memory while in protected mode, switch back to real mode, and then give the required pages to the application. However, DOS extenders must be incorporated directly into application software. They aren't add-on utilities. If it has one built into it, your application uses it transparently. If it doesn't have one, you can't add it. Applications that run under an operating environment, like *Windows* or *DESQview*, can benefit from its ability to use built-in DOS-extender technology to manage memory for its applications.

Programs can also access extended memory while in real mode through use of drivers. Drivers are simply additions to the operating system that provide a communication protocol between an application and some resource like extended memory, a network or a disk drive.

The first extended-memory driver was one that IBM included with every original AT: VDISK.SYS, a RAM disk. Unfortunately, RAM disks aren't directly addressable by applications as is EMS or memory accessed by a DOS extender. Although, they remain as volatile as the RAM on which they're based, RAM disks are accessed using file-management conventions.

Other drivers that access extended memory include those used to provide XMS and EMS. They're usually provided by operating systems, operating environments or memory-management utilities. Only the SMARTDRIVE and RAMDRIVE utilities (and variants) and DOS-extended programs can directly use XMS. Many popular DOS programs use EMS.

- *High Memory Area.* The HMA is the section of extended memory just above the first megabyte. DOS usually can't address this memory, even when running on an 80386 or later processor. However, an XMS driver like the HIMEM.SYS bundled with MS DOS 5.0 and *Windows* 3.0, gets to this "high memory" area by exploiting a feature of 80286 and later architectures, address line A20, that normally goes unused by DOS's 16-bit architecture. Memory utilities with XMS built into them support this feature, too. With an XMS driver, programs can directly access nearly an entire 64K of extra memory.

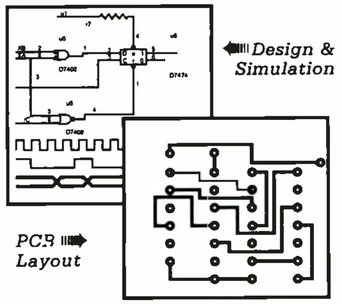
Several bindings hobble the HMA. For example, only one program, of type COM or SYS, can be run in the HMA; not those with an EXE file extension. The entire file must fit; programs larger than 64K can't be run there. Moreover, programs that are interrupt driven—initiated by certain hardware signals—may not run due to the slight delay that occurs in handling the A20 line.

- *Virtual Memory.* Virtual memory was originally developed for mainframes, where it extended addressable core (main memory) by "paging" its contents back and forth to mass storage (hard disks). This same method is used by *Windows*' swap files.

In microcomputers, virtual memory takes advantage of non-addressable extended memory, memory on special "expanded-memory" adapters and disk drives. It's still a technique that pages data (called a "page") that can't be directly addressed by a program to an area (called a "frame" or "page frame") that can. However, if an adapter or extended memory is used as the storage area, paging is done by logically changing addresses in look-up tables, and it's unnecessary to physically move the data.

- *Expanded Memory* (EMS or its variant EEMS). The expanded-memory specification (EMS) is a type of virtual memory provided by BIOS firmware or utility software. It's also sometimes referred to as the LIM standard for Lotus, Intel and Microsoft, three of its developers. Like the original virtual memory, EMS pages data to addressable memory frames, as required by applications, and pages data that's not referenced back to non-addressable storage media as they're replaced. Only DOS applications specifically written to use EMS conventions can access this memory.

EMS pages can reside on a special adapter card with its own addressing circuitry and memory. The card also has a BIOS that contains the expanded memory manager (EMM) that gives



HMA Workings

If you ignore a couple of mere technical details (such as the four-bit offset that gives DOS an effective address range of 20 bits with a 16-bit register, and the 16 bytes that can't be addressed as a consequence), this is how the HMA works.

Memory in the 8086 family is addressed by adding a pair of addresses called "base" and "displacement." By combining a maximum base address (FFFF0, or nearly 1M) with a maximum displacement (FFFF, or 64K) it's possible to generate an address (10FFEF) nearly 64K beyond the 1M pale. However, 8086 through 80286 processors have only 20 address lines (A0 through A19). So, an address that exceeds 1M (FFFFF) is wrapped around back into low memory by truncating its high bit. It's as if the byte that followed FFFFF was 0, not byte 100000 (1,048,576 decimal). This kind of arithmetic may be okay for clocks, but it isn't so good for computer programs.

DOS was designed with this hardware shortcoming in mind. When the 80386 and later processors were designed, they allowed for additional address lines, but DOS still couldn't use them. XMS drivers overcome this deficiency by allowing the system to use a 21st address-line, A20. With this addition, even the largest address that can be generated in DOS's 16-bit registers (10FFEF) retains its high bit. An operating system like MS-DOS 5.0, can use this extra 64K as real memory (that is, without paging or running in protected mode). By moving some of its own code into the high-memory area, DOS can free more conventional memory for applications.

applications access to the memory. (A similar functionality is also built into some laptop computers.) Some cards can optionally configure their memory as extended. Memory managers can often convert this memory to XMS memory, if required, and use it to create UMBs.

If EMS is emulated by utility software alone, it must use either extended memory or a hard disk to store its non-addressable pages. This hard-disk memory is truly virtual, not real memory at all. A processor can't access it directly in any mode, and management utilities can't use it for loading programs high.

The three flavors of EMS are EMS 3.2, enhanced EMS (EEMS) and EMS 4.0. EMS 4.0 and EEMS are compatible with the 3.2 standard and work with programs that require it. All versions of EMS require a minimum of 64K bytes, in four 16K-byte frames, for their buffers.

The earlier EMS 3.2 provides just four frames for EMS memory and can place frames only in upper memory. Hardware that features this version of the standard is obsolete, but many boards based on it have been installed in older machines. (And that's where they are today.)

EMS 4.0 incorporates changes introduced by EEMS and has superseded it. It allows up to 64 16K-byte EMS frames and can place them anywhere in the first megabyte of DOS-addressable memory. EMS 4.0 is the version required by most memory managers that work with EMS adapters. However, some utilities, like the Quarterdeck Expanded Memory Manager (*QEMM*), are also compatible with EMS 3.2 and/or EEMS adapters. (Quarterdeck's QRAM 286 manager can also work with EEMS adapters.)

Memory Managers

Memory managers usually provide a bundle of memory services through XMS and EMS drivers. Certainly, all of those researched for this article provide management of UMBs. They use them to load TSRs and drivers into the space between the video buffer ending at BFFFF (or the VGA BIOS ending at C7FFF) and the beginning of system BIOS at F0000.

Most utilities provide EMS buffers for programs that require them, many provide access to the HMA, and some can load extra DOS 3.x system buffers high, as well. Note, however, that not all of those that provide EMS can provide it for *Windows*' real and standard modes. The better managers also move most of their own code out of the first megabyte of memory. (It's an important feature because the memory addresses available in real mode are all too quickly exhausted—even with the use of EMS.) Most provide shadow RAM, in extended memory, for machines that don't already have shadow RAM installed at upper-memory addresses.

With a single exception, memory managers load programs high by modifying the CONFIG.SYS and/or AUTOEXEC.BAT files. Nearly all make the required changes automatically for 386 and 486 computers but require manual editing either for customization or if they provide management on 286 machines. And let's face it: Many systems will work with any of the automatic-installation systems, but others are going to be a problem, no matter what memory manager you select. A lot depends on the adapters you have and the software you run.

Without exception, every memory manager, no matter how automated, has a method for including and excluding regions of memory from its manipulations. The nearly catholic method, which prevents a manager from using regions in use by undetectable processes or hardware is to use an EXCLUDE parameter on the command line. For example, IBM token-ring adapters have memory that's difficult to detect because it's activated only when required. To exclude a region from D0000 to D4000 with MS-DOS 5's EMM386.SYS, the command:

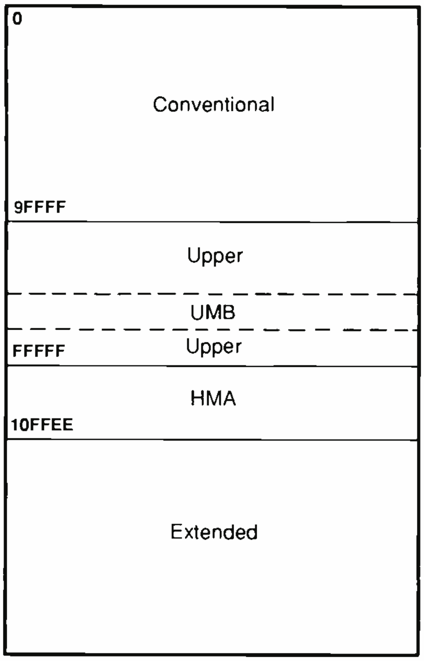
```
DEVICE = EMM386.EXE X = D000-D400
```

would be added to the CONFIG.SYS file. Note the use of paragraph addresses and the terse form of the command.

Managers can increase available UMB space by adding unused fragments of upper memory as small as 4K—including those in the dedicated BIOS area above F0000. Unused BIOS areas can include code used only during system start-up, such as the power-on self test (POST) and the system setup. Regrettably, these techniques are dependent on very intimate knowledge of (and work only with) a limited number of BIOS chips. They're not available for all machines. A complementary INCLUDE statement typically recovers omitted areas. To ensure recovery of a 32K video range beginning at B8000, append MS-DOS 5's equivalent version of INCLUDE to our earlier statement:

```
DEVICE = EMM386.EXE X = D000-D400
  I = B800-BFFF
```

DOS 5's terse commands aren't common. EXCLUDE and INCLUDE are the parameters for nearly all memory-management utilities. However, *QEMM* allows use of both verbose forms (EXCLUDE and INCLUDE) and terse forms X and I) for the great majority of its commands. An equivalent



Upper memory allocation for Hardware Models 1 and 2 converts physical RAM to UMB.

statement for *QEMM-386* could be written in a form similar to the one for MS-DOS as follows:

```
DEVICE=QEMM386.SYS EXCLUDE
    =D000-D400 INCLUDE x B800-BFFF
```

Memory managers are constantly evolving to provide more services because many of their basic features are now also part of the principal small-computer operating systems: MS-DOS and DR DOS. Utilities can continue to compete only by aggressively providing more available memory than do more-conservative operating systems. Thus, nearly all of today's managers offer special features that differentiate them from their competition. About the only familiar memory-management feature that still isn't offered by anyone is the ability to remove TSRs or drivers from memory. A number of TSR managers provide this in conventional memory, and Helix's *HEADROOM* works with *NETROOM* in upper memory as well.

The more-aggressive a manager's approach, however, the more familiar it must be with specific hardware and software in its environments, and the more prone it will be to compatibility conflicts. Even among operating systems, the more-aggressive DR DOS is more likely to feel the constraints of compatibility than is MS-DOS, which can provide less available memory on some machines.

As an example, DOS isn't allowed to load its tables and buffers into EMS memory while using V Communications' *Memory Commander*. This means that VDISK, FASTOPEN and the BUFFERS commands mustn't employ their /X parameter. (*MC* can load all this, plus executable code, high instead.) The same is true for *QEMM* when using some versions of DOS 4.x. More examples follow.

In addition to EMS and XMS services, memory managers can provide applications with access to additional physical memory. *QMAPS*, for example, can recognize a large number of system-logic chip sets and, thus, is able to detect many AT-type machines that have dynamic RAM chips (DRAM) installed in the upper-memory area. *QMAPS* recovers the part of this memory not used for shadowing to store code or data that can be accessed in the UMB address space. *386MAX* and *QEMM* can do the same with Compaq Top Memory.

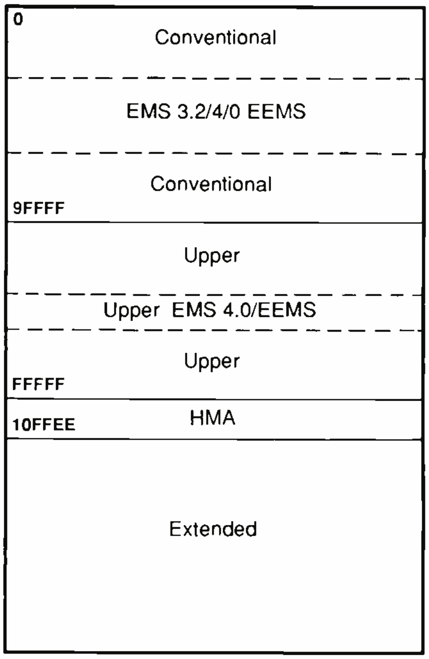
It isn't possible to detect every instance where the technique can be used, but unless a computer can physically switch this DRAM into the extended-memory-address space, managers without this ability let much of it go to waste.

A scheme that has become commonplace in the latest generation of memory utilities is "backfilling" conventional memory with unused addresses from the video buffer. Monochrome adapters (and EGA and VGA monochrome modes) don't require the first 64K of video addresses, from A0000 to AFFFF, for their buffers. Instead, these addresses can be added to a computer's contiguous conventional space, for a total of 704K. For a CGA adapter, or for EGA or VGA color-text modes, the video buffer starts at address B8000.

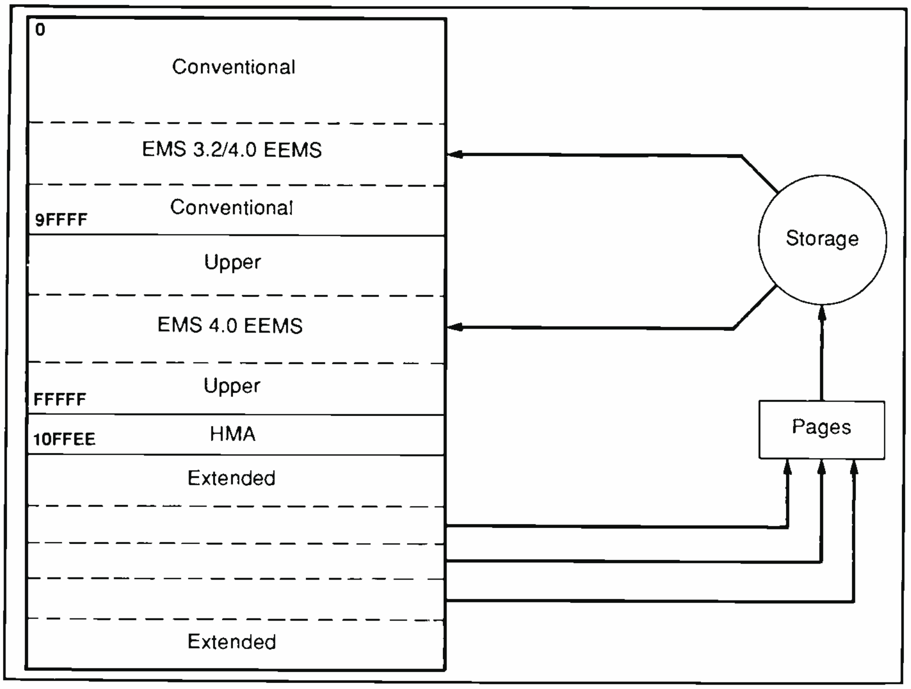
Many managers make available the 96K from A0000 to B7FFF for contiguous conventional memory. Therefore, CGA-graphics or color text—CGA, EGA or VGA applications—can have a total of 736K. Furthermore, there are different backfill strategies. *QEMM-386*, for example, normally requires an EGA or VGA adapter and adds memory, depending on monitor type. It adds memory only if it exists as RAM at those addresses. DR DOS does this, too, but it can also backfill monochrome and CGA adapters by mapping to other memory. (This eliminates the risk of crashes, because they can't be switched to the wrong modes.)

There's one potential drawback to backfilling from EGA or VGA. DR DOS, and some other managers, require you to run a utility before you switch an application back to graphics mode on an EGA or VGA adapter. In some cases, if you forget and try to run a color-graphics program without rerunning the utility, the system is likely to crash.

There are also a couple of 32K regions in EGA- and VGA-adapter buffers you may be able to recover for UMB space. The area from B0000 to B7FFF isn't used for color operation of these adapters. The area from B8000 to BFFFF isn't used during monochrome operation. Either region can be recovered when it isn't being employed as a buffer. Some utilities alternately use the region at B0000 to relocate the 32K VGA BIOS from



EMS memory allocation for Hardware Model 3. Memory manager cannot provide EMS service when provided by a card. Whenever a memory manager is available, memory on an EMS card should be configured as extended memory, if possible. Use the manager to provide all the memory types from extended.



EMS memory for Hardware Models 1 and 2. Also for Hardware Model 3 if EMS board is configured as extended memory, and for Hardware Model 4 with 80386 or i486 CPU.

C0000. Other utilities require you to configure these areas yourself.

Another trick is to free up fragmented areas of upper memory for use as conventional memory. The approach *Memory Commander* uses is to compress active areas, such as UMBs and the video buffer, as far as possible towards the top of the upper-memory space. Unused slack is allocated downward to main memory. This method provides more program memory than any other. However, there's a tradeoff.

Any program that writes directly to the physical address of video memory must either use a standard method (INT 10, function FE), developed by IBM and used by both V Communications (the company's relocated screen interface specification, RSIS) and Quarterdeck (for *DESQview*), or pay a performance penalty while *Memory Commander* translates the addresses for every video-buffer access. (A program that uses DOS-service or BIOS calls for screen operations doesn't require translations and pays no penalty.) Nevertheless, a performance hit of 10% during video access (the company's performance claim) may be quite tolerable when the alternative is the inability to fit a program into available memory.

NETROOM has an even more radical scheme that can add as much as 576K of EMS memory to a complete, and separate, conventional-memory space, and up to 224K of UMB space. In other words, you can move up to 576K of TSRs and drivers out of conventional memory without touching upper memory. Helix contends that its NETSWAP4 utility uses "virtual machine" (VM) technology similar to that used by *Windows*, and that its VM even allows *Windows* two DOS sessions to communicate with each other. Using this technology, it's possible to put a network redirector into one session and a DOS application that uses it in another. Nothing else gives *Windows* this ability, and it's almost scary to think of so many electrons running wild in there all at once.

There's a disadvantage to the above, naturally. You can't attach and detach network resources from the *Windows* control panel. Performance is also degraded—no more than 30% on throughput from a busy server and less than 10% on a workstation, according to Helix president Mike Spilo. A smaller VM can alternately be placed in upper memory, and networks will run faster loaded there.

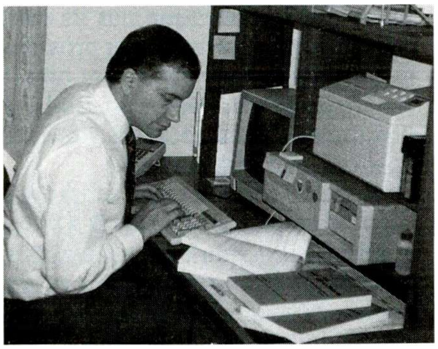
Memory managers also offer memory-related services, one of which is optional "instancing" of TSR programs or drivers for use with *Windows* 3.0. *Windows* 3.0-aware TSRs and drivers—the MS Mouse driver, for example—automatically provide instancing for each of the VMs *Windows* uses to run DOS applications. Every DOS application has its own copy. The memory manager provides instancing for programs that aren't *Windows*-aware. (Never use it with a disk cache, though, because you have only one real disk surface.)

Another routine extra is the addition of emulated shadow RAM for machines that don't have DRAM installed at the upper-memory addresses. The memory utility provides the shadow in extended memory that's mapped to the ROM addresses. This method can offer an advantage over a built-in manager if a computer optionally allows its physical shadow RAM to be re-mapped as extended memory. In this case, the memory manager still can use the RAM for shadowing, but it can also recover unused areas for inclusion in its extended-memory pool.

286 Versus 386 Memory

There are actually two classes of memory managers: those for 386-based systems and those for systems based on the 286. As already noted, the two processor families have different architectures and, so, require different strategies to provide memory services. The most important difference is that 386 processors have memory-management circuitry built into them that a utility can use for addressing and mapping. It's almost certain that you'll be able to get EMS and XMS memory for your 386 machines through the expediency of an inexpensive memory-management utility. This isn't necessarily so for 286 systems.

Because the 286 processor doesn't have built-in memory-management circuits, memory management must be provided by external chips. The missing features are sometimes provided by the support chips that 286 AT manufacturers use to simplify building their machines. These system-logic chips combine many of the original PC's separate circuits, such as the memory controller, direct-memory access (DMA) controller, interrupt controller, universal asynchronous



receiver/transmitter (UART) and parallel input/output (PIO) circuits. But not all chip sets offer memory-management support, and those that do, don't offer the required services in the same way.

ATs built from chip sets that have support, may or may not work with a 286 memory-management product like Quarterdeck's QRAM, depending on whether software was written for that machine's particular chips. Fortunately, most 286 products also work in systems that have an EMS 4.0 adapter card installed in them.

There are also utilities that work with their own proprietary hardware. Just about all 286 machines work with products like the All Charge Card. However, there's a drawback to this approach too—high cost. While these products work well, the price of 386SX upgrades and replacement motherboards has fallen to the point where hardware-based memory managers are no longer attractive at a $200 to $400 price point.

More and more, the market for hardware solutions shrinks to include just those premium machines where upgrade costs are still high. And even at the high end, products like the Kingston Technologies SX/Now! can upgrade a 286-based PS/2 (Models 50, 60, AT and XT 286) with a 20-MHz 386SX processor. It has a fairly simple plug-in installation that doesn't require removal of the original motherboard, and it gives both memory management and a faster 32-bit processor for a cost of $475.

Besides the standards used to provide memory services, programs that access memory in protected mode may conform to one or more standards used to coordinate their activities with hardware, firmware, other programs, environments and operating systems. The most important of these are the DOS protected-mode interface (DPMI), Virtual Control Program Interface (VCPI) and Virtual DMA Services (VDS). The protocols that DPMI and VCPI provide are required for protected-mode programs like memory managers and Autodesk's *AutoCAD* to coexist with each other.

DESQview, for example, cooperates with memory managers through VCPI, a protocol that allows a DOS-extended program to run when loaded after an expanded-memory manager.

Address Calculation

Memory managers have restrictions on where they can place UMBs and EMS page frames. UMBs must begin on 4K boundaries. Page frames require a 16K boundary. ROM relocation has similar prerequisites. Fortunately, the necessary hexadecimal calculation requires no math, just the ability to recognize only five hexadecimal digits. The digit positions in a hexadecimal address have the following values:

Digit Position	Value In Bytes
4	64K
3	4K
2	126
1	16

The highest-order digit in any address (Digit 4) represents a 64K boundary. The next lower-order digit (Digit 3) represents a 4K boundary. The other positions will always be 0 for any 4K or 16K boundary.

For example, if "X" stands for any hexadecimal digit, the following number always falls on a 4K boundary: XX000. Numbers with any value (X) in the highest digit and a 0, 4, 8 or C (which equals the decimal number 12) in the next position are on a 16K boundary. These numbers all look like X00000, X4000, X8000 or XC000.

Of course, the alternative forms of notation explained earlier can also be used. In this case, a 4K boundary has the form XX00 or XX00:0000. 16K boundaries are either X000, X400, X800 and XC00 or X000:0000, X400:0000, X800:0000 and XC00:0000.

What follows is the complete table of 16K boundaries in upper memory, as represented in the abbreviated paragraph form usually required by memory managers:

A000	B000	B000	D000	E000	F000
A400	B400	B400	D400	E400	F400
A800	B800	B800	D800	E800	F800
AC00	BB00	BC00	DC00	EC00	FC00

Windows, in contrast, supports DPMI in the virtual machines it uses to run enhanced-mode DOS sessions. Without DPMI, DOS extended programs have to switch to real mode whenever they want a DOS service (such as a mouse or driver), use the service and then switch back. With DPMI, applications make a call to a DPMI host that satisfies these requirements with its translation services. (DPMI host services are available

Video Map

The following represents the regions used by standard video modes on PCs and ATs. Unfortunately, one of the hazards of memory management is that software doesn't always use the mode you expect. For example, upon detecting a VGA adapter, some programs ignore a monochrome monitor and use the color region at B8000. This isn't normally a problem for the VGA adapter, but it's disastrous if a UMB has been mapped at B8000.

Address Standard Uses and Buffer Locations
00000 Beginning of conventional memory
9FFFF End of conventional memory
A0000 640K boundary
- Beginning of upper memory

VGA-Adapter Data
- Beginning of video buffer on VGA adapters
- Beginning of region used in all VGA graphics modes
- Beginning of region free in VGA color-text modes

CGA-Adapter Data
- Beginning of vacant RAM region on CGA adapters

Monochrome-Adapter Data
- Beginning of vacant RAM region on monochrome adapters

AFFFF
VGA-Adapter Data
- End of VGA monochrome-graphics region
- End of standard VGA color-graphics region

B0000
VGA-Adapter Data
- Beginning of first special 32K VGA region
  - used by VGA monochrome-text modes
  - free in standard VGA color modes
  - used by some super-VGA adapters in high-resolution modes

Monochrome-Adapter Data
- Beginning of video buffer on monochrome adapters

B0FFF
Monochrome-Adapter Data
- End of video buffer on monochrome adapters

B7FFF
VGA-Adapter Data
- End of first special 32K VGA region
- End of region free in VGA color-text modes
- End of regions used in VGA monochrome-text modes

B8000
VGA-Adapter Data
- Beginning of region used in VGA color-text modes
- Beginning of second special 32K VGA region free in all VGA monochrome modes

CGA-Adapter Data
- Beginning of video buffer on CGA adapters

B8FFF
CGA-Adapter Data
- End of video buffer on CGA adapters

BFFFF
VGA-Adapter Data
- End of VGA color-text region
- End of some super-VGA high-resolution graphics regions
- End of all video buffers

C0000 End of 32K VGA BIOS (ROM) region
- Beginning of region used for UMBs
- Beginning of region used for miscellaneous adapter RAM
- Beginning of region used for miscellaneous adapter ROM (regions used by networks interface cards [NICs], fax boards, etc.)

E0000 Beginning of area sometimes used by built-in shadow RAM to relocate video BIOS
- Beginning of the system BIOS ROM

Notes: (1) Standard VGA and EGA video share the same starting addresses; (2) Size differences between EGA and VGA regions are insignificant to creation of UMBs and EMS frames; (3) Standard monochrome addresses are also Hercules addresses; (4) The last byte of a 64K region has an FFFF address ending; (5) The last byte of a 4K region has an FFF address ending.

from OS/2, as well as *Windows*.) Lotus *1-2-3* Version 3.1, in turn, requires memory managers to coordinate with it through either VCPI or DPMI.

VDS is a specification that coordinates direct-memory access (DMA) device drivers and the memory manager so that they work with the same addresses. It ensures that DMA channels are correctly handled when operated in protected mode.

Address Conventions

Memory addresses in this article are given in decimal kilobyte figures (such as, 640K) or hexadecimal bytes (such as, A0000). There are other standard forms of notation you may encounter, often unexplained, in your documentation. An address like A0000 can be written as A000 or A000:0000, all referring to the same location. In either of the latter cases, A000 represents the number of 16-byte paragraphs of memory, not bytes.

Multiplying A000 by the size of a paragraph, hexadecimal 10 (decimal 16), gives an address of A0000, the address after the 640K of conventional memory (00000 to 9FFFF). However, A000 can also represent bytes, in which case, it refers to the address immediately following the first 40K, which runs from 0000 to 9FFF. Pay close attention to the convention used in the documentation that accompanies all hardware and software.

Configuring a memory manager for an AT-class computer often requires knowing where certain boundaries are. This requires knowing a few simple tricks (see Address Calculation box). If you also commit some of the standard boundary addresses to your own memory, you'll make manual changes and troubleshoot with more confidence.

Tune in next month for our discussions on MS-DOS 5.0 and DR DOS 6.0 and reviews of memory-management products that enhance the utility of these two operating systems. ■

Yacco

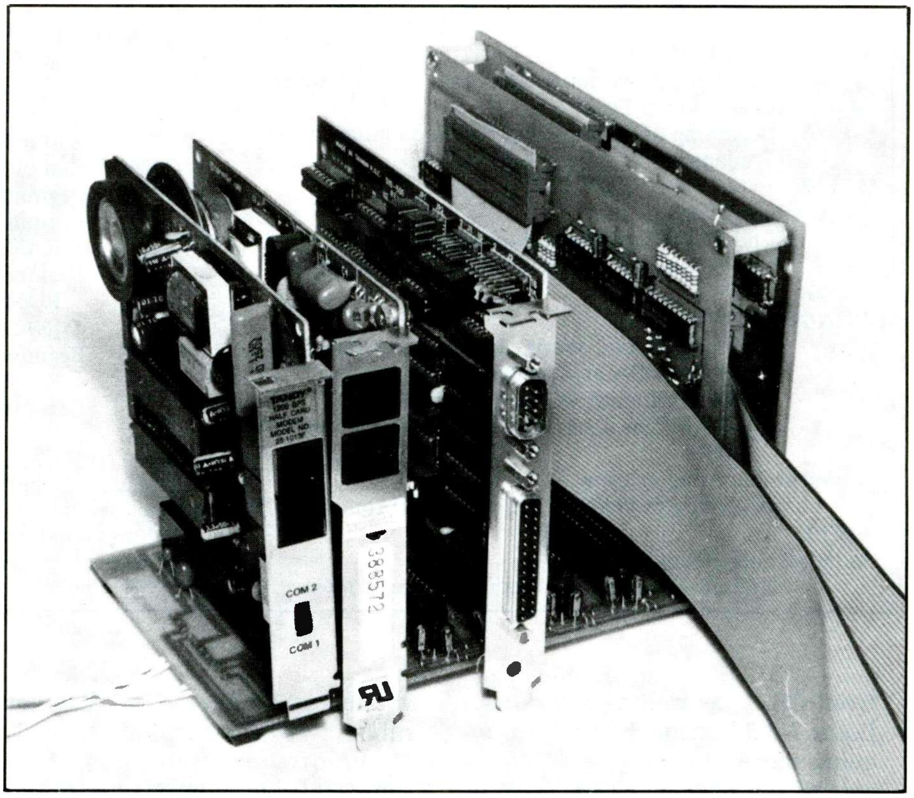
Upgrading By Nick Goss

A Tower of an Enclosure

Part 4

Construction, checking out the CYANCE Bus Expander system and final installation

Last month, we detailed how the CYANCE Bus Expander can add six more expansion slots to an existing PC/compatible computer. We focused on how the circuitry works. Now we get on with how to wire the various elements that make up the system and we step you through checkout to make sure everything is running smoothly. Then it's on to installation of the system in the CYANCE enclosure and, finally, connecting together all the elements.



Construction

When building the CYANCE Bus Expander, it's important that you take your time. Don't expect to complete the project in an evening or two. Keep in mind that in a complex system like this, a single solder bridge can prevent the entire system from operating. So be very careful when soldering components into place. Use only enough solder to assure good electrical and mechanical connections. If you do accidentally create a solder bridge, clear it immediately.

Circuit layout is critical in this Bus Expander project. Therefore, I highly recommend that you use the actual-size printed-circuit artwork provided in Fig. 7 if you make your own boards. If you do make your own double-sided printed circuit fabrication, see the "Making Double-Sided Boards" box elsewhere in this article for guidance. You can also make single-sided boards and use the component-side artwork for installing jumper wires in place of the conductor patterns shown. Alternatively, you can purchase ready-to-wire boards from the source given in the Note at the end of the Parts List.

Begin assembling your Bus Expander by wiring the Master Control Card, using the wiring guide shown in Fig. 8. I prefer to solder the ICs directly into the board. However, you might want to use sockets. If so, it's important that you use the barrel-pin type socket that lets you solder the pins on top of the board.

Once the ICs or sockets are in place, mount *P1* and *P2*, making sure to position them for component-side soldering access if you're using a home-fabricated board. Then mount and solder into place the capacitors, making sure you polarize them as shown.

Note that resistors and jumpers are arranged side by side near 40-pin control cable header socket *P1*. When you install and solder into place these items, be particularly careful to avoid solder bridges. Next install the feed-throughs, using either cut-off resistor leads or No. 22 solid hookup wire, soldering them to the copper pads on both sides of the board.

As you work on alternate sides of the board, be on the lookout for breaks and bridges in the copper traces. If you locate any bridges, clear them with a sharp hobby knife. Repair breaks with solder if they're very fine and with bare hookup wire and solder if they're larger.

Next, jumper the pins 1 and 20 direction control lines as indicated.

Mount 40-pin header socket *P1* and 36-pin male strip connector *P2* in their

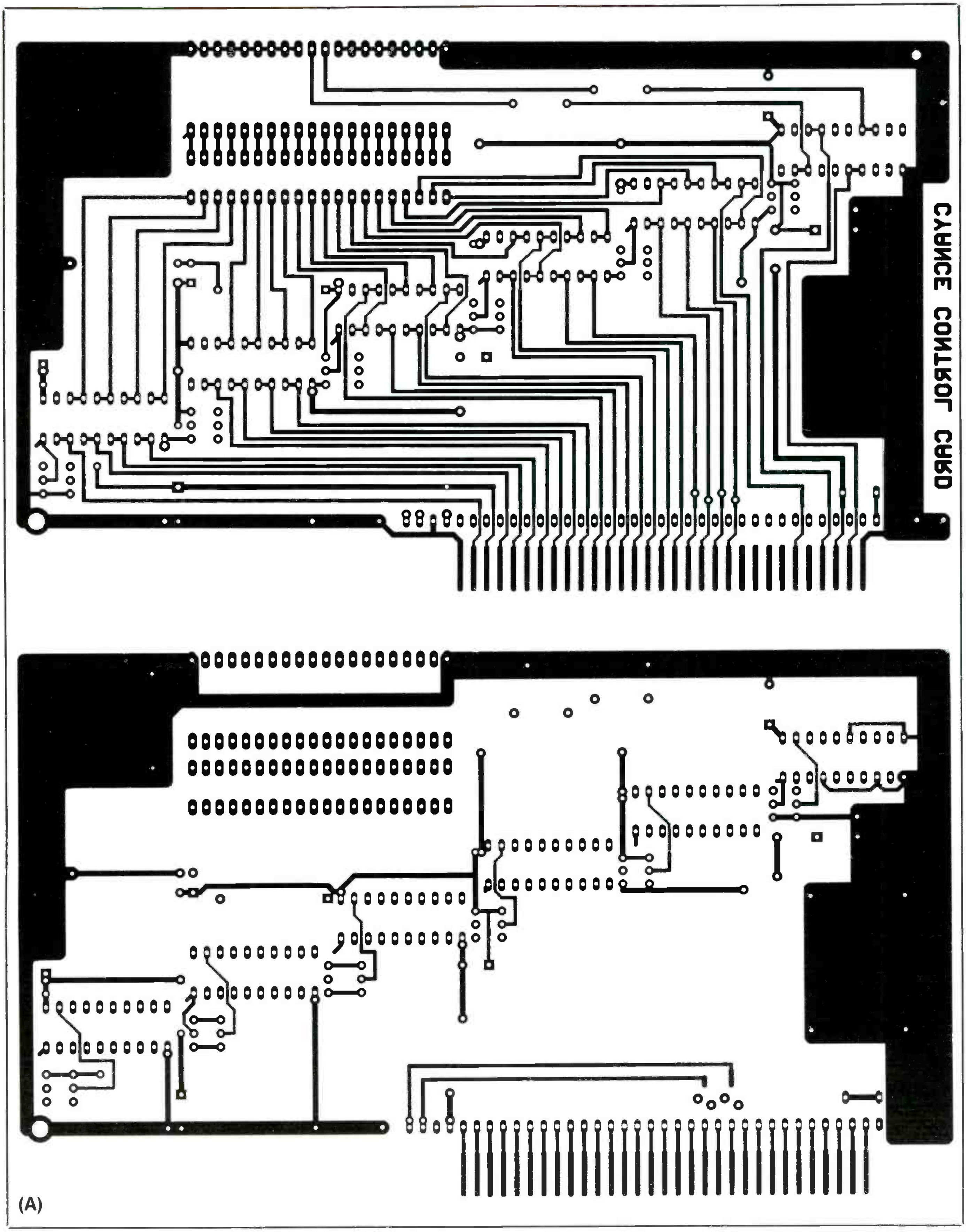
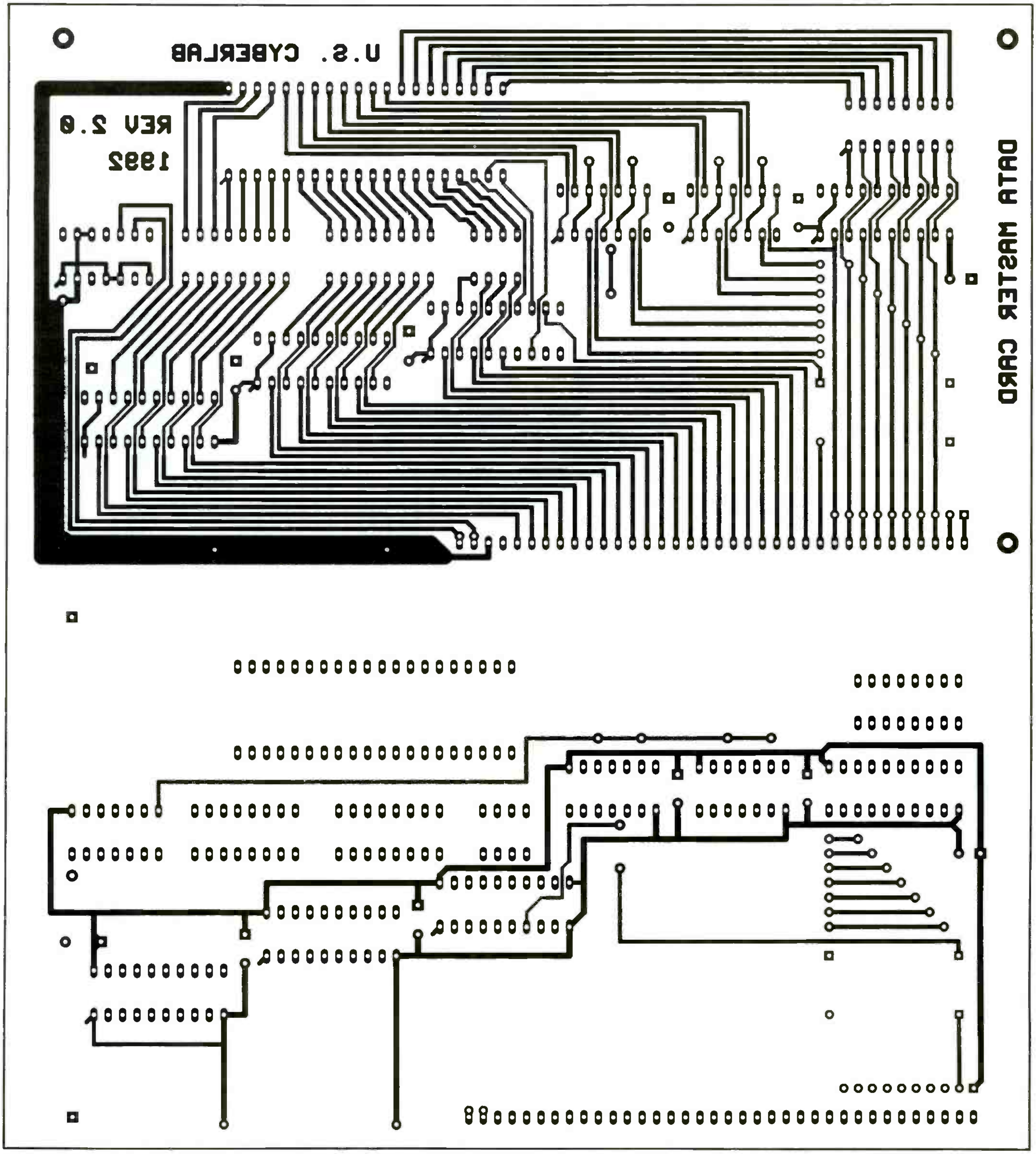


Fig. 7. Actual-size printed-circuit artwork for (A) Master Control Card; (B) Data Master Card; (C) Data Slave Card; and (D) Bus Card.



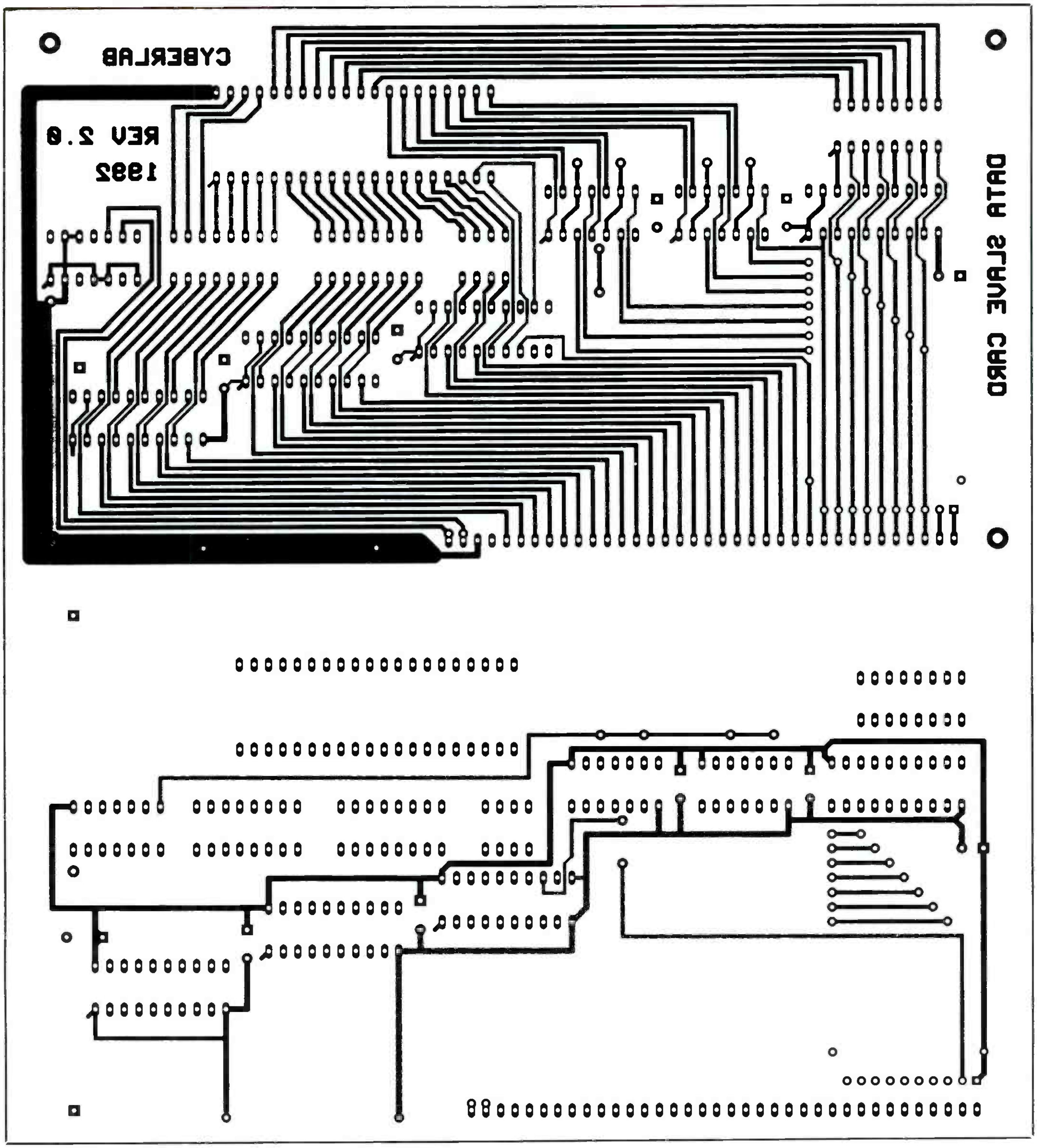
(B)

respective locations. Position *P2* to give soldering access on top of the board. Configure the MEMW, MEMR, IOW and IOR lines for Master mode.

Wire the Slave Control Card next, following the same procedure detailed above. However, make sure you configure this card as a Slave. Again, use Fig. 8 as a wiring guide.

Construction of the Data Master and Slave Cards is similar to that for the Master Control Card and is detailed in Fig. 9. Begin by placing the damping resistors in all shunt locations, as indicated. Mount the capacitors and install the through-board via wires. Solder 40-pin header socket *P1* into place. Then mount the ICs, directly or via sockets.

Mount SIP resistor pack *R21*. Place the small dot at one end of it in the

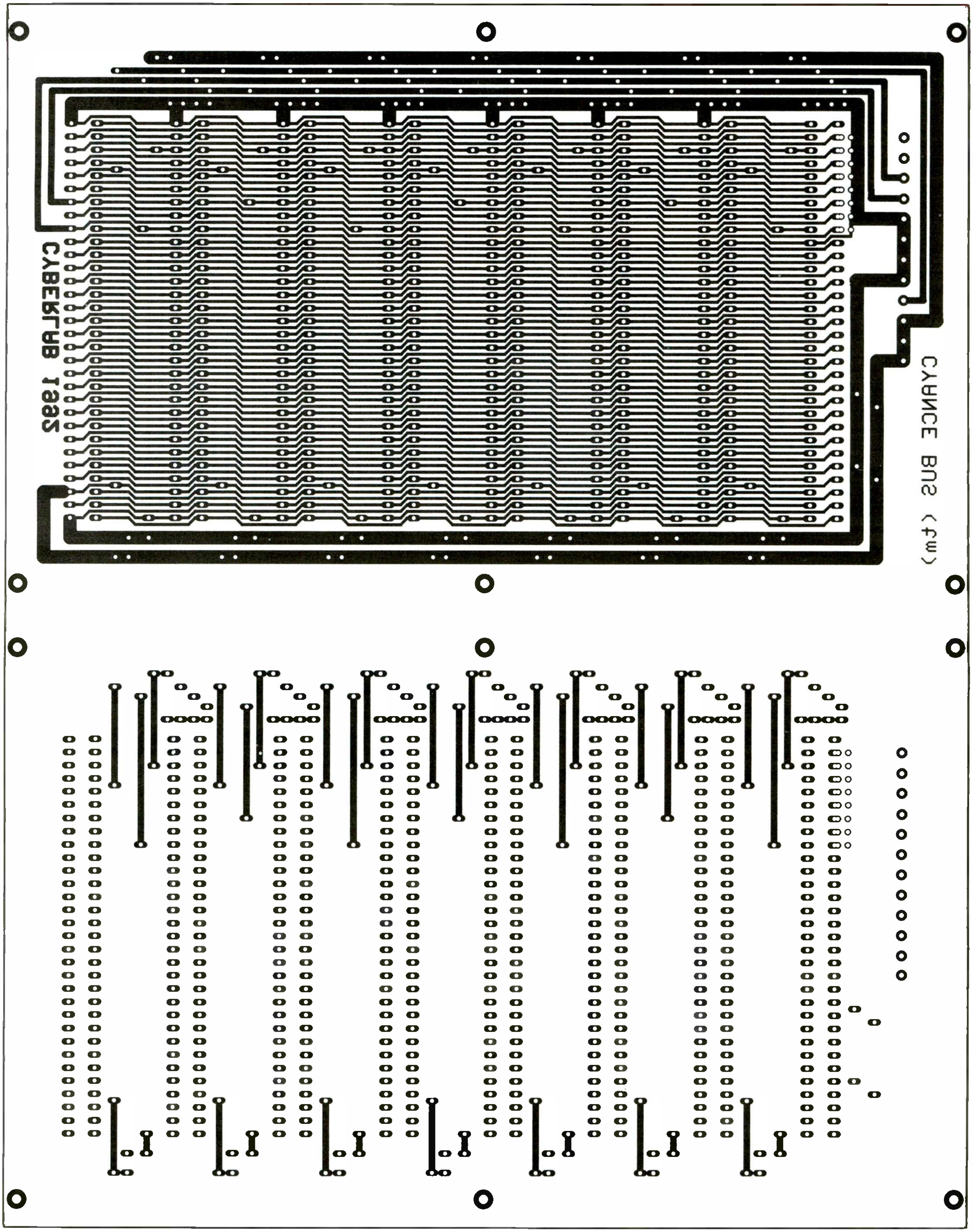


(C)

square pad +5-volt hole. Mount *D1* and *D2*, and finish up by mounting *P2* on the bottom side of the card.

You wire the Data Slave Card exactly the same as you did the Data Master Card, except for the damping resistors and jumpers. Use Fig. 9 as a guide. Also, notice that the value of SIP resistor pack *R21* changes to 470 ohms and extra 470-ohm *R10* discrete resistor installs next to it.

The Bus Card is the backbone of the Bus Expander. If you're using the single-sided board option, first be sure to install No. 22 wire jumpers in place of the traces for the component side of the board (see Fig. 10 for wiring details). Then install and solder into place the 62-contact bus card-edge connectors flush with the top surface of the card.



(D)

Install the power connector and supply-line capacitors as shown. If you plan to mount the Bus Card inside the CYANCE enclosure, use the mounting holes, screws and spacers. However, if you plan to use the Bus Card on a benchtop, press five or six self-stick square rubber feet on the bottom of the card to permit the bus to free-stand on your bench.

Two 40-conductor ribbon cables with 40-pin IC headers at each end are required. Make your cables only as long as needed for your setup, but not longer than 10 feet. Keep in mind that the longer the cable, the greater the chance of bus signal distortion at high clock speeds. Also, make sure the cables are the same length.

Use a vise or connector crimping tool to secure the IDC (insulation-displacement connector) header on the cable. If you use a vise, place a piece of metal, plastic, or wood that fits between the two rows of pins on the header to protect the pins as you clamp down. Your protector block should be about 0.100″ taller than the header pins to protect them as the vise snaps the rear shell of the connector into place.

Your ribbon cable will probably have a colored stripe along one side to indicate line 1. This conductor will really go to pin 2 if you check, but it won't matter, as long as the color strip is at the correct end of the header.

Install the first header so that the red strip is on the left side of it, with the header pins facing away from you, and pin 1 in the lower-left corner.

With the first header installed on one end of the cable, hold the cable ends up together so that the cable hangs down and forms a U shape. Install the second connector in the same manner as the first. When you're done, set the cable on a table so that the header on your left has its pins facing away from you. Now, with the cable stretched out flat on the table, the pins of the header on your right should be facing you.

Make both cables in the same manner. When you plug the headers in the sockets on the Control and Data Cards, you can put a 90° fold in the cable so that it runs out the front of the assembly.

With your Bus Expander completed, it's a good idea to go over everything one more time. Check for proper wiring (components installed in the proper locations and properly polarized or oriented), missed solder connections, etc. Make absolutely certain that your work is correct. Remember that you are getting ready to plug the Bus Expander system into a slot on your computer's motherboard and mistakes can be costly.

Checkout

To properly check your CYANCE Bus Expander, you need an oscilloscope. Though meters are okay for making static measurements, you must be able to view the waveforms on the bus. For this, a scope is the only practical instrument to use when viewing the activity on individual contacts on both buses.

Begin checkout by connecting the CYANCE Bus Card to the power supply in the CYANCE enclosure. Use Fig. 1 from last month to verify all pinouts for the buses. Then use the scope or a DMM to check the voltage outputs of the power supply.

When you're satisfied with the connections, apply power to the CYANCE Bus Card without any other cards plugged into its bus connectors. Now check the various power pins to make sure the proper voltages appear at each pin in each connector. If everything isn't in order, power

PARTS LIST

Master Control Card

Semiconductors

U1 thru U6—74S240 buffer

Capacitors

C1 thru C7—10-μF, 16-volt electrolytic

Resistors (¼-watt, 5% tolerance)

R1 thru R13—100 ohms

Miscellaneous

P1—40 pin DIP IC socket

P2—36-pin male single-row connector

Printed-circuit board; IC sockets (see text); solder; etc.

Slave Control Card

Semiconductors

U1 thru U6—74S240 buffer

Capacitors

C1 thru C7—10-μF, 16-volt electrolytic

Resistors (¼-watt, 5% tolerance)

R1 thru R9—100 ohms

Miscellaneous

P1—40 pin DIP IC socket

P2—36-pin male single-row connector

Printed-circuit board; IC sockets (see text); solder; etc.

Data Master Card

Semiconductors

U1,U2,U3,U6—74S240 buffer

U4,U5—74S38 quad two-input NAND gate with open collectors

U7—74S00 quad two-input NAND gate

D1,D2—1N4148 switching diode

Capacitors

C1 thru C6—10-μF, 16-volt electrolytic

Resistors (¼-watt, 5% tolerance)

R1 thru R20,R22 thru R29—100 ohms

R21—2,200-ohm SIP pack

Miscellaneous

P1—40-pin DIP IC socket

P2—36-pin female single-row connector

Printed-circuit board; IC sockets (see text); solder; etc.

Data Slave Card

Semiconductors

U1,U2,U3,U6—74S240 buffer

U4,U5—74S38 quad two-input NAND gate with open collectors

U7—74S00 quad two-input NAND gate

Capacitors

C1 thru C6—10-μF, 16-volt electrolytic

Resistors (¼-watt, 5% tolerance)

R1 thru R8—100 ohms

R10—470 ohms

R9—470-ohm SIP resistor pack

Miscellaneous

P1—40-pin DIP IC socket

P2—36-pin female single-row connector

Printed-circuit board; IC sockets (see text); solder; etc.

Bus Card

Capacitors

C1 thru C28—10-μF, 16-volt electrolytic with radial leads

C29—47-μF, 16-volt electrolytic with radial leads

C30—1-μF, 16-volt electrolytic with radial leads

C31 thru C37—10-μF, 16 volt electrolytic with axial leads

Miscellaneous

P1 thru P8—62-pin card edge connector with contacts on 0.100″ centers

P9—12-pin male PC power connector

Printed-circuit board; solder; etc.

Note: The following items are available from U.S. Cyberlab, Inc., Rte. 2, Box 284, Cyber Rd., West Fork, AR 72774 (tel.: 1-501 839-8293 or 1-800-232-9865 voice only): All five double-sided pc-board kit with holes not plated-through, $79.95; complete CYANCE Bus Expander electronic kit, including pc boards, $169.95. Add $4.95 P&H. Akansas residents, please add 6% sales tax. MasterCard and Visa welcome.

down and correct the problem. Do *not* proceed until you're certain everything checks out okay.

Next, connect a clip lead with a 4,700-ohm current-limiting resistor to the +5-volt terminal of the power connector to make a signal injector that you'll use to check the other pins across the bus.

Using Fig. 1 as a guide, work your way up and down the contacts of the slot 8 connector. Apply +5 volts through the 4,700-ohm resistor while checking for +5 volts along the entire length of the bus. Your scope or meter should indicate about 4.5 volts. If you find that this voltage is grounded, shorted to another pin, or absent, power down and correct the problem.

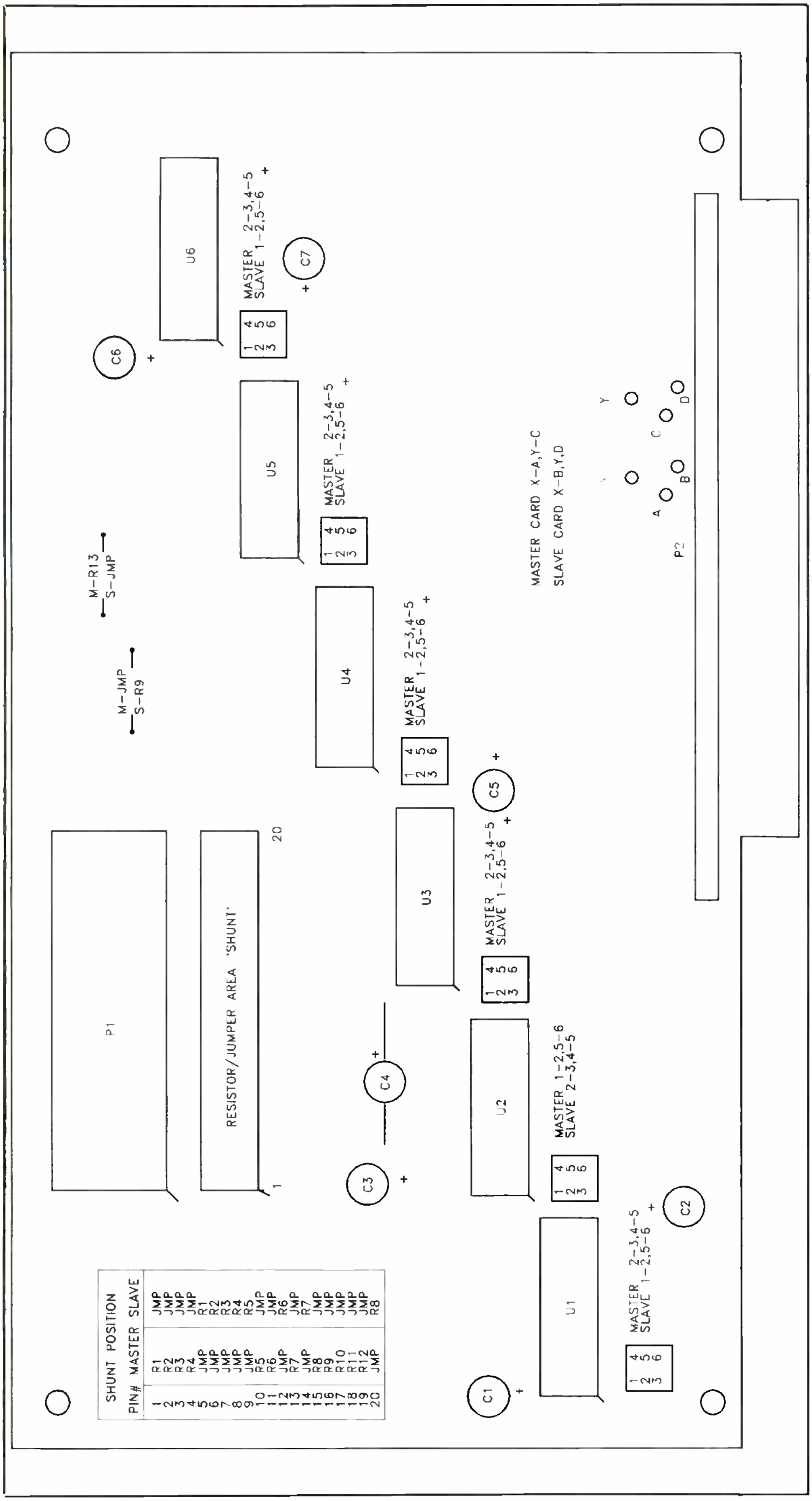
If you encounter a location where the measured potential is down about 1.5 to 3 volts (don't be fooled by the various power-supply pins), the low reading probably indicates a resistive short caused by excessive flux in the solder at that connection. The solution is to clean your CYANCE Bus Card with a good-quality solvent.

At each contact location, check the contacts immediately adjacent to it as well. If a copper-trace bridge or solder bridge is shorting two or more pins together, clear it now.

With the Bus Card in front of you on a nonconductive surface and the CYANCE enclosure's power supply shut down, connect the two together. Make absolutely certain you make this connection properly and that no other cards are plugged into the slots on the Bus Card. Plug the Master Control Card into slot 1. With the power-supply connector at the far end of the Bus Card (away from you), the Master Control Card should have its foil side toward you.

Warning: Because the Bus Card is out in the open during this procedure, it's very easy to lose track of which edge is the front of it. Plugging in a peripheral card backwards will more than likely destroy it in an instant! So keep double-checking yourself on orientation! I put a small sticker on the front of my Bus Card that identifies it as such. You should do the same.

With the Master Control Card in place, power up the supply in the CYANCE enclosure while monitoring the +5-volt power bus. If the measured potential comes up to about 4.5 volts, everything is okay. If you



	SHUNT POSITION	
PIN#	MASTER	SLAVE
1	R1	JMP
2	R2	JMP
3	R3	JMP
4	R4	JMP
5	JMP	R1
6	JMP	R2
7	JMP	R3
8	JMP	R4
9	JMP	R5
10	R5	JMP
11	R6	JMP
12	JMP	R6
13	R7	JMP
14	JMP	R7
15	R8	JMP
16	R9	JMP
17	R10	JMP
18	R11	JMP
19	R12	JMP
20	JMP	R8

Fig. 8. Master wiring guide for Master/Slave Control Cards.

should observe a low voltage or no voltage at all, power down and re-check everything.

Once you're sure everything is okay, power up again. Checkout of the Master Control Card is relatively unstructured because it would take a written procedure about the size of this entire magazine to do it right.

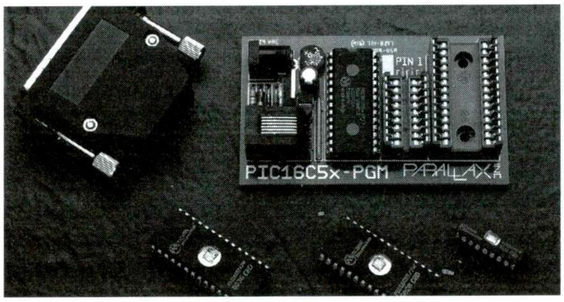
Because the 74S240 buffer ICs are inverters, you have only to use a grounded clip lead to check each input. Place your scope or DMM on any particular output pin of the buffer IC under test. (Be sure to note which "bank" is enabled by the direction control voltage on pins 1 and 19. This selects which pins are inputs and which are outputs.) You can make an output go high by grounding the appropriate input pin or connector pin. Use this method to check each buffer, and compare what you see with the schematic and layout drawings. If you discover anything unusual, power down and correct the problem. This test is very important because it locates most problems very quickly.

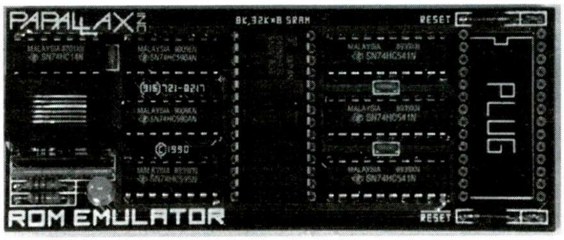
When you're certain everything is in order, power down and remove the Master Control Card from the Bus Card slot. Then, still with power off, plug the Slave Control Card into the bus (remember to observe proper orientation), and test it in the same manner as you did for the Master Control Card. Remember, though, that the Slave Control Card's inputs and outputs are the opposite of those of the Master Control Card.

Power down and plug the Master Control Card back into the Bus Card, and plug the Data Master Card onto the Master Control Card, leaving the spacers and screws off at this point. Testing both Data Cards is the same as for the Control Cards.

Check each input using the grounded clip lead, and check for output switching at the appropriate output pins. (Make sure you ground only the input pins, not the outputs. Though it's unlikely, shorting the outputs of these chips could damage the buffers.)

To test the 74S38 ICs, you must ground pins 9 and 10 of *U7* to force high output pin 8 of this chip and enable *U4* and *U5*. Then use a 4,700-ohm series resistor connected to the +5-volt power connector to "probe" the inputs at pins 1, 4, 10 and 13 of *U4* and *U5*. The appropriate open-collec-





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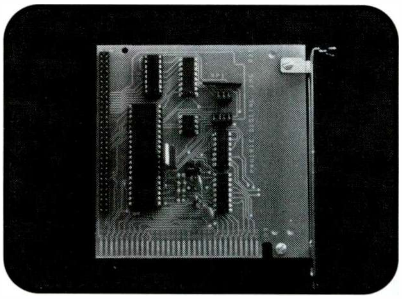

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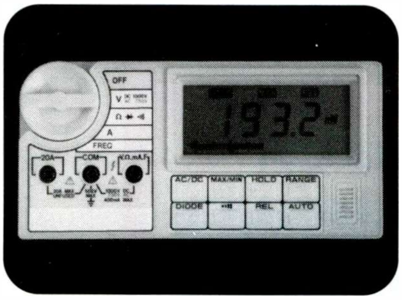

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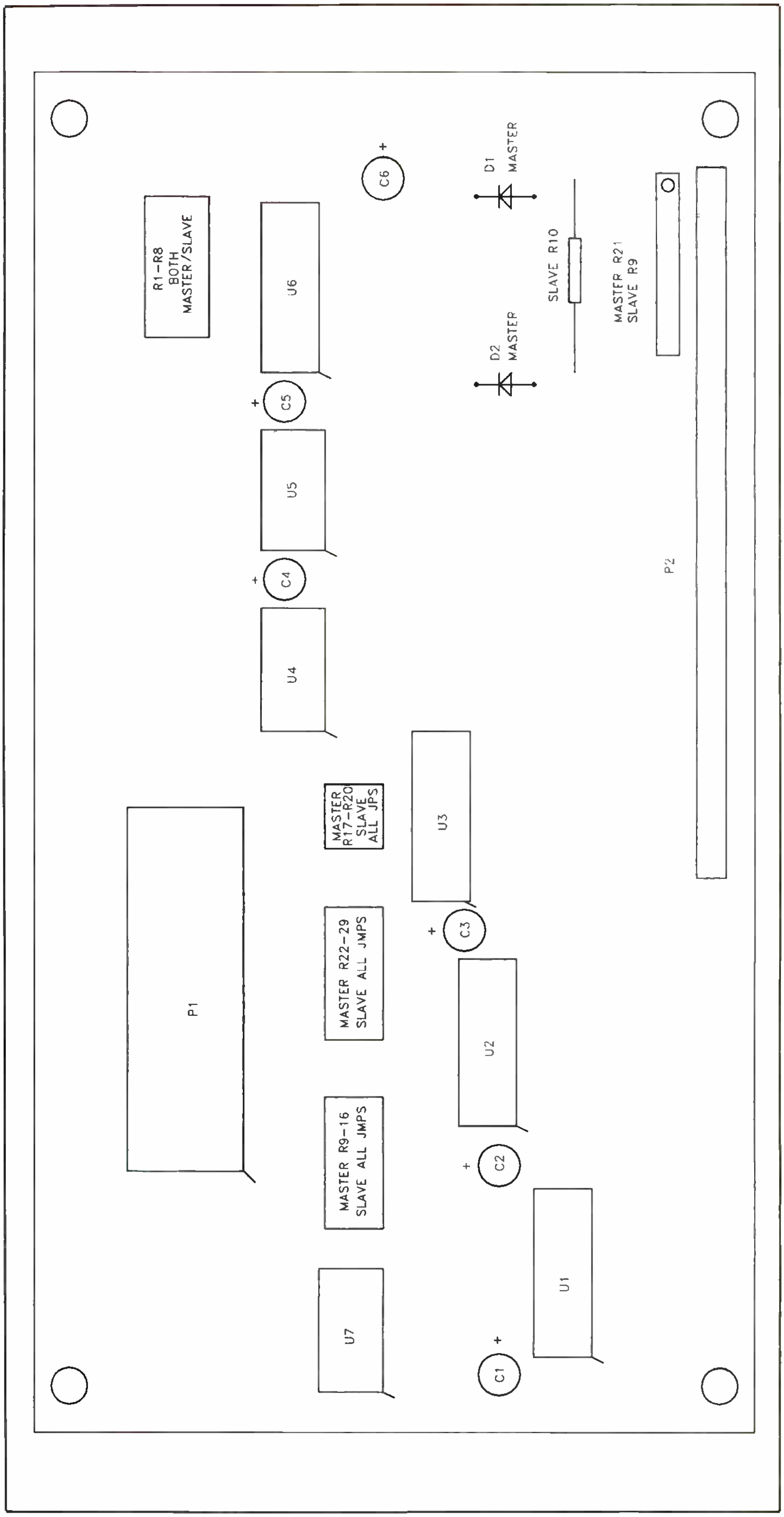

Fig. 9. Wiring details for Master/Slave Data Cards.

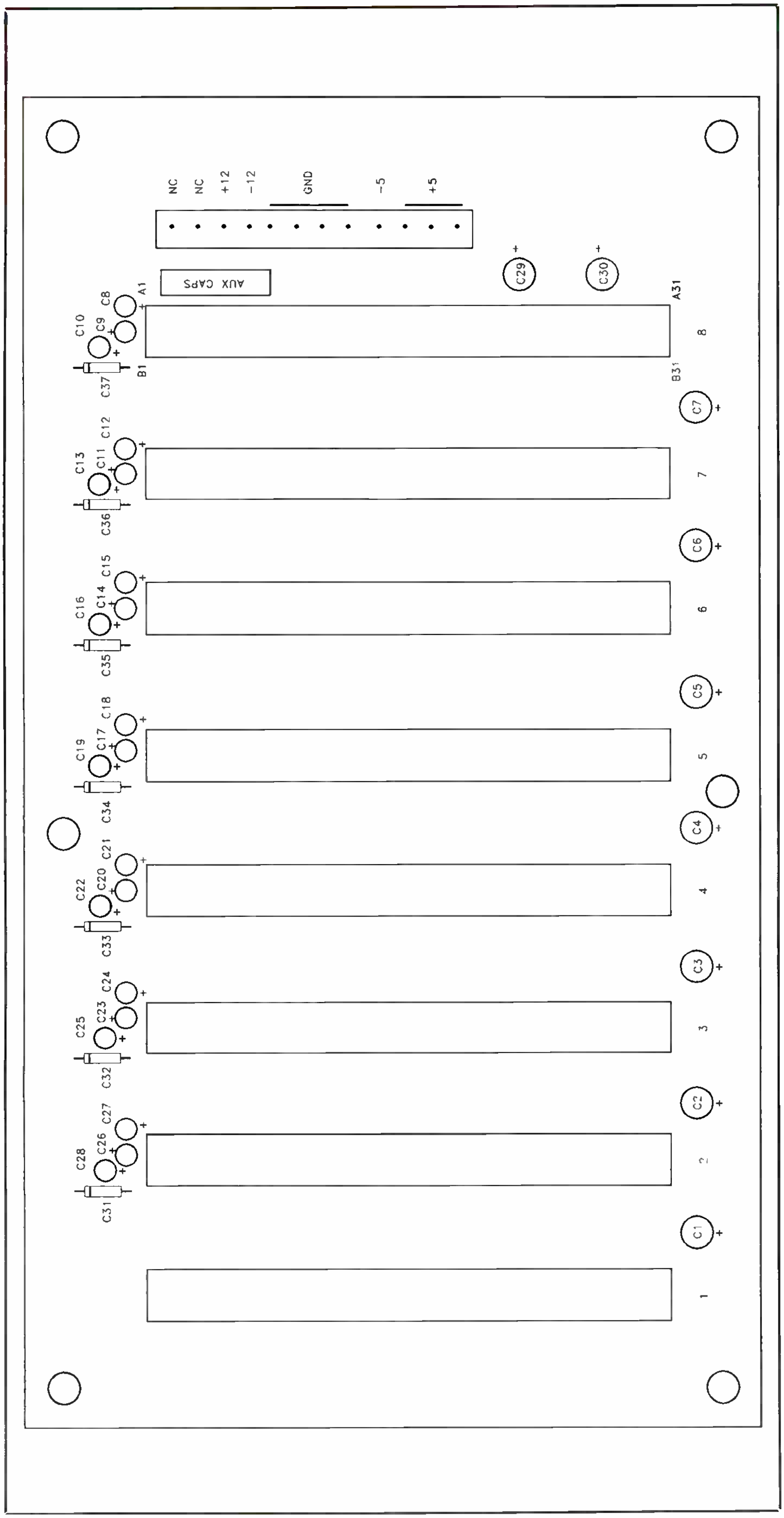

Fig. 10. Wiring details for Bus Card.

tor output pin should pull down to near ground potential as you apply the input voltage.

Power down and repeat the above procedure with the Slave Control Card onto which you've plugged the Data Slave daughterboard. Checkout of this pair of cards is almost identical to that detailed above. Use the appropriate schematic and layout drawings as guides as you make your tests. When everything checks out okay, you're ready to proceed to installation of the CYANCE Bus Expander in the CYANCE enclosure.

Installation

With the CYANCE Bus Card either mounted in its enclosure or out on your work surface, plug the control cable into the Master Control Card. Then plug the data cable into the Data Master Card and attach it to the Master Control Card. If you feel confident that everything is okay, put the spacers and screws in place.

With no power applied to either your computer or the Bus Expander, plug the Master assembly into slot 8 of your computer's motherboard. (Slot 8 is the one closest to the processor on most motherboards.) If necessary, move your video card or any other card that might be occupying slot 8 to another slot. Then unplug all other peripheral cards from your motherboard, making a note of from which slot you removed each card. The only items you should have plugged into the bus slots of your computer's motherboard should now be a video card and the Master assembly.

Connect the control cable to the Slave Control Card and the data cable to the Data Slave Card. Now plug the Data Slave daughterboard to the Slave Control Card with spacers and machine hardware. Finally, plug the Slave assembly into the Bus Card.

Turn on CYANCE's power supply and check for proper operating supply voltages. If everything checks out okay, turn on your video monitor and wait a few seconds for it to warm up. With your scope or DMM probe placed on the +5 volt pin of your PC's motherboard power connector, turn on your computer. If the +5 volt supply doesn't appear normal, power down and recheck everything.

Once the +5-volt bus is operating

properly, leave the power to your PC on and watch for signs of the BIOS booting on your video monitor. It should come up in the usual manner. This is a good sign that your motherboard doesn't mind having the Master assembly "on-board." You will soon see a message on-screen that states something like, "Can't continue without disk!" If your system makes it to this point, simply power down your computer and switch off the CYANCE Bus Expander.

Next, plug a peripheral card into any free slot on the CYANCE Bus Expander. (Again, watch for proper orientation if the Bus Card isn't installed in the CYANCE enclosure!) I prefer to use a modem card or serial card for this test. Power up the Bus Expander and then your computer. The latter should boot as before and give the same message about needing the disk. If your system does this successfully, it means the CYANCE Bus Expander isn't interfering with operation of your computer's motherboard. Once again, power-down both units.

Now plug your floppy-disk (or combined floppy/hard-disk) controller into the bus on your PC's motherboard. Connect the power and data cables to your floppy disk but *not* to your hard disk. Place a bootable diskette in floppy drive A and close the door on the drive. Power up first the CYANCE Bus Expander and then your computer. The system should boot and load the operating system from the diskette.

With DOS loaded, try a directory (DIR) command. If you see a directory listed on the screen of your video monitor, try loading BASICA or some other program and make sure that it performs properly. Exit whatever program you just loaded and checked out and then load a terminal program that can access your remote modem or serial card. If the CYANCE Bus Expander is functioning properly, you will obtain normal operation.

The acid test for the CYANCE Bus Expander is to power down completely and move first the disk controller, followed by the video card out onto the CYANCE Bus Card. On power-up, your system may or may not work with this hardware configuration. If it doesn't, your system may be too fast to allow this type of operation. If this is the case, you needn't worry because you should really keep your video, disk controller and memory-expansion cards as close as possible to the processor on your computer's motherboard. Simply locate less-demanding cards in your Bus Expander unit.

In Conclusion

Before signing off, I should mention that I've included pads on the CYANCE Bus Card for some small 100- to 1,000-pF capacitors to be installed if they're needed to get your system running smoothly. One computer with which I tested the CYANCE Bus Expander wouldn't permit the disk controller to operate on the CYANCE Bus Card without 1,000-pF capacitors installed across the data bus. If you find that your particular systems requires this type of modification, install the capacitors on the CYANCE Bus Card.

Remember that the CYANCE Bus Expander is basically an experimental PC bus platform. As such, perhaps you can improve upon the operation of the basic unit by making changes that enhance its performance. If so, you might want to share your ideas with other users on the CYBERNET bulletin board. To access the NET, simply call 501-839-8293 after 6 P.M. CST. The network is available to all *ComputerCraft* readers who are interested in exchanging information and ideas.

Nick Goss

Making Double-Sided Boards

In professional circles, double-sided printed-circuit boards have "plated-through" holes (called "vias") that provide conductive bridges between the conductor pattern on one side of the board and that on the other side. The plating that "bridges" the two sides of the board is accomplished using a complex number of steps, using expensive and specialized equipment not normally available to hobbyists and experimenters.

With plated-through holes, ordinary components and hardware are used to assemble a circuit using ordinary soldering techniques. If you fabricate your own boards, you won't be able to plate-through the required holes. Therefore, you have two alternatives from which to choose when making your own boards. One is to go single-sided and replace the conductors on the side that has the lesser complex conductor pattern (usually the "component" side) with wire jumpers. The other is to go double-sided but make provisions for soldering access on *both* sides of the board through which a component lead or pin or a wire passes.

The CYANCE Bus Expander described in the main article was designed so that you can fabricate your own cards at home, using essentially the same techniques you'd employ for two separate single-sided cards.

Transfer the four mounting-hole positions at the corners of your boards from the artwork to the copper surface of the blanks with a sharp pin, awl or hobby knife. Then drill the holes in the marked locations with a No. 68 bit. This step allows you to register the artwork on the pc blank while exposing each side.

When you set up for exposing the boards, make sure to keep track of which side of the artwork is inside and which is outside. Otherwise, you may end up making your boards inside out!

Expose the pc blanks and then develop and etch them as you would a single-sided board. Be careful to avoid scratching the resist on the sides facing away from you as you agitate the boards in the etchant.

When etching is complete, drill all appropriate-size holes. The boards for the Bus Expander were designed to minimize the number of connection that must be soldered on the component side. In addition to several IC pins that must be soldered to the pads on both sides of the board, you must use solid bare hookup wire as "feed-throughs" that take the place of vias in a number of locations.

This process may be a little more time-consuming than for a single-sided board, but it's worth the effort. Its only major limitation, aside from the extra time needed to solder connections on the component side of the board, is that some connectors must be raised slightly to give soldering access to the pins between connector body and board. This shouldn't be a problem if you keep this in mind when you position the connectors.

By Hardin Brothers

Adding Mouse Support to Your Programs

Making programs respond to mouse commands can be deceptively simple

When Apple introduced the Macintosh computer, many PC users commented that they'd never be caught with a mouse on their desks. Today, desktop rodents are a familiar part of most computers, whether they use DOS, Microsoft *Windows*, the Macintosh operating system or something more exotic.

If you're a programmer but have never written a program that makes use of a mouse, you may think that adding mouse control is difficult. On one level, at least, it's very easy to include mouse support in your programs. The mouse driver, MOUSE.SYS or MOUSE.COM, supplied with every mouse does the work of displaying the mouse cursor, moving it around the screen and interpreting button clicks.

Your software communicates with the mouse driver with simple interrupt calls. Your software can ask for the status of the mouse, its current position and whether a button click has occurred. If the mouse driver senses a button click, it tells your program the screen coordinates of the cursor when you press the button and which button is pressed. Your software can also use the mouse driver to set the text and graphics mouse cursor, turn on and off the mouse cursor, position the cursor anyplace on-screen and ask the mouse driver to perform a number of other housekeeping tasks.

It's all pretty simple, but deceptively so. The only rule you have to follow is to turn off the mouse cursor before you update the screen and then turn back on the cursor to avoid having "ghost" mouse cursors showing up all over the screen. Otherwise, communicating with a mouse is simpler than working with any other piece of computer hardware except, perhaps, the keyboard.

```
Menu:
    Display Menu
    Get User's Choice
    Call Chosen Routine
    Go to Menu:
```

Fig. 1. A simple menu system.

It doesn't take most programmers long to realize that learning to communicate with the mouse driver isn't enough. Unless your program insists that input come from the mouse instead of the keyboard, you'll want to create a modern mouse-and-keyboard interface. And you'll find that doing so brings you face to face with all sorts of complications. For example, suppose your program begins, as many do, with a full-screen menu. No matter what programming language you use, the menu routine will look something like that shown in Fig. 1.

In a keyboard-only application, the second step, getting the user's choice, may mean that you simply get a keystroke or input line. Even if you add a moving cursor bar to let the user highlight each choice and then press ENTER, the code is quite simple, as illustrated in Fig. 2.

```
    Put cursor bar on default item
Get User's Choice:
    Wait for a key
    If it is a cursor key
        Move the cursor bar
    If it is a "hot key"
        Move cursor bar to keyed item
    If it is an Enter key
        Select highlight item
    If no item is selected
        Go to Get User's Choice
```

Fig. 2. Get the User's Choice (keyboard only).

Now add a mouse. You have several choices here. If you wish, you can turn off the mouse cursor and interpret mouse movements as if they're cursor keys and the mouse click as if it's the ENTER key. Lots of programs do this, and they're almost all unsatisfactory. The problem is that users expect the mouse to act differently from the keyboard. They expect the mouse cursor to move smoothly over the entire screen and the cursor bar to move when the mouse cursor touches new menu items.

If you want to please users, the "Get User's Choice" portion of your menu routine will suddenly seem pretty complicated. It may end up looking something like that shown in Fig. 3.

Notice that all we've done so far is implement a simple, full-screen menu. Now add a data-entry screen with several fields. In a keyboard-only program, it's a simple matter to move through the fields one at a time, insisting that the user fill in each before moving on to the next one. If the program needs to be "friendly," you'll probably want to add some way to let the user move backwards and edit some text again. You may even want

```
Put cursor bar on default item
  If mouse is installed
    Turn on Mouse Cursor
Get User's Choice:
  Poll the Keyboard
    If a Key is available then
      If it is a cursor key
        Turn Off Mouse Cursor
        Move the cursor bar
        Turn On Mouse Cursor
      If it is a "hot key"
        Turn Off Mouse Cursor
        Move cursor bar to keyed item
        Turn On Mouse Cursor
      If it is an Enter key
        Select highlighted item
  If no item is selected and mouse is installed
    Poll the Mouse
    If the Mouse has moved
      If the Cursor is on a choice
        Turn Off Mouse Cursor
        Highlight Item under Mouse Cursor
        Turn On Mouse Cursor
      Else ignore mouse movement
    If Left Mouse Button Click
      If the Cursor is on a choice
        Select the item
      Else ignore the click
  If no item is selected
  Go to Get User's Choice
```

Fig. 3. Steps for Get User Choice (mouse plus keyboard).

to provide context-sensitive help with the F1 function key.

When you add a mouse, the complexity of your code increases. The user will probably expect to select edit fields with the mouse, move the editing cursor in a field with a mouse and be able to select a block of text inside a field by dragging the mouse. You'll have to keep track of which fields haven't yet been filled, you'll need more-complex editing procedures and you may want to add a clipboard of some sort. You'll need to know where every edit field is to match the mouse coordinates with screen locations. And you'll probably want to add an "Okay" button to accept the entire form, a "Help" button for context-sensitive help and maybe other buttons to run the clipboard.

Of course, your program will have to keep track of all these buttons and edit fields to know how to react to every mouse click as well as every keystroke. And every routine that accepts keystrokes will also have to know how to react to mouse activities. If you then decide to add a series of pull-down menus that can be activated with either the mouse or the keyboard, you'll have a mass of confusing input instructions and tests.

If you decide to change the arrangement of input fields, entries in the menus, locations or sizes of the buttons or anything else, you'll face a nightmare. You'll have to change all input routines and location tests throughout the entire program.

A Different Look

Don't throw up your hands in frustration and vow to work with keyboard-only programs forever. There's a much easier way to handle all this complexity. You may eventually find that it's easier to write a program with a modern user interface than it is to write an old-fashioned program.

Early computers ran batch-oriented programs. An operator gave the machine a program to run and a batch of data, often on punch cards or tape, and let it grind away until it had a result. The "user," if there was one, simply told the computer operator what program or data set to run and often had to wait hours or days to obtain the results.

Time-sharing terminals and personal computers ushered in an age of procedure-driven or "modal" programs that change from one mode to another as user and program move from one procedure to another. It's up to the application designer and programmer to decide what capabilities of the program are available in each possible mode. For example, many word processors leave edit mode and its capabilities when print mode is selected.

It's very difficult to add a modern user interface, complete with keyboard and mouse support and pull-down menus, to a modal program. Users expect to be able to access any mode through menus, but the underlying program is written to work in one mode at a time.

In the last few years, programmers have been slowly adopting a completely different way of organizing programs. Their goal is to write "modeless" programs that always have all program capabilities available to the user. While few, if any, major applications are completely modeless, many programs approach this ideal. Instead of being organized by procedures, they're organized around "events."

An event in this sense is anything that can create a signal. It may be a keystroke, mouse movement or button click or a character arriving at a serial port, for example. It might also be generated internally by the program. At the heart of a program organized by events is an Event Manager that collects events and places them in a queue or first-in/first-out (abbreviated FIFO) buffer.

The Event Manager is responsible for sending event signals to the parts of the program that need them. For example, in the data-entry screen I described above, assume the user has selected a block of text. If he now clicks the mouse on "Edit" on the menu bar, the Event Manager sends the mouse click to the menu system.

The menu system could then drop down the Edit menu. If the user next clicks on "Cut" to move a block of text to the clipboard, the menu system might recognize this selection as a synonym for the Shift-Delete keystroke. Instead of performing the cut itself, it would send the Shift-Delete event to the Event Manager, which would handle this event just as if it had been typed instead of selected from a menu.

Now the Event Manager would send Shift-Delete to the input-editing routine, which would remove the text from the edit field and send it to the clipboard. At a later time, the user can press the appropriate keys (Shift-Ins, perhaps) or select "Paste" from the Edit menu. The input-editing routine could then request the text from the clipboard.

The advantage of using an Event Manager is that user input and inter-procedure signals are handled in a consistent and simple manner. The user has wider access to the program's capabilities, and the program is much easier to update and change. It's easy to add another menu item and a new signal—much easier than it is to add a new feature to a program that has all its procedures communicating directly with each other.

There are some complications to the above, however. One is how to organize the Event Manager. If the Event Manager spends all its time polling the keyboard and mouse, there will be little processing power left for the program itself. Therefore, the Event Manager often gathers user input through a series of interrupts.

Handling the keyboard through interrupts is easy. Each time the user presses or releases a key, the keyboard hardware creates an INT 09 interrupt. Normally, the BIOS handles this interrupt by translating the hardware key number into the appropriate ASCII signal and placing the key into the BIOS type-ahead buffer. An Event-based program can either monitor or take over INT 09. If it simply monitors the interrupt, it knows when to call the BIOS to collect each keystroke as it appears. If it takes over INT 09, it can interpret each keystroke itself.

Mouse events can also be collected through interrupts. One of the mouse-driver services tells the driver that a program wants to be interrupted whenever a mouse event occurs. The Event Manager merely has to register the appropriate function with the Mouse Driver.

The Event Manager will probably want to be called every time the mouse moves to support dragging items around the screen, but most systems don't record every mouse movement as a separate event. If the user moves the mouse back and forth across the screen several times, a huge number of events are recorded, which can overflow the event queue. Instead, mouse movements are usually accumulated into a single event until the signal is sent to a receiving procedure. However, mouse button clicks and releases, along with the mouse position when they occur, are usually stored as individual events.

The Event Manager can also capture and store system timer ticks, characters received through a serial port and other hardware events in a similar fashion. In some systems, the Event Manager really becomes a generalized interrupt handler, taking care of several kinds of hardware events.

Another complication is how the Event Manager sends event signals to the correct procedures. Though there are several possible methods to accomplish this, the simplest seems to be for the Event Manager to keep a list of procedures that are eligible to receive event signals. It maintains this list in order of eligibility.

When it's time to send a signal, the Event Manager sends it to the most-eligible procedure first. It does this by calling this procedure and sending to it the details of the event as a calling parameter. The procedure checks to see if the signal is, indeed, meant for it. If so, it does whatever needs to be done with the signal, responding to the particular keystroke, mouse click or other signal type as it sees fit. It then marks the signal as used and returns to the Event Manager.

If the procedure can't handle the signal, it simply returns to the event manager, which then calls the next procedure on its eligibility list. If the Event Manager has called all procedures on its list and the signal still hasn't been marked as used, the Event Manager normally calls a default procedure that simply discards the signal as meaningless for the system.

The procedure at the top of the eligibility list is often said to "have the focus" because it usually takes care of standard keyboard input. Mouse clicks are usually handled by the first procedure that owns the part of the screen in which the click occurred. However, a procedure like an open menu bar can react to a mouse click away from its part of the screen by simply closing the menu and marking the signal as used.

Event-Based Systems

Event-based or event-driven systems require programmers to change their way of thinking about a program. Instead of a set of procedures that are tightly interrelated, an event-driven program is more like a loose confederation of independent routines. In many ways, such programs are easier to write than are conventional applications because the members of the confederation can often be written, tested and debugged separately.

The underlying Event Manager is critical to the success of the entire system. Many programmers prefer to work with an existing, proven system instead of creating their own. One event-driven system, Microsoft *Windows*, is well known. For programmers, *Windows* can be frustrating to learn because it provides such a large number of program services and can send so many different messages and event signals to each program's procedures.

Another Event-based system that's gaining a great deal of popularity is Borland International's *Turbo Vision*, which is available with the newest versions of the company's Pascal and C++ compilers. *Turbo Vision* requires programmers to understand how to use the object-oriented features of C++ or Pascal because it relies heavily on classes, inheritance and virtual functions. If you're familiar with either C++ or Turbo Pascal, *Turbo Vision* will help you create very powerful character-based programs while it takes care of the user interface. Once you understand how the system works, you'll find using it is quite simple. Other event-driven systems are also available.

If you prefer, you can write your own event-driven programs from scratch. Languages that can call functions by a pointer, like C, are ideal for this, because the list of eligible signal receivers is easy to maintain. Also, such languages usually make the event-gathering portions of the Event Manager easy to write. But there's no inherent reason why you couldn't write an event-driven program in *QuickBASIC*, for example, as long as you're willing to add a couple of assembly-language routines. GW-BASIC, however, is probably out of the running because of its severe limitations.

Event-based programming isn't a substitute for the structured programming techniques that most of us have learned. Instead, it's an extension of those techniques that makes modern and complex programs easier to build. For short programs that you'll run once or twice and then discard, it's probably more trouble than it's worth. But for professional-looking programs you can enlarge and improve upon without causing a rat's nest of confusion, it's the best technique currently available. ■

Detecting & Measuring Physical Parameters

How to Use Sensors to Detect and Measure Just About Anything

Who makes sensors to measure carbon monoxide, ultraviolet radiation or fluid velocity? Is there a sensor that can detect cracks or bumps on a surface? How can a sensor's ± 12-volt output interface to a + 5-volt microcontroller? Is there a way to interface an analog voltage to a microcontroller port without using eight or more data lines?

You can do lots of interesting things with sensors if you know where to find what you need and how to use the sensors once you have them. This article will help you in finding and using sensors in your microcomputer circuits, including finding the right sensor for your application, interfacing sensors to microcontrollers and a microcontroller and BASIC compiler for data-acquisition (and other) applications.

As usual, my focus will be on designs that use microcontrollers and other dedicated single-purpose computers, rather than general-purpose personal computers, although you certainly can interface sensors to personal computers as well.

Sensor Basics

A sensor is a device that responds to a physical variable, such as temperature, light, chemical composition, motion or electrical properties. Other terms for sensor include detector and transducer. Table 1 gives a more extensive list of sensor types, which clearly shows that you can use sensors to detect and measure all kinds of variables, properties and conditions in the world around you.

In addition to differences in what they respond to, sensors also vary in how they respond. A weather vane, for example, responds to changes in wind direction by rotating, while a strip of litmus paper responds to acidity by changing color. We'll concentrate here on sensors that respond electrically, usually with a change in voltage, current or resistance because these qualities are most easily detected and measured by electronic circuits.

Finding Sensors

Some sensors are readily available. These include thermistors, which respond to temperature, and photodiodes and solar cells, which respond to light. (See "A Sensor Roundup" in the February 1992 issue of *ComputerCraft* for more on temperature and light sensors.)

Surplus catalogs sometimes have good deals on more-exotic sensors. A recent catalog from All Electronics included a dollar-bill sensor, several sound-activated switches and a passive infrared detector equipped with selectable lenses.

Sometimes you can make your own sensors from everyday materials. The conductive foam commonly used to hold CMOS components can double as a simple pressure sensor, since its top-to-bottom resistance decreases as the foam is pressed. A popular homemade moisture detector is a printed-circuit board with two interleaved but not touching copper traces. When the board is wet, water shorts together the isolated traces and changes the resistance between them from near-infinite to zero ohm.

Some projects call for a specialized device that you just won't find in the usual sources. While researching this article, I discovered a complete reference for sensor sources in the Sensors Buyer's Guide, published annually by *Sensors* magazine. The Guide lists more than 1,200 companies involved with sensors and indexes them according to property sensed, technology used, manufacturer and related products and services.

From the list of properties sensed, you can select the category that interests you and consult a list of companies that offer products in that area. For example, under Microwave Radiation six companies are listed, while under Carbon Monoxide, there are 64 companies and under Temperature, hundreds of companies are listed.

You can also locate companies according to the technologies their products use: acoustic, bimetallic, Bourdon tube, and so on through zirconium oxide.

For more information about a type of sensor, you can contact the companies listed under the category in which it's listed. Complete addresses and phone numbers are included. In addition to basic product information and specifications, many companies publish applications notes to help you use their sensors.

Sensors magazine, subtitled The Journal of Machine Perception, is another useful resource. Each issue has research and development news, applications articles by sensor users, new-product notes and my favorite, "Wish List," which publishes reader requests for sensors to suit unusual or difficult tasks.

Sensors is mailed free to qualified subscribers, who receive the buyer's guide at no charge. The guide is available to non-subscribers for $29.95 plus $2.50 for shipping in the U.S. (see the Sources list for where to write or call for more information).

Many sensor companies specialize

Table 1. Properties of Some Sensors, Transducers and Detectors.

- Acceleration
  - linear
  - rotational
- Acoustic emission
- Altitude
- Chemical/gas
  - carbon dioxide
  - carbon monoxide
  - chlorine
  - dissolved oxygen
  - hydrocarbons
  - hydrogen
  - hydrogen sulfide
  - ion selective electrodes
  - NOx
  - ORP-REDOX
  - oxygen
  - pH
  - sulfur dioxide
- Color
- Consistency
- Density
- Distance
- Electrical
  - capacitance
  - charge
  - conductivity
  - current
  - field strength
  - frequency
  - impedance
  - inductance
  - microwave radiation
  - power
  - radio frequency
  - resistance
  - resistivity
  - voltage
- Energy
  - BTU/heat
- Fire
- Flame
- Flow
  - fluid
  - gas
  - mass
  - steam
- Force
- Hardness
- Humidity
- Ice
- Level
  - fluid
  - slurry
  - solid
- Light
  - infrared
  - ultraviolet
  - visible
- Magnetic
  - direction
  - field strength
- Mass
- Moisture
- Motion
- Opacity
- Particle
- Photoelectric
  - analog
  - interruptive
  - reflective
- Position
  - absolute
  - incremental
  - relative
  - linear
  - angular
- Pressure
  - absolute
  - barometric
  - blood
  - differential
  - fluid
  - gas
  - gauge
  - vacuum
- Proximity
- Radiation
  - alpha
  - beta
  - gamma
  - neutron
  - proton
  - radioactivity
  - x-ray
- Smoke
- Solar
- Sound
  - intensity
  - pressure
- Speed
- Strain
  - compression
  - tension
- Surface condition/defects
- Tactile
- Temperature
- Thickness
- Tilt
- Torque
- Turbidity
- Velocity
  - angular
  - fluid
  - linear
- Vibration
- Visibility
- Viscosity
- Vision/image
- Weight
- Wind
  - direction
  - speed

(Courtesy of Sensors 1992 Buyer's Guide.)

in one product area. One company that offers sensors in many areas is Omega Engineering. It carries sensors for temperature, pH, conductivity, flow, level, pressure and strain. Omega also publishes a set of handbooks that are actually catalogs with technical references included.

Choosing Sensors

To select the right sensor for a job, you must first define what you want the sensor to do. From there, you can search for a sensor that meets your requirements. Following are some of the questions you'll want to answer about your desired sensor. The answers in parentheses describe a temperature sensor needed for a temperature controller used in film processing:

What property do I want to measure? (temperature)

What kind of output do I need—analog, digital, voltage, current, etc.? (eight-bit digital output would be ideal, but analog voltage or current output is okay)

What range of inputs do I need to measure? (60° to 110° F)

What power supplies are available to power the sensor? (+12 volts, +5 volts)

What resolution and accuracy do I need? (accurate to within 0.5° F)

How fast must it respond to input changes? (quick response not critical for this application)

Only when you've satisfactorily answered such questions, you're prepared to make your selection.

Working With Analog Signals

The outputs of most sensors are analog voltages, currents or other quantities that vary continuously between limits. An output may range from 0 to 1 volt, 0 to 100 milliamperes or within some other range, depending on the sensor. This presents a problem for microcomputer interfacing, since computers are digital devices that acknowledge only two voltage levels, high and low. To interface a sensor to a microcomputer, its analog output must be translated to a digital form that the computer can understand.

Sometimes this is easily done. Some integrated sensors contain their own analog-to-digital (A/D) converters, saving you the trouble of providing them. Some microcontrollers also contain their own A/D converters. Probably the best known of these is Motorola's 68HC11, which can directly measure voltages at eight 0- to 5-volt analog inputs. Using devices like these will simplify your circuit designs.

If none of these solutions is feasible, a separate A/D converter can interface a sensor's output to a microcomputer's inputs. All kinds of converter chips are available with varying resolution, accuracy, speed, method of conversion, number of analog inputs, and so on. One example is National Semiconductor's ADC0848, which is an easy-to-use, low-cost, general-purpose, eight-channel A/D converter.

In many ways, the ADC0848 is similar to National's long-popular ADC-0809 A/D converter, but with some

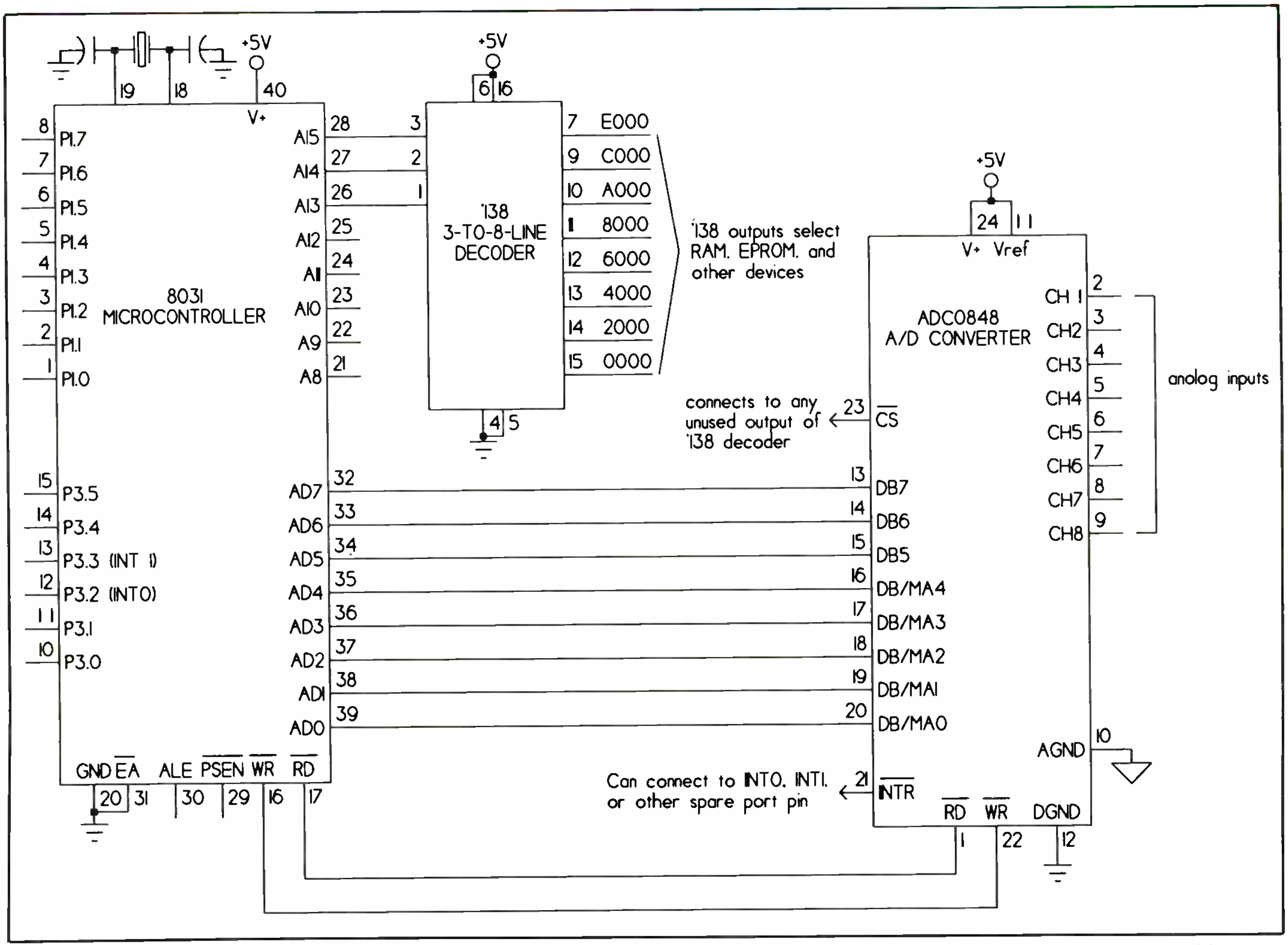

Fig. 1. The ADC0848 analog-to-digital converter measures up to eight analog inputs and is easily interfaced to an 8031 or other microcontroller. (External memory, address latches and other components not used by the ADC0848 are not shown.)

advantages. The ADC0848 doesn't require an external clock, its control signals interface directly to many microcontrollers and it's faster, with a typical conversion time of 30 microseconds. The ADC0848 is available from Digi-Key and other sources.

Figure 2 shows a circuit in which an ADC0848 interfaced to an 8031 microcontroller. The connections are similar to those used for memory chips. The converter's RD and WR inputs are driven by the matching outputs on the 8031, CS is driven by an address decoder's output, and DB0 through DB7 connect to AD0 through AD7 on the 8031.

Up to eight analog inputs can connect to pins 2 through 9 on the ADC-0848. The potential at V_{ref} determines the converter's full-scale voltage, which is the input that results in an output of 11111111, or 255 in decimal. For maximum range, connect V_{ref} to the +5-volt supply or to a more-precise 5-volt reference like an LM336-5.0 reference diode. The analog inputs can then range from 0 to +5 volts.

If your sensor's output is much less than 5 volts, you can connect V_{ref} to a voltage slightly greater than the maximum voltage you expect to measure. This will give you more precise readings than you would get with a 5-volt reference.

To illustrate, consider a sensor whose output ranges from 0 to 0.5 volt. The eight-bit digital output of the converter represents a number from 0 to 255. If V_{ref} is 5 volts, each count equals 5/255, or 19.6 mV. A 0.2-volt analog input results in a count of 10, while a 0.5-volt input results in a count of 26. If your input goes no higher than 0.5 volt, your count will never go higher than 26, and the measured values will be accurate to within only 20 mV, or 1/255 of full-scale.

However, if you adjust V_{ref} down to 0.5 volt, each count now equals 0.5/255, or 2 mV. A 0.2-volt input gives a count of 102, a 0.5-volt input gives a count of 255 and the measured values are accurate to within 2 mV (ignoring other sources of error for now).

Layout of ground wires or traces is important in circuits that mix analog and digital circuits. The rapid switching of digital circuits can cause spikes in the ground lines, and these can cause errors in analog measurements. You can minimize the problem by providing separate ground paths for analog and digital signals. The two grounds should connect at only one point, and this as near the power supply as possible.

In Fig. 3, this means that AGND and any ground connections related to the analog inputs or V_{ref} follow one path, while DGND and other grounds for logic, computer, or memory chips fol-

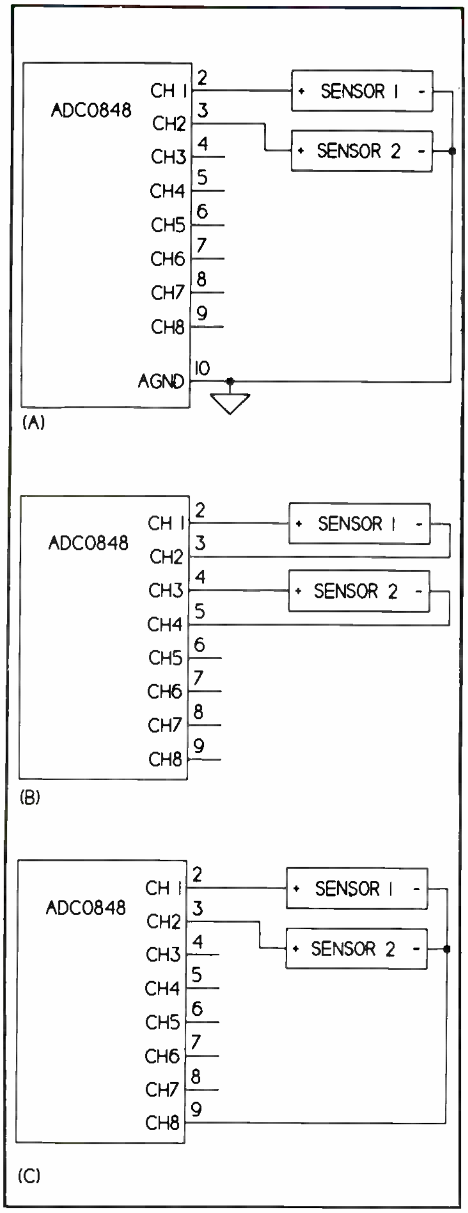

Fig. 2. Three measurement modes available with the ADC0848 converter: (A) single-ended, (B) differential and (C) pseudo-differential.

low a different path. The two paths meet only at the power supply. Notice that the schematic diagram uses different ground symbols for the two signal paths.

Measuring Modes

To allow for different circuit requirements, the ADC0848 offers a choice of three software-selectable modes of operation: single-ended, differential and pseudo-differential. Fig. 2 illustrates this.

In single-ended mode, each analog input is referenced to AGND. This is the simplest mode and will work fine for many applications.

The other modes are useful for more-critical measurements, where you must reject background noise of offset voltages and measure only the sensor's response to a desired property. In differential mode, each channel is paired with an adjacent one, with the voltage on one channel referenced to the voltage on the other.

For example, you could connect an output from a sensor to Channel 2 and a ground or other reference from that sensor to Channel 1. With differential mode selected, Channel 1 will read the difference between Channel 1's and Channel 2's voltage. This mode cancels out errors due to noise, such as 60-cycle interference, that's common to both channels in the pair.

The final mode of operation is pseudo-differential. In this mode, Channels 1 through 7 are all referenced to Channel 8. This allows you to make seven differential measurements, all with the same reference. This mode is useful if you're measuring multiple channels in the same location.

To begin a conversion on the ADC0848, the microcontroller writes to the converter to indicate the desired channel and mode. Bits 0, 1 and 2 specify the channel (000 = 1, 001 = 2, 010 = 3, etc.), and bits 3 and 4 specify mode of operation (00 = differential, 01 = single-ended, 11 = pseudo differential). For example, in the Fig. 1 circuit, to begin a single-ended conversion at Channel 5, you'd write 0000 1101 (0Dh in hex) to the converter's address in external memory. If pin 23 of the converter connects to pin 7 of the '138 decoder, the converter's address is E000h.

After writing to the converter, the conversion is triggered automatically. When conversion is complete, a read operation to the converter's address causes the the converted value to appear at DB0 through DB7, where the microcontroller reads it.

The INTR pin indicates when a conversion is complete and can be used to trigger a read. INTR is low when a conversion has occurred that hasn't yet been read. It goes high after a read and remains high until the next conversion is completed.

You can connect INTR to an interrupt pin on the microcontroller and write a routine to cause the microcontroller to read the converter when an interrupt occurs. Or you can connect INTR to a port pin that you read to ensure that it's low before reading a value, or you can ignore INTR and just be sure to wait the maximum conversion time of 60 microseconds before reading a value.

National's *Linear Data Acquisition Databook* (also available from Digi-Key) has complete specifications, applications information, and example circuits for the ADC0848. You'll want this or a copy of the IC's data sheet if you plan to use the chip. Another good information source is National's *Linear Applications Databook*.

Choosing a Converter

In addition to the ADC0848, there are hundreds of A/D chips offered by dozens of manufacturers; so you should be able to find precisely what you need. Following are some of the questions to ask when choosing an A/D converter. Example answers in parentheses describe the ADC0848, using information from its data sheet.

What's the analog input range? (0 to V+)

How many channels are there? (eight)

What's the converter's resolution? (eight bits)

How fast is the conversion? (30 microseconds typical)

How accurate is the conversion? (±1 LSB, ½-LSB version available, where *LSB* is least-significant bit)

What are the power-supply requirements and power consumption? (+4.5 to +6 volts at 15 mW)

What input modes are available? (single-ended, differential, pseudo-differential)

How is the converter controlled and interfaced? (control signals are RD, WR and CS)

Are there any special features on-chip, such as sample-and-hold, voltage reference, etc.? (an internal clock times the conversions)

What package types are available? (24-pin skinny DIP and 28-pin chip carrier)

An additional component you may need for rapidly changing analog inputs is a sample-and-hold circuit. To ensure correct conversions, the analog

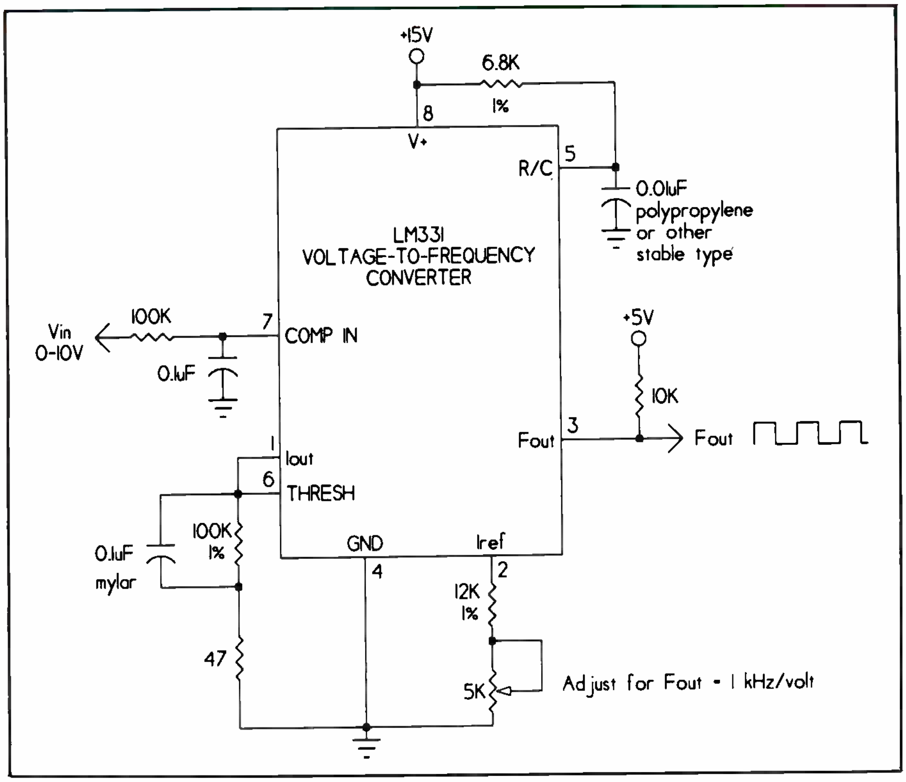

Fig. 3. The LM331 takes a different approach to A/D conversion by converting an analog voltage into a frequency that a microcontroller can measure at a single input pin.

input mustn't change in value while conversion is taking place.

A sample-and-hold circuit ensures that the analog signal is stable by sampling the signal at the desired measurement time and storing it, usually as a charge on a capacitor. This stored signal is used as the input to the A/D converter.

When do you need sample-and-hold? The ADC0848 requires 60 μs or less to convert; so you should have no problem with inputs that don't vary in this amount of time. When a rapidly-changing input does require one, sample-and-hold ICs like the LF398 are available, or you can use a converter like the ADC0820, which has an on-chip sample-and-hold.

A Different Approach

Not all microcontroller circuits have external memory space available for use by an A/D converter. In some designs, the microcontroller stores its program on-chip, with only a limited series of port pins for access to other components. In this situation, you could connect an A/D converter's data and control lines to port pins on the microcontroller if enough are available. Using an A/D converter that outputs binary numbers in serial format is another option.

Another method takes a different approach and requires only one port pin per channel. Instead of converting the analog voltage into a binary number, you convert the voltage into a square (or rectangular) wave whose frequency varies with the voltage. Figure 3 shows such a circuit, using National Semiconductor's LM331 precision voltage-to-frequency converter.

You can connect the output of the LM331 (F_{out}) to a microcontroller port pin and program the microcontroller to measure the period or frequency of the signal using on-chip timer/counters. An added advantage of this method is that the frequency output can be transmitted over distance with greater noise immunity than an analog voltage.

To measure frequency, one of the microcontroller's timers is programmed to run for a specific period, such as 1 second. During this period, the microcontroller counts pulses at F_{out}. After 1 second, the count equals the signal's frequency. Since the frequency is proportional to V_{in}, you have, in effect, measured the voltage.

An alternative is to measure F_{out}'s period. With this method, a counter is triggered on and then off when predefined signals (such as a falling edge) occur at F_{out}. The resulting count is proportional to F_{out}'s period, or 1/frequency. If a 1-MHz counter is turned on for one cycle of F_{out}, its count will equal F_{out}'s period in microseconds.

If you plan to use this type of converter, make sure your microcontroller and control program are fast enough to measure the converter's output frequency without missing any counts. The lower the output frequency, the easier it will be to count. Some versions of Intel's *Embedded Applications Handbook* (1989, 1990) contain article reprint No. AR-517, "Using the 8051 Microcontroller with Resonant Transducers," that describes in detail how to measure period and frequency with the 8051 (and other microcontrollers) and what kinds of things to watch out for. (See Intel's new free Handbook Directory for a list of applications notes contained in current handbooks.)

National's *Linear Data Acquisition Databook* has more on the LM331, including example light-to-frequency and temperature-to-frequency converter circuits.

Level Translating

Not every sensor has an output that's usable as-is. If a sensor's output ranges from + 12 volts to − 12 volts and your A/D converter operates at + 5 volts, you must shrink the signal's range and shift its level to be compatible with the converter.

Figure 4 shows a circuit that can amplify or reduce an input and can also raise or lower signal levels by adding or subtracting a voltage. Separate, independent adjustments control gain and offset. The circuit is a series of three op amps: buffer, level shifter and amplifier. The example circuit is designed with three of the devices in an LF347 quad JFET-input op amp, selected for its high input impedance and high speed.

The first op amp is a noninverting amplifier with V1 equal to V_{in}. The op amp presents a high-impedance input to V_{in}, to minimize loading.

The second op amp is an inverting summing amplifier that shifts V2's voltage up or down as *R5* is adjusted. Adjusting *R5* raises and lowers V2, but V2's shape and peak-to-peak amplitude remain constant.

The third op amp is an inverting amplifier whose gain is adjusted by *R4*. This amplifier increases or decreases the peak-to-peak amplitude of its input. If V_{in} varies from +12 to −12 volts, you can adjust *R4* for a ±2.5-volt swing at V_{out} and then adjust *R5* to raise V_{out} to achieve the desired 0-to-5-volt swing.

Resistor *R4* can increase gain as well as decrease it. To shift a signal down instead of up, connect *R5* to V+ instead of V−. If no level shifting is required, remove *R5* and connect pin 6 only to *R1*.

Data-Acquisition Chip and Software

In preparing this article, I wrote sample programs using Systronix's BCI51 BASIC compiler ($299) for the 8051 family. In many ways, BCI51 is similar to, and compatible with, the BASIC-52 interpreter contained in the 8052AH-BASIC chip. But because BCI51 is a compiler, it creates programs that can run on their own, without requiring BASIC-52 in memory.

Because the syntax of the two BASICs is similar, you can test your code with BASIC-52's interactive interpreter, then compile it into executable form. You can also use BASIC-52 as a monitor program for loading and debugging your compiled programs.

According to Systronix, BCI51 instructions typically execute 20% to 50% faster than their equivalents in BASIC-52. Along with the compiler, you get a stand-alone 8051 assembler and utility and sample programs.

Because BCI51 doesn't limit you to the 8052AH-BASIC chip, you can develop programs for other members of the 8051 family. In fact, Systronix offers an optional set of BCI51 language extensions ($149) for Dallas Semiconductor's DS5000 8051-compatible microcontroller.

Since Dallas Semiconductor specializes in nonvolatile, battery-backed

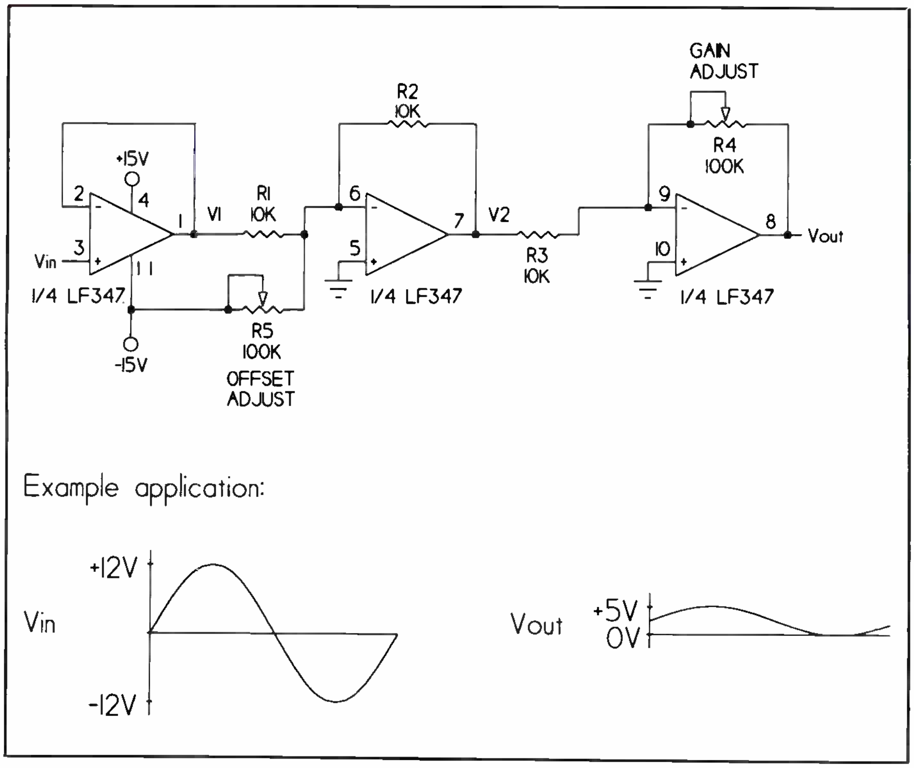

Fig. 4. This circuit adjusts the gain and offset of an analog signal to make it compatible with an A/D converter's input.

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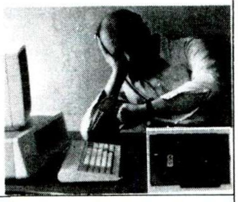

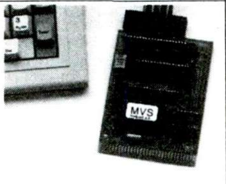

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All Electronics Corp.
P.O. Box 567
Van Nuys, CA 91408-0567
Tel.: 1-800-826-5432, fax: 818-781-2653

Binary Technology
Main St.
P.O. Box 67
Meriden, NH 03770
603-469-3232
Fax: 603-469-3530

Dallas Semiconductor
4350 South Beltwood Pkwy.
Dallas, TX 75244-3292
Tel.: 214-450-0400, Orders: 1-800-336-6933

Digi-Key Corp.
701 Brooks Ave. S.
P.O. Box 677
Thief River Falls, MN 56701-0677
Tel.: 1-800-344-4539

Intel Corp.
3065 Bowers Ave.
Santa Clara, CA 95051
408-765-8080
Tel.: 1-800-548-4725 for literature

Omega Engineering
One Omega Dr.
Box 4047
Stamford, CT 06907
Tel.: 1-800-826-6342, fax: 203-359-7700

Sensors Magazine
Helmers Publishing, Inc.
174 Concord St.
P.O. Box 874
Peterborough, NH 03458-0874
Tel.: 603-924-9631

Systronix, Inc.
754 E. Roosevelt Ave.
P.O. Box 526398
Salt Lake City, UT 84152-6398
Tel.: 801-487-7412, fax: 801-487-3130

RAM, it's not surprising that their DS5000 contains 8K or 32K of nonvolatile RAM that can be used for program or data storage. Other chip features include a power-fail warning and automatic power-down, encryption logic to protect unauthorized reading of RAM and an optional real-time clock/calendar. Dallas' *DS5000 Soft Microcontroller Users Guide* has more details about the chip.

The BCI51 extensions allow easy access to the added features, including variables for the clock/calendar and commands for custom power-up and reset options.

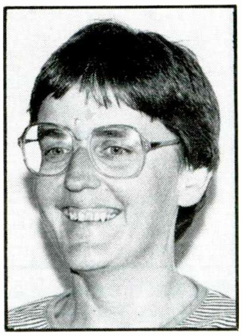
A development kit from Dallas (No. DS5000TK, $160) includes a DS5000T with 32K of RAM, hardware for downloading software from a serial port to the DS5000, IBM-software for IBM compatibles, documentation and a users guide.

The DS5000, along with the BCI51 compiler, is especially suited for portable data-acquisition systems, where sensor readings are taken periodically and stored in memory, perhaps along with the time and date. Many other uses are also possible, of course. Contact Systronix and Dallas Semiconductor for more on these products. Binary Technology is another source for 8051 BASIC compilers.

And a final note for anyone who is interested in digital signal processing: Motorola has a new 68HC16 Tool Kit that includes an evaluation board, software, guide to digital signal processing and a kit for building a frequency analyzer. Price is $168.16. Contact your Motorola distributor or call 1-800-521-6274 to locate a distributor in your area.

Next time, we'll discuss how timing diagrams can help you design microcomputer circuits that work and fix ones that don't.

Send your comments, suggestions and questions on topics relating to designing, building and programming microcontrollers and other small dedicated computers to Jan Axelson, ComputerCraft, 76 N. Broadway, Hicksville, NY 11801. For a personal reply, please include a self-addressed, stamped envelope. ■



Jan Axelson

Windows & OS/2 Conference

A glimpse at what's churning for the corporate world

This third anual winter session met for three days in San Jose, California, on January 28, 29 and 30. Showing an increased acceptance by Fortune-1,000 companies, the theme was "Map Your Corporate Migration Path Into The 1990s." Several thousand people attended, getting the latest in corporate strategies presented by industry leaders from IBM, Microsoft, Borland and others.

The main conference targeted the corporate environment and was divided into three sections: Conferences, Fast Tracks and Exhibits. All three offered something for everyone and much more information—and technobabble—than anyone could possibly absorb.

Topics ranged from *Windows* and OS/2 training issues to pen-based systems, font technologies (including *Windows* 3.1 on-the-fly font scaling TrueType technology) to groupware, LAN/WAN strategies to mission-critical database front ends, principles of software design, including OOP (Object Oriented Programming), to multimedia desktop video and in-house development of CD-ROMs. With the big guns adding *Windows* and OS/2 to their arsenals, the desktop will surely become a much richer graphical environment over the next few years.

Until this happens, however, that ol' DOS prompt will keep peeking through. This could be seen time and again when industry experts scrambled to boot a copy of *XTree* or their favorite DOS file manager or rebooted *Windows* after a fearful UAE. Even Philippe Kahn, President/CEO of Borland, prophylactically rebooted *Windows* while giving sneak previews of *Quattro Pro* and *Paradox* for *Windows*.

The corporate mobs heard about BLOBs. Mr. Kahn introduced BLOBs, which are binary large objects such as images, video, graphics, audio information (voice), satellite signals, CAD/CAM objects and intelligent documents. Sounds like multimedia to me. Managing these BLOBs requires new database management tools and increased capabilities of client/server technologies to acquire, compress, store and transfer these huge chunks of data. These new tools will be fundamental to this evolving integration of telephone, television, video and imaged documents.

Hercules SUPERSTATION 3D offers optional 64-bit RISC processor.

To this end, Borland's CEO presented a beta version of *Paradox for Windows*, with a new level of object management. Incorporating BLOBs directly into a table in *Paradox* was a real crowd-pleaser. Then playing back full-motion video BLOBs in a window brought another round of applause. You could see Borland's modular—"Lego-like"—developer's tools like *ObjectVision* and *Turbo C++* blending right into the functionality of their application products.

Windows developers are playing catch-up to products like Blyth Software's *Omnis 7* that works with Apple's *QuickTime* multimedia operating-system extensions, allowing users to add "movie" files to databases. *QuickTime* provides a standard method for compressing/decompressing, cutting, copying, pasting and displaying multimedia data. Microsoft's new Multimedia PC (MPC) extensions attempt to address those capabilities and will probably evolve to be compatible with *QuickTime*.

Still lacking are the ability to effectively move behemoth mounds of multimedia data in *Windows* and industry standards for data compression/decompression methods for the PC. Microsoft's forthcoming enhancements to its MPC extensions will support digital video to compete more effectively with Apple's *QuickTime* for the Macintosh. Microsoft says that its Audio Video Interleaved (AVI) software will provide an interim solution until Moving Pictures Experts Group (MPEG) compression, which allows for full-motion video, is available.

Faced with these new demands for managing multimedia data, users have yet to decide what operating system will meet the fundamental requirements of this integrated data environment in a complex corporate world. Their options were being displayed like salvos on the battlefields of the conference rooms and on the exhibition floor.

NT or OS/2?

To address these evolving needs, Microsoft and IBM duked it out on the exhibition floor for the best operating system. Microsoft presented a beta *Win* 3.1 and alpha *NT*, while IBM showed OS/2 1.31 and a beta version of OS/2 2.0.

Microsoft's emphasis on *NT* (*New Technology*), combined with interim solutions using *Win* 3.1, attempted to out-flank IBM's efforts to convince users that OS/2 2.0 is the future for 32-bit computing in the corporate environment. While dozens of IBM employees wore blue and white buttons reading "I Want OS/2," an apprehension by others suggested it should read "Oh Yes/Too." Still others wondered if *NT* would really be MT.

Giving credence to *NT*, industry experts, like Technology Investment Strategy Corp. (TISC), project that OS/2 2.0 will be dominated in the market by *Windows NT* because OS/2 won't be able to compete against *Windows*' huge installed base, not because *NT* will be a better operating system. Consequently, the battle is on for technohegemony.

IBM says OS/2 is better because it runs multiple DOS sessions and *Windows* applications better than *Windows*, as well as OS/2 applications. Microsoft says, "So what, with the exception of running OS/2 applications, *Win* 3.1 does the same." And on the exhibition floor, "so what" prevailed. Vendors demonstrated hundreds of *Windows* applications/development tools, compared to a few dozen OS/2 products, most of which were available for *Windows*. If this is any indication, finding a compelling reason to switch to OS/2 2.0 may be a difficult task for many people.

Networking is the other important factor determining the ultimate winner in the corporate setting. Since OS/2 is commonly used for networking (even Microsoft's LAN Manager runs under OS/2), *NT* must tackle this task. So in addition to being fully portable, Microsoft says *NT* will have preemptive thread-based multitasking and will include many basic networking functions, such as messaging, directory services, database access, symmetric multi-processing, fault tolerance and network security. Since *Windows* is popular as a front-end in client/server systems, and would be able to run on servers, this will ease development efforts, further adding muscle to Microsoft's installed-base strangle-hold.

NT appears on a steady development path. Early reports indicate that developers are having a smooth transition with efforts to port existing *Windows* applications to *NT*.

One way or the other, a 32-bit operating system is just around the corner. Not only does 32-bit code run faster than 16-bit code, but it also allows direct access to larger amounts of memory. And the neotenic transformation of intelligence—replacing DOS's brain-dead limitation of 64K segments with gargantuan segments as large as 4 gigabytes—lays the foundation for memory management that brings us a much more mature and sophisticated desktop computing environment.

To take full advantage of this, most of us will need new EISA/MCA buses and I/O cards, as well as a minimum of 8M of RAM. And if history is our guide, minimums are stifling. We'll probably need 32M of RAM for efficient computing. By all appearances, the 286 is heading south. If *NT* is in your future, then the 286 isn't. In fact, already, the new *Windows* Multimedia PC (MPC) standard was revised, requiring as minimum a 386/SX. So your games and entertainment now require a 32-bit processor.

On the Sidelines

For those keenly interested in making history today, pre-conference tutorials offered all-day sessions on optimizing *Windows*, networking, OLE and DDE, and *VisualBasic*. While the Fast Tracks program provided three days of tips and tricks for installing and configuring *Windows*, programming in *WordBASIC*, programming for non-programmers and developing traditional business and multimedia presentations.

Sampling as many sessions as possible, I stayed for the full course of *WordBASIC*, a macro language in *Word for Windows*. I'm impressed. Similar to *VisualBasic*, users of *WordBASIC* can write programs without a compiler. All *WinWord*'s pull-down menu commands are available for writing a script. You take control of *WinWord* at the system, global and template levels. Creating interactive word-processing documents expands *WinWord* to a developer's tool. In fact, Microsoft *WordBASIC* development team (800-227-4679) will assist you with a Developer's Resource Kit, lots of information about resources and put you in contact with several leading developers. Check out the MSAPP forum on CompuServe, where Library 12 (Lib12) offers KeyWordHacker.

Oh Yes, Too

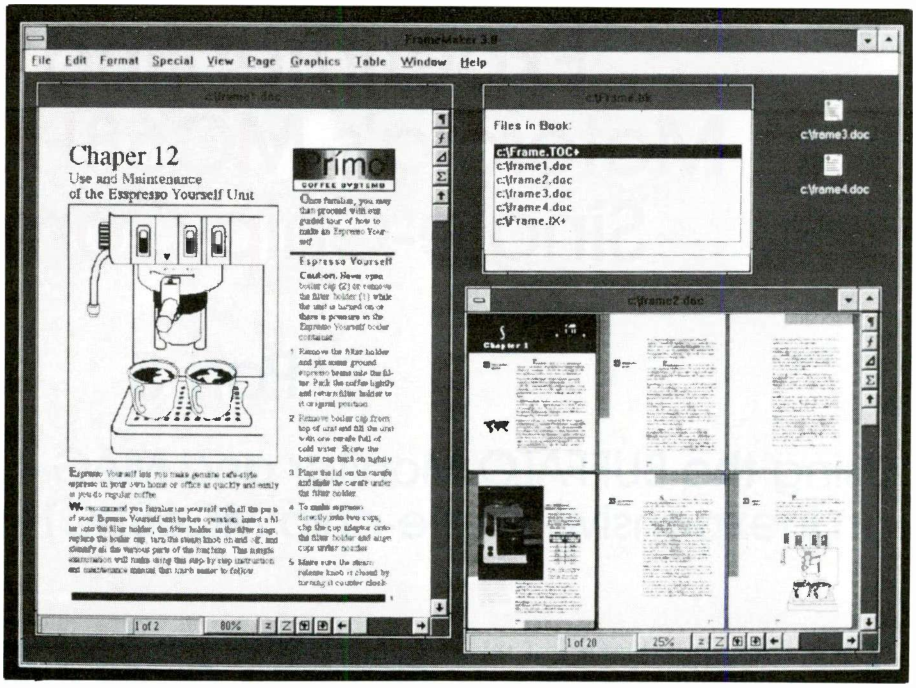
More than a hundred technoevangelists (vendors) hawked their wares to the thousands of attendees. There were no big surprises, but many interesting products were well-received. I'll mention a few new or interesting products that caught my eye.

Unless you like watching paint dry, *Windows* users need industrial-strength processing power to obtain satisfactory video performance, which means raw CPU power or graphics accelerator boards.

Accelerator boards abound, most using either Sierra Semiconductor's S3 chip or Texas Instruments' TMS340X0 chips. Hercules, rising from the ashes like a Phoenix, offers a new line of impressive boards. Its high-end 1,280 × 1,024 SUPERSTATION 3D board, using a fully programmable 32-bit TMS34020 chip equipped with 15 display formats and 16-million colors, offers blazing colors and an optional 64-bit i860 RISC processor.

Effectively exploiting these new graphical technologies means corporate and government users need the ability to edit documents in electronic form and to develop interactive applications for the service and education industries.

Radius Inc. offers one solution for document management with its Full Page Pivot color monitor, which displays a full 8½" × 11" document. The pivot feature results from a special graphics card that permits 90° rotation for landscape mode. Therefore,



A FrameMaker screen with selected page in main window, available files and samples of pages in secondary windows.

it addresses the need for word processing in portrait mode and using spreadsheets in landscape mode.

Touch screens are popping-up in kiosk applications from airline terminals to franchised carpet stores. With a touch of a finger, Elographics emulates a mouse with a complete line of touch-screen monitors and upgrade kits that are compatible with *Windows* and OS/2 environments.

The new kid on the desktop publishing block is *FrameMaker*. This top-notch workstation program was ported to *Windows*. Unlike most desktop-publishing and word-processing programs, *FrameMaker* offers conditional text and automatic table generation. Conditional text allows users to create several versions of the same document with one file, specifying which sections of text and graphics will change. It also features integrated support for Desktop Color Separation (DCS) graphics. If you create large, complex technical documents, especially on a network, you may find a new friend in *FrameMaker*.

Perhaps the most noticeable group of exhibitors offered *Windows* and OS/2 development tools. While within this group many OOP tool kits were notable, procedural languages appeared dominant.

More powerful than Borland's *ObjectVision*, though not designed for novice users, Expert-Ease Systems Inc's *Guild* lets you build interactive graphical interfaces for new and existing C applications. Blue Sky Software Corp.'s *WindowsMaker* Professional can be used as a back-end C code generator and as a graphical front-end for creating user interfaces. Pilot Executive Software Inc's *Lightship* allows users to build their own data-driven executive information systems (EIS). PowerSoft Corp's *PowerBuilder* permits users to create database front-ends for client/server applications. Offering Structured Query Language programming tools, *PowerBuilder* lets users create fully event-driven database front-ends that are independent of the interfaces of the existing database packages with which they are and that run as native *Windows* applications.

With the smoke cleared away, the mirrors and hyperbolists back in the closets, you could clearly see battle lines were drawn while large numbers of people placed their bets and others calculated their odds. And one thing is for sure: history is in the making. The graphical user interface (GUI) has moved swiftly and forcefully into the PC environment. ■

Application By Tom Fox

Experimenting With Motorola's MC68HC11 True Single-Chip Computer

Part 5

Using the BUFFALO Monitor and MAG-11 to produce an inexpensive single-chip MC68HC11 system

In previous installments of this series, we've discussed the MC-68HC11 true single-chip microcomputer, details for building a basic SBC computer and an optional battery-power system with Logic Monitor. Last month, we also briefly explored how to use the BUFFALO monitor that makes possible an almost unlimited variety of uses for the MAG-11 SBC. This time around, we go into more detail on using the BUFFALO monitor.

Getting Better Acquainted

The ASM (line assembler/disassembler) will be the primary command you use when working with the BUFFALO monitor. ASM makes it a snap to try out simple programs and can be used for the most complex program you can devise. Be aware, though, that a sophisticated cross-assembler can save you time.

One ASM feature allows you to put a program into internal EEPROM as quickly and cleanly as you can in RAM. Except for the fact that the program in EEPROM remains long after power has been removed, it's virtually impossible for you to detect that EEPROM and not RAM is being used. And because internal EEPROM is located from $B600 to $B7FF, you know when you write to these addresses you're writing to EEPROM.

Keep in mind another feature when using BUFFALO with MAG-11. When position 1 of *S2* is set to ON, BUFFALO jumps directly to EEPROM so that the program in EEPROM starts automatically.

The source code for the line assembler is extensive. The following starts the line assembler, disassembles opcode at <addr> and then allows you to enter a line for assembly: ASM <ADDRESS> <CR>

Keep in mind the following rules for assembly:

(1) All arguments are in hexadecimal. Do *not* key in the "$" prefix; it's included here only as a reminder that arguments are expressed in hexadecimal format.

(2) The "#" (pound symbol) prefix indicates immediate addressing.

(3) The "," (comma) indicates indexed addressing and requires the next character to be X or Y.

(4) Separate arguments by one or more spaces or tabs.

(5) Any input after the required number of arguments is ignored.

(6) Upper- and lower-case are treated identically.

The following commands are available to signify the end of an input line:

<cr>—Finds the next opcode for assembly. If there is no assembly input, the next opcode disassembled is retrieved from the disassembler.

<**line feed**> or <+>—Similar to ENTER, except if there is no assembly input, the <ADDr> is incremented and the next <addr> is disassembled.

< > or <–>—decrements <addr> and the previous address is disassembled.

</> or <=>—Disassembles the current address again.

<.> (period) or <**Ctrl-A**>—Exits the assembler/disassembler.

The best way to learn how to do something is to do it. However, start simple. The simple program in Listing 1 causes *LED1* through *LED8* on the SBC to flash on and off. Start at address $B600 to place the code in EEPROM. The source code is in a format that BUFFALO's line assembler understands. Bold entries are what appears on-screen from the BUFFALO monitor, all entries that aren't bold are what you type on the keyboard. <CR> means carriage return (or enter, depending on the keyboard you use). Although you key in a carriage return, it doesn't appear on-screen.

Start BUFFALO's Line Assembler by typing ASM, followed by a space and then starting address in hexadecimal and concluding with a carriage return. If the EEPROM is erased the screen display should be exactly as shown in Fig. 12.

```
>ASM B600 <CR>
B600 STX $FFFF   > CLRA <CR>
     4F
B601 STX $FFFF   > STAA 7000 <CR>
     B7 70 00
B604 STX $FFFF   > STAA 7001 <CR>
     B7 70 01
B607 STX $FFFF   > STAA 7002 <CR>
     B7 70 02
B60A STX $FFFF   > STAA 7003 <CR>
     B7 70 03
B60D STX $FFFF   > STAA 7004 <CR>
     B7 70 04
B610 STX $FFFF   > STAA 7005 <CR>
     B7 70 05
B613 STX $FFFF   > STAA 7006 <CR>
     B7 70 06
B616 STX $FFFF   > STAA 7007 <CR>
     B7 70 07
B619 STX $FFFF   > LDX #3000<CR>
     CE 30 00
B61C STX $FFFF   > DEX<CR>
     09
B61D STX $FFFF   > BNE B61C<CR>
     26 FD
B61F STX $FFFF   > COMA<CR3>
     43
B620 STX $FFFF   > BRA B601<CR>
     20 DF
B622 STX $FFFF   > .
>
```

Fig. 12. BUFFALO displays this listing after start-up if nothing is programmed into EEPROM.

You'll notice several interesting and possibly confusing features in the Fig. 12 listing. After entering ASM B600 and a return, ASM displays on-screen B600 STX $FFFF. This means ASM looked for an opcode at address B600; since the EEPROM is erased it finds, FF there. However, FF is the opcode for Storing Index Register X using extended addressing (mnemonic "STX"). Since the erased EEPROM contains all 1s (Fs in hex), ASM interprets this as an instruction to Store Index Register at location $FFFF.

The opcode listed below the STX xxxx is the new opcode stored there after it's entered in mnemonic form from the terminal. The "." at the end of the last line terminates ASM.

As you can see, while it's a BUFFALO dogma that you shouldn't enter the "$" prefix to indicate a hex number, ASM displays the dollar sign for extended addresses.

After entering a line of code and pressing the return or ENTER key, if you see on the next line "rom - xx" (*xx* is data at this location), the line assembler assumes you're trying to enter code into ROM since the memory location doesn't retain the data you tried to enter. Most likely, the line assembler is correct. This message appears if the memory to which you try entering to is defective RAM or EEPROM. Another simple possibility is that the address at which you tried to write has no memory installed.

To execute the program directly from the BUFFALO screen, use the GO command, followed by the address (first make sure you exit ASM by typing a period):

```
> GO B600<CR>
```

If you entered the program correctly, *LED1* through *LED8* should flash on and off rapidly. Stop the flashing by pressing the RESET switch on MAG-11. Turn off power to the SBC and then set position 1 of *S2* to OFF to cause pin 17 of *U1* to go high when power returns.

Now power up MAG-11. What happens and why? You answer these questions yourself. Keep in mind that internal EEPROM is located at addresses $B600 through $B7FF and that BUFFALO jumps to address $B600 if pin 17 of *U1* is high.

To get back to the BUFFALO prompt, set position 2 of *S2* to ON and then press the RESET switch. You can experiment with the blink frequency by changing the instruction at address $B619. Loading the index register with a larger number decreases the frequency, and vice-versa. You may wish to leave the blinker program in

EEPROM while experimenting with MAG-11 with the BUFFALO monitor installed on the SBC.

Whenever you want to check operation of MAG-11, set position 1 of *S2* to OFF so that *LED1* through *LED8* flash after pressing the RESET switch. To erase the blinker program from EEPROM, use the BULK command. (Before erasing the EEPROM, you may want to try out the TRACE command.)

Other Commands

Another simple but useful command is MEMORY or MM or even the undocumented M. Follow this command with the address of interest to see the data contained at the specified address. Change this data if you like or press ENTER.

If you'd like to see a large block of memory at one time, use memory dump command MD or DUMP, which causes your terminal to display the contents of memory in blocks of 16. The format is: MD <ADDr1> <ADDr2> <CR>, where *addr1* and *addr2* are the starting and ending addresses. If you list only one address, nine blocks of memory are displayed; if you want only one block, make addr1 = addr2.

The LOAD T command can be a real time-saver because it allows you to download S-records (files in MOT-S format) via your terminal.

If you have a problem with your program, you can use the TRACE command. Place after this command the number (up to $FF in hex) of instructions you want executed and displayed after each carriage return. If you don't enter a number, TRACE executes one instruction at a time. TRACE starts at the address pointed to by the Program Counter (P register).

Try out the TRACE command on the blinker program discussed above. Make sure the Program Counter is pointing to $B600 using the register-modify RM command to change program counter P, if necessary. The T command is the same as the TRACE command, except that it saves having to type four extra letters.

To use the TRACE and BREAK commands with MAG-11, jumper from XIRQ pin 40 of *U1* to PA3 pin 5 of *U1*. The simplest way to accomplish this is to tack-solder a length of Wire Wrap wire between the pins on the solder side of the board. (The latest revision, MAG-11b, from Magicland and MAG-11s on-disk pc artwork feature a jumper block that can be used instead of a jumper wire.)

A carriage return, without a previous command on the line, repeats the last command.

As shown in the printout of the BUFFALO monitor last month, there are several other commands you might want to try, but I recommend you use BULK sparingly and avoid BULKALL until you know exactly what you're doing with the MC68HC11 and its CONFIG register.

Do-It-Yourself System

The design of the HC11 and use of the BUFFALO monitor make it unbelievably simple to achieve an MCU-based turnkey system in which MAG-11 starts running a custom program when powered up. In addition, this program can be quickly changed at any time by connecting the board to a terminal.

The primary limitation to the above is the size of the EEPROM, which is 512 bytes in the "A" version of the chip. If the source code is written in assembly language and care is taken to produce tight code, a rather sophisticated program can be squeezed into those 500 bytes, especially with HC11's greatly expanded instruction set. If you really need more storage space, the 68HC11E2 version provides 2K bytes of EEPROM.

So far, to automatically run the blinker program in EEPROM, you must use the BUFFALO monitor or similar software, to "point" to the EEPROM. That is, you must somehow get the program started at address $B600. Anticipating that some users might want to jump directly to internal EEPROM after a RESET, rather than to the RESET vector located at $FFFE and $FFFF, the designers of the HC11 provided for this feature in the internal bootloader firmware contained in every HC11 version A, whether or not it has internal ROM. This avoids complicating the chip with another special mode.

To implement a jump directly to internal EEPROM, place the chip in Special Bootstrap Mode (by jumpering pins 2 and 3 of *JP1* on MAG-11). Then tie together the RxD and TxD pins

Table 1. SMOD and MDA Conditions

Mode Description	Latched at Reset SMOD	MDA
Single Chip	0	0
Expanded Multiplexed	0	1
Special Bootstrap	1	0
Special Test	1	1

and jumper to a pull-up resistor (jumper pins 1 and 2 of *JP12* on MAG-11).

When MAG-11 is configured as above, the chip will jump directly to $B600 after a reset is issued. The reason for this is that in Bootstrap Mode the Bootloader ROM is enabled, which initializes the SCI and Port D. The bootloader looks for the $FF character that determines the baud rate. If it finds a break character instead, the bootloader jumps directly to EEPROM. Tying together TxD and RxD provides this break character.

Power down and remove the BUFFALO monitor EPROM from MAG-11. Then power up again and reset the system. You'll note that nothing happens. After resetting the system, the LEDs won't blink. Examination of address and data lines with the Logic Monitor (if you incorporated it in your project) will reveal that the HC11 appears dead.

At this juncture, you might be wondering what has happened. If you tried this without first reading about it, you might be panicked, fearing the HC11 has become silicon junk. Nothing that drastic has occurred. Remember that the chip is in Special Bootstrap Mode, with its external data and address bus disconnected from the internal workings. While the HC11 is most likely executing all instructions stored in its EEPROM perfectly, it's operating invisibly since *LED1* through *LED8* require external data and address lines to operate.

If you're wondering what good is a perfectly working MCU if it doesn't interact with the outside world, keep in mind that the HC11 is loaded with I/O ports that are still active. To demonstrate, try a variation of the TEST-6811 program given in Part 1 of this series. Here we'll cause *LED10* to blink. It's connected to bit 3 of Port A, just as *LED1* was in Part 1.

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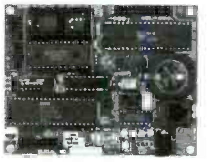

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To program the EEPROM again, use BUFFALO's ASM. Remember to first plug the BUFFALO EPROM into MAG-11 and jumper pins 2 and 3 of *JP12*. Also, place the HC11 in Expanded Multiplex Mode by removing the jumper from *JP11* and jumpering pins 1 and 2 of *JP1*.

Remember, the starting address is $B600. Enter the following, using BUFFALO's ASM:

```
   CLRA
STAA      1000
LDX       #B000
DEX
BNE       B607
COMA
BRA       B601
```

Run this program by removing the BUFFALO EPROM from MAG-11 and setting the jumpers for Special Bootstrap operation. Move the shorting jumper at *JP12* from pins 2 and 3 to pins 1 and 2. Now press the RESET switch on MAG-11 and note if *LED10* blinks on and off. Do *not* try to run this program from BUFFALO's GO command unless you remove the jumper between pins 5 and 40 of *U1*.

Notice that the system is extremely simple. Basically, only *U1, U2, Q1* and voltage regulator *U4* are operating. You can build a complete microprocessor project with only a 68HC11 and a microprocessor supervisory IC like the MAX690 or Motorola's MC-34064. Projects like these can be simple in physical design, sophisticated in function and, best of all, inexpensive to build.

Until now, you've been operating in the Special Bootstrap Mode, which limits what you can do. However, even though you must start in Special Bootstrap Mode to enable the jump directly to EEPROM, you don't have to stay there. You can use software to jump into Expanded Multiplex Mode.

The procedure for getting back to Expanded Multiplexed Mode is straightforward. All you do is modify the HPRIO register at $103C using software.

Bit	$103C	RESET
7	x	?
6	SMOD	?
5	MODA	?
4	x	?
3	x	0
2	x	1
1	x	0
0	x	1

Here, *x* stands for the bits that aren't of interest right now. Table 1 shows that the condition of bits SMOD and MDA after RESET depends on the operating mode at RESET. With jumpers set for Special Bootstrap Mode, SMOD and MDA are 1 and 0, respectively. This is the opposite condition from Expanded Multiplex Mode. The one requirement is that MDA can be changed by software only when SMOD is set. Thus, MDA must be changed before SMOD is cleared.

As you can see, to switch to Expanded Multiplexed Mode, you want SMOD cleared and MDA set. In practice, you first write a 1 to MDA to temporarily send the MCU into Special Test Mode. The next set of instructions should clear SMOD to cause the HC11 MCU to go into the Expanded Multiplex Mode.

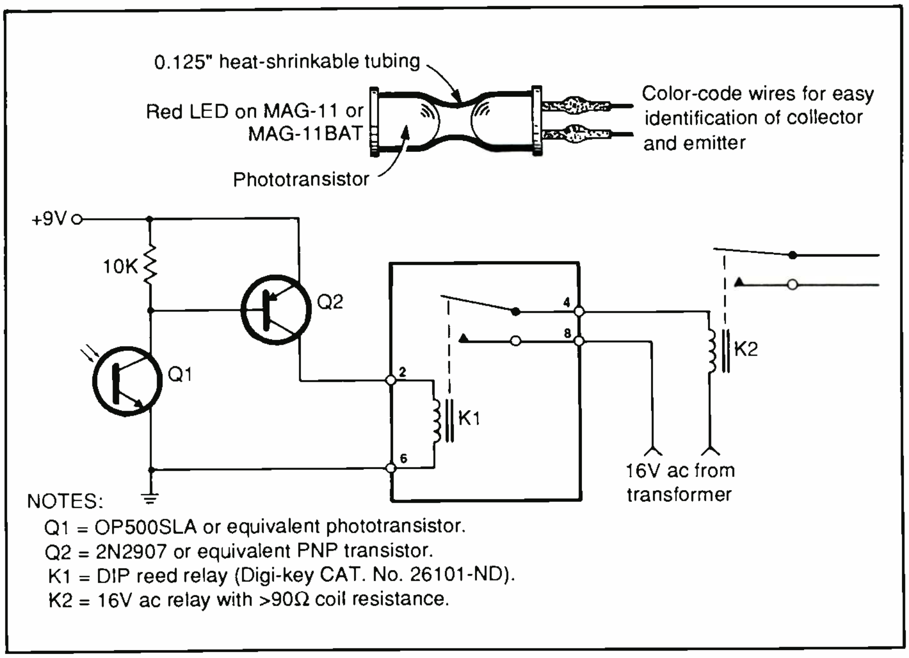
The following short program makes *LED1* through *LED4* blink on and off at half the rate of the previous blinker program. To program the EEPROM, configure the jumpers for Expanded Multiplex Mode and plug the BUFFALO EPROM into socket *U7*. Remember to start the program at address $B600. With BUFFALO's ASM, type ASM 600<cr> at the ">" prompt and follow with:

```
LDAA
#75
STAA      103C
LDAA      #35
STAA      103C
LDS       #C0
CLRA
STAA      7000
STAA      7001
STAA      7002
STAA      7003
LDX       #6000
DEX
BNE       B61C
COMA
BRA       B60D
```

The first and second lines set the MDA bit; the third and fourth lines clear the SMOD bit; and the fifth line sets the stack pointer. The fifth line isn't needed, but it's good practice to include it.

To try out the program, power down and set the jumpers for Special Bootstrap Mode. (If you wish, you can remove the BUFFALO EPROM.) Again jumper pins 1 and 2 of *JP12*. Power up and press the RESET switch. Now *LED1* through *LED4* should flash on and off at a slower rate than in the program that flashes all eight LEDs. Do *not* try to run this program from BUFFALO's GO command.

You can experiment with your own unique program to operate automat-



NOTES:
Q1 = OP500SLA or equivalent phototransistor.
Q2 = 2N2907 or equivalent PNP transistor.
K1 = DIP reed relay (Digi-key CAT. No. 26101-ND).
K2 = 16V ac relay with >90Ω coil resistance.

Fig. 13. Details for making an optical coupler (A) and the schematic diagram (B) of a simple circuit that allows a red type T-1 LED control a power relay (K2) via the contacts of a low-power DIP reed relay (K1).

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Describes new circuit design "MAGIC POLYHEDRON" concept. Soldering typically reduced to less than 20% of PC and perf board designs - much less risks of toxic chemicals, burns, bad solders, cooked parts, etc. Compact, efficient, low-noise, reliable. Versatile size, shape, layout. Easy to troubleshoot and change design. Cost effective. Easy to integrate with chassis, controls, connectors, displays, power supplies, etc. Assemble circuits just about anywhere! **$19**.

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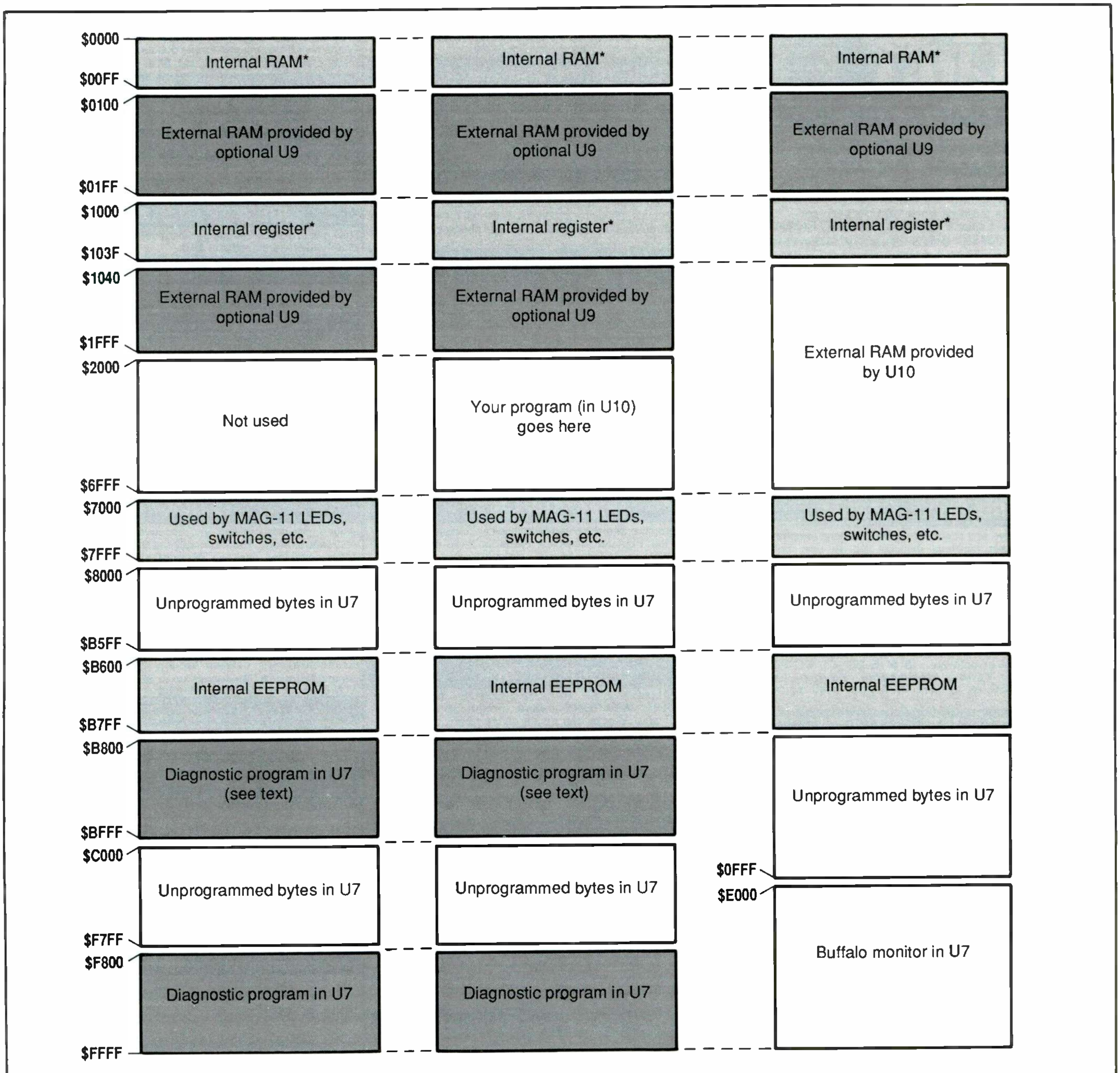


NOTE:
*Internal RAM and internal registers can be remapped (see text)

Fig. 14. Memory map for MAG-11 single-board computer.

ically when the jumpers are set for Special Bootstrap Mode. (MAG-11BAT's Logic Monitor is ideally suited as an output display for experiments.) For instance, you can connect short lengths of No. 24 hookup from the Port A outputs of *U1* (such as, PA4, PA5 and/or PA6) to *J1* on the Logic Monitor. (As can be seen from MAG-11's connector pinout illustration shown last month, PA4, PA5 and PA6 are connected to pins 8, 6 and 4, respectively, of *J3*.)

With a suitable program, you can control the respective Logic Monitor LED. For instance, if you connect PA4 to pin 1 of *J1, LED12* on the MAG-11BAT board will light if bit 4 of Port A at $1000 is set, and *LED20* will light if this bit is cleared.

You can modify MAG-11BAT so it will serve as an optically-isolated output board that can control relays. Use a short length of heat-shrinkable tubing of suitable diameter to optically connect a phototransistor to one LED on MAG-11BAT. If necessary, use black electrical tape to seal out external light. Connect the phototransistor in a simple circuit that controls a small DIP relay. A sample circuit is shown in Fig. 13.

While the relay mentioned can control up to only 0.5 ampere directly, it can be used to activate a power relay that, in turn, can control devices with larger current drain. It would be simpler, and probably more reliable, to connect an optoisolator directly to the output pins of Port A—but it isn't as informative or as much fun to do it this way.

Complete Memory Map

Figure 14 shows the complete memory map for MAG-11. This map is important if you plan to expand MAG-11. Notice that there are a substantial number of bytes that aren't programmed in EPROM *U7*. You can easily add a complex program to either the diagnostic or BUFFALO-monitor EPROM. The 68HC11A1P permits considerable flexibility in repositioning internal RAM and I/O registers, to the beginning of any 4K-byte page. The INIT register, located initially at $103D, sets the addresses for RAM and the I/O register.

Bit	RESET
7—RAM3	0
6—RAM2	0
5—RAM1	0
4—RAM0	0
3—REG3	0
2—REG2	0
1—REG1	0
0—REG0	1

RAM3 through RAM0 specify the upper hex digit of the RAM address. As you can see, after a reset, these bits are 0; so RAM is initially positioned from $0000 to $00FF. Similarly, REG3 through REG0 specify the upper hex digit of the I/O registers. After a reset, bit 0 is 1 and all other bits are 0; so the I/O registers are initially positioned from $1000 through $103F.

If RAM and registers are inadvertently mapped to the same space (for example, if the INIT register is cleared) the registers have priority. With the "A" version HC11, internal EEPROM is fixed between addresses $B600 and $B7FF.

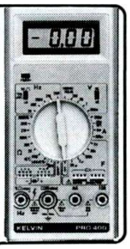
Now that you've built the MAG-11 SBC and its companion MAG-11BAT add-on battery board with Logic Monitor and experimented with them, you'll undoubtedly want to begin experimenting on your own. A good place to start is with this series of articles. Follow up with the manuals and downloaded software from Motorola's Freeware BBS to get more in-depth experience using these items.

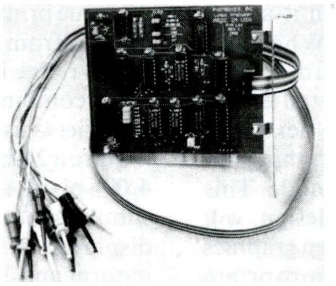
Hardware & Software Availability

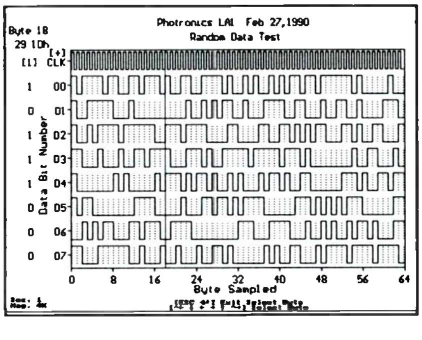
Parts and software for the MAG-11 single-board computer system are available from Magicland, 4380 S. Gordon Ave., Fremont, MI 49412. These include: double-sided MAG-11 pc board with plated-through holes and screened component overlay, Part No. MAG-11BD), $25; all ICs, except optional ones, including the MC68HC11A1P and a 27C256 EPROM with MAG-11DIAG or BUFFALO firmware (specify choice) and JB31J1 thermistor, 7,320-ohm 1% resistor and a loaded PC compatible MAG-11 software disk (specify 5¼" or 3½") but not including U9 or U10, Part No. MAG-11CDK, $49.50. Order bare MAG-11 pc board and set of ICs and disks, and pay just $69.

Available separately are: MC-68HC11A1P, $25; 27C256 EPROM with MAG-11DIAG firmware, Part No. MAG-11DIAG/E-256, or BUFFALO monitor, Part No. BUFFALO/E-256, $12 each; PC-compatible disk (part No. 6811ME-5 for 5¼" or Part No. 6811-ME-3 for 3½"), $7.50. All prices are postpaid in the U.S.; add $5 for shipment to Canada, $10 for shipment via air to other countries. Michigan residents, please add 4% for sales tax.

Motorola Freeware BBS—Tel.: 1-512-891-3733, 2400/1200/300 baud, eight data bits, no parity, one stop bit.







VGA To The Max

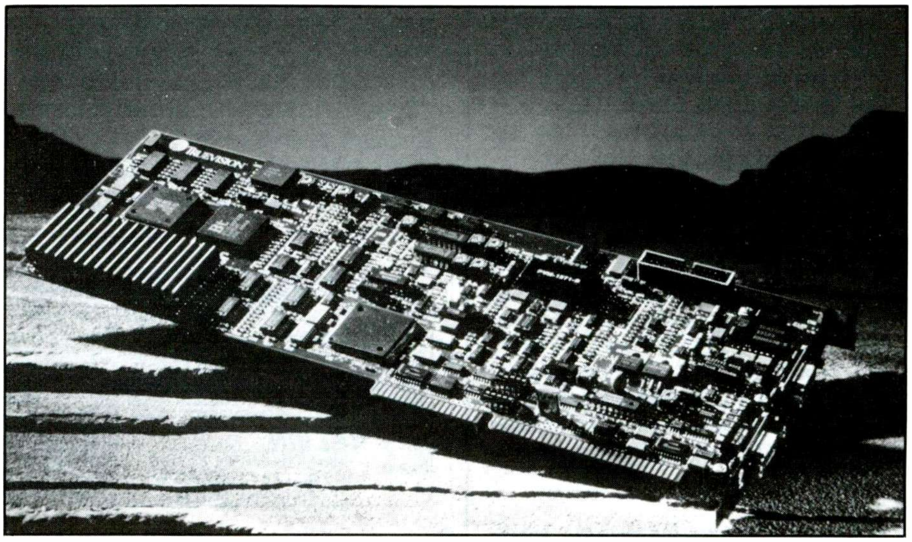
Part 1

A Look at Inexpensive Near-True Color Graphics and Windows Accelerators

You're probably aware by now of a quiet revolution—or evolution—spreading throughout the PC industry. It isn't *Windows*, but the long-awaited improvements in hardware and software that *Windows* 3.0 and other windowing graphical user interfaces (GUIs) have inspired. Integration gave *Windows* its sudden popularity. Long the exclusive desktop domain of the Apple Mac GUI, system integration under *Windows* simply means that all applications written for it essentially look and work alike. And integration goes all the way down to the hardware level.

Once *Windows* is configured for a particular PC, all applications for it follow suit. This is especially convenient with regard to the graphics controller being used. Set up *Windows* for 640 × 480 × 256-color resolution, and all applications within it adjust themselves accordingly. When you upgrade your graphics card, simply run the *Windows* Setup, install the appropriate driver, and the next time *Windows* is launched, everything appears in the new graphics mode. This means that *Windows*, by design, will take full advantage of a given graphics adapter, provided the appropriate software driver has been installed to support it.

To make things even more interesting, most graphics-intensive *Windows* applications like *PageMaker, Windows Paint, Ventura Publisher, Publisher's Paintbrush, ImagePrep, Excel*, etc., provide full support (display and editing) of 24-bit true color image files (originally, Truevision's 24- and 32-bit Targa formats).


Truevision's TARGA+ Graphics Engine.

"True color" refers to the fact that the human eye can't distinguish subtle differences among more than 256 shades of any given color. Each pixel within a 24-bit image is constructed from three eight-bit RGB (red, green and blue primary colors, each ranging in value from 0 to 256). This translates into a range of 16.7-million possible color combinations. The "possible" qualifier is used here because it would require a 24-bit resolution of 4,096 × 4,096 pixels to realize all these colors simultaneously. Images created and displayed in this pixel depth appear natural and lifelike.

The graphical PC cart is clearly ready, now what about an affordable horse to pull it?

This month, we discuss the latest trends in VGA technology. Next month, in the conclusion of this article, we'll present a brief but fairly comprehensive Glossary of Technical Terms commonly used in video display technology in general.

Evolving Graphics

Remember MDA, CGA and EGA? The same thing appears to be happening to VGA, with the exception that instead of disappearing altogether, it's evolving again. Originally, IBM tried to give the PC true high-resolution analog RGB graphics with the professional graphics adapter (PGA). However, its acceptance was limited largely because it was never really a standard, it was expensive at around $2,000 and it was hardware-inefficient because it required two full-length expansion cards to implement.

A far better solution came with the video graphics array (VGA) for IBM's line of PS/2 computer systems. Promising a true analog graphics solution at reasonable cost, VGA quickly became an easily cloned standard that has been greatly enhanced over the past few years. Originally offering 256 on-screen colors, or "attributes," only in a very chunky 320 × 200-pixel resolution, chip makers quickly pushed this resolution up to 800 × 600 pixels SVGA (super-VGA) and beyond by increasing the video page buffer to 512K and then to 1M.

Although these extended-VGA modes were essentially proprietary with respect to a given graphics controller (these non-standards are quickly giving way to the new guidelines laid down by the Video Electronics Standards Association, or VESA), software drivers are shipped with these graphics cards to provide support for numerous popular applications packages. However, recent releases of programs like *Windows* and applications written for its environment are beginning to make 256-color VGA (pseudocolor) appear dated.

Unlike EGA, though, SVGA still has a lot of life left. Rather than discard SVGA in search of a new platform, innovative semiconductor houses are breathing new life into what has turned out to be a very versatile approach to PC graphics.

More Enhancements

One of the more-elegant and most-promising means of boosting the color performance of VGA graphics is HiColor, a registered trademark of its developer, Sierra Semiconductor. HiColor essentially permits existing VGA controllers to break the 256-color barrier via the exclusive HiColor line of color palettes (the more familiar term coined by Brooktree Corp. is RAMDAC).

Simply put, the VGA palette is a device with three on-chip D/A (digital-to-analog) converters and 256 bytes of RAM used for a color attribute look-up table that provide the RS-343A-compatible RGB outputs required to drive an analog color monitor.

Industry standard VGA palettes like Brooktree's BT471/476/478 series, with which HiColor is pin-for-pin compatible, can at best produce only eight-bit pseudo-color. Although VGA has 262,144 possible color combinations, it's restricted to displaying only 256 of these at any given time. To obviate this limitation, HiColor palettes cleverly bypass the look-up table to provide pixel depths of 15 and 16 bits, for 32K and 64K on-screen colors, approaching true-color output.

Often requiring little modification to an existing SVGA board design, other than a video BIOS upgrade and additional software drivers to support the available HiColor modes, the upward transition to HiColor for the graphics card OEM is a very easy one. This translates into an inexpensive upgrade path for consumers who want to obtain a perceived depth of color that approaches those of such prohibitively-expensive display adapters as the Truevision 1024-32.

As of this writing, HiColor boards are selling in the US for less than $200. Compare this with IBM's original 64 color EGA (false-color), which sold for $1,000-plus a just few years ago!

If you still aren't convinced of the merits of such enhancements, you probably haven't seen *Windows* or *AutoCAD* applications like *Renderman* and *AutoShade* running in HiColor mode.

Here's an experiment that stresses this point: If you currently use *Windows* in a 256-color SVGA mode, try opening two or more windows simultaneously with eight-bit (or greater) color images displayed within them. You'll be surprised to see all palette information for the inactive windows (those still visible but with tasks suspended) are temporarily discarded. Only the currently active window will appear to have its correct color information. This occurs because of that 256-attribute limitation of VGA.

Only one color map (virtually the entire contents of the 256-byte RAMDAC look-up table) can be assigned at any given time. If two or more different color images, each with its own unique color map, are to be displayed simultaneously, only one is given priority over the look-up table.

Interestingly, *Windows* seizes a few of the available color attributes for its own use when launched. These confiscated attributes are then used for coloring icons, window borders, etc., and are no longer made available to applications. Therefore, if *Windows* is running in, say, pseudo color mode, a number of those possible on-screen colors are lost. This isn't the case with HiColor because its viewable on-screen attributes aren't bound by VGA's 256-color limitation.

Under the Rainbow

Viewing a Targa image (or any 16-, 24- or 32-bit graphics file format) in HiColor mode is a real treat. Edges and color gradations within an image appear smooth and realistic (a sort of "anti-aliasing") when compared to the jaggies apparent in pseudo-color modes, with a depth that 256-color VGA can't begin to approach.

Also gone is the obvious "banding" that's apparent with pseudo-color when viewing true-color images under HiColor. Banding is an inability to smoothly gradate between light to dark adjacent shades of a given color. Images with large areas of like shades, such as blue skies and water, readily display this anomaly as strips or "bands" of stepped colors, instead of a more realistic, smooth transition from light to dark shades.

Although some color/detail-complex eight-bit graphics images can look quite good, they quickly pale next to 16- and 24-bit formats with which you can work under a HiColor-enhanced video system.

Proof of the increasing popularity of HiColor is evidenced by its support in the shareware arena with Version 4.6 of Bob Montgomery's perennial VPIC. Originally a GIF image-only (Compuserve's Graphics Interchange Format) viewing program, VPIC is now configurable for HiColor cards that utilize the Tseng Labs ET4000 controller and supports a broad range of image formats. VPIC Version 4.6 lets you view and manipulate 16- and 24-bit Targa files on your PC in 32K HiColor mode, while maintaining support for lesser graphics platforms.

If there's a down side to HiColor, it's the fact that it can marginally slow down graphics throughput. This is because there's a lot more color information to be processed when compared to 256-color graphics. Just how great the slowdown will be depends on the graphics controller you use with the HiColor palette. It's applicable when in HiColor mode. In all other modes, display speed is unaffected. If the graphics card in question makes use of VRAM (dual-port DRAMs), the slowing effect of HiColor is virtually nil when compared to 256-color modes at the same resolution.

HiColor a Standard?

If imitation is the sincerest form of flattery, copying the other guy's chip means you have a sure winner. Such is the case with HiColor. As of this writing, at least one semiconductor house (Music Semiconductor, a Dutch company with a sales and marketing office in Colorado) has announced a color palette (MU9C1715) claiming 8-, 16- and 18-bit color support. It seems targeted at Sierra's HiColor market. It remains to be seen if this new chip will succeed.

The MU9C1715 is available only in a 44-pin plastic leadless chip carrier (PLCC) package (industry standard palettes are packaged almost exclusively in 28-pin DIPs) and requires additional "glue" logic to implement on existing SVGA designs. Such shortcomings aren't suffered by HiColor.

VGA On Steroids

Windows and other GUIs make the most of a given hardware installation by pushing a system to its performance limits. Minimal system memory, slow hard disks and inefficient graphics controllers can all add bottlenecks to *Windows,* making it agonizingly slow to respond to your input.

I've seen 33-MHz 386DX-based PCs running *Windows* with a poorly designed SVGA system and it was nearly comedic (or tragic, depending on how you look at it). Opening or closing a window in 1,024 × 768 × 256-color mode was akin to using venetian blinds. You could actually see individual strips of each window being drawn! Although the software driver was probably just as much at fault as the controller chip itself, this was an object lesson in how power-hungry *Windows* truly is.

On the other side of the coin, there are truly speedy VGA controllers like the Tseng Labs ET4000/AX. Arguably the fastest non-coprocessed VGA controller available, the ET4000/AX performs exceptionally well with HiColor under *Windows.* Even without the added advantage of VRAM, an ET4000/AX is capable of driving noninterlaced 1,024 × 768 × 256 displays by accessing normal DRAM memories in zero wait-states and providing full support of faster throughput VRAM memories if incorporated into the board design.

Getting Ergonomic

Although a *Windows* driver alone won't automatically enable a noninterlaced 1,024 × 768 display, most of these boards are bundled with controller-specific utilities that sense when 800 × 600 or 1,024 × 768 display resolution has been invoked. They then take appropriate action to enable noninterlacing by increasing the rate at which the screen refreshes.

Pushing VGA performance even further are the new generation of *Windows* accelerators. Unlike true coprocessed graphics engines like those that incorporate a dedicated RISC processor or the Texas Instruments' TI34010 and TI34020 vectored-graphics processors (TIGA) familiar to high-end CAD workstations (that require a separate, standard VGA controller to maintain boot-up VGA compatibility), the new *Windows* accelerators are targeted specifically at GUIs.

Lacking the vector processors mentioned above, these latest controllers are essentially built around superset VGA cores with on-chip engines to perform rectangular bit-block transfers (BitBlts) and line draws, which are the two most CPU-intensive graphics calls in *Windows* and similar GUIs.

Surprisingly, these accelerators can often outperform the TIGA cards when it comes to running *Windows.* This can likely be attributed to the fact that both approaches differ greatly in design philosophy and target markets. While the TIGA or RISC-based platforms are optimized for the vectored graphics world of CAD, *Windows* accelerators are optimized for the raster-

WHEN YOU'VE FINISHED YOUR ESSAY, PUT YOUR NAME ON YOUR FLOPPY DISK AND PASS THEM FORWARD.

based, bit-map world of GUIs.

By relieving the host CPU of such mundane tasks as redrawing a window (BitBlts) and its border (linear line draws), perceived graphics speed and overall system throughput is markedly increased. One of the hotrods in this rapidly expanding field comes from a company called S3 (pronounced S-cubed), which supports HiColor.

I recently had the opportunity to witness an impressive "*Windows*" demo of an S3 Carrera-based graphics card (sans HiColor) given by a marketing team that really showed what these chips can do. Performing in 1,024 × 768 × 256 noninterlaced mode, this single-chip controller (the demo board, looking like any typical SVGA card, with no 8514/A processor) was literally snapping windows open and slamming them shut. Even text writes within *Windows* were nearly instantaneous. A platform like this equipped with HiColor would make using *Windows* a very pleasurable experience indeed.

The first of these S3-based graphics accelerators to become commercially available is the Fahrenheit 1280 graphics card from Orchid Technology ("1280" presumably refers to the 1,280 × 1,024 × 16 *Windows* 3.0 driver under development). Priced at less than $500 (with a HiColor upgrade to be made available), the 1280 is definitely worth considering.

Another hot contender to watch for is the recently announced ET4000/X32 graphics engine from Tseng Labs. These chips are a superset of the existing ET4000/AX controller with BitBlts in hardware (up to 30 times faster than block transfers performed in software, according to Tseng Labs), hardware line drawing, area fills and more. The new controllers will also support 2M of video RAM, providing 1,024 × 768 XGA (64,000 colors) and 800 × 600 24-bit true-color (16.7-million colors) resolutions.

Other VGA controller manufacturers, like Weitek Corp. with its recently released W5086 engine, are currently planning their own graphics accelerators, or are already in production.

Unfortunately, monitor technology hasn't kept up with the current price-versus-performance pace of graphics cards. To take the fullest advantage of these cards requires relatively expensive multi-frequency analog monitors that can display 1,024 × 768 (or greater) noninterlaced resolutions with dot pitch (space between pixels) of 0.28 mm and smaller. If you plan to run *Windows* at this resolution, don't even think about diagonal screen sizes smaller than 16". On a 14" screen, for example, those cute little icons become unrecognizable at 1,024 × 768. And forget *Windows* word processing. Even with the aid of something like Adobe *Type Manager* or Bitstream's *Facelift*, word processing under *Windows* on a 14" monitor at 1,024 × 768 resolution is like reading a newspaper at arm's length.

A resolution of 800 × 600 is bare minimum for seeing the full width of a standard page of text under *Windows*. Seeing even half the length of that same page puts you back at 1,024 × 768, something that's definitely 16" territory to be usable over extended viewing sessions.

Prices for quality 16" monitors are still hovering at around $1,000. Is it worth it? When you consider the significant reduction in eyestrain and fatigue and increase in productivity via true WYSIWYG displays that larger monitors offer (all items that should be of major concern to corporations), I'd have to say "yes." Unless you are on a really modest budget, don't even consider less than HiColor-equipped VGA for your next graphics card. For just a little more money, you can obtain a HiColor-ready *Windows* accelerator capable of meeting or beating the performance of those very expensive TIGA and RISC-based systems for bit-mapped GUIs.

Tune in next month, when we'll conclude with our Computer Graphics Glossary of Terms.

Companies Mentioned

Sierra Semiconductor
2075 N. Capitol Ave.
San Jose, CA 95132

Tseng Laboratories Inc.
10 Pheasant Run
Newtown Commons
Newtown, PA 18940

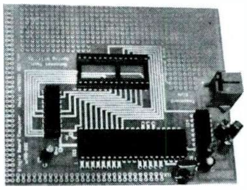
VPIC Version 4.6, $20
Bob Montgomery
543 Via Fontana No. 203
Altamonte Springs, FL 32714

Brooktree Corp.
9950 Barnes Canyon Rd.
San Diego, CA 92121

Truevision
7340 Shadeland Sta.
Indianapolis, IN 46256

S3 Inc.
2933 Bunker Hill Lane
Santa Clara, CA 95054

Orchid Technology
45365 Northport Loop W.
Fremont, CA 94538



PC-Generated Printed-Circuit Boards: Experiences With "PCBoards" Software

Dozens of programs on the market let you design printed-circuit boards directly on a PC/compatible computer. *PCBoards* ($99 postpaid) by Ralph A. Lindstrom may not be the most sophisticated or advanced, but it has about everything needed to produce professional-quality artwork that can be used directly to fabricate at home pc boards of professional quality.

Before looking at what *PCBoards* can do, let's review its limitation in its latest release. Because it doesn't permit pad spacing of less than 0.1", it can't be used to design a board that contains surface-mount ICs that have 0.05" pin spacing. Additionally, board size is limited to 6.05" × 13" maximum. Since the program doesn't do overlays, you must generate component-mounting guides by hand or with a separate general-purpose CADD program.

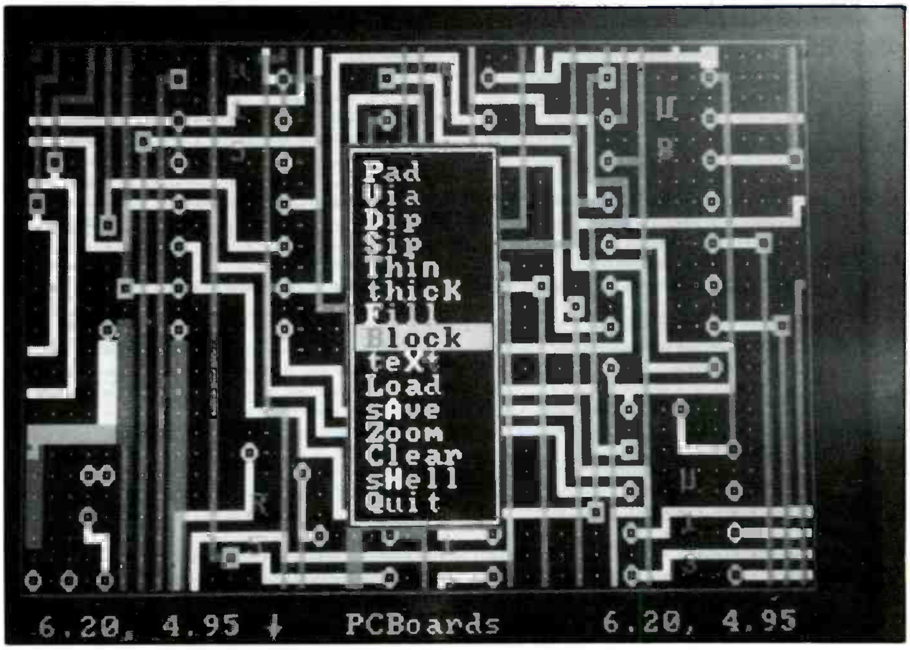
PCBoards doesn't come with a printed manual; it's a file on-disk. What it does have is an intuitive, game-like genius. It's good-natured and enjoyable to work with. It's one of those well-thought-out, simple programs that boosts your ego by turning you into an expert in half a day!

Despite its limitations, what *PCBoards* does provide for the design of most pc boards is more than enough. This program is capable of producing excellent art on a Hewlett Packard LaserJet II or compatible laser printer and can be used to design virtually any single- and double-sided pc boards you might require.

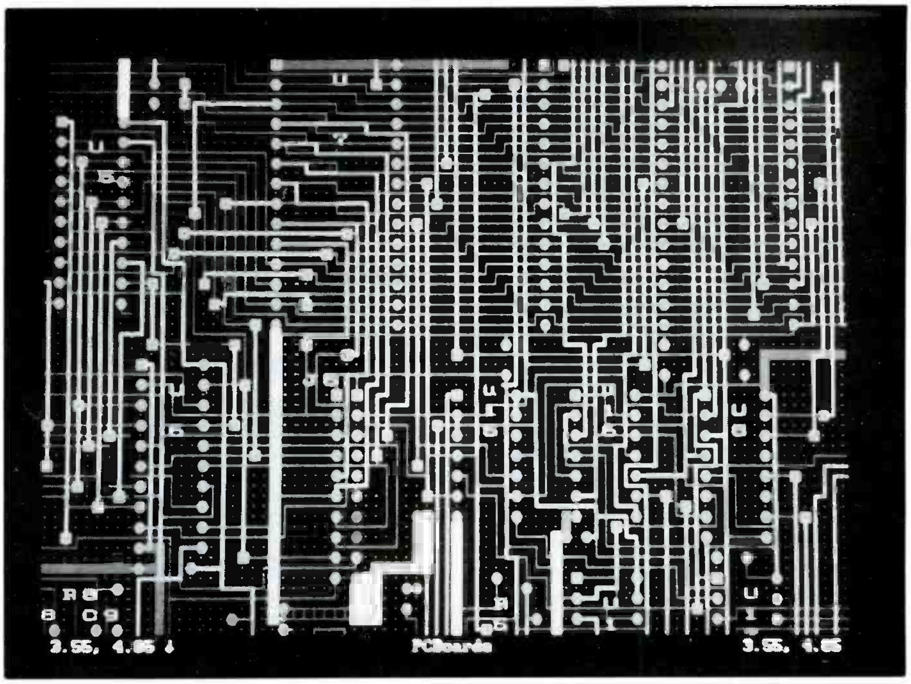
To run *PCBoards*, you need an IBM PC or compatible system with at least 384K of RAM and CGA or VGA graphics. DOS version 3.0 or later is recommended for use with the Shell option. While it isn't listed as a requirement, it seems foolish to run *PCBoards* without a color display. A mouse is nice, too, but it isn't required.

The latest version of *PCBoards* permits use of either CGA or VGA. I designed the MAG-11 single-board computer that appeared as a build-it-yourself project in the February issue of *ComputerCraft* using Version 1.65 of *PCBoards*, which supported only CGA. With VGA supported in the later Version 1.7, it should be even easier to do because more of the board will fit on the screen.

Its obvious I like *PCBoards*. I'm not completely smitten by it, though. While using this program, I discovered a few things I didn't like. One had to do with the



The PCBoards printed-circuit design package has a fairly rich lineup of commands from which to choose, as shown here in menu at center of screen.



A wide range of single- and double-sided pc layout patterns can be generated with PCBoards, from very simple designs to the fairly complex example shown here.

"Text" command. A problem occurs when trying to erase old text. By fiddling a bit, it's possible to erase old text, but it's clear something is amiss here. All in all, the "Text" command seemed to need a bit of polishing up.

PCBoards doesn't generate a ".bak" file, which can cause real problems if, instead of selecting "Load" from the menu, you select "save" by mistake. If you should make this error, you'll get an automatic but useless gross simplification of your design! Also, though the "Fill" command may be bug-free, it's a bit confusing to use. However, judicious application of the easy-to-use "Thick" command can do anything "Fill" can, though it may take a bit longer to do it.

If you'd like to try out *PCBoards*, a demo version is available for $10, refundable with purchase. The demo can do everything the full-blown version can do, except save files to disk. However, several sample file patterns stored on the demo disk can be printed out so that you can check for quality and compatibility with your printer or plotter. Included in this offer are demo versions of an auto-router (*PCRoute*) and a schematic-drawing CAD program (*SuperCAD*).

The positive photographic technique is the simplest method of making printed-circuit boards using *PCBoards*. You can make pc boards directly from the artwork produced on a Laser printer. To use the artwork generated in this manner, you must place the bottom (solder-side) artwork printed side down (in contact with the board and top (component-side) artwork printed side up.

I used *PCBoards* and an Okidata 400 laser printer to design and print out the pc guides shown in the MC68HC11 SBC article referenced earlier. Laser printers will print on suitable clear transparencies. However, some nearly transparent vellums seem to do a better job and are easier to touch up with a pen. The main difference is that vellum requires the UV exposure light be left on for 10% to 30% longer time period than with a transparency. Exact time depends on the light transmission characteristics of the vellum used.

To ensure solidly opaque artwork, you must set your laser printer to maximum darkness. Also, manually feed the vellum and set the printer so that the finished copy feeds out the back and not the top. I've used several different types of vellum. Most worked okay, but Micro 100% Rag Vellum Tracing Paper from the Dick Blick Art Catalog (Cat. No. 931218) gave best results. With this and GC Electronics' positive-photoresist-sensitized pc blanks, I determined that about 15 minutes of exposure time to a 275-watt sunlamp with reflector at a distance of 12″ produced good boards. Of course, you should always run a small sample test before attempting to make a large, expensive board.

I detected one problem in the initial tests. The corners of thin traces didn't always come out well. They sometimes left a tiny break in what should have been a solid "foil" pattern. I repaired these breaks with a touch-up pen. It would certainly be an annoyance if I had to repeat this touch-up procedure every time I generated pc-guide artwork. Regardless of the cause, the problem disappeared after I ran out a few later pc guides and hasn't arisen since. Perhaps my new printer had to settle down, as this was the first thing I tried printing with it.

The real test came after etching. The board turned out nearly perfect. I detected neither short circuits or breaks either visually or with an ohmmeter. ■

In Brief

PCBoards, $99
PCBoards
2110 14 Ave. S.
Birmingham, AL 35205
Tel.: 1-800-473-PCBS or 205-933-1122

Dick Blick
P.O. Box 1267
Galesburg, IL 61401
Tel.: 1-800-447-8192

GUI Guts By Yacco

Fitting More Power into Windows

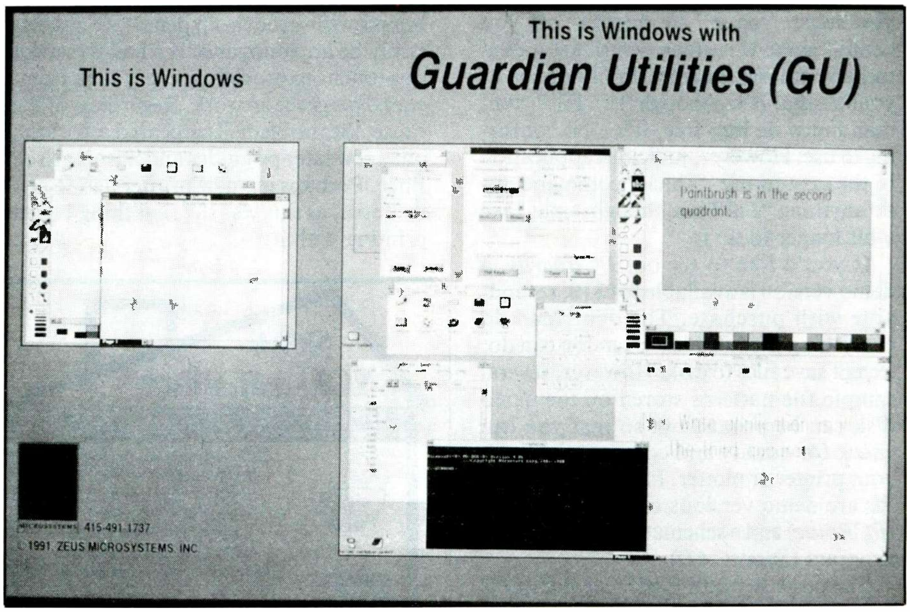
A new column, GUI Guts, makes its debut this month. In each issue, it will offer tips, tricks and applications that increase the productivity of graphical user interfaces (GUIs). Microsoft Windows *will receive a lion's share of the attention here—so long as its momentum leads the other GUIs. But other alternatives will be covered as well. Readers are invited to correspond with questions about, or favorite tips and tricks for, their favorite GUIs.*

It doesn't take much effort for a DOS power user to become a *Windows* power user. The mark of a power user is an ability to extend into the full capacity of the computing environment. It means knowing the tools and how to use them. With DOS, it's intimately knowing the grit and smell of hordes of commands. With the more intuitive GUI interface, such depth is somewhat de-emphasized, and the power user's acumen can be transferred to a greater breadth of applications. It's not surprising, therefore, that power users tend to collect tools like suburbanites collect at a Sears fire sale.

Such power users are likely to find Microsoft *Windows* a cramped environment. As more and more applications are opened, the desktop becomes so cluttered that, soon, most windows are likely to be iconic. Congestion is only likely to get worse. Version 3.1 is expected to lift certain restrictions imposed by the current implementation of *Windows* and support a far greater number of applications.

Fortunately, keeping all those applications open and readily productive isn't hopeless. If you've got the right *Windows* utilities, it's possible to open an enormous number of applications—simultaneously—without having them chock-a-block, one upon the other.

All of these utilities work their miracle in much the same way: by providing *Windows* with a virtual desktop. This is essentially a workspace that's some multiple of your monitor. With a virtual desktop, you can conveniently fit your contact manager, calendar, spreadsheet, word processor, database and everything else into *Windows*. It's also possible to quickly jump among several applications sharing the same data. A spreadsheet, charting program, presentation program, word processor, and desktop-publishing program could all be open—sharing a chart and underlying data—with instant access to the formatting, editing and publication tools in each application.



Zeus Microsystem's "Guardian Utilities" opening screen under Windows.

Windows doesn't know when a virtual desktop is installed, and neither do the applications. The utilities create and manage the workspaces with desktop maps that let you move applications from area to area. The maps also let you move your display between areas—something like the way scroll bars let you move over large documents within an application window.

Guardian Utilities

A simple example of these tools is the "virtual large desktop" in the *Guardian Utilities (GU)*. It's two-by-two configuration is fixed, but *GU*, alone among workspace-clone artists, allows you to move from area to area by simply moving your cursor. You can also move around with hot keys or its desktop map. Its map does lack the ability to follow active applications or float to the top of active *Windows*, but you can switch to any area without regard to the existence of applications there.

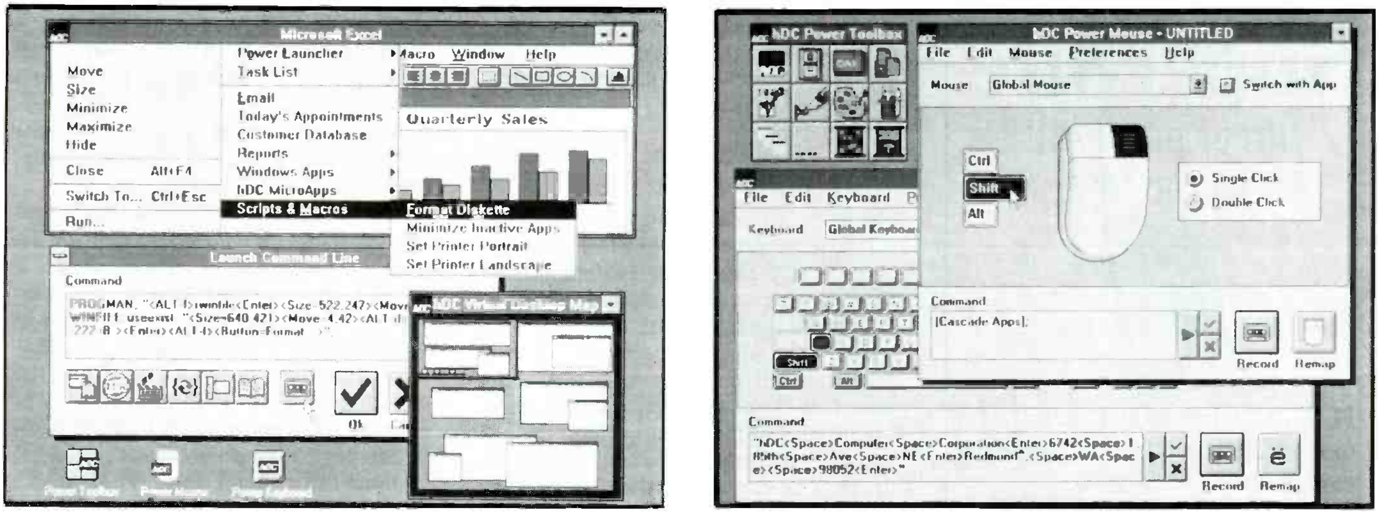
GU includes other utilities, such as screen notes, a screen saver and animated wallpaper. And although *GU* lacks a few luxuries, such as automatic installation, it's a solid product that, at $19.95, costs less than many shareware programs. Anyone can afford to experiment with it.

Amish Utilities

Big Desk is shareware. However, it's been incorporated into a commercial product called *Amish Utilities* that will ship in April. You can try the shareware, but *AU* is where development will continue, and as part of the collection, *Amish Desk* (as it's now called) has been modified and integrated with other utilities. It has a common look-and-feel and shares a common DLL library with an applications launcher that can serve as the *Windows* shell, quite sophisticated screen notes and on-screen status monitors for memory and clock functions.

Amish Desk (*AD*) lets you select up to 64 areas that are easily navigated via its desktop map. The map, or its icon, can be made to follow the active application and stay on top (float) of other windows.

Versions of *AD* are already in development for OS/2 and *NT*. So *AD* will have an early advantage for multi-platform GUI environments. (In fact, if you're going to Windows World in Chicago, president Ted Matsumura promises that you'll be able to see it running on *NT* in the Microsoft booth.)



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PROGMAN, "<ALT-I>winfile<Enter><Size-522,247><Move
WINFILE useexist "<Size=640 421><Move-4,42><ALT-d
222 8 ><Enter><ALT-I-t><Button=Format >"
```

```
[Cascade Apps];
```

```
"hDC<Space>Computer<Space>Corporation<Enter>6742<Space>1
85th<Space>Ave<Space>NE<Enter>Redmond^,<Space>WA<Spac
e><Space>98052<Enter>"
```

The main menu of hDC's Power Launcher utility, shown at left, includes a Virtual Desktop Map. The screen at the right is an example of the utility's PowerApps screen.

Power Launcher

This utility package from hDC includes an advanced launcher and four utilities: screen saver, keyboard macros, mouse macros and floating toolbox builder (more macros). Its virtual desktop is part of the launcher, as is the screen saver, and it is very slick. You can even have applications automatically open to exact sizes at specific locations on each desktop area. Navigation is through the desktop map—the only one of these maps in a sizable window. It can produce up to 64 desktop areas, and has both follow and float features. I wouldn't be surprised if it shared some core technology, or development staff, with *AD*.

The *Power Launcher* and toolbox builder, though, are all on their own. It's the depth of these applications that really sets this utility apart. Nothing else has their automated macro-generation buttons and dialogs. They also have a recorder, and for hacking, there's complete documentation of the macro-language's syntax and semantics. Yet while "Power" is far from a misnomer, it doesn't take a Ph.D. in C to figure it out, either. Despite its one or

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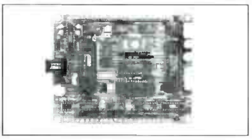
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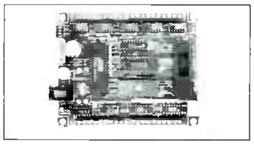
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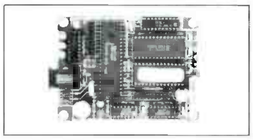
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two flaws—an occasional minor instability and an annoying copy-control installation —*Power Launcher* unquestionably gives you the most bang.

WideAngle

WideAngle is neat. There are enough options to customize it for any taste I can imagine, even the kinky ones, within its fixed three-by-three configuration. (Of course, I know of these uses for *Windows* only second-hand.) Its X-ray view, for instance, lets you see all of the apps in an area at the same time. You can move icons across area boundaries in the desktop map, though you can't directly drag windows between areas. You can automatically open applications in a particular desktop area also.

WideAngle is powerful but moderately complex if you want to take advantage of its full power. Hot keys will navigate the workspaces, or bring specific windows into them, only if you program them. You can also create up to nine different "groups" that can be used to open applications when *WideAngle* starts. Naturally, this requires configuration. It also requires use of more than a single menu. Nevertheless, although it's not as intuitive as I'd like it to be, *WideAngle* lets you use its basic features easily. Its map will follow you around. It'll float over other applications, too.

MoreWindows

There's one more utility that provides a virtual desktop. However, it does it in a very different way from the rest. *MoreWindows* is actually a special set of drivers; a program that makes it possible to install them. (The *Windows* Setup program can return to any other driver. So, I suspect that requiring an installer is simply an innocuous form of copy control.) Since it's implemented as a driver, *MoreWindows* doesn't clone the desktop area. Instead, it uses more pixels as would a larger monitor. Rather than several workspaces, it provides one large one. Unexposed areas move into view as the cursor approaches them.

The great advantage of *MoreWindows* is that, because it works like a larger monitor, applications can display larger windows. *PageMaker* can display a full page or a pair of pages side-by-side, depending on the model you select. (There are four for EGA and five for VGA.) Instead of using scroll bars that require applications to tediously re-draw parts of the screen, you can instantly move back and forth over whole pages.

As far as applications are concerned, the other virtual desktops provide additional, not larger, workspaces. Applications don't get any larger than usual, and you're left scrolling documents as you would normally. However, you can conveniently use *MoreWindows* with all of the other virtual desktops, except *WideAngle*. Guardian is also somewhat less efficient with *MoreWindows*. (Their maps don't compensate for the change in scale and, consequently, grow unwieldy.)

The only drawback is that the current version of *MoreWindows* uses only a VGA graphics mode for its virtual output. It doesn't support either 256- or true-color adapters. Nor will it drive a monitor at more than 640 × 480 resolution. (Incidentally, for those in the know, while the documentation for all these products was at least satisfactory, the brief but impressive *MoreWindows* manual was done by none other than Daniel Will-Harris.)

Nonetheless, wrap your eyes around any of these tricksters, and you'll soon be displaying more applications than ever before. Use the cloners for high-resolution, high-color paint or drawing programs. Use *MoreWindows* for page-layout in word processing, desktop publishing, spreadsheet publishing and forms design. Even use them in combination to display several layouts at once. But watch out, you may need to get some suspenders for your tool belt.

Amish Utilities, $99.95
Amish Software
1325 Mills St., No. 1B
Menlo Park, CA 94025
Tel.: 415-323-4627

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Power Launcher, $99.95
hDC Computer Corp.
6742 185 Ave. NE
Redmond, WA 98052
Tel.: 206-885-5550

CIRCLE NO. 152 ON FREE INFORMATION CARD

MoreWindows, $99
Aristosoft
6920 Koll Center Pkwy., Ste. 209
Pleasanton, CA 94566
Tel.: 510-426-5355

CIRCLE NO. 153 ON FREE INFORMATION CARD

Guardian Utilities, $19.95
Zeus Microsystems
Box 6143
San Rafael, CA 94903
Tel.: 800-727-2603 or 415-491-1737

CIRCLE NO. 154 ON FREE INFORMATION CARD

WideAngle, $129.95
Attitash Software
20 Trafalgar Sq.
Nashua, NH 03063
Tel.: 800-736-2803 or 603-882-4809

CIRCLE NO. 155 ON FREE INFORMATION CARD

Ted Needleman

The Software Toolworks "Miracle Piano Teaching System"

Did you have to take music lessons when you were a kid? I remember taking piano lessons when I was seven or eight and, like many kids, disliking them intensely. Not only were the endless scales boring and difficult to master, but having to walk several blocks every day to use a family friend's piano on which to practice just added insult to injury. As you might imagine, like a lot of kids who had piano lessons foisted on them, I soon talked my parents into letting me free from the "piano tedium."

As an adult, now I wish I hadn't been so successful in weaseling out of my lessons. Over the years, I've picked up some facility in chording on a guitar, but despite several false starts in trying to learn piano by myself (remember those old advertisements for a mail-order music course that started out "They all laughed when I sat down at the piano.."?), the $30 to $50 an hour cost of piano lessons, along with hours of tedious practicing of scales and hand exercises, have kept me far from a career as a piano virtuoso.

Perhaps it's this frustration that has me, as a parent of four, wanting my kids to learn a musical instrument. But with my hoard, technology might make learning a musical instrument a great deal easier. An outstanding example of an educational use of a PC is the Miracle Piano Teaching System from The Software Toolworks.

As its name implies, the Miracle Piano Teaching System (*MPTS*) is somewhat more than just another electronic musical instrument. As with any system, it consists of several components. Two are physical: an electronic keyboard and software for whichever system with which you're using the MPTS (it's available, or soon will be, for IBM, Amiga, Macintosh, NES and Super NES computers). The last, and probably most important part of the system is somewhat more metaphysical—a very cleverly crafted and well-thought-out and implemented approach to teaching the basics of playing piano and sight-reading music.

I first saw the MPTS demonstrated at the Fall 1990 COMDEX show in Las Vegas. At that time, the Toolworks was just getting ready to introduce the first model, which worked in conjunction with the Nintendo Entertainment System (NES). A cable from the Miracle was plugged into the first controller socket, and the Miracle program cartridge plugged into the NES control deck. You followed the program on your TV receiver and used the second game controller to advance screens as lessons progressed.

At that time, it knocked me out; so I immediately requested a review unit, hoping to become somewhat familiar with the system until the PC version was ready. Unfortunately, none of the three units I tried worked reliably, and the quality of the TV image was, at best, poor. I can't blame this on the Miracle, as games played on our Nintendo also tend to take a sharp left turn frequently (with four kids in the house, I'm surprised when things *do* work reliably!).

The Miracle enjoyed some modest success that Christmas season. For the holidays that have just past, the Toolworks finally had the PC version ready and in stores. I decided to take another look, and I'm glad I did. It was worth the wait.

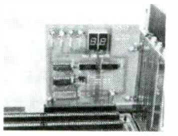
The Keyboard

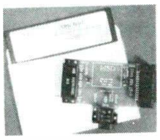
Obviously, an important part of any system that purports to teach one how to play the piano is a keyboard. Some home-study courses assume you have a standard piano or an electronic keyboard available, but the Miracle's keyboard, though it doesn't look it, is a bit different from what you can buy in a department or music store.

At first glance, the Miracle keyboard looks very much like any generic Casio, Yamaha or other electronic keyboard selling in the $250 price range, though it has far fewer buttons than most department-store bargains. The keys are just about standard size, and the 31½" long by 13" wide case contains 49 of them instead of the standard 88 keys normally found on a full-size piano. The missing octaves on the top and bottom won't really make any difference in your learning how to play. By the time you get to the difficulty level where they're important, you're far beyond what the Miracle System has set out to teach.

The big differences in this package aren't apparent from a casual glance at its contents. Firstly, just like with much more expensive keyboards, the keys are velocity sensitive so that the harder you press them, the louder the sound obtained. A standard mechanical piano has a somewhat different feel, but it operates exactly the same way—pound the keys for loud music, gently press them for softer notes. Also, like many of the better electronic keyboards, the Miracle is a MIDI device. MIDI is a specialized form of serial network that was developed specifically to link electronic musical instruments with each other and with computers.

As with any MIDI device, the Miracle can control, and be controlled by, other MIDI devices. Eight innocuous rocker switches can be used to select the "patch," or instrument voice, as well as control vol-





ume level when the Miracle is being used in its stand-alone mode.

The Miracle contains 128 different instrument sounds, including various piano, organ, guitar, bass, percussion and woodwinds. These patches are detailed in one of the two manuals that accompany the system. They can be selected from the top switches, another MIDI device or a computer-controlled sequencer package. The keyboard is 16-note polyphonic. That is, you can play 16 different notes at the same time, and the keyboard can be split so that the top and bottom halves are different instrument patches.

Sound emerges from two top-mounted stereo speakers (which sound pretty good), or it can be routed through an audio or musical instrument amplifier. There's a set of stereo phono jacks on the unit's back panel. The Miracle keyboard has an additional DB-25 connector beside the MIDI port for connecting the keyboard to a computer or game system. Though it's not detailed in the documentation, the extra DB-25 connector provides access to a fairly standard serial port.

Finally, unlike many lower-end keyboards, the Miracle doesn't run on battery power. You must use a supplied ac power supply. To top off the Miracle package, the Toolworks includes earphones, a foot pedal made of conductive rubber that you use as a damper pedal or instead of the mouse/space bar to advance the lesson and a special serial cable to attach the keyboard to your PC.

The Software

The second physical component of the Miracle Piano Teaching System, and the metaphysical basis that makes the system work so well, is the supplied software. Installed from two 1.2M 5¼" or three 720K 3½" diskettes, the software is both interactive with the keyboard and adaptive. Incidentally, while the software isn't copy protected, it's in a compressed format. Software Toolworks recommends backing up the installed software, rather than copying the disks.

The two keys to the software's utility are the degree of its interaction with the keyboard and the way it adapts the lesson plan and presentation as a result of this interaction.

When you enter the program, you are presented with an overhead view of a "music school." The different rooms define different activities you can perform. The first stop is "Administration," where, you register yourself as a student (so that the system can keep track of multiple users), set preferences (like which serial port you're using and whether you want to use the foot pedal to advance the screens) and print out certificates of completion as you finish each of the 36 lessons that comprise the course. The other rooms are the Classroom, Practice Room, Performance Hall, Arcade and Recording Studio.

Most of your time will be spent in the Classroom, Practice Room and Arcade. In the Classroom, lessons are presented on a "chalkboard," and you are asked questions and encouraged to try out what's being presented. As you progress through a lesson, you play along with a screen presentation while your performance is analyzed.

For more formal practice, you move to the Practice Room, where you can select from a variety of pieces at each lesson level. Finally, when you're comfortable with a piece, the Performance Hall lets you play with accompaniment from the Toolworks Orchestra (the computer plays the other instrumental parts through the Miracle keyboard).

The Arcade lets you practice vital skills through clever games. For example, the shooting gallery has you knock off animated ducks swimming along the treble clef by hitting the correct note on the keyboard. Likewise, chords are practiced in the Ripchord game. If your preference is to just listen to the Miracle play, the Jukebox can be set to play any piece that's contained in the lessons with full orchestral accompaniment.

Finally, there's the recording studio, which is actually a pretty neat eight-track sequencer that lets you record and play back your own compositions. I played around with it a bit, but to really get any use out of the Recording Studio, you have to get a bit further along in the lessons.

Having gotten at least somewhat familiar with the NES version of the Miracle, I was impressed with just how much better the PC version is. Obviously, because the PC has a much greater program space, the software can be more sophisticated than what can be contained in a NES ROM/game cartridge. The NES version leaves off such niceties as the ability to track multiple users, the Recording Studio and the Jukebox. The graphics on the PC version are also vastly superior, especially when viewed in VGA mode.

The basic adaptive technology used is the same in all versions of the MPTS. The software monitors the keyboard as you go through lessons and exercises, noting if your timing is off, whether you're hitting the correct notes and if you're pressing the keys with the correct amount of pressure and releasing them too soon or holding the note too long. It uses this information to determine how rapidly you should be presented with the next technique or if you need more practice. And it never gets impatient or annoyed with you.

Of course, if you think you need more practice in an area, or you're not sure you understand something, you can back up as far as you'd like to or simply repeat past lessons. You can also jump ahead should you wish to do so. I've seen a lot of CAI (Computer Assisted Instruction) over the years (in fact one of my first programming jobs more than two decades ago was in this area), and the Miracle system is one of the best-implemented CAI applications I've ever run across.

Is It Really a Miracle?

Not really, but it comes very close to being one. Let's face it, there's no "miracle" way to learn how to play any musical instrument well. To become proficient in anything, playing piano included, takes lots of practice and a fair amount of time. The MPTS suggests that it should take about six months to complete the lessons and that you should try to use the system for 45 minutes to an hour a day. In the real world of human teachers, this is about the same amount of time you'd be spending practicing, though it's possible to pick up things a bit faster with the excellent organization and approach the Miracle provides. With a little applying yourself, you'll be playing simple two-handed pieces in one to three weeks. And when the Miracle orchestra accompanies you, even "Mary Had a Little Lamb" sounds good!

At the same time, it's work to practice so much. After 30 or 40 minutes on the Miracle, my hands ache. It makes practice a lot more enjoyable, though, especially when compared to the dry rote method of running scales still extensively used in teaching piano. But you still need to practice to become proficient, even if it takes the form of shooting ducks off the scale in the shooting gallery.

While the software does a good job of evaluating your performance, it doesn't have quite the insight that a good human teacher has. For example, it can't really determine if your hand positioning needs more work, if you're actually using the right fingers on the key or if your eyeglasses need cleaning.

At a retail price of $479 (for the PC version), the MPTS costs less than a few month's worth of a decent piano teacher's visits and is available when you are. Several available "music packs" add lots of additional practice pieces, should you master all of those included with the system. The system's game-like approach makes the thought of piano lessons a lot less threatening to your kids, should you be considering the unit for them rather than yourself.

In the final analysis, whether the Miracle Piano Teaching System is worth the price depends on whether or not you (or your children) will stay the course. There's no easy way, but the Miracle Piano Teaching System does make learning to play the piano a lot less painful.

I frequently like the products I review in this column, but in the more-than-four years I've written this column, there haven't been all that many products on which I'd spend my own money. I'd like my oldest to get about a year older before I get my own Miracle so that he won't have so much difficulty because of his small hand span. But I had so much fun with the system while reviewing it, I don't know if I'll have the patience to wait.

If you've always wanted to surprise your friends by sitting down at the piano, give the Miracle Piano Teaching System a good hard look. It just might be a fun way to go.

Miracle Piano Teaching System, $479.95
(IBM PC version)
The Software Toolworks
60 Leveroni Ct.
Novato, CA 94949
Tel.: 415-883-3000

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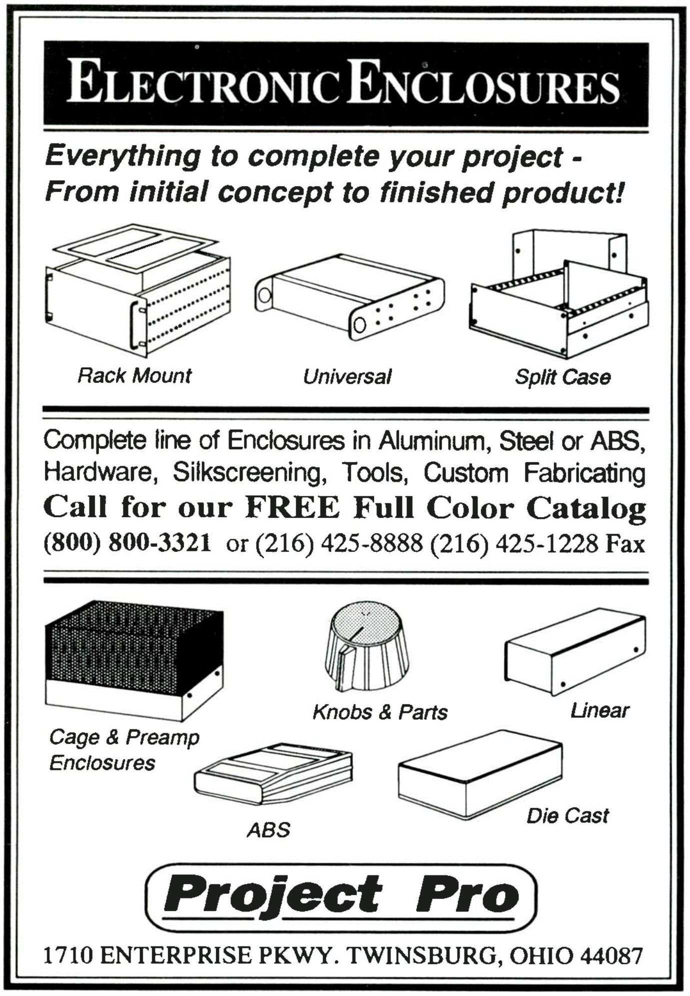
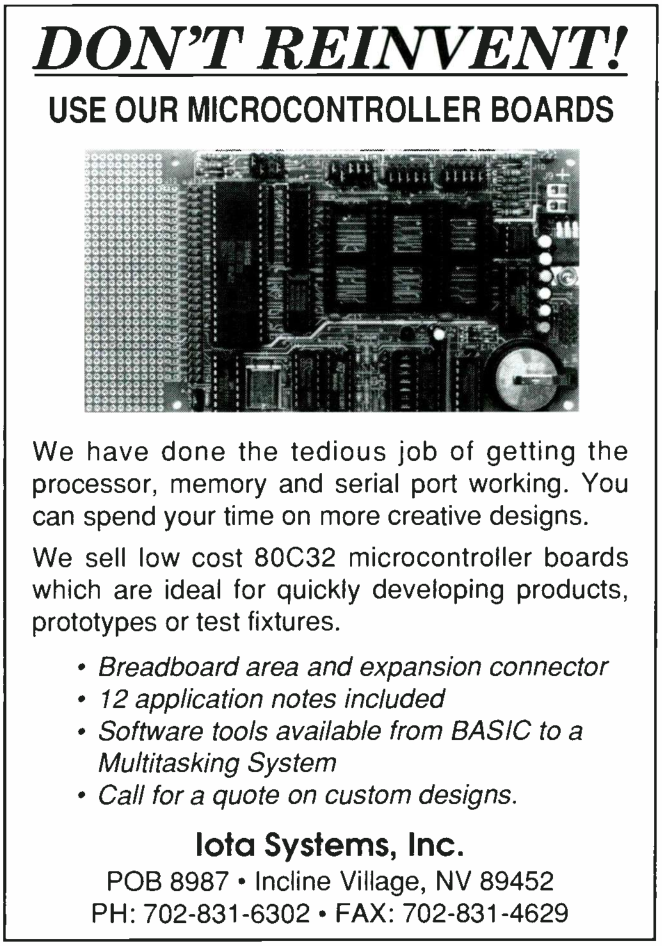




Joseph Desposito

A New Neuron Chip, Multiple Array Matrix EPLD, New NEC Microcontrollers and a Dual RS-232 IC

Companies come out with breakthrough technologies almost as fast as we can report on them. This column highlights a new neuron chip from Motorola and a new Multiple Array Matrix EPLD from Altera.

Neuron Chip

Motorola's (MOS Digital-Analog Integrated Circuits Div., P.O. Box 6000, Austin, TX 78762) newly-announced MC-143150 Neuron Chip is an intelligent controller capable of running Echelon's LONTalk Protocol. The Neuron Chip is the heart of LONWorks-based intelligent distributed control applications. This chip is based on a multi-processor architecture that contains the complete seven-layer LONTalk communication protocol in firmware.

In the LONWorks technology environment, the chip can support communication over a variety of media, including twisted pair, power line, fiber-optic, radio frequency and others.

Motorola is also licensed by Echelon to sell to its customers the LONBuilder Developer's Workbench. This is a comprehensive set of tools for building LONWorks-based intelligent distributed control applications.

In support of LONWorks, Motorola has placed LONBuilder development tools and trained application engineers in sales offices across North America. With LONBuilder tools and engineers in the field, the company expects to provide any level of support for both hardware and software inquiries relating to LONWorks.

Motorola also provides an extensive literature package that's available through the field sales offices. Order under part number LONPak/D.

Among the technical features of the Neuron Chip you'll find:

- Three eight-bit pipelined processors for concurrent processing of application code and network packets
- An 11-pin I/O port that's programmable in 24 modes for fast application program development
- Two 16-bit timer/counters for measuring and generating I/O device waveforms
- A five-pin communications port that supports direct connect and network transceiver interfaces
- 1,024 or 2,048 bytes of static RAM for buffering network data and storing network variables
- 512 bytes of EEPROM with an on-chip charge pump for flexible storage of address and binding data
- An external memory interface to support large application programs
- A sleep mode to reduce power consumption
- A unique 48-bit ID number in every device to facilitate network installation and management.

Price per Neuron Chip in 1,000-piece quantity is $11.78. It's available in a 64-pin quad flat-pack.

Multiple Array Matrix Debuts

Altera Corp. (2610 Orchard Pkwy., San Jose, CA 95134) has introduced the first two members of its Multiple Array matriX (MAX) 7000 family of high-density, high-speed erasable programmable logic devices (EPLDs), the EPM7256 and EPM7032.

The EPROM-based EPM7256 has 256 macrocells and provides a 70-MHz in-system clock rate. The device has 164 user I/O pins and 10,000 available gates, providing 5,000 usable gates in most logic designs. This makes it a good programmable alternative to gate arrays. The EPM7256 is offered in a 192-pin erasable, windowed ceramic pin-grid array (PGA) package. A 208-lead quad flat pack (QFP) version will be offered in mid-1992.

The 32-macrocell, 44-pin EPM7032 is Altera's first EPLD manufactured on EEPROM technology and reveals a strategy to expand MAX 7000 technology offerings from EPROM exclusively to EEPROM as well.

Because MAX 7000 architecture is technology-independent, the EEPROM-based, 44-pin EPM7032 shares the same advanced architectural features as the EPROM-based EPM7256. Structurally, the only difference is that the EPM7032 uses EEPROM transistors to construct its logic arrays, whereas the EPM7Z56 uses EPROM transistors. In use, the only difference the device user will notice is how the part is erased. With EPROM, UV-energy is used, and with EEPROM, an electrical pulse replaces UV energy.

Offered in an erasable, plastic leaded chip carrier (PLCC), the logic density, 12-ns logic delays and 83.3-MHz in-system performance of the EPM7032 make it well-suited for integration of multiple PAL or GAL designs or the implementation of complex state machines, counters, decoders and other glue-logic functions.

MAX 7000's architecture differentiates itself from other EPLDs and FPGAs by utilizing a Programmable Interconnect Array (PIA) that provides a single, uniform signal delay between any two logic elements on the device. Unlike cumulative and variable logic delays inherent in gate arrays and channel-routed FPGAs, the PIA in MAX 7000 gives predictable performance without significant signal skew. In addition, MAX 7000's macrocell architecture provides fast parallel and flexible shared logic expanders to support efficient implementation of logic. The result is a unique combination of high performance and usable density that fits the widest range of logic applications.

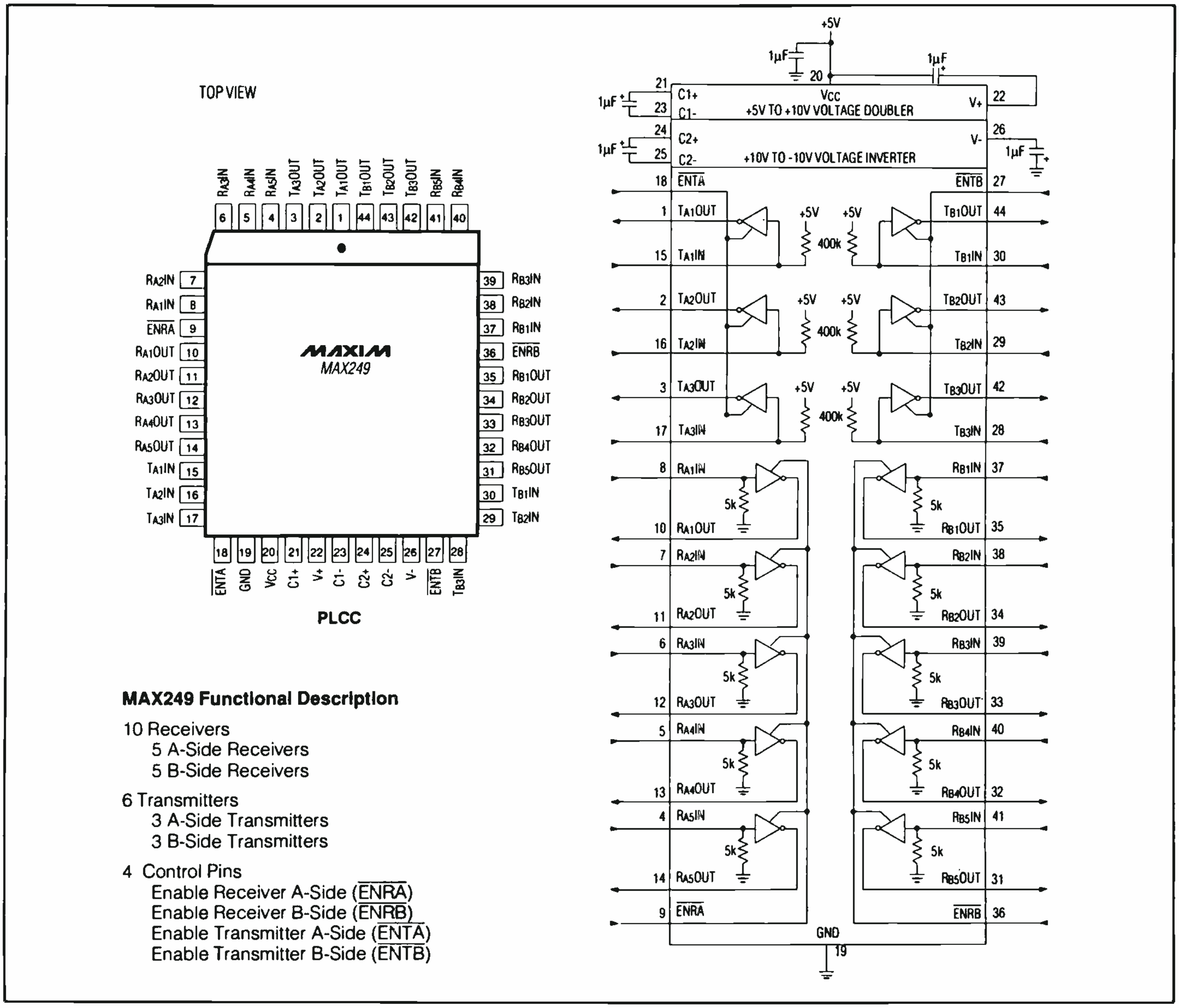
The entire MAX 7000 family of EPLDs will be supported by Altera's *MAX+PLUS II* software available on PC and workstation platforms. On the PC, Altera offers a complete *Windows* 3.0-based design system including schematic, text and waveform design entry, as well as automatic logic synthesis and design partitioning into multiple EPLDs. Available design verification options include a full timing simulator, timing analyzer and delay predictor.

For Sun and HP/Apollo workstation platforms, Altera offers the *MAX+PLUS II* compiler with industry-standard electronic design interchange format (EDIF) netlist input and output to effectively work with standard CAE tools from Cadence/Valid, Logic Automation and Mentor Graphics.

The EPM7256GC192 is available in single unit quantity for $395, and the EPM-7032LC44 is priced at $14.75 in 100-piece quantity.

Eight-Bit Microcontrollers

NEC Electronics (401 Ellis St., P.O. Box 7241, Mountain View, CA 94039) has added five new microcontrollers to its high-end K2 family. The eight-bit single-chip products feature increased memory sizes and sophisticated control of peripherals via a Macro Service Transfer Facility provided by a Peripheral Management Unit within



MAX249 Functional Description

10 Receivers
  5 A-Side Receivers
  5 B-Side Receivers

6 Transmitters
  3 A-Side Transmitters
  3 B-Side Transmitters

4 Control Pins
  Enable Receiver A-Side ($\overline{\text{ENRA}}$)
  Enable Receiver B-Side ($\overline{\text{ENRB}}$)
  Enable Transmitter A-Side ($\overline{\text{ENTA}}$)
  Enable Transmitter B-Side ($\overline{\text{ENTB}}$)

Fig. 1. The MAX249 transceiver has six RS-232 drivers and 10 RS-232 receivers that make up two complete Data Terminal Equipment (DTE) serial ports on a single chip.

the CPU. The five new products are the µPD78217A, µPD78218A, µPD78237, µPD78238 and µPD78P238.

K2 is an eight-bit family of CMOS microcontrollers that are designed for real-time embedded control applications. NEC's K2 family offers large on-chip memory capacity, including products with up to 32K of ROM and 1K of RAM. K2 members can address up to 64K of program memory and 1M of data memory. Operating at 12 MHz, K2 devices execute their fastest instructions from internal ROM/PROM in just 333 ns, or external memory at 500 ns.

All K2 products include the patented Macro Service Transfer Facility that greatly reduces the interrupt load on the CPU by handling many of the repetitive service requests that normally require the CPU to execute a time-consuming interrupt service routine. Tasks commonly handled by Macro Service include output of a sequential pattern to drive a stepper motor (with ramping of speed) and movement of blocks of information like movement of a buffer of data via a serial port.

Within the K2 family are a number of product lines. The five new products have been added to the µPD7821X and µPD7823X lines.

The two new additions to the µPD7821X line are a ROM-less version (µPD78217A) offering 1K RAM and a mask ROM version (µPD78218A) with 32K ROM and 1K RAM. NEC plans to introduce an EPROM/OTP version (µPD78P218A) that features 32K EPROM in the first half of 1992. All µPD7821X devices include the following peripherals, most of which are supported with Macro Service:

- 54 general purpose I/O lines
- Real-time output port (two four-bit or one eight-bit)
- A/D converter (eight-bit, eight-channel)
- UART for RS-232 interfaces
- Serial I/O port for micro-to-micro or peripheral communication
- One 16-bit timer
- One eight-bit timer/event counter
- Two eight-bit timers
- Two timer-capture registers
- Six timer-compare registers
- One timer-capture or -compare register
- Four pulse-width modulated (PWM) outputs from the timers

Three remaining microcontrollers added to NEC's μPD7823X line are a ROM-less version (μPD78237) with 1K RAM, a mask ROM version (μPD78238) with 1K RAM and 32K ROM and an EPROM/OTP version (μPD78P238) with 1K RAM and 32K EPROM. All μPD7823X devices include the following peripherals, most of which are supported with Macro Service:

- 64 general purpose I/O lines
- Real-time output port (two four-bit or one eight-bit)
- A/D Converter (eight-bit, eight-channel)
- D/A Converter (eight-bit, two-channel)
- One 16-bit timer
- One eight-bit timer/event counter
- Two eight-bit timers
- Two timer-capture registers
- Six timer-compare registers
- One timer-capture or compare register
- Four PWM outputs from the timers
- Two modified 12-bit PWM outputs

K2 devices can be used for motor control, including stepper motors and servo systems. They're also suitable for such office automation products as printers, plotters, typewriters and point-of-sale terminals, including the disk drives and power supplies they contain. They also find application in communications and transportation equipment, like facsimile machines, telephone equipment, portable radios and display controllers, as well as a wide variety of general-purpose applications such as security systems, instrumentation, air conditioners, robotics and multi-media equipment.

As with all K2 products, the newest devices are offered in a variety of package configurations, including 64-, 80-, 84- and 94-pin packages. Prices in 1,000-piece quantity are: μPD78217A, $7; μPD78218A, $8.50; μPD78237, $8.25; μPD78238, $10; μPD78P238, $18 (OTP)/$65 (EPROM).

NEC offers an evaluation board and development system for support of each family. The real-time in-circuit emulator system, IE-78240-R, with one probe is offered at $9,490 to support the μPD7821XA group, and the IE-78230-R support the μPD7823X members. Evaluation boards EB-78240-PC and EB-78230-PC are priced at $595 each and support, respectively, the μPD7821XA and μPD7823X families. They can be used alone or with the same optional probes to form a low-end in-circuit emulation system.

Two-Serial-Port Chip

Maxim Integrated Products' (120 San Gabriel Dr., Sunnyvale, CA 94086) MAX249 is one of seven new devices from its RS-232 line of +5-volt multi-channel drivers and receivers. The MAX249 transceiver offers six RS-232 drivers and 10 RS-232 receivers—two complete Data Terminal Equipment (DTE) serial ports in one IC (see Fig. 1).

An important feature of the MAX249 is its separate shutdown mode for each port. In shutdown mode, power supply current is reduced to 8 μA (typical), and the MAX249's receivers are still able to receive data at up to 20 bits/sec. The new device uses space-saving 1-μF capacitors, making it well-suited for RS-232 applications where space is limited, such as in laptop PCs. The chip meets all EIA-232D and EIA/TIA-562 specifications and is guaranteed to operate at data rates up to 64K bits/per second.

MAX245, MAX246 and MAX247 require no external components and are ideal for RS-232 limited-space applications. MAX244, MAX248, and MAX249 use 1-μF capacitors.

Prices for 1,000-piece quantity are: MAX244, $7.65; MAX245, $12.15; MAX246, $12.15; MAX247, $12.15; MAX248, $7.65; MAX249, $7.65. ■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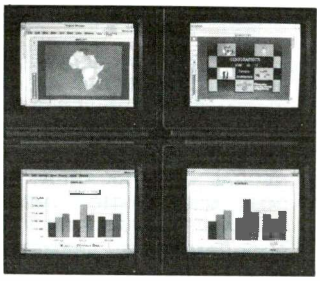
What's New!

Dual VGA Drivers

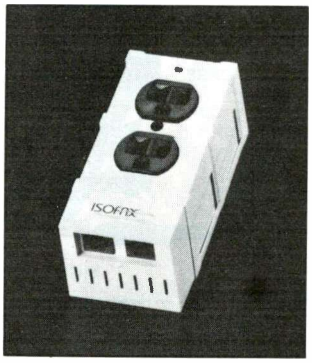
Colographic Communications has new drivers for the company's Dual VGA graphic cards and *Windows* that permit a single large window to be displayed across two screens. Or two full-size windows can be opened at the same time. More viewable windows and the ability to pick them up and move them over two physical screen boundaries in real time gives the user greater flexibility. With the new driver, *Windows* can address up to eight displays simultaneously (requires additional Dual VGA graphic cards). $795 and up. *Colographic Communications Corp., 5388 New Peachtree Rd., P.O. Box 80448, Atlanta, GA 30366; tel.: 404-455-3921; Fax: 404-458-0616.*



CIRCLE NO. 20 ON FREE CARD

Fax Protector

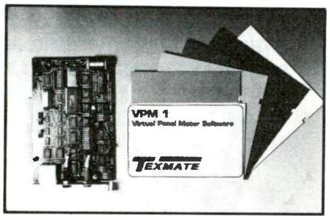
Isofax from Tripp Lite protects fax machines from spikes on both ac power and telephone lines. The Isofax combination surge suppresser features two ac outlets with Isobar-quality surge suppression and two surge-protected RJ-45 phone-line jacks for complete protection of fax machines and/or modems. Isofax plugs directly into a standard ac outlet. It's UL 1449 listed for 330-volt let-through. A green LED indicates the circuitry is functioning properly. $65. *Tripp Lite, 500 N. Orleans, Chicago, IL 60610-4188; tel.: 312-329-1777; Fax: 312-644-6505.*



CIRCLE NO. 22 ON FREE CARD

Virtual Panel Meter

Texmate introduces a hardware/software package called VPM1, which combines the simplicity of a panel meter with the flexibility of a personal computer. The VPM1 is a 16-bit A/D converter (60,000 counts) with optically-isolated inputs of 20 mV/200 mV/2 volts/20 volts dc. Input connections are made via standard banana plugs at the rear of the computer. All configuration is done in software, from a menu that requires only a keyboard or mouse. The software supports four input cards, one being required for each signal. Optional data logger and large display software are available, as is a demo disk. $545. *Texmate, 995 Park Center Dr., Vista, CA 92083-8397; tel.: 619-598-9899; Fax: 619-598-9828.*



CIRCLE NO. 21 ON FREE CARD

Parallel-Port ASIC

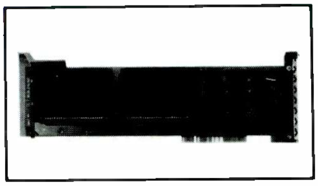
Trantor Systems offers a custom ASIC peripheral controller chip for parallel-port add-on products. Called the P3C, the new general-purpose chip is geared towards products intended to plug into IBM/compatible parallel ports. The P3C dramatically simplifies the task of designing parallel port add-ons and addresses three problems in parallel port add-on design: unidirectional versus bidirectional ports, concurrent use of a printer and I/O speed.

Products that use the P3C can take advantage of the greater speed of bidirectional ports while maintaining compatibility with the more common unidirectional ones. The P3C is available in sampling quantities in a 60 PQFP package. *Trantor Systems, Ltd., 5415 Randall Pl., Fremont, CA 94538-3151; tel.: 510-770-1400; fax: 510-770-9910.*

CIRCLE NO. 23 ON FREE CARD

Micro Channel Memory

Boca Research has a new 8M zero-wait-state RAM memory board for IBM PS/2 Micro Channel Architecture systems. The board provides extended memory support for DOS, UNIX and XENIX. It carries its own Micro Channel ID, making it automatically recognized by the system at cold boot, and is easily configured through the IBM PS/2 installation program and a configuration file supplied. Boca supplies EMS 4.0 software drivers for applications that require expanded memory. The board is offered in four configurations (0K, 2M, 4M and 8M), and uses 1M × 9 SIMMS. $195 (0K). *Boca Research Inc., 6413 Congress Ave., Boca Raton, FL 33487; tel.: 407-997-6227; Fax: 407-997-0918.*



CIRCLE NO. 24 ON FREE CARD

Smart Cards

The Micro Card QwikLINK model TLP0720 is a high-performance, second-generation smart card "drive." It offers high-speed card communication design, Lexan™ case, small footprint and single-cable design. Micro Card offers two families of card products for use with the TLP0720, the SCOT single-service operating system and the TB multiple-service. Capacities range from 8K bits to 64K bits.

Security within a TB integrated-circuit card is based on encryption techniques. Primary security functions include random number generation, password authentication, secure write, ciphering and deciphering, message-authentication code generation and verification and secure erase. The TB card operating system utilizes an algorithm that conforms to DES TLP0720. $225. *Micro Card Technologies, Inc., 15851 N. Dallas Pkwy., Ste. 500, Dallas, TX 75248; tel.: 214-788-4055.*

CIRCLE NO. 25 ON FREE CARD

The Upgrade Wars

If you have a good thing, make it better. This axiom may not be official policy at software companies, but using it on good software makes good sense. The objective is to stay in head-to-head competition with other companies. Combine this with the unpredictable nature of the computer game market, and you have a healthy technological sparring that, in its own way, might be called a war. I like to call it The Upgrade Wars.

The Wars Begin

Once upon a time, personal computers that performed real work were priced out of reach for most people. Commodore was king of the computer hill because it gave good computing at a likewise price. Its Models C-64 and C-128 are still found in homes today, some of them even in use.

A software company named MicroProse fired up the Commodore 64 with military simulations. One of these, *Stealth Fighter*, was an early strike and quickly established MicroProse as a high-powered leader in the Upgrade Wars.

Stealth Technology

Stealth Fighter for the Commodore portrayed the then highly secretive aircraft. Although the Commodore version was loads of fun, it was limited in scope. Armament selection was sparse, and flying at altitudes of thousands of feet was not only done with impunity but expected. The game lacked much in the way of stealth tactics. But when one owns only a C-64, one takes what one can get and enjoys it.

Stealth Fighter, a rousing bang-up job for MicroProse, used virtually all the resources of the vintage C-64. As computer gamers soared to gaming heights and played the invisible nemesis to radar, MicroProse was strategically planning to escalate the War.

Accordingly, the Commodore *Stealth*

Scouring the sands of the Middle East.

The Falcon's complex new look.

The F-16 takes off after a long hiatus.

The Apache helicopter sits ready, willing and able.

Fighter was reincarnated in the form of *F-19 Stealth Fighter*. The new incarnation sported smoother operation, more realistic simulation and graphics so much improved that they served as a nucleus around which future MicroProse games would build. This new IBM version of *Stealth Fighter* took off with fire and smoke like a reborn digital Phoenix.

Reincarnation

F-19 was the unequaled simulation for the *Stealth Fighter*. It stayed that way for a long time, as measured by computer game reckoning. *F-19* lets players fly 99 missions before forcing retirement of a playing character. By then, any air-combat enthusiast worth his joystick had learned Stealth operation and tactics and had set skill levels at Veteran and Elite. Stealth technology, still riding the stratosphere of the best, approached the end of its service life and needed a boost.

Ironically, while the real Stealth Fighter speared through the cover of night in hidden flight testing and secret missions, MicroProse worked ambitiously on an upgrade to *F-19*. Surprisingly to industry experts, the Pentagon performed outstandingly on keeping security clamps on the real Stealth. But when MicroProse finally got a look at it, an upgrade to *F-19* wasn't far behind. The upgrade rolled out as *F-117A Nighthawk* and ascended with a new look, better graphics and yet more realistic simulation. *Nighthawk* is simply the best and most definitive simulation of America's radar-illusive fighter.

F-117A is up-to-date and complete with missions into the Persian Gulf. It has brilliant graphics and tests players with intriguing mental challenge. Actually, the necessary tactics of proper ordnance usage, mission planning and alert flying are the game's focus. The whiz-bang visuals of game technology just make the brainwork more enjoyable.

An interesting feature comes with *Nighthawk*: the option of flying the Lockheed version of the Stealth Fighter or winging off in MicroProse's own version. The difference is that the Lockheed version is more like a real-life mission. With it, you have only two weapons bays, you can't carry air-to- air weapons and there's no cannon for dogfighting. You always fly at night and never launch from a carrier. The MicroProse version isn't quite as stealthy as the Lockheed version, but it affords more variety in weapons and types of missions you can fly. And when the going gets tough, you can take out the opposition with air-to-air missiles.

Rotary-Wing Attack

One of the meaner combat helicopters ever to hit the field is the AH64-A, otherwise known as the Apache. Some consider it to be *the* meanest. Well, the experts can debate the matter in real life. Slide into the world of computer games, and *Gunship* is undoubtedly the best helicopter combat simulator for the personal computer.

Like MicroProse's *Stealth Fighter, Gunship* had its genesis in the Commodore era. Owners of the then high-tech IBM PC XT and faster clones had to watch in awe and envy as skilled Commodore helicopter pilots swooped upon enemy infantry, tanks and radar sites with free-fire rockets and laser-guided missiles. Sometimes the envy bordered on pain.

Fortunately for simulation enthusiasts, MicroProse "brass" was planning the tactical insertion of an IBM version of *Gunship*. Not only would it offer a more-fertile development platform for *Gunship* designers, but an opportunity for marked changes in games design as well. It seems that, without hesitation, *Gunship* designers snatched the opportunity and ran with it like a super-spy carrying high-level information.

The new *Gunship* was everything that IBM'ers wanted and more. Graphics were much better, combat scenarios widened and got more realistic, helicopter flight controls became more reactive and overall game play jumped in intensity. Deliberately, the national computer game combat area had a new player. Commodore fans watched in envy as the Upgrade Wars branched toward a new evolution.

Years passed. *Gunship* successfully denied all challenges to its rotary-wing air superiority. Then, after pleadings from hungry gamers, *Gunship* re-emerged with a new look and graphics quality that leaped an order of magnitude. Christened *Gunship 2000* by its designers, the new concept gave users a choice of five aircraft, including the Kiowa scout ship, Blackhawk assault/transport, the trusty Cobra and the ol' Apache of yesteryear. *Gunship 2000* offers more kinds of weapons, updated combat scenarios that include the Persian Gulf and the long-awaited chance to fly your chopper in groups. It's a welcome upgrade for a game that remains in a class by itself.

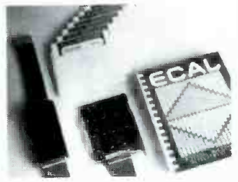
Competition

It's true that MicroProse established itself early in the game of combat simulations. But other warriors suited up for computer competition.

Spectrum HoloByte pushed into military simulations with *Falcon*, its rendition of the venerable F-16. At first launch, *Falcon* came in four-color CGA, which was a tad below EGA standard, but tolerable nevertheless. *Falcon* was an early attempt at serious flight simulation for the F-16. It had a few programming quirks and documentation problems, but PC gamers eagerly bought it and flew their IBM XTs into the blazing sky of imagination.

A succeeding version of *Falcon* flew as a chaser behind the original. *Falcon AT* was its moniker and it effectively raised the simulation to EGA graphics, better playability and faster execution of the 80286 processor. *Falcon AT* was difficult to play, nearly impossible to land and had a users manual that read like a technical document. But it was fun enough and remained the best F-16 simulator.

Computer games have a relatively short market life. No one knows this better than the people who design them. Therefore, it was puzzling to simulation enthusiasts when, after a normal period of time, no further Falcon upgrade was seen. An eter-



nity of about two (maybe three) years went by. Still no new *Falcon*. Finally, like a call from the presidential hot line, *Falcon* 3.0 was announced. The message set the computer game world buzzing with anticipation—simulations couldn't wait. Well, another year went by, and then some more months with no new *Falcon* making its appearance. What was wrong?

Spectrum HoloByte explained the long wait in the pages of the Fall/Winter 1992 edition of its newsletter, The *Spectrum Hologram*. Spectrum HoloByte CEO Gilman Louie said, "*Falcon* 3.0 is probably the most ambitious flight simulation ever developed. Few sims can boast the same dedication to detail and accuracy. Spectrum HoloByte is uncompromising when it comes to quality—we simply will not release a product until it's ready." The newsletter went on to reasonable explanations about technical delays. Computer gamers were willing to forgive the wait, but how much longer would it take?

Suddenly, appearing with the shocking immediacy of a Stealth fighter, *Falcon* 3.0 landed on the shelves of computer stores. Some resellers quickly sold all copies. Gilman Louie had been right. The game is complex, more so that any of its predecessors. But even after years of waiting, the initial release wasn't ready.

Users, including this gamer, had problems with this *Falcon* from the start. My personal copy refused to install. The problem was quickly remedied by downloading a fix from a bulletin board. Subsequently, I experienced computer hangs, where the game froze in the middle of play, occasions when keyboard commands weren't obeyed and much trouble with the throttle controls. Communication with other users verified these game quirks as common experiences.

Already, weeks after it release, a *Falcon* 3.0 update (Version 3.0a) is sitting on a bulletin board. A text file comes with it that outlines the numerous bug fixes being addressed. Despite Spectrum HoloByte's statement that it wouldn't release a game before it's time, *Falcon* 3.0 was clearly not ready to be properly released.

With game quirks, fixes and updates, *Falcon* 3.0 is still the best F-16 simulator. The game manual still reads mostly like a technical document and could be better organized. The game itself is still difficult to manage while playing, but once you put in the hours of study and practice, some of the bugs and quirks can be ignored by staunch simulationists. More generic players might wait until the bugs are shaken out before signing on.

Global Conflict

The beginnings of the Upgrade Wars saw MicroProse take an early lead. Spectrum HoloByte competes very well, although it isn't as prolific. Other game designers have since entered the fray, to the delight of computer users.

Deserving of honorable mention are:

Electronic Arts for the intriguing *Attack Sub* and the scholarly *Chuck Yeager* series and for the gimmickry of *Megafortress* and the headiness of *Harpoon*, which has a new Persian Gulf Battleset.

Maxis for two versions of the action-oriented *Jet Fighter the Adventure*.

LucasFilm Games for spectacular historical simulations like *Battlehawks, Battle of Britain* and *Secret Weapons of the Luftwaffe*, which has a new Tour of Duty addition for the P-38 Lightning and the P-80 Shooting Star.

Spectrum HoloByte for the tough action of *Tank* and a good effort at *Falcon* 3.0.

MicroProse for many quality simulations, including two versions of *Silent Service*, two versions of the hot action of *F-15 Strike Eagle*, the brawling *M1-Tank Platoon* and a superbly playable rendering of Tom Clancy's *Red Storm Rising*.

The future of the Upgrade Wars looks promising, as more players and new technology join the fight. When this particular war heats up, its good for game designers, good for game players and good for a market economy. This kind of war we can deal with! ■

Bird's Eye View

F-117A Stealth Fighter 2.0, $69.95
MicroProse
180 Lakefront Dr.
Hunt Valley, MD 21030
Tel.: 301-771-1151

Requirements

RAM Memory	640K
Graphics	VGA only
Sound	IBM, AdLib, Roland
Controllers	Joystick, Mouse

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Long
Complexity	High
Play Length	Medium
Playability	Good

In brief: A fitting upgrade to a favorite and long-standing simulation. Recommend an 80386 and joystick for best performance.

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Bird's Eye View

Gunship 2000, $69.95
MicroProse
180 Lakefront Dr.
Hunt Valley, MD 21030
Tel.: 301-771-1151

Requirements

RAM	640K
Graphics	VGA only
Sound	IBM, Tandy, AdLib, Roland
Controllers	Joystick

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Long
Complexity	High
Play Length	Medium
Playability	Good

In brief: Improvements on the best helicopter combat simulator. Recommend an 80386 and joystick for best performance.

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Bird's Eye View

Falcon 3.0, $79.95
Spectrum HoloByte
2061 Challenger Dr.
Alameda, CA 94501
Tel.: 510-522-3584

Requirements

RAM Memory	1M, DOS 5.0
Graphics	VGA only
Sound	AdLib, Roland, SoundBlaster
Controllers	Joystick, Mouse

Evaluation

Documentation	Fair
Graphics	Excellent
Learning Curve	Long
Complexity	High
Play Length	Medium
Playability	Fair

In brief: Long-awaited upgrade. Quirky and sometimes vexing, but worth a shot. Recommend an 80386, joystick and expanded memory for best performance. Math coprocessor needed for high-fidelity flight model.

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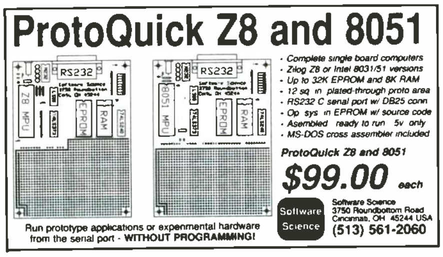

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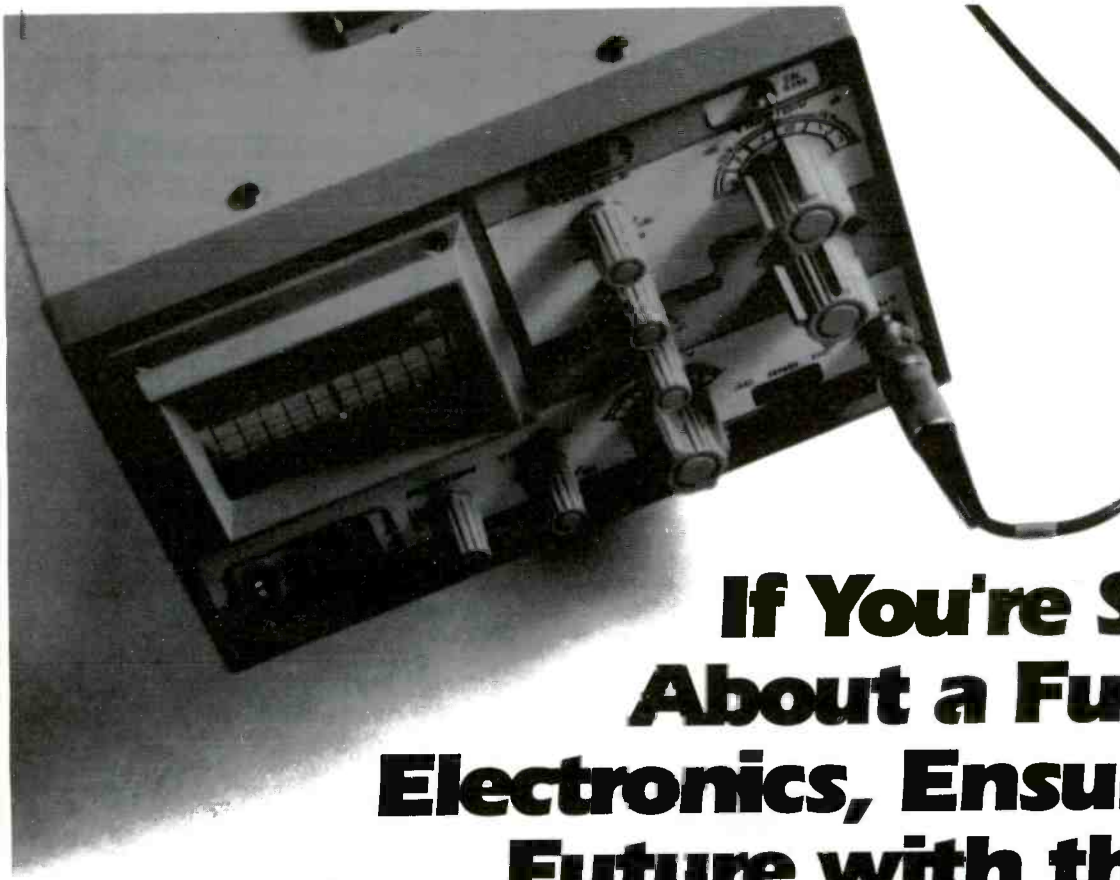

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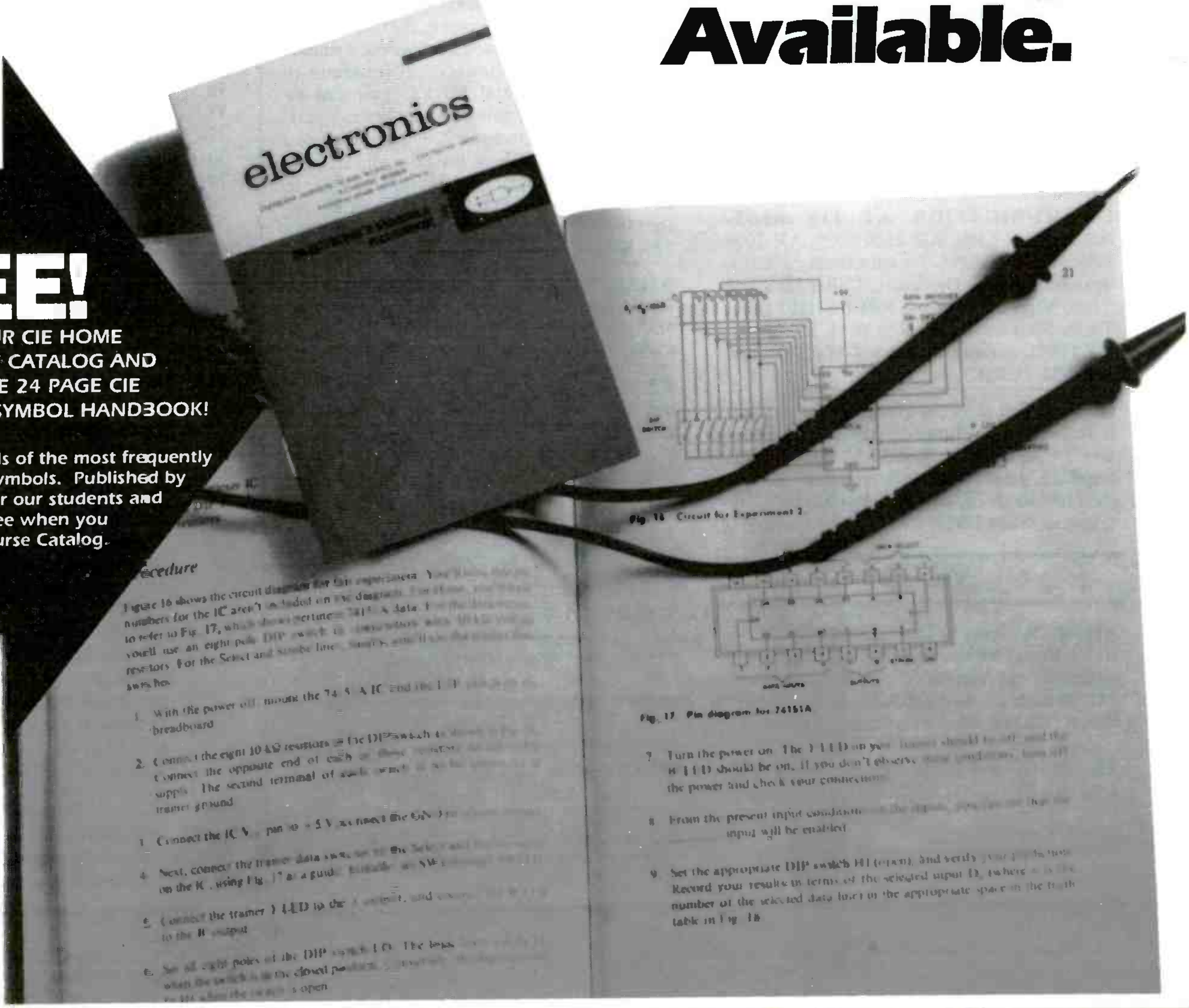

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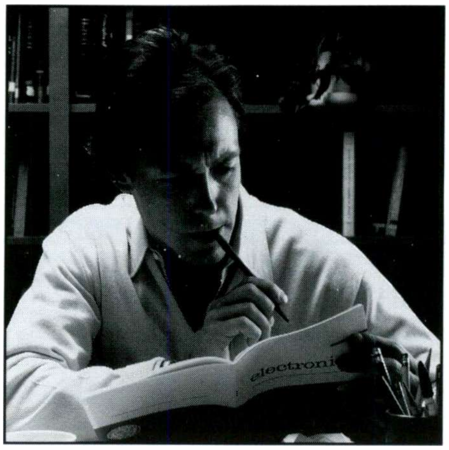

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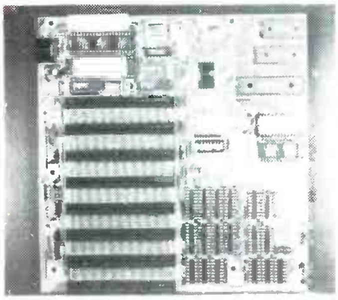
MOTHER BOARDS

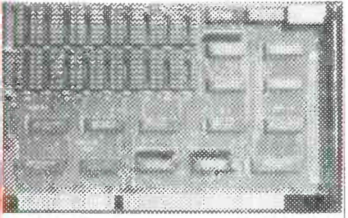


MB286-12	12 MHz 286 Mini Motherboard	$99
MB286-16	16 MHz 286 Mini Motherboard	$109
MB386-25	386 25 MHz Motherboard	$229
MB386-33C	386 33 MHz Motherboard	$459
MB486-33	486 33 MHz Motherboard	$799

CALL NOW
1 (800) 531-5369
FOR THE NEW ALTEX CATALOG

MEMORY BOARDS

All memory boards come with 0/K. Call for pricing with memory



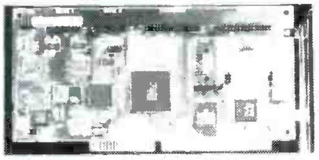
Part#	Description	Each
IFC-47A	BOCA 128K AT Memory Board	$79
IFC-60	AT Plus - Up to 8 MEG RAM	$119
IFC-60A	AT Memory Board 8 MEG Using SIMMS	$119
IFC-61	AT Memory Board with I/O - up to 4 MEG	$119
IFC-62	PS-2 MOD 50 60 EMS up to 2 MEG	$119
IFC-64	PS-2 EMS up to 2 MEG	$99
MEMO-576	576K Ramboard	$23

IIT MATH CO-PROCESSORS

2C87-12	For 286 up to 12.5 MHz	$78
2C87-20	For 286 up to 20 MHz	84
3C87-16SX	For 386SX up to 16 MHz	100
3C87-20SX	For 386SX up to 20 MHz	113
3C87-25SX	For 386SX up to 25 MHz	125
3C87-25	For 386 up to 25 MHz	150
3C87-33	For 386 up to 33 MHz	163

CALL FOR PRICING ON DYNAMIC MEMORY AND MEMORY MODULES

DISK CONTROLLER BOARDS



Part#	Description	Each
IFC-14	2 Floppy Controller Board PC/XT	$13
IFC-15	Disk I/O Board Serial, Parallel, Clock, Game PC/XT	$25
IFC-24	Fixed Disk MFM/2 Floppy Controller AT	$55
IFC-27-2	AT 2 IDE 2/Floppy Controller	$19
IFC-27X	XT 2/IDE Controller	$69
IFC-28	XT MFM Hard Drive Controller Board	$47
ST-01	8 Bit SCSI Controller	$29
ST-02	8 Bit SCSI/Floppy Controller Board	$47
IN-2000	16 Bit SCSI Hard/Floppy	$189

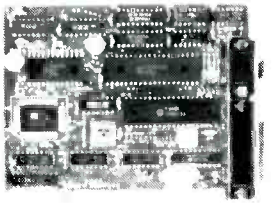
EXPANSION BOARDS

Part#	Description	Each
IFC-12	Serial Board PC/XT	$11
IFC-12A	Second Serial Port Kit for IFC-12	$6
IFC-25	2 Serial, Parallel, Game Board XT/AT	$16
IFC-13	Parallel Board XT/AT	$9
IFC-19	Clock Board PC/XT	$10
IFC-19B	Chipchip for PC/XT	$24
IFC-20	Game Board XT/AT 2 Ports	$9
IFC-70	BOCA 2 Serial, 2 Parallel I/O Board	$49
IFC-73	BOCA 2 Serial, 1 Parallel & Clock Board	$49
IFC-75	BOCA 2 Serial, 1 Parallel MCA I/O Board	$99
IFC-76	BOCA Parallel Port MCA I/O Board	$55

COMMUNICATION BOARDS

Part#	Description	Each
MS-400A	Multi-Serial Board for PC/AT	$89
MS-422A	Dual RS-232/422 Serial Card for PC/AT	$69
MU-440	Multi-User Board	$139
LCS-8880	4-Port Multi-Terminal Card	$75

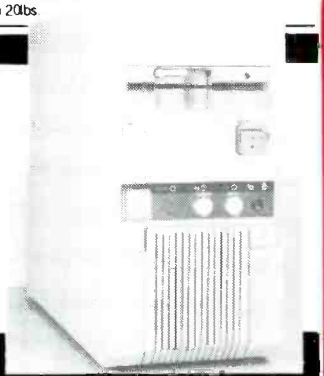
VIDEO BOARDS



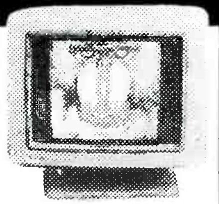
IFC-32	Mono Board w/printer port XT/AT	$16
IFC-33	Color Graphics w/printer port XT/AT	$25
IFC-42	640x480 VGA Card	$59
IFC-42C	BOCA Super VGA Card	$139
VG-7000	Super VGA w/512K	$85

COMPUTER CASES

Part#	Description	Each
STC-12	Baby AT Case	$83
STC-05	Baby Vertical w/230 Watt Power Supply	$89
STC-10	Regular AT Case w/230 Power Supply	$95
STC-08	Medium Vertical Case w/230 Watt Power Supply	$119
STC-18	Regular Vertical w/250 Watt Power Supply	$133
STC-16	Regular Vertical w/250 Watt Power Supply	$136

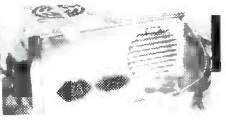


RELISYS MONITORS



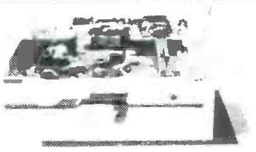
RM9502	Monochrome VGA (800 x 350, 400, 480)	$139
RE1420	Super VGA (1024 x 768) Unlimited Colors	$359
RE1520	15" Super VGA Monitor (Noninterlaced up to 1024x768)	$469

POWER SUPPLIES



PS-150	150 watt XT Power Supply	$32
PS-150UL	Same as PS-150 - UL Listed	$69
PS-200M	200 watt XT power Supply	$36
PS-200MUL	Same as PS-200M - UL Listed	$89
PS-200	200 watt AT Power Supply	$42
PS-200UL	Same as PS-200 - UL Listed	$89
PS-220	220 watt Vertical Case Power Supply	$79
PS-230UL	230 watt Vertical Case Power Supply - UL Listed	$99
PS-200MINI	200 watt Baby Vertical Case Power Supply	$59

DISK DRIVES



DDD-04	5 1/4 inch DSDD 360K black faceplate	$59
DDD-05	5 1/4 inch DSDD 360K beige faceplate	$59
DDH-06	5 1/4 inch DSHD 1.2MB beige faceplate	$59
DDH-09	3 1/2 inch 720K beige w/brkt	$59
DDH-10	3 1/2 inch 1.44MB beige w/brkt	$59
DDH-11	Same as DDH-10 without 5-1/4" mounting bracket Fits in 3-1/2" bay	$55
RAIL01	AT Drive Rail Kit	$1.99
FP-BLK	1/2 Height Black Faceplate	$2.49

MONITORS

MON-05	Monochrome TTL Amber 12"	$89
MON-06	Paper White TTL 14"	$112
MON-10	CGA/RGB (640 x 240) 14"	$219
MON-07	VGA .41 Dot Pitch (640 x 480) 14"	$239

KEYBOARDS

Limited Quantities

KBY-60	AT Style 10 Function Keys XT or AT	$19

Part#	Description	Each
KBY-39	Enhanced Style 12 Function Keys XT or AT	$49
K-156	(XT,AT) 101 keys with regular footprint for XT or AT. Size: 20 1/2"L x 7 7/8"W x 1 13/16"H	$35
K-160	Narrow Footprint 101 keys XT or AT Size: 18 1/2"L x 6 1/2"W x 1 5/16"H	$36
K-158	Small Footprint 101/102 keys. 22 percent smaller than regular footprint Size: 15 3/4"L x 7 7/8"W x 1 13/16"H	$43
K-158-1	Small Footprint Spanish Language	$47

HARD DRIVES

ST-251	40 MB MFM 28 MS Hard Drive 5-1/4"	$259
ST-351A	40 MB IDE 28 MS Hard Drive 3-1/2"	$219
ST-3120A	105 MB IDE 15 MS Hard Drive 3-1/2"	$359
ST-3144A	120 MB IDE 19 MS Hard Drive 3-1/2"	$419
ST-1239A	210 MB IDE 15 MS Hard Drive 3-1/2"	$649
ST-296N	84 MB SCSI 19 MS Hard Drive 5-1/4"	$369
ST-1239N	204 MB IDE 15 MS Hard Drive 3-1/2"	$649
ST-1480N	426 MB SCSI 14 MS Hard Drive 3-1/2"	$1399

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