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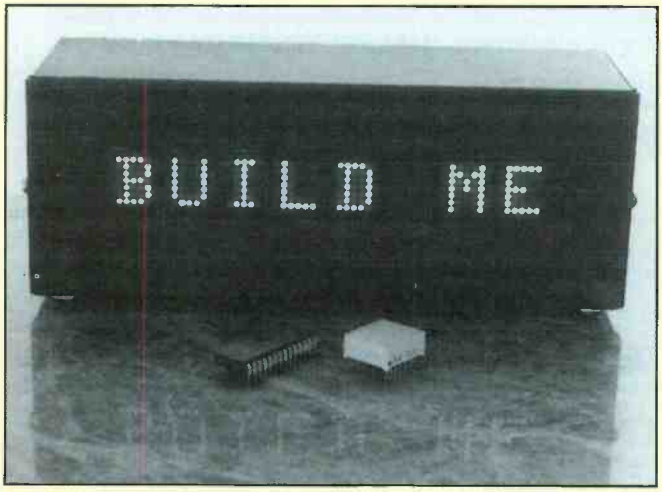
ComputerCraft

Volume 2, No. 3, March 1993



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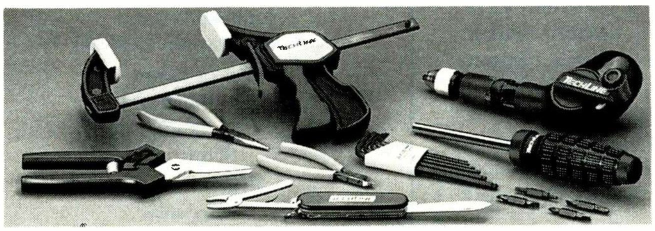

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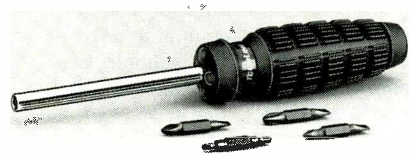

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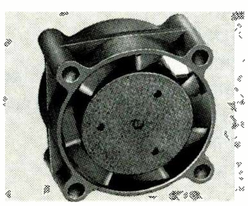

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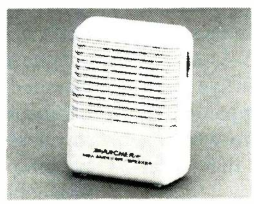

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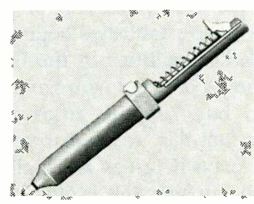

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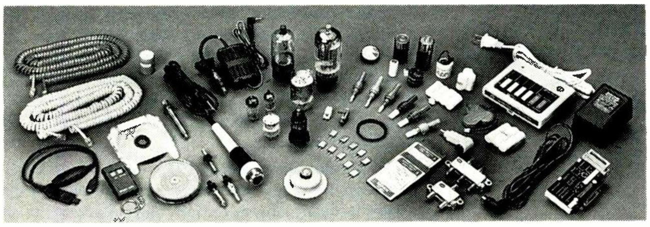

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CIRCLE NO. 142 ON FREE INFORMATION CARD

Editorial By Art Salsberg

Deep Pockets

To develop cutting-edge technology, you need deep pockets...lots of money to invest that won't return profits for some time, if ever. It's disconcerting, therefore, to learn that IBM will cut $1-billion from its research and development programs this year. The company's woes apparently make this necessary, but it's saddening nevertheless. This goes against the Clinton Administration's hopes for our country's economic growth down the line, which depends on more R&D, not less. It's a harbinger of being unable to compete as successfully as we'd like to with some other countries.

Japan, in particular, continues to invest big in R&D projects. Particularly interesting is that only a handful of computer companies in Japan account for most of such funding. In 1991, for example, only six Japanese computer companies accounted for 95% of 1991's long-term R&D in the industry—$11-billion! Moreover, they get a lot of assistance from their government and banks. Japan's Ministry of International Trade and Industry, for instance, is plowing about a half-billion dollars into the computer industry through a Real World Computer Project.

Other intriguing industry moves have been made by Japanese computer makers. Many have established both manufacturing and R&D facilities in the U.S. Although Japanese countries here have always tended to buy supplies from companies in Japan that they're accustomed to working with, even if prices are higher than what they'd pay here, this is changing.

Price is too important to ignore in the computer field if one intends to remain competitive. As a result, U.S. executives for Japanese subsidiaries here are being given more freedom to source parts in the U.S. (This is a move that's long overdue!)

Japan has never gotten a good foothold in the desktop-computer market, except for a very few companies like NEC, which ranks eighth in North America, while it ranks number-three worldwide (it owns more than half the market share in Japan itself, however, while U.S. leader IBM only has about 7% there).

The profit-margin in desktops, given all the cutthroat competition here, isn't to the liking of Japanese companies, anyway. "Portable" is where they believe the action is. For example, with nearly 13% of the U.S. market in its pocket, while a U.S. company, Compaq, is next with about 11%. More than 50% of the notebook market in the U.S., however, is split among a multitude of companies, with Taiwanese makers dominating the low end.

But we've seen only the tip of the iceberg in the portable computer field from Asian makers. Personal Digital Assistants (PDAs) will hit us full blast in the near future. These hand-helds are expected to represent a market that's estimated to be ten times larger than the desktop market. Japanese manufacturers—Casio, Epson, Sharp and Sony, among a bevy of others—have already revved up their designs. American makers like Apple and Tandy, seeing the writing on the wall, are collaborating with Japanese companies to produce their own PDAs.

You'll see IC cards galore holding all sorts of programs, pen-driven devices and all manner of peripherals packed into one-pound devices. Sharp already has them on the shelves in Tokyo for an even $1,000. You may not see them here soon, but they promise to change the face of personal computing when they do finally arrive.

I watched an interesting documentary about how Japan does it on a cable-TV channel this week. It showed how Matsushita (Panasonic) captured the videocassette market, even though a U.S. company, Ampex, which developed video recording, had been the powerhouse here. Let's not forget other Japanese industrial conquests with technological products invented elsewhere, either, such as facsimile machines and laser printers. So give Japanese makers credit for being especially innovative in some high-production product areas.

There's sure to be an outpouring of new product advances down the road that are being researched right now in high-tech labs. Among them are optical computing, neural networks and virtual reality. Will we be the leader? Much of the answer to this question depends on how much effort goes into R&D that won't quickly be turned into marketable products. And such efforts are primed by money, whether it's in the form of tax breaks or other federal assistance. Let's hope that such aid is forthcoming now. Hardware profit margins are just too low in most cases to allow companies to invest heavily in long-term R&D without help. ■

Art Salsberg

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"Stone-Age" Booster

• As one who is still writing hand-assembled machine-language programs to run on a KIM-1 single-board computer (circa 1976), I have been an avid reader of your magazine since the premiere issue. Your hardware approach is a very welcome change from software-oriented computer magazines, and I particularly enjoy Jan Axelson's superbly written articles on single-board computers and microcontrollers. She may yet coax me out of the stone age!

Joseph C. Fischesser
Winston-Salem, NC

Other Readers Speak Out

• I read the December 1992 issue of *ComputerCraft* and find your magazine to be a very informative one for those of use who are interested in computers in a technical sense. It shows how to manipulate computers and their hardware to get the most out of them. I do not believe it would be too easy to get this information elsewhere and I am glad that I picked up my first copy of *ComputerCraft* when I did.

Lee Rodriguez
Camp LeJeune, NC

• I have only recently discovered *ComputerCraft* magazine after deciding to tackle a project. My background is not in electronics, but in computer science (I have a B.S. and was a programmer for several years). I am trying to learn as much as possible from the sources I have available to me, but I will definitely need more to see this project through.

Ed O'Brien
Phoenix, AZ

What Gives...?

• Something caught my eye while reading the newly-arrived November 1992 issue of your *ComputerCraft* magazine. The cover photo shows a Software Science ProtoQuick 8051 microcontroller board with a 20-character by two-line LCD display (I counted the spaces) under the heading "Build a Miniature Scrolling Marquee." The article of the same name by Scott Edwards that begins on page 22 of the same issue, however, uses a PIC 16C54-type controller with only a 16 by 1 display. What gives:? Is this one of those things that can be attributed to "A Funny Thing Happened on the Way to the Printers..."?

Jose E. Korneluk
W. Palm Beach, FL

Sorry for the confusion. Though it, indeed showed a microcontroller-operated LCD message display, the cover photo had nothing to do with Scott Edwards' "Scrolling Marquee" article. Rather, it was supposed to point the way to the "Special Report on Microcontroller Boards" by Jan axelson that begins on page 66. You have a sharp eye in correctly identifying the ProtoQuick microcontroller board in the photo, though. While we're at it, we'd like to thank Software Science for providing the cover photo that caught your eye.—Ed.

Trial Lawyer Simulation Game. The computer game "Objection" caters to law and murder-mystery fans. It provides courtroom simulation for lawyers and non-lawyers, and law schools and colleges are among its best customers. The program comes in three flavors: a lawyers version (S99); a layman's version ($49.95); and a Continuing Legal Education (CLE) version ($249). The last can earn college credit in the states of California, Colorado, Connecticut, Florida, Montana, New Mexico, North Dakota, Oregon and West Virginia. The player represents and innocent man accused of murder, while the game offers features as sound, animation and thousands of different questions that are posed to witnesses. Available from TransMedia Productions, Toledo, OH. Call 1-800-832-4980 for more info.

Make CD-ROMs. You can make CD-ROMs at your desk with Philips' new CD-ROM recorder and CD-Gen software from CD-ROM Strategies. The system allows you to make a single CD-ROM in just 35 minutes, storing up to 650M of data on a disc, representing up to 300,000 pages of text or 15,000 graphics images. If you can spare $7,895, call 800-328-2347.

IC Library Updated. The newest D.A.T.A. Integrated Circuit Library has increased by 12% or more than 32,200 components over earlier 1992 editions. Among the product-specific digests—Digital, Linear, Interface and Microprocessors—Memory has shown the largest growth, with more than 15,000 new devices. The Library includes device function, generic and part-number indexes, technical sections that permit the user to make component comparisons, package and pin drawings, suggested replacements, manufacturer directory and sales offices. For more information, call 800-447-4666.

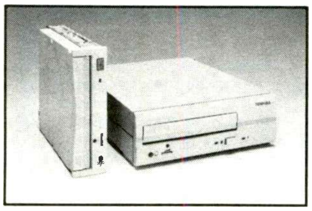
Computer FAX Software. MBS Software (Portland, OR) released its DB FAX Connection software, a unique package that enables organizations to send both individual and broadcast faxes from any Clipper-compiled applications of dBASE III-compatible files using the Intel SatisFAXtion and other popular faxmodem cards. It also has the ability to let users send a fax to anyone in their database on-demand by simply hitting a hot-key from whatever software is being run. Call 800-962-9310 for more information.

Windows Shareware. The Window Wizard catalogs more than 3,500 Microsoft Windows shareware programs with an offer to "try before you buy." Prices range from only $1 to $3. To obtain a free catalog, call 305-751-3117 or write to Window Wizard, P.O. Box 470892, Miami, FL 33247.

New Low-Voltage EEPROM. Semiconductor maker Atmel offers the industry's first 2.7-volt, 64K electrically erasable programmable read-only parallel memory (EEPPROM). The AT28LV64 has read-access speeds to 300 ns (200 ns at 3 volts) and consumes only 28.8 milliwatts while operating and 180 microwatts when in standby or deselected. Price is $8 each in 100-piece quantities. Anyone who requires alterable, nonvolatile memory for pocket or hand-held electronic devices or for portable-computer hard-disk drives will be interested in this device. Write to 2125 O'Nel Drive, San Jose, CA 95131.

Fast CD-ROM

Toshiba's XM-3401 series CD-ROMs boast double-speed drives that feature 2.2 times the rotational speed to provide a fast 330K/second data-transfer rate and a claimed industry first 200-ms random access time. To achieve these specifications, Toshiba developed a proprietary high-differential servo-mechanism and employed a new low-mass optical pick-up and a high-torque brushless spindle motor. Enhancements in ECC capabilities, employment of a 256K data buffer and synchronous data transfer over the SCSI bus at 4.2M/second further contribute to the high performance.

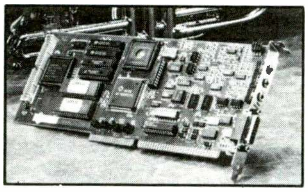


MTBF for the XM-3401 is rated at 50,000 hours. Available in both internal and external configurations, several models can be had to suit different needs. From $695. *Toshiba America Information Systems, Inc., Disk Products Div., 9740 Irvine Blvd., Irvine, CA 92718; tel.: 714-582-3000.*

CIRCLE NO. 18 ON FREE CARD

New MPC Audio Card

AudioBahn from Genoa Systems is a multimedia audio card with full MPC compatibility that offers full support for most current audio standards. Compatible with Sound Blaster and Ad Lib sound cards, AudioBahn includes an SCSI-bus interface for comprehensive



device support, including CD-ROM and hard drives. AudioBahn also supports the multimedia extensions to *Windows* 3.0 and the full *Windows* 3.1 sound features.

Sampling is done at a rate of 44.1 KHz at 16-bits for full CD stereo quality. Speech recognition is achieved with an algorithm encoded in the DSP chip. Easily upgradable ROM, with samples of real instruments, allow you to achieve near-professional music quality and voices. Up to 32 stereo voices can be played simultaneously. $399. *Genoa Systems, 75 E. Trimble Rd., San Jose, CA 95131; tel.: 408-432-9090; fax: 408-434-0997.*

CIRCLE NO. 19 ON FREE CARD

Notebook Has Removable Hard Drive

Aurum Computer's new GoldnoteSX is a 6.38-pound, 25-MHz Intel 80486SX-based notebook computer that has a removble hard disk (60M, 80M or 130M). The standard unit is configured with an 80M drive, a 3½" floppy drive, 4M of RAM (expandable to 16M), full-size 80-key keyboard with 12 function keys and embedded numeric keypad and adjustable backlit VGA LCD with 16 levels of gray. It comes with power management utilities to extend battery life.

External ports are provided for a full 101-key keyboard, ex-

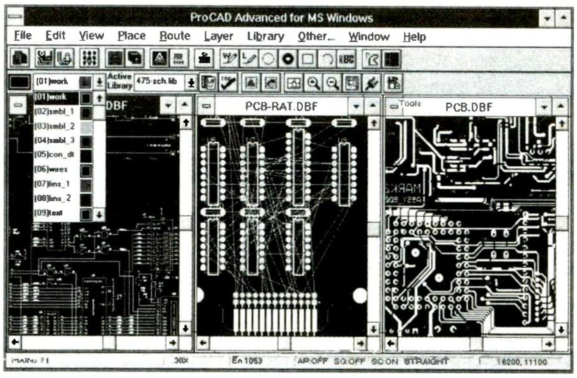
ternal VGA monitor, a parallel and two serial ports and a proprietary 100-pin port for an external AT bus-expansion station. The standard configuration includes an external power pack, DOS 5.0, *Windows* 3.1 and carrying case. $1,995. *Aurum Computer Corp., 5 Pond Park Rd., Hingham, MA 02043; tel.: 617-749-5092; fax: 617-749-5188.*

CIRCLE NO. 20 ON FREE CARD

New Windows CAD Version

ProCAD Advanced for Windows is a completely re-designed schematic-capture, printed-circuit board layout and automatic router program for the *Windows* 3.x environment. It's an upgrade from *ProCAD Xtra-XL* Version 8.50. This product adheres to the standards of the *Windows* user-interface specifications.

Key features *ProCAD Advanced for Windows* include support for real and virtual memory beyond 32M, support for extensive graphics, display and printer drivers, uniform GUI, multitasking and task-switching support, extensive help system, and clipboard for transferring information into and out of other *Windows* applications. The new *Windows version* is 100% binary-level database and library compatible with the DOS version. You can open as many as 25 designs at the same time. $995. *Interactive CAD Systems, PO Box 4182, Santa Clara, CA 95056; tel.: 408-970-0852; fax: 408-986-0524.*



CIRCLE NO. 21 ON FREE CARD

Blue Multimedia

Four new 486-based "Ultimedia" computers running at 25 MHz to 66 MHz are a part of the revamped line of IBM's PS/2 computers. Each Ultimedia model offers high-speed XGA graphics, 600M CD-ROM II drive with extended architecture capability and 330-ms seek time, system CDs loaded with programs, tools and samplers, 16-bit sound, headphone jack, microphone and volume control. These models are upgradable and compatible with other PS/2s. OS/2 and/or *Windows* and DOS are available pre-loaded on a 212M 12-ms hard drive.

Each unit includes 8M RAM and has at least three open expansion slots and one open drive bay. Options include 8516 Touch Display and TouchSelect panels, PS/2 TV for video monitoring and an ActionMedia II DVI card for digital video. $4,225 to $5,675. *IBM, 1133 Westchester Ave., White Plains, NY 10604.*

CIRCLE NO. 22 ON FREE CARD

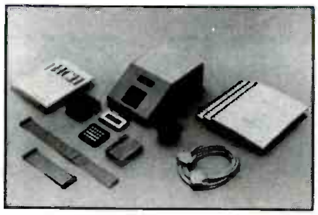
Shareware Communications Software

Communique from TopSoft is a complete IBM/compatible telecommunications package that supports X-, Y- and Z-modem protocols, as well as ANSI and AVATAR screen control and IEMSI log-on. It features easy-to-use pop-up and pull-down menus. Shareware/ $40. *TopSoft Software, Inc., 3503 Trail Ridge Rd., Louisville, KY 40241; tel.: 502-425-9939; data: 502-425-9942.*

CIRCLE NO. 23 ON FREE CARD

Board & Design Kit

Mosaic Industries' QED board is a 3.2″ × 4″ embedded controller that hosts a high-level programming environment in on-board ROM. A FORTH interactive compiler and 68HC11 assemble facilitate programming via any PC or terminal, and symbolic debugging tools support break-point insertion, tracing and single-stepping. The built-in programming tool kit includes a multitasking executive, memory manager, I/O device drivers and comprehensive floating point and matrix



math libraries.

Up to 384K of on-board memory includes battery-backed write-protect-able RAM that eliminates the need for PROM burning. Battery operable, the surface-mount board provides with up to 60 I/O lines, including keypad and display interfaces, digital I/O, 16 eight- and 12-bit A/D inputs, eight D/A outputs, eight timer-controlled signals and dual RS-232/485 serial interface ports. $495.

Also from Mosaic is the QED Product Design Kit that consists of integrated hardware and software created as a turnkey tool for instrument prototyping. It includes a QED board outfitted with 160K battery-backed RAM, 64K development ROM, power supply, serial cables, 5 × 4 keypad, 4 × 20 LCD screen, prototyping board with cables, comprehensive documentation and enclosure with mounting hardware. Flip-of-the-switch write-protection and battery-backed RAM facilitate "PROM-less" development. Programming is done via an RS-232 link using any PC or terminal. $875. *Mosaic Industries, Inc., 5437 Central Ave. Ste. 1, Newark, CA 94560; tel.: 510-790-1255; fax: 510-790-0925.*

CIRCLE NO. 24 ON FREE CARD

New Drawing Program

IntelliDraw from Aldus is a cross-platform "smart" drawing program that provides a new way to visually experiment, refine and show ideas. People create dynamic drawings in which objects stay aligned, distributed or connected in whatever way they want, even as the objects are moved or manipulated. It can be used as a general-purpose drawing program by anyone who needs to draw.

IntelliDraw is based on a platform-independent object-oriented architecture that allows people to create "smart" artwork by establishing relationships among the objects they draw. These relationships can be based on spatial, alignment or dimensional requirements; links or connections between objects; "master item-clone" relationships; or many other kinds of interconnections. Once established, the relationships remain intact, no matter how much the individual components change. For instance, a planner might show how a courtyard would look in 10 years when the trees and shrubs have grown to full height. The program is available for IBM and Macintosh environments. $299. *Aldus Corp., 9770 Carroll Center Rd., San Diego, CA 92126-4551; tel.: 619-695-6956.*

CIRCLE NO. 25 ON FREE CARD

Build Your Own Computer Accessories And Save A Bundle

By Bonnie J. Hargrave & Ted Dunning
(Windcrest/McGraw-Hill. Soft cover. 362 pages. $29.95.)
This construction-project book is designed to carry the neophyte builder past initial jitters into hands-on experience with his computer. The first 10 projects show how to make cables. No soldering is needed in these projects. They include cables, loop-back connectors, jumpers and a gender flipper.

Six intermediate projects involve soldering (mostly quite simple) and include two cable devices and four switch-box projects. The switches are an A/B RS-232, A/B monitor, A/B printer, and A/B/C RS-232 switches. Four separate software projects that can be used in conjunction with the hardware projects are included. Each program is written in Turbo C Version 2.0.

There are seven advanced circuit projects that include an RS-232 cable tester, software-controlled RS-232 switch, data detector, continuity tester, RS-232 merger and time-domain reflectometer. Much of the explanatory information is given in eight appendices. You'll find definitions of terms, photos of all the components needed to build these projects and instructions on general techniques such as soldering and crimping. There are also two tutorials: one on using schematics and another on understanding RS-232 port-to-port communications.

If you don't have a lot of hands-on experience, the projects in this book will provide you with a fun way to quickly come up to speed. It's a good book for beginner or intermediate builder, but it's unlikely that experienced builders will find much of a challenge here.

Environmentally Safe Static Dissipative

Chemtronics' new Static Clean removes contaminants and provides a long-lasting static-dissipative surface that's said to help prevent electrostatic damage while presenting no known threat to the ozone. It's packaged in a non-aerosol fine-mist pump spray and is formulated with a fresh, clean scent.

Static Clean is said to effectively reduce attraction of dust, dirt and other airborne contaminants to all environmental surfaces and is engineered for use on data-processing equipment, visual display terminals, printers, word-processing equipment, calculators, phones and desktop computers. Static Clean contains no CFCs, HCFCs, HFCs, or chlorinated solvents. *Chemtronics, PO Box 1448, Norcross, GA 30091-9931; tel.: 404-424-4888.*

CIRCLE NO. 26 ON FREE CARD

Adapters From ETC

ETC has two new adapters that attach to an IBM/compatible computer via a parallel port for ease and simplicity of installation. The Magic Converter II adds a SCSI port to your computer for immediate access to up to seven daisy-chained hard disks, CD-ROMs and similar devices. It comes bundled with installation software that includes device drivers, disk-preparation utilities, tape-backup utilities and macro options. ETC LAN adapter offers a quick and easy solution for connecting a computer to a LAN (IEEE 802.3 specifications). Available with either BNC or RJ-45 connectors, it's fully compatible with Novell and other popular installations. Installation software is included for 286- and 386-based machines. Both devices provide a pass-through connection for printers and other accessories. *ETC Peripherals Inc., 5426 Beaumont Center Blvd., Ste. 300, Tampa, FL 33634; tel.: 813-884-2863; fax: 813-333-9535.*

CIRCLE NO. 27 ON FREE CARD

Portable Chip Programmer

Transdata's PGM17 compact pocket programmer is dedicated to the PIC17C42 high-end microcontroller by Microchip. It's software driven and works with all IBM/compatible systems via a parallel interface. A special parallel adapter is included to ensure the programmer doesn't interfere with printing. Constructed of die-cast anodized aluminum, it's the size of a hand-held calculator and features LED indicators and a ZIF socket. Quick Pulse algorithm is used to ensure minimum programming time and reliable data storage.

The PGM17 comes with menu-driven software, cross-assembler, parallel interface cable, power adapter and user's guides. Installation is simple, usually taking less than a minute. $245. *Transdata, 14330 Midway Rd., Ste. 104, Dallas, TX 75244; tel.: 214-980-2960; fax: 214-980-2937.*

CIRCLE NO. 28 ON FREE CARD

New Video Products

Digital Vision's TelevEyes is a hardware device (external module connected between the computer's VGA output and the monitor) that outputs an NTSC composite-video image of whatever is on a VGA screen. It lets you record computer displays on standard VCR video tape. TelevEyes supports computer display modes up to 640 × 480 and features simultaneous computer and NTSC display, accurate NTSC, color mapping, and full resolution composite video output. $300.

CIRCLE NO. 29 ON FREE CARD

Digital Vision also has enhanced the software bundled with ComputerEyes/RT, a frame grabber that works with IBM/compatible computers. New features include support for the HiColor display technology and a new CineMaker animation routine that allows you to capture and play back video animations in several of the new multimedia motion video formats. $599 (hardware and new software). *Digital Visions, Inc., 270 Bridge St., Dedham, MA 02026; tel.: 617-329-5400; fax, 617-329-6286.*

CIRCLE NO. 30 ON FREE CARD

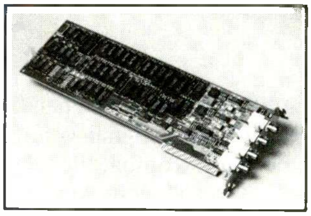
Motion Controller

MicroKinteics' new QuickStep stepper-motor controller contains on-board translators and power drivers for up to three axes on a single card. It plugs directly into any 8- or 16-bit ISA bus slot, which eliminates the need for an external enclosure. Other features include programmable acceleration/deceleration, automatic over-temperature protection, end-of-travel detection on all axes, two auxiliary outputs per card and a shield-open interrupt. The software is reportedly easy to incorporate into any application. Subroutine libraries provide support C and QuickBasic and include linear and circular interpolation, ramping, keyboard interactive jog and electronic gearing. $389. *MicroKinetics Corp., 1220 Kenneston Cir., Ste. J, Marietta, GA 30066; tel.: 404-422-7845; fax: 404-422-7854.*

CIRCLE NO. 31 ON FREE CARD

Computer Oscilloscope

Gage's CompuScope Lite 64K is a single-slot IBM/compatible expansion card that provides full digitizing oscilloscope functions in a personal computer. It comes with digital oscilloscope software that enables you to store, analyze, print and communicate your data. Key features include 40



MSPS digitizations for one channel and 10 MSPS simultaneous digitization on two channels, eight-bit resolution, 32K of memory depth per channel, external trigger capability and software drivers. Multiple Lite cards can be used to digitize up to 16 channels with a common clock and trigger in the same chassis. $995.

CIRCLE NO. 32 ON FREE CARD

Also from Gage, GageScope uses one or more CompuScope cards to provide real-time sampling rates up to 100 MHz (10 ns per sample) and memory depths up to 8M bytes on up to 16 channels. Typical oscilloscopes provide only two channels with 4K of memory. GageScope requires an IBM/compatible with 640K RAM, single floppy drive and VGA graphics adapter and monitor as a minimum. It allows you to load and store literally infinite numbers of signals and setups, print the screen for record keeping and use mathematical functions to analyze data. The program automatically detects any CompuScope cards present in the system, obviating tricky configuration problems.

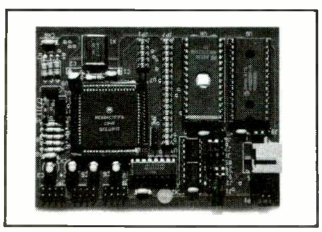
In continuous mode, GageScope repeatedly captures new data and re-draws the signals on the screen, while allowing you to change capture and display parameters without leaving the mode. You can set such features as timebase, vertical scale, sample rate, coupling, input voltage range, trigger source, level and slope using hotkeys while in continuous mode. $100. *Gage Applied Sciences Inc., 5465 Vanden Abeele, Montreal, QB, Canada H4S 1S1; tel.: 514-337-6893; fax: 514-337-8411.*

CIRCLE NO. 33 ON FREE CARD

Networked Microcontroller

The GCB11 from Coactive Aesthetics is an eight-bit networked microcontroller hardware and software package. Measuring just 3″ × 4″, the board is based on the popular Motorola MC68HC11F1 chip. It includes 32K of static RAM and 32K of ROM and requires only a +5-volt supply.

The 485 multi-drop network and master/slave packet communications software provides rapid development of distributed control applications (up to 115.2K bps). A standard PC can be used as a master or slave in the network, with no additional hardware, and code can be downloaded and debugged across the network. The GNU



C cross-compiler (PC/DOS), Linker and ROM Monitor/debugger provide a turn-key system for a wide range of applications.

A set of application libraries for motor/actuator control and sensor sampling is included. Source code for all software is available. $179. *Coactive Aesthetics, Inc., PO Box 425967, San Francisco, CA 94142; tel.: 415-626-5152; fax: 415-626-6320.*

CIRCLE NO. 34 ON FREE CARD

By Scott Edwards

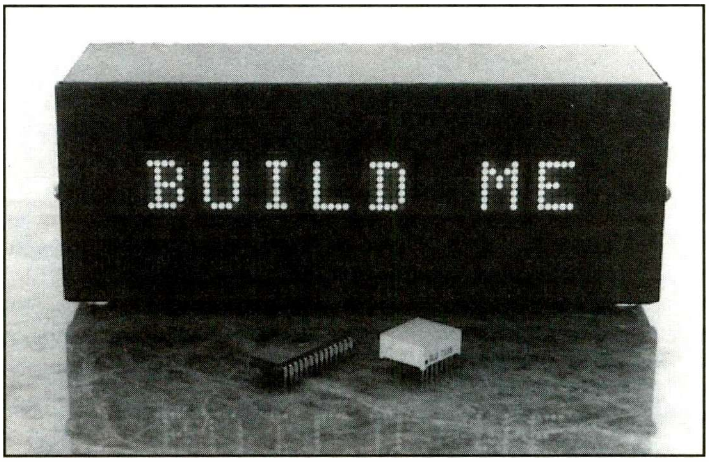
Build an Intelligent Scrolling Display

Connected to your PC or microcontroller, this Project serves as an eye-catching message "board" for displaying, in ticker-tape fashion, messages that contain up to 64 characters

Large, attention-getting message boards have lots of useful applications, ranging from point-of-sale advertising to warning of danger to monitoring equipment parameters to providing time and temperature and thousands of others. If you have a need to display attention-getting messages, the Intelligent Scrolling Display project described here will admirably fill your needs.

The Intelligent Scrolling Display uses eight 3/4"-tall dot-matrix alphanumeric LED display stages to get your message across. It can handle messages containing up to 64 characters, scrolling in ticker-tape fashion, to create an eye-catching "moving" message. When properly housed and filtered, the large display can easily be read at distances of up to 20 feet or so under even bright daylight conditions.

Connected to an RS-232 port of a PC or microcontroller, the Intelligent Scrolling Display accepts an ASCII text message that contains up to 64 characters. Though the project uses only eight display stages, it handles longer messages by automatically scrolling ticker-tape style.The Intelligent Scrolling Display works under conditions where CRTs and LCD displays might be too dim, too small or too fragile to be of much use.



How it Works

The Intelligent Scrolling Display is designed to perform three functions. It receives serial data through a 1,200-baud RS-232 port, maintains a buffer that stores and retrieves text and displays text on its eight LED-type displays. As illustrated in Fig. 1, these tasks are handled by Microchip's 16C57 PIC microcontroller. Primary virtues of this PIC controller are simplicity, low cost and high speed.

The PIC's major disadvantage is its obscure assembly-language instruction set, the commands of which are unfamiliar to programmers trained on Motorola and Intel controllers. For this project, I used an alternative assembler (supplied by Parallax, a manufacturer of PIC programming tools) that let me use standard instructions modeled after the Intel 8051. This made it easier to write the program shown in Listing 1. It should make it easier for you to read it.

If you'd like more information on the PIC, see "Build a Miniature Scrolling Marquee," which appeared in the November 1992 issue of *ComputerCraft.*

Before the PIC controller can handle incoming RS-232 data, signal voltage level must be made compatible. RS-232 specifies –3 to –12 volts to represent a binary 1 and +3 to +12 volts to represent a 0. The PIC, on the other hand, interprets at or near +5 volts as a 1 and near 0 volt as a 0.

To bridge the gap between these incompatible requirements, the Intelligent Scrolling Display uses one stage of an MC1489 quad line receiver (*IC1*). In addition to changing RS-232 voltages to standard 5-volt logic levels, *IC1* helps reject electrical noise that might be picked up in a long conductor run between computer and display. The value of *C1* was selected to reject fast noise pulses without blocking the relatively slow 1,200 baud data signals. Inputs of the three line receivers in the 1489 that aren't used are tied to ground.

Once the RS-232 signals have been converted to the appropriate logic levels, they're routed to an input/output (I/O) port on the PIC controller. The PIC's program is written to receive serial data in a specific format of 1,200 baud, one start bit, eight data bits, no parity bit and one stop bit. Figure 2 shows timing details for transmission of one byte of serial data in this format. Listing 2 is a BASIC program that sets a PC serial port to talk to the display.

Larger systems, like personal computers, often use dedicated hardware to send and receive serial data, which

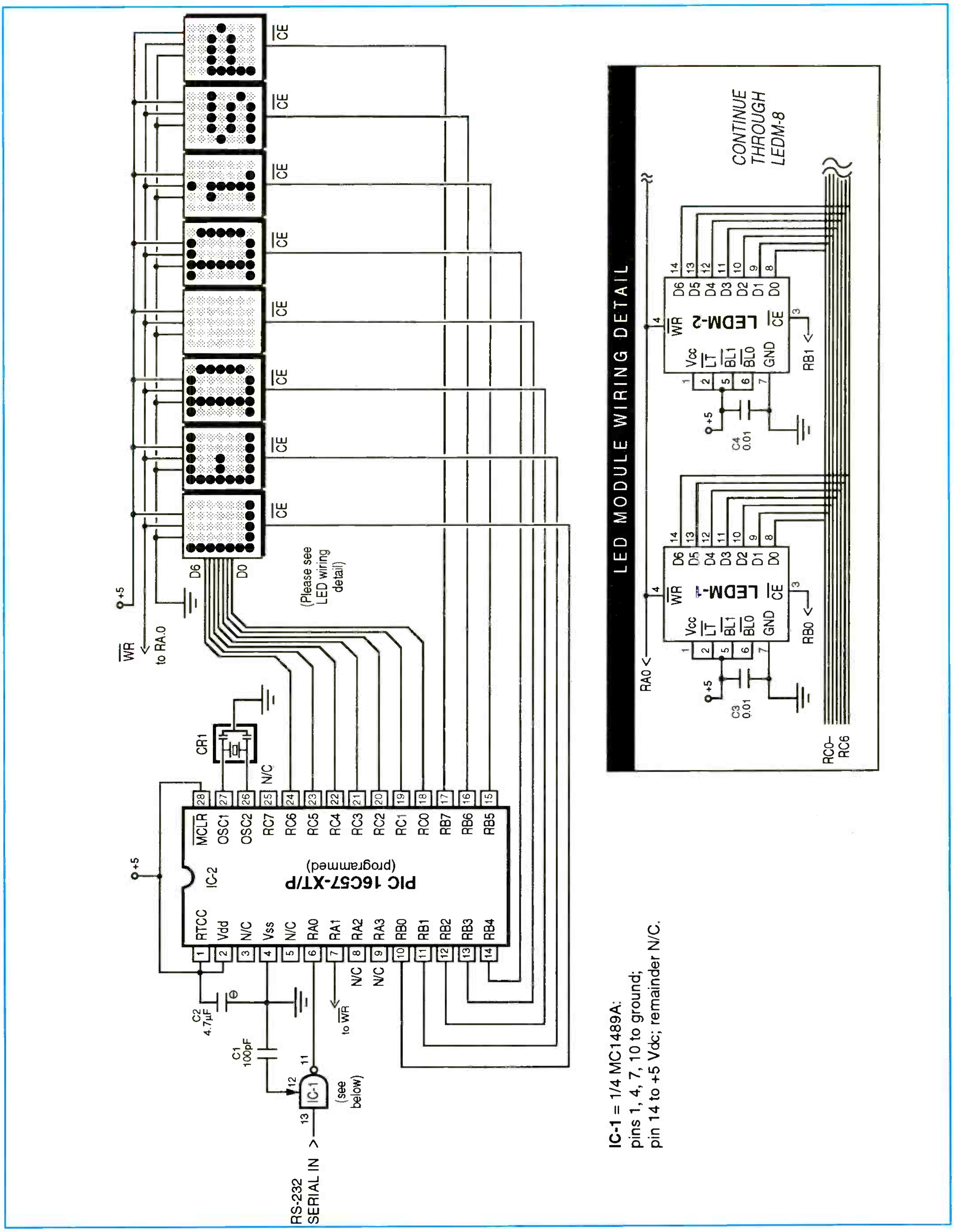


Fig. 1. Complete schematic diagram of the Intelligent Scrolling Display's circuitry.

PARTS LIST

Semiconductors
IC1—MC1489 RS-232 quad line receiver
IC2—Programmed PIC 16C57-XT
LEDM1 thru LEDM8—Siemens DLO 7135 Intelligent Displays
CR1—2-MHz ceramic resonator with integral capacitors (Digi-Key Cat. No. PX200)

Capacitors
C1—100-pF ceramic disc
C2—4.7-µF tantalum
C3 thru C10—0.01-µF ceramic disc

Miscellaneous
Ribbon cable; Molex pins (see text); regulated 5-volt dc power supply (see text); snap-able header stakes; 14- and 28-pin IC sockets (optional); suitable enclosure (see text); tinted acrylic (see text); machine hardware; solder; hookup wire; etc.

Note: Blank PICs and tools to program them are available from Parallax, Inc., 6359 Auburn, Ste. C, Citrus Heights, CA 95621 (tel. 916-721-8217) as follows: assembler and programmer, $199; emulator, $299; assembler, programmer and emulator, $449. DLO 7135 displays are available through Tanner Electronics, 1301 W. Beltline Road No. 105, Carrollton, TX 75006; (tel. 214-242-8702). Price was eight for $24.95 at the time of this writing. These items are surplus and subject to availability. Jameco, 1355 Shoreway Rd., Belmont, CA 94002-9864; (tel. 1-800-831-4242) has a suitable 5-volt dc, 1-ampere power supply (Cat. No. JE200) in kit form.
PICs programmed with the software described in this article are available for $20 each (check or money order) postpaid from Scott Edwards, 964 Cactus Wren Lane, Sierra Vista, AZ 85635. Write to the same address for availability of DLO 7135 displays. The author has secured an additional limited supply to support readers' projects. Send comments or questions via E-mail to CompuServe mailbox 72037,2612.

reduces the load on the processor and allows communication routines to run faster or in the background of other applications. The disadvantage is that these devices, known as UARTs, are relatively expensive and generally require odd-frequency crystals to drive their internal clocks. Since the PIC in the Intelligent Scrolling Display has a simple task to perform, data is received in software instead.

As show in Fig. 2, before any data appears on the serial line, the PIC is looking at a steady logic high (1). Incoming data is announced with a 0 start bit. The PIC program detects this change and waits to receive the first data bit. At 1,200 bits per second, each bit is allotted 1/1,200" of a second, or 833 µs.

For safety's sake, a serial routine should look at a bit during the middle of its time allotment. This way, if timing is slightly off, or electrical problems like noise and line capacitance have knocked the square corners off the bit's shape, the routine will still receive a valid bit. The program includes an additional 415-µs delay after detection of the start bit to center itself on the data bits that follow.

Once a start bit is detected, the program enters a simple loop that detects data bits and arranges them into an eight-bit byte. It does this by waiting one bit delay, putting the input bit into the PIC's carry register and then performing an rr (rotate right) instruction.

Visualize the byte as a conveyor belt and the carry bit as a chute over the left-most end of the conveyor. Each time an rr occurs, a bit drops out of the chute onto the belt and the belt moves one bit width to the right. Repeat this eight times, and you have eight bits arranged in a row. This is how the routine takes bits arriving in single-file and arranges them to form an eight-bit byte.

After the eighth bit is received, the routine stores the completed byte in the buffer, waits one bit length to land in the middle of the stop bit and then starts watching for the next start bit. Notice that the stop bit is the inverse of the start bit (1 versus 0). This allows the program to distinguish the end of one byte from the beginning of the next.

Because the program re-synchronizes on each new start bit, errors in timing don't accumulate to affect subsequent bytes. Therefore, the clock has only to be sufficiently stable to avoid drifting more than a total of, say, 100 µs during the 8.33 ms it takes to receive a byte. A ceramic resonator like the one used in the circuit is many times more stable than required.

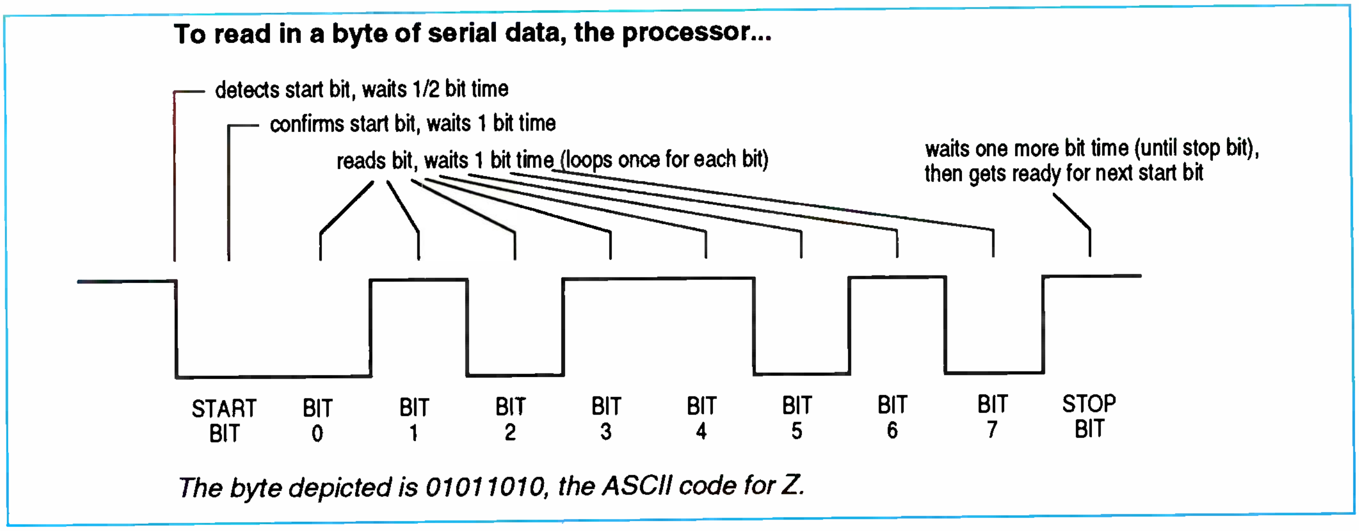


Fig. 2. How the program reads a byte of serial data.

Listing 1. Assembly-Language Listing For Intelligent Scrolling Display

```
; This listing is in Parallax assembler format. See the
; Parts List for availability of appropriate programming tools.

; Define I/O ports.
Serial_in       =       ra.0
write           =       ra.1
data            =       rc
select          =       rb

; Declare variables.
delay_cntr      =       08h
bit_cntr        =       09h
byte_cntr       =       0Ah
rcv_byte        =       0Bh
temp            =       0Ch
offset          =       0Dh
index           =       0Eh
msgcnt          =       0Fh
buffer          =       010h

; Set ROM origin to beginning for program.
                org     0

; Device data and reset vector.
                device  pic16c57,xt_osc,wdt_off,protect_off
                reset   begin

; Set up the I/O ports, clear the display.
begin           mov     ra,#0FFh
                mov     rb,#11111111b
                mov     !ra, #00000001b
                mov     !rb, #0
                mov     !rc, #0
                mov     rb,#0
                mov     rc,#32
                clrb    write
                setb    write
                clr     byte_cntr

; Wait for serial data.
:start          snb     Serial_in
                jmp     :start
                call    start_delay
                jb      Serial_in,:start
:reenter        mov     bit_cntr, #8
                clr     rcv_byte
:receive        call    bit_delay
                movb    c,Serial_in
                rr      rcv_byte
                djnz    bit_cntr,:receive
                cjbe    rcv_byte,#31,:pad_buf
                mov     w,byte_cntr
                call    buf_ptr
                mov     indirect,rcv_byte
                inc     byte_cntr
                cjae    byte_cntr,#63,display
                call    bit_delay
                jmp     :start

:pad_buf        cjae    byte_cntr,#8,display
:pad_more       mov     w,byte_cntr
                call    buf_ptr
                mov     indirect,#32
                inc     byte_cntr
                cjbe    byte_cntr,#7,:pad_more
                jmp     display

display         call    bit_delay
                mov     index, #0
                mov     offset, #0
                mov     msgcnt,byte_cntr
                dec     msgcnt
:disp           mov     index,#0
```

```
                call    Write_disp
                csa     byte_cntr,#8
                jmp     :one_liner
                mov     bit_cntr,#150
:wait           jb      Serial_in, :cont1
                call    start_delay
                jnb     Serial_in,new
                jmp     begin
:cont1          djnz    delay_cntr,:wait
                djnz    bit_cntr,:wait
                inc     offset
                cjbe    offset,msgcnt,:jump
                sub     offset,byte_cntr
:jump           jmp     :disp

; Display one-line messages (eight or
; fewer characters) without scrolling.
:one_liner      jb      Serial_in, :one_liner
                call    start_delay
                jnb     Serial_in,new
                jmp     :one_liner

new             clr     byte_cntr
                goto    begin:reenter

; Write to each LED module in turn.
Write_disp      mov     temp,index
                add     temp,offset
                cjbe    temp,msgcnt,:cont
                sub     temp,byte_cntr
:cont           mov     w,temp
                call    buf_ptr
                mov     data,indirect
                mov     w,index
                call    LEDs
                mov     select,w
                clrb    write
                setb    write
                inc     index
                csae    index,#8
                jmp     Write_disp
:return         ret

; 816-us delay--one bit at 1200 bps.
bit_delay       mov     delay_cntr,#136
:loop           djnz    delay_cntr, :loop
                ret
; 408-us delay--half a bit at 1200 bps.
start_delay     mov     delay_cntr,#68
:loop           djnz    delay_cntr, :loop
                ret

; Convert the number of the module to be addressed (0,1,2...)
; into a low on the appropriate line (11111110, 11111101, 11111011...).
LEDs            jmp     pc+W
                retw    254,253,251,247,239,223,191,127

; Accept a number from 0 to 63, convert it to the appropriate
; RAM bank and position, and put the result into the fsr.
; If you want fsr to point to the 36th position of the
; buffer, move 36 into w and call buf_ptr.
buf_ptr         mov     temp,w
                mov     fsr, temp
                cjae    temp,#030h,:bank3
                cjae    temp,#020h,:bank2
                cjae    temp,#010h,:bank1
                jmp     :bank0
:bank3          add     fsr,#010h
:bank2          add     fsr,#010h
:bank1          add     fsr,#010h
:bank0          add     fsr,#010h
                ret
```

One more point about the serial-receive routine is that the system must have a way to determine when a message is finished or it will wait for more serial data and never get around to displaying it. The program looks for two conditions to determine the end of a message, length and terminating characters.

If a message completely fills the storage buffer with 64 characters, the program breaks out of the receiving routine and begins scrolling the message across the display. Likewise, if the program receives a character with

Listing 2. QBASIC Program to Drive Intelligent Scrolling Display

```
' Set com1 to 1200 baud, disable all handshakes
OPEN "com1:1200,N,8,1,CD0,CS0,DS0,OP0" FOR OUTPUT AS #1
New.msg:
CLS
LINE INPUT ; "Message:  "; A$
PRINT #1, A$
GOTO New.msg
CLOSE
```

an ASCII value of 31 or less, it goes to the display routine. Characters below 32 all display as blanks on the LEDs. This range includes carriage-return, line-feed and other invisible control characters. This strategy puts the fewest restrictions on the system sending data to the display, since almost any end-of-line character will work.

The next function of the PIC controller is maintaining a text buffer. This is a portion of the chip's 80 bytes of on-board RAM the program sets aside for storing messages. Writing and reading this buffer requires indirect addressing and memory page-management programming techniques.

Most PIC operations that affect RAM include the address of the memory location involved. For instance, mov 010h, #0FFh means move the hexadecimal value FFh into memory location 10h. This is known as direct addressing, which is used when a programmer wants to specify in advance the RAM location to use. Nothing the program can do will change this location. However, there are times when you want to perform identical operations on many different RAM locations, such as stuffing data into sequential bytes of RAM. This operation could be very inefficient with direct addressing.

Indirect addressing involves two of the PIC's file-select register (fsr) and the indirect register (indirect). Although these registers are "special" in function, they're ordinary in other respects. They can be read, written, added, subtracted and compared.

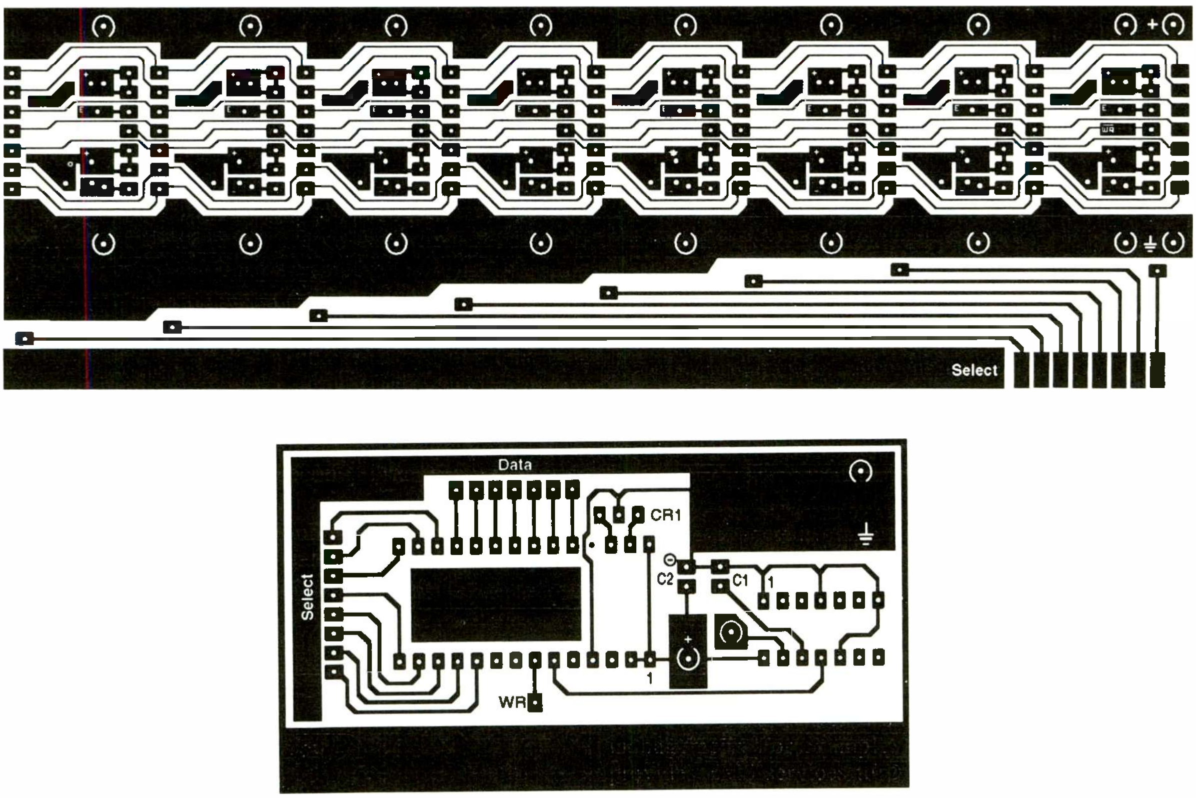


Fig. 3. Actual-size artwork for making (A) display and (B) controller printed-circuit boards.

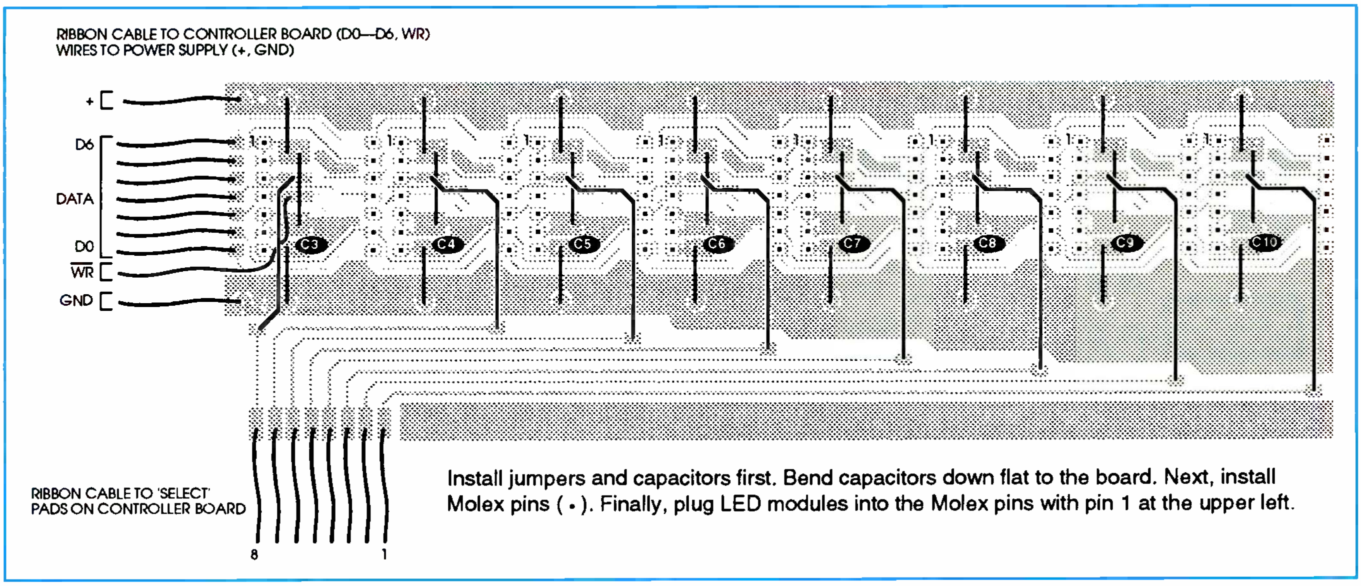


Fig. 4. Wiring guide for the display board.

What's special about them is that the number stored in the fsr is the address affected by operations to indirect. To illustrate, move 0FFh into memory location 10h via indirect addressing with the following routine:

```
mov fsr, #010h
mov indirect, #0FFh
```

The power of this technique is that it allows you to program a simple loop that writes to many different addresses by changing the value in the fsr.

Two subtle problems can make using indirect addressing a little more complicated than it sounds. One has to do with the fsr. PICs with 32 bytes of RAM have a five-bit fsr. The 80-byte 16C54 has a seven-bit fsr. All PIC operations are designed to work on regular eight-bit bytes. The "missing" bits are permanently fixed as 1s. So, if you write 10h (00010000b) to fsr and then read back fsr, you'll get F0h (11110000b) in a 32-byte PIC and 90h (10010000b) in an 80-byte PIC.

There are two ways around this problem. You can trim the additional fsr bits by programming a logical AND with 00011111b using 32-byte PICs or 01111111b using 80-byte PICs. Alternatively, you can use a separate byte of memory for counting and comparison operations, writing it to the fsr only when you must perform an indirect operation. The Intelligent Scrolling Display's program uses this approach.

The other problem occurs only with the 16C57 used in this project. This unit's seven-bit fsr allows it to address memory locations ranging from 0h to 7Fh (0 to 127 decimal). With 128 addresses but only 80 registers, some addresses are vacant lots. This unclaimed space isn't at the end of the RAM, either. There are gaps in the PIC's memory map, as follows:

0h through 7h are special-purpose registers
8h through 1Fh are general-purpose RAM
20h through 2Fh are gap
20h through 3Fh are general-purpose RAM
40h through 4Fh are gap
50h through 5Fh are general-purpose RAM
60h through 6Fh are gap
70h through 7Fh are general-purpose RAM

Documentation for the PIC puts the best face on this situation by calling the sections of general-purpose RAM "memory pages." However, this doesn't eliminate the gaps. The Intelligent Scrolling Display's program solves this problem with a subroutine called buf_ptr (for buffer pointer) that jumps the RAM gaps. Given an input between 0 and 63, this subroutine calculates the correct memory page and address and puts the result into fsr. The serial receive and display routines call buf_ptr.

This project takes advantage of a tremendous surplus bargain that puts some normally very-expensive parts within reach of home experimenters. At their usual price, one Siemens DLO 7135 Intelligent Display™ module would cost as much as the eight required for this project. If you have any desire to build this project, order soon before the price goes back up.

Two primary components make up the display modules. These are a 5 × 7 grid of bright red LEDs and a latching decoder/driver IC. Since the decoder/driver circuitry is CMOS, the majority of the current from the power supply drives the LEDs.

According to the manufacturer's specifications, full-brightness display-module current draw is approximately 125 to 160 mA each, with 20 LEDs on. This is the largest number that will be on for by any ASCII character, which is the # symbol). Thus, the Intelligent Scrolling Display could draw as much as 1.28 amperes. At –40° F, the situation worsens to 200 mA per module, for a total of 1.6 amperes.

With a normal mixture of text, the eight display modules draw less than 800 mA at room temperature. Because of this wide range of possible current requirements, I elected to keep the power supply separate.

My present application for this project's display is indoors. So, I use an inexpensive 1-ampere supply. Even if the current drawn exceeded 1 ampere, the IC voltage regulator would prevent damage to the supply. The worst that might occur would be a temporary voltage sag as the regulator's safety feature kicks in. Since the PIC and

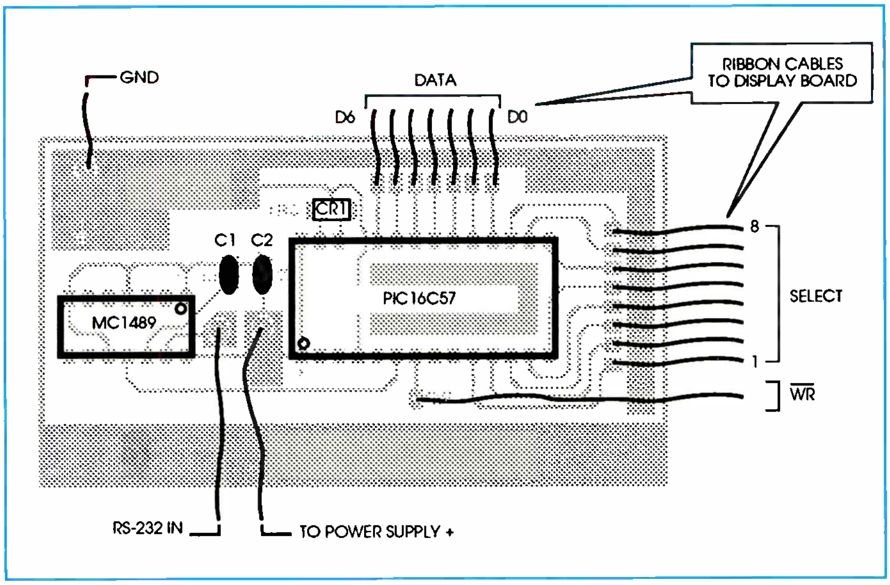


Fig. 5. Wiring guide for the controller board.

display modules tolerate at least a 0.5-volt drop in supply voltage, this setup has proven reliable.

The latching decoder/driver portion of the LED modules serves as an interface between the LEDs and PIC controller. Operation is simple. First, the desired ASCII code is put on the seven data lines. Next, a 0 is put on the chip-enable (CE) line. Finally, a 0 is put on the write (WR) line. The ASCII character appears on the LED display. The CE line allows multiple LED modules to share a common data bus and WR line. Only the module that has a low CE line when the WR line goes low receives and displays the ASCII code on the data bus.

Construction Details

To build this project, you need a programmed PIC 16C57-XT (or program one yourself using tools from the source given in Note at the end of the Parts List) and eight LED display modules. Next, fabricate the printed-circuit boards, using the actual-size artwork given in Fig. 3.

As shown in Fig. 4, one pc board interconnects eight LED modules in bus fashion, with common lines for data, WR and power. The CE line of each module is brought out separately. You can connect this board to any controller that has 16 output bits. If you wish to experiment with directly driving the LED modules with an SBC or digital I/O card, you can use this board alone.

Figure 5 shows how the PIC microcontroller, RS-232 line receiver and support components mount on the other board. The PIC's I/O lines come out to pads spaced to accommodate single in-line sockets like Molex pins. Header stakes soldered to the end of the ribbon cables from the display board plug into these sockets.

The power supply is a separate unit. Though you can get by with a 5-volt, 1-ampere regulated supply, I recommend you use a 2-ampere supply for best results and maximum reliability.

The construction procedure is fairly straightforward, but you might not be familiar with one of the techniques I used and recommend here. Because of the non-standard pin spacing on the LED modules, I used Molex spring clips to mount them and to make sockets to accept the header plugs on the ribbon cable from the display board. Also known as Molex pins, these are tinned spring clips that come attached to a metal strip. Cut the strip to get the required number of clips (seven for the LED modules). Don't separate the clips from the connecting strip.

Insert the the clip pins into the holes on the board and solder them into place. This done, remove the metal connecting strip by gently flexing it back and forth until it breaks free.

Build and test the display board before you start on the controller to make troubleshooting easier if the project doesn't work on the first try.

When you finish building the display-board assembly, use a plug-in prototyping board and a power supply to test it. Start by connecting a 5-volt, 1-ampere (minimum) power supply to the common rails of the prototyping board, usually located across the top and bottom of the board. If the board lacks these rails, connect together several rows of contacts to serve as the +5-volt connection. Repeat for ground. Don't turn on the supply yet.

Now connect the LED display board as follows: +5 volts to V+ on D6, D0, all CE lines and the +5-volt power-distribution rail; and common ground return to WR, D1 through D5 and the power GND rail.

With the power supply wired to the display circuit, turn on power. If everything is okay, the displays should remain blank. Moving a CE line from +5 volts to ground should cause an "A" to appear on the corresponding display module. Repeat this procedure for each module in turn. All modules should display an "A."

If you get the proper response at each display stage, the display board is working properly. If you don't, recheck your work. Suspect first the mounting of the modules in the Molex pins. It's easy to miss a pin.

Once the display module is working properly, refer to Fig. 5 to assemble the controller. When you're done, connect the controller to the display board via ribbon cables. You can solder the pins of the ICs directly to the copper pads on the controller board, though I strongly recommend using sockets. Be sure to orient the ICs as shown. Also, note that *C2* is polarized, with the stripe on the body of the capacitor indicating the negative lead that must connect to the pad with the minus (–) symbol on the pc board.

You'll probably want to run through the procedures detailed under Checkout & Use below before mounting the boards in an enclosure. Use an enclosure that will accommodate the circuitry. For best results, the enclosure should completely surround the displays so that it shades the LED display from ambient light to make them appear even brighter, though they're very bright to begin with. Also, consider placing tinted transparent plastic in front of the display, which further enhances contrast.

I used 1/4"-thick acrylic glazing with

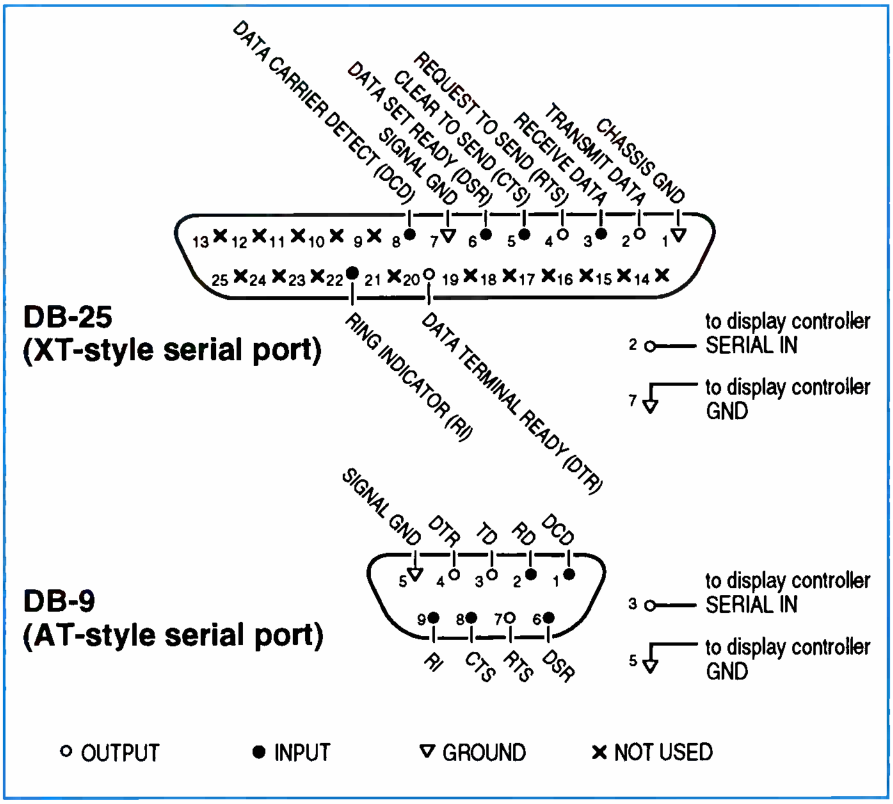


Fig. 6. Pinout details for standard PC serial-port connectors.

a dark bronze tint I found in my local hardware store. You can cut and drill this material with woodworking tools, but go easy. Too much pressure will melt, chip or crack the plastic, especially during drilling.

Checkout & Use

Regardless of the system you intend to use to drive the Intelligent Scrolling Display, it's a good idea to test it using a PC and the program given in Listing 2. Figure 6 shows how to make the two-wire serial connection to the display.

Carefully type in the Listing 2 program and run it. The program sets communication parameters to 1,200 baud, eight data bits, no parity and one stop bit and disables all handshaking.

Connect the display assembly to its power supply and turn it on. Now type in a sample message and press Enter. The message should appear on the display and should begin scrolling if it exceeds eight characters in length.

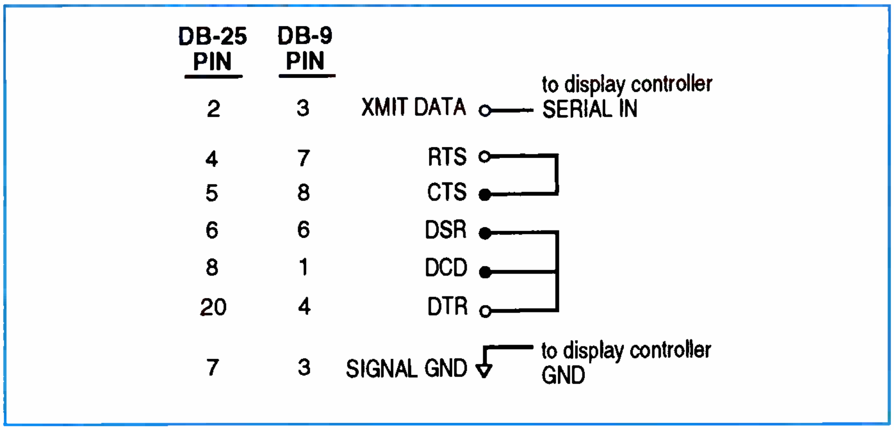


Fig. 7. Wiring details for disabling hardware handshaking, accomplished by cross-wiring handshaking lines.

You can type and transmit additional messages to the display. These will replace the previous messages as they're received.

Once you've tested the Intelligent Scrolling Display and are satisfied that it's working properly, you can connect it to other serial devices if you wish. Make sure that whatever device you connect it to is set to the correct baud rate, that line feeds are turned off, that each line of text is followed by a carriage return and that any hardware handshaking is either disabled or looped back. For loop-back, the question and answer pins are wired together, as shown in Fig. 7. Note that the ready-to-send (RTS) pin is wired back to the same port's clear-to-send (CTS) pin. Wired in this manner, the port answers its own question and automatically sends the data.

If the display works on a PC but not on the system you want to use and you've eliminated every possible serial-interfacing problem, the cause may be line feeds. Many serial senders treat every other device as a printer. At the end of a line, they send both a line feed and carriage return, which are legal end-of-line markers recognized by the scrolling display. The display circuit will receive the line of text, recognize an end-of-line marker and start displaying the message.

Before it gets started, though, the display circuit detects new data on the serial line, signaled by the second end-of-line marker. This new message will blank out the display. To prevent this from occurring, make sure you eliminate line feeds.

You can locate the scrolling display up to 50 feet from the serial sender, depending on the wire or cable you use and amount of electrical interference at the location. If your application requires that the display be used at a farther distance from the serial sender or involves use in an electrically noisy environment, consider converting it to RS-422 operation. A *ComputerCraft* article ("PC Serial Communications," September 1991) describes how to make the conversion with an existing RS-232 port and a handful of parts. With the noise immunity provided by RS-422 and the Intelligent Scrolling Display's low data rate, maximum wire length may truly be measurable in miles! ■

Floppy Diskettes

Cutting through the myths and misinformation that have grown up around them and selecting the best diskettes for your system

If you're like most computer users, you have stacks of diskettes scattered around your computer room, neatly stowed in disk boxes or teetering in piles on your desk and just about everywhere else you can find room for them. With a fairly new desktop computer, you may be able to use four or even five kinds of diskettes. If you have a laptop or an older computer, though, you may be restricted to one or two kinds of floppy disks. By exercising a little common sense, your floppy diskettes can be a reliable form of data storage. Conversely, if you use your floppies unwisely, you'd be better off saving your data on notes pasted to your video monitor.

To understand how diskettes work and what pitfalls to avoid, you have to cut through the myths and misinformation that surround them. You also must have a basic understanding of how diskettes differ and which ones are best to use on your computer.

Table 1. Drive Specifications

Drive Type (Size/Capacity)	Number of Tracks	Track Width (Millimeters/Inches)	Rotation Speed (rpm)
5 ¼"/360K	40	0.300/0.0118	300
5 ¼"/1.2M	80	0.155/0.0061	360
3 ½"/720K	80	0.115/0.0045	300
3 ½"/1.44M	80	0.115/0.0045	300
3 ½"/2.88M	80	0.115/0.0045	300

Buying Diskettes

Walk into any computer store today, and you'll find diskettes in two sizes: 5¼" and 3½". Many years ago, minicomputers and mainframe computers used 8" floppy disk, which has now fallen out of vogue. There have also been brief flurries of interest in drives that used non-standard diskette sizes, but very few stores now carry anything other than the two "standard" sizes first mentioned.

If you look closely at the packages diskettes come in, you'll see that they have different media-type labels. Larger 5¼" diskettes are available in both DD (double-density) and HD (high-density) designations. The same names are used for 3½" diskettes, and you'll soon see some with an ED (extra-high-density) label. Generally, DD diskettes are less expensive than HD diskettes of the same size. The new ED diskettes will command a premium price, at least until they're widespread use.

If diskette boxes are very informative, they'll tell you the capacity of each diskette. A 5¼" DD diskette holds 360K of data, while its HD cousin has a capacity that's four times as great, or 1.2M. Capacities in the 3½" diskette size are 720K for DD, 1.44M for HD and 2.88M for ED.

If you ask most sales clerks what the difference is between DD and HD, you'll get a false but revealing answer. If the clerk is interested in saving you money, he might tell you that there's no difference and you might as well buy the cheaper kind. In some stores, the same clerk may try to sell you an expensive punch that puts an HD sensing hole in 3½" DD diskettes.

On the other hand, a clerk working on commission might try to persuade you that more-expensive higher-density diskettes are simply made better and should be used for all data storage. He might argue that since the diskette is made to hold more data, it will be more secure even when it's formatted for a smaller capacity.

Don't listen to either statement. Both are simple myths that indicate a lack of understanding of simple floppy-disk basics. The only way to store data securely on a floppy diskette is to format each to the manufacturer's specification. Keep in mind that there are important differences among the various diskette types that make each unsuitable for use at other capacities.

Early 5¼" diskettes were designed for frequency modulation (FM) recording, usually on only one side. These diskettes were sold as "single-sided, single-density" and were used in such early desktop computers as the Apple II and Osborne-1. They generally had a capacity of 90K or so, depending on the way they were formatted. By the time the first IBM PCs appeared, modified frequency-modulation (MFM) recording was used to double the amount of data that could be stored on each diskette sold as "single-sided, double-density" media.

Single-sided drives (they have only one read/write head and a pressure pad on the opposite side of the diskette facing this single head) soon gave way to double-sided drives that have read-write heads on both sides of the diskette. All floppy drives sold today are double-sided, as are almost all diskettes. With double-sided drives came "double-sided, double-density" or "DSDD" diskettes that could store 360K of data on both surfaces.

During formatting, a diskette's surface is divided into tracks or concentric circles of recording area. All tracks under the read/write heads at any given moment constitute a cylinder. On double-sided drives, each cylinder is made up of two tracks (on multiple-platter, multiple-head hard drives, a cylinder can comprise many tracks).

The floppy-disk controller further divides each track into sectors or data blocks. The beginning and end of each sector are marked with special address bytes that let the controller find its way around a disk. The original floppy controllers supported any sector size that was a power of 2. IBM chose sectors of 512 bytes, which is still the standard sector size for both floppy and hard disks on almost all MS-DOS computers.

For optimal performance, a disk drive and its controller hardware should be able to transfer data between the diskette and computer as fast as that data passes under the read/write heads. If you look at Tables 1 and 2, you'll see that a 360K diskette revolves at 300-rpm. Each revolution, therefore, requires 200 milliseconds, and five revolutions are made every second. Since a track contains nine sectors of 512 bytes each, 23,040 bytes (512 × 9 × 5) or 184,320 bits can pass beneath a head every second. Add a little overhead for sector IDs and inter-sector information.

With the foregoing in mind, a 360K controller must be able to send 250,000 bits per second (bps) between computer and diskette. Without counting the time needed to move the heads and find the first sector on each track, a minimum of 16 seconds (80 tracks × 200 ms) are needed to transfer a full disk of data to or from a computer.

Diskette manufacturers can't just splash a magnetic solvent on a diskette and state that it's ready. The recording characteristics of the diskette must meet fairly rigid specifications.

Perhaps the most important characteristic is the strength of a magnetic field needed to change the orientation of a field on the diskette. If the diskette is too sensitive, or if the drive records data with too much magnetic force, data adjacent to or on the reverse side of the disk from the data being recorded may be corrupted. If the diskette isn't sensitive enough, or if the drive doesn't use enough force, newly-recorded data may not completely displace previous data on the diskette in the same area.

The magnetic coercivity of a diskette, usually measured in Oersteds, is an indication of its sensitivity. The greater the coercivity measurement, the stronger the signal needed to record new data and the less sensitive the diskette.

The DOS FORMAT command performs both low-level and high-level formats of a diskette. Under low-level format, sectors are created with empty data, and sector IDs are written on the diskette. Under high-level format, the first sector on the disk is set to reveal whether or not the disk can be used to boot the computer.

If a diskette isn't set up to boot the computer in which it's used, a small program on the sector displays the familiar error message and pauses. If the disk is bootable, the first sector contains a short program that loads and runs DOS.

High-level format also initializes a File Allocation Table (FAT), which DOS uses to keep track of the locations of files and a root directory. When it's done being formatted, the diskette is ready for use in any standard DOS computer.

Table 2. Floppy Diskette Specifications

Size Inches/ Density*	Tracks Per Inch	Bits Per Inch	Doping Agent	Coercivity (Oersteds)	Thickness (μinches)
5 1/2/DD	48	5,876	Ferrite	300	100
5 1/2/HD	96	9,646	Cobalt	600	50
3 1/2/DD	135	8,717	Cobalt	600	70
3 1/2/HD	135	17,434	Cobalt	720	40
3 1/2/ED	135	34,868	Barium	750	100

* DD = double density; HD = high density; ED = extra high density.

Table 3. Floppy-Disk Formatting Instructions

Command Syntax	3.0	3.1	DOS Version 3.2	3.3	4.0	5.0
5 1/4", 360K Disk in 1.2M Drive:						
FORMAT d: /4	Yes	Yes	Yes	Yes	Yes	Yes
FORMAT d: /N:9 /T:40			Yes	Yes	Yes	Yes
FORMAT d: /F:360					Yes	Yes
3 1/2", 720K Disk in 1.44M or 2.88M Drive:						
FORMAT d: /N:9 /T:80				Yes	Yes	Yes
FORMAT d: /F:720					Yes	Yes
3- 1/2", 1.44M Disk in 2.88M Drive:						
FORMAT d: /N:18 /T:80						Yes
FORMAT d: /F:1.44						Yes

Notes: d: is letter assignment of drive to format; /N: is number of sectors per track; /T: is number of tracks per side; /F: is format capacity; DOS 2.x supports only 360K diskettes; DOS 5 is required for 2.88M diskettes.

Increasing Capacity

The 5 1/4" 360K drive is standard in the PC/XT and all compatibles based on the Intel 8088 and NEC V20 and V30 chips. The original PC/AT had a new drive that was capable of storing 1.2M of data on a high-density 5 1/4" diskette. Added capacity was gained by doubling the number of tracks (and

Table 4. Physical Floppy-Disk Format Characteristics

	5 1/4" DD	5 1/4" HD	3 1/2" DD	3 1/2" HD	3 1/2" ED
Bytes Per Sector	512	512	512	512	512
Sectors Per Track	9	15	9	18	36
Tracks Per Side	40	80	80	80	80
Capacity in K Bytes	360	1,200	720	1,440	2,880

Table 5. Logical Floppy-Disk DOS Format Characteristics

	5 1/4" DD	5 1/4" HD	3 1/2" DD	3 1/2" HD	3 1/2" ED
Cluster Size In Sectors	2	1	2	1	2
FAT Type (Bits)	12	12	12	12	12
FAT Length In Sectors	2	7	3	9	9
Number Of FATs	2	2	2	2	2
Root Directory Length In Sectors	7	14	7	14	15
Maximum Root Directory Entries	112	224	112	224	240
Sectors On Disk	720	2,400	1,440	2,880	5,760
Sectors Available	708	2,371	1,426	2,847	5,726
Clusters Available	354	2,371	713	2,847	2,863
Bytes Available	xxxx	xxxx	xxxx	xxxx	xxxx

making each track about half as wide as was previously the case) and adding more sectors per track. Also, the 1.2M drive was made to rotate at 360 rpm, or 6 revolutions per second.

A 1.2M drive can read 360K diskettes without problem by "double-stepping" or moving the heads a double two track widths to reach each new track. Even though it spins the disk more rapidly than in a 360K drive, the 1.2M drive has no problem keeping up with data transfers because drive and controller can process data at a rate of 500,000 bps.

A 1.2M diskette has half the sensitivity (twice the coercivity) of a 360K diskette, which means that the drive must produce twice the signal strength of a 360K drive. It can write to a 360K diskette by dividing its signal strength in half with electronics on the drive's circuit board. However, its read/write head is half the width of a head in a 360K drive, which leads to incompatibilities if you plan to transfer diskettes between types of 5¼" drives.

If you format a diskette or record data on a 360K drive, a 1.2M drive will have no trouble reading the data because it simply samples part of each track and double-steps from one track to another. However, if you record new data with a 1.2M drive, a 360K drive may not be able to read this data (nor the update FAT and directory). The new data won't completely fill a track, nor will it completely obliterate previous data in the newly-written sectors of a track.

The only way to reliably transfer data from a 1.2M drive to a 360K drive is to format a new (or bulk-erased) diskette on the 1.2M drive and do all writing with this drive. Since spaces between tracks will be empty, the 360K drive will be able to read the data without confusion. However, as soon as the 360K drive writes to a diskette, you should never try to write new data on the same diskette with a 1.2M drive.

You should never try to format a 360K diskette for a 1.2M capacity. DOS will let you do it, but the signal strength will be too great for the magnetic coating. The diskette will be unreliable because the write signal will over-saturate the magnetic coating. The only way to recover the diskette for normal use is to use a bulk eraser and then reformat it for 360K of storage capacity.

Micro Diskettes

Compared to 5¼" diskettes, the smaller 3½" diskettes (or micro diskettes, as they're sometimes called) are simple to understand and use. Double-density or 720K diskettes have a single notch in the plastic housing. They hold 80 tracks of nine sectors each.

High-density micro diskettes have a second square hole in their plastic housing and hold 80 tracks comsisting of 18 sectors each. The second hole is used by the drive to determine whether a DD or HD diskette is being used. The drive uses the information to determine what recording intensity to use when it writes to the diskette.

Extra-high-density (ED) diskettes and drives are just beginning to appear. These use a special vertical recording technique that squeezes 36 sectors into each of 80 tracks. An ED diskette has a media-type hole in a different location in the housing than on a standard HD diskette.

You'll find people who claim that DD and HD micro diskettes are the same, except for their media-sensing hole. The same people claim that you can turn a DD diskette into an HD diskette by punching a hole through the plastic housing with a special tool.

As you can see from the tables, any manufacturer that ships the same diskettes in different plastic housings isn't following specifications. Although the difference in coercivity is much smaller than in the 5¼" floppy-disk world, there is a sufficient difference to cause a diskette formatted at the incorrect density to fail prematurely.

Because 3½" diskettes all have the same number of tracks of the same width, there should never be a compatibility problem when you move a diskette from one drive to another. A 720K diskette can be read and written in a 1.44M drive, and the resulting data will be accessible when the diskette is moved to a 720K drive. You don't have to worry about which drive was used to format the diskette or which has written to the media. The drive automatically adjusts its recording intensity according to diskette type being used.

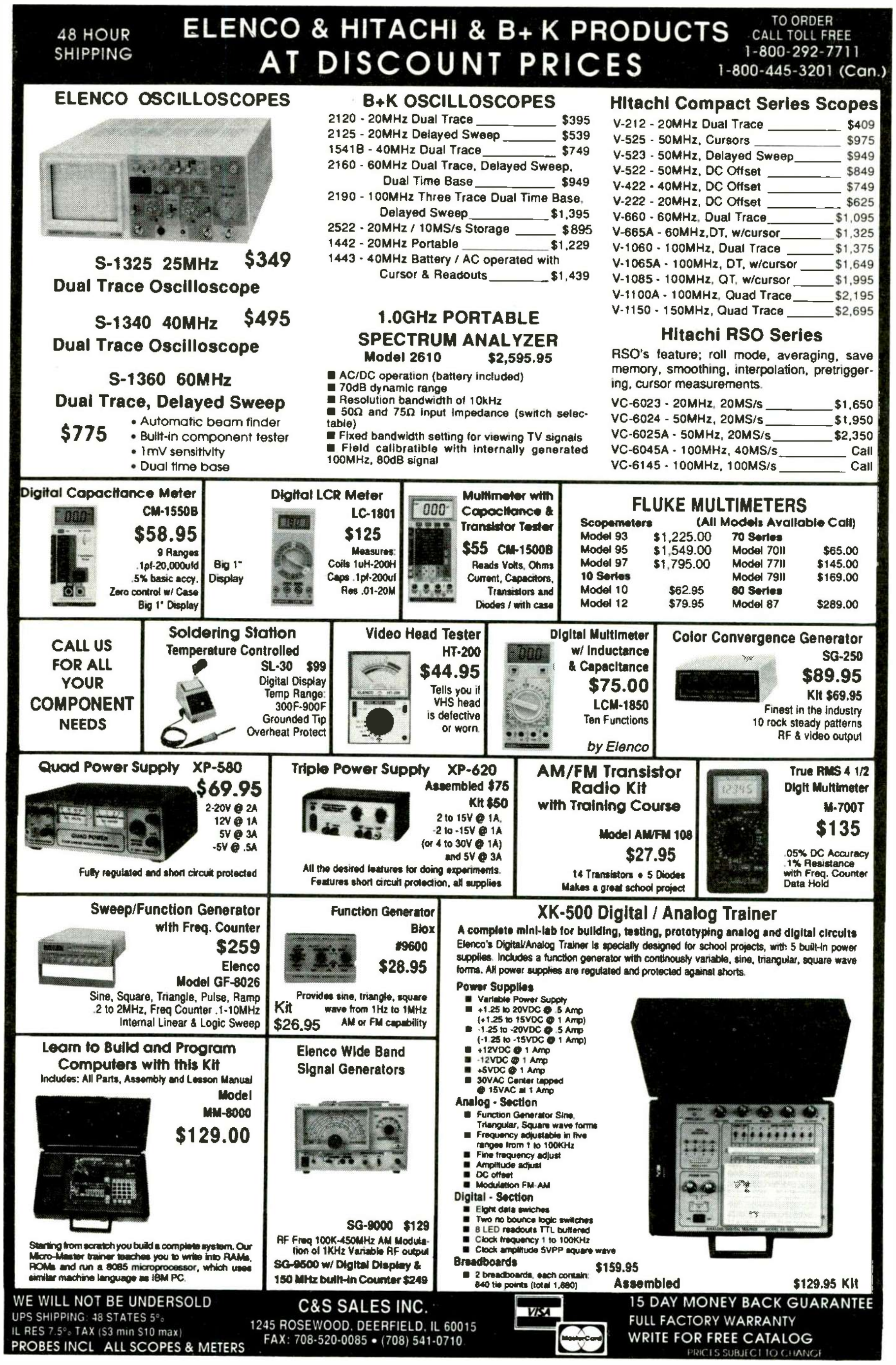
Unfortunately, DOS (along with the BIOS and disk controller) does a poor job of sensing diskette type and always tries to format a diskette for maximum drive capacity. If you format a 360K diskette in a 1.2M drive, or a 720K micro diskette in a 1.44M drive, you must give DOS the appropriate instructions. If you fail to do so, you may lose data you subsequently record on the diskette. At the earliest opportunity, you should bulk erase the entire diskette and reformat it correctly. Don't believe the myth that that once a disk is formatted, it will hold data reliably.

Table 3 shows the correct formatting commands for all types of diskettes and each version of DOS. If you're using DOS 4.0 or 5.0, use the simplified syntax with the /F switch. All you need do with this syntax is tell DOS the diskette capacity.

If you travel with a laptop computer, you should be aware of one last myth. Security machines in airports come in two types. Those that check carry-on baggage use X-rays to view luggage contents and are perfectly safe for computers and diskettes because only a magnetic field changes a diskette's data. On the other hand, metal detectors through which passengers walk, and hand-held detectors that some security agents have, use a magnetic field to detect metal. Obviously, you should keep your computer and diskettes as far as possible from metal detectors.

When you go through airport security, put your computer and diskettes on the conveyor belt that passes through the X-ray machine, where they'll be protected from the metal detectors. Don't carry them through the metal detector or hand them to an agent standing next to the detector. Film can be harmed by the X-ray machines, but data on your diskettes won't be affected at all by them.

Much of the information in this article was taken from Scott Mueller's excellent *Upgrading and Repairing PCs*, Second Edition (Que Corp., 1992). If you want to know more about diskettes, or about any other part of your computer, this book is an excellent place to start. ■



How to Use Flash EPROMs in Your Own Circuits

What they are, how they work, how they're positioned in the nonvolatile memory family, important details on their use and more

You've probably heard of flash EPROMs, the newest option for user-programmable memory chips. Unlike traditional EPROMs, flash EPROMs don't require ultraviolet (UV) radiation for erasure. In many circuits, a flash EPROM can replace UV-erasable EPROM, EEPROM or battery-backed RAM for low-cost, secure, non-volatile storage of programs and data. In this article, I'll introduce you to flash memory and tell you how it works, when to use it (and when not to), what types of devices are available and how to use flash memory devices in your own circuits.

Memory Choices

Flash EPROMs are one of several forms of nonvolatile memory that retain data after power is removed. In microcontroller circuits and single-board computers, nonvolatile memory usually holds the program the circuit executes on power-up. Other information stored in nonvolatile memory includes user-defined operating parameters, data entered by users (at a keypad, for example) and measurements taken by sensors and used for calculations or tabulations later.

Four major types of user-programmable, nonvolatile memory are: the classic UV-erasable EPROM (erasable, programmable, read-only memory); EEPROM (electrically erasable PROM); battery-backed, or nonvolatile (NV), static RAM; and flash EPROM. Table 1 summarizes the major characteristics of the different types.

"Flash" describes the ability to erase an entire array of memory cells at once, or "in a flash." Flash EPROMs are sometimes referred to as flash EEPROMs, since they're electrically erasable, or they may simply be called flash memory, to avoid confusion with other EPROM and EEPROM types.

Table 1. Characteristics of User-programmable Memories

Memory Type	Flash	UV-erasable EPROM	EEPROM	NV RAM
Device	28F256A	27C256	28C256	DS1230
Erase Time	1 second	15 minutes	0	0
Programming Time (seconds)	0.5	4	2.5	0.1
Programming Voltage (Vpp)	12	12.75	none	none
Programming Voltage (Vcc)	5	6.25	5	5
Program/Erase Cycles (minimum)	10,000	<1000	10,000	infinite
Erasure Method	electrical	UV light	electrical	electrical
Byte Erasable?	N	N	Y	Y
Cost (single quantity, typical)	\$8-\$15	\$4-\$7	\$15-\$50	\$25

If you compare current data books with those from just a few years ago, you'll see that flash-EPROM technology is still very much under development. Each year, improved devices are introduced, offering easier programming and erasing, greater numbers of program/erase cycles, larger capacities and new features. Prices have dropped as well.

Let's look at how today's flash EPROMs compare to their competitors in ease of programming and erasing, number of program/erase cycles, price, availability and data retention.

• *Programming and Erasing.* Both flash and UV-erasable EPROMs must be erased before they're programmed. Since the flash EPROM is electrically erasable, you can erase it in-circuit, without the extra step of removing the chip from its socket, exposing it to UV radiation for 15 to 20 minutes and

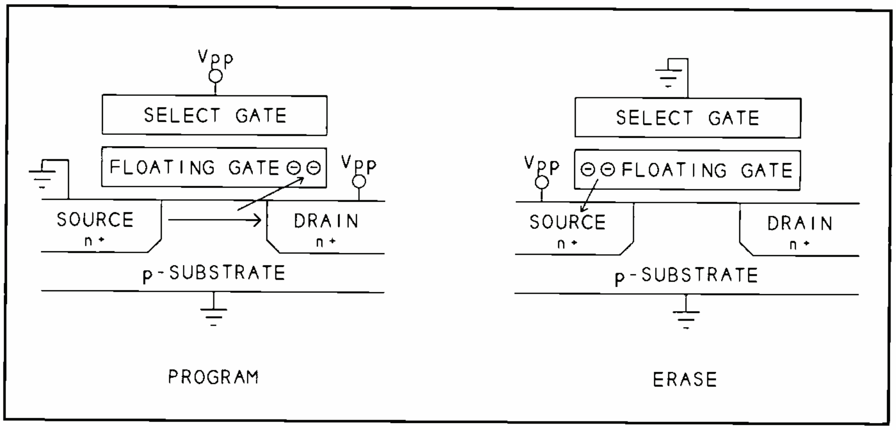


Fig. 1. Drawings show structure of a typical flash EPROM cell, with programming and erasure voltages applied.

returning it to its socket for use.

Erasing a typical flash EPROM requires following a recommended algorithm, or procedure, that includes applying +12 volts to a programming pin, writing a timed sequence of commands to the device and verifying that erasure is successful. Some 5-volt-only devices are beginning to become available, though at higher cost.

With some flash EPROMs, you erase the entire device at once. Others are divided into several blocks, each of which erases individually.

EEPROMs and NV RAMs require no separate erase operation before programming.

As with erasing, programming a typical flash EPROM requires following a specific algorithm: applying +12 volts to a programming pin, writing a timed sequence of commands and data to the device and verifying the programmed data after writing.

UV-erasable EPROMs also require you to follow a recommended programming algorithm. In addition to applying a programming voltage (which varies with device), programming these EPROMs often requires raising the 5-volt dc supply to 6 volts or more.

Writing to NV RAM requires only a simple write instruction, with no additional programming voltages, and verifying isn't necessary. Writing to EEPROM is similar to writing to RAM, although you typically must wait 2 to 10 ms after writing before you can access the chip again. (A second type of NV RAM combines a static RAM and EEPROM in a single chip. For nonvolatile storage, you copy the RAM's data into the EEPROM.)

For erasing and programming speed, you can't beat NV RAM, but flash EPROM comes in second, followed by EEPROM, with UV-erasable EPROM trailing far behind, due to its erase time.

One advantage to requiring +12 volts for programming is that you need only remove the programming supply to prevent overwriting the contents by accident. But Dallas Semiconductor has come up with a secure NV RAM in its DS1645, which is divided into 16 blocks, any or all of which you can write-protect by executing a sequence of 24 read cycles.

• *Program/Erase Cycles.* Intel's current flash EPROMs are guaranteed to give 10,000 erase/write cycles, which is much improved over earlier the specification, which was as low as 100 cycles. This compares with infinite write capability for NV RAMs, 10,000 write cycles for a typical EEPROM and 100 to 1,000 erase/program cycles for EPROM. (These values are minimum. A typical device will withstand as many as ten times as many cycles.)

• *Price.* For now, flash EPROMs are more expensive than UV-erasable EPROMs, though flash prices have been dropping and will probably continue to do so. EEPROMs and NV RAMs are more expensive than flash devices, especially in those that have larger capacities. When you calculate overall cost, remember to include the cost of any required programming hardware and power supplies.

• *Availability.* Flash EPROMs seem to be limited to 32K-byte size and larger. So if you need a smaller-capacity device, you may be out of luck. Of course, you can always use a larger-capacity device in a circuit and access only needed locations.

As for microcontrollers with on-chip flash EPROM, Motorola has announced two devices that have on-chip 48K-byte flash EPROM, the 68HC916Y1 and 68HC916X1, both in the 16-bit HC16 family.

You buy flash EPROMs in single-unit quantity from a number of vendors. For example, try Arrow's Catalog Store, Jameco, Newark Electronics and Unicorn Electronics. Large-capacity chips (1M-bit and up) may be hard to find, due to high demand and problems that Intel has been having while switching from its pilot line to full production.

• *Data Retention.* One specification where all devices are equal is data retention. All are guaranteed to retain data for a minimum of 10 years.

To sum up, flash EPROM isn't a magic solution to nonvolatile memory needs. NV RAM's infinite number of write cycles makes it the only choice for information that changes continually. NV RAM and EEPROM are the most convenient to use for 5-volt-only operation and ease of programming. And UV-erasable EPROM is still the least-expensive alternative, if you consider only the cost of the chip.

Flash memory will inevitably continue to increase in popularity because it's the lowest-cost non-volatile memory that can be programmed in-circuit.

Flash-Memory Basics

Flash EPROM was invented by Toshiba, which published a paper on it in 1984. However, Intel took the lead in developing memory devices using flash technology. Advanced Micro Devices (AMD) also manufactures Intel-compatible flash EPROMs, and Texas Instruments is another company that's involved with this technology.

You don't have to understand the technology behind how flash EPROMs work to be able to use these devices in your own circuits. But for the curious, the following is a brief explanation.

Figure 1 shows a cell based on Intel's flash-EPROM technology. Devices from other manufacturers may vary slightly in structure, but the theory remains basically the same.

Flash EPROM is similar to UV-erasable EPROM, with each memory cell containing a special type of field-effect transistor (FET) consisting of source, drain, select gate and floating gate. The gates are insulated from the source, drain and each other by a thin oxide layer.

Intel's flash EPROMs require just one transistor per memory cell, with each cell storing one bit of information. Other manufacturers use a second transistor to control erasure. In comparison, UV-erasable EPROMs have one transistor per cell, EEPROMs have two or three and static RAMs have four to six. The greater the number of transistors per cell, the more difficult it is to squeeze a large number of memory cells onto a chip and the more expensive the device becomes. This helps to explain the high cost of large-capacity NV RAMs and EEPROMs.

In a flash-EPROM cell, the oxide layer that insulates the floating gate from source and drain is extremely thin (10 to 20 nm, compared to greater than 30 nm for UV-erasable EPROMs). The thin oxide layer is what allows electrical erasure.

To program a flash EPROM cell, you ground the source and bring the gate and drain to a high voltage, typically 12 volts. This causes electron flow from source to drain and allows the select gate to pull free electrons across the oxide layer into the floating gate. The electrons' charge remains on the floating gate even after the programming voltages are removed.

To erase a cell, you ground the gate and apply a high voltage to the source. This causes electrons to "tunnel" through the thin oxide layer from the floating gate to the source, removing the charge on the floating gate. In a typical device, the sources of many cells are tied together and all erase at the same time.

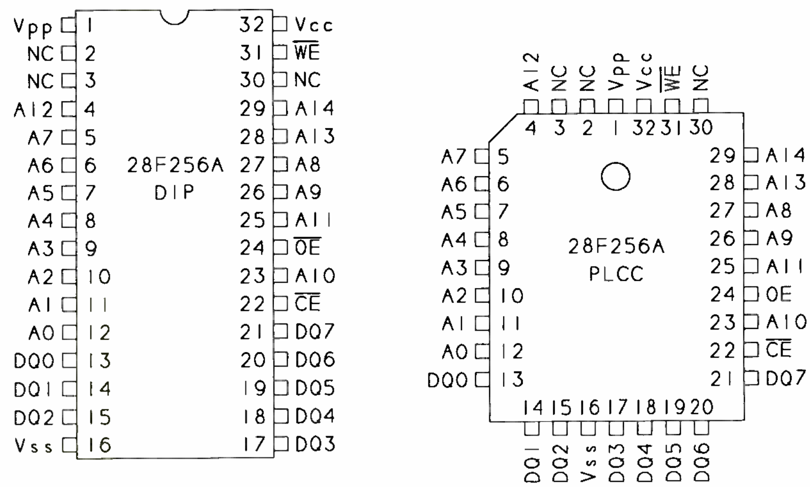
When a computer reads a flash-memory cell, address-decoding circuits in the chip cause a voltage to be applied to the select gate. In an erased cell, gate voltage causes the transistor to switch on. At the corresponding data output, the cell appears as a logic high (1). In a programmed cell, the charged floating gate prevents the transistor from switching on and causes the corresponding data output to be read as a logic low, or 0. In a typical byte-wide device, eight bits are selected and read simultaneously.

Many different flash-EPROM devices exist, in different package types, speeds and architectures. Sizes from 32K to 256K bytes are available in the familiar 32-pin DIP (dual in-line package), as well as in 32-lead PLCCs (plastic leaded chip carriers) for surface-mount designs. Like other memory devices, flash EPROMs are rated by access time, typical values ranging from 150 to 200 ns.

Unlike UV-erasable EPROMs, which require expensive ceramic packages with transparent windows, flash EPROMs are available in low-cost plastic packages. Figure 2 shows the pinout of Intel's 28F256A Flash EPROM, which stores 32,768 (32K) bytes of data.

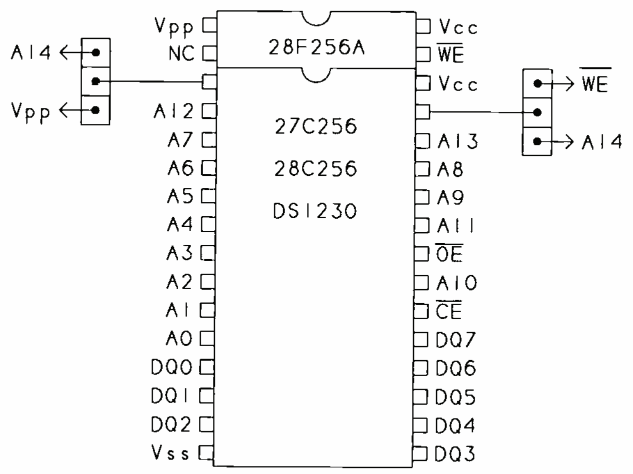
In the 28F256A, the entire memory array erases at once. In contrast, Intel's 28F001BX 128K-byte (1M-bit) boot-block flash EPROM is divided into four blocks, each of which can be erased and reprogrammed individually. There's a 112K-byte main block for storing main program code; two 4K-byte parameter blocks for storing configuration data, diagnostic messages or additional boot or program code; and a secure 8K-byte boot block for storing code that will minimally boot the system and control programming and erasing of the other blocks as needed.

For interfacing with processors that boot from high or low memory, two versions of the 28F001BX exist. In the -T version, the boot block is addressed in high (top) memory, while in the -B version, the boot block is in low (bottom) memory. The 28F001BX also



Symbol	Type	Function
A0-A14	Input	Address inputs
DQ0-DQ7	Input/Output	Data input/output
CE	Input	Chip enable
OE	Input	Output enable
WE	Input	Write enable
Vpp	Power	Erase/program power supply (12V ±5%)
Vcc	Power	Device power supply (5V ±5%)
Vss	Power	Ground
NC	-	No connection

Fig. 2. Pinout details and pertinent data for 28F256A 32K-byte flash EPROM, available in DIP and PLCC packages.



MEMORY TYPE	PART NUMBER	JUMPER PIN 3 OF SOCKET TO:	JUMPER PIN 29 OF SOCKET TO:
UV EPROM	27C256	Vpp	A14
EEPROM	28C256	A14	$\overline{WE}$
NV RAM	DS1230	A14	$\overline{WE}$
FLASH EPROM	28F256A	DON'T CARE	A14

Fig. 3. This universal site can accept a 32K-byte UV-erasable EPROM, EEPROM, NV RAM or flash EPROM. Two jumpers configure the site for different memory types.

has simpler, more automated program and erase procedures when compared to the 28F256A.

Another package type for flash memory is the memory card, which is a credit-card-size package with a two-row, 68-pin connector along one edge. Memory cards are easy to plug in and remove and make convenient memory devices that can even substitute for floppy or hard disks in portable computers.

Pinouts for many flash EPROMs are similar, but not identical, to pinouts of other memory chips. A 32K-byte flash EPROM requires a 32-pin socket, while the same-capacity UV-erasable EPROM, NV RAM or EEPROM uses a 28-pin package.

Figure 3 shows a universal site that accepts a 32K-byte flash EPROM, UV-erasable EPROM, NV RAM or EEPROM. To change from NV RAM or EEPROM to flash or UV-erasable EPROM, you move jumpers to switch the functions of the pins that vary. In the universal site, 28-pin devices install in the bottom of the site, with pin locations 1, 2, 31 and 32 left unoccupied.

Programming Flash EPROMs

UV-erasable EPROMs are usually programmed by a device programmer that generates the appropriate programming voltages and signals. Many EPROM programmers are capable of programming flash EPROMs as well. But since flash EPROMs can be erased electrically, you might want to include the ability to erase and program them in-circuit.

To erase and program a flash EPROM in-circuit, you have to provide the programming voltage and follow the recommended procedures for erasing and programming. These are more complex than the simple write instructions used when writing to conventional RAM.

I'll use the 28F256A as an example to illustrate erasing and programming procedures (which may vary for other devices). For erasing and programming, the 28F256A requires +12 volts at V_{PP}. When powered by a single 5-volt dc supply, the chip acts like a read-only memory, using control signals and timing conventions similar to those for RAM or UV-erasable EPROM. Figure 4 shows interfaces between a flash EPROM and 8031 and 68HC11 microcontrollers.

To control programming and erasing, the 28F256A contains an internal state machine, which consists of digital logic that executes defined commands. To access the state machine, V_{PP} must be +12 volts. The following are the available commands:

• *Read Memory.* Writing 00h to the command register causes the device to act like read-only memory. This is the default command on power-up.

• *Set Up Erase/Erase.* Erasing requires writing 20h to the device twice in a row. The first byte is the set-up byte. The second byte starts erasure, which returns all locations to FFh. Before erasing, program all bytes to 00h to ensure that all cells are equally charged before erasure and guard against over-erasing.

The 28F256A has an internal stop timer that automatically terminates the erase operation at the appropriate time. In a preliminary version (the 28F256, without the A suffix), the programmer was responsible for writing a Verify Erasure command precisely 10 ms after erasing. If this wasn't done, you risked over-erasing and destroying the ability to program the device. Thankfully, in the 28F256A, this is no longer a concern.

• *Verify Erasure.* After erasing, each byte must be verified to find out if erase is successful. Writing A0h to the command register causes the device to internally generate a margin voltage used in verifying erasure. Reading FFh from a location indicates that erasure was successful. Unlike the Erase command, which erases the entire device at once, an individual Verify Erasure must be written for each location in the chip.

• *Set Up Program/Program.* Programming is done in two steps: Write 40h to the device to set it up for programming; and Write the desired address and data to the device, which programs the specified address with the desired data.

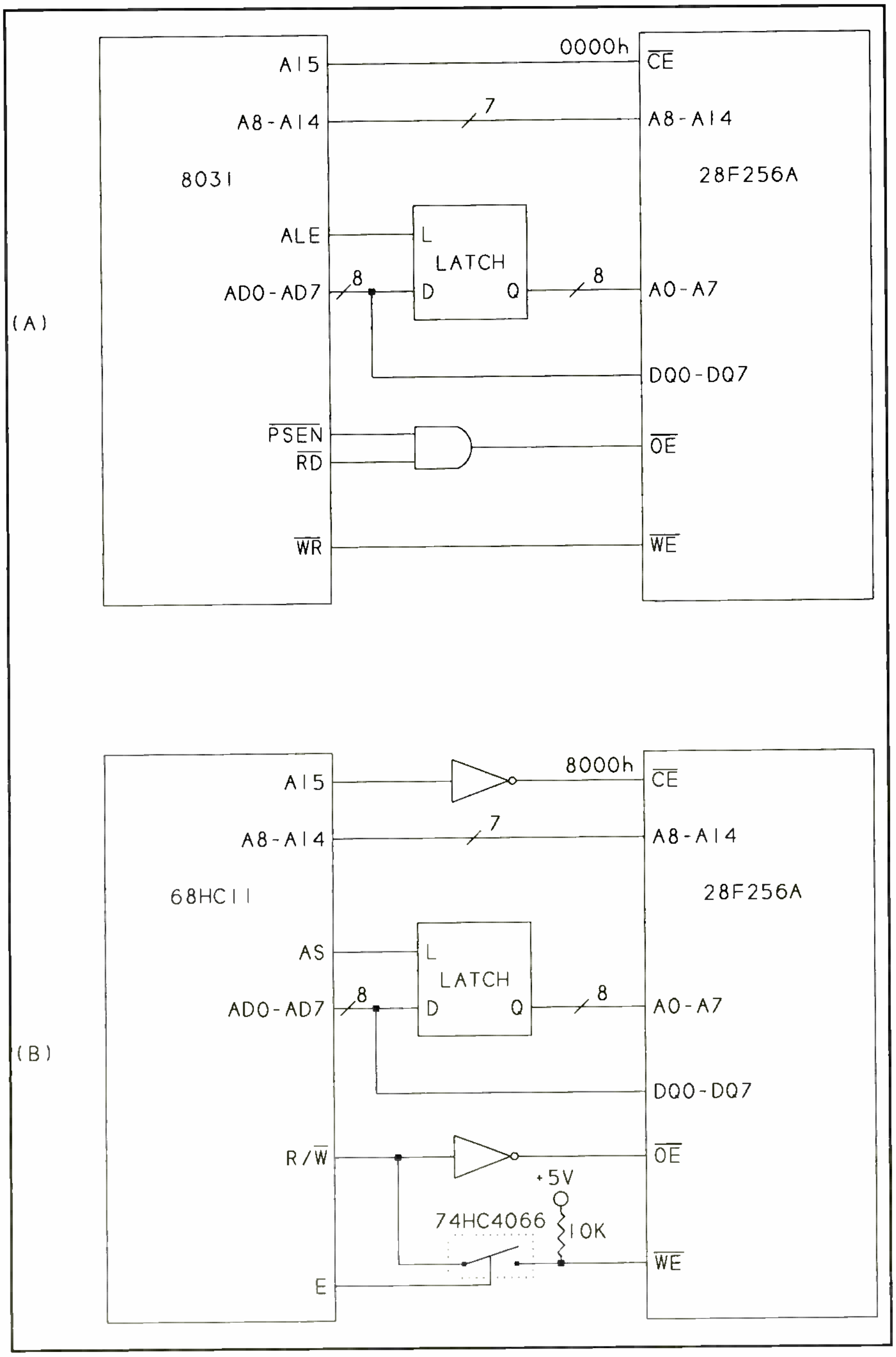


Fig. 4. Interfacing details for a 28F256A flash EPROM to an (A) 8031 microcontroller and (B) 68HC11 microcontroller.

• *Verify Program.* As with erasing, each location must be verified after programming. To verify, write C0h to the command register, and the next Read operation will return the data stored at the just-programmed location. Like Verify Erasure, this operation uses an internally-generated margin voltage.

• *Reset.* If you follow a Set Up Erase or Set Up Program command by writing FFh twice to the device, the erase or program command safely returns the device to read mode without altering the contents of memory.

• *Read ID.* Many nonvolatile memories, including the 28F256A, store bytes that identify device and manufacturer. Programming equipment that reads these identifiers can automatically select the recommended programming procedures. After writing 90h to the command register, reading address 00h returns the manufacturer's code (89h for Intel), and reading 01h returns the device code (B9h for the 28F256A).

ID codes don't take up space in the main memory array. They're accessed only by this special command (or by using the traditional EPROM identifying method of raising A9 to a high voltage and reading memory locations 00h and 01h).

Intel specifies a timed series of steps to take when erasing and programming its flash EPROMs. The programming procedure is a variation of Intel's Quick Pulse programming algorithm for UV-erasable EPROMs. In short, the algorithm programs each location and then reads it back to verify, with up to 25 tries allowed for each location before a programming failure is announced. In a new device, most locations should verify on the first or second try. After many program/erase cycles, programming and erasing may take longer.

The Quick Erase procedure uses similar steps, with up to 1,000 tries allowed. Figures 5 and 6 summarize the programming and erasing procedures. The specified delays in the procedures are minimums.

If you design a circuit that includes the ability to program flash EPROMs in-circuit, your software (or on-chip firmware) must follow the recommended algorithms. The following are some things to be aware of in programming and erasing 28F256A flash EPROMs, with other devices having similar requirements.

As with UV-erasable EPROMs, you can program the bytes in any order, and you don't have to program the entire device at once. But once a bit has been programmed to 0, you can't change it back to a 1 unless you erase the entire device and start over.

You can leave the 12-volt dc programming supply applied for the entire erasing and programming process. You can even leave +12 volts applied to V_{PP} when you use the device as read-only memory, although this makes it easier to accidentally overwrite the stored data. The program and erase commands, not the programming voltage, control programming and erasing.

The 12-volt dc source can be any regulated supply between 11.4 and 12.6 volts. The 28F256A requires 30 mA (maximum) for programming. If

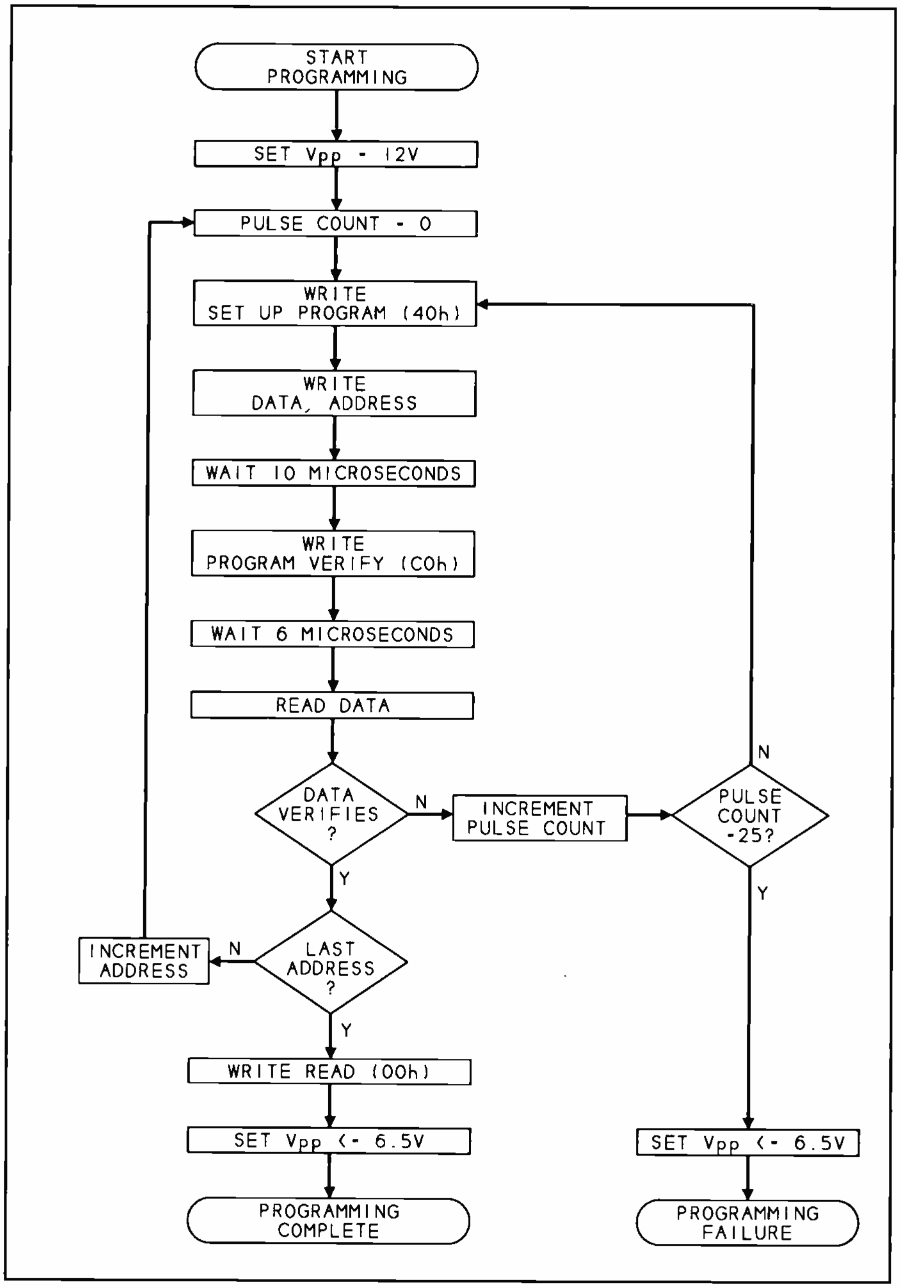


Fig. 5. Flow chart of Intel's Quick Pulse programming algorithm for flash EPROMs.

your circuit already contains a regulated 12-volt supply, you can use it. If not, there are several single-chip converters that generate a 12-volt supply from 5 volts. Maxim has a variety of these, including the MAX661, which outputs 30 mA at 12 volts and requires no inductors, just five additional capacitors.

Never leave open the V_{PP} pin when V_{CC} is applied. If you plan to disconnect the 12-volt supply after programming, connect a 10,000-ohm or larger-value resistor from V_{PP} to ground.

The 28F256A returns to its read-only mode whenever V_{PP} is less than or equal to 6.5 volts. In read-only mode, the value of V_{PP} isn't critical. In fact, it can be as low as 0 volt.

On the circuit board, for each flash EPROM, place a 0.1-µF ceramic capacitor between V_{CC} and GND, and another between V_{PP} and GND. Locate these capacitors as close as possible to the pins to which they connect. Also, include one 4.7-µF capacitor for each eight devices, locating it near the power-supply connection.

Obtain and read the data sheet for any flash EPROM you're using. Data sheets contain much more information than I can include here, and specifications may vary from manufacturer to manufacturer.

Intel's *Memory Products* data book (No. 210-830-011; $21.95) contains many application notes, engineering reports and article reprints on flash memory, including a 45-page designer's guide to hardware and software for in-circuit programming, and a guide to designing universal memory sites. AMD's CMOS Memory Products (No. CMEM; no charge) also includes applications information.

Uploading Programs

With Fig. 5 and Fig. 6 to guide you, use assembly language, C, BASIC or just about any programming language to write a program that copies data to a flash EPROM from RAM, a port or another memory location. But this isn't enough if you want to upload an assembled or compiled program from a personal computer directly into flash memory on a microcontroller board or other single-board computer.

The missing link is a loader program that receives a file from a personal computer and programs it into the flash EPROM. With this ability, you have a complete development system that can load programs, operating parameters, data or whatever you wish into flash EPROM.

Motorola's 68HC11 microcontroller has a special bootstrap mode that enables easy loading of programs into RAM on power-up. Minotaur Systems takes advantage of this in its F1-KIT microcontroller-board kit. The board uses bootstrap mode to upload a short program that, in turn, programs a flash EPROM with data received at the HC11's serial port.

The F1-KIT contains: a bare printed-circuit board and components to be soldered, including a 68HC11-F1FN microcontroller, 28F256A FLASH EPROM, 32K-byte static RAM, and MAX232 serial interface; DL.COM communications software to upload programs to the HC11's internal RAM or EEPROM or external flash EPROM; Motorola's A11 freeware cross-assembler for assembling HC11 programs on IBM-compatible computers; a sample program for testing file uploading and flash programming; and assembly and operating instructions.

To use the F1-KIT, you must provide the time and labor to solder components to the board; a personal IBM/compatible computer and serial cable, for running DL.COM; regulated 5- and 12-volt power supplies, or use unregulated supplies and solder 7805 and 7812 voltage regulators to the pads provided on the pc board.

After soldering the parts to the pc board and installing socketed components, connect the F1-KIT's serial connector to your personal computer's serial port and run DL.COM on your PC to enable serial communication. Then set the F1-KIT's jumpers so that the HC11 powers up in its bootstrap

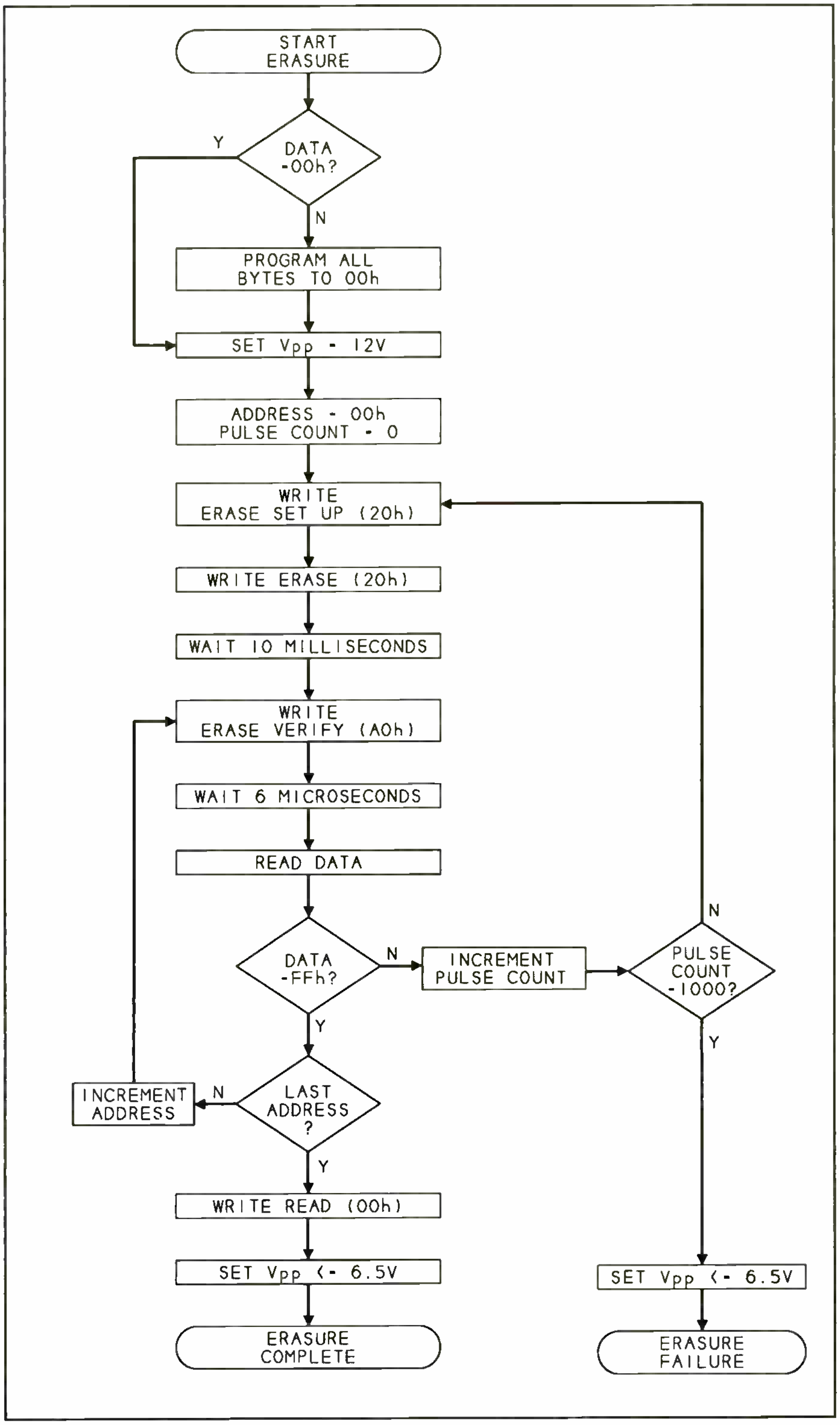


Fig. 6. Flow chart of Intel's Quick Erase algorithm for flash EPROMs.

Sources

AMD (Advanced Micro Devices, Inc.)
901 Thompson Pl.
Sunnyvale, CA 94088
Tel.: 1-800-222-9323 or 408-749-5703
CIRCLE NO. 100 ON FREE INFORMATION CARD

Arrow Electronics, Inc.
Catalog Div.
1860 Smithtown Ave.
Ronkonkoma, NY 11779
Tel.: 1-800-932-7769; fax: 516-585-0878
CIRCLE NO. 101 ON FREE INFORMATION CARD

Intel Books
P.O. Box 7641
Mt. Prospect, IL 60056-7641
Tel.: 1-800-548-4725 or 408-765-1596
CIRCLE NO. 102 ON FREE INFORMATION CARD

Jameco
1355 Shoreway Rd.
Belmont, CA 94002
Tel.: 1-800-831-4242 or 415-592-8097; fax: 1-800-237-6948
CIRCLE NO. 103ON FREE INFORMATION CARD

L.S. Electronic Systems Design
2280 Camilla Rd.
Mississauga, Ontario L5A 2J8 Canada
Tel./fax: 416-277-4893
CIRCLE NO. 104 ON FREE INFORMATION CARD

Maxim Integrated Products
120 San Gabriel Dr.
Sunnyvale, CA 94086
tel.: 408-737-7600
CIRCLE NO. 105 ON FREE INFORMATION CARD

Minotaur Systems
4241B Valley Rd
Drexel Hill, PA 19026
CIRCLE NO. 106 ON FREE INFORMATION CARD

Newark Electronics
4801 N. Ravenswood Ave.
Chicago, IL 60640-4496
Tel.: 312-784-5100
CIRCLE NO. 107 ON FREE INFORMATION CARD

Unicorn Electronics
10010 Canoga Ave. Unit B-8
Chatsworth, CA 91311
Tel.: 1-800-824-3432; fax: 818-998-7975
CIRCLE NO. 108 ON FREE INFORMATION CARD

mode. Connect the power supplies to appropriate terminals on the board and power up.

On power-up in bootstrap mode, the HC11 runs a small program stored in its internal ROM. This program initializes the on-chip serial communications interface (SCI) and waits for a program in S-record format to arrive at the serial port.

DL.COM then sends the program EEPROG1Y over the serial link to the HC11. The HC11 copies the received program into internal RAM and then executes the program. EEPROG1Y is similar to the original program that the HC11 ran on power-up, except that it copies data from the serial port into the flash EPROM, instead of to internal RAM. The F1-KIT uses three port pins on the HC11 to control the EPROM's Write Enable, Chip Enable and Output Enable inputs.

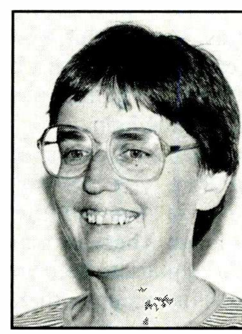
After the HC11 executes the loaded program, you use DL.COM to send your assembled or compiled program to the F1-KIT's flash EPROM. When the flash EPROM is programmed, you set jumpers to place the HC11 to expanded mode and reboot to run your program.

EEPROG1Y is an adaptation of Motorola's freeware EEPROG1Y, which copies programs into the HC11's internal EEPROM. EEPROG1Y has this capability as well. If you prefer the 8051 microcontroller family, L.S. Electronic Systems has two 8031 boards that use flash memory. The DG31F ($110) contains a 28F256, and the EMC32F ($72) has a 28F001BX-B.

Each board includes a serial port and monitor program that provides a user interface for uploading and downloading files and programming and erasing the flash EPROM. In the DG31F, the monitor program is in UV EPROM, while the EMC32F stores its monitor in the boot block of flash EPROM. The DG31F also has an 8255 peripheral interface and supply-voltage supervisor circuits.

In addition to the assembled and tested versions, both boards are available at reduced prices as complete kits and bare boards with documentation but no components. Documentation includes hardware descriptions, schematic diagrams and even source code for the monitor program so you can see how it works and modify it if you wish. Many application examples for the boards are available, including a telephone pulse dialer with keypad entry, infrared remote-control system, EPROM programmer, EPROM emulator and others.

Next time, I'll discuss prototyping methods. Until then, you can contact me on Compuserve at 71163,3555, or by mail at P.O. Box 3374, Madison, WI 53704-0374. Questions and comments of interest to all may be published and answered in this space. For a personal reply by mail, please include a self-addressed, stamped envelope. ■


Jan Axelson

Coping with PC Problems

A roundup of hardware and software products that help you diagnose and repair PCs

By Joe Desposito

Personal computers are, for the most part, reliable machines. Like all electronic products, however, PCs sometime break down and require repair. But unlike other machines, servicing may be complicated because PCs are modifiable. That is, the computer you first buy can—and usually does—change and evolve by adding boards, memory chips, peripherals and so forth. Any time you decide to upgrade a PC, you may inadvertently introduce problems. As a result, you sometimes face a computer that isn't broken in the traditional sense but, nevertheless, needs diagnostic help.

When a PC needs repair of one sort or another, you probably require assistance in determining and solving the problem. There are many products in the marketplace to help you do this job better. For example, there are board-level products that plug into an expansion slot to diagnose PC problems, even if the computer is completely dead. There are also software programs that delve into many areas of your system and report on the results so long as the machine can be booted up to load the program. Furthermore, many computers have limited built-in diagnostic programs, many of which also require that the machine be bootable.

In this two-part special feature, *ComputerCraft* takes a look at 22 products you can use to diagnose and repair PCs. Eight of them are hardware products you add to a PC to reveal its problems. Six others are software products you can use to diagnose hard-to-resolve problems on PCs that are capable of booting up and displaying information on a monitor. Each group is examined here in separate installments. The subject of this first installment is hardware products. Next month, we'll finish up with software products, including programs that handle *Windows* as well as DOS problems.

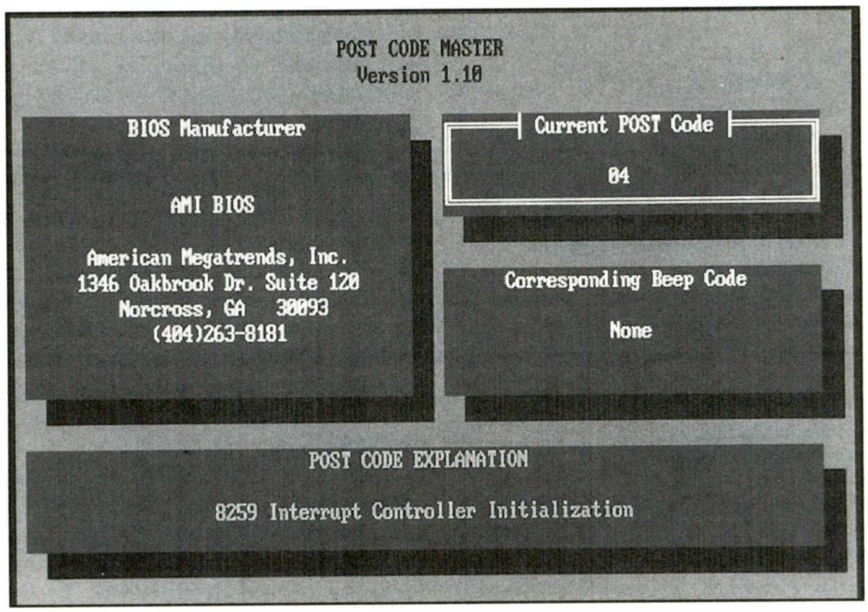


Fig. 1. POST Code Master includes POST codes on disk as well as in manual.

Board-Level Diagnostics

With the right hardware or software, a computer itself can diagnose many problems that prevent it from working properly. In fact, many computers have built-in diagnostics, contained in a ROM, that automatically step through a series of tests when the machine is turned on. You might observe it working as you stare at a blinking cursor while it makes these checks or by rapid display of user memory amounts checked from zero to total. After this delay, your computer loads the operating system.

This POST (power on self test) calls out defects, if present, by displaying an error code and very brief message on-screen, as well as by issuing an audio beep code. At this time, the system halts and you can't use the computer for meaningful work until the problem is corrected. If you get a POST error code, write it down quickly because a screen refresh often eradicates its on-screen presence.

In general, the POST routine examines the microprocessor, memory, keyboard interface, video signals and drive status. Some computer makers also provide a supplementary diagnostic disk to check a variety of other considerations, such as a math coprocessor, mouse port and so on. Many PCs also have an extra built-in diagnostics program that prompts you to choose the option when

AT Test Suite

```
U74 CPU Registers and
 Logic
U27 Landmark/SuperSoft ROM
 A Checksum
U47 Landmark/SuperSoft ROM
 B Checksum
U103 8254 Timer Channel 0
U103 8254 Timer Channel 1
U103 8254 Timer Channel 2
U111 8237A DMA Controller
 1
U122 8237A DMA Controller
 2
U124 74LS612 DMA Page
 Registers
U126 8042 Parity Detected
16KB Critical Memory
 Region
Memory Refresh
Protected Mode CPU
U114 8259 Interrupt
 Controller 1
U125 8259 Interrupt
 Controller 2
Hot Interrupt
Interrupt Level 0
Real Time Clock Interrupt
Nonmaskable Interrupt
U76 Numeric Co-Processor
U126 Keyboard Controller
Keyboard Scan Lines
CMOS RAM Test
Floppy Controller
Floppy Drive Read
MDA Memory
CGA Memory
EGA/VGA Memory
System Memory to XXXXXX
Slow Refresh to XXXXXX
System BIOS
CMOS RAM Configuration
```

Fig. 2. At Test Suite of Landmark's AT Rom POST.

the machine is powered up. These are generally limited to basic check-outs of hard- and floppy-disk drives, keyboard, video and adapter, and serial communication and printer adapters. Some computers also self-correct configurations when a new, different device is added.

If the foregoing isn't available on your computer or they're too limited to guide you toward isolating the PC's problem, a hardware diagnostic board (or software diagnostic program, covered) may provide you with the troubleshooting weapon you need to solve the dilemma.

Hardware diagnostic boards, examined here, include models specifically designed to provide information about an MS-DOS-type personal computer that essentially doesn't start up, and to attack other problems. Perhaps you turn on the power and very little occurs. You may hear the faint hum of a fan or see an LED turn on, but nothing else. Maybe the blinking cursor doesn't appear and you're looking at a totally blank screen. Perhaps the computer doesn't emit its reassuring beep that lets you know everything is functioning properly. Whatever the symptom of a dead PC, it's difficult to get started beyond checking your ac wall outlet.

The particular attraction of hardware diagnostic boards is their claimed ability to properly diagnose a PC computer problem when the machine's POST code doesn't even appear for one reason or another.

We look here at a bevy of diagnostic hardware models—boards and ROMs—to find out if these products really work in such situations and what differentiates one from the other. We gathered eight such products from seven companies. These are in ascending prices: Post Code Master ($59) from MicroSystems Development; PC Fixer $119.95) from Sibex, Inc.; Pocket Post ($199) from Data Depot; AT ROM POST ($199) from Landmark; WindsorPOST ($395) from Windsor Technologies; POST Probe ($399) from Micro-2000, Inc.; KickStart 2 ($599) from Landmark; and R.A.C.E.R. II ($649) from Ultra-X, Inc. All of these products work on AT-, 386- and 486-class ISA and EISA bus computers, excepting WindsorPOST which isn't designed for 486 computers. Most also work on PC-class computers, and one works with MicroChannel-bus designs.

Testing Diagnostic Hardware

To test these eight diagnostic products, we pulled out seven old PC, AT and 386 computers of various makes and models from our PC morgue. These computers were pronounced dead many months ago and thrown into a heap. Since no one could recall the circumstances of their ruin, we had no clues t0 guide us in repairing these FCs.

When we closely examined each computer, three needed only minor work to bring them back to life. On these computers, the diagnostic boards weren't used to solve the problem. Thus, it's important to realize that many "broken" PCs can be fixed through inspection, board swapping or other conventional troubleshooting techniques.

Having eliminated the obvious, we were left with with four dead computers—all AT-class machines. Computer 1 was an ITT Xtra 286 ATW with a proprietary BIOS; Computer 2 was an AST Premium 286 with an Award BIOS; Computer 3 was a clone called the Challenger AT with a Phoenix BIOS, which had two chips missing on the system board (the MC146818 clock chip and 8254-2 timer chip); and Computer 4 was a clone without a name whose BIOS was missing. Obviously, these are especially tough dogs to troubleshoot.

Before we enter into details of how well each diagnostic product performed and what each offers, we want to give you an overview of this field.

The overwhelming sentiment expressed by company representatives we spoke to about their diagnostic hardware products was this: These products are meant to save you time. They should help you decide, in a few minutes, whether or not to repair the system board of a computer or throw it away. Keep in mind that with 286 system boards selling for as little as $50, it's not worth spending much time troubleshooting a problem. Even if you can single out which chip caused the failure, it may not be worth the effort to desolder and replace the chip. Why go through this hassle with a clock chip or system RAM on an original IBM PC, which are soldered into place?

If a chip is socketed, however, as are most CPUs and many support ICs, replacement can be a simple task. One manufacturer, Micro-2000, told us that this isn't the case with IBM MicroChannel motherboards. With some motherboards, costing as much as $1,500, it's indeed worth the time to repair, rather than replace. Consequently, Micro-2000's $399 Post Probe has an add-on attachment for MicroChannel computers.

Whereas software diagnostic tools require that most of the system be operable, especially the floppy-disk drive from which its program is loaded, a hardware diagnostic product can often ferret out problems even though the system appears dead. Some hardware diagnostics need a working power supply, but others have indicators that tell you if the power supply is working and whether or not it's operating within accepted tolerances.

Diagnostic hardware products differ significantly in the signals they monitor. Signals generally monitored are power supply (+5, –5, +12 and –12 volts), ALE, clock, oscillator, I/O read and write, memory read and write, and reset. An Ultra-X spokesman, whose R.A.C.E.R. II board (the highest-priced one we examined) doesn't monitor clock and oscillator signals, said that these signals are best monitored with an oscilloscope.

Most of the products reviewed here display POST (power-on self-test) codes. Keep in mind that some computers, such as those that use the DTK BIOS, don't display these codes. If you're trying to fix one of these, the diagnostic product must necessarily give you more information than POST codes to be effective.

Good documentation isn't always critical for many products. For most of these diagnostic products, however, good documentation is crucial to the troubleshooting process. After a product issues a POST code, for example, you need the documentation to explain the code and point you to the offending chip or other defect. If the documentation doesn't do it, you have to telephone the company's technical support team. We found that technical support often fills in the gaps left by the documentation, though it may be time-consuming and add the cost of one or more long-distance phone calls to the cost of a repair. Excellent documentation, therefore, saves you time in tracking down problems and money.

The products reviewed here range in price from about \$60 to more than \$600. This gives you an indication of who these products are aimed at. The less-expensive models are for end users who want to troubleshoot their own PCs. The more-expensive ones are for professional technicians. Of course, a question arises as to the worth of a product in performing its assigned task. No matter how inexpensive a product may be, you still expect it to help you fix your PC. And if an inexpensive product provides a solution, why do you need to buy a product that costs ten times more? Our reviews should give you some answers to this question.

Finally, some words need to be said about the products chosen for review in these pages. The criterion we used is this: Each product must be a general hardware diagnostic tool that works with ISA bus computers running under MS-DOS. Each company was asked to provide one product model for this roundup, except for two diverse models from Landmark. Most companies do sell a range of diagnostic products, both hardware and software, for DOS-based PCs and other platforms.

Hardware Diagnostic Technology

Many of the diagnostic products reviewed here make use of POST codes to do their job. POST codes are embedded in the ROM BIOS of most IBM AT and compatible computers. As a computer begins to boot up, the microprocessor sends these two-digit hexadecimal codes to a designated port address. By monitoring this address, a POST-type diagnostic board can display the code on two seven-segment displays. Whenever an error occurs during the power-on self test, the ROM BIOS stops issuing codes. The POST board captures the code that caused the error and displays it.

To decipher the code, you must know the error message assigned to it by the manufacturer of the ROM BIOS. The meaning of the error code isn't necessarily stored in the ROM, although many machines do provide error messages along with it. If an error message isn't provided, you'll have to get it from another source, such as the manufacturer of the ROM BIOS. Boards that employ these POST codes should include the meanings in their product manuals, of course.

Some manufacturers of diagnostic products include their own ROMs, which issue unique codes or perform unique tests. In addition, the test suite isn't limited to the tests performed by the system's ROM BIOS. Products of this type can, and usually do, display more information than a simple two-digit hexadecimal code. A full-screen display is the norm, if available, or else the product may emit beeps or send the results to a printer.

WindsorPOST Tests

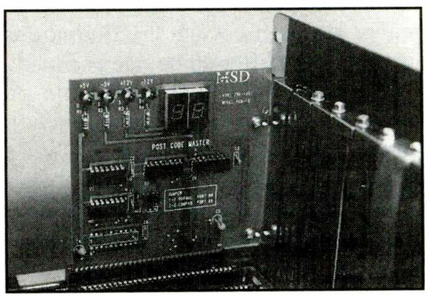
```
1-80286 Microprocessor
2-DMA 74LS610 Page Register
3-8254 T0
4-8254 T1
5-8254 T2
6-8237 DMA0
7-8237 DMA1
8-Keyboard Interface
9-Keyboard Input
10-Refresh Timing
11-Dynamic RAM Refresh
12-Port B Parity and
Speaker Control
13-CMOS RTC Battery
14-CMOS RTC Checksum
15-CMOS RTC Memory
16-Master 8259 Interrupt
Controller
17-Slave 8259 Interrupt
Controller
18-Speaker
19-Interrupt
20-Interrupt
21-Interrupt
22-31 0-704K System RAM
32-35 Monochrome Video
36-37 Color Graphics
Adapter (CGA) Video
```

Fig. 3. WindsorPOST battery of 37 tests for an 80286 based copmputer.

Hardware Product Evaluations

POST Code Master

(MicroSystems Development; \$59)



POST Code Master is half the price of its nearest competitor. The board displays

POST codes and has LEDs for ±12 and ±5 volts. An on-board jumper lets you switch between the normal setting of port 80 and the Compaq setting of port 84 for POST codes. To install the board, you just plug it into an expansion slot on the computer.

Documentation is a 23-page manual that includes the POST code meanings for two versions of the AMI BIOS, the Award Modular BIOS, the Chips & Technologies BIOS, the IBM AT BIOS, the Microid Research BIOS, the Mylex 386 System BIOS, the Phoenix BIOS, and the Quadtel AT compatible BIOS. There's just a single page of general troubleshooting information. To reach technical support, you call the company's general number.

POST Code Master is the only one of these products to include POST codes on-disk as well as in the manual (see Fig. 1). This database of codes went beyond the manual to include codes for Compaq. The software is simple to use. You enter the POST code number for the appropriate BIOS, and the software provides an explanation of the code, which is the same as those in the manual. Explanations sometimes direct you to the chip-level source of the problem and sometimes not.

When using POST Code Master on our four test machines, we obtained the following results. For Computer 1, POST Code Master issued a POST code of 00, but there was no way to interpret it, since the ITT BIOS is proprietary.

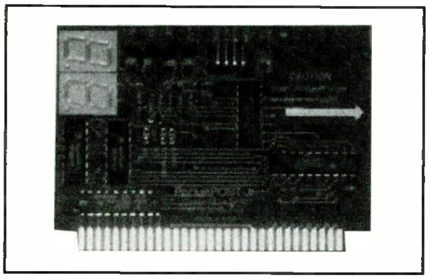
For Computer 2, we obtained a code that wasn't on the Award BIOS list. For Computer 3, we obtained a 02 POST code for the Phoenix BIOS. According to the manual, the explanation for this code is "CMOS Write/Read Failure." This kind of general explanation forces you to call the company's tech support line, unless you've experienced the problem before and know how to solve it. When we called Micro-Systems Development's tech support line, the person we spoke to correctly identified the MC146818 clock chip as the culprit.

After inserting this chip, the POST Code Master gave us an 04 code. In this case, the manual explained this code as "Programmable Interval Timer Failure." Again, a call to technical support indicated the likely chip to be the 8254-2, which was correct. The Post Code Master couldn't be used to diagnose problems with Computer 4, since there were no BIOS chips in it. The card showed that the power supplies of all four computers were operating.

Conclusion: Post Code Master is an affordably priced diagnostic tool targeted at the end user. Because the manual isn't so thorough that you can solve every problem on your own, you'll likely need the assistance of MicroSystems Development's support staff. This is a long-distance toll call for anyone who isn't in the 408 area code. With the assistance of tech support, Post Code Master helped in reviving one of the four dead computers we had on hand.

PC Fixer

(Sibex, Inc.; $119.95)



PC Fixer is a diagnostic board for IBM XT, AT, Compaq and compatible clone computers. It displays POST codes and has LEDs for ±12 and ±5 volts. The board has two sets of jumpers. One set lets you switch among XT, AT, Compaq and clone computers. The other lets you switch among OSC, ALE, CLK and IOR. One yellow LED is an indicator for all these options. To install the board, you just plug it into an expansion slot on the computer's bus.

Documentation is a 42-page mini-size manual that includes POST code meanings for two versions of the AMI BIOS, the Award XT and AT BIOS, the IBM AT BIOS, the Phoenix BIOS and the Compaq BIOS. Additionally, there's information for the IBM XT regarding beep and error codes. The documentation also includes troubleshooting hints, a troubleshooting chart and repair suggestions. To reach technical support, you call the company's general number.

In addition to the board, Sibex also includes Landmark's *PC Certify* software in the package. *PC Certify* is basic diagnostic test software for IBM PC, XT, AT, PS2 and compatibles.

When we used PC Fixer on our four test machines, we obtained the following results. For Computer 1, PC Fixer issued a POST code of 00, but there was no way to interpret it due to the proprietary ITT BIOS. For Computer 2, we obtained a code that wasn't on the Award BIOS list.

For Computer 3, we obtained a 02 POST code for the Phoenix BIOS. According to the manual, the explanation for this code is "CMOS RAM failed, check battery; check setup configuration." This explanation didn't pinpoint the problem of the missing timer chip. However, a call to tech support indicated the MC146818 chip could be the problem, which was correct.

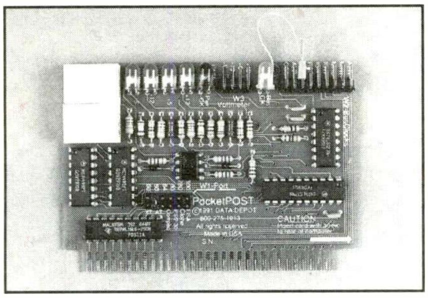
After inserting the MC146818, PC Fixer gave an 04 code. In this case, the manual explained this code as "Programmable Timer Failure." Again, a call to tech support indicated the likely chip to be the 8254-2, which was correct. (This was the same set of events that occurred with the Post Code Master).

The PC Fixer could not be used to diagnose problems with Computer 4, due to the lack of BIOS chips in this machine. For all systems, the PC Fixer indicated that power supplies were working and the condition of the CLK, OSC, ALE and IOR signals.

Conclusion: PC Fixer is an affordably priced diagnostic tool targeted at end users and service technicians. Because the manual isn't so thorough that you can solve every problem on your own, you'll likely need the assistance of the Sibex support staff. This is a long-distance toll call for anyone who isn't in the 813 area code. With the assistance of technical support, the PC Fixer helped in reviving one of the four dead computers.

Pocket POST

(Data Depot; $199)



Pocket POST is a diagnostic board for IBM XT, AT, Compaq, PS/2 Model 30 and compatible clone computers, as well as EISA-bus computers. It displays POST codes and has LEDs for ±12 and ±5 volts and Pwr OK. The board has three sets of jumpers. One set lets you switch among XT, AT, Compaq, PS/2-30, clone and EISA-bus computers. Each jumper setting switches to a different port setting, which is labeled on the board.

Another set of jumpers lets you switch among OSC, ALE, CLK, REF (memory refresh), IOR, IOW, MRD, MWR and AEN. One yellow LED is an indicator for all of these options.

The third set of jumpers lets you find out if power-supply voltages are within 10% of their rated values. As you switch from jumper to jumper, the red Pwr OK LED lights if voltage is sensed to be within 10% of the rated value.

To install the board, you simply plug it into an expansion slot on the computer.

Documentation is a 180-page pocket-size manual that includes POST code meanings for three versions of the AMI BIOS, three versions of the Award BIOS, the Chips & Technologies BIOS, the Eurosoft/Mylex BIOS, the Faraday A-Tease BIOS, the IBM AT and PS/2 BIOS, the Landmark AT JumpStart BIOS, the Microid Research BIOS, two versions of the Olivetti BIOS, the Phoenix BIOS, two versions of the Quadtel BIOS and two Compaq BIOS versions.

Information is included in the manual for the IBM XT regarding beep codes and error codes and there's a listing of IBM display diagnostic codes and their meanings. The documentation also includes troubleshooting hints, connector data and a glossary.

To reach technical support, you call the company's toll-free 800-275-1913 number. In addition to the board, Data Depot also includes Landmark's *PC Certify* software in the package.

When we used Pocket POST on our four test machines, we obtained the following results. For Computer 1, Pocket POST issued a POST code of 00, but there was no way to interpret it, due to the proprietary ITT BIOS. For Computer 2, we obtained a code that wasn't on the Award BIOS list.

For Computer 3, we obtained a 02 POST code for the Phoenix BIOS. According to the manual, the explanation for this code is "CMOS write/read test failed." This explanation didn't pinpoint the problem of the missing timer chip. However, a call to tech support indicated the MC146818 chip could be the problem, which was correct. After inserting this chip, the Pocket POST gave an 04 code, which the manual explained as "Programmable Interval Timer Failure." Again, a call to tech support indicated the likely chip to be the 8254-2, which was correct. The same sequence occurred with the two previous boards examined.

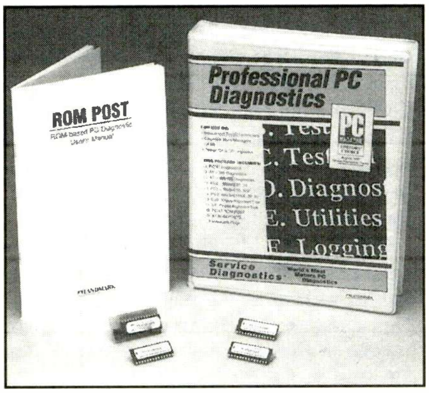
The Pocket POST couldn't be used to diagnose problems with Computer 4 due to the lack of BIOS chips in this machine. For all systems, the Pocket POST indicated that power supplies were working and the condition of CLK, OSC, ALE, REF, IOR, IOW, MRD, MWR and AEN signals.

Conclusion: Pocket POST is a medium-priced diagnostic tool targeted at service technicians. Since the manual isn't so thorough that you can solve every problem on your own, you'll likely need the assistance of the Data Depot support staff. This is a toll-free call. With assistance of technical support, the Pocket POST helped to get one of the four dead computers operational again.

When speaking with the Data Depot representative, we were told that the company is working on an expert system for the Pocket POST that works under *Windows* 3.1. The program is supposed to tell what the POST code means and which chip is causing the problem and is slated to be bundled with Pocket POST.

AT ROM POST

(Landmark Research International; $199)



Unlike the other products reviewed here, AT ROM POST isn't a similar general-purpose diagnostic board. Rather, it's simply special diagnostic ROMs for IBM AT and compatible computers. For XT-type computers, Landmark sells XT ROM POST for $99. If you purchase both the AT and XT ROM POST, the cost is $249.

To install AT ROM POST, you remove the existing ROMs in the computer and replace them with the Landmark ROMs. (AT ROM POST is a two-chip set, but Landmark also offers a one-chip version.)

Documentation is a 42-page manual that explains the tests AT ROM POST performs and tells you what to do when a test fails. If you have any trouble interpreting the tests, you can call Landmark tech support toll-free at 800-683-0854.

To use AT ROM POST for testing, Landmark recommends a working graphics adapter and display. If the display isn't working, AT ROM POST emits beeps for any failing test. We followed the recommendations and tested AT ROM POST with a monochrome/graphics display adapter and monochrome display.

AT ROM POST tests a computer with 32 separate tests, called the AT Test Suite. These tests, shown in Fig. 2, are displayed on the monitor while in progress, and a pass or fail is noted after the test is finished.

The AT ROM POST gave the following results on our four test machines. For Computer 1, no response was obtained—nothing displayed on the monitor. For Computer 2, AT ROM POST displayed the test suite on the monitor. This is the only product of the eight reviewed here that gave any useful information about this system! The system passed the first 12 tests and then hung on test 13, "Protected Mode CPU."

The manual suggested, "If a failure occurs in this test, try replacing the CPU and observe results." We replaced the CPU, to

V-ATE *plus*: More Diagnostics for More Dollars

Though not reviewed here, there are other more-capable—and more-expensive—diagnostic products for PC, XT, AT and EISA computers. One is V-ATE *plus* from Vista Microsystems, Inc. This product is a redesign of the original V-ATE diagnostic board. V-ATE offered diagnostics for AT/compatible computers; V-ATE *plus* adds compatibility with XT and EISA computers as well.

Using an on-board 8051 microprocessor, V-ATE *plus* fully exercises *all* signals that pass over the bus. Some of those tests include: bus mastership emulation; DMA Channels 0 through 7 emulation; IOCHCK and IOCHRDY emulation; zero-wait-state emulation; Address Bus 0 through 24 loopback; Data Bus 0 through 15 loopback; Interrupt 0 through 15 emulation; IOCS16 and MEMCS16 emulation; and voltage monitoring with noise detection.

V-ATE *plus* can run in stand-alone mode, or it can be controlled from a second PC running Vista's *V-CON* diagnostic software. The V-ATE *plus* board fits into a 16-bit expansion slot on the computer system under test. It has a metal shield and ruggedized bus connectors. Two on-board ports let you make a standard serial connection to the controlling PC and connect the board to the keyboard connector of the test system. In addition to the wide variety of built-in tests, you can download your own test code or customize the V-ATE board with library functions available from Vista.

The advanced models of the V-ATE board include logic analysis hardware controlled by the *V-CON* software. *V- CON* can display analyzer data as waveforms, state information and disassembled instructions. The waveform display shows 20 signals at a time. It looks and acts like a traditional logic analyzer display. The state display is a listing of samples that shows the state of key signals for each sample point. The disassembler can filter out certain bus transactions to aid in understanding the data.

V-ATE *plus* comes in three models. The V-ATE *plus* Field Service Inspection System includes the V-ATE 1000 Diagnostic Board and sells for $995. The V-ATE 2000 *plus* Manufacturing Test System includes the V-ATE 2000 Diagnostic Board, probes and on-board Deep Logic Analyzer (15 MHz by 2,048 samples) and sells for $1,495. The V-ATE 4000 *plus* Advance Manufacturing Test System includes the V-ATE 4000 Diagnostic Board, probes and an on-board Deep Logic Analyzer (25 MHz by 4,096 samples) and sells for $1,995. All products include *V-CON* software, cables, cable adapters and user's manual.

Vista Microsystems, Inc.
6 Whipple St.
North Attleboro, MA 02760
Tel.: 508-695-8459

CIRCLE NO. 167 ON FREE INFORMATION CARD

no avail. After replacement, we no longer got the AT ROM POST to display its tests on-screen.

For Computer 3, we obtained a display of the tests, which showed failure of the 8254 timer tests. Since this was the correct diagnosis, we inserted the 8254-2 chip into the board and ran the tests again. This time, the Test Suite continued up to test 13, "Protected Mode CPU," and began to recycle.

All tests passed, and there was no indication that the MC146818 clock chip was missing. We spoke to a Landmark technician about this, who thought the program skipped the clock tests because it couldn't find the clock chip, which isn't necessary for the system to run.

Though Computer 4, which lacked a BIOS, could be checked with AT ROM POST, we obtained no response during the test. AT ROM POST doesn't check the power supply, but Landmark has other products that can do this.

Conclusion: AT ROM POST is a medium-priced diagnostic tool targeted at service technicians, manufacturers, distributors, dealers and educators. The manual is thorough enough that you can solve problems on

your own, but you may still need to call (toll-free) tech support for advice on interpreting certain actions related to the Test Suite.

The AT ROM POST gave information no other product gave about Computer 2, but it didn't completely solve the problem of Computer 3. Consequently, it didn't get any of the four dead computers completely operational again.

It's important to note that, when working with a product like AT ROM POST, ROMs are fragile. In conversations with Landmark, it was recommended that we use ZIF (zero-insertion-force) sockets for the ROMs. These sockets aren't provided with the product, nor is the advice about using them to be found in the manual.

WindsorPOST

(Windsor Technologies; $399)

Windsor POST, like AT ROM POST, isn't a diagnostic board, but special diagnostic ROMs for IBM XT, AT and 386 computers. To install WindsorPOST, you remove existing ROMs in the computer and replace them with the supplied Windsor ROMs. Windsor provides nine ROMs in all: a 128K 8088 ROM, two 128K 80286 ROMs, two 256K 80286 ROMs, two 128K 80386 ROMs and two 256K 80386 ROMs. Each is mounted in reliable machine-screw solder-tail sockets.

Documentation is a 24-page manual that explains the tests WindsorPOST performs.

To use WindsorPOST for testing, Windsor recommends that you have a working graphics adapter and display. If the display isn't working, WindsorPOST sends its data to the printer port. We followed the recommendations and tested WindsorPOST with a monochrome/graphics display adapter and monochrome display.

WindsorPOST tests a computer with 37 separate tests. These tests are shown in Fig. 3. They're displayed on the monitor while in progress, and a pass or fail is noted after the test is finished.

WindsorPOST gave the following results on our four test machines. For Computer 1, we obtained no response. That is, nothing was displayed on the video monitor. For Computer 2, once again, we obtained no response.

For Computer 3, the display monitor indicated a failure of the 8254 timer tests. Since this was the correct diagnosis, we inserted the 8254-2 chip into the board and ran the tests again. This time, all RTC (real-time clock) tests and some related tests failed. Additionally, the test procedure hung up at the CMOS RTC interrupt test, after which we waited 10 minutes before shutting down.

Although the test pointed to the failure of the real-time clock, there was no indication that the MC146818 clock chip was at fault. The documentation also failed to pinpoint this or similar chips. If you don't already know the information, you have to call Windsor tech support to find out.

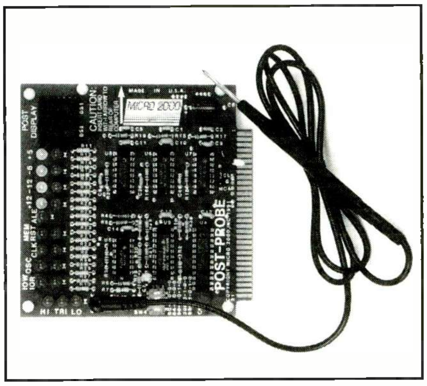
Computer 4, which lacked a BIOS, could be checked with WindsorPOST. However, there was no response. WindsorPOST doesn't check the power supply.

Conclusion: WindsorPOST is a high-priced diagnostic tool targeted at service technicians. The manual is sparse, and if you aren't well-versed in PC chip technology you'll have to call tech support for advice to help you interpret certain test results. WindsorPOST gave us no information on three of our test computers, but it solved completely the problem of Computer 3.

Windsor deserves credit for mounting its ROMs in high-reliability socket assemblies. This makes the ROMs relatively easy to insert and remove and almost completely wipes out the threat of damaging them.

POST Probe

(Micro-2000; $399)



POST Probe is a diagnostic board for all ISA, EISA and MicroChannel-architecture computers. It displays POST codes, has LEDs for ±12 and ±5 volts and four voltage pads that allow you to make measurements with a multimeter. A DIP switch on the board lets you select one of four port addresses. Other on-board LEDs indicate the presence of the following signals: IOW, IOR, OSC, ALE, CLK and MEM. One other LED, named RST, lights whenever a hardware reset of the system occurs.

POST Probe has two features that none of the other products have. One is a MicroChannel adapter card, the other a logic-probe board. A probe with a 3-foot-long cable plugs into a jack on the POST Probe card. Three on-card LEDs indicate HI, TRI and LO logic states.

To install the POST Probe card in an ISA- or EISA-bus computer, you simply plug it into an expansion slot. To install the POST Probe card in a MicroChannel computer, you first plug the MicroChannel adapter card into an expansion slot and then plug the POST Probe card into an ISA-bus connector on the adapter card.

Documentation is a 255-page manual that includes the POST code meanings for three versions of the AMI BIOS, four versions of the Award BIOS, the IBM AT and PS/2 (MCA) BIOS, the Hewlett-Packard BIOS, the Microid Research BIOS, two versions of the Phoenix BIOS, the Quadtel BIOS and three versions of the Compaq BIOS. Additionally, there's a listing of IBM display diagnostic codes and their meanings.

The documentation also includes troubleshooting techniques, pinouts for many of the chips that appear on system boards and a list of chip and BIOS manufacturers. One knock against the manual is the dearth of information regarding use of the built-in logic probe.

To reach tech support, you call the company's standard number.

The POST Probe card has a carrying case that sells for an additional $25.

When we used POST Probe on our four test machines we obtained the following results. For Computer 1, POST Probe issued a POST code of FF, but there was no way to interpret it, due to the proprietary ITT BIOS. For Computer 2, we obtained a code that wasn't on the Award BIOS list.

For Computer 3, we obtained a 02 POST code for the Phoenix BIOS. According to the manual, the explanation for this code is "CMOS RAM, battery." The manual further directed us to another part of the manual, which indicated the chip that caused the problem—the MC146818—which was correct. After inserting that chip, the POST Probe gave us a 04 code. In this case, the manual explained this code as "8353/4 Chip," which correctly identified the chip that caused the problem.

POST Probe couldn't be used to diagnose problems with Computer 4, due to its lack of BIOS chips.

For all systems, POST Probe indicated that power supplies were working and the condition of the CLK, OSC, ALE, IOR, IOW and MEM signals.

Conclusion: POST Probe is a high-priced diagnostic tool targeted at service technicians. The manual is very thorough. With it, you can probably solve every problem on your own, without having to resort to assistance of the Micro-2000 support staff. However, POST Probe, like most of the lower-priced competition, helped us to get just one of the four dead computers up and running again.

ComputerCraft Magazine's Connector Guide

This is the second in a continuing series of pull-outs that contain important and often hard-to-find data needed for understanding, maintaining, troubleshooting and repairing IBM PC and compatible computers ranging from the initial 8088-based PC to the latest-technology systems now in use. The first pull-out, which appeared last month in the February issue, provided tabular listings and pinout drawings for Serial, Printer and Mouse Ports and Video Interfaces. This time around, we focus on floppy-, hard-disk and SCSI interfaces.

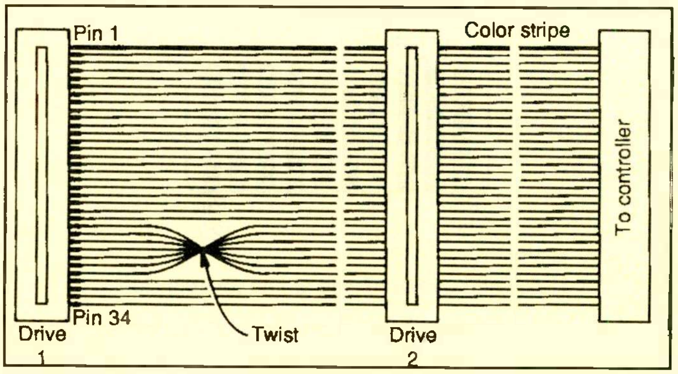
Disk-Drive Interfaces

Floppy and Hard Disk-Drive Interfaces

Floppy-Disk Drive A Interface
(34-Pin Edge Connector)

Pin	Signal	Signal Description
2	RPM/LC	Speed Select For Two-Speed Drives
4	N.A.	Not Used
5	Key	Missing Pin
6	N.A.	Not Used
8	INDEX	–Track Index
[10	MOTOR0	–Motor Enable Drive 0]
[12	FDSEL1	–Floppy Drive Select 1]
[14	FDSEL0	–Floppy Drive Select 0]
[16	MOTOR1	–Motor Enable Drive 1]
18	DIR	Direction
20	STEP	–Step
22	WDATA	–Write Data
24	WE	–Write Enable
26	TRK0	–Track 0
28	WP	–Write Protect
30	RDATA	–Read Data
32	HDSEL	Head Select
34	DSKCHNG	Diskette Change
1,3,7,9,11,13,15,17,19,21,23,25,27,29,31,33 Go To Ground		

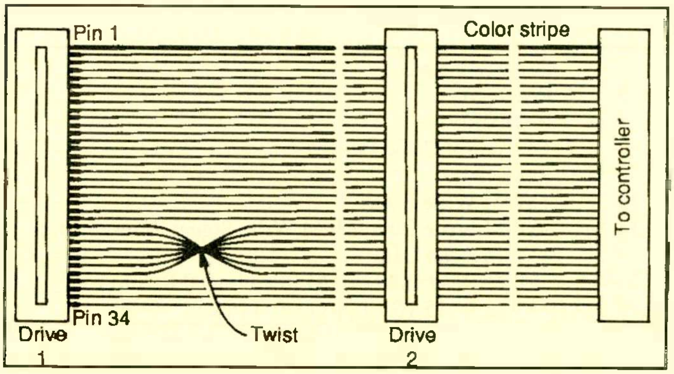
Single cable with two printed-circuit board edge connectors services both A and B floppy drives. Twist in cable changes pinout of control signals, making it simple to activate desired drive without affecting the other.



Floppy-Disk Drive B Interface
(34-Pin Edge Connector)

Pin	Signal	Signal Description
2	RPM/LC	Speed Select For Two-Speed Drives
4	N.A.	Not Used
5	Key	Missing Pin
6	N.A.	Not Used
8	INDEX	–Track Index
[10	MOTOR1	–Motor Enable Drive 1]
[12	FDSEL0	–Floppy Drive Select 0]
[14	FDSEL1	–Floppy Drive Select 1]
[16	MOTOR0	–Motor Enable Drive 0]
18	DIR	Direction
20	STEP	–Step
22	WDATA	–Write Data
24	WE	–Write Enable
26	TRK0	–Track 0
28	WP	–Write Protect
30	RDATA	–Read Data
32	HDSEL	Head Select
34	DSKCHNG	Diskette Change
1,3,7,9,11,13,15,17,19,21,23,25,27,29,31,33 Go To Ground		

Single cable with two printed-circuit board edge connectors services both A and B floppy drives. Twist in cable changes pinout of control signals, making it simple to activate desired drive without affecting the other.

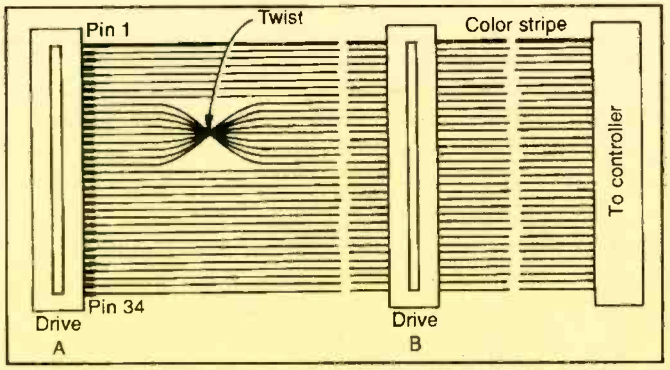


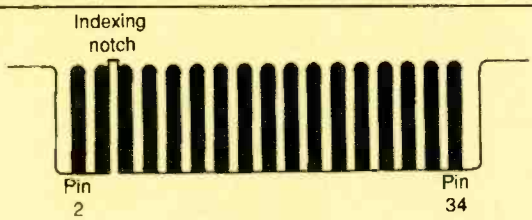
ST-506/412 Hard-Disk Drive Interface

(34-Pin Control-Cable Edge Connector)

Pin	I/O Status	Signal Description
1	I	–Head Select 8
3	I	–Head Select 4
5	I	–Write Gate
7	O	–Seek Complete
9	O	–Track 0
11	O	–Write Fault
13	I	–Head Select 1
15	N.A.	To Data Cable Pin 7
17	I	–Head Select 2
19	O	–Index
21	O	–Ready
23	I	–Step
25	I	–Drive Select 1
27	I	–Drive Select 2
29	I	–Drive Select 3
31	I	–Drive Select 4
33	I	–Direction In
2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34 Go To Ground		

ST-506/412 hard-disk drives interface to controller via 34-pin control and 20-pin data cables. Like floppy drives, twist in 34-pin cable changes control-signal pinouts so that two drives can be controlled from single cable. However, twisted area is wider, making floppy-drive and ST-506/412 cables non-interchangeable, though ST-506/412 cables are interchangeable with ESDI cables.





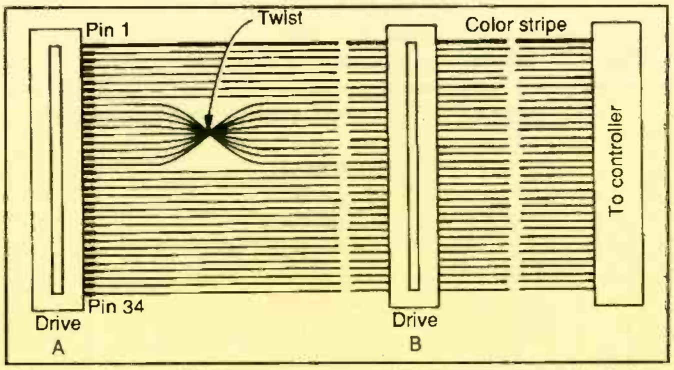
NOTE:
All odd-numbered pins are on reverse side.

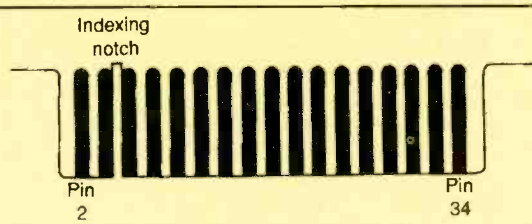
ESDI Hard-Disk Drive Interface

(34-Pin Control-Cable Edge Connector)

Pin	I/O Status	Signal Description
1	I	–Head Select 3
3	I	–Head Select 2
5	I	–Write Gate
7	O	–Configure/Status Data
9	O	–Transfer Acknowledge
11	I	–Attention
13	I	–Head Select 0
15	O	–Sector/Address Mark Found
17	I	–Head Select 1
19	O	–Index
21	O	–Ready
23	I	–Transfer Request
25	I	–Drive Select 0
27	I	–Drive Select 1
29	I	–Drive Select 2
31	I	–Read Gate
33	I	–Command Data
2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34 Go To Ground		

ESDI hard-disk drives interface to controller via 34-pin control and 20-pin data cables. Like floppy drives, a twist in 34-pin cable changes pinout of control signals so that two drives can be controlled from single cable. However, twisted area is wider, making floppy and ESDI cables non-interchangeable. ESDI and ST506/412 cables are interchangeable.



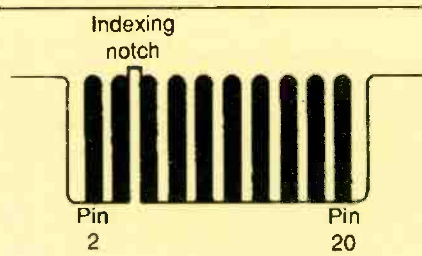


NOTE:
All odd-numbered pins are on reverse side.

ST-506/412 Hard-Disk Drive Interface

(20-Pin Data-Cable Edge Connector)

Pin	Signal Description
1	Drive Selected
3	Reserved
5	Reserved
7	To Control Cable Pin 15
9	Reserved
13	+MFM Write Data
14	–MFM Write Data (MFM Write Signal Return Line)
17	+MFM Read Data
18	–MFM Read Data (MFM Read Signal Return Line)
2,4,6,8,9,10,11,12,14,15,16,19,20 Go To Ground	



NOTE:
All odd-numbered pins are on reverse side.

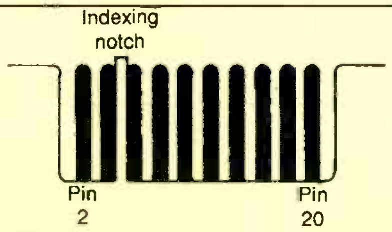
See note at end of ST-506/412 Hard-Disk Interface control-cable table for details.

ESDI Hard-Disk Drive Interface

(20-Pin Data-Cable Edge Connector)

Pin	Signal Description
1	–Drive Selected
2	–Sector/Address Mark Found
3	–Command Complete
4	–Address Mark Enable
5	Step Mode (Reserved)
7	–Write Clock Return Line
8	+Write Clock
9	Cartridge Changed
10	+Read/Reference Clock
11	–Read/Reference Clock Return Line
13	+NRZ Write Data
14	–NRZ Write Data Return Line
17	+NRZ Read Data
18	–NRZ Read Data Return Line
20	–Index
6,13,15,16,19 Go To Ground	

See note at end of ESDI Hard-Disk Drive Interface for further details.



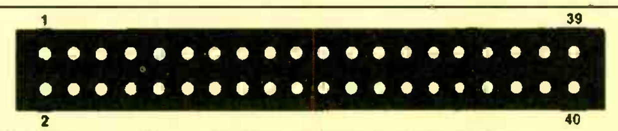
NOTE:
All odd-numbered pins are on reverse side.

IDE Hard-Disk Drive Interface (For PC/XT)

(40-Pin Dual In-Line Berg Connector)

Pin	Signal	Signal Description
1	Reset	-Reset
3		D7 Data Bit 7
5		D6 Data Bit 6
7		D5 Data Bit 5
9		D4 Data Bit 4
11		D3 Data Bit 3
13		D2 Data Bit 2
15		D1 Data Bit 1
17		D0 Data Bit 0
20	Key	Pin Missing
21	AEN	Address Enable
23	IOW	I/O Write Data
25	IOR	I/O Read Data
27	DACK	DMA Acknowledge
29	DRQ	DMA Request
31	IRQ14	Interrupt Request From IDE
33	A1	Address Bit 1
35	A0	Address Bit 0
36	A2	Address Bit 2
37	–CSIFX	Drive Chip Select 0 (1F0 Through 1F7)
39	N.A.	Not Used
2,4,2,8,10,12,14,16,18,19,22,24,26,28,30,32,34,36,38,40 Go To Ground		

Because IDE control electronics is built into drive, no external controller is needed and drive generally just plugs into data lines on motherboard via a single cable. IDE interfaces exist for 16-bit PCs (80286 and later designs) and eight-bit PCs (8086 and 8088).

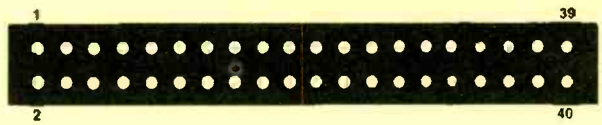


IDE Hard-Disk Drive Interface (For PC/XT)

(40-Pin Dual In-Line Berg Connector)

Pin	Signal	Signal Description
1	RESET	-Reset
3	D7	Data Bit 7
4	D8	Data Bit 8
5	D6	Data Bit 6
6	D9	Data Bit 9
7	D5	Data Bit 5
8	D10	Data Bit 10
9	D4	Data Bit 4
10	D11	Data Bit 11
11	D3	Data Bit 3
12	D12	Data Bit 12
13	D4	Data Bit 4
14	D13	Data Bit 13
15	D1	Data Bit 1
16	D14	Data Bit 14
17	D0	Data Bit 0
18	D15	Data Bit 15
20	KEY	Pin Missing
21	DMARQ	DMA Request
23	IOW	I/O Write Data
25	IOR	I/O Read Data
27	IORDY	I/O Channel Ready
28	ALE	Address Latch Enable
29	DMAC	DMA Acknowledge
31	IRQ14	Interrupt Request From IDE
32	–IOCS16	Current Data Transfer = 16 Bits
33	A1	Address Bit 1
34	PDIAG	Passed Diagnostics
35	A0	Address Bit 0
36	A2	Address Bit 2
37	–CS0	Drive Chip Select 0 (1F0 Through 1F7)
38	–CS1	Drive Chip Select 1 (3F6 Through 3F7)
39	ACTIVE	IDE Drive Active
2,19,22,24,26,30,40 Go To Ground		

See note at end of IDE Hard-Disk Drive Interface (For PC/XT) for more details.



SCSI Ports

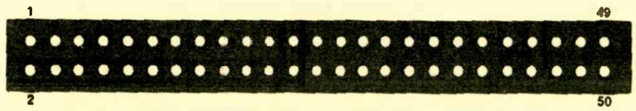
SCSI Single-Ended Interface

(50-Pin Connector, All Versions, Berg Shown)

Pin	Signal	Signal Description	Pin	Signal	Signal Description
2	DB0	Data Bit 0	44	SEL	Select
4	DB1	Data Bit 1	46	C/D	C/D
6	DB2	Data Bit 2	48	REQ	Request
8	DB3	Data Bit 3	50	I/O	Input/Output
10	DB4	Data Bit 4			
12	DB5	Data Bit 5			
14	DB6	Data Bit 6			
16	DB7	Data Bit 7			
18	DBP	Parity			
25	N.A.	Not Used			
26	TEMPWR	Terminator Power			
32	ATN	Attention			
36	BSY	Busy			
38	ACK	Acknowledge			
40	RST	Reset			
42	MSG	Message			

1,3,5,7,9,11,13,15,17,19,20,21,22,23,24,25,27,28,29,30,31,33,34,35,37,39,41,43,47,49 Go To Ground

Single-Ended SCSI cable can stretch up to 20 feet in length, while differential SCSI cable can reach lengths of 75 feet. Pinout numbering is same for all three different SCSI connectors.



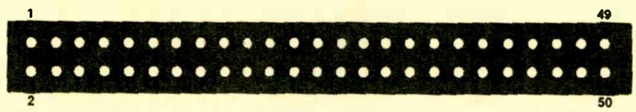
SCSI Differential Interface

(50-Pin Connector, All Versions, Berg Shown)

Pin	Signal	Signal Description	Pin	Signal	Signal Description
1	SG	Earth Ground (Shield Ground)	33	+BSY	Busy
2	GND	Ground	34	–BSY	Busy Twisted-Pair Return
3	+DB0	Data Bit 0	35	+ACK	Acknowledge
4	–DB0	Data Bit 0 Twistted-Pair Return	36	–ACK	Acknowledge Twisted-Pair Return
5	+DB1	Data Bit 1	37	+RESET	Reset
6	–DB1	Data Bit 1 Twisted-Pair Return	38	–RESET	Reset Twisted-Pair Return
7	+DB2	Data Bit 2	39	+MSG	Message
8	–DB2	Data Bit 2 Twisted-Pair Return	40	–MSG	Message Twisted-Pair Return
9	+DB3	Data Bit 3	41	+SEL	Select
10	–DB3	Data Bit 3 Twisted-Pair Return	42	–SEL	Select Twisted-Pair Return
11	+DB4	Data Bit 4	43	+C/D	C/D
12	–DB4	Data Bit 4 Twisted-Pair Return	44	–C/D	C/D Twisted-Pair Return
13	+DB5	Data Bit 5	45	+REQ	Request
14	–DB5	Data Bit 5 Twisted-Pair Return	46	–REQ	Request Twisted-Pair Return
15	+DB6	Data Bit 6	47	+I/O	Input/Output
16	–DB6	Data Bit 6 Twisted-Pair Return	48	–I/O	Input/Output Twisted-Pair Return
17	+DB7	Data Bit 7			
18	–FB7	Data Bit 7 Twisted-Pair Return			
19	+DBP	Parity			
20	–DBP	Parity Twisted-Pair Return			
21	DIFFSENS	Differential Sense			
25	TERMPWR	Terminator Power			
26	TERMPWR	Terminator Power			
29	+ATN	Attention			
30	–ATN	Attention Twisted-Pair Return			

22,23,24,27,28,31,32,49,50 Go To Ground

See note at end of SCSI Single-Ended Interface for details.



Cumulative Index

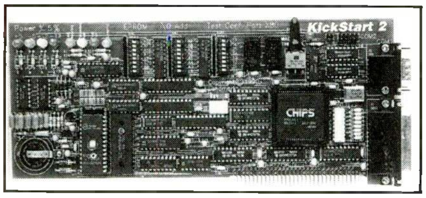
PC Diagnostic Boards

Features	AT ROM POST	KickStart 2	PC-Fixer	Pocket POST	POST Code Master	POST Probe	R.A.C.E.R. II	WindsorPOST
BIOS POST Code Listings								
AMI		x	x	x	x	x		
AMI 2.2x		x	x	x	x	x	x	
AMI AT/EISA				x		x	x	
Award XT						x		
Award XT 3.1			x	x		x		
Award AT 3.0x		x	x	x	x			
Award AT 3.1		x		x				
Award AT 3.3						x		
Award ISA/EISA 4.0				x		x	x	
Chips & Technologies				x	x		x	
Compaq			x	x	x	x		
Compaq Deskpro 286				x		x		
Compaq Deskpro 386s, 386s/20, 386/20e,386/25e				x		x		
Compaq Deskpro 386/33, 386/33L, 486/25, 486/33L						x		
Eurosoft 4.71				x				
Eurosoft/Mylex EISA				x				
Faraday A-Tease				x			x	
HP Vectra ES						x		
HP Vectra QS & RS						x		
IBM AT		x	x	x	x	x	x	
IBM PS/2				x				
IBM PS/2 (MCA)						x		
Landmark XT JumpStart				x				
Landmark AT JumpStart		x		x				
Landmark/SuperSoft PC/XT/AT				x				
Microid Research 1.0A		x		x	x	x		
Mylex 386		x			x			
Olivetti EISA 2.01				x				
Olivetti PS/2				x				
Phoenix XT						x		
Phoenix		x	x	x	x	x	x	
Quadtel 16K XT				x				
Quadtel AT 3.00		x		x	x	x		
Tandy 3000							x	
IBM XT Beep Code Listing			x	x				
IBM Diagnostic Display Error Code Listing				x		x		
POST Code 7-Segment Display		x	x	x	x	x	x	
LED Signals								
+5V, -5V, +12V, -12V		x	x	x	x	x	x	
Power OK				x				
OSC			x	x		x		
ALE			x	x		x		
CLK			x	x		x		
IOR			x	x		x		
IOW				x		x		
REF				x				
MEM						x		
MRD				x				
MWR				x				
AEN				x				
Proprietary Diagnostics Pass/Fail							x	
Ports/Systems								
60 (XT)			x	x			x	
80 (AT)		x	x	x	x	x	x	
84 (Compaq)			x	x	x	x		
90 (PS/2-30)				x		x		
280 (Clone)			x	x				
300 (EISA)				x		x		
680 (MCA)						x		
SPXT							x	
AT 386							x	
Proprietary Error Diagnostics	x	x					x	x
Proprietary Beep Codes	x							
POST Code Listings on Disk					x			
Built-in Logic Probe						x		
MCA Adapter						x		
Voltage Pads						x		

SPECIAL REPORT:

KickStart 2

(Landmark Research International; $599)



KickStart 2 is a diagnostic board for all PC, XT, AT, 386 and 486 ISA- and EISA-bus computers. It displays POST codes and has LEDs for ±12 and ±5 volts (which can be set at either 2.5% or 5% tolerance levels). Five additional LEDs let you set memory parameters. A RESET switch and battery (for storing configuration settings in CMOS RAM) round out the board.

KickStart 2 also includes two ROMs, called the Landmark JumpStart ROMs, you can substitute for ROMs on the system board. Other hardware includes loop-back plugs for the serial port (9- and 25-pin) and the parallel port (25-pin).

KickStart 2 is one of two products reviewed here that has its own set of diagnostic tests (in ROM) and also displays POST codes.

To install KickStart 2, you plug the board into an expansion slot on the computer. If you aren't certain of the meanings of the POST codes for the system's ROM BIOS, you can substitute the Landmark JumpStart ROMs by removing system ROMs and replacing them with the supplied ROMs.

Documentation is a 114-page manual that includes the POST code meanings for two versions of the AMI BIOS, two versions of the Award BIOS, Mr. BIOS, the Mylex BIOS, the IBM AT BIOS, the Phoenix 80286 BIOS, the Quadtel AT BIOS 3.0 and, of course, the Landmark JumpStart BIOS. Also included are troubleshooting aids, glossary, description of chip sets, and explanation of all diagnostic tests.

To reach tech support, you call the company's toll-free number.

We used KickStart 2 alone and with the JumpStart ROMs on our four test machines, obtaining the following results. For Computer 1, KickStart 2 displayed a meaningless FF code on its display and indicated that power was okay. For Computer 2, we obtained the same results.

For Computer 3, the 02 code appeared on the display. Referring to the Phoenix 80286 POST codes in the User's Manual gave us a "CMOS write/read bad" error message. This is correct, but it didn't direct us to a specific chip to replace.

When we inserted the missing chip and powered up again, POST code 04 appeared on the display. The error message in the User's Manual stated, "Programmable interval timer bad." Again, the message didn't direct us to a specific chip. After inserting the 8284-2 to correct the problem, we turned the computer on once more.

When the POST tests were completed, the board displayed on the monitor a menu of diagnostic tests. These tests can be run from the keyboard or directly from the KickStart board through appropriate switch settings.

KickStart 2 had the ability to diagnose Computer 4, but results were the same as those for Computers 1 and 2.

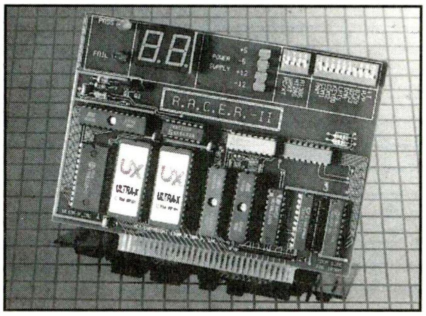
You can leave KickStart 2 in a computer permanently if you wish. The board includes a standard serial port for communicating with it remotely. The board also allows you to set a password to stop unauthorized use of the computer.

With KickStart 2, you can output results of a test to a printer or disk file, using its built-in parallel port. This is especially useful in pinpointing intermittent failures because the tests can be set to run continuously or for a certain number of passes.

Conclusion: KickStart 2 is a premium-priced diagnostic tool targeted for three major types of applications: service (on both local and remote systems), PC manufacturing and systems integration (for permanent placement of the board). The manual is good, but it doesn't provide all the information you need to diagnose a system problem. You'll probably need the assistance of the Landmark tech support staff to solve some problems. Finally, KickStart 2, like most of its lower-priced competition, correctly diagnosed just one of the four dead computers.

R.A.C.E.R. II

(Ultra-X; $6649)



R.A.C.E.R II is a pricey diagnostic board for all PC, XT and AT-type computers. It displays POST codes and has LEDs for ±12 and ±5 volts. One of two DIP switches on the board lets you select one of four choices: PC/XT, SPXT (special XT clone), AT286 and AT386. The other lets you select RAM, COM1, COM2, keyboard, LPTS, DMA, 8253, 8259, R/P (diagnostics mode or POST mode) and LT (lamp test).

R.A.C.E.R. II comes with ROMs you substitute for those on the system board. In the component-level diagnostic mode, R.A.C.E.R. II displays its test results on the computer's display. If the display isn't working, there are two pass/fail LEDs on the card that indicate how the system fared on a test.

One other piece of hardware is included with R.A.C.E.R II—an I/O loop-back tester for the serial and parallel ports of a system. Note that R.A.C.E.R II has its own diagnostic tests and also displays POST codes.

To install R.A.C.E.R. II for component-level diagnostic tests, you first remove the ROMs from the target computer and replace them with the supplied ROMs. You then plug the R.A.C.E.R. II card into an expansion slot in the computer. If the system's video adapter and monitor are operational, you should see a display as soon as you turn on the failed system. If you want to use R.A.C.E.R. II in POST mode, you don't need to replace system ROMs.

Documentation is a 127-page manual that includes the POST code meanings for two versions of the AMI BIOS, the Award BIOS, the Chips & Technologies BIOS, the Faraday A-Tease BIOS, the IBM AT BIOS, the Phoenix BIOS and the Tandy 3000 BIOS. Also included are troubleshooting techniques, an explanation of all diagnostic tests and block diagrams of IBM and other systems.

To reach tech support, you call the company's standard number.

We used R.A.C.E.R. II's component-level diagnostics mode on our four test machines and obtained the following results. For Computer 1, R.A.C.E.R. II didn't perform its built-in diagnostic tests. We then followed the guidelines given in the manual for troubleshooting a dead system. These point out the chips most likely to fail in a system. However, we didn't have any luck in getting Computer 1 operational using these guidelines. The same results were obtained for Computer 2.

For Computer 3, diagnostics appeared on the display and indicated failures for both timer and clock. The display also pointed to the suspect chips—MC146818 and 8254—which was correct. Of the products tested here, R.A.C.E.R. II was the only one to provide information directly, without the help of the manual or a tech support staff!

R.A.C.E.R. II had the ability to diagnose Computer 4, but the board didn't perform its diagnostic tests.

Company Information

POST-Code Master
Micro Systems Development
4100 Moorpark Ave.
San Jose, CA 95117
Tel.: 408-296-4000
CIRCLE NO. 109 ON FREE INFORMATION CARD

PC Fixer
Sibex, Inc.
1040 Harbor Lake Dr.
Safety Harbor, FL 34695
Tel.: 813-726-4343
CIRCLE NO. 110 ON FREE INFORMATION CARD

Pocket POST
Data Depot
1525 Sandy Lane
Clearwater, FL 34615
Tel.: 813-446-3402 or 800-275-1913 (toll-free technical support)
CIRCLE NO. 111 ON FREE INFORMATION CARD

AT ROM POST; KickStart 2
Landmark Research Int'l.
703 Grand Central St.
Clearwater, FL 34616
Tel.: 800-683-6696 or 800-683-0854 (toll-free technical support)
CIRCLE NO. 112 ON FREE INFORMATION CARD

WindsorPOST
Windsor Technologies
130 Alto St.
San Raphael, CA 94901
Tel.: 415-456-2200
CIRCLE NO. 113 ON FREE INFORMATION CARD

POST Probe
Micro-2000
1100 East Bway, 3rd Fl.
Glendale, CA 91205
CIRCLE NO. 114 ON FREE INFORMATION CARD

R.A.C.E.R. II
Ultra-X, Inc.
P.O. Box 730010
San Jose, CA 95173
Tel.: 408-988-4721
CIRCLE NO. 115 ON FREE INFORMATION CARD

R.A.C.E.R. II can output test results to a printer. This is especially useful in pin-pointing intermittent failures since the tests automatically cycle and a printout is produced after each series of tests. One drawback of the printout is that it doesn't include all information displayed on-screen. Thus, you must copy down suspect chip numbers by hand.

Labeling on the diagnostic ROMs should be improved. Printing is in a direction opposite to the orientation of insertion (arrows point to the proper direction). This is confusing and can lead to improper insertion and damage to the ROMs.

As with other products that use diagnostic ROMs, it's a good idea to mount the ROMs in ZIF sockets to avoid damaging the pins on the ROMs.

Conclusion: R.A.C.E.R. II is a premium-priced diagnostic tool targeted at service technicians. The manual is good, and the built-in diagnostics are excellent when they provide information for a system. With this board, you probably can solve most problems on your own, without the need of Ultra-X support staff assistance. However, R.A.C.E.R. II, like most of its lower-priced competition, helped just one of the four dead computers to become operational again.

Final Thoughts

The reviews in this roundup provide a good flavor of the range of diagnostic hardware available for IBM PC and compatible computers. It's clear from our test results that even the most-inexpensive of these tools can help you fix a system that's repairable. You may, however, have to spend more time finding exact solutions with the less-expensive products. In other words, you may have to lean on a company's technical support staff until you gain experience with a product.

Although we were disappointed that a number of systems that were already dumped couldn't be resurrected by speedy magical suggestions of these diagnostic boards, in a sense, each of them did its job properly. All gave enough information to get Computer 3 operational, and all indicated (by their lack of supplying useful repair information) that the system boards of Computers 1, 2 and 4 be trashed. All of the boards are more useful in solving more mundane problems.

In deciding which of these products to buy, you first have to decide which category you represent—end user or service technician. Then you have to determine a price point suitable to your situation. Finally, you need to establish how much information you want the product itself to provide (check Table 1 for a feature comparison). For example, you may decide to buy one product over another based on the BIOS POST codes it supports or the signals it monitors.

From our viewpoint, the R.A.C.E.R. II board did its job the best. We didn't have to check the manual or call tech support to find a complete solution to the problems of Computer 3. Also, R.A.C.E.R. II provides a good way to catch intermittent problems in a system. But $649 may be too dear a price to pay for the conveniences of R.A.C.E.R. II, unless you do full-time system servicing and repair. ■

By Ralph Tenny

Boost the Performance of an Old PC

Using RAM disks can breathe new life into an old PC at little or no cost for new hardware or software

Is your old PC/XT or AT beginning to show its age by taking an inordinately long time to run new software you absolutely must use nowadays? If so, you're probably considering trading up to a newer-technology 386 or 486 machine to get the performance boost and extra memory demanded by new software applications. Hold on, though, because you just may not have to go this expensive route if you use RAM disks. Given certain conditions, *all* computers—not just older ones—can be enhanced to run faster with most software

Some DOS-based computers can accommodate total user RAM of more than 4M. With normal DOS operation, only 640K of this memory can be used for applications. Under DOS, any application that requires more memory uses overlays to accommodate available memory. (An overlay is a segment of a program that's too large to fit into RAM memory. When a different part of the program is required, the new segment is written over the current segment.)

In this article, I introduce you to a neat trick you can use to speed up the performance of older PCs that may just save you a bundle of money. The RAM-disk technique discussed here works for all kinds of software, but performance enhancement is greater for programs that require overlays. Any computer that includes or can be expanded to include a high-density 5¼" or 3½" disk drive or a hard drive, RAM in excess of the base 640k and the RAM used by DOS (provided it can be configured as a RAM disk) and, optionally, battery-backup for the RAM disk is a candidate for the speed-enhancement technique described here.

Time Requirements

The method of the speed-up described here is based on reducing computing time. This includes the time used by applications software to compute the required data, time to load software and data and to write new data back to disk and time required by the operator interface. Data computation time is defined by the software used and CPU factors you can't change. To enhance speed, you need a faster CPU and faster software.

Software and data loading time is affected by disk-access time, disk data-transfer rate and number of bytes loaded. Programs that use overlays spend time loading each overlay when they're used. The only way to decrease loading time is to use a faster disk. RAM-disk data transfer times are essentially zero, compared to the loading time of hard drives. So using RAM drives greatly reduces data loading and saving time.

The largest component of computing in DOS is the operator interface—specifically, the DOS command structure. DOS commands operate very quickly, but some are difficult to understand. Others are complex and long and are prone to errors when being entered.

As you read about the techniques presented here, DOS command sequences may seem formidable. However, you can use batch files (see Batch File Basics box) to automate these commands to provide much more rapid start-up than is possible using conventional techniques and setups.

Using the *Windows* interface with a mouse is fairly rapid and much simpler than DOS commands, but only for single operations. The techniques described here typically require two or three keystrokes, which is much faster than mouse activity for most users.

Computer Configuration

The Toshiba T1000SE, an example of an older (and slower) laptop, is a prime candidate for enhanced opera-

Table 1. Programs Required in Root Directory for Speed-Up Operations

Filename	Extension	Comments
COMMAND	COM	(Installed by system during formatting)
DRIVER	SYS	Required interface for hardware
VDISK	SYS	Establishes RAM disks
EMM	SYS	Manages expanded memory
MOUSE	COM	Interface for mouse
MORE	COM	Utility for listing long files
AUTOEXEC	BAT	Special startup file (see Table 2)
CONFIG	SYS	Special configuration file (see Table 2)

Batch-File Basics

Batch files are simple programs that consist of one or more regular DOS commands. Filenames for batch files can be any legal DOS file name with a .BAT extension, such as X.BAT, L.BAT, etc.

Since saving time by minimizing keystrokes is one of their advantages, batch files are often given single-character names that are mnemonically related to the function they perform. For example, U.BAT (up) changes to the next higher level directory and T.BAT (top) changes to the root directory. You invoke U.BAT with the syntax "u" and pressing Enter and T.BAT using "t" and pressing Enter. U.BAT saves four keystrokes, and T.BAT saves four keystrokes for each directory level between the current and root directories:

File Name	U.BAT	T.BAT
File Contents	cd ..	cd \

Creating Batch Files

You can create batch files using a text editor or word processor. By the rules, a batch file must be stored on-disk as a pure ASCII file with no blank lines. Don't end any line with a period and don't end the last line of the file with a carriage return (Enter).

If you don't have (or don't want to use) a text editor or word processor, an alternative is EDLIN.COM, which is a basic part of DOS. EDLIN is a rudimentary editor that contains many commands. A subset of six of these commands suffices for batch-file editing. Spend enough time practicing these commands until you're comfortable using EDLIN.

Begin an EDLIN session by typing edlin name.bat and hit Enter at the DOS prompt. If the file name.bat exists, EDLIN opens the file for editing. If it doesn't, EDLIN creates a directory entry and an edit buffer.

Table A. Useful EDLIN Commands

i or I	**Insert.** For a new file, this command creates the first line of the file.
i2 or I2	**Insert** a line ahead of line 2.
e or E	**Exit.** Terminate edit and save file. If an existing file was being edited, rename the old file name.bak
q or Q	**Quit.** Close the file, ignore edits, don't create *.bak file.
l or L	**List.** Display all existing lines of file. (For files with more than 20 lines, consult your DOS Manual.)
d or D	**Delete** current line. Use 6D to delete line 6.

Figures A and B illustrate creation, review for correctness and file editing of a batch file using EDLIN. User entries are shown in bold type. Figure A is the File-Creation Transcript.

Let's analyze Fig. A. Invoking EDLIN yielded the prompt "*." After line 3:, EDLIN prompted for line 4:, which isn't needed. The response " C" (control-C) is made by holding down the ctrl key and pressing C. This key combination is often used to stop DOS processes.

Line 2 in the file contains an error, which must be corrected before the batch file will perform as desired. Figure B shows how this is done.

As the batch file examples in the main article execute, each command is displayed on-screen. However, if you place an @echo off command in the first line of a batch file, only lines with an "echo" command as the first word on the line will be displayed as the program executes.

EDLIN commands used in the demonstration transcripts shown in Fig. A and Fig. B are normally all you need to create batch files. The commands are listed in Table A.

The information presented here has been excerpted from a primer on DOS batch files, *Batch Files for Casual DOS Users*. This 40-page booklet is available from Computer Automation Hardware, P.O. Box 830545, Richardson, TX 75083, for $7.95 plus $2.50 postage and handling. Texas residents, please add 8.25% state tax.

```
C:\> edlin sample.bat
New file
*i
        1.*line one
        2.*line 2
        3.*line three
        4:*^C
*e

C:\>
```

Fig. A. File-creation transcript for creating an EDLIN file.

```
C:\> edlin sample.bat
End of input file
*1%%
        1:*line one
        2: line 2
        3: line three
*2
        2:*line 2
        2:*line two
*l
        1:*line one
        2: line two
        3: line three
*e

C:\>
```

Fig. B. File-edit transcript for editing an EDLIN file.

tion using the RAM-disk technique. It has no hard drive, but it does have provisions for memory expansion using 1M or 2M RAM cards. Other laptops with memory-expansion capability can use the speed-up techniques as well, as can almost any desktop computer.

In this discussion, I use a Toshiba T1000SE laptop as an example of how to configure just about any computer for rapid changes of computing environment and enhancement of the operator interface. The T1000SE is fully loaded, with 1M of standard RAM, a 1.44M floppy and 2M of memory expansion. The expansion memory can be configured variously as expanded or extended memory, RAM disk (not battery-backed), battery-backed RAM drive or some combination of these techniques.

Toshiba refers to the battery-backed RAM as Hard RAM that must be formatted before it can be used as a hard drive. (RAM disks set up using VDISK.SYS aren't backed up and, thus, lose their contents on power-down and don't have to be formatted).

The target machine uses 1,958K of Hard RAM (configured by SETUP10, a resident utility) and 272K of RAM disk that's set up by VDISK.SYS when the computer boots. After running SETUP10 and booting the machine, DOS uses the standard configuration files (see Table 1 and Table 2) to set up the following disk drives:

A:—The 1.44M 3½" floppy drive installed in the machine.

B:—An external 5¼" floppy drive, available as an accessory.

C:—ROM resident in the machine (contains a selected subset of DOS used for initial booting of a new machine that can be used to salvage the computer in case of virus attack)

D:—Hard RAM disk that must be formatted whenever the size (using SETUP10) is changed.

E:—A virtual drive that's accessed via the A: drive mechanism and formats high-density media to 720K.

F:—Volatile RAM disk that's set up by VDISK.SYS with 272K capacity and is used as a scratchpad during normal operation. When using the F: drive, you must save files before turning off your PC because whatever was stored on drive F: is lost on power-down.

Required Boot Files

The key to easy context switching to change the computing environment begins with software that's fully configured on a bootable floppy in the standard fashion. Some special DOS files must also be available in the root directory of the boot disk because drive C: doesn't contain a full set of DOS programs.

The bootable disk must have a \USER directory in which to store the applications and DOS programs in the root directory, as detailed in Table 1.

Table 2. Example Boot Configuration Files for Speed-Up Operation

AUTOEXEC.BAT	CONFIG.SYS
echo off	break = on
path d:\;d:\user;c:;a:\;a:\user	buffers = 25
set comspec = c:\command.com	fcbs = 20,8
verify on	files = 20
prompt pg	lastdrive = f
c:	device = driver.sys /d:0
	device = vdisk.sys 272 512 16

After being configured, RAM drive D: should contain exactly the same data as the boot disk, including the same program in the D:\USER directory. (The reconfiguration process changes only the software in the D:\USER directory.)

To compute entirely in RAM, active applications software must reside on RAM disk; data file(s) for the applications must reside on RAM disk; and special command files (batch files) are created to automate the user interface for speed and accuracy.

Maximum speed gain requires the RAM disks to be battery-backed (to avoid having to load software each time you start the computer).

•**First Time Operation—Single Application.** Beginning with an empty D:\USER directory, I copy the program from A:\USER to D:\USER and the data file to drive F:, which is used as a temporary data disk. Since DOS returns to the disk where a command sequence originates, I switch to drive F: to begin operation.

•**Dual-Environment Operation.** Some tasks use more than one program for one application, such as an editor and compiler, an editor and separate grammar checker, etc. I put the most-computation-intensive program in D:\USER and the other program on drive A:. At the end of a work session, I replace the program disk on drive A: with the data disk. Then I save the work file (or files, in the case of compiler and assembler operations) to drive A:.

As an example of running two programs together, I put a text editor on drive A:, C compiler on drive D: and data file on drive F:. I can then make rapid changes between edit and compile cycles for quicker program development. Depending on relative program sizes, it may be possible to have two or more programs in Hard RAM simultaneously.

•**Multiple Environments.** Since neither a spelling checker nor help files for the text editor are needed in assembly-language program development, D:\USER has room for my text editor, assembler and simulator. With all three programs and the source file in RAM, my assembly-language development cycle times are dramatically shortened over normal operation using files on three separate disks. Even with all three application programs on a typical hard drive, there's a significant time gain with RAM operation.

After a work session, the environment can be changed simply by erasing the contents of D:\USER, changing to a different boot disk and copy-

Listing 1. L.BAT

```
d:                  REM change to drive D:
cd d:\user          REM and select the USER subdirectory
erase *.*           REM erase the contents (DOS will verify this
                        command).
copy a:\user\*.*    REM copy the applications software
dir /w              REM and verify the copy.
```

For DOS 5.0 Users

Version 5.0 has three features that aren't available in earlier DOS versions. These are: the MS-DOS EDITOR, an easy-to-learn full-screen text editor; DOSKEY, an editor for DOS commands; and MACRO, a special command structure that supplements batch files. MS-DOS EDITOR is an alternative tool for creating batch files, while DOSKEY helps manage DOS commands and can be used to create macros.

A macro is similar to a batch file. It can be called by entering the macro name, just as you would with a batch file. Although macros are similar to batch files, there are significant differences between the two, as summarized in the table.

With the availability of MS-DOS EDITOR, EDLIN need no longer be used. However, I use EDLIN for short batch files. It's faster for batch files that contain five or fewer lines. With EDLIN, testing of the file is faster, too, because you can create a batch file and immediately test it. With EDITOR, you must load the editor, create and save the file and exit the editor before testing the new command. With both EDLIN and MS-DOS EDITOR in RAM, EDLIN is still faster until a batch file becomes fairly large.

Differences Between Macros and Batch Files

Characteristic	Batch Files	Macros
Where Stored	Disk File	RAM
Loses Power on Power-Down	No	Yes
Uses Program Memory	No	Yes
Number of Commands	Unlimited	127 Maximum
Commands Per Line	1	127 Maximum
Stop Operation	/C	/C Each Command
Replaceable Parameters	%1 thru %9	$1 thru $9
Uses GOTO Command	Yes	No
Calls Batch File	Yes	Yes
Calls Macro Command	No	No
Uses Echo Off to Inhibit Command Display	Yes	No
Create Using	Text Editor or EDLIN	Text Editor or DOSKEY

ing the new program to D: \ USER, as before. When starting from power-off, boot with the new disk and perform the delete/copy cycle as before.

Listing 2. G.BAT

```
d:
cd user
dir /w
```

Usually, software configuration on the boot disk is easiest to accomplish by making a standard installation to D: \ USER. Once the software is working from D: \ USER, it can be copied to A: \ USER. Each computing environment is set up on a separate bootable disk, unless the program requires more room. (A special procedure has been developed to handle larger programs on computers that don't have a hard drive.)

System Parameters

Correct speed-up operation requires that you set certain parameters. DOS uses the AUTOEXEC.BAT and CONFIG.SYS files to set parameters on boot-up. My files are shown in Table 2. Critical boot-file statements include the following:

PATH, which uses the PATH statement as a list of directories to search for commands. The search accesses the directories in the sequence they appear in PATH. For maximum speed-up during RAM operation, the search must start with D: \ , as coded in the example. During most RAM operation, only drive D: contains the commands, since a data disk or a second environment will be in drive A:.

SET COMSPEC specifies which COMMAND.COM file to use. DOS uses this file each time an applications program terminates. Without this statement, DOS pauses to request a disk containing COMMAND.COM.

DEVICE = VDISK.SYS 272 512 16 specifies the parameters for the RAM disk. Capacity is 272K, sectors are 512 bytes and no more than 16 files can be saved. If a larger data work space is needed, adjust the VDISK parameters.

Using a RAM disk can dramatically increase operating speed under proper conditions. Maximum speed is obtained when both software and data files are in RAM. This requires a minimum hardware configuration and careful planning. For many users, this means some investment, a new system configuration and a change in computing discipline.

Power back-up is the most important single factor for safe computing in RAM. Most laptops satisfy this requirement automatically. Data is preserved long after the main battery has run down. Also, work files should be

Listing 3. LF.BAT

```
a:              REM  change to Drive A
copy %1 f:      REM  copy first data file to RAM work disk
copy %2 f:      REM  (Optional) Copy a second file to RAM
f:              REM  change to work disk
edit %1         REM  start the text processor and open data file
                     (This command may vary with the requirements
                     of the software used.)
```

Listing 4. PC.BAT

```
f:                  REM  change from current directory to F:
erase *.bat         REM  delete all backup files
copy *.* a:         REM  copy all remaining files to the disk in A:
a:                  REM  change directory to Drive A
a: dir /w           REM  verify that the files were copied
echo ***SAVE USER DICTIONARY***
```

Listing 5. SP.BAT

```
a:                      REM  change to A:.
cd user                 REM  change to /USER
copy d:\user\words.use  REM  copy user dictionary
dir w*                  REM  list all files beginning with "w"
cd ..                   REM  return to root directory
```

saved frequently (which should be done with *any* computer configuration you use). Minimum computer memory configuration must include the following:

•**RAM Disk 1** with enough space to hold the largest applications software package you expect to use. If this block of RAM is battery-backed, you save software loading time during boot-up.

•**RAM Disk 2** with enough space for the largest data file you need.

•**System RAM** exceeding the minimum requirement used by the applications software.

When the software residing in D: \ USER doesn't include the programs you need for a given task, it's

Listing 6. FX.BAT

```
f:
erase *.&*
copy *.* a:\cs
a:
cd cs
dir /w
```

Choosing RAM-Disk Size

AT-type desktop computers rarely accommodate more than 3M of RAM on their motherboards and often only 2M. All installed memory beyond 1M can be used as either expanded or extended memory. In the Toshiba T1000SE example cited in the main text, Hard RAM had to be installed in expanded memory. Any application that uses expanded memory requires that EMM.SYS be loaded as a memory manager.

Three factors should govern how you partition memory beyond the 1M limit DOS can access. These are: size of the application you wish to run; the maximum size of a data file you expect to use; and the amount of available extended memory.

Let's assume you have 2M of RAM and no hard drive. The setup I use on my Toshiba is 272K in VDISK RAM disk and the rest in Hard RAM. A 1.44M 3½" diskette just barely accommodates *QuickBASIC* (1,270K) and the boot files, which makes this the practical limit for running from boot floppies.

If you boot from a hard drive and use a 272K scratchpad RAM disk, a batch file can automatically load whatever combination of utilities will fit into the remaining RAM in your computer. Without a utility like SETUP (available only on the Toshiba; you must use VDISK.SYS to configure the scratchpad and one other RAM disk with the remaining RAM).

Obviously, if you have more RAM, larger applications and larger work files will fit. With only 1M of expanded memory, everything must be scaled down. Welcome to the world of agonizing choices.

The table lists applications I've installed as individual environments on my Toshiba T1000ES, some in combination with others for maximum utility. Sizes listed in it are installed versions, not total files.

Applications Author Installed on a Toshiba T1000ES

Application/Utility	Type	Size
PC Write	Shareware Word Processor	450K
PseudoSam A51	8051 Assembler	86K
Snooper	8086 Disassembler	330K
SuperCAD	Schematic-Capture	900K
QuickBASIC	BASIC Compiler	1,270K
IT	Shareware Communications	57K
Required Boot and Batch Files Used on Toshiba T1000ES		164K

```
 Volume in drive A is WP1
 Directory of  A:\USER

.            <DIR>        4-20-92    7:45a
..           <DIR>        4-20-92    7:45a
WPHELP   FIL    215030    9-25-91   12:00p
WP       EXE    228352    9-25-91   12:00p
WP       FIL    617619    9-25-91   12:00p
WP       MRS      6072    9-25-91   12:00p
WP       QRS     17034    9-25-91   12:00p
WPSMALL  DRS     47892    9-25-91   12:00p
WP51     INS      2307    4-20-92    7:28a
WP{WP}   SET      2952    5-29-92    3:13a
WP}WP{   CHK         0    4-20-92    8:05a
WP}WP{   TV1         0    4-20-92    8:05a
WP}WP{   BV1         0    4-20-92    8:05a
WP}WP{   SPC      4096    4-20-92    8:05a
       14 File(s)    314368 bytes free

 Volume in drive A is WP2
 Directory of  A:\USER

.            <DIR>        5-29-92    5:08a
..           <DIR>        5-29-92    5:08a
WP51         <DIR>        5-29-92    5:17a
STANDARD IRS      4905    9-25-91   12:00p
STANDARD PRS      1942    9-25-91   12:00p
STANDARD VRS     30482    9-25-91   12:00p
WP       QRS     17034    9-25-91   12:00p
HPDES500 PRS     16386    4-20-92    7:29a
        8 File(s)    765440 bytes free

 Volume in drive A is WP2
    Directory of  A:\USER\WP51

.            <DIR>        5-29-92    5:17a
..           <DIR>        5-29-92    5:17a
WPMS50   ALL    202851    1-18-91    3:20p
WP51     INS      2307    5-29-92    2:17a
WP}WP{   WPM      1325    5-29-92    2:17a
WPMS1    ALL    302566   11-05-91   12:00p
HPDE50AD PRS     32373    5-29-92    2:38a
        7 File(s)    765440 bytes free
```

Fig. 1. Example distribution of WordPerfect files on boot disks.

time for a change. Usually, because this RAM disk has limited capacity, the current contents must be replaced with the software you need. To load and use the software, do the following:

(1) Switch to D: \ USER and erase all files there. This process may be somewhat complicated if the existing application uses more than one directory.

(2) Copy the new software to D: \ USER.

(3) Copy the data file to drive F: (scratchpad RAM drive).

(4) Change to drive F: and run the applications program.

Software replacement is a somewhat complex operation. Unless these changes can be done quickly and automatically, much of the savings in computing time will be lost. Two or more batch files can be written to perform all the software changes and handle file management. For example, batch files L.BAT and G.BAT help speed up changes in computing environment and general operation of the computer. A typical operating cycle with an environmental change is as follows:

(1) Boot the computer from a boot disk in drive A:.

(2) Type l and hit Enter to install new software in D: \ USER (L.BAT).

(3) Type g, followed by Enter to access the installed program in D: \ USER (G.BAT).

Alternate configuration steps are as follows:

(3) Use a specialized batch file tailored to match the program's needs. See LF.BAT for a simple example.

(4) Change to a data disk in drive A:, copy the data file to drive F: and start the new program (see LF.BAT).

If RAM drive D: already contains the desired software, skip Step 2.

I use an archive disk and save to both the original disk and an archive disk each time I save a working file.

Listing 7. LW1.BAT

```
@echo off
d:                            REM  change to drive D:
cd d:\user                    REM  change to USER subdirectory
erase *.*                     REM  kill existing files; DOS will
                                     query "OK?"
echo "Insert disk wp1 then activate lw2.bat"  REM  prompt for
                                     first disk
```

Listing 8. LW2.BAT

```
@echo off
copy a:\user\*.*                    REM  copy all files to D:\USER
echo "insert disk wp2 then activate lw3.bat"   REM  prompt for
                                                     second disk
```

Listing 9. LW3.BAT

```
@echo off
copy a:\user\*.*                    REM  copy all files to D:\USER
md wp51                             REM  create directory
cd wp51                             REM  and go there
copy a:\user\wp51\*.*               REM  copy the remaining files
```

Listing 10. CW.BAT

```
a:                                  REM  switch to drive A:.
copy %1 f:                          REM  copy file "filename" to drive F:
f:                                  REM  and change to F:.
wp                                  REM  and start WordPerfect
```

Besides having back-up files for data, a virus can attack only the boot disk and drive D:, both of which are easy to rebuild, if necessary. Power-failure protection on a laptop computer is essentially automatic, as long as you always remember to save the data in drive F: before you turn off your computer.

The following batch files contain REMarks that define operations. These REMarks aren't part of the file and must not be entered. If the PATH statement contains the location of the batch files, batch commands can be executed from any directory.

Let's look at some general-purpose batch files.

L.BAT in Listing 1 is a universal batch file for changing the applications software in D: \ USER. It's executed after booting with an environment disk that contains the new software you need. **G.BAT** in Listing 2 transfers control to D: \ USER from any active directory. This program reminds you of the command to start the software (normally an .EXE file) if the program must be started from its home directory. **LF.BAT** in Listing 3 automatically loads one or two data files and starts a text processor. Total load time is less than 5 seconds. The command syntax for this file is: lf fileone filetwo, followed by an Enter. Additional parameters %3 through %9 may be added to the file. If the number of file names entered is less than the number of parameters, parameters not used are ignored.

PC.BAT in Listing 4 erases backup file(s) and copies the modified data files to drive A:. To make a backup file, change disks and execute FC.BAT again. You execute SP.BAT in Listing 6 after work files have been saved and the text editor boot disk has again been placed in drive A:. This file copies the supplemental spelling dictionary from D: \ USER to A: \ USER and makes a directory listing to verify the copy. **SP.BAT**. in Listing 5 is executed after work files have been saved and the text-editor boot disk is placed in A:

```
cd d:\user\prog1\sub1\sub2   REM  begin with lowest level directory
erase *.*                    REM  and erase each in turn
cd ..
rd sub2
erase *.*
cd ..
rd sub1
erase *.*
cd ..
rd prog1
erase *.*
l                            REM execute L.BAT
```

Fig. 2. Nested erase commands required when a program needs a directory structure two or three levels deep.

Listing 11. RWP.BAT

```
cd d:\user\wp51        REM  change to the WordPerfect
                            subdirectory
erase *.*              REM  and erase the files there.
cd ..                  REM  go up to the /USER directory
rd wp51                REM  and remove the wp51 subdirectory.
l                      REM  execute L.BAT to complete the change.
```

again. This file copies the user's supplemental spelling dictionary from D: \ USER and makes a directory listing to verify the copy.

FX.BAT in Listing 6 is a variation of FC.BAT. In this case, the work file is copied to a subdirectory on the data disk.

Working With Large Programs

Large programs like *WordPerfect* can also be accommodated, with certain compromises and special techniques, by the boot disks. For *WordPerfect*, the compromise is to load style sheets from drive A: and run the spelling checker from drive A:.

Two boot disks are required to hold resident *WordPerfect* files because total resident code is more than one high-density disk can accommodate, not including boot files. I prepared the boot disks by making a standard small installation of *WordPerfect* on D: \ USER and verifying that it works properly. These files were then copied to two 1.44M floppies, each with a USER directory. Fig. 1 shows my file distribution. Except for the contents of \ WP51, exact file distribution isn't important.

Files required for *WordPerfect*, including a special driver for a Hewlett-Packard DeskJet 500 printer, total 1.75M. With these files distributed between two diskettes, the batch file required for program updating is more complex. Actually, it becomes three batch files that prompt me to change diskettes as needed while loading *WordPerfect*.

LWx.BAT is a trio of batch files (Listings 7, 8 and 9) that replace the application program currently in D: \ USER with *Wordperfect*. These batch files must be used together. Each prompts for the next file in the chain. This seemingly extreme measure is required because data files have no mechanism for operator interaction, except to issue instructions via the ECHO command. These files have an extra feature: the line "@echo off" prevents each line of the file, except those beginning with "echo," from being displayed on-screen during the operation.

CW.BAT in Listing 10 copies a data file to drive F: (after *WordPerfect* loads) and executes *WordPerfect*. The syntax for this command is cw <FILename>, followed by Enter.

When a large program like *WordPerfect* or any program that requires more than one level of directory structure to be removed from the RAM drive, the special RWP.BAT batch file given in Listing 11 can automate the reconfiguration process. If some program needs a directory structure two or three levels deep, the equivalent RWP.BAT would need nested erase commands, as detailed in Fig. 2.

Special Cases for Laptop Enhancement

If your laptop has a hard drive, boot disks aren't needed. Simply install applications programs in different directories on the hard drive. Normally, installation instructions for commercial programs do this automatically. The major change in the batch files is that L.BAT will have to become a unique file for each application. In particular, the batch command to load *WordPerfect* might be as shown in Fig. 3.

The major problem in having multiple-loading batch commands is remembering the different commands. It's helpful to use mnemonic names for these commands to help the memory process.

Speeding Up Desktop Computers

The most important differences between laptop and desktop computers are that most of the latter don't have battery backup for RAM, they typically have hard disks and standard DOS forces complete RAM erasure on reset. Reliable RAM computing requires that these machines have an uninterruptible power supply (UPS) to obviate data loss in the event of an ac power-line failure during normal operation.

Once the data has been protected, batch files can be written to move applications software and data from the hard drive to RAM disks. If you leave your computer powered up after you finish configuring it, operation becomes identical to that for a laptop.

```
d:                   REM change to drive D:
cd d:\user           REM and select the USER subdirectory
erase *.*            REM erase the contents (DOS will verify this command)
copy c:\wp51\*.*     REM copy the applications software
dir /w               REM and verify the copy.
```

Fig. 3. Batch command to load WordPerfect on a laptop computer's hard drive.

Enhancing By Nick Goss

Build-It-Yourself Digital Laser

This project offers a unique opportunity to do sophisticated experimenting and build a host of practical application projects you control from your computer

Nowadays, lasers aren't something for just the scientific community, built into commercial and consumer products or something to be used as prop in sci-fi movies. They're practical, moderate-cost items with which a home user can use to perform serious experiments, as exemplified by the Cyber Laser project described here.

What makes our Cyber Laser relatively unique is the fact that you control it with your PC via a card that plugs into your computer's serial port. With this arrangement, you can use your PC to digitally modulate/demodulate laser-based data. This gives you the opportunity to experiment with a wide variety of applications. Among the literally hundreds of things you can do with Cyber Laser are making ultra-precise distance measurements using digital interferometry; setting up computer-to-computer and computer-to-peripheral data links; control laser light shows and demonstrations with your PC; prototype optical systems; build laser security systems;and do laser seismology, to name just a few.

About the System

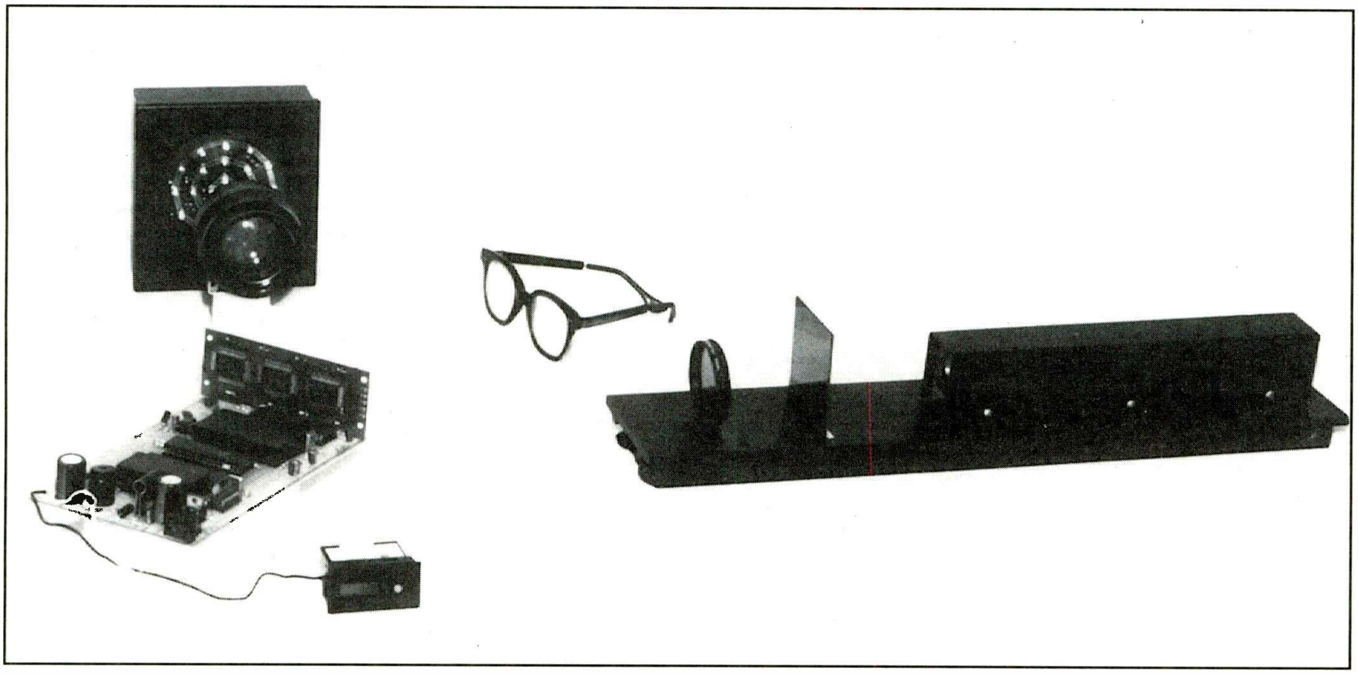
The laser diode is essentially a LED that has been carefully designed to produce coherent laser energy when it's electrically driven beyond its threshold current. This condition represents the minimum amount of electrical energy that must be applied to stimulate light "amplification."

In the Fig. 1 cross-section of the laser-diode semiconductor, photons created in the active layer are reflected back and forth between the cladding layers until they begin to spill - out the edges of the device. Energy emitted from the back of the semiconductor is directed onto a photodetector that measures the relative number of photons being released. This integral monitoring feature is important in a laser diode because excessive energy in the semiconductor material can produce high temperatures that can damage the device.

Photons emitted from the front of the laser diode are temporally and spatially coherent but not well-aligned. This "beam divergence" (as much as 40°) requires a collimator lens to create the concentrated beam of energy associated with lasers.

In many laser-diode designs, photons are emitted at infrared frequencies, well below the spectral range of the human eye. Energy created by this type of laser diode is invisible and difficult to experiment with. Cyber Laser however, uses a newly developed form of laser diode that emits visible red light at about 670 nm, which greatly simplifies alignment and operation.

The solid-state Cyber Laser connects to an RS-232 port on a computer or to any other digital output port or device. This self-contained laser has an internal automatic current-limiting driver circuit, RS-232 and direct digital modula-



tor circuit, laser diode and heat sink, collimator lens and adjustable objective lens and polarizing filter holders.

An extremely simple, though unstable and possibly dangerous, solid-state laser can be built using just a battery, current-limiting resistor and laser diode. Without a sophisticated setup like that used for Cyber Laser, any research work with lasers that require a very stable light source would be useless. For example, Cyber Laser can resolve distances down to around 335 billionths of a meter! You can't get anywhere close to this kind of resolution with a bare-minimum laser setup.

For serious work, a laser must produce very constant coherent energy output. As the semiconductor material produces light, it heats and becomes less efficient. Consequently, you need an automatic current regulator that can monitor or "track" actual energy output of the laser diode. Cyber Laser accomplishes this with the Fig. 2. circuit.

The laser diode you'll be using is rated at 3 mW, but it can produce 50 mW or more if allowed to draw excessive current, if only for only a brief time before the laser diode destructs. Until destruction occurs, however, excessive current draw can be dangerous.

You need a way to collimate and focus the laser diode's energy beam. Cyber Laser uses an adjustable objective lens for fine-tuning beam diameter. It also provides an in-line polarizing filter mount scheme that you'll use in some experiments.

Your last laser need is a direct digital interface. For communications work and holographic research, you must be able to modulate the laser beam. You can operate Cyber Laser in several direct-modulation modes directly from your PC or other direct-digital device.

About the Circuit

Cyber Laser uses an automatic current-regulator circuit to precisely control the output of the laser diode. The Toshiba TOLD9200 laser diode (*D1* in Fig. 2) was chosen based on cost, ease of use and excellent visible energy output. It also contains an internal optical energy output monitoring photodiode. The TOLD9200 is housed in a solid aluminum housing and heat sink. When producing laser energy, the TOLD9200 generates appreciable thermal energy. Cyber Laser's heat sink has enough thermal mass to absorb this unwanted heat and re-radiate it as infrared energy over a large surface area.

Voltage regulator *U2* provides the very stable power source required by the circuit. A 9- or 12-volt dc plug-in power supply lets the driver circuit source +5 volts to the circuit.

Notice that the body of laser diode *D1* is filtered by *C2* and *C4*. Ideally, the current through the laser-diode section in *D1* is set between 70 and 100 mA. A minimum of 70 mA or so is needed to cause *D1* to "lase." This current level is called the "threshold" of the device. In

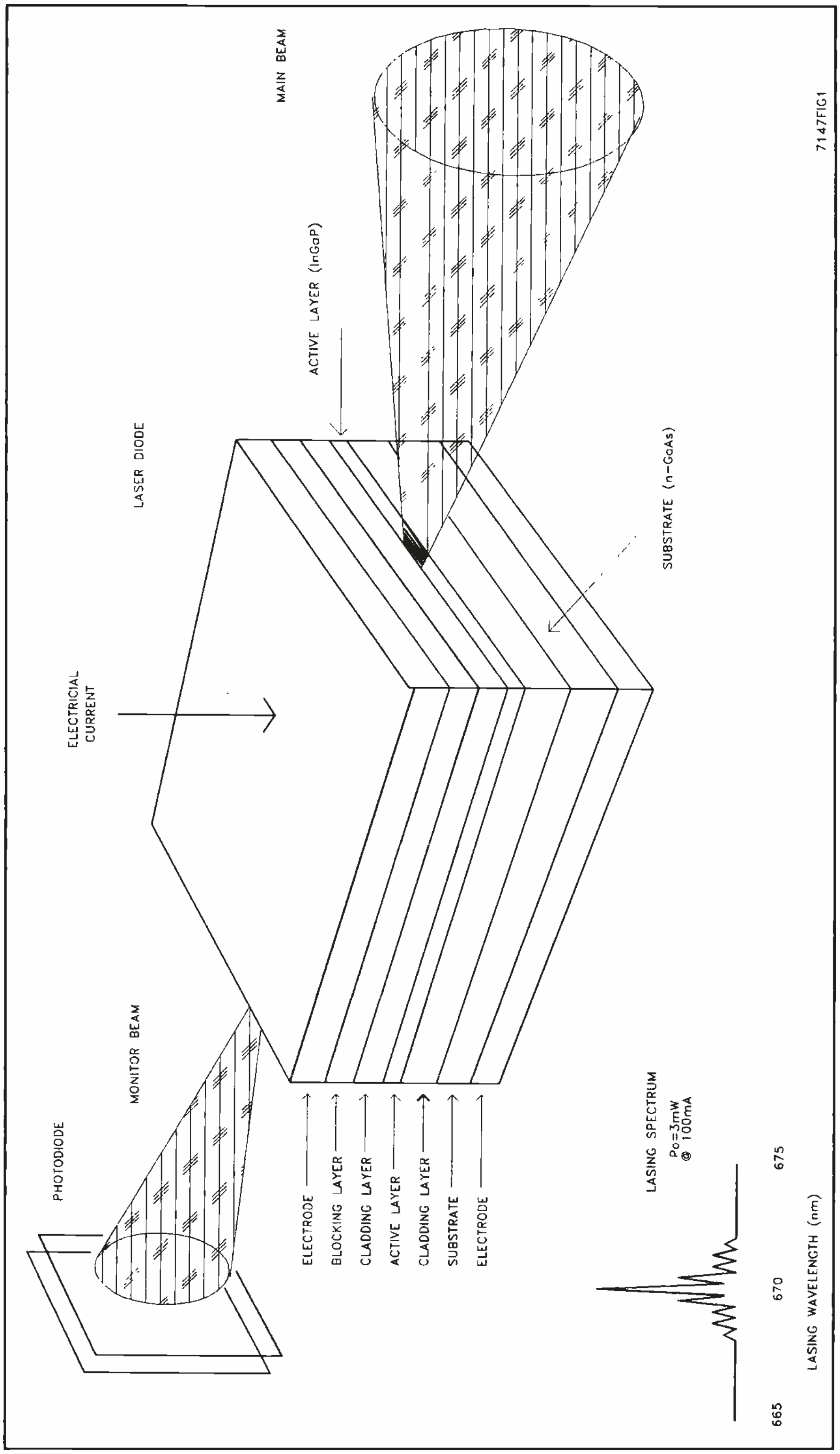


Fig. 1. Pictorial representation of the structure of a laser diode.

Historical Background

The theory of light amplification by stimulated emission of radiation, commonly shortened to "laser." can be traced to work done by Albert Einstein shortly before World War I. He reasoned that "optical chain reactions" could be created in special highly-energized atomic structures, just like the nuclear chain reactions in radioactive materials. In fact, he coined the phrase "stimulated emission of radiation" we use today.

As history records, it wasn't until the summer of 1960 that the first laser was brought on-line. A simple xenon flashtube was wrapped around a synthetic ruby rod and a high voltage was discharged through it. Photons released by the xenon tube "pumped" atoms in the ruby rod to highly energize them. As the high-voltage charge dissipated in the flashtube, chromium atoms in the ruby dropped back to their original energy state and released massive numbers of photons.

As photons were released, mirrors at each end of the ruby rod reflected and redirected them back into the rod. These photons stimulated release of even more photons, resulting in light amplification. Thus was born the first working laser.

Many different types of lasers have been developed since that historic first one. Each new type of laser exploited the same physical laws that govern the ruby rod process.

Nowadays, to build a laser for home experimenting, you don't need an expensive ruby rod and flashtube. Today, creating laser light is as simple as biasing a special type of light-emitting laser diode (LED). Similar to the ordinary visible LED, the solid-state laser diode operates at low voltages and currents that make it ideal for digital control. The laser diode is covered in more detail in the main article under the "Laser Diode" heading.

some cases, threshold current is a little greater, in others a little less. As the temperature of *D1* increases, more current is required to maintain a constant energy output.

For the foregoing reasons, you need an active current regulator that monitors actual energy output and adjusts the amount of current needed to maintain a constant level.

Resistors *R1* and *R2* make up a simple resistive voltage divider at the top of trimmer *R3*. Trimmers *R3* and *R6* must be multi-turn pots. Less-expensive single-turn trimmers will compromise the

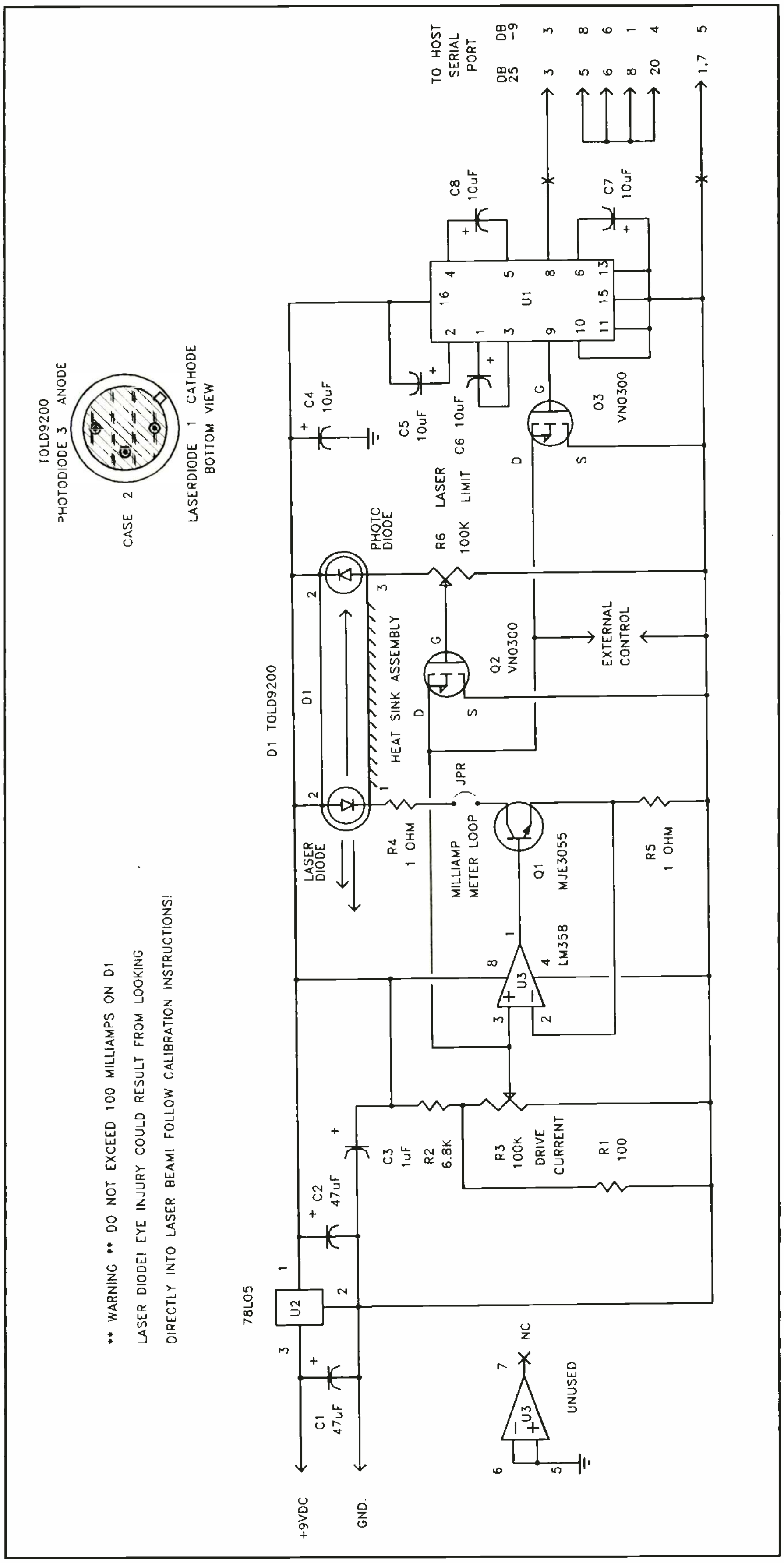


Fig. 2. Complete schematic diagram of Cyber Laser's circuitry.

amount of resolution obtainable to the point that you can damage *D1* while trying to adjust these them.

The wiper of DRIVE CURRENT trimmer *R3* applies a percentage of the approximately 70 mV at the top of the trimmer to the noninverting (–) input at pin 3 of *U3*. Here, *U3* and *Q1* are configured as a voltage-to-current converter. Current along the path from the anode of *D1* and through *D1*, *R4*, *Q1* and R5 are sensed at the pin-2 inverting (–) input of *U3*. This feedback loop tracks the actual current in the emitter of *Q1*. As *R3*'s wiper moves closer to *R2*, the voltage applied to *U3* increases. This increases the current available to *D1*.

Current required by *D1* to maintain constant energy output will fluctuate widely. The pn junction of *D1* becomes very inefficient when temperature begins to rise.

A photodiode inside *D1* samples the energy coming from the rear of the laser diode. The photodiode converts photons released by the die directly back into electrons in a very efficient process that produces in excess of 1.7 volts at the anode of the photodiode. Trimmer *R6* provides the photodiode with a current path to ground.

Connecting the wiper of *R6* directly to the gate of hexFET *Q2*, permits precise monitoring of the voltage and, consequently, relative strength of *D1*'s output. FET *Q2* has a forward gain of more than 50,000. When coupled with the fact that the gate current required to operate the device is only nanoamperes, *Q2* becomes an ideal "comparator."

With gate potential below the preset gate threshold voltage, *Q2*'s drain "floats" and doesn't provide a ground path for *R3*'s wiper. In this condition, the laser-diode circuit operates as discussed above. However, when the photodiode detects high photon levels, *Q2*'s gate voltage rises above the gate threshold, causing the drain to drop very near to ground potential. Due to the high gain of the device and clamp the current-control voltage at the wiper of *R3*, this transition occurs rapidly.

As *Q2*'s drain pulls down pin 3 of *U3*, it directly reduces the current in *D1*. This reduces the number of photons released and creates the feedback necessary for the circuit to self-regulate. The drive circuit would output a constant source of laser energy. In this steady-state mode, Cyber Laser serves as a "static" emitter and can be used with a digital interferometer, laser gyro and similar applications.

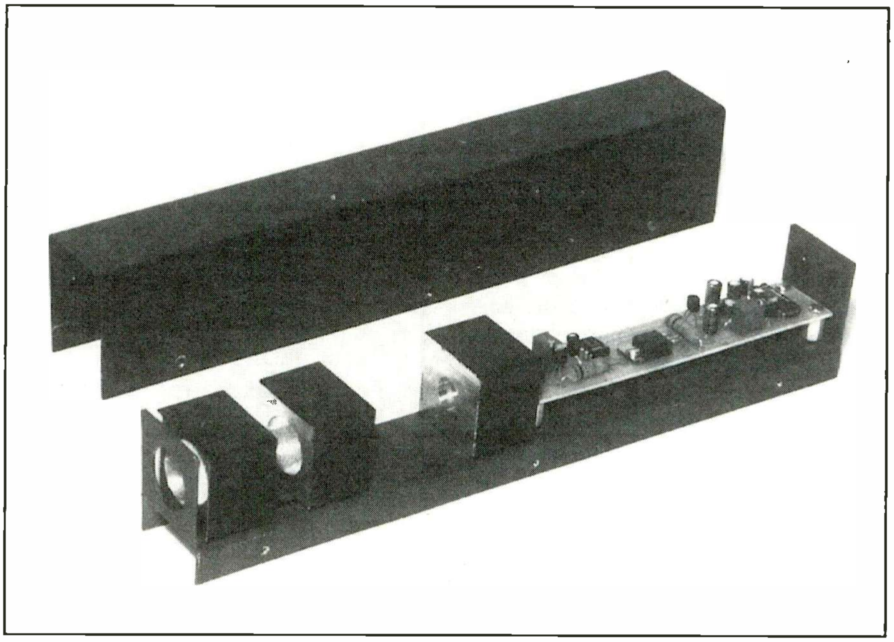
Notice the MAX-232 interface IC used for *U1* operates from the +5-volt power bus on the driver board and converts standard ±15-volt RS-232 input levels to 0- and 1.5-volt TTL levels. Pin 9 of *U1* connects to the gate of *Q3*. The drain of *Q3* pulls down when a gate voltage (greater than the gate threshold) is applied to the gate.

Pull-down is independent of the action created by *Q2* and won't be a function of the photodiode. Rather, it drops the voltage at *U3*'s wiper to very near ground potential, causing a radical reduction in *D1*'s drive current and resulting in cutoff of the laser diode.

When connected to a serial port on a PC, *U1* and *Q3* directly influence operation of *D1*. This forms the direct-digital interface from a PC to Cyber Laser. As you can see, serial data from the PC

PARTS LIST

Semiconductors
D1—TOLD-9200s laser diode (Toshiba)
Q1—MJE-3055 npn power transistor
Q2,Q3—VN0300 hex FET (Siliconix)
U1—MAX232 RS-232 interface
U2—78L05 +5-volt regulator
U3—LM358 dual operational amplifier
Capacitors
C1,C2—47-uF, 16-volt electrolytic
C3—1-uF, 16-volt electrolytic
C4 thru C8—10-uF, 16-volt electrolytic
Resistors (1/4-watt, 5% tolerance)
R1—100 ohms
R2—6,800 ohms
R3,R6—100,000 multi-turn trimmer potentiometer
R4,R5—1 ohm, 1-watt
Miscellaneous
Printed-circuit board (see text); laser base assembly; objective lens holder; objective lens element; polarizer filter holder, polarizer filter element; collimator lens; 9-volt dc, 200-mA power-supply module; Cyber Laser aluminum cover; DB-9 or DB-25 pc-mount connector; mounting hardware; hookup wire; solder; etc.
Note: The following items are available from U.S. Cyberlab, Inc., 14786 Slate Gap Rd., West Fork, AR 72774 (tel.: 501-839-8293): TOLD-9200s (3 mW) laser diode, $39.95 (call for 5- and 10-mW prices); kit of only mechanical parts that contains laser base, objective lens holder, polarizing filter holder, heat-sink for laser diode, PC board holder and painted cover, $39.95; kit of all electronics components, including power supply and TOLD-9200s laser diode, $84.95; complete kit of all Cyber Laser parts, including all metal parts, objective lens element, collimator assembly, TOLD-9200 laser diode, power supply, all electronics, etc., $154.95. Add $5.60 for UPS delivery for partial kits, $10.30 insured UPS delivery for full kit.



Interior view shows how pc-board assembly, heat sink, lens and filter are to be arranged inside enclosure.

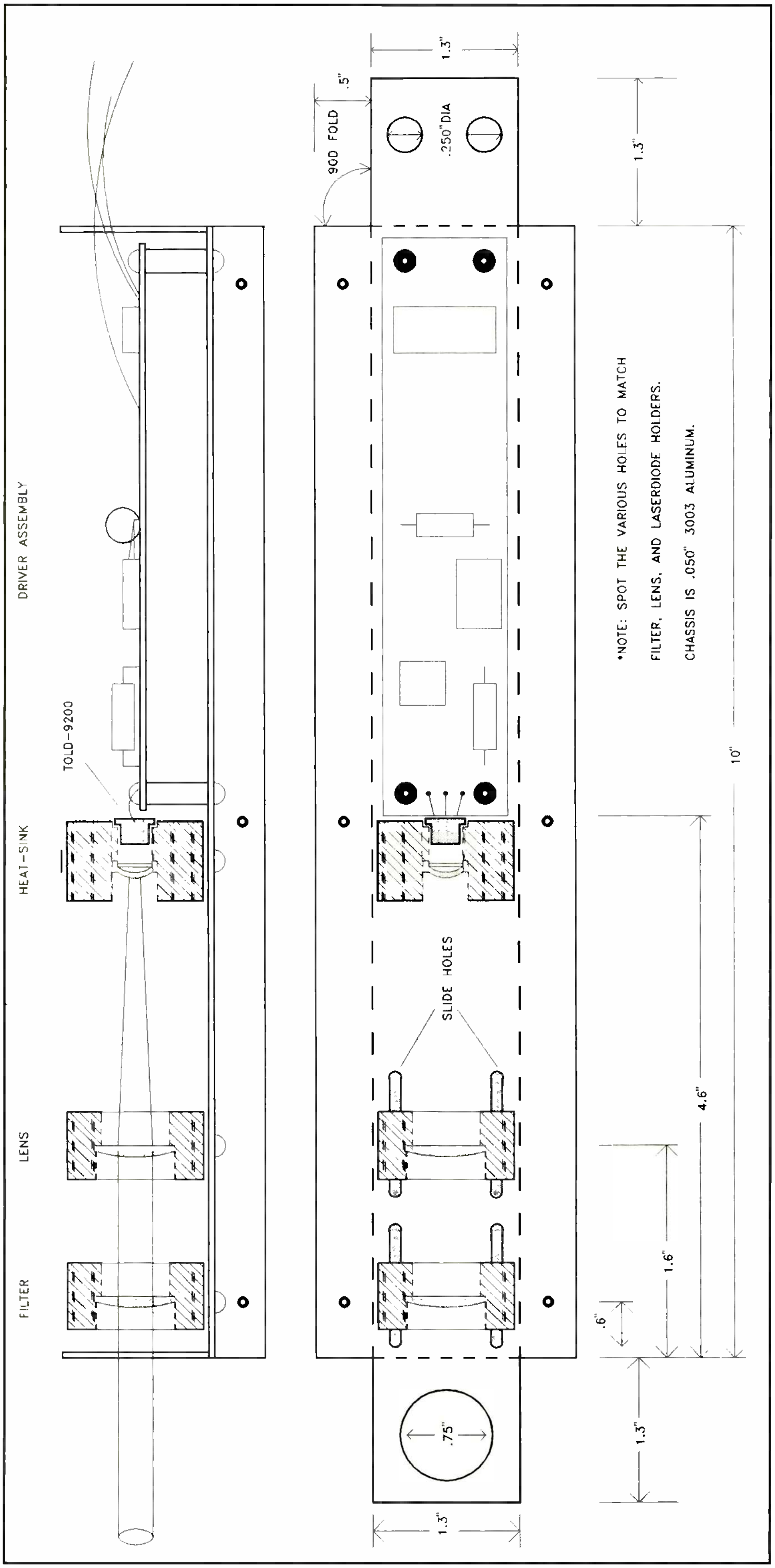


Fig. 3. Mechanical fabrication and mounting details.

switches on and off Cyber Laser's output. When used in this mode, Cyber Laser can transmit digital data over great distances.

In some cases, it may be desirable for you to connect Cyber Laser directly to a Discrete Digital Modulator (DDM), which can, in turn, be connected across the drains of *Q2* and *Q3*.

Construction

Begin building Cyber Laser by fabricating the various metal components. This project is designed around standard 1.25" square aluminum stock. You can make the parts yourself or obtain premachined and conversion-coated ones from the source given in the Note at the end of the Parts List.

Though it's easiest and best to use a vertical mill and lathe to machine the metal parts, as a home builder you can make do with a hacksaw and hand drill. If you use the "hacksaw" method, work very carefully.

Referring to Fig. 3 and Fig. 4, cut the various pieces to length and smooth the edges with 600-grit wet/dry sandpaper or a file. Then drill the various holes. Work up through several smaller sizes of drill bits for the larger holes to obtain smooth holes of the final diameters.

Keep in mind that the objective lens and polarizing filter holder through holes must be slightly larger than the lenses themselves. If you use surplus lenses and filters, be sure to get them before drilling the final hole to the required diameter. You'll find that lenses and filters of the same specified diameter vary slightly from one vendor toanother.

The hole that mounts the laser diode should be extremely close to the body diameter of the case. You want a slightly snug fit between the body of the diode and the aluminum heat sink. In my experiences, I've found that about a 0.005" clearance works best.

After drilling all holes and tapping those that must be threaded, prepare the laser base. You can fabricate it from sheet metal or machine it from a solid piece of 1/4" aluminum stock. Make sure all mounting holes and slides are aligned parallel to the sides of the base to ensure proper optical alignment.

Give the base a coat or two of flat black paint. You may also want to give the other metal components a flat black finish to absorb any reflected laser ener-

Danger Warning

Whenever you work with or are in the vicinity of an operating laser, it's important that you exercise caution. The Cyber Laser is a Class IIIa device that emits less than 5 mW of coherent energy. Though it's safe to work with and operate, it's no exception to safety rules. There's only one way to assure complete safety: rigidly adhere to strict rules of operation.

Never look into the front of the laser nor directly into the window of a laser diode.

Carefully set the laser diode's operating current so that it never exceeds the 100-mA maximum specification.

Treat any laser, regardless of its type and power, like a serious scientific instrument. Lasers of any type are not toys.

Don't let anyone operate your Cyber Laser who isn't qualified to do so in complete safety. Remember that it's your responsibility to maintain safety.

Post on your Cyber Laser and in the area in which you operate it warning decals photocopied from the artwork given in Fig. 7 in the main article.

gy and help re-radiate the infrared energy emitted from the heat sink.

Fabricate the laser cover from 0.050" aluminum. Shear and fold the aluminum and drill the mounting holes to match the base. Use No. 4 or 5 sheet-metal screws to secure the cover during normal operation.

Now mount the objective lens and polarizing filter (if used) in their respective mounting blocks. I used a small amount of super glue to secure lens and filter in place. If you go this route, be sure to avoid getting glue on the elements. Even a small amount of glue on an optical surface can significantly reduce the performance of your laser.

With lens and filter mounted, attach both holders on the laser base. Don't fully tighten the screws until after you've aligned the laser.

To mount the laser diode, first press it into the heat-sink assembly with a small-diameter brass or aluminum tube that's slightly larger than the area defined by the diode's leads. Align the leads on the laser diode to correspond to the proper pads on the pc board. Make absolutely certain of the pinout before soldering the pins into place because *improperly connected pins will destroy the laser when power is first applied to the circuit!* Also, be sure to exercise safe-handling procedures for static-sensitive devices. Ground yourself, your soldering iron and the heat sink when working with the laser diode.

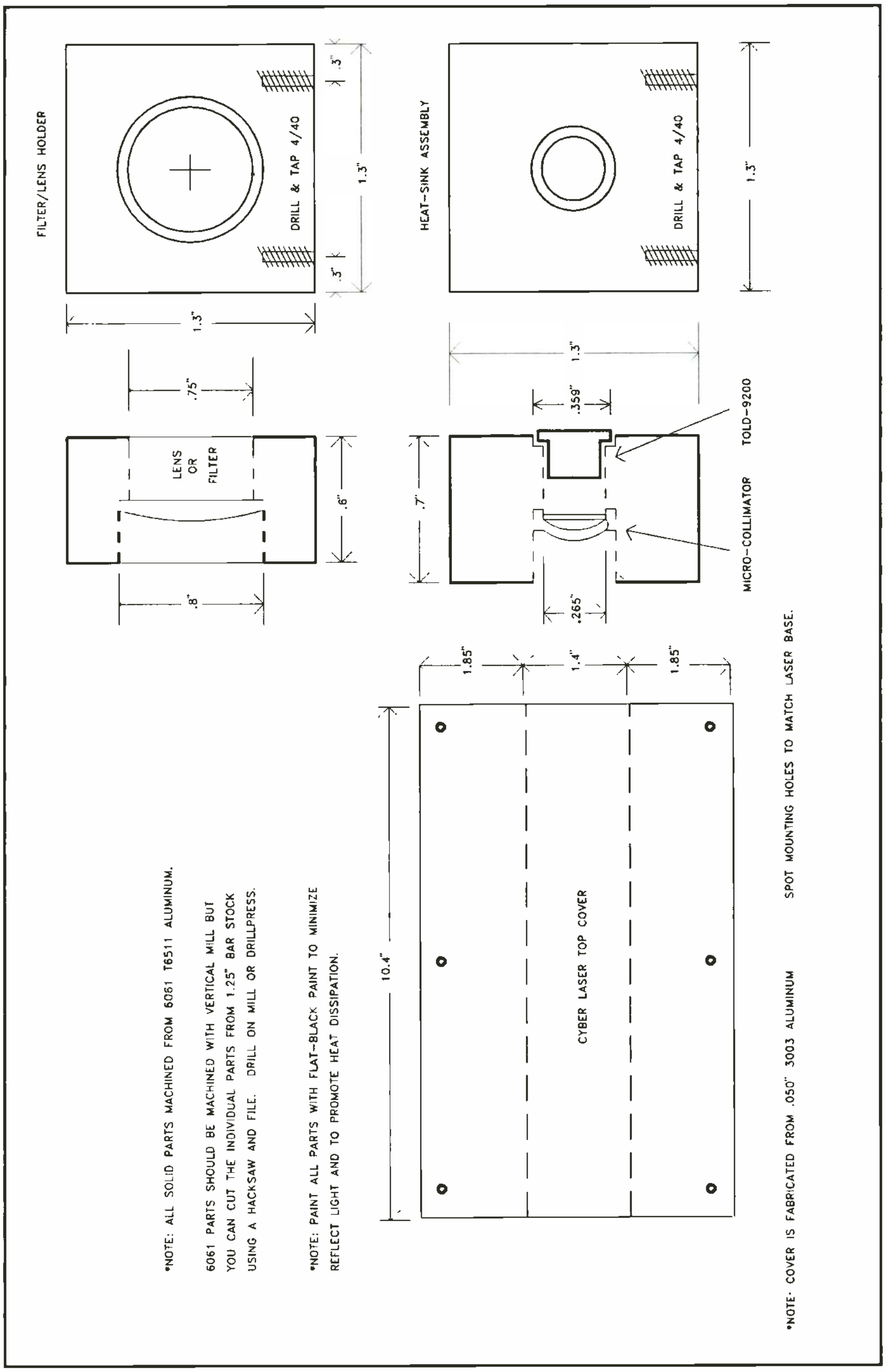


Fig. 4. Machining details for fabricating Cyber Laser's mechanical elements.

Be sure to use some heat-sink compound on the diode body but not so much that it collects in front of the diode's body as you slide it into place. Otherwise, this opaque material might interfere with the path of the energy emitted from the diode.

The output from the laser diode diverges at about a 30° to 40° angle. The collimator lens focuses the diverging beam into relatively parallel rays. The adjustable objective lens further aligns these parallel rays and lets you set beam diameter.

Position the collimator lens as indicated in Fig. 4 and secure it with super glue, being careful to avoid getting glue on the small optical surfaces. If you have super-glue accelerant, use it to make the glue set in seconds rather than the min-

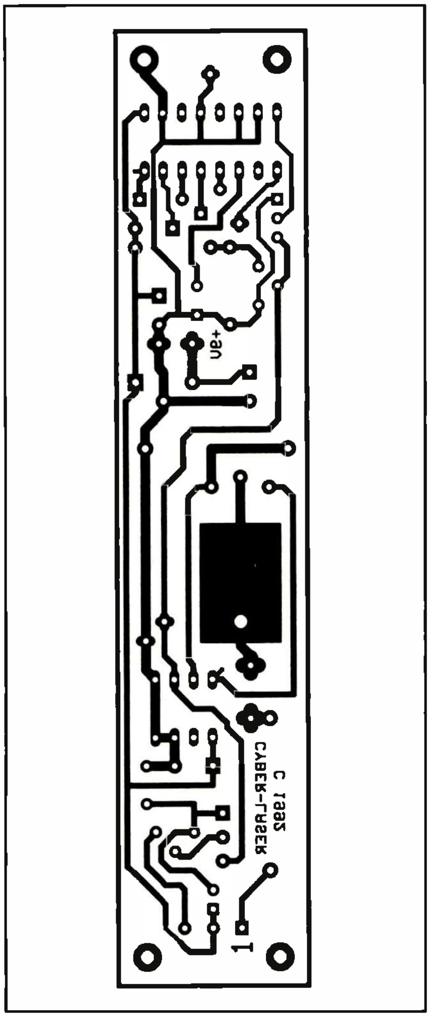


Fig. 5. Actual-size artwork for fabricating Cyber Laser's driver-circuit pc board.

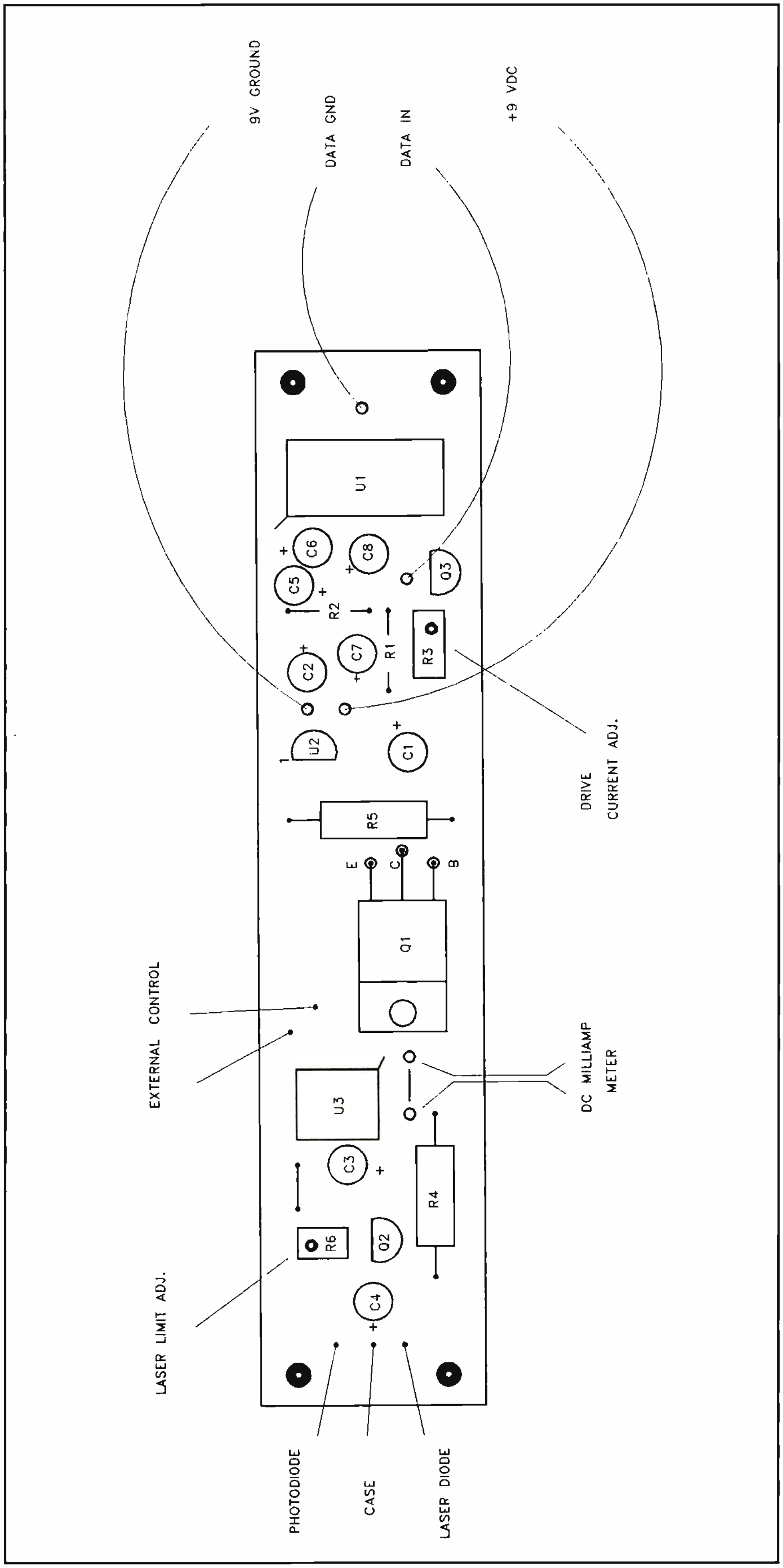


Fig. 6. Wiring guide for pc board.

utes normally needed or use an ultraviolet-cure cyanoacrylate cement.

With the mechanical and optical assembly done, use Fig. 5 to fabricate the printed-circuit board needed for this project (or purchase a ready-to-wire board from the source given in the Note at the end of the Parts List). This done, populate the board as detailed in Fig. 6.

As you populate the pc board, take your time and double-check your work frequently. With laser diodes costing as much as they do, you don't want to ruin *D1* because of something you overlooked. Though *Q1* gets only warm to the touch under normal operation, it's a good idea to apply a little heat-sink compound on the base of it to provide an added measure of insurance.

When you mount *R4* and *R5*, space them so that they're about 1/16" above the surface of the pc board to allow air circulation to carry away heat. Also,

properly orient the electrolytic capacitors, transistor and ICs for proper polarization, basing and pinouts.

Solder *U1* directly onto the pc board since it's a durable component that should never need replacing. Exercise the usual static-prevention precautions when handling, mounting and soldering *Q2* and *Q3* into place.

Test & Calibration

Begin calibration by soldering a visible red LED in place of the laser diode in the *D1* location, between pins 1 and 2. Use of a visible LED, rather than the laser diode, for checking out the circuit is for safety reasons.

Connect a dc milliammeter or DMM set to a dc current range that measures up to 200 mA between the cathode of the LED and the side of R4 to measure the current in the drive circuit very accurately. Because the laser diode isn't connected to the circuit at this point, it won't be able to lase and, consequently, won't bias the internal photodiode. With the photodiode not active, *R6* and *Q2* won't be operating in the driver, which leaves you free to concentrate on the *R3/U3/Q1* circuit.

After checking your wiring one more time, plug the power supply into an ac outlet while monitoring pin 1 of regulator *U2* to ascertain that +5 volts appears at this point. If not, unplug the supply and correct the problem.

The LED may or may not be on at this point. Slowly adjust *R3* to increase the voltage applied to pin 3 of *U3* while observing the milliammeter as you increase the voltage. The LED should become increasingly brighter as the voltage increases. Adjust the trimmer until drive current is about 100 mA and then back off until it's less than 10 mA. Do this several times to make sure that the current-drive circuit is functioning properly.

When working with semiconductors, most failures occur in the first few minutes of operation. Because proper operation of the circuit is so important in terms of user safety, you might want to let the circuit burn-in for a few hours to make sure it doesn't fail in full-power mode. Resistor values in this circuit were calculated to limit worst-case current to slightly greater than 100 mA.

With the voltage-to-current converter working properly, set LED current to about 70 mA and power down. Unsolder the LED from the circuit and solder the leads of the laser diode into place, making sure to observe the usual precautions for handling static-sensitive devices. Don't overheat the leads of the laser diode during soldering.

Final Adjustments

Before switching on your system, fix firmly in mind the need for safety and read the "Danger Warning" box elsewhere in this article. Then set up your Cyber Laser in a clear area. Try to visualize exactly where the beam will strike when the system is powered. Make sure no shiny or reflective objects are in the beam's path that might reflect the laser's

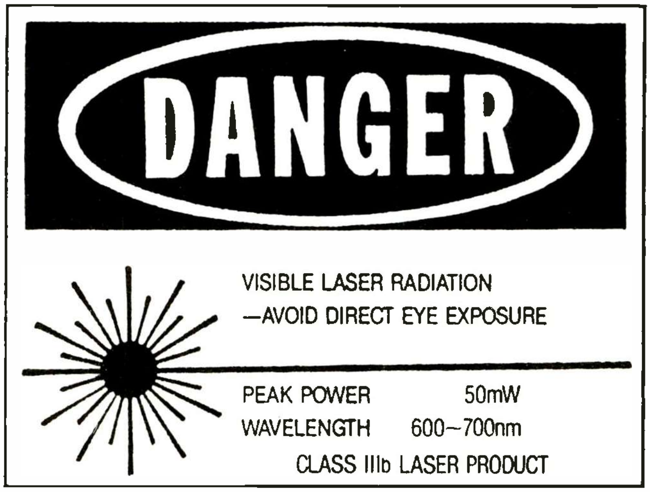


Fig. 7. Place one or more photocopies of this label to your Cyber Laser to warn anyone in the vicinity of the possible danger this project represents to vision.

energy into your eyes or the eyes of anyone else in the vicinity.

If you want to be extra-cautious, wear sunglasses when tuning on your Cyber Laser for the first time. Place a plain white—buff, not glossy—sheet of paper where you anticipate the beam will strike.

With Cyber Laser's enclosure top off, power up while monitoring the milliammeter. You should obtain a reading that's close to the 70-mA level you previously set using the visible LED. If the reading is significantly greater, immediately power down and recheck your work. A lower reading is okay and may be the result of the uncalibrated photodiode current-limiter circuit acting on the drive circuit.

With current at about 70 mA, look for the beam on the sheet of paper. It will probably be fairly bright and 1" to 2" in diameter. If necessary, slide the objective lens holder in both directions until the beam's image on the paper is between 1" and 2" in diameter.

While monitoring the milliammeter, slowly adjust *R6* until you see the current begin to decrease, which represents the gate threshold voltage of *Q2*. Adjust *R6* in the other direction until the full 70 mA is restored. Then take an extra turn of *R6* in the same direction to give yourself a little headroom as you increase drive current. Slowly increase drive current to 80 mA with *R3*. If you find that *R6* and *Q2* limit maximum current, adjust *R3* a bit to give about 80 mA.

Repeat the above procedure until you obtain a reading of about 95 mA. As a final adjustment, use *R6* to bring drive current to about 90 mA. This gives the circuit about 5 mA of control range with which to work.

Check the temperature of the heat sink with the tip of a finger from time to time to make sure it's less than 100° F. As you check the temperature, avoid obstructing the path of the laser beam. The laser energy won't hurt your finger, but excessive reflection of it from your finger can be harmful to your eyes.

Monitor drive current for about 30 minutes to an hour. It will fluctuate as the laser diode comes up to operating temperature. Keep in mind that drive current automatically tracks the optical output of the laser diode, which will be reflected in the reading on the milliammeter.

Now, connect the project to the serial port on your PC with a suitable DB-9 or DB-25 cable. Use the MODE command to set up the communication parameters for: COM1, no parity, eight data bits and one stop bit (format is MODE COM1:300,N,8,1). If you're using a port other than COM1, substitute whichever it is for COM1.

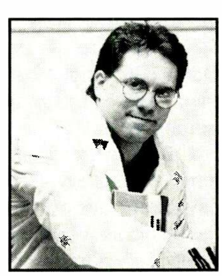
Initially test Cyber Laser at 300 baud because you'll want to be able to see the laser beam modulated at a low, visible, rate. Using a communications program, or from a BASIC program, output some characters to the serial port. You'll see Cyber Laser's beam rapidly pulse on and off, which indicates that the beam is being modulated.

When wiring the DB-9 or DB-25 connector, be sure to connect together the appropriate pins, as indicated. These connections "fool" the handshaking lines commonly used in conjunction with the RS-232 standard so that your computer automatically transmits data without regard for the status lines that aren't being used.

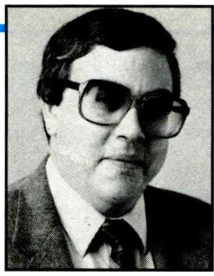
With final calibration complete, remove the power source and disconnect the milliammeter. Jumper the meter loop so that the cathode of *D1* connects to the high side of *R4*. Daub a nail enamel on *R3* and *R6* to lock their settings.

When you finish adjusting the circuit, objective lens and polarizing filter, assemble the enclosure. Photocopy the artwork for the Class IIIa label shown in Fig. 7 and cement it to the enclosure where it will be readily seen. For safety's sake it's important that you let others know what the unit is and the danger it can represent when misused. If necessary, overemphasize the possible danger represented eye contact with the laser beam. And, if you can, photocopy Fig. 7 blowups to place around the area in which you work with Cyber Laser.

Next month, I'll present plans for building an optical device you can connect to a second serial port to provide short- and long-distance computer-to-peripheral interfacing. ■



Nick Goss

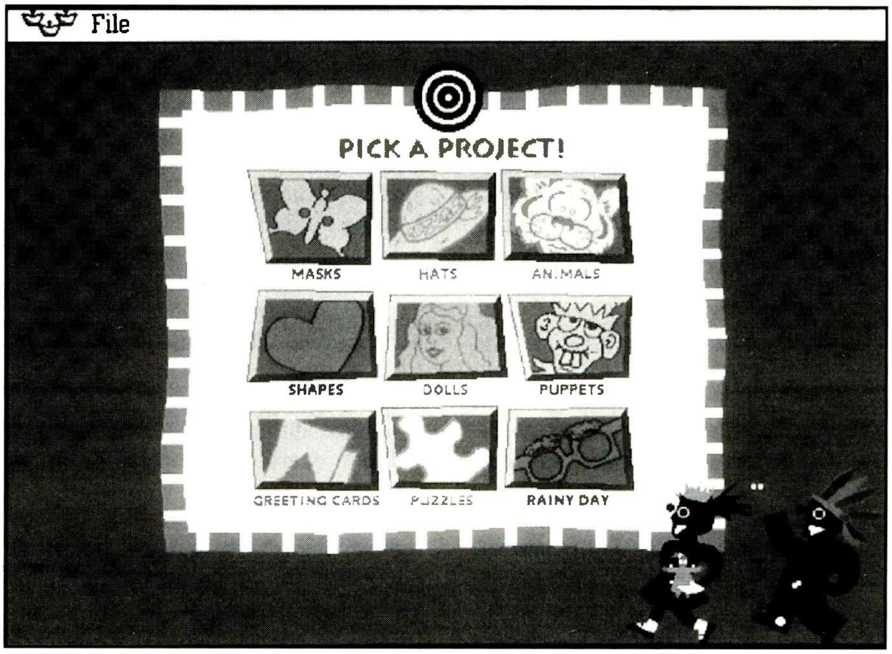


Ted Needleman

A Bit of This, a Bit of That

There's lots of stuff to cover this time around. So I'll get right to it. First off, I have a few comments about the Fall COMDEX show. I'll restrict what I have to write here to just the few things that struck me as interesting/important. The COMDEX shows, Fall in particular, are huge. More than 2,000 exhibitors and about 135,000 attendees were there this time around.

In four days, I doubt I saw even half of what was on the floor. In fact, the sheer size of this show makes covering it a daunting task, something akin to Sisyphus pushing the rock up the hill. Never-the less, it does provide a good indication of what the industry itself finds important.



"Pick A Project!" screen from Broderbund's "Kid Cuts."

The Big Splash

This year, the big splash was for multimedia and handheld PCs. Many of the multimedia exhibits were located at Bally's hotel, but plenty of companies with multimedia products were scattered hither and yon about the rest of the show floor at The Los Vegas Convention Center, The Sands Convention Center and five hotels.

After spending several hours wondering about the exhibits at Bally's, with all of the multimedia vendors blasting their products at high volume, I had a raging migraine. But I expect several really interesting products to show up soon to play with and, of course, report on.

One of the more interesting of these, which should start shipping a bit after this column sees print, is Studio Magic from Brown-Waugh Publishing. This is the company that bootstrapped the Sound Blaster into its current position of market prominence. Now that CMS is handling its own product, B-W is marketing the first of its own internally developed line.

Studio magic is a combination of hardware and software that provides image acquisition, video editing, audio editing and special video effects. These capabilities are already available in an Amiga-based add-on called Video Toaster, which costs in excess of $5,000—hardly a home or hobbyist item at this price.

Studio Magic claims to offer many of the same capabilities as the Video Toaster for less than $500. We'll see how well it lives up to the claims made for it and the demonstration I sat through when the review unit arrives. If they even deliver half of what they promise, it will be a dynamite product.

The other big deal at this particular COMDEX was for products that don't even exist yet, except in prototype form: Personal Digital Assistants, or PDAs. Apple's Newton, announced in early 1992, was only the first of the horde. IBM and ATT were also showing off their versions in private suites, and you can expect to see another half-dozen or so companies jumping into the fray when these units actually start shipping later this year.

With touch screens, and pen-based handwriting recognition, these "super organizers" will be expensive. When Apple's Scully first announced the Newton at the Winter CES (Consumer Electronic Show), his announcement was meant to signal Apple's entrance into the consumer area. The response he received from the trade press about the likelihood of success for an over-$1,000 electronic "Day Book Plus" caused Apple to quickly reposition the upcoming Newton as an essential for busy executives and business people. Other companies that are now announcing their own PDAs, have adopted this positioning as well.

I look forward to examining these systems when they become available, but I have some serious doubts that they'll take the business world by storm. PDAs may be showcase examples of technology, but the target market for them already gets even more benefits from their existing PHAs (Personal Human Assistants: secretaries and executive assistants). I'm a big believer in automation. Machines (including personal computers) can often handle repetitive tasks a whole lot better than humans can. At the same time, you have to know where the limitations of any particular technology are.

In my job, I use PCs to augment, not replace, staff. Our PCs make all of us a lot more productive, and I'd hate to have to go back to the old way of doing things. At the same time, I know that my staff has the experience and judgment to handle the unexpected. Equally comforting is knowing that if I've forgotten to do something, one of my associates in the office can handle it for me.

Organizers, both the dedicated kind like the Wizard and BOSS and those residing in handhelds and notebooks, are really useful business and personal productivity enhancers. And maybe PDAs will be the next step. But from what I've seen up to this point, I'm just a little bit skeptical about all the hoopla.

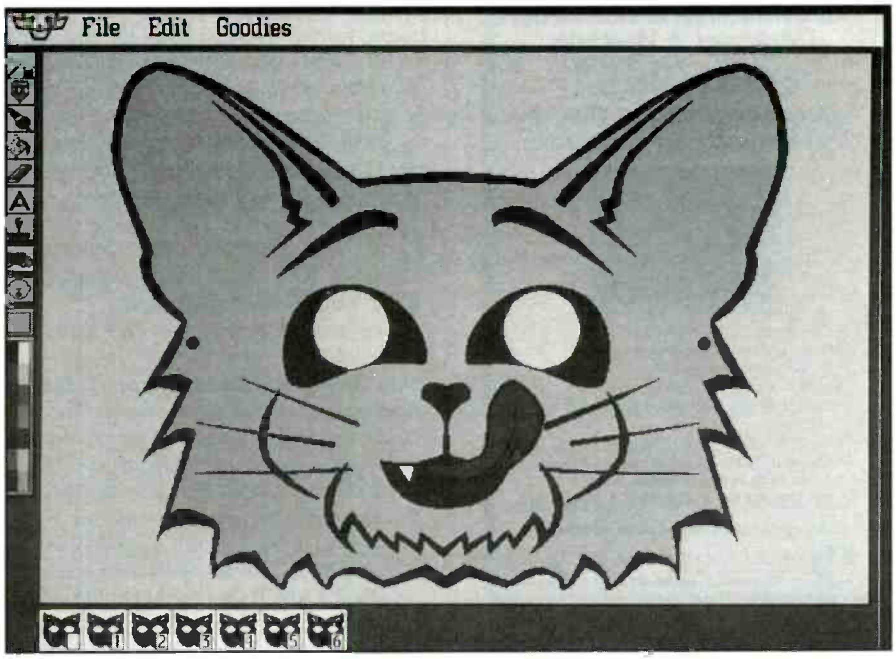
On the other hand, I did see another product on the show floor that should be shipping by the time you read this and that I think might have a profound effect on the market. If you've been reading this column for a while, you've no doubt noticed that I very much like having the ability of printing in color.

At least at the moment, good color output tends to be very expensive. The Hewlett Packard DeskJet 500C I reviewed here last year having been returned, my main color printer for business-related documents is a NEC ColorMate PS, an expensive 300-dpi thermal-transfer unit. At home, I have an Epson LQ-860 dot-matrix printer with four-color ribbon that's fine for much of the stuff my kids like to do and draft copies of business documents. But even with its 360 × 180 resolution, print quality from the LQ-860 doesn't approach what I get out of the NEC.

A new printer from Fargo Electronics just might be the solution for getting good-quality output at a reasonable price. By leaving out complex controller electronics and PostScript, Fargo has produced a color thermal wax-transfer printer with 300-dpi resolution for a list price of just $995! And the per-copy cost of using this printer is a very reasonable 45 cents.

The downside of the Fargo approach is that all page processing takes place on the PC side of the combination, and printing must take place under *Windows* 3.1, which contains the scalable TrueType technology that substitutes for PostScript. At $995, which is less than 25% of what the technology costs right now.

Fargo's printer is also much slower than current thermal-transfer color printers. In fact, it's not all that much faster per page than the DeskJet 500C. But at this price, you can afford to be patient. I'm supposed to receive one for review in the next month or two, and I'm exited at the possibilities it presents.



Example of a fun mask children can make with "Kid Cuts."

Windows for Workgroups

In the January GUI Guts column, Yacco provided a good overview of Microsoft's new peer-to-peer network built around *Windows—Windows for Workgroups*, or *WFW*. I've had a bit of experience with it during the past month that I'd like to share. Since I'm sure that Yacco will be providing more detailed coverage of the product, I'll limit my description of *WFW* to the fact that it builds easy-to-use sharing of resources, like disks and printers, right into *Windows*.

My first experience with *WFW* was very positive. I networked the three 386SX PCs my kids use. Setting up a three-node network took about an hour and half, much of which was installing three Intel EtherExpress network interface cards. These cards, available in standard thick/thin EtherNet (which use coaxial cable) and 10-Base T (which uses twisted pair cable and eight-conductor telephone-like RJ connectors), are unusual in that you set the interrupt and base address through a software program included with the card. I used thin EtherNet, which uses coax and BNC connectors.

Card and cable installation took about 45 minutes, most of which was spent on mechanical tasks like taking off the PC's case, installing the card and cable and putting the case back on. Setting the interrupt and base address took about 5 minutes for all three systems. I spent the remainder of the time installing the *Windows for Workgroups* software and specifying the shared resources.

WFW automatically recognized the Intel card and configured itself. The network was instantly available, and my seven-year-old and six-year-old twins seem to have no trouble with the concept of "Scotty's hard disk" being available on Marc's and Bryan's machines.

My second experience was quite the opposite. *WFW* can be run concurrently with several in-place networks, including NetWare, LanMan, and others. The one caveat Microsoft gives is that the ArcNet (a less-popular type of network setup) versions of these LANs can't concurrently run the network operating system and *WFW*. Believe it! I tried to set up *WFW* in my office, which has an ArcNet twisted-pair NetWare LAN. It was my hope that even if we couldn't run currently with the Novel NetWare LAN, we might be able to share the wiring. No such luck!

The bottom line is that as the primary network for a workgroup, *WFW* is one of the easiest to install and use that I've yet come across. Sharing resources is as easy as clicking on an icon, and drag and drop (in the File Manager) works just fine for transferring files across the network. On the other hand, adding a *WFW* workgroup to an existing network setup may not go quite that easily.

Kid Cuts

Even though this is primarily an adult-oriented column, with so many readers having children and grandchildren, every once in a while I try to cover some of the many excellent programs that are available for them. Several readers, and many vendors, have asked me how I decide which software products I'm going to cover. After all, as an adult, my perspective of what's interesting is obviously much different from a child's (or at least it's supposed to be; in reality, it probably isn't all that much different!). The answer's easy—I have my own "pediatric software test lab" right in my own home.

This lab has a staff of four kids, ranging in age from seven down to four years old. When a package comes in, I install it on one of the three 386SX PCs my kids use, give all four of them a walk-through on the package and step aside. Their actions and reactions over the next few weeks determine whether or not a program gets reviewed.

The first step is to see if any of the other kids demand that the software be installed on their PCs. (Please don't write to tell me that this violates the license agreement. I tell vendors that for their packages to be considered for review, it will have to be used by at least two, and possibly three kids simultaneously. If they aren't willing, they don't send their package.) If at least two kids want the package and are still using it three or four weeks later, it gets reviewed.

The latest hit here at the "lab" is Broderbund's *Kid Cuts*. Broderbund is famous for its *Print Shop* program and the *Carmen Sandiego* series (which has even been turned into a TV show) and has lots of great software for kids. *Kid Cuts* is a follow-on to Broderbund's very successful *Kid Pix* package and is virtually an arts-and-crafts studio on a disk.

Conceptually, *Kid Cuts* is very much like Broderbund's *Kid Pix*. It provides lots of easy-to-use drawing tools, like "wacky" paintbrushes and lots of "rubber stamps" that let kids reproduce the same designs all over the screen. Where *Kid Cuts* differs from *Kid Pix* and the software really shines is in its pre-defined templates, called "projects."

These projects provide basic outlines for kids to color and otherwise embellish on and are organized into animals, masks, puzzles, hats, dolls, puppets, greeting cards, shapes and "rainy day" surprises. To use the software, a child picks a topic, such as masks and chooses from a list of what's available under that topic. For example, under masks, he can choose from a cat mask, butterfly, monster or knight. When the mask chosen appears on-screen, the child can apply a pattern or, if a color printer is being used, a color to it. Then the mask is printed out and assembled. Along with the particular project being printed, the program also prints out accessories, such as a magic dagger to accompany the knight mask.

Documentation for *Kid Cuts* gives clear directions on how to use the program, though my "lab assistants" found it pretty much intuitive. There are also assembly instructions for some of the more-complicated projects (though none are all that complex), and suggestions for further decorating ideas. *Kid Cuts* even includes a pair of safety scissors for kids to cut out their projects.

Broderbund's literature gives the target audience as kids between 4 and 12. While I believe that many 12-year-olds might find the projects a bit too childish, my four-, six- and seven-year-olds haven't stopped playing with *Kid Cuts* since it was installed. In fact, they're already asking if Broderbund is going to provide any additional projects.

Kid Cuts is a DOS-based program (though it should also be available for the Mac, since most Broderbund software is) and requires a hard disk and mouse. It also requires VGA video, and a sound card is both supported and recommended. The Sound Blaster cards installed in all of the kids' systems work just fine, though the noise level in the playroom when *Kid Cuts* is running on all three systems is not to be believed! The Disney Sound Source, the $40 sound box that's available for the Disney Software line, is also supported.

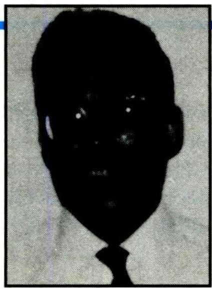
Kid Cuts supports a wide range of printers, including dot-matrix, ink-jet, and PostScript color types. It's best used, however, with a printer that can feed heavy construction paper or report covers through it. These make much better masks and playthings when cut out.

One of the most delightful discoveries I've made as a middle-aged parent is just how imaginative children can be. Give them a napkin or tablecloth, and they become Zorro, Superman or a Ninja Turtle. At a list price of $59.95 (which is probably closer to $40 or $45 at big computer superstores), *Kid Cuts* is a terrific way to leverage that imagination. I think it's a great program, and so do all four of my kids!

Product Reviewed

Kid Cuts, $59.95
Broderbund Software
P.O. Box 6125
Novato, CA 94948
Tel.: 800-521-6263

CIRCLE NO. 116 ON FREE INFORMATION CARD



Joseph Desposito

Low-Voltage RISC Microprocessor; Dynamic Bus Sizer; 4M VRAM; Low-Dropout Regulator; and Multi-Function Supervisory IC

Low-voltage logic circuitry has become the rage for low-power and portable computer equipment. With this in mind, I lead off this column with a new 3.3-volt RISC microprocessor that features internal clock that operates at speeds ranging up to 150 MHz.

Low-Voltage RISC Microprocessor

The VR4400 from NEC Electronics, Inc. (401 Ellis St., P.O. Box 7241, Mountain View, CA 94039) is a fully optimized family of RISC microprocessors that operate at 3.3 or 5 volts. These devices feature external clock speeds of up to 75 MHz and internal clock speeds that can double this figure to 150 MHz. With more than 2-million transistors on a chip, the VR4400 family is suitable for workstation, high-end PC and multi-processing system applications.

The VR4400 family of RISC microprocessors is based on the MIPS R4400 architecture that implements such techniques as super-pipelining, pipelined floating-point unit, two-level cache memory and high-performance on-chip translation look-aside buffer (TLB). In addition, cache and a memory management unit (MMU) offer high-performance in handling both large-address-space tasks and a large number of users.

This microprocessor offers 64-bit integer and floating-point operations, registers and virtual addresses. On-chip primary cache memory consists of 16K each of instruction cache and data cache, which allows for higher integer and floating-point performance. Simulation of an R4400 processor delivers 113 SPECmarks overall, with 95 SPECint89 (integer performance) and 126 SPECfp89 (floating-point performance).

A 0.6-micron fabrication process was used to boost external and internal clock speeds to 75 and 150 MHz, respectively. The VR4400 family also includes 67-MHz external/34-MHz internal and 50-/100-MHz versions in both 3.3- and 5-volt designs. The devices feature an optional 128-bit secondary cache interface that allows for up to 4 megabytes of secondary cache.

This fully integrated CPU chip is also upward-compatible with all NEC VR-Series 32-bit and 64-bit microprocessors, which includes the VR3000A and VR4000 families.

Included in the VR4400 device family are the VR4400PC primary cache version, VR4400SC secondary cache version and VR4400MC multi-processing version.

NEC plans to offer VR4400-family devices, in more-than-10,000-piece quantities, for $1,250 each for the VR4400PC; $1,450 each for the VR4400SC; and $1,750 each for the VR4400MC.

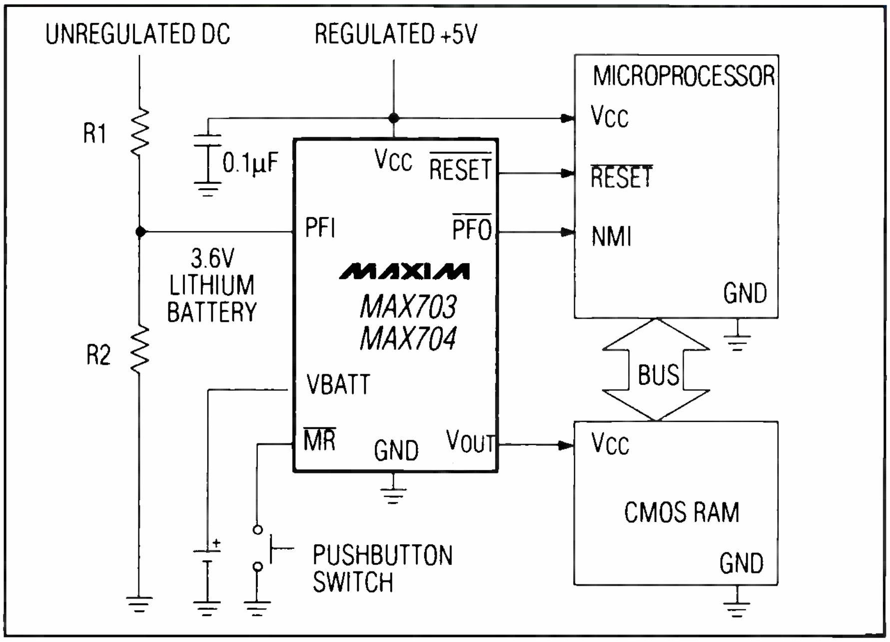


Fig. 1. Maxim Integrated Products' MAX703 and MAX704 guard microprocessors, RAM and other critical circuits against power-supply interruptions and failures. Offering battery-backup, power-fail warning, reset and manual-reset functions, these compact eight-pin devices draw only 200 µA of quiescent supply current. In back-up mode, they draw only 50 µA.

Dynamic Bus Sizer

Motorola's (2200 W. Broadway, Mesa, AZ 85202) new dynamic bus sizer reduces design time and board space and allows 32-bit buses to communicate bi-directionally with 32-, 16- and eight-bit peripherals and memories. The MC68150 Dynamic Bus Sizer dynamically recognizes the size of the selected peripheral/memory and then reads or writes the appropriate data to or from the accessed location.

The MC68150 bus sizer gives designers an easy method of bus sizing to eight- and 16-bit peripherals while designing with MC68040, MC68EC040, MC68LC040 and other processors. The Dynamic Bus Sizer also allows designers to choose between synchronous and asynchronous timing control, which allows greater application flexibility. Also, systems designed to use the 68000 processor, which has built-in bus sizing features, can now be easily upgraded to the 68040 processor by incorporating the MC68150 Bus Sizer.

With the MC68150 Bus Sizer, designers have an advantageous alternative to existing ASIC and discrete approaches. Designs done with ASICs are more expensive, require an NRE charge and additional design time. Discrete solutions take up more board space and also require additional design time.

The Dynamic Bus Sizer replaces PALs, latches and transceivers, which are the discrete solutions currently used to size buses. Therefore, printed-circuit-board layout is simplified and board real estate is reduced, thanks to the Dynamic Bus Sizer's reduction in number of components needed to implement a design.

Typical operations that call for bus sizing are boot-up instructions from eight-bit ROM and communicating with eight-bit SRAMs for scratch-memory storage during interrupt operations. The dynamic property is necessary because the processor doesn't always know the size of the bus used in the peripheral it's accessing, as in the case of communicating with a VME bus. Specifically, the MC68150 is useful in any application that uses MC68040, MC68LC040 or MC68EC040 processors when bus sizing is required to access eight- or 16-bit peripherals or eight-, 16- or 32-bit variable-size buses.

The MC68150 Dynamic Bus Sizer is available in a 68-pin PLCC package with an operating temperature range of 0°C to +70°C. In 100-piece quantities, the chip is priced at $9 for U.S. delivery only.

New 4M VRAM

Micron Semiconductor, Inc. (2805 East Columbia Rd., Boise, ID 83706) has a next-generation video RAM. The 4M VRAM, designed with a JEDEC-standard, provides 512 × 16 full-length SAM (Serial Access Memory) for upward compatibility. This latest VRAM design anticipates the demands of the rapidly evolving workstation and graphics markets.

With such JEDEC-standard features as eight-column block write, split read/write transfers, full-length SAM and programmable splits, the 4M VRAM is said to fully support the higher bandwidth requirements and faster display refresh capabilities of state-of-the-art graphics applications in high-performance systems.

In addition to providing full compatibility with previous generations, the 4M VRAM's full-length SAM requires fewer transfers than a half-length SAM, thus increasing performance. The MT42C256K16 4M VRAM has the same function set as the full-featured MT42C8256 2M VRAM, providing an easy path for upgrading.

Micron plans to begin sampling its 4M VRAM in the second quarter of 1993. The first parts will be available in speeds as fast as 70 ns, with 20-ns serial access time. Organized as 256K X 16, the MT42C256K16 is packaged in a 64-pin SOP.

Low-Dropout Voltage Regulator

Linear Technology Corp. (1630 McCarthy Blvd., Milpitas, CA 95035) has a family of micro-power low-dropout regulators with a very high ratio (10,000) of output current to quiescent current. Though the LT1129 family (LT1129-5V, LT1129-3.3V and LT1129-2.85V) operates on a quiescent current of 50 µA, it can supply up to 700 mA of output current with a dropout of only 0.45 volt.

Due to their low quiescent current, this new family is a good choice for battery-powered systems. The devices also will find application in many other low-current line-powered systems, post-regulators for switching power supplies and SCSI active-termination circuits.

All devices in the LT1129 family are equipped with a pin that permits the output to be shut down. Quiescent current is only 30 µA in shut-down. Quiescent current of the new family is well controlled and doesn't increase significantly in dropout, unlike other pnp low-dropout regulators. The new devices have trimmed outputs of 2.85, 3.3 or 5 volts.

A benefit of the LT1129 is its ability to operate with a small 3.3-µF output capacitor, rather than the 10- to 100-µF capacitor required by older low-dropout regulators.

If the input of the LT1129 is connected to ground or a reverse voltage, it doesn't permit current to flow from the output back to the input. This makes the device suitable for back-up power situations where the output is held high and the input is pulled to ground or some negative potential. When the output is held high by an external source, only 16 µA flows from the output pin to ground.

Pricing of the LT1129-2.85, LT1129-3.3 and LT1129-5 in 100-and-up quantities is $2.25 to $2.35, depending on packaging.

Multi-Function Supervisory ICs

Maxim Integrated Products' (120 San Gabriel Dr., Sunnyvale, CA 94086) MAX703 and MAX704 ICs guard microprocessors, RAM and other critical circuits against power-supply interruptions and failures. Offering battery-backup, power-fail warning, reset and manual-reset functions (Fig. 1), these compact eight-pin devices draw only 200 µA of quiescent supply current. In backup mode, they draw only 50 µA.

The ICs differ only in their supply-voltage monitor levels. The MAX703 generates a reset when the supply drops below 4.65 volts, and the MAX704 generates a reset below 4.4 volts.

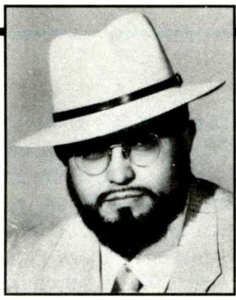
On power-up, RESET* is guaranteed low after Vcc reaches 1 volt and remains low until approximately 200 ms after Vcc has risen above the trip threshold. Other automatic RESET* signals are issued in response to power-down, brownouts and momentary power interruptions. An MR* input lets you command manual resets, and the RESET* pulse's width (140 ms minimum) effectively debounces this input. RESET* signals are valid for supply-rail Vcc as low as 1 volt.

The MAX703 and MAX704 protect the contents of system RAM and other critical circuits by switching over to an emergency backup voltage when Vcc drops below the trip threshold.

Batteries can provide this backup. For other applications, a large capacitor, such as MaxCap or SuperCap, charged via Vcc, provides adequate backup voltage.

An independent power-fail circuit monitors an applied voltage, issuing a digital warning (PFO*) when the potential is less than 1.25 volts. This power-fail comparator can give the uP early warning of a Vcc failure, or monitor any other voltage.

Prices for the MAX703 and MAX704 start at $1.38 when purchased in quantities of 25,000 pieces or more.



Windows Memory Management

A byte just won't buy what it used to any more. Remember when you were growing up? Andy Cap's would pour you a straight shot, or draw one from the tap, for half a byte (just four bits or one thin nibble). You could get a gallon of high-test gas at the Flying "A" or a pack of Old Golds cigarettes at the check-out counter, for two bits. You could even take a bit to the movies, and that girl you liked behind the candy counter would give you a Look and a Big Hunk.

Back in the "Good Old Days," if you had a couple of kilobytes, people called you a "killionaire." Mainframes had only 4K bytes, and if a system had 16K, it was darn near a super-computer. Heck, you had no idea what you'd ever do with all that memory. People even began to speculate that someday COBOL might not need an ALTER command.

That's not the way it is today. DRAM isn't core. A past when memory cost a dollar per byte seems as dim as a 3-watt bulb. Even many kilobytes, more or less, on each of several hundred workstations adds up to only a few inexpensive megabytes. Nevertheless, there are some bytes that can bring back the old cost of memory with a vengeance.

"No way," you say? If a new driver or TSR requires just an extra byte or two, the cost could go way, way over a buck a byte. Ask yourself this question. What's the cost to your company if you can't run needed applications because they won't fit on your workstations?

Unfortunately, until now, memory management under *Windows'* Enhanced mode has largely been a moot point. You could talk it to death, but with a few specialized exceptions, you couldn't do much about it.

Memory managers, such as Qualitas *386Max* and Quarterdeck *QEMM-386*, let you precisely tailor memory for DOS. You can use them to move things about and free large areas, but only for use by DOS applications. *Windows'* Standard mode works with these memory managers to provide their services to DOS applications too. However, *Windows* operates as only a task switcher in Standard mode. It doesn't allow you to multitask DOS applications.

If you want to run DOS tasks, such as diskette formatting or file downloading, in the background, you must use *Windows* Enhanced mode. But Enhanced mode's first step is to replace any existing memory management with services that are carefree but largely beyond user control. Some extra memory is no longer available for direct use by DOS applications (see "Windows Tip" box).

This relationship between *Windows* and memory-management software is about to change—in a major way—with introduction of Helix Software's Cloaking technology. This February, Helix will introduce its *NETROOM* Version 3.0 memory manager. It will quite likely have a new name that smacks slightly less of networking and better reflects its wide applicability. But you'll know it when you see it (if not from Cloaking, then perhaps from my "Memory Management" article in the May and June 1992 issues of *ComputerCraft*).

Product Summary

Here's a summary of *NETROOM* 3.0 features that are most relevant to users of current hardware and systems software. *NETROOM* continues to offer a replacement for HIMEM.SYS (to provide XMS and HMA memory). It provides both UMB and EMS memory and loads TSRs, drivers, DOS BUFFERS, DOS FILES, and COMMAND.COM high. (*NETROOM* loads drivers high from either CONFIG.SYS or from AUTOEXEC.BAT or the command line, eliminating the need to reboot when adding modules to a configuration.)

The program's sophisticated automatic installation finds not just the TSRs and drivers in AUTOEXEC.BAT, but also those in nested batch jobs. (A vast array of parameters alternatively gives you precise control of memory resources. *NETROOM's* DISCOVER module provides both a memory map and an editor you can use to find available memory regions and add them to the XMS or EMS pools by modifying CONFIG and AUTOEXEC files.)

NETROOM claims to be more clever than most memory managers at excluding areas like hard-to-detect token-ring cards. It runs on just about any technically current hardware and normally allocates all memory from a shared pool. Moreover, this version of *NETROOM* is also a DOS Protected Mode Interface (DPMI) host.

The NETSWAP4 utility is still part of *NETROOM*. It creates a virtual machine you can load drivers and some TSRs "out." Helix says that loading out, combined with loading high, can give you a total of at least 704K for TSRs and drivers—in addition to application memory. It can provide 776K using some *NETROOM* BIOS-compression tricks, and as much as 800K for monochrome applications by combining BIOS compression with recovery of some extra video-buffer space. Of course, this functionality comes at the expense of a performance penalty as *NETROOM* switches between virtual machines during inter-process communication.

Helix admits that its worst-case performance degradation for such large virtual machines can amount to as much as 30% on a busy network server, but the company claims less than a 10% hit on average. Furthermore, *NETROOM* can also create a smaller virtual machine that overlays only the area occupied by upper memory blocks (UMBs) and not all of conventional memory. This arrangement can sometimes run relocated code without degradation, because there's a performance loss only if code in one virtual machine communicates with code in the other. Code in low memory can't conflict in this case since it doesn't occupy the same address space as the smaller virtual machine.

Does the foregoing mean you can have more than 1M of DOS addressable real memory? Yes. You could, for instance, run *PC Tools*, NetWare and a CD-ROM drive without using any conventional space. It works with any graphics application, including *Windows* in Enhanced mode. You can actually have a network re-director running in one *Windows* DOS session working in conjunction with a DOS program that you're running in a completely different session.

I began this column with the premise that the *Windows* Enhanced mode doesn't use the services of a memory manager. This is usually true. However, SWAPNET4 is written as a VxD, or virtual device driver. A VxD can perform privileged functions under *Windows*. (VxDs are documented in the *Windows* Device Driver Kit, or DDK.) *Windows* 3.0 required memory managers to cooperate through use of one of these drivers, LOADHI.VXD. *NETROOM* used them to its advantage to control instancing of processes and its virtual machines.

In *Windows* 3.0, a memory manager had to have a VxD because *Windows* hadn't fully implemented the Windows/386 Paging Import Specification (WPIS) that Version 3.1 uses to smoothly transfer memory-management control. In *Windows* 3.1, a VxD isn't strictly necessary, but it still can be used. *NETROOM* 3.0 (now in

Windows Tip

Windows loads different routines for Standard and Enhanced modes, and they work with memory managers in distinct ways. When you load a memory manager under DOS, the first thing it does is take over the hardware in protected mode and moves DOS into a virtual machine. The memory manager runs in Ring 0, which is the highest protected-mode privilege level. (Virtual machines, by contrast, rate lower than the lowest protected-mode ring.)

In Standard mode, *Windows* is just a task switcher. When *Windows* loads in Standard mode, the memory manager stays in Ring 0, controls protected mode and provides memory services to applications through Virtual Control Program Interface (VCPI) protocols. *Windows* runs in a virtual machine and provides task switching for applications. When it changes between applications, an entire virtual machine is swapped out to disk and replaced with another. Only the application running in the current virtual machine is active. Only non-pre-emptive multitasking is provided within a virtual machine, and *Windows* provides this cooperative form of operation for its applications.

When *Windows* runs in Enhanced mode, things proceed quite differently. Initially, Enhanced mode takes over protected operation in Ring 0. It uses a protocol called the Windows/386 Paging Import Specification to transfer the location and size of upper memory blocks, as well as expanded memory (EMS) and extended memory (XMS) to handle information between memory-management utilities and *Windows*. It replaces any stand-alone memory manager with its own (while the memory manager becomes dormant), takes over control of all active memory management and continues to manage memory for itself and its client applications— including DOS applications running either in a window or in full-screen mode, through DOS Protected Mode Interface (DPMI) services.

All memory is placed into a common pool from which *Windows* allocates EMS, XMS or other resources as programs require them. *NETROOM* 3.0 is an exception in this scenario because it includes routines that function as a virtual device driver. Those routines allow it to coexist with *Windows* and continue to provide certain protected-mode memory services.

Windows' Enhanced mode loads the routines that provide its graphical environment—the part users perceive as *Windows*—into the first virtual machine. It loads additional DOS sessions into other virtual machines as the memory resources it's managing allow. *Windows* applications all run from one virtual machine, just as they do in Standard mode, with non-pre-emptive multitasking. However, *Windows* pre-emptively multitasks among its virtual machines. This allows DOS applications to run in the background.

When Enhanced mode swaps to disk, it stores only pages of inactive code. All applications remain active, concurrently sharing system resources, as they're multitasked by the processor. However, DOS applications lose the benefits provided by customizable memory managers since they're replaced by the *Windows* memory manager. When *Windows* shuts down, control of memory areas is handed back to the memory manager with the related applications intact.

The significance of the memory-management differences between Standard and Enhanced modes is demonstrated by an application like Lotus *1-2-3*. Version 3.0 of *1-2-3* had only VCPI support and ran in only Standard mode. Version 3.1 of *1-2-3* has DPMI support and runs in Enhanced mode and can recalculate in the background.

beta, and expected to ship in February) continues to use VxD technology as it did before, and also to implement its new Cloaking features.

Cloaking allows DOS to load 32-bit protected-mode programs and run them in extended memory. This can provide substantial advantages over ordinary memory management. For example, *NETROOM* provides EMS services to DOS applications with its RAM-MAN/386 utility. EMS frames are automatically created for RAM-MAN/386 by the CUSTOMIZE routine. It automatically finds the optimum fit for loading TSRs and drivers high and places the required commands into the AUTOEXEC.BAT and CONFIG.SYS files on your disk.

CUSTOMIZE also exercises the system BIOS and finds areas that can be recovered for UMBs. It can compress a BIOS down to as little as 32K using this method. These services are comparable to those provided by other top memory managers. Cloaking, though, can do even better by moving the entire system BIOS—and even video BIOS—into extended memory and running them in *Windows* protected mode. These areas are then available for applications, drivers and TSRs.

To take advantage of the technique, however, protected-mode applications must be Cloaking-aware. The only applications to use the API are presently those provided in the *NETROOM* package, but they're formidable. For example, Helix includes three Award-licensed replacement system BIOSes. These versions rely on your built-in BIOS for the POST (power-on self test) and setup routines. So, they're compatible with almost any currently shipping computer and can be substituted for the native BIOS in 386SX, 386 and 486 systems for ISA, EISA and Micro Channel.

The Award-Helix BIOS have several advantages. They not only give your machine an instant upgrade, but Helix says they're likely to be faster than your old BIOS. Running in protected mode gives them a linear address space and lets them run in Ring 0, which is the most privileged level. As a consequence, they don't slow down when they do things like I/O-port access. Another big benefit is that you get access to the 64K of upper memory blocks that are normally occupied by the native system BIOS.

Helix also provides VGA BIOS options. The first of these moves the BIOS on VGA video cards into protected mode. Lamentably, this method is compatible about only 80% of the time. For those BIOSes that don't move successfully, you can substitute an Award version that's included with *NETROOM*. (Helix says that the Award video BIOS is probably faster than yours, but it lacks super-VGA support which must be specific to each video card.) Either option frees another 32K of VGA BIOS for other use.

Other Cloaked utilities include a RAM-disk and a disk cache that replaces SmartDrive. There's also a graphical screen saver that runs in protected mode. Each utility requires only 40 to 50 bytes (not kilobytes) of conventional memory. The cache alone returns 38K to 40K of conventional memory to applications.

Cloaking can also provide caching for VGA screen fonts. Six different fonts are included with VGA to support various screen modes. Normally, they're all kept in conventional memory at once, even though your screen can be operating in only one mode at a time.

NETROOM saves about 10K of additional memory by sharing one area for all six fonts and loading just the one that's currently needed. It works with most software, except those programs—*Quattro Pro,* for instance—that access more than one font at a time.

Cloaking makes the new *NETROOM* world champ of memory providers. Running everything in protected mode and using font caching can give you as much as 928K of conventional DOS memory to run applications—including *Windows* DOS sessions. (Text applications that don't need the memory-mapped graphics area can have as much as 984K.)

Next month, I'll continue this discussion with some advice for running *Windows* without a memory manager, more details about how *Windows* 3.1 handles memory (including how 3.1 differs from 3.0) and more tips that can make its memory work harder for you.

Products Mentioned

NETROOM, $99
HEADROOM, $129.95
Helix Software Co.
47-09 30 St.
Long Island City, NY 11101
Tel.: 718-392-3100

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What's New!

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J*Com's new line of Transceiver Control Cables interfaces IBM computers with all transceivers and receivers that can be controlled over a serial TTL link. The entire interface is sandwiched into the shielded hood of a DB-25 connector that's compatible with all rig control software, including Kenwood's *HamWindows*, the *K1EA CT* program, PDA's *LOGic*, Scientific Solutions *DXBase* and most others.

Each cable comes completely assembled and ready to plug in. Four models cover all Kenwood, ICOM, and Yaesu computer-ready transceivers/receivers. $54.95. *J*Com, Box 194, Ben Lomond, CA 95005; tel.: 408-335-9120; fax: 408-335-9121.*

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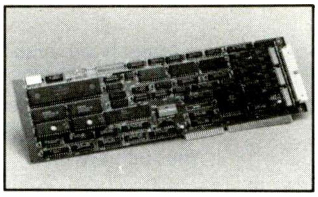
Improved "Sneaker Net"

FileRunner from MBS Technologies is an innovative program designed for users who need to work with the same file on two or more computers that aren't interconnected by wires, cables, modems or networks of any sort. Once installed, the program identifies files that have been added or updated, compresses and saves them to a floppy encoded with data that indicates to which other computers the files should be transferred. "Overwrite Safeguard" prevents overwriting of files changed on more than one computer since the last time *FileRunner* was used. The program checks all files to ensure that a virus isn't transmitted from one computer to another. It automatically adjusts for computers with clocks set for different time zones. Licensing is for a single user, but there's no limit to the number of computers that can be used. $100. *MBS Technologies, Inc., 34 W Sycamore, Arcadia, CA 91006; tel.: 800-860-8700.*

CIRCLE NO. 36 ON FREE CARD

Three-Axis Stepper Control

PcStep from nuLogic is a high-performance three-axis stepper-motor controller board that plugs into a single 16-bit ISA slot in IBM/compatible computers. It enhances the processing power of the computer for integrated motion-control applications. The board includes a disk with a host of *Windows*-compatible motion programming tools.



PcRunner, nuLogic's *Windows*-compatible application, provides out-of-the-box motion control. Simply pointing to and clicking on the desired motion icon lets you interactively set up and control velocity, acceleration, step count, limit switch and all micro-step motion system parameters. *Windows* compatibility is further enhanced by DLLs that implement the entire pcStep command set. $1,095. *nuLogic Inc., 475 Hillside Ave., Needham, MA 02194; tel.: 617-444-7680; fax: 617-444-2903.*

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 (from page 94)

with buxom Amazons who swim topless and regard Rex as a "real" man.

The amount of nudity and sexual innuendo in this game are comparable to what might be seen and heard in an R-rated movie. Accordingly, parents might want to think twice before letting younger children have the game. In any case, the game's Naughty play mode can be changed to something more tame. Concerned parents can even set the game so that Naughty mode isn't accessible.

Graphics of Rex Nebular are somewhat disappointing. The game box uses exciting language concerning graphics: "Mind-blowing graphics and ultra-realistic animation!" This game's graphics are good, but certainly not "mind-blowing" or "ultra-realistic." These descriptors might have been accurate a couple of years ago, but not now, with the advent of super-VGA VESA graphics.

In fairer perspective, *Rex Nebular*'s graphics do a fine job of integrating hand-drawn art with digitization and three-dimensional rendering. What's missing is resolution. Some graphics look very good, like external views of spaceships. Views of game characters, though, like Rex himself, are so poorly resolved that facial features and other physically small details are indistinct to the point of being almost nonexistent. Lack of visual clarity is pointed when Rex is sitting at the console of the *Slippery Pig*.

Playboy Rex is supposed to be slim, handsome and naturally muscular. In great contrast, the game has him resembling a humanoid smear wearing clothing. Additionally, poor graphic resolution undermines the game's Naughty mode. For this mode's sexual titillation to be effective, graphics must support its bawdy dialogue. In the case of the topless bathing Amazon, graphics should be detailed enough so than anyone playing Naughty mode could readily see that the Amazon is truly topless. Otherwise, why have a Naughty mode in a graphic adventure?

Going to more prudent issues, the game's user interface is very good. It's quick for users to grasp and is the kind of interface that allows complete interaction without having to type text. This seems to be the modern trend for adventure games. If so, it's welcome.

Another excellent game feature is its lack of punishment meted out to the player when he makes mistakes or wrong decisions. Like most adventure games, serious mistakes cause death, but *Rex Nebular* doesn't have to start the entire game over. Nor do players have to reload a previously saved game. Rex dies horribly but reappears in a few seconds to continue the game.

MicroProse's first venture into graphic adventure is a decent showing, but it needs some polish. Its humor is all too predictable and deliberate. Though it's sometimes amusing, it's rarely laughably funny. Its game interface is excellent so that even novice adventure gamers should have no problem with it.

Rex Nebular is a fair play for novice-to-median adventurers. Veterans of adventure gaming, however, may find it lacking. By any measurement, it's a good first showing and MicroProse is encouraged to continue this new direction.

Amazon

Access Software has been a leading producer of graphic adventures for a few years. It helped pioneer some game technology that's now considered standard. The company's latest product is a parody of action-packed movie serials that were popular in the 1940s and 1950s. More-experienced adventurers might remember the likes of *Flash Gordon, The Lost City, Rocketman* and *Commando Cody*. This particular graphic adventure, *Amazon: Guardians of Eden*, pays homage to that naive Hollywood entertainment era.

Like the old movie serials, *Amazon* tells its story in succeeding chapters, each chapter having a cliff-hanger ending. Chapter 1, "Terror In The Jungle," kicks off the story. Intrepid archeologist and researcher Allen Roberts is deep in the Amazon River basin. He's on an important safari for Allister Research. His party falls under attack and the entire troupe is missing, and Allen himself is presumed dead.

Back in the states, Allen's younger brother Jason is given the terrible news. Jason is a clean-cut all-American kid, bubbling with life and enthusiasm. He gets a secret letter from Allen that outlines a dangerous mission for Jason to find specified items and personally carry them to Allen. This means making a trip to the Amazon. To make matters worse, Jason is stalked by evil persons unknown to him who will stop at nothing to wreck Allen's expedition.

Amazon sets up this classic plot and takes off running with it, mixing arcade sequences and timed scenes. Arcade sequences are required when Jason is forced to use a makeshift weapon for self-defense. During timed scenes, definite action is needed within minutes or seconds. Failure to act leads to disaster, sometimes immediate death.

Artwork in this game is typical of what Access has been doing for a couple of years. Digitized actors and objects combine with hand-drawn scenes to create an overall believable presentation. This style of work was an early success for Access Software, and it's good to see the company stay with the style.

Amazon offers some improvements over previous Access adventures. Notably, the game interface is easier to use because it doesn't require typing of text and demands less mouse manipulation. This improvement lets gamers concentrate on the story.

Another improvement is the institution of sound effects that are more diverse and music that has more fidelity. A further improvement is the game's support of VESA graphics, which is still a new vehicle for graphic adventure games. Unfortunately, *Amazon*'s VESA graphics aren't very useful. When placed into super-VGA VESA mode, game playing area shrinks to perhaps a third (or less) of original screen size. VESA graphics are extremely sharp and colorful, but on a 14" monitor, one has to almost squint to see what's going on. The rest of the screen is taken up with helpful information, like which story chapters have been done and what usable items Jason has.

Normal VGA mode does well enough for game play, but Access has used this mode on most of its graphic adventures with little change. Perhaps a larger 17" or more monitor would display the game's VESA mode in a more-utilitarian manner.

Amazon joins the growing list of adventure games that reject the arduous, perplexing path in favor of story and enjoyment. Designers actually want players to finish the game, as is demonstrated by the *Amazon*'s pop-up hint window that features more then 600 game hints. Oddly enough, after emphasizing its frustrationless approach, *Amazon* proceeds to subtract game points each time the hint system is used. Refer to the hint window too many times, and you don't get to see the nifty whiz-bang ending of the game; interesting diametric indicators.

Amazon is a good play for adventurers because it's an interesting story, punctuated by testy arcade sequences and challenging timed scenes. It continues an established Access tradition that may be losing its cutting edge in light of competing products. Seasoned adventurers, however, won't find it disappointing.

Indiana Jones

If adventure has a name, it's got to be "Indiana Jones." Movie-goers got a large dose of adventure from the *Indiana Jones* motion picture series. The lovable archaeologist graces the cinema no more, but computer gamers can still thrill to his exploits. *Indiana Jones and the Fate of Atlantis* is the latest saga in the continuing catalog of Indy adventure games. Like its predecessors, *Indy Atlantis* is a very fine game.

LucasArts began its adventure-game tradition a few years ago. It sought to change the face of adventure games and make them more fun and less work. It accomplished its aims admirably with a diverse

Bird's Eye View

Indiana Jones & the Fate of Atlantis, $59.95
LucasArts Games
P.O. Box 10307
San Rafael, CA 94912
Tel.: 415-721-3300

Requirements

Memory	640K, Hard Drive
Graphics	VGA, MCGA
Sound	Ad Lib, Roland, Sound Blaster, SoundMaster II
Controllers	Keyboard, Mouse, Joystick

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Short
Complexity	Easy
Playability	Excellent

In Brief: Graphic adventure at its best. Recommend at least a medium-speed 386 and mouse for best performance.

CIRCLE NO. 118 ON FREE INFORMATION CARD

Bird's Eye View

Amazon: The Guardians of Eden, $69.95
Access Software, Inc.
4910 Amelia Earhart Dr.
Salt Lake City, UT 84116
Tel.: 800-800-4880

Requirements

Memory	640K, Hard Drive
Graphics	VGA, VESA
Sound	All Major Sound Cards
Controllers	Keyboard, Mouse

Evaluation

Documentation	Fair
Graphics	Good
Learning Curve	Short
Complexity	Easy
Playability	Good

In Brief: Graphic adventure that mimics the style of old movie serials. Recommend at least a medium-speed 386 and mouse for best performance.

CIRCLE NO. 119ON FREE INFORMATION CARD

selection of adventure games that had good sport, good fun and ease of play. *Indy Atlantis* is LucasArt's best example yet of adventure without frustration.

Indy Atlantis gets going with fast paces. A Nazi spy steals an artifact and makes a

Bird's Eye View

Rex Nebular and the Cosmis Gender Bender, $69.95
MicroProse Software, Inc.
180 Lakefront Dr.
Hunt Valley, MD 21030
Tel.: 800-879-PLAY

Requirements

Memory	640K, Hard Drive
Graphics	VGA, MCGA
Sound	Roland, Ad Lib, Sound Blaster, Covox, Pro Audio Spectrum
Controllers	Keyboard, Mouse

Evaluation

Documentation	Fair
Graphics	Fair
Learning Curve	Short
Complexity	Easy
Playability	Good

In Brief: An amusing first graphic adventure for MicroProse. Good, but it lacks polish. Recommend at least a medium-speed 386 and mouse for best performance.

CIRCLE NO. 120 ON FREE INFORMATION CARD

near-clean getaway. Indy manages to retain some valuable clues and seeks out his former colleague and old beau, Sophia, a street-wise gal who rakes in dough working as a psychic. Why she quit archaeology and turned to shamanism is beyond the noble precepts of one Indiana Jones. Sophia is even suspected of selling her archeological finds for personal gain. Worse, she believes in the lost continent Atlantis. Still, Indy enlist her support, and the two of them take off for the arctic regions of Iceland to gather more information about mysticism, force fields, space aliens and the lost continent of Atlantis.

If the lost continent exists, Indy must find it and discover its power before the Nazis can do so. Otherwise, America and the free world will have to march to the tune of a goose-stepping dictatorship.

This is one of the best adventure games I've played--maybe the best. *Indy Atlantis* plays so smoothly that one hardly senses the passing of hours of playing time. Its user interface is so seamless that it anticipates logical choices and has them ready for selection. The game's artwork, down to each scene, looks as though it was handcrafted by capable and caring artists.

Game story is immediately intriguing so that it sucks you into play before you know it. Dialogue and humor are witty and campy without being obnoxious, predictable or juvenile. Game puzzles are challenging without giving the feeling of hopelessness. They're compelling without the added fear of having to start over as a result of death due to an abstract silliness.

Finally, the game's musical score carries all the emotion of the original motion-picture soundtrack.

It's just plain difficult to find something bad to write about *Indy Atlantis.* The only possible thing the game could be missing is speech. But everything else is so refined and workable that speech might not be a significant improvement.

Indy Atlantis and other LucasArts games owe their success to the ample resources of LucasArts and the willingness of management to take time to do the job correctly. Therein lies a dual reward. Computer gamers like good games, and good games make money for the designer.

Indy Atlantis is one of those rare games that you're proud to own and don't mind telling someone how much you paid for it. Both novice and experienced gamers will have little problem, and probably no regrets, with *Indy Atlantis.* Though it may not be the best adventure game currently on market, there are surely none better.

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NOTES. Including source and assembled code on disk and printed User manual covering specs, addressing modes, instruction set, and app notes. PCB 3x4 layout for Hitachi HD6303XCP, 8K/32K Ram-Rom, Max690, Max232, 40 pin Bus exp header, 40 pin user port header, on board +5v, reset switch, ext 3V Bat conn. User port has 31 I/O port pins, SCI, Timers, Low Power, sleep, standby pins. App notes ei. LCD, keypad, A/D, D/A, printer, RF serial port, many more! ALL FOR $29 US. **SYSTEM MONITOR** $10, on 27C64, includes Assembler, Disassembler, Simulator, **FREE** shipping. Cheque or Money order TO: **MICROTREK** Universal Microcomputer Products, #107-4141 Dixie Rd., Mississauga, Ontario, Canada L4W 1V5. TEL 416-607-6970.

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MISCELLANEOUS

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A Neo-Adventure

It's interesting to note the change in computer adventure games. Early models were all text and almost deliberately difficult. New adventure games, on the other hand, are heavily graphic and emphasize having a good time and enjoying the story. The following are some examples of Neo-Adventure.

Rex Nebular

MicroProse is widely known, at least in the computer games community, for its authentic military simulations. About a year ago, this computer-game giant made a mediocre foray into the realm of space combat/adventure with a game titled *Lightspeed.* Now MicroProse is looking for a successful jaunt into graphic adventure with the release of *Rex Nebular and the Cosmic Gender Bender.*

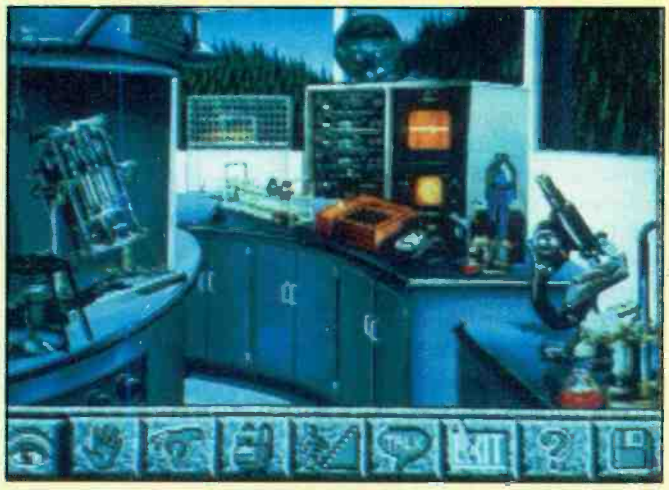
As its name might imply, *Rex Nebular* is a humorous design that's reminiscent of campy movies of a bygone era. Galaxy-hopping space playboy Rex Nebular is about as rich as he's bright, which isn't saying a heck of a lot. He accepts a foolish assignment from a wiseguy space alien to recover a certain vase. Its owner claims that this family artifact has sentimental value.

The vase was last reported on the planet Terra Androgena, which planet disappeared from space many years ago. The mission seems simple enough, but Rex gets much more than for what he bargains. He finds the planet, falls under attack by a ship of space Amazons and ends up at the bottom of a large lake with his ship (the *Slippery Pig*) in tatters. Thus, the adventure begins.

This graphic adventure fosters an attitude and style that's brash and rude. Part of the game's documentation is the personal log of Rex Nebular, leading up to the crash on Terra Androgena. The log evidences Rex's loose and grimy life style, portraying him as a galactic mercenary and womanizer who thinks that sex and drunkenness are the height of life. As you might guess, this game is male chauvinistic; so feminists may not want to play. There's some nudity in the game, as Rex meets

(Continued on page 88)

The "Slippery Pig" in "Rex Nebular" sits at the bottom of a lake.



Allen Roberts' lab in "Amazon: The Guardians of Eden."

Indy faces a bruising doorman in "Indy Atlantis."

Indy and Sophia search for clues in "Indy Atlantis."