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ComputerCraft

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UPGRADING & ENHANCING

APPLICATIONS

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DEPARTMENTS

ON THE COVER: The power and advantages of CD-ROM aren't just for the personal computer user anymore. A variety of companies—with Tandy/Memorex, Sony, Kodak and Philips, among the major players in the arena—are marketing largely non-compatible no-computer units. Though they haven't eliminated the computer altogether, they insulate him from having to be technically capable or computer-proficient. The story behind these new players begins on page 22 of this issue.

Cover Photo by Liz Benford

Editorial By Art Salsberg

In a Flash

Flash mass-storage modules aren't yet challenging disk drives, but they show promise of capturing a large share in sub-notebook and palmtop computers. Without any moving parts, they're faster than electromechanical drives. Moreover, a credit-card-size flash-memory card can store as much as 20M of data.

Then why aren't they displacing drives, you may ask? The answer is simple. Drives are a lot less costly in 10M to 20M capacities. But in 1M or 2M-or-so capacities, where drives aren't even made, flash cards are appealing due to their small size, ruggedness, low power requirements and good speed performance.

Obviously, one couldn't use a mass-storage device that has only 1 or 2 megabytes for applications that require more than this, which is commonplace with today's software. But for certain limited applications, where easy portability is a primary consideration, they can fill the bill well.

In particular, Personal Digital Assistants, the palmtop systems that are expected to inundate the market in the near future, don't require large memory capacities. They'll be largely used for phone books, diaries, calendars and the like.

The whole flash-memory technology is rather new. So are the cards and slots, which started with the Personal Computer Memory Card International Association, formed in 1989. The Association developed a handful of standards, which can also accommodate small-form-factor hard drives, as well as flash memory that emulates drives. There are some 300 companies in the Association, including IBM, Intel and Lotus Development.

PCMCIA cards come in three sizes: Type 1, which is 3.3-mm thick; Type II, which is 5.0-mm thick; and Type III, which is 10.5-mm thick. A card can be pulled out and another plugged in, so that you can choose, say, a fax/modem card, a flash drive emulator, a 1.8" hard drive or other device as you need it.

Type I PC cards are used for memory enhancements, such as RAM, EEPROM and flash memory. Type II cards are generally used for memory, too, as well as modem and input/output (I/O). Type III cards are double the thickness of Type II to accommodate removable hard-disk drives. All use the same interface.

Standards relate to more than hardware. They specify the interface to access a computer's PCMCIA sockets, detecting insertion and removal of a PC card while power is on, allocating memory and interrupts and an interface to higher-level software to load hardware drivers.

All the foregoing permit plug-and-play capabilities in a device the size of a plastic credit card. Once software is loaded, a card can be inserted into an external slot and can be removed and replaced by a card with a different function without powering down the computer. Moreover, the initially loaded software automatically configures the system when a new card is added or removed.

PCMCIA cards originally called for a memory-array implementation. More recently, an ATA (AT Attachment) protocol was adopted that's actually a superset of the protocol for IDE drives. In addition to enabling much higher storage capacity, a flash card can be configured as a disk using PCMCIA commands to make it appear as an IDE hard-disk drive to the computer being used

To use a PCMCIA card for disk emulation requires special software, which is available from such companies as Phoenix Technologies, Award Software and American Megatrends, among others.

Unfortunately, the standard isn't an absolute one followed precisely by manufacturers, reminding one of the RS-232 serial port. Manufacturers are permitted to "customize" their cards with special software solutions. It's likely, therefore, that some industry leader will develop an architecture that becomes a *de facto* standard so that you could use cards interchangeably on most PCMCIA machines instead of wondering if the addressing and I/O schemes are compatible.

Expect to see more and more card-ready machines, even desktop computers, with such provisions. Hopefully, PCMCIA compliance will soon be achieved. Among major flash-memory makers are AMD, AMI, AT&T Fujitsu, Intel, Oki, SCM, SST, Sundisk and Toshiba. Many more makers are expected to enter the field as it reaches for critical mass in the marketplace.

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Diagnostics Musings

• I purchased *CheckIt, QAPlus, QAPlus/FE, Landmark Service Diagnostics for AT and PS/2, AMI Diagnostics* (my best choice at this time) and *KickStart 2*. I was looking for an all-around diagnostic for testing hardware but have yet to find one where everything works well. None of these diagnostics found the problem with Micronics 486 motherboards that had a hardware flaw that caused them to lock up with more than one under/overflow error. A lot of diagnostics failed timer tests on the newer 486DX/2s due to a need to tune the delay loops within their software. (Most BIOSes had to be modified on the systems as well because of speed difference.) The problem is that just when you think you have a diagnostic that works well, newer machines with different hardware come out and new standards are presented (local bus) or updated (SCSI 3).

The problem of finding IRQ and DMA conflicts is two-fold. One is that the interrupt must be generated at when the diagnostic software is looking for it. (You will notice that the programs generally ask you to move the mouse so that it can detect the interrupts.) The other is that drivers for the board need to be installed and even then no interrupts may be generated. The only way to check out these machines is to pull off their covers and find the documentation for the systems and peripherals. Unfortunately, lost literature is usually the biggest obstacle to resolving problems of this nature because a lot of small companies have been swallowed up or have gone under and their literature is difficult to come by.

The industry is moving toward making boards on which you set I/O, MEM, IRQ, DMA and BIOS location via software. This could make things easier, but watch out. The default settings of a new board being installed, if already being used by other peripherals already present in the computer, can lock up a computer during boot-up. IBM PS/2s with third-party boards have been known to have this problem. I find EISA boards more difficult in this area because setup gives too many choices and there are not many, if any, manuals that show how to set up EISA machines with both EISA and ISA boards installed. The main manual I keep around, besides the IBM Technical Reference guides, is *Upgrading and Repairing PCs*, second edition, by QUE Publishing.

I find that the diagnostics have more features than are necessary. I generally use QEMM's *Manifest* and Microsoft *Diagnostic*, along with the hardware diagnostics. I am seeing a trend to have diagnostics broken up to test specific items due to the wide variety. Video like monochrome, Hercules, PGA, CGA, EGA, VGA, SVGA, etc.; hard disks like RLL, MFM, ESDI, IDE, SCSI); memory types like nine- or 32-bit, DIP, SIPP or SIMM, page mode, static column mode, interleave, band switched, SRAM (usually cache memory), or DRAM or virtual (hard disk), parity bit or on-chip error-correcting coding. I could go on and on.

Here are my notes on these diagnostics, beginning with strong points:

• *QAPlus*—COM DEBUG utility

• *QAPlus/FE*—Gives more selections of test routines to choose from and tests PS/2s

• *Landmark*—Small program size (double density for old units, most of the others now fit on high-density disks at the least)

• *CheckIt*—Good overall user interface

• *AMI Diagnostic*—Strong contender. Tells you RAM cache size and tests cache, both internal (486 only) and external

Weak points: these programs will not run on Tandy, PS/2 (Landmark makes a separate set for PS/2s), ITT and machines that have peculiar hardware (8086 instead of 8088, for example) and/or firmware. I thought of this while I read in your article in the March issue that mentioned how all

(Continued on page 83)

NYT Computer Fax. The New York Times provides a new fax-delivery service on articles that it published about computers and elated subjects. Available by fax (or mail), there's a $3.95 per article charge that can be selected from its computer columns, the Science Times section and from its Executive Computer column. Callers may dial 1-800-551-0159 if they wish to pay by credit card or get articles by mail, or call 1-900-737-4446 for immediate fax delivery.

New PC Audio Standards Committee. Yamaha Systems Technology Division joined with several leading PC audio hardware and software manufacturers to for the Gold Sound Standard Council to promote an open standard for PC audio. The Standard surpasses MPC and Windows sound requirements, addressing the emerging Windows- oriented business audio field along with DOS-based games and educational titles. More than 80 new Gold Sound Standard compatible software titles are said to be shipping or awaiting final release.

FAX-A-CHECK. CheckMaster Corp. (Oceanside, CA) announced FAX-A- CHECK, which is a pre-authorized draft that can be used for payment by fax instead of a credit card or COD charges. Drafts are drawn by the payee on the bank account of the depositor authorizing the draft, using an MICR line that the user can print using CheckMaster's software. It's a Windows-based program that requires Windows 3.1, a laser printer and an MICR toner cartridge. Base price is $199.

Imprinted Sportswear for PC Enthusiasts. Imprinted sportswear and gift items that reflect personal computer interests has been announced by ComputerWear (206-788-6353). The line consists of computer-generated art and humorous computer-oriented cartoons imprinted on cotton T-shirts, ceramic coffee mugs and canvas tote bags.

Getting Smaller. PCMCIA (Personal Computer Memory Card International Association) PC slots are expected to be in more than half of all new PCs shipped by 1997, says the Gartner Group (Stamford, CT), based on its market analysis. The PC card standards will play a significant role in the evolution of highly mobile PC products. Portia Isaacson, president of Dream IT, Inc. (Colorado Springs, CO) expects to see desktop computers with PC Card slots, too, while projecting that palmtop computers and PDAs to match U.S. shipments of notebooks and tablet Pen computers by 1995.

Windows Speech-Recognition Interface. Verbex Voice Systems (Edison, NJ) announced the first continuous speech interface for Windows. It allows users to quickly command, control, enter data, navigate and make inquiries by voice. Includes a Speech Commander coprocessor board with digital signal processing and Listen for Windows software. Listen has hundreds of resident words that can be spoken individually or combined to create sentences used for controlling desktop menus, utilities and common Windows application commands. The system is a conversational speech interface that accepts vocal information without requiring pauses between words in much the same way as when speaking to another person. The board plugs into any ISA-bus PC running Windows 3.1. Priced at $995,there's a special introductory price of $695. (Tel. 908-225-5225.)

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Multimedia Portable PC

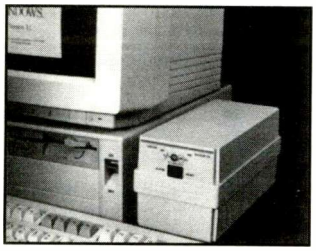
The Multimedia Portable PC from Micro Express features VESA-standard local-bus graphics and a high-resolution (0.26-mm dot pitch) Sony Trinitron color CRT. Based on the 33-MHz 486DX CPU, it has 4M of RAM, 250M IDE hard drive, 5¼" and 3½" floppy drives, SoundBlaster card, two external speakers and internal hi-fi speaker, Sony CD-ROM drive, mouse, *Windows* 3.1 and DOS 5.0. With a digitally synthesized clock for setting CPU clock rates, this upgradable system can also be ordered with a 486DX/50 or 486DX2/66 CPU. The 8½" diagonal-measure video monitor provides up to 1,024 × 768 resolution and has adjustable brightness and contrast controls.

Up to 32M of RAM and up to 1M of direct-mapped, write-back or write-through RAM cache can be added to the motherboard. This PC is packaged in a 17½" × 14" × 6¾" portable case with integral handle. It weighs about 30 pounds. $3,250. *Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705; tel.: 714-852-1400.*

CIRCLE NO. 1 ON FREE CARD

Small UPS

Tripp Lite's Model BC 400 small, lightweight 400-VA battery backup system is said to combine outstanding performance from its redesigned circuitry for powering desktop PCs, phone systems, cash registers and such internet hardware as hubs, bridges and routers. The UL listed UPS features two spike-protected ac outlets, larger batteries for longer life and a highly efficient pulse-width-modulated wave form output. $219. *Tripp Lite, 500 N Orleans, Chicago, IL 60610-4188; tel.: 312-329-1777; fax: 312- 644-6505.*



CIRCLE NO. 2 ON FREE CARD

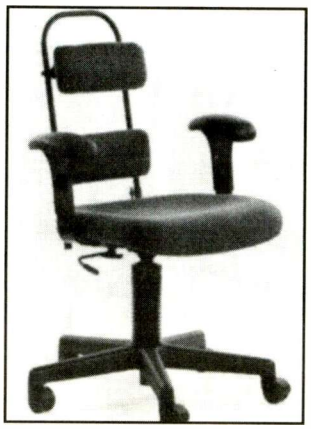
Hard-Drive Setup Program

Micro House's *EZ-Drive* IDE hard-drive installation program for general-public use eliminates confusion for those who wish to upgrade their own systems. It maximizes hard-drive capacity and finds optimum settings for the drive. It also permits up to 2G in one partition, overcoming DOS's limitations, and over 1,024 cylinders without using any memory. $40. *Micro House, 4900 E. Pearl Cir., Ste. 101, Boulder, CO 80301; tel.: 800-926-8299.*

CIRCLE NO. 3 ON FREE CARD

Computer Chair

ZACKBACK's Computer Posture Chair is designed on a new theory of proper sitting posture. Invented by a former rehabilitation specialist in physical therapy at the Mayo Clinic, the Chair challenges the concept of direct lower-back support. With two adjustable supports that are individually fitted above and below, rather than against, the lower back, the Chair is claimed to restore proper posture by bringing the upper trunk over the hips. This is said to reduce stress not only to the lower and upper back and neck, but also on the upper extremities. $499/$599. *ZACKBACK Int'l,, Inc., PO Box 9100, Rochester, MN 55903; tel.: 507-252-9293.*



CIRCLE NO. 4 ON FREE CARD

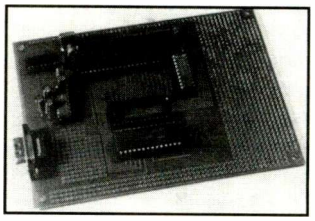
Software Catalog

BSOFT's new Software Engineering Tools #6 catalog offers descriptions and ordering information about the company's hardware and software. Described are low-cost stand-alone engineering programs and hardware designed for engineers, technicians and hobbyists for use on IBM PC/compatibles. Programs are listed for drawing schematic diagrams, simulating logic-control circuits, FFT analysis and circuit analysis. CAD programs for structural analysis, designing electronic circuits and printed-circuit board layout are listed, along with some of the company's newest PC bus board products for control and data acquisition. *BSOFT Software, Inc., 444 Colton Rd., Columbus, OH 43207-3902; tel.: 614-491-0832; fax: 614-497-9971.*

CIRCLE NO. 5 ON FREE CARD

Economical SBC

Suncoast's 70691RAM is an expanded version of the company's 70691C SBC based on the 8051 microcontroller chip. Incorporating the 6264 chip, the normal 128 bytes of RAM contained inside the 8051 is now expanded to 8K. The SBC also contains the standard RS-232 interface circuitry that uses the MAX232 or Teledyne TPC232 integrated chips. The RS-232 line is terminated in a standard DB-9 male connector for interfacing to a desktop PC.

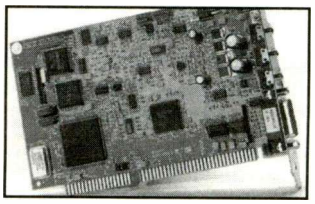


To permit easy interfacing with peripherals, the 70691RAM includes a 2 × 20-pin header. This SBC is compatible with BASIC-52 programs. The board measure 6" × 4½" and operates at 11 MHz. $50. *Suncoast Technologies, PO Box 5835, Spring Hill, FL 34606; tel./fax: 904-596-7599.*

CIRCLE NO. 6 ON FREE CARD

Stereo Sound Card

Logitech's SoundMan CD-quality 16-bit stereo audio card for IBM/compatibles incorporates 20-voice MIDI support, 44-kHz digitization, 16-bit digital audio playback and recording, guaranteed SoundBlaster 1.5 compatibility and a variety of software and hardware enhancements designed to optimize and streamline installation and use. Based on the Yamaha OPL-3 sound chip, the Media Vision 16-bit Spectrum chip set, SoundMan requires a 386SX processor or better computer, DOS 3.3 or later, 640K of RAM (2M is recommended), one 16-bit full slot, a



hard drive and speakers or headphones. Because the board features completely software-selectable IRQ, DMA and I/O address, you don't have to set jumpers or DIP switches.

SoundMan features jacks for stereo input and 4-watt output, mono microphone jack and combination MIDI/game port. $289. *Logitech Inc., 6505 Kaiser Dr., Freemont, CA 94555; tel.: 510-795-8500; fax: 510-792-8901*

CIRCLE NO. 7 ON FREE CARD

Fast VGA Board

STB's PowerGraph X-24 is a quick graphics adapter that's claimed to increase the overall performance of video functions up to 15 times over a standard VGA card. It provides a color palette of more than 16.7-million colors per pixel and supports resolutions of 640 × 480, 800 × 600, 1,024 × 768, 1,280 × 960 and 1,280 × 1,024. Built around the S3 801 video controller chip, the card operates independently of the CPU's processing speed. It's compatible with DOS and *Windows*. Installation requires no switch settings. *STB Systems, Inc., 1651 N. Glenville, Ste. 210, Richardson, TX 75081; tel.: 214-234-8750.*

CIRCLE NO. 8 ON FREE CARD

New Memory Manager Version

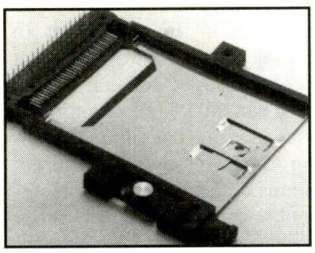
Helix's *Netroom* Version 3 features "cloaking," a new memory-saving technology that moves BIOS, video BIOS, screen savers, disk-cache, RAM Disk, screen accelerators and other utilities out of conventional memory and into extended memory, freeing up virtually all memory for additional applications. Cloaking technology lets programs run in 32-bit protected mode while remaining DOS-compatible. It doesn't require new operating system software or a DOS extender.

The *Netroom* cloaked system BIOS and video BIOS take up only 8K of memory, instead of the typical 96K. The utility frees up to 240K of memory, reportedly without the performance penalty experienced with other '386 memory managers. Cloaking can be implemented in any TSR, device driver or other program. *Netroom* 3 comes with several additional utilities and an API for programmers who want to add cloaking capability to products they support and sell. $99. *Helix Software Co., Inc., 4709 30 St., Long Island City, NY 11101; tel.: 800-451-0551.*

CIRCLE NO. 9 ON FREE CARD

Memory Card Ejector

Oupiin America's Model 902-68MS memory card ejector is designed for use with laptop and palmtop computers, instrumentation, printers, etc. The new ejector has a guide that eliminates having to rock memory cards back and forth during insertion and extraction, eliminating the possibility of bent male connector pins. The ejector also permits memory cards to sit completely inside units, reducing the possibility of accidental damage from persons moving near the unit.



Features of the extractor include: three-wall construction that uses the PC board as a guide to provide a profile that's only 6.2 mm high; molded PBT plastic and stainless-steel construction; a snap-on design that provides an easy means of adding options and upgrades to computers and instrumentation; and attachment to Oupiin No. 902-68M and most 68-pin male headers. $2.20 in 1,000-piece quantity. *Oupiin America, Inc., 26821 Reuther, Unit D, Santa Clara, CA 91351; tel.: 805-252-4760; fax: 805-252-9214.*

CIRCLE NO. 10 ON FREE CARD

Keep Your PC Cookin'

By Keith Aleshire
(Bantam Books. Soft cover. 414 pages. $21.95.)

This is a layman's guide to maintaining and upgrading IBM and compatible computers and, as such, is a relatively good one, though it's unlikely that a regular reader of *ComputerCraft* would be satisfied with its lack of technical information. However, this is an upgrade/repair book you can confidently recommend to your "non-techie" friends who want to do some of their own upgrading and maintenance.

Chapter 1 offers an overview of upgrades and repairs and what they can do for the PC user, while Chapter 2 focuses on preventive maintenance (avoiding heat build-up and avoiding smoke near a computer, for example). Opening the case and exploring the inside the system unit is covered Chapter 3. Expansion cards is the topic of discussion for Chapter 4. Chapter 5 deals with power supply issues, including how often to turn the computer off, grounding, and calculating the workload your computer power supply is experiencing. Chapter 6 is a guide to memory upgrades, while Chapter 7 discusses the Intel 80x86 family of microprocessors and what the various chips are capable of. Chapter 8 focuses on the motherboard, with particular emphasis on replacing it with a faster and better one.

Hard disks are the subject of Chapter 9. Backing up a hard disk is the topic of the Chapter 10. Chapter 11 covers floppy-disk drives, with emphasis on adding a new drive to an existing computer. Chapter 12 focuses on monitors and video cards, while multimedia and sound cards are covered in Chapter 13.

Chapter 14 is dedicated to the different types of printers and their uses. Mice and other input devices are covered in Chapter 15. The final chapter is devoted to "bad connections" (cables and what can go wrong with them).

The writing style in this book is clear and easy to understand, and the drawings are well-done. Anyone who is brave enough to take screwdriver in hand should have little trouble following Aleshire's directions for upgrading his machine. Recommend this one to your friends.

VGA To NTSC/PAL

Telebyte's Model 702 Desktop Videoverter offers all video formats, including AV Video, S-Video and r-f-modulated output for use with any TV device, and it's claimed to be compatible with all notebook and desktop PCs that operate in VGA display mode. The Videoverter converts the image on any VGA screen to NTSC for use on any standard TV receiver or VCR. It's choice of outputs permit interfacing to any video device from a low-end TV that has only an r-f input to a VCR that has AV inputs (composite video) or to a leading-edge large-screen TV receiver that uses S-Video. Each of these three outputs offers a different level of quality, with S-Video being the best for 80-column text display. There's said to be virtually no difference for pic-

ture-type images. All three video outputs can be used simultaneously.

The Model 702 is a self-contained package that provides a pass-through link for VGA signals from PC to VGA monitor. For notebook PCs, the connection is through the external monitor connector. Supplied software includes a TSR that toggles on and off the Model 702. $345. *Telebyte Technology, Inc., 270 E. Pulaski Rd., Greenlawn, NY 11740; tel.: 800-835-3298; fax: 516-385-8184*

CIRCLE NO. 25 ON FREE CARD

Drawing Program

Abracadata's *Mighty Draw* creates numerous designs, including pie charts, bar charts, flow charts, newsletters, greeting cards, flyers and complete presentations. It includes hundreds of pre-drawn symbols and graphics you can copy, re-size, move and rotate. You can create your own custom images as well as use those from the library. *Mighty Draw* lets you import .PCX images from a PC/compatible or PICT images from a Mac. The program is available in DOS, *Windows* and Mac formats. $50/$60. *Abracadata, PO Box 2440, Eugene, OR 97402; tel.: 800-451-4871; fax: 503-343-2450.*

CIRCLE NO. 13 ON FREE CARD

Windows Spreadsheet

Borland's *Quattro Pro for Windows* is a powerful spreadsheet designed from the ground up for the *Windows* environment. Two new technologies that provide a significant departure from traditional spreadsheet models are an integral part of the product's design. Object Inspector menus let you "right-click" on an object to display a list of all options that can be changed for that object. You can make all changes at once, saving the time of wading through several different menus. Spreadsheet Notebooks, based on the familiar tablet paper notebook, organize spreadsheet data and dramatically improve the way you build and manage spreadsheets. SpeedBar controls are collections of conveniently placed buttons that provide point-and-click access to such most-frequently-used features as cut, copy, paste, instant summing, automatic data entry, formatting, graphing and others. SpeedFill determines what information should be placed into a range of cells, based on information you provide (adding the remaining month labels to a row once "JAN" is entered, for example). Drag and Drop lets you select a block of cells, drag it and drop it to move or copy to another location. Speed Buttons are user-created pushbuttons that run macros.

Several other significant areas of functionality include point-and-click feature accessibility, comprehensive presentation graphics, easy access to external *dBASE* and *Paradox* database files and visual applications building tools. *Quattro Pro for Windows* is compatible with *1-2-3* and *Excel* at the file and even at the macro levels, simplifying upgrading existing applications. Upgrades and DOS/*Windows* bundles are available. $495. *Borland, PO Box 660001, Scotts Valley, CA 95067-0001; tel.: 800-331-08777.*

CIRCLE NO. 14 ON FREE CARD

VGA-to-Video Adapters

ADDA Technologies has a new series of VGA-to-video adapters is calls the 1000V line. Adapters in this line feature the Tseng 4000 VGA chip. Each adapter comes in 512K, 1M and Hi-Color versions. Video output formats include S-video, composite and RGB in both NTSC and PAL formats.

Application areas for the 1000V line include multimedia authoring systems, video production, titling, training and education.. *ADDA Technologies, 48501 Warm Springs Blvd. #109, Fremont, CA 94539; tel.: 510-770-9899; fax: 510-623-1803*

CIRCLE NO. 15 ON FREE CARD

Hand-Held DMM

A new line of hand-held digital multimeters designed to combine the high reliability, range and accuracy of high-end professional DMMs with maximum usability on the job is available from Simpson. Included in the 490 Series is the Model 494 meter that offers a solar recharging capability that employs a solar cell and rechargeable lithium battery to ensure that maximum battery power is always available and eliminate the need for constantly replacing batteries. The Models 493 and 494 feature a back-lit display for enhanced

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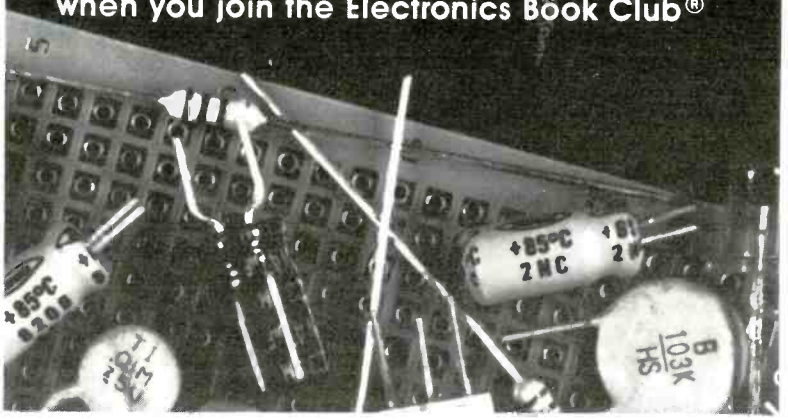

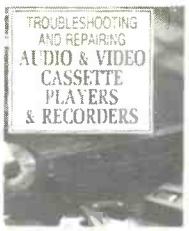

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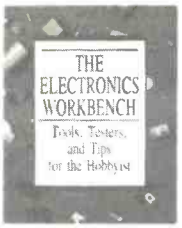

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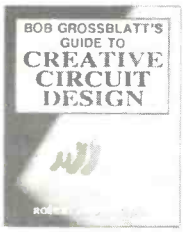

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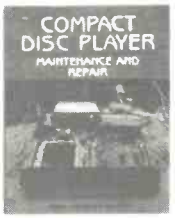

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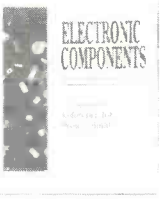

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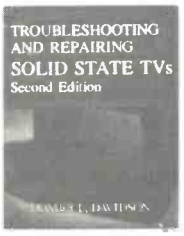

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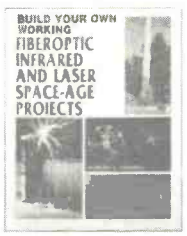

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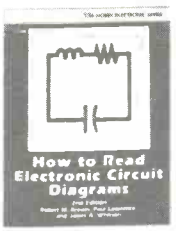

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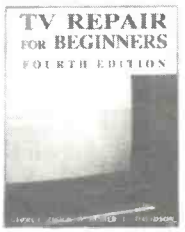

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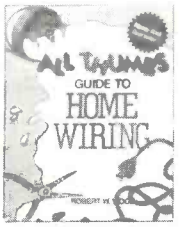

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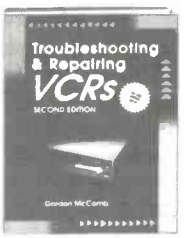

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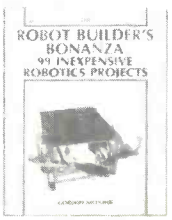

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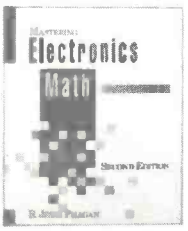

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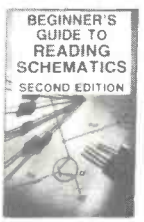

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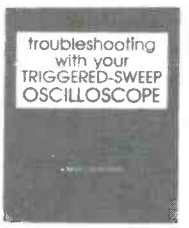

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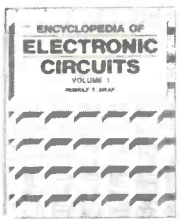

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MDNE693

readability in dimly-lighted locations.

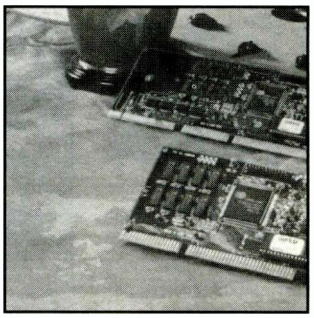
All DMMs in the 490 Series share such features as: memory and read-memory function; relative value measurements; maximum and minimum value measurements; hold and timer-hold measurements; 3,999 count display (999 for frequency measurements; automatic polarity and ranging on voltage, resistance, frequency and capacitance measurements; and 40-segment bargraph for peaking and nulling. Ranges covered by the Model 494 include 1,000 volts dc and 750 volts ac; resistance to 40 megohms; current to 12 amperes ac and dc; frequency to 999 kHz; and capacitance to 40 µF.

CIRCLE NO. 17 ON FREE CARD

Color Video Accelerator Card

WindowsVGA 24, a new color accelerator card from Genoa, is offered in both 16-bit ISA bus and 32-bit VESA local-bus models. With their 24-bit accelerator, these new True-Color cards support up to 16.8-million colors in a low-cost solution for *Windows* users. With 1M of standard RAM, the Models 8500 (ISA) and 8500VL (local-bus) cards offer a maximum resolution of 1,280 × 1,024 pixels and support a 72-Hz refresh rate at 800 × 600 and 70-Hz refresh rate at 1,024 × 768 noninterlaced resolution. Genoa claims three to eight times the performance over standard SVGA-based cards for these new cards. Both models conform to all current video standards (VESA, 8514/4, VGA, EGA, CGA and Hercules monochrome), and both are compatible with all analog and analog multi-synchronous video monitors. The cards also incorporate Genoa's Flicker-Free technology that eliminates flash and flicker for more comfortable viewing. Geona's Safescan feature also eliminates the black border around the perimeter of the screen to provide 100% screen usage for overscanning monitors.

WindowsVGA 24 comes with video drivers for a variety of programs, including *Windows,, AutoCAD, AutoShade, 3D-Studio, WordPerfect*, OS/2 and more. Driver updates can be downloaded at no cost from Genoa's Bulletin Board Service by dialing 408-943-1231. $179 for 24 Model 8500; $199 for Model 8500VL. *Genoa Systems, 75 E. Trimble Rd., San Jose, CA 955131; tel.: 408-432-9090; fax: 800-934-3662 or 408-434-0997.*



CIRCLE NO. 18 ON FREE CARD

Windows 3.1 Demystified: Tips, Tricks & Techniques

By James Forney

(*Windcrest/McGraw-Hill. Soft cover. 345 pages. $24.95.*)

If you're a *Windows* 3.1 user, you'll want this book on your reference shelf, and you'll probably to read it from cover to cover at least once. There's a wealth of *Windows* information tucked away in this deceptively simple volume. Forney's style is easy to read and lively, making dry material come alive.

The first five chapters are devoted to an overview of *Windows*. Chapters 6 and 7 focus on installing and fine tuning *Windows* applications. Then the next five chapters discuss .INI files, with particular emphasis on how to make the best of the options in these files. Chapter 10, which focuses on WIN.INI, is the best discussion of this important file I've seen to date.

Chapters 13 and 14 cover disk-related issues, with a full chapter devoted to disk compression. Backing up data and program files is briefly discussed in Chapter 15. Data input devices are covered in Chapter 16. Integrating *Windows* with other programs such as *DESQview* or OS/2 is discussed in Chapter 17. Chapter 18 focuses on memory managers, while Chapter 19 deals with troubleshooting.

The final chapter in this book offers a short look into the future, from the author's perspective. Two appendices and a glossary round out the volume. This book is a winner. Buy it.

Data-Acquisition Boards

Texmate now offers two 16-channel data-acquisition analog input boards for IBM PC/compatible computers. Both boards feature 12-bit resolution and 10-s conversion time and work with any PC/XT/AT or compatible for data acquisition or data logging. Since it contains 12-bit DACs and 24 TTL CMOS digital I/O, the Model PC-30AT is also useful for processing control.

Input ranges for both cards are bipolar 1 to 10 volts dc. Optional screw-terminal connectors ($99) and *Dash 300 Windows* software ($295) complete an economical package. $335 for PC-27; $785 for PC-30AT. *Texmate Inc., 995 Part Center Dr., Vista, CA 92083-8397; tel.: 619-598-9899; fax: 619-598-9828.*

CIRCLE NO. 21 ON FREE CARD

Cleaning Products

Read/Right has added several new items to its line of cleaning products. The new No. TX255 4-mm data-drive cleaning cartridge provides 25 cleanings, and No. TX256 8-mm data-drive cleaning cartridge provides six to eight cleanings. These are said to provide the latest technology in automatic data-drive cleaning. To use, you plug a cartridge into the machine's drive and let it run for 15 to 20 seconds. Regular use is claimed to safely eliminate residue and dust build-up without damaging tape heads.

The No. TX258 CD-ROM disk cleaner uses the radial cleaning method recommended by CD-ROM disc manufacturers to avoid scratching the discs. Data-error and signal-interpretation skips caused by contamination of the surface, smudges and other foreign matter can often be avoided by regular cleaning. The kit contains a small brush, non-abrasive cleaning wand, foam-cushioned disk holder, 1 ounce of specially formulated cleaning solution in non-aerosol pump spray and an instruction sheet. Each kit provides 25 cleanings and comes in a convenient compact storage case. *Read/Right Products, 650 E. Crescent Ave., Upper Saddle River, NJ 07458; tel.: 800-327-1237; fax: 800-569-3600.*

CIRCLE NO. 20 ON FREE CARD

New *Generic 3D*

Autodesk's *Generic 3D* Release 2 has the same interface as *Generic CADD* 6.0, the company's popular 2D CADD program, making it easy for DOS users to employ 3D as a conceptual design, visualization and presentation tool. Key enhancements in Release 2 include cursor alignment/tracking for quick and easy object placement, sculpt mode for quickly adding and subtracting three-dimensional closed surfaces, *AutoCAD* compatibility (direct import/export of .DWG files), linear dimensioning and text lines, nested commands, "bite-sized" exercises and tutorials and a large library of sample programs. Minimum requirements are an AT/compatible computer, 1M of RAM (additional LIM-EMS V3.2 recommended), DOS 3.0, EGA, hard drive with 7M free space and mouse or other pointing device. A math coprocessor is also recommended. $399; $75 upgrade. *Autodesk Retail Products, 11911 N. Creek Pkwy. S., Bothell, WA 98011; tel.: 800-228-3601 or 206-487-2233; fax, 206-483-6969.*

CIRCLE NO. 26 ON FREE CARD

(Continued on page 75)

Caches: Sorting Fact From Fiction

Understanding how caches work can greatly speed up the performance of your computer

Cache is a buzzword that most PC users translate to mean faster speed. While this is largely true, it's not always the case. Using the wrong type of cache can actually cause speed to suffer, rather than improve. At the very least, you could be paying for a cache that you'll never even use.

A cache is fast electronic memory you use to temporarily store frequently used blocks of data, such as information from a hard disk or program instructions for the CPU. For example, when a program requests data from a disk drive, the cache is checked first. If the requested information is in the cache, transfer occurs at lightning-fast speed instead of the much slower mechanical speed of the disk drive. If the data isn't found in the cache, it's read from the disk, placed in the cache and labeled as most recently used. In this way, the most-recently used data is always at hand and the least used is eventually purged from the cache. Moving data from disk to a cache speeds up the process considerably.

There are two types of caches: disk caching and CPU caching. Shown in Fig. 1 is the relationship between the two within the PC. As you can see, the two technologies aren't conflicting; rather, they're complementary.

Disk caching is available to everyone and is used to store and move data from mechanical drives to faster system memory. Software disk caches, like *Super PC-Kwik* and DOS's Smart Drive, are the most popular form of disk caching. Software caches set aside a sizable chunk of your system's RAM for their own use, leaving less memory for your applications.

CPU caching, on the other hand, stores and moves data/instructions between system RAM and CPU. Unlike disk caching, which claims a portion of system memory for itself, CPU caching has its own clutch of memory that's independent of system RAM. On average, a CPU cache will boost the speed of a PC by as much as 145% (see Table 1). However, CPU caching isn't available to everyone. Only 486 PCs and a handful of 386SX and 386DX PCs support a CPU cache. Which means PC/XT, AT and most 386 users have to rely on disk caching alone to speed up their PCs.

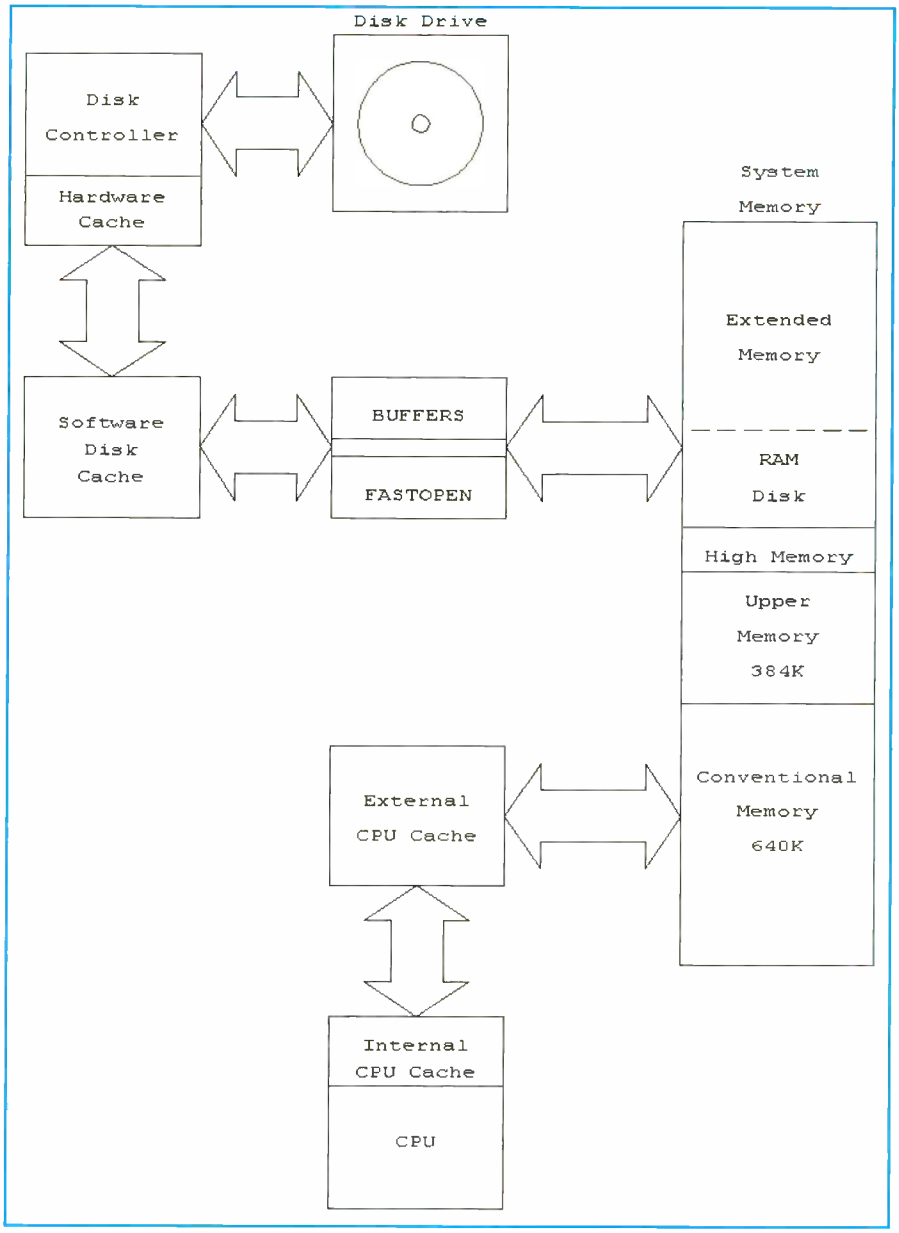


Fig. 1. A disk cache can be put in any of four types of system RAM.

Disk Cache

Obviously, a disk cache is a given for anyone who owns a computer. Three popular disk-caching methods exist: DOS basic, caching software and caching disk controllers.

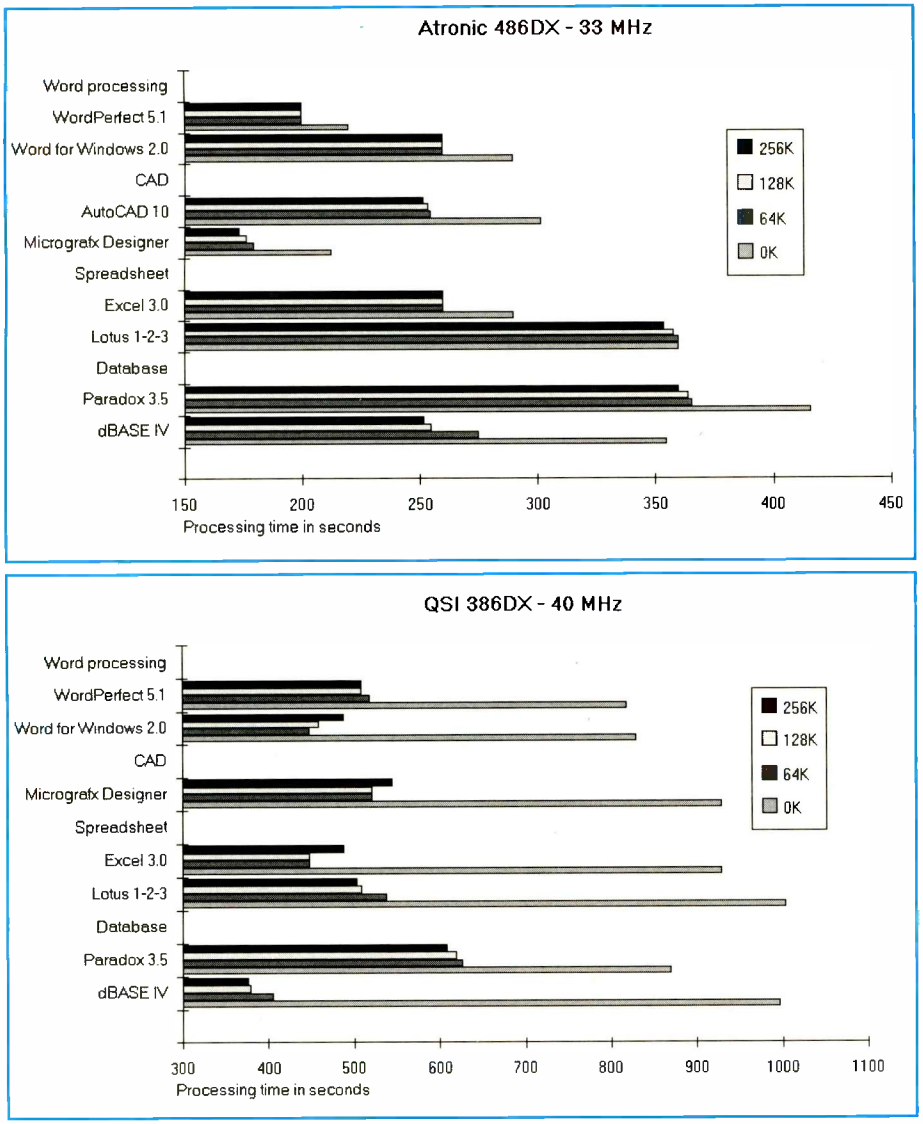


Fig. 2. Different types of applications benefit differently when using CPU memory caching.

DOS has two rudimentary disk-caching utilities, BUFFERS and FASTOPEN, which worked okay with 1980 applications that used only a few kilobytes of a PC's memory, but they're overwhelmed by today's megabyte applications like *Windows* In fact, using them with some programs, like disk optimizers, can actually lock up a system.

Caching software, like *Super PC-Kwik* and DOS's SmartDrive, is today's mainstream disk-caching technology for desktop computers. Unlike BUFFERS and FASTOPEN, they make full use of a PC memory's resources and work with virtually all DOS and *Windows* applications.

The third disk-caching method, caching disk controllers, is just as fast as caching software and has almost no software application problems. Since the controller contains its own memory chips, it uses none of the PC's memory resources. It's also the only disk cache that works with such non-DOS applications as Novell *NetWare* network servers. But caching controllers sell for hundreds of dollars more than what you'd have to pay for software caches.

Overall, software caches are marginally faster than hardware caches. They're also easier to install and cost hundreds of dollars less. In fact, one of the fastest software caches is yours free in your DOS or *Windows* directory under the filename of SmartDrive. Furthermore, software caches can cache a large variety of different drive types (MFM, RLL, IDE and ESDI), and a few are able to cache SCSI and CD-ROM drives. By comparison, caching disk controllers cache only the drive type supported by the controller card.

The bad news is that a software cache steals its caching resources from the PC, leaving less RAM available for applications. So dirt-cheap caching software may force you to add RAM to your system—at about $30 per megabyte if you have a PC that accepts standard SIMMs. But some computers, like IBM's PS/2 series, don't use standard RAM. A couple of megabytes of PS/2 RAM can cost $200 or more.

Caching disk controllers have their own RAM installed right on the board, which explains their higher cost. Hardware caches are generally better behaved and support more applications than software caches. For example, very few software caches can work with Quarterdeck's *QEMM-386* memory manager in Stealth mode. And many vendors warn that using their software caches with data-compression programs, like some versions of *SuperStor,* can cause system crashes and data loss. Hardware caching controllers, on the other hand, can run both programs without a hitch.

It's important for you to decide where added RAM will do the most good. If you have a system with 4M of RAM and you're a *Windows* user who runs multiple applications and background processing, boosting system RAM to 8M will provide much more system speedup than adding a 4M caching hard-disk controller. And you won't have to pay an extra $200 or more for the controller card.

It's important to note that older slower machines will benefit much more from hardware than software caching for two reasons. One is that the CPU that's performing the caching is slower. The other reason is that in PC/XT-class and earlier 286 and 386 systems, total RAM may be too limited to leave enough space in which to cache. Then, too, with many older systems, the cost of a hardware caching controller may exceed the value of the PC.

A disk caching controller is mandatory if it's to be used as a Novell *NetWare* server. While all software caches work on Novell client stations (the node), not a single one supports Novell as a server. Several cachingdisk controllers do. Many caching con-

trollers also provide mirror backup in which the entire contents of the primary drive are duplicated in a slave drive. Should the primary drive fail, the controller automatically defaults to the backup drive, eliminating a network crash.

Optimizing a Cache

Choosing a cache is only half the battle. The other half is optimizing the cache for fastest speed. Following are tips on how to configure a disk or CPU cache for maximum performance.

• *Software Disk Caches.* While most caching software has an installation program that automatically installs the cache in your PC, none that I've looked at do a perfect job of it. There's always something you have to do manually. Fortunately, fine tuning a software cache isn't complicated or product-specific. What works for *Super PC-Kwik* is also good for Norton's *NCache, for example.*

First make sure that the software cache you're installing is the only disk cache. Having two software caches running at the same time noticeably reduces system speed and uses twice as much RAM. If you've installed *Windows* or MS-DOS 6.0, you already have DOS's SmartDrive cache up and running. To install a different software cache, you must remove SmartDrive by editing your AUTOEXEC.BAT file.

You'll also have to adjust the number of BUFFERS in your CONFIG.SYS file to 3. This way, DOS doesn't spend a lot of time rummaging through buffers looking for data when it should be searching your software cache. If you install a new program after the cache is in place, check your buffer count again. Several applications change the buffer count to their liking, unaware that a software cache is on the job.

• *Choosing the Right RAM.* Where you locate a cache is important. System RAM comes in four flavors, and a disk cache can be put in any one of the four (see Fig. 1). Conventional RAM occupies the first 640K of memory and is used mostly by software applications. Because this RAM is vital to applications, it's not the best cache choice, although it's available to all software caches, except SmartDrive.

The best place to locate a software cache is in extended RAM, which resides above 1M. It's the fastest RAM and can be expanded to 16M and more.

Between 640K and 1M is an area that used to be known as "shadow RAM," but is now called upper RAM. Originally, this area was reserved for PC housekeeping, like video management. But now it's used for a wide variety of things, including disk caching. However, this small segment of RAM is better served as a gateway for expanded RAM.

Before extended RAM was commonly supported, a consortium of Lotus, Intel and Microsoft (LIM) devised a way for applications like *1-2-3* to use memory beyond the 640K limit imposed by the original PC. They did this by using 64K of upper RAM to serve as a gateway to extended RAM, calling it LIM or expanded memory. But herein lies a problem. Because data is moved between upper and expanded memory in 64K blocks, the software cache is noticeably slower than if it simply used extended RAM in the first place. But for users who have software that needs expanded RAM, it's a good place to stash the cache.

• *Sizing Up a Cache.* The default size of a cache varies according to available RAM and the cache program. Software caches like *Flash* and *HyperDisk* use all that's available. Others, like DOS's SmartDrive, place an upper limit on the cache size (2M). While there's much debate as to which cache size is optimal, studies show that 256K is plenty sufficient for most DOS applications, and 1M is optimum for *Windows* users. Caches larger than 2M can actually degrade speed. Remember, this memory comes from your system; so the less the cache uses, the more you have left over for programs.

• *Smarter, Faster Disk Caching.* Today's software disk caches are smarter than ever, thanks to new and improved read-ahead algorithms. The algorithm continually monitors the disk for activity. If it senses that you're performing sequential reads, the cache reads large blocks of non-solicited sectors into the read-ahead buffer, saving time by anticipating future needs and combining them with reads that have already been requested.

But like cache size, bigger isn't always better. There's no ideal read-ahead buffer size, and it can vary from 3 sectors (about 1.5K) to 64 sectors (about 32K). The larger the file, the more read-ahead buffers you want. However, it does no good to read ahead if the sectors don't contain the data you need. The right count depends on how fragmented your hard disk is and the size of your data files (not the application).

Ideally, the cache should let you adjust the number of read-ahead buffers to match your needs. For instance, the default size of SmartDrive's read-ahead buffers is 16K, but it can be adjusted upward or downward using the /B: switch (Example: SMARTDRV /B:3K).

Caching Disk Controllers

Hardware disk caching controllers have different optimization needs. For example, while 4M of cache isn't a recommended size for a software cache, it's the ideal size for a hardware cache.

When installing a caching controller, pay attention to the hardware addresses and interrupts. If the hardware address or interrupts are already claimed by another adapter card or peripheral, the system will lock up. If there's a conflict, it's best to change the offending peripheral than it is to change the disk controller's setting, if possible. This is usually done by changing jumpers or setting DIP switches on the peripheral card.

Like software caches, caching controllers use a read-ahead buffer to speed performance. Buffer size is usually adjustable via a setup menu contained in a CMOS chip aboard the controller card. Again, you'll have to experiment with different buffer sizes to determine which is best for you.

CPU Memory Caches

Now that prices of 486 PC have dropped to affordable levels, more and more users are discovering the benefits of CPU caching. This is because the 486 CPU chip has 8K of built-in cache. Actual speed increase depends on the application. Database programs like *dBASE IV* gain the most. Word processors show the least improvement, but it's still an impressive 10% and more when compared to an identical PC with the cache disabled and running at the same speed (see Fig. 2). Fortunately, CPU caches aren't limited to just 486 systems anymore. More and more 386 desktop and notebook computers now support them, too.

CPU caches come in two flavors: internal and external. Internal CPU caches are an integral part of the CPU, like those in Intel's 486 series and Cyrix's 486DLC. External caches are

made using SRAM chips that are soldered to the motherboard, which is the only type a 386 PC can use. CPUs that have an internal cache can also use an external cache.

However, SRAM chips are relatively expensive. Which brings up the question: How much CPU cache is best? Does bigger mean better? To answer these questions, I configured and tested several 386DX/33, 386DX/40, 486-SX/25 and 486DX/33 systems with 0K, 64K, 128K and 256K of external cache. Two of the systems tested are shown in Fig. 2 and Table 1. As expected, I found dramatic improvement between caching and no caching.

Greatest improvement was with 386DX PCs. Because 386 chips don't have an internal cache, increases up to 145% were noted; overall the cache improved 386DX performance by a hefty 84%. 486 PCs showed a more moderate increase of 14% on average. Surprisingly, the numbers showed almost no increase in speed between a 64K cache and a 128K or 256K cache. In a few instances, the larger cache actually caused performance to drop.

The exception is *dBASE* IV, which my benchmarks show runs about 10% faster with a 128K cache. Both Intel and Borland tell me that, unlike most DOS applications, the tightly-written *dBASE IV* code requires just slightly more room than a 64K cache provides. I also learned, from Intel, that there's a possible speed gain using a larger CPU cache if you're a Novell network server. So if you fall into these two categories, 128K is better.

What do these numbers say to you, the two-fisted DOS and *Windows* user? They say don't waste your money on CPU cache you'll seldom, if ever, use. A 64K cache is plenty sufficient for virtually all desktop users.

CPU Caching Architecture

A major point of confusion is the architecture used for the CPU cache. Vendors throw around terms like "direct memory mapping" and "four-way associative." What do such phrases mean and

Table 1. Cache Performance[1]

Atronics 486-33

Cache Size	0K	64K	Increase[3]	128K	Increase[4]	256K	Increase[5]
Database							
dBASE III	841	752	12%	753	0%	763	–1%
dBASE IV	355	275	29%	255	8%	252	1%
Paradox 3.5	554	488	14%	485	1%	480	1%
Spreadsheet							
1-2-3, Release 2.2	180	180	0%	179	1%	177	1%
1-2-3, Release 3.1	259	229	13%	228	0%	225	1%
Excel 3.0	29	26	12%	26	0%	26	0%
CAD							
Micrografx *Designer*	71	60	18%	59	2%	58	2%
AutoCAD Release 10	201	170	18%	169	1%	168	1%
Word Processing							
Word for Windows 2.0	29	26	12%	26	0%	26	0%
WordPerfect 5.1	44	40	10%	40	0%	40	0%
Average Increase			14%		1%		1%

QSI 386DX-40[2]

Cache Size	0K	64K	Increase[3]	128K	Increase[4]	256K	Increase[5]
Database							
dBASE III	1,468	992	48%	1,001	–1%	1,027	–3%
dBASE IV	997	407	145%	380	7%	378	1%
Paradox 3.5	870	628	39%	620	1%	609	2%
Spreadsheet							
1-2-3, Release 2.2	1,004	539	86%	510	6%	505	1%
1-2-3, Release 3.1	1,368	658	108%	640	3%	622	3%
Excel 3.0	93	45	107%	45	0%	49	–8%
CAD							
Micrografx *Designer*	155	87	78%	87	0%	94	–7%
AutoCAD Release 10	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Word Processing							
Word for Windows 2.0	83	45	84%	46	–2%	49	–6%
WordPerfect 5.1	82	52	58%	51	2%	51	0%
Average Increase			84%		2%		–2%

[1]All times are in seconds; [2]Without math coprocessor; [3]0K versus 64K; [4]64K versus 128K; [5]128K versus 256K.

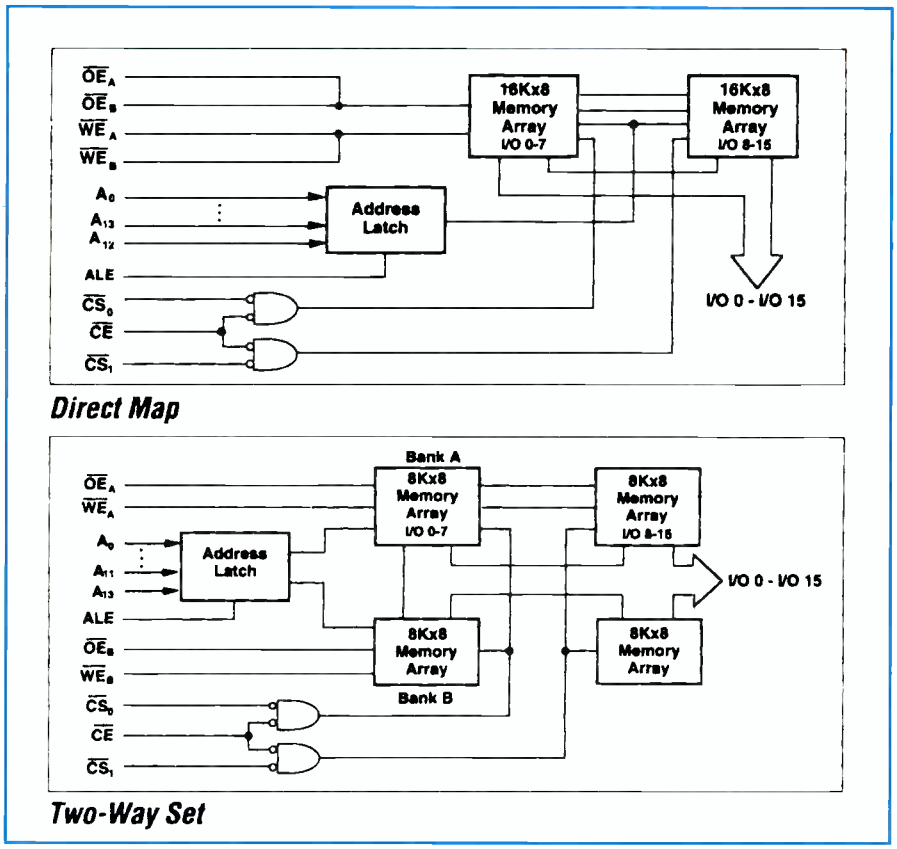


Fig. 3. In CPU caching, the two types of memory mapping are direct and associative.

what are the speed differences?

There are two types of memory mapping: direct and associative (see Fig. 3). Direct mapping is just what it implies. You put data in a certain memory location and expect to find it in that location on your next query. It's the fastest architecture for applications that use the same instructions over and over again—like spreadsheets. However, if your program doesn't find the requested information at the address expected, the application searches system memory for it, overwriting the cache with the new data..

Programs like *AutoCAD* don't use the same instructions as often as spreadsheets do. So what used to be in cache address one gets shoved into cache address two. The associative cache's algorithm, expecting this, searches more than one cache address before giving up and going to system memory. Two-way means that it looks at the last two lines (Banks A and B in Fig. 4) for a match, while four-way looks at the last four lines for a match. There's no limit to an associative cache search. You can have 100 or more associative searches if you don't mind spending SRAM or time. In fact, this is often done on mainframe computers, where files are measured in tens of megabytes. But for desktop applications, a four-way associative search is all that's needed. The internal cache built into Intel's 486 CPUs is four-way associative.

A few PCs let you choose the cache's architecture, either by making changes to the CMOS setup or by setting jumpers on the motherboard. Two that we know of are 40-MHz 386 PCs from QSI (Klonimus) and SAI. However, most don't give this option, forcing you to go with whatever the vendor ships.

Wait States

Wait states are another very misunderstood technology. Wait states are necessary because of the mechanics of semiconductor memory chips. When information is requested from a memory chip, the CPU first has to activate its memory address. For example, if the information asked for is located in the area between 1,024K and 1,088K, these address lines are triggered.

However, a lapse of time occurs before requested data is actually available to the CPU. The amount of time involved depends on the speed of the memory chips. A 70-ns chip can be read within 70 ns, whereas a 120-ns chip takes almost twice as long to settle in. Logically, the shorter the settling time, the more expensive the chip.

To keep memory cost down, PC vendors often use wait states for both CPU cache and main memory so that slower RAM chips can be used. One wait state is equal to one tick of the PC clock, during which absolutely nothing happens, except the "wait" for the RAM to settle down. As the number of wait states increases, the CPU stalls program execution for a longer period of time. If you're experiencing data loss or memory parity errors, especially when using *Windows*, you may have to increase the number of wait states. Wait states are usually adjustable from CMOS setup or via motherboard jumpers.

Cache The Wave

As you can see from the foregoing, the correct cache will speed up your PC significantly. This is particularly true of 8088 PCs and systems that were manufactured before caching was popular. With software caching now shipping with DOS, there's no reason to put up with poky performance any longer. ■

RAM Disk Speeds Up Old PC

The reason why an old PC/XT or AT computer chugs along like a Disneyland train ride isn't so much a problem with the speed of its CPU as it is the slow hard-disk drives that shipped when these machines were state-of-the-art. While a software disk cache will noticeably speed up applications, things still grind to a halt whenever a computer has to access the drive for a read or write operation.

A better way to speed up an aging PC is to use the system's memory for a RAM disk. Unlike a disk cache, a RAM disk reads the hard disk at only one time—when you first load files. After this, the application reads and writes to the RAM disk in essentially zero access time. When you close the application, or at scheduled intervals, the file is transferred from the RAM disk to your hard drive for permanent storage.

RAM disks are readily available at little or no cost and often come bundled with disk-caching software. Versions of DOS 3.0 and later also contain a RAM-disk utility called VDISK. (See the March 1993 issue of *ComputerCraft* for an in-depth look at RAM-disk installation.)

Building Plug-In Cards for PC/Compatibles

What you should know to successfully and safely interconnect new hardware designs you build with your PC's expansion bus

PC and compatible computers let you easily design custom plug-in cards for almost any application you can imagine. Among a multitude of others, ideal applications for PC control include home security systems, automatic thermostats and lighting control. Using a high-level language like BASIC, Pascal or C even makes programming such projects a pleasure to do. Before you jump right in, though, it's important that you familiarize yourself with the basics involved in designing and building plug-in cards for the PC.

I begin this article with the information needed to successfully and safely utilize the PC's expansion bus for plug-in cards and then take you on a tour of the design procedure itself. To illustrate the design procedure, I'll describe a sample card that adds a liquid-crystal display (LCD) module to your PC system. With this example project, you'll soon come to appreciate just how easy it really is to design and build PC expansion cards

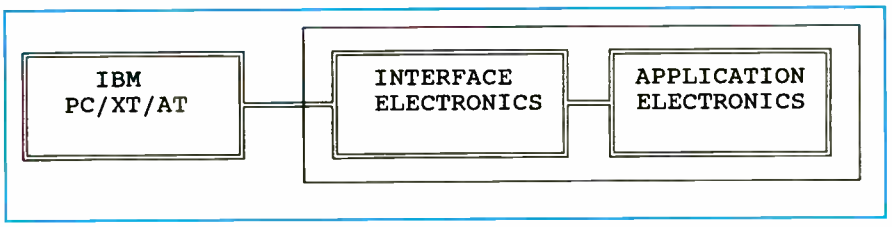


Fig. 1. This block diagram illustrates the three basic requirements for designing a plug-in application card for the PC.

Some Basics

Every expansion card you plug into your PC's bus must satisfy two basic require-

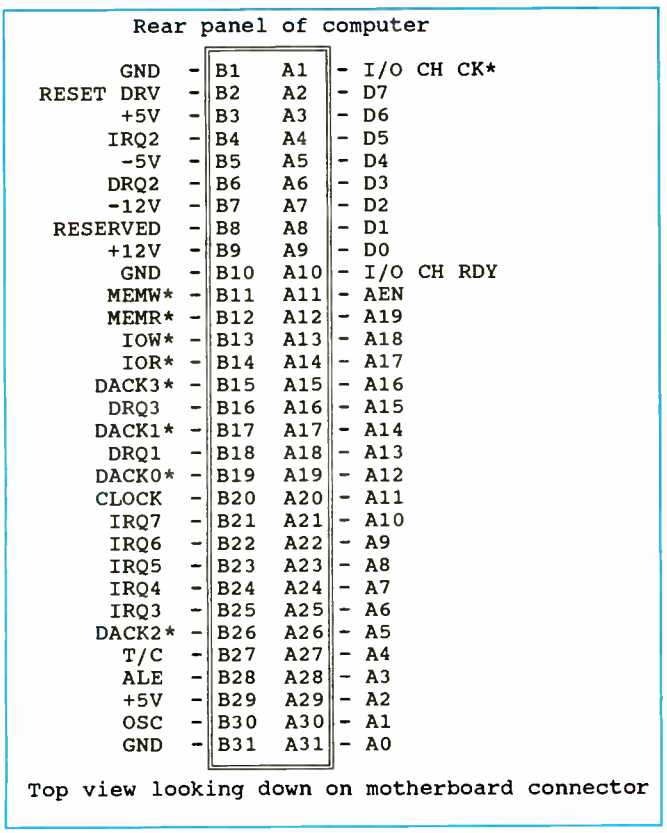
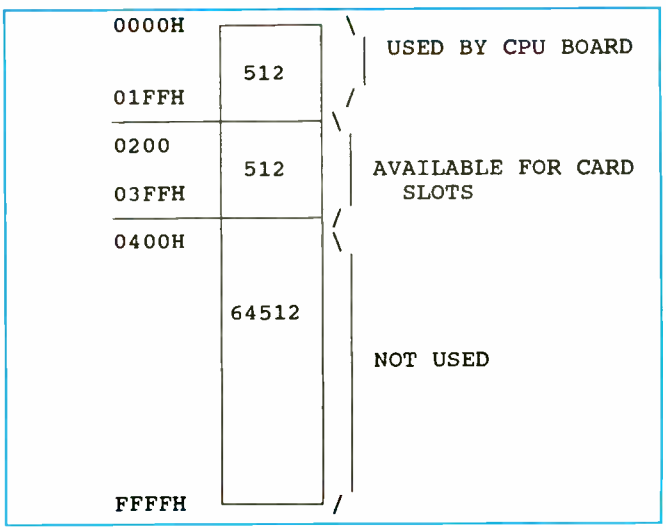


Fig. 2. Shown here are some, but by no means all, IBM expansion-slot definitions. This is a top view looking down on the motherboard connector. An asterisk (*) indicates an active-low signal.

Fig. 3. This is the complete schematic diagram of the LCD module plug-in card's circuitry.



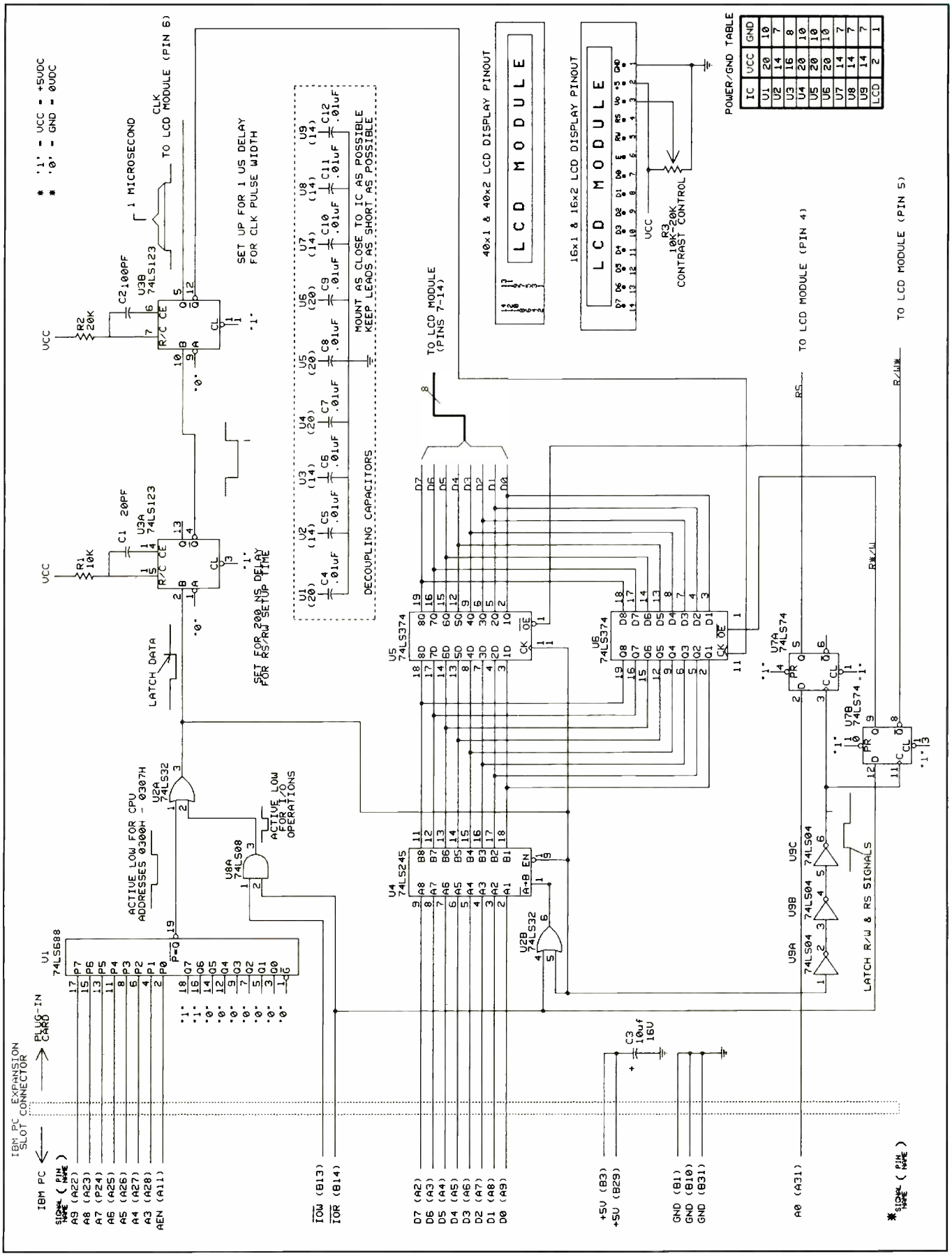


Fig. 4. This is a graphical representation of the IBM PC's input/output (I/O) memory map.

PARTS LIST

Semiconductors
U1—74LS688 magnitude/address comparator
U2—74LS32 quad OR gate
U3,U7—74LS74 dual D-type flip-flop
U4—74LS245 bidirectional bus transceiver
U5,U6—74LS374 eight-bit tri-state latch
U8—74LS08 quad AND gate
U9—74LS04 hex inverter
Capacitors
C1—20-pF ceramic disc
C2—100-pF ceramic disc
C3—10-uF tantalum
C4 thru C12—0.01-uF ceramic disc
Resistors
R1,R2—10,000 ohms, 1/4-watt, 5% tolerance
R3—10,000-ohm pc-mount trimmer potentiometer
Miscellaneous
Plug-in circuit card (see text); LCD module (see text and Note below); sockets for all ICs (optional); hookup wire; solder etc.

Note: The following items are available from Simple Design Implementations (S.D.I.), PO Box 9303, Forestville, CT 06011-9303 (tel.: 203-582-8526): All items listed above, including 16 × 1 LCD module with data sheet but *not* including plug-in card, $29.95 + $3 S&H; the same items but substituting a 40 × 2 LCD module and *no* card, $39.95 + $3 S&H. Also available are 16 × 1 LCD module with data sheet, $15.95 + $2 S&H, and 40 × 2 LCD module with data sheet, $25 + $2 S&H. Shipping charge is $5 maximum on quantity orders.

Table 1. Expansion Card Slot I/O Map

I/O Address	Function Reserved For:
0200h	Not Used
0201h	Game Control Adapter
0202h through 0277h	Not Used
0278h through 027Fh	Second Printer Port Adapter
0280h through 02F7h	Not Used
02F8h through 02FFh	Second Serial Port Adapter
0300h through 0377h	Not Used
0378h through 037Fh	Printer Port Adapter
0380h through 03AFh	Not Used
03B0h through 03BFh	Monochrome/Printer Adapter
03C0h through 03CFh	Not Used
03D0h through 03DFh	CGA Adapter
03E0h through 03EFh	Not Used
03F0h through 03F7h	5-1/4" Disk Drive Adapter
03F8h through 03FFh	Serial Port Adapter

Table 2. PC Expansion-Slot Power Capabilities

Contact Number	Slot Voltage (dc) Maximum	Per Slot Minimum	Current	Power
B3,B29	5.25	4.80	700 mA	3.5 W
B5	–5.50	–4.60	30 mA	0.15 W
B9	12.6	11.52	100 mA	1.2 W
B7	–13.2	–10.92	50 mA	0.6 W

Table 3. System Bus Drive Capabilities

Bus Output Signal	IOL	IOH
D0 through D7	23.6	–14.96
A19 through A16	7.2	–2.46
A14,A15	21.2	–2.51
A0 through A12	23.4	–2.56
IOR,IOW, MEMR,MEMW	23.8	–4.98
CLK	23.2	–14.96
AEN	24.0	–15.00
DACK0	24.0	–15.00
DACK1	3.2	0.20
DACK2,DACK3	2.8	0.18
ALE	14.8	–0.94
RESET DRV	8.0	–0.40
TC	5.0	–1.00

All current values for the IOL and IOH columns are in milliamperes. Table values have been adjusted for loads take on system board. Values listed are "worst case" for CPU or DMA drive.

ments, as detailed in Fig. 1. The interface, as its name implies, "interfaces" the expansion card to the PC's data bus and must adhere to the timing, power and pinouts of the PC hardware. It must provide the signals and data to whatever electronic circuitry is used by the application electronics for it to function as designed. The application electronics performs whatever task or tasks you wish the card to perform.

The best place to begin the design of any expansion card is to determine the tasks or functions the circuitry on the card is to perform. Then you must determine what signals and data are required from the interface electronics to implement the functions you want.

In the sample LCD design I'll detail later, the LCD card contains a 40-character by two-line LCD module that will be controlled by a PC. The data sheet for the LCD module shows that an eight-bit data bus (lines D0 through D7 on the PC bus), an R/W (read/write) signal, an RS signal (control/data operation) and a CLK (clock) signal are needed from the PC. Refer to Fig. 2 for pinout details of the eight-bit PC expansion bus. The microprocessor (CPU) in the PC must be able to perform reads and writes of eight-bit data words to and from the LCD module while adhering to the timing requirements of the LCD interface signals.

The next step is to define the interface electronics so that it provides the required signals and data. Before you can

Listing 1. LCD Module Demonstation BASIC Program

```
1 REM ****    LCD MODULE DEMONSTRATION PROGRAM    ****
2 REM **** THIS PROGRAM ECHOES KEYBOARD ENTRIES ON THE LCD DISPLAY
****
3 REM *
9 GOSUB 10000     INITIALIZE LCD MODULE
10 A$=INKEY$
20 IF A$="" GOTO 10
24 REM EXIT PROGRAM ON CONTROL "Z"
25 IF ASC(A$)=26 THEN STOP
26 PRINT A$;
35 REM LINES 36 - 80 HANDLE KEYSTROKES LIKE "ENTER," "BACKSPACE," ETC.
36 IF ASC(A$)=8 THEN OUT 768,16:OUT 769,32:OUT 768,16:CHARCNT=CHARCNT-
   1:GOT0 10
37 CHARCNT=CHARCNT+1
38 IF ASC(A$)=19 THEN OUT 768,28:CHARCNT=CHARCNT-1:GOTO 50
40 IF ASC(A$)<>13 THEN OUT 769,ASC(A$)
50 IF ASC(A$)=13 THEN IF LPOINT=1 THEN GOTO 30000
60 IF ASC(A$)=13 THEN IF LPOINT=2 THEN GOTO 2000
70 IF CHARCNT=C THEN IF LPOINT=1 THEN GOTO 30000
80 IF CHARCNT=C THEN IF LPOINT=2 THEN GOTO 20000
90 GOTO 10
10000 REM ILITIALIZATION ROUTING FOR LCD MODULE
10010  LPOINT=1
10020  CHARCNT=0
10021 CLS
10025 PRINT "CNTL Z TO EXIT"
10026 PRINT
10030 INPUT "ENTER NUMBER OF CHARACTERS (8,16,20,40)";C
12000 REM LINE 1 CONTROL DATA
12010 FOR X=1 TO 5
12020 READ L1(X)
12030 NEXT X
12040 DATA 1,2,56,6,14
12050 REM
12060 REM
12070 REM LINE 2 CONTROL DATA
12080 FOR X=1 TO 1
12090 READ L2(X)
12100 NEXT X
12110 DATA 192
12120 REM
12999 REM ************************************************************
20000 REM
20005 REM THE FOLLOWING LINES CLEAR THE DISPLAY AND SEND THE CURSOR TO
      LINE 1
20010 LPOINT=1
20015 CHARCNT=0
20020 FOR X=1 TO 5
20030 OUT 768,L1(X)
20035 FOR Y=1 TO 10: NEXT Y
20040 NEXT X
20050 GOTO 90
29999 REM ************************************************************
30000 REM
30005 REM THE FOLLOWING LINES SIMPLY SEND THE CURSOR TO LINE 2
30010 LPOINT=2
30015 CHARCNT=0
30020 FOR X=1 TO 1
30030 OUT 768,L2(X)
30035 FOR Y=1 TO 10:NEXT Y
30040 NEXT X
30050 GOTO 90
```

design the interface, though, you must familiarize yourself with the different types of buses in the PC.

Expansion cards can interface to a PC as an I/O device, memory device or DMA (direct-memory-access) device. The I/O interface lets the CPU communicate directly with the expansion card via IN and OUT commands. The memory interface allows the CPU to treat the card as a memory device.

I/O interfacing is less complicated, but it limits CPU and card interaction to simple IN and OUT commands. Memory interfacing is slightly more complicated, but it allows the CPU to utilize its full instruction set when interfacing with the card. Although relatively simple to implement, both I/O and memory techniques involve direct CPU-to-card communication and don't allow the card to independently access the computer's memory or other I/O devices. While somewhat more complicated than I/O and memory techniques, DMA interfacing gives the card direct access to the computer's memory and I/O buses without CPU interaction.

To keep things simple, I'll limit this discussion to I/O interfacing. Because the sample LCD module expansion card design I'll discuss next doesn't require complicated CPU or memory interaction, it's well-suited to the I/O type of interface.

The Plug-In Card

The CPU in the PC must be able to perform four interface operations with the LCD module: data read, data write, control read and control write. To implement the system, you must assign two unique ports to the LCD module to accommodate the CPU/LCD display interface. One port is for the data reads and writes, the other for control reads and writes. Since the IBM PC reserves certain I/O ports for internal operations and other expansion cards installed in the PC might utilize some I/O ports, you must make certain that you assign only unused I/O ports for the LCD card being designed.

Figure 3 is a graphical representation of the PC's I/O memory map. Table 1 lists the assignments of the expansion-card slot I/O map. Notice that locations 0300h through 0377h aren't used by the PC and most standard plug-in cards. Consequently, you'll use this address range to interface a personal computer to the LCD module.

To get things started, arbitrarily define the I/O ports as 0300h for control read/write and 0301h for data read/write. Remember, though, to exercise care in selecting these ports. If they conflict with other custom cards in your system, select two other ports that aren't being used.

With definition of the I/O ports complete, you can begin designing the interface electronics. The interface electronics transforms the signals and timing of the expansion interface slot to those required by the LCD module.

Shown in Fig. 4 is the complete schematic diagram of the interface circuit for the LCD module. On the left are shown the PC expansion-slot interface signals and on the right the LCD module interface signals and the LCD module itself. The logic shown in the middle performs the translation between the expansion slot and LCD module.

In this circuit, *U1* is an eight-bit address/magnitude comparator that produces an active-low when the address on the CPU address bus (connected to input A of *U1*) matches the preprogrammed address hard-wired to input B of *U1* (0300h or 0301h in this example). In many custom card designs, the "hard-wired" address at input B of the address comparator is selectable with a DIP switch to provide for flexibility in selecting the I/O port. The AEN signal is used by *U1* as part of the address decode to distinguish between CPU operations and DMA operations. This signal is active-low for CPU and active-high for DMA operations.

Stages *U2A* and *U8A* further qualify the logic to generate an active signal only when the CPU is performing an I/O operation. Chip *U3* and a handful of resistors and capacitors transform the output of *U2A* from a short 600-ns pulse to a longer 1-µs pulse, which is delayed 200 ns from the original pulse. Also, *U3A* and *U3B* guarantee the signal to be a 1-µs pulse, regardless of the length of the pulse input from *U1*. This results in an LCD signal that doesn't depend on the speed of the host computer being used. This 1-µs pulse becomes the clock signal (CLK) for the LCD module.

The eight-bit data bus is fed through bidirectional buffer *U4* to prevent loading on the CPU's data bus. Data from the CPU is latched in eight-bit register *U5* during I/O writes. Similarly, data from the LCD module is latched in *U6* during I/O reads. The direction of the bidirectional buffer and latch of the registers is controlled by the I/O read, I/O write and address signals from the expansion slot.

Read-versus-write operations are controlled by the IOR signal available directly from the expansion slot. When IOR is active, a CPU I/O read operation is indicated. An IOW is indicated whenever the CPU performs an I/O operation while the IOR line is inactive. The resulting signal is latched by *U7B* and is fed to the LCD module as the R/W* signal.

Control-versus-data operations are distinguished by address line A0, which is at logic 0 when addressing I/O port 0300h and logic 1 when addressing I/O port 0301h. This signal is latched by *U7A* and becomes the RS signal for the LCD module.

Latching of the data, RS and R/W lines is needed because the LCD module requires that the data and control signals be valid during the entire 1-µs clock cycle. The expansion slot guarantees the validity of the data only during the I/O operation, which is approximately 600 ns in duration.

Some basic rules should be followed when designing an expansion card. They aren't specific to the IBM PC but are general requirements that should be

Listing 2. LCD Module Initialization BASIC Program

```
1 REM ****              LCD MODULE INITIALIZATION PROGRAM        ******
2 REM **** THIS PROGRAM SCROLLS AN AIRPLANE ACROSS THE SCREEN ***
3 REM *
4 CLS
5 PRINT "LCD ACTIVE DEMONSTRATION PROGRAM"
9 REM INITIALIZE DISPLAY
10 GOTO 10000
90 FOR X=1 TO 25
100 OUT 768,28
110 FOR Y=1 TO 200:NEXT Y
120 NEXT X
130 FOR X=1 TO 15
140 OUT 768,24
150 FOR Y=1 TO 100:NEXT Y
160 NEXT X
170 GOTO 90
10000 REM INITIALIZATION ROUTINE FOR LCD MODULE
12000 REM LINE 1 CONTROL DATA
12010 FOR X=1 TO 5
12020 READ L1(X)
12025 OUT 768,L1(X)
12030 NEXT X
12040 DATA 1,2,56,6,12
12060 REM
12110 REM DO CHARACTER GENERATOR RAM INITIALIZATION
12120 OUT 768,64
12130 FOR X=1 TO 24
12140 READ L1
12150 OUT 769,L1
12160 NEXT X
12165 THE NEXT LINE IS THE AIRPLANE CODE FOR THE CG RAM
12170 DATA 0,0,0,28,30,0,0,0,16,12,6,31,31,6,12,16,24,24,24,31,31,0,0,0
12180 GOSUB 13000
12190 FOR X=1 TO 14
12200 READ L1
12210 OUT 769,L1
12220 NEXT X
12225 REM THE NEXT LINE OS FOR THE DISPLAY
12230 DATA 60,72,69,76,76,79,62,45,45,45,45,2,1,0
12240 GOTO 90
13000 FOR X=1 TO 5
13010 OUT 768,L1(X)
13020 NEXT X
13030 RETURN
```

followed with *any* CPU or digital-logic circuit design. They include:

(1) Decoupling the power supply by connecting a 10- or 20-µF tantalum capacitor from V+ bus to ground at the card edge and also at the top end of the card (*C3* in Fig. 4, for example).

(2) Decouple ICs, which means that, as a minimum, you should connect a 0.01-µF disc-type capacitor from +5 volts to ground on each bus transceiver. Mount such capacitors as close as possible to the ICs. Although not required, it's good practice to decouple *all* ICs in this manner, not just bus transceivers (*C4* through *C12* in Fig. 4 are examples).

(3) Observe expansion-slot contact loading. Each expansion-slot signal is capable of driving a certain number of loads. If the load rating is exceeded, reliable operation isn't guaranteed. To be safe, always use bus transceivers to buffer expansion-slot signals. Also, make sure that the expansion electronics on the card doesn't draw more dc current than the expansion-slot's power pins can safely deliver. Refer to Tables 2 and 3 for details on Expansion Slot Power Capabilities and System Bus Drive Capabilities, respectively.

Construction

You have a few decisions to make before you proceed to build your expansion card. The most important is that you must ensure that the card conforms to the physical size requirements of an IBM PC. The easiest way to guarantee an exact fit is to buy a generic prefabricated PC card. One common manufacturer of prefabricated plug-in cards is Vecrotboard. Vector boards come in a variety of foil patterns and are available from Digi-Key (tel.: 1-800-344-4539).

You can mount the LCD module's circuitry on the blank pc board and wire it using Wire Wrap or point-to-point wiring/soldering techniques. Be particularly careful to verify all wiring before you plug the expansion card into your PC's bus slot. It's good practice to first power up the card on an isolated power supply while verifying proper voltages and current before plugging the card into your PC. Remember, don't plug it in until you're certain it works!

The Software

The I/O ports of the IBM PC are accessed via IN and OUT instructions that correspond to reads and writes, respectively. IN/OUT instructions can be used with assembly language and BASIC.

Shown in Listing 1 is a simple BASIC program that performs an active demonstration of the features of the LCD card. Listing 2 is a program that causes the LCD module to display each character as it's typed at the computer's keyboard.

Summing Up

In this article, I've given you a brief look at the details involved in designing and implementing a custom plug-in card for the IBM PC. If you want to become more deeply involved in this area, a number of reference books with complete detailed descriptions of the expansion slots are available. I recommend *Interfacing to the IBM Personal Computer* by Lewis C. Eggebrecht to anyone who wants to tackle a project of this nature. This book is written in an understandable format and contains many examples, including circuit and timing diagrams. ■

CD-ROM For Everyone

New hardware and software eliminate the need for a computer to get the power of CD-ROM

By Tom Benford

The rapid rise in popularity of CD-ROM systems as add-in devices for personal computers has made this permanent data-storage format a formidable profit maker for manufacturers. As a result, more and more Macintosh and PC users are putting CD-ROM systems high on their lists of must-have peripherals. Fueling user demand for CD-ROM drives is a growing user appetite for optical software to run in them. Disc houses are beginning to meet this demand with an expanding range of titles in virtually every area of interest. The marketplace has changed so dramatically in just the past year, in fact, that even industry skeptics now concede that CD-ROM has done exceedingly well for a read-only peripheral device.

Inspired by the success of computer CD-ROM, some more-innovative hardware manufacturers have now set their sights on the lucrative mainstream consumer electronics marketplace, their goal to make a CD-ROM "player" that will rapidly become as accepted and readily purchased as VCRs now are for even totally non-technical consumers. What they've devised to date offers exciting prospects for the near future, though a lot of confusion has also resulted because no single format has emerged to set a standard in this area.

Players in the CD-ROM-for-the-masses arena include such big hitters as Tandy/Memorex, Kodak, Philips and Sony. A few smaller companies are also seeking to cash in on what's potentially a multi-billion dollar industry by carving specialized niches for themselves.

To bring you up to speed on what you can expect right now, I'll give you a brief look here at some of the products the four major players already have on the market and tell you how each works and what each is capable of doing. Before getting into the products, though, a little background is needed to set the stage.

Background

CD-ROM equipment manufacturers decided early on that the products they'd bring to market would have to be as easy as or easier than a VCR to operate if they were ever to become mainstream items that consumers would flock to purchase. From the very beginning, though, two obstacles had to be overcome to accomplish this aim: the computer and the user interface.

CD-ROM requires a computer to control the drive and provide a user interface. But computers are fairly technical devices that not everyone wants and relatively few people have in their homes. Therefore, elimination of the computer was a primary design objective. At the present time, this isn't possible. So, instead of eliminating the computer, the designers removed it from sight and integrated into the devices themselves.

Though computers still control the current crop of CD-ROM devices for everyone, they're not obvious (nor does a user have to learn how to use them). In fact, with one of the products I'll discuss in detail later, a non-technical user would be hard pressed to find the computer "brain" that controls the whole shebang because these complicated pieces of machinery are manipulated via friendly user interfaces.

To accomplish this, the next important step was to make the user interface easy to use. Taking advantage of the power of the CD-ROM on a Mac or on a PC under *Windows* is still far too-complex a procedure for it to gain mainstream acceptance by people who aren't computer users. To achieve mass-marketing success, the product must be simple, easy and not intimidating to use.

The solution was to design a CD-ROM player with such qualities as hiding any required logic and computing circuits and components inside the player to maintain an uncluttered physical appearance, displaying its data on the family TV receiver, rather than requiring a dedicated video monitor or viewing screen, and supplying a simple wireless remote controller for the user to access player functions and software. Giving the device the ability to play audio CDs was deemed essential to make it easier for consumers to justify its purchase and help it gain acceptance.

On the way to market, another obstacle cropped up that directly affects the consumer: media compatibility. The issue of proprietary CD-ROM formats is reminiscent of the Beta-versus-VHS situation that arose in the early days of VCR marketing. Back then, only two players were in the arena. This time around, however, four major players are involved, which considerably complicates matters.

Each of the four major hitters in this arena is capable of committing a great deal of money to developing and promoting a product and has lots of marketing savvy and the support of software developers to produce titles for these machines. And don't forget that in addition to these four major companies, other proprietary CD-ROM machines and formats waiting in the wings.

Products by the main contenders that are already on the scene include Philips with its CD-I (Compact Disc-Interactive) player, Tandy with its Memorex 2500 VIS (Video Information

System), Kodak with its Photo CD Players and Photo CDs and Sony with its MultiMedia Compact Disc player.

Media compatibility between machines is a big issue and not one that will be resolved in the near future, if ever. Consequently, this should be a major consideration if you're thinking of purchasing one of these machines. While all of these machines can play audio CDs, they can't use dedicated media interchangeably. More importantly, if you're thinking of getting double-duty from your computer CD-ROMs by playing them in one of these players connected to your TV receiver, you can forget it. None of these consumer-level players can read or display information written for computer CD-ROM use, although computer CD-ROM drives can read some of these stand-alone player formats.

The two standard computer CD-ROM formats are ISO 9660, the "legal" version of the original High Sierra format draft that's used with IBM-compatible PCs, and Apple HFS (Hierarchical File System), a tree-structured file format on the Macintosh in which folders can be "nested" within other folders.

The CD/XA (eXtended Architecture) format, also referred to as CD-ROM/XA, is a standard that was jointly developed and announced by Philips, Sony and Microsoft in August of 1988 but didn't attract much attention until recently. The extended architecture primarily deals with the error-correction algorithms used that, in turn, affect the amount of data a disc can contain.

Computer CD-ROMs use multiple levels of error correction and have audio-CD sound quality (Red Book Standard). This is known as Mode 1 data. Mode 2 is a data format that utilizes less error correction and substitutes low-to-medium-fidelity audio that results in longer play times and increased data capacities on the disc. By mixing both modes on the same CD-ROM, low-to-medium-fidelity digital audio can be simultaneously processed while other data is being viewed.

CD/XA, or permutations of it, has been used mostly on dedicated-purpose players like some of the game machines (TurboGrafx, Sega and the like).

Some CD/XA discs can be used with a computer CD-ROM drive, but a special CD/XA controller card is required in a PC to access X/A capabilities. As of this writing, there were no CD/XA controller cards for PCs on the market, making this a moot point. Virtually all new model computer CD-ROM drives, however, are XA-capable and can read some CD/XA discs (like the Kodak Photo CD), or at least some portions of them.

Commodore Computers, best known for the Commodore 64 and Amiga computers, was among the first on the proprietary-format scene with CDTV (Commodore Dynamic Total Vision), a proprietary CD-ROM format used in Amigas. In fact, the CDTV player has an Amiga computer as its heart.

The CDTV player uses a hand-held controller unit that's similar to a Sega Genesis controller for directing the on-screen cursor arrow and to interact with the program material. The machine connects directly to a TV receiver and can be connected to a stereo system as well since it's capable of producing full-fidelity stereo sound.

In addition to proprietary-format CDTV discs, the Commodore unit can play audio and CD+G (an audio CD format that also contains such embedded graphics information as notes on the artist, song lyrics, etc.) CDs. CDTV players aren't compatible with any other CD-ROM format but have still managed to attract a loyal base of users.

Commodore endows its CDTV player with expansion options and ports for attaching a keyboard, modem, printer and other accessories for those people who want to do more with the machine. CDTV has been around for about two years and has had a niche market largely unto itself. Despite a considerable amount of TV and print advertising over the 1992 holiday season, however, the future of CDTV is dubious in light of the competition posed by these other consumer CD-ROM machines.

Product Reviews

Kodak Photo CD

Kodak has taken a unique approach in its CD-ROM player, devoting it entirely to playback of the company's proprietary-format Photo CDs and to playing standard audio CDs. As the world's leading photographic company, Kodak designed, perfected and implemented what can best be described as ultra-high-definition digital imagery.

Kodak Photo CD players connect directly to a TV receiver or video monitor and, optionally, to a stereo system. They can play only audio and Photo CDs. No other CD-ROM format can be read by them.

Photo CD discs contain photographs taken with ordinary cameras and film. Images are scanned and transferred onto the optical media using one of Kodak's writeable CD systems like the Kodak PCD Writer 200. Since the equipment required to transfer images from film to a CD is expensive and the Photo CD format is still very new, only a handful of photo finishers are equipped to do this sort of "processing." Kodak's facilities also provide processing through local dealers.

A Photo CD disc can accommodate up to 100 images (the equivalent of four 24-exposure rolls of film). Images are stored in several formats that make them viewable on different CD-ROM reader devices, including many of the newer XA-capable computer CD-ROM drives.

Resolution of the scanned images is 16

Tandy/Memorex MD-2500 VIS player looks innocuous as a consumer-level device, but it' really a DOS-based PC in disguise, capable of playing audio CDs and CD+G discs a proprietary VIS format but not Photo CDs.

times greater than today's TV standards and four times greater than the standards currently being considered for HDTV. This seeming over-abundance of image data results in pristine images with sparkling clarity and brilliant, lifelike colors. I had some of my 35-mm slides transferred to Photo CD and they look better on TV and my PC monitor (with a hi-color card) than they do when they were projected on a screen from the original slides.

One of the main reasons for this ultra-high-resolution scanning is that the Photo CD Master disc can also function as a "digital negative." Thus, you can take the disc to your local photo finisher and have prints made of the images on the disk.

When images are viewed using the Kodak Photo CD Player connected to a TV receiver, the image display is controlled via a wireless remote controller. With this system, you can select a specific image, program it to appear in a particular order, rotate it and zoom-in on part of it for a close-up look.

As of this writing, Kodak has three Photo CD player models, each of which has full hi-fi/stereo audio capability in addition to a unique set of picture-viewing functions. One is a low-priced player with basic picture-viewing and audio CD features that allows you to delete some pictures from the playback sequence and keep others. It can also remember the changes, which eliminates the need to program a disc every time you view it. An "autoplay" feature lets the player automatically sequence through selected images at 2-second intervals.

A deluxe player provides a variety of more-advanced viewing options, in addition to the standard audio-play features. With this player, you can view close-ups of images, selecting a rectangular portion for magnification with a "2 × tele" feature. An "expanded favorite picture selection" feature provides additional memory for recalling individual picture edits and viewing order selections of more discs.

The final Photo CD player offers all of the advanced features of the deluxe version and adds a five-disc carousel mechanism. This player also provides on-screen display of the selected image number for easy indexing and fast photo identification.

Intended primarily as a "bridging mechanism" to help consumers make the inevitable transition from film-based photography to totally electronic imaging, Kodak's Photo CD players and Photo CD discs successfully merge the brilliance and clarity of photography with the digital image processing capabilities of CD-ROM.

Without question, Kodak has defined with its Photo CD technology a new proprietary format that successfully bridges the gap that formerly existed between photographic image quality and digitized quality. PC and Macintosh users with CD-ROM drives that are capable of reading Photo CD discs can manipulate, enhance, export and use their Photo CD images in their desktop-publishing and other computer applications as well. Kodak, Mathematica, Corel and other companies have software products available for working with Photo CD images on the computer (see the Software box).

Philips CD-I

Another proprietary format is CD-I, which stands for Compact Disc-Interactive, which comes from Philips, the company responsible for development of the compact disc and the audio cassette. The Philips CD-I player has already made a noticeable impact in the consumer marketplace since its release in November of 1992.

The name Compact Disc-Interactive succinctly describes what this product is and does. Simply stated, it's a CD-ROM that permits you to interact with it.

A CD-I player connects directly to a TV receiver and has audio line output jacks for connection to a stereo system. Thus, the unit can play audio CDs and CD+G discs.

You use a wireless remote controller to interact with the CD-I software and control certain functions of the player. The remote unit has buttons for "clicking" on a control function, ejecting the disc and performing other functions, which include adjusting the volume of the audio.

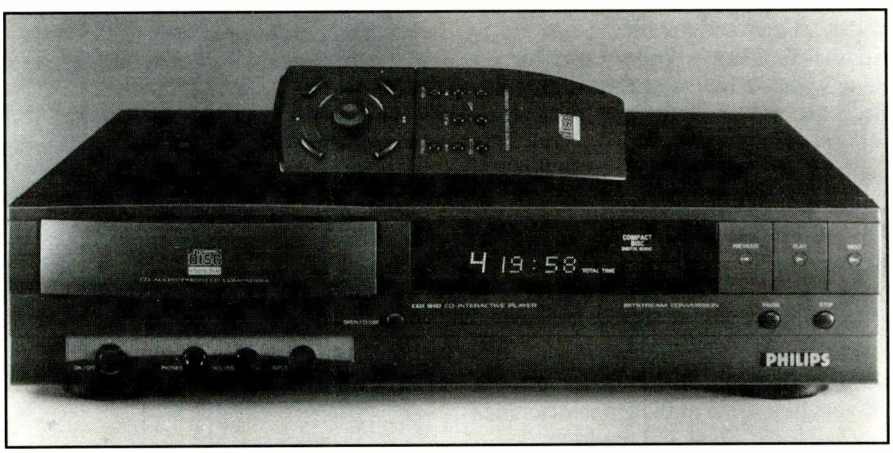
You use a miniature joystick built into the wireless remote to control a cursor arrow that's displayed on the screen of the TV receiver. An optional trackball controller that connects to a jack on the CD-I player is available at extra cost. The trackball is easier for youngsters to use and is much more responsive for high-speed operation of some CD-I software titles, like action games.

Not surprisingly, Philips has attracted a substantial number of software developers and publishers to support its CD-I format. As of this writing, about 100 software titles are available in the CD-I format and more are on the way.

I had the opportunity to use several CD-I titles and found that the amount of interactivity they support is dictated entirely by the subject matter of the software. For example, the *Amparo Museum* and *Treasures of the Smithsonian* require relatively little interactivity once you select a topical section for presentation. On the other hand, *Pinball* and *CyberCity*, two game discs, require constant user interaction.

The way you can interact with a CD-I disc is limited to the "possibility paths" programmed into the software. For example, if you "walk" down the main corridor of a museum via a CD-I disc, you're permitted to go to the right or left only when the program has provisions for branching in either direction. Access to information contained on the CD-I disc is limited to what the programmers permit.

All choices on CD-I discs are made by moving the cursor arrow to the desired selection and pressing one of the "action" buttons. (These have the same effect as pressing "return" or "enter" on a PC keyboard.) Keeping the design of the CD-I player sim-



Philips CDI-910 CD-Interactive Player plays all audio CDs in full hi-fi stereo and can play Kodak Photo CDs and CD+G discs. A joystick is built into the wireless remote controller for making user interaction possible. An optional extra-cost trackball controller is better for game play than the standard wireless remote.

ple also dictated making the software applications equally simple to operate, which, in turn, affects the level of interactivity possible on a disc.

Picture quality and stereo sound of the CD-I player are quite good, and animation and interactivity makes using the applications fun and easy. Users can look forward to seeing lots of titles for this machine on dealers shelves right now, with many more to follow as the CD-I format gains popularity and support.

I tried reading a CD-I disc to see what would happen on my 486 PC's NEC CDR-84 CD-ROM drive, but the directory came up blank.

The ability to read and display Photo CD images is a big plus for the CD-I player. In fact, Kodak puts image data in CD-I format, as well as its own proprietary format, on Photo CD discs (known as a bridge disc). This imprimatur from Kodak gives Philips CD-I machines some extra weight in the marketplace, bolstered by heavy TV and print-media advertising.

Model PCD 5870 Photo CD Player shown is Kodak's top-of-the line five-disc carousel changer that can play back Photo CD images on any TV receiver and provides hi-fi/stereo playback for audio CDs.

Tandy/Memorex MD-2500 VIS

Another CD-ROM proprietary-format is the Video Information System developed by Memorex and manufactured, marketed and distributed by Tandy through its Radio Shack stores. The VIS player is another machine that connects directly to a TV receiver and, optionally, a stereo system for full hi-fi/stereo playback of both audio CDs and VIS-format discs.

The Tandy machine is also capable of playing CD+G discs, but it can't play Kodak Photo CDs in either single- or multi-session format. Nor is this player capable of playing CD-I discs, CD/XA discs or computer CD-ROMs in ISO 9660 or HFS format.

I was able to list the directory and even play some the .WAV sound files of VIS discs on my PC's CD-ROM drive, but I couldn't execute any of the programs. Applications designed for CD-I, incidentally, run under a runtime version of *Windows* on the machine.

The VIS dedicated format has attracted lots of attention and support from software developers for two reasons. One is that Tandy is a major manufacturing and marketing force, with nearly 7,000 stores and an exceptionally loyal customer base. The other is that it's a DOS-based machine on the programming level, which makes it a relatively easy and speedy task to convert existing DOS CD-ROM code to conform with the VIS specification and interactive interface requirements. The result is a rich assortment of software released simultaneously with the VIS player, not to mention an ongoing

Compatibility Table

Data Formats	Generic CD-ROM Drives (PC or Macintosh)	Philips CD-I	Kodak Commodore Photo CD VIS	Tandy/ Memorex Player	Sony Multimedia	CDTV
CD-Audio	Yes	Yes	Yes	Yes	Yes	Yes
Photo CD	Some Models	Yes	Yes	No	No	No
HS/ISO 9660	Yes	No	No	No	Some Titles	No
MAC HFS	Yes	No	No	No	No	No
CD+G	Audio Only	Yes	Yes	Yes	Audio Only	Yes
CDTV	No	No	No	No	No	Yes
CDI	No	Yes	Yes	No	No	No
VIS	No	Yes	Yes	Yes	No	No
CD-ROM/XA	Some Models	No	No	No	Yes	No

Media format incompatibility between various players is a serious issue to consider when contemplating a purchase. Note that computer CD-ROMs (High Sierra, ISO 9660 or Macintosh HFS formats) can't be used on any of these other machines..

stream of additional titles.

As of this writing, approximately 50 software development and publishing companies have committed to delivering more than 100 VIS titles. These will have suggested retail prices of $29.95 to $79.95.

You use a wireless remote controller, provided with the unit, to interact with the software, which is very similar to the dual-pad type of controller used with the Genesis game machine. A rocker-type switch mechanism, rather than a joystick, provides directional control and a slide-selector switch lets you select solo or two-player action. A four-button control pad is also built into the hand control unit.

The controller is ergonomically shaped to fit the hand's contours. So even youngsters will be able to use it without difficulty.

Options for the VIS player include a second hand controller for head-to-head play action. A modem is also available for connecting with on-line information services.

A unique feature of the VIS unit is its included Save-It cartridge that provides a means of saving game scores, preserving electronic "bookmarks" in reference books and saving other user-selected information for recall and use at a later time.

The Model MD-2500 CD-I player comes with a specially-designed VIS version of the entire 26-volume *Compton's Multimedia Encyclopedia*, which includes a complete *Webster's Intermediate Dictionary*, all on the same disc. This bundled title contains thousands of colorful illustrations, excellent animated sequences and digital sound and speech.

Several of the currently-available software titles (see Software box) and those yet to be released are appealing to all members of the family, with the *Compton's Multimedia Encyclopedia* disc as a good representative example.

The Model MD-2500 VIS takes longer to "boot" (get an opening display that tells you it's ready for business), than any of the other machines covered here. As a computer in consumer clothing, the VIS machine has some inherent advantages over some of the other machines.

VIS's principal advantage is that additional capabilities can be given to the machine when upgrade firmware becomes available. An example of this may include an upgrade that gives the machine the ability to accommodate other formats it isn't presently able to read, such as Photo CD.

Expansion slots and I/O ports are built into the VIS machine. This kind of open architecture strongly suggests that keyboards and other peripherals will be forthcoming to expand upon the capabilities of the machine when you wish to progress further. The Save-It cartridge also gives this hardware platform additional flexibility.

Sony Multimedia Player

Sony, another major technological product-development and consumer-electronics company, has taken yet another proprietary approach in making CD-ROM practical for the consumer with its portable Multimedia

Available Software

Kodak Photo CD

Kodak's Photo CD Access software is available for DOS/*Windows* and Macintosh operating system users. This basic software utility lets the Kodak player read and save Photo CD images in other formats.

Kodak PhotoEdge image-enhancement/correction software lets users do more advanced image correction and improvement.

Kodak Renaissance design software is a page-layout package that has been upgraded to permit direct input of Photo CD images. Mathematica also has a program called *Tempra Access* that permits viewing, editing and exporting Photo CD images on a PC. *Corel Draw* 3.0 also includes a utility program called *Mosaic* that can open and display Kodak Photo CD "thumbnail" photos (like an electronic contact sheet).

Philips CD-I

Philips shipped an assortment of CD-I titles along with the player it supplied, giving me a good opportunity to use several of the CD-I titles, including *Compton's Interactive Encyclopedia, Smithsonian Treasures, Caesar's World of Gambling, A Visit to the Amparo Museum, American Treasures, Gifts to Behold, Gardening by Choice, Private Lessons: Classical Guitar, Private Lessons: Jazz Guitar, Pinball* and *Escape from CyberCity*. Sound, video and overall ease of use are beyond reproach, regardless of the title used with the CD-I.

Tandy/Memorex VIS

In addition to the *Compton's* disc packed with the player, I also had an opportunity to use several VIS software titles that included: *Atlas of U.S. Presidents*, the *Great Lives Series* (Vol. 1), *American Vista, World Vista, Sherlock Holmes: Consulting Detective* (Vols. I and II), *Time Table of History: Business, Politics and Media*, the *American Heritage Illustrated Encyclopedia and Dictionary, SmartKids Challenge One Games*, eight of the *Kids Read* titles, *Rick Ribbit's Adventures in Early Learning, Rainbow & Snowflake's Search For The Sea* and two *Henry and Mudge* story titles. As you can tell by their names, many of these titles are for youngsters ages four and up. They're excellent educational products that will teach pre-schooler's and youngsters while holding their attention for hours.

The interactivity of the programs permit progressing at a pace that's comfortable for a child, and the ability to control, to one degree or another, on-screen events is a very attractive element to children, since they have to depend on grown-ups for just about everything else.

Being quite familiar with the computer CD-ROM counterparts of several of these titles (*Time Table of History, Compton's Encyclopedia, Sherlock Holmes* and others), I had a good frame of reference for assessing the quality and content. I must admit that I was highly impressed with how little the VIS versions deviated from the computer CD-ROM versions.

Sony MMCD

Sony's MMCD Player comes with a User Guide Disc that takes you on a basic tour of the machine, its features and its capabilities. Also included with the player is an *IBM Business Series Sampler* disc that gives a preview of some of Big Blue's software. I also received two of IBM's UltiMedia Business Series titles (*Training for Business Success* and *A Corporate Guide to National Parks*) as well as *Fodor's Wall Street Journal Guides to Business Travel for the USA & Canada*). These titles are all surprisingly usable and viewable on the MMCD's LCD screen, and they take on a whole new persona when viewed on a TV receiver or monitor.

As of this writing, there are already more than 60 software titles available for productivity, education, reference and entertainment, with dozens more soon to be released. Since some of the software produced for the MMCD player is or will be DOS- and/or *Windows*-compatible, some titles may also be usable with PC-based CD-ROM drives as well.

Glossary of Terms

Bridge Disc. A disc that will play on a CD-XA or CD-I drive. An example of a bridge disc is the Kodak Photo CD.

CD+G. An audio CD format that contains some embedded graphics information, which can be notes on the artist, song lyrics, etc. CD+G discs can be played on standard audio CD players. But unless the player has video output capabilities, you'll hear only the audio portions of the material.

Firmware. This consists of such software instructions as start-up routines, low-level input/output instructions, etc. stored in read-only memory, making it ideal for instructions and information that are needed by the device on a permanent basis.

Mode 1. An encoding scheme used in producing CD-ROM that utilizes three layers of error detection and correction for maintaining the integrity of computer data (text, numbers, etc.).

Mode 2. An encoding scheme used in producing CD-ROM to provide two layers of error detection and correction, used most often with audio or compressed audio/video data (sound, full-motion video, etc.).

Multi-Session/Single Session. These terms pertain to the Kodak Photo CD. Single-session Photo CDs are discs that have had all their images transferred onto them in a single session, and one table of contents for the disc is generated. Multi-session Photo CDs contain images transferred during several different sessions, with each subsequent session generating its own table of contents. The ability of CD-ROM drives and other consumer-level devices to read these discs varies from product to product. A drive is said to be single-session-capable if it can display images listed on the disc's single table of contents. A drive (or device) is multi-session-capable if it can read and display images contained in all directories in the table of contents (single-session drives will display only the images of the original TOC if a multi-session Photo CD is being used).

Red Book. The standard specification for CD Audio, as detailed and agreed upon by Philips, Sony and other major manufacturers. Since these technical specifications were published in a book with a red cover, this specification for audio became known as the "Red Book" standard.

Player. A radical departure in form and format from the Kodak Photo CD player, the Philips CD-I and the Tandy/Memorex VIS, the Sony Multimedia Player is small enough to carry around and has a built-in display screen, making it a totally portable stand-alone unit.

The Sony player measurers only 7"W × 6"H × 2"L and weights just 2 pounds. Since it also plays audio CDs and has an audio jack for stereo headphones or small "Walkman-type" speakers, this unit is sure to become a favorite leisure-time device for listening to audio CDs when it's not being used for data retrieval.

Sony's Multimedia Player is capable of reading CD-ROM/XA discs that conform to its data format requirements and audio CDs. Additional format capabilities may be offered in later versions of the unit or as optional upgrades.

The device integrates a CD-ROM drive that supports the CD-ROM/XA standard, a PC-compatible microprocessor (the operating system is on ROM), LCD display panel, speaker, keyboard and cursor pad, all in a compact unit that's small enough to fit inside a briefcase.

Out of curiosity, I tried reading a Sony MMCD-format disc on my desktop PC equipped with an XA-compatible NEC MultiSpin CD-ROM drive. I was able to list the directory of the MMCD disc, but trying to run any of the executable files bombed my system. Some MMCD-format discs are capable of being utilized with computer CD-ROM drives, and icons are used on the packages to denote these capabilities.

A DOS or WIN icon states that the software is compatible with either of these platforms, a book icon signifies that the disc has readable text, a light-bulb icon indicates search capabilities, a headphone icon means playable audio, a camera icon indicates pictures and a movie-projector icon indicates video clips as part of the content.

You can also connect the Sony Multimedia Player directly to a color TV receiver. The player is also equipped with a serial port that can be used for sending information to a printer, uploading information to a personal computer or, with the proper software, connecting to a modem.

Sony's stature in the electronics and computer industries and its highly-respected reputation for quality products in the consumer marketplace assure the Multimedia Player a promising future.

Sony and Nintendo have been negotiating an alliance that could result in yet another proprietary format for optical media. A possibility also exists that Sony may attract a

strong enough following to gain a foothold for its XA format. Certainly, having Microsoft and Philips as fellow definers of the standard doesn't hurt Sony's position.

Major software developers and publishers, including such names as Axxis Electronic Publishing, Compact Publishing Inc., Compton's New Media, Random House and IBM all have announced intentions of releasing titles that are compatible with the Sony Multimedia Player.

Other Formats

There are several other proprietary CD-ROM formats that are intended exclusively for use with a particular machine. Many of these are recreational software products, such as those developed and produced for the TurboGraphics, Sega and other CD-ROM game machines that are usually, but not always, also capable of playing audio CDs. Many include line-output jacks for connection to a stereo system, in addition to a headphone jack.

Since these products are developed exclusively for use on their proprietary players, they aren't compatible with any other CD-ROM drive or consumer-level player.

The table indicates which media formats will work with each of the player types discussed here.

Conclusion

CD-ROM will continue to have an impact on data storage, retrieval and exchange. With the new machines discussed here, making large volumes of information available to consumers becomes feasible and affordable. Which disc formats and machines will survive the inevitable shake-out that's certain to occur in the not-too-distant future remains to be seen. But with such heavyweight contenders already vying for market share, the consumer stands to be the winner, regardless of which format(s) eventually dominate the field.

Sony's MultiMedia CD Player is a true stand-alone device that provides an LCD viewing screen and built-in speaker and can connect to a TV receiver, interface to a PC and more to play audio CDs and its own XA format only.

Names & Addresses

Commodore Business Machines
1200 Wilson Ave.
West Chester, PA 19380
Tel.: 215-431-9100
CIRCLE NO. 123 ON FREE INFORMATION CARD

Eastman Kodak Co.
343 State St.
Rochester, NY 14650
Tel.: 716-724-4000
CIRCLE NO. 124 ON FREE INFORMATION CARD

Philips Interactive Media of America
11111 Santa Monica Blvd., Ste. 750
Los Angeles, CA 90025
Tel.: 310-444-6619
CIRCLE NO. 125 ON FREE INFORMATION CARD

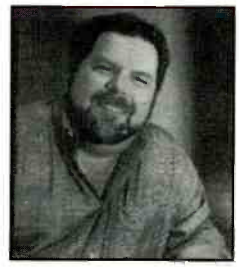
Sony Computer Peripheral Products Co.
655 River Oaks Pkwy.
San Jose, CA 95134
Tel.: 800-352-7669
CIRCLE NO. 126 ON FREE INFORMATION CARD

Tandy Corp.
1500 One Tandy Center
Fort Worth, TX 76102
Tel.: 817-390-3011
CIRCLE NO. 127 ON FREE INFORMATION CARD

Compton's New Media
2320 Camino Vida Roble
Carlsbad, CA 92009
619-929-2500
CIRCLE NO. 128 ON FREE INFORMATION CARD

Mathematica Inc.
402 S. Kentucky Ave.
Lakeland, FL 33801
Tel.: 813-682-1128
CIRCLE NO. 129 ON FREE INFORMATION CARD

Corel Systems Corp.
1600 Carling Ave.
Ottawa, Ontario, Canada K1Z 8R7
Tel.: 613-728-8200
CIRCLE NO. 130 ON FREE INFORMATION CARD

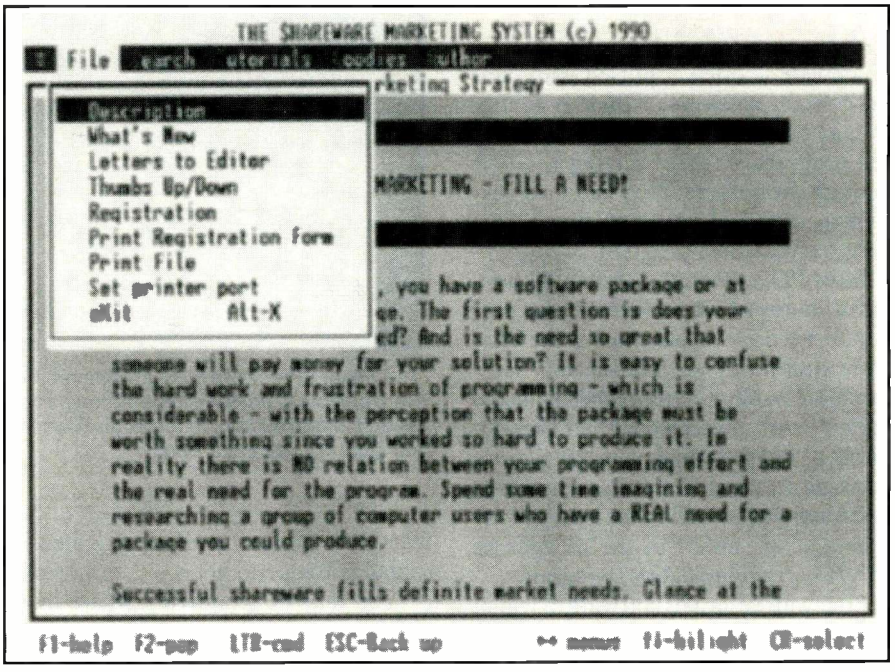


Tom Benford

Discover Shareware

An introduction to this goldmine of software for authors and users

There's a goldmine of more than 30,000 shareware programs out there to sample before buying. With such a plethora of shareware titles from which to choose, covering virtually any application you can imagine, there's almost certainly at least one package to suit some computing needs you have for far less money than what you'd have to pay for a similar commercial package.



Jim Hood's $hareware Marketing $ystem shareware author resource includes more than 4,000 addresses of disk vendors and addresses for BBSes, computer clubs, international agents and key industry contacts in *dBASE*-compatible format.

Shareware Defined

The term "shareware" is usually considered to have been coined by Bob Wallace, author of the 1982 *PC-Write* IBM PC word-processing program. Wallace's concept involved free distribution with formal registration if you use the program. At about the same time, Jim Button wrote *PC-File*. To date, his ButtonWare, Inc. has sold more than 800,000 copies.

Shareware is a method of distribution, not a type of software. For example, the highly respected telecommunications program, *ProCOMM*, started out as a shareware program and has since become a mainstream commercial product available through traditional commercial channels.

Only people who actually use a shareware program pay for its development, distribution and maintenance through registration fees. This form of distribution lets you try software before you buy it to make sure that it's compatible with your system and works to your satisfaction.

Some shareware authors suggest registration, others require it and a few specify a maximum trial period. Everything works on the honor system.

The shareware alternative to commercial retail software has some advantages to users. With no up-front cost for it there's little risk of getting stuck with a high-priced program that doesn't meet your needs. Because overhead is low, prices are low. Given the foregoing, shareware has the ultimate money-back guarantee: If you don't use it, you don't pay for it.

Another advantage is that you can often contact the author of a program for assistance. Still another advantage is that some software, like certain utilities, is available only as shareware because it often doesn't pay for commercial software houses to commit resources to small specialty programs. This allows an enterprising author to develop neglected but important software niches.

Copyright laws apply to shareware, as creative works, and the copyright holder retains all rights. The author specifically grants the right to copy and distribute the software. So you usually can legally copy the software and give it to others. However, some authors require permission before commercial disk vendors and distributors are permitted to copy their software.

If a shareware program is protected by copyright, you aren't permitted to modify any part of it to sell or incorporate it into another program, though some authors include source code so that others can modify and improve it for their own benefit. If you change code or documentation, send the alterations to the author for evaluation and possible incorporation into future updates.

Normally, shareware is distributed free of charge or for a small disk copy and distribution fee to remunerate software distributors. After you try the software for a short test period, normally 15 to 90 days, you're asked to send the author a registration or user-support fee. The vendor who distributes the disks gets no percentage and doesn't track those who register. Despite this relaxed atmosphere, much shareware isn't second-rate, and most authors support their products.

Registration fees usually range

between $10 and $80, which most authors use to provide such tangible benefits as product updates, notices of bugs and fixes and a printed manual. Some offer telephone support and automatic program updates and pay commissions to users whose friends register. Registration provides feedback to authors and helps them improve their programs.

Public-Domain Software And Freeware

Shareware is often confused with public-domain software, which is totally free and not copyrighted. You can use PD programs without having to compensate the authors. You can also customize, alter and use PD software as a base for your own programs.

Most PD software is written by hobbyists, many of whom wish to fill a particular need by creating a unique software routine or application that isn't available through commercial channels.

The term "shareware" isn't trademarked, but a similar concept-a cross between PD and shareware known as freeware-was coined by the late Andrew Fluegelman, author of the pioneering *PC-Talk* communications program.

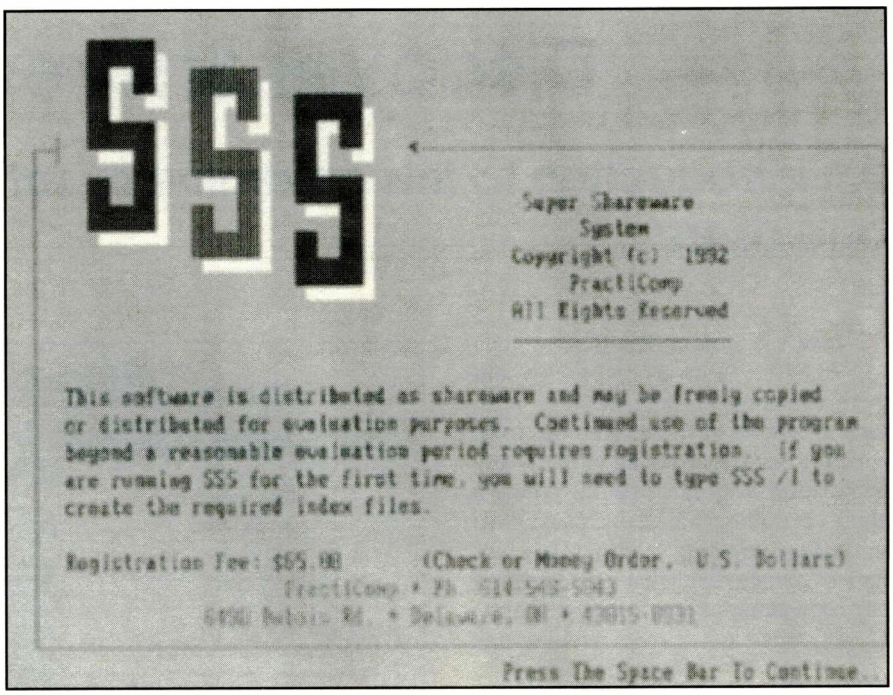
Freeware describes software to which the author retains a copyright but lets the public use it at no charge for the product. There can be a fee here, too, but it's more of a donation than a requirement, which can be confusing. Muddying the waters even more, you'll often see shareware and freeware used interchangeably, even though there is (or was) a fine distinction between the two.

Software quality varies widely. Much PD software and freeware is of good quality but may not offer as many features as commercial retail and shareware products.

Tapping the Sources

Some of the best sources for low-cost, non-commercial software include local bulletin-board systems (BBSes), commercial on-line services and shareware disk distributors.

Thousands of open-access BBSes let you download software posted on their boards. Most offerings are free, though some are by subscription. While much BBS software is a mixed bag of sometimes useful and sometimes not useful PD material, most boards also post good shareware for downloading. All you need is a modem and appropriate terminal software to get it.



The Super Shareware System comprehensive business-management system enables shareware authors to track customers, prospects, distributors, contacts, products, sales and expenses and allows authors to target mailings to customers, prospects and distributors, using mailing label or postcard options.

You may be wondering where these BBSes are. Modem users in local PC user groups are good sources of BBS numbers.

You can usually use a BBS the first time you sign onto it, although you may have restricted access to files until the BBS sysop (system operator) verifies your registration. It's good to read the sysop's on-line rules and bulletins the first time you sign onto the board so that you know what to do to keep you in good standing.

According to industry sources, on-line services have nearly 3-million members. Shareware is available on CompuServe, America Online, PC-Link, GEnie, Prodigy and ZiffNet, to name just a few. Let's look at some of these commercial services.

• **Exec-PC.** Bob Mahoney's Exec-PC is a cross between an on-line utility and a BBS. Although there are others, this one has the world's largest subscription roll. It has some 500,000 shareware programs and files for the IBM PC, Macintosh, Amiga and Atari ST and is said to have the best file location and download facility available on any system. With more than 280 telephone lines, you aren't likely to get a busy signal when you dial Exec-PC. Downloads are free on your first call.

• **CompuServe.** This Columbus, Ohio-based on-line service has nearly a million members and boasts multiple megabytes of software you can download in its many forums and other accessible areas, but you must be a member to gain access. Several membership plans are available, and free start-up memberships are bundled in many software packages.

• **ZiffNet.** Through CompuServe, you can access the ZiffNet service for PC buyers and users. It brings together a wealth of shareware, freeware and PD software and offers forums, product reviews and more. Membership is separate from CompuServe. You can access ZiffNet through CompuServe or directly if you aren't a CompuServe member. Information on ZiffNet is available by calling the CompuServe telephone numbers given in the Names & Numbers box. ZiffNet also recently began to offer a comparable service, ZiffNet for Prodigy, for users of this on-line utility.

Shareware disk distributors don't sell software. They sell a physical disk with software for evaluation, duplication and distribution services. Once you purchase a disk, it's your responsibility to

register programs you use.

Hundreds of PD and shareware vendors exist, but the following four appear to be among the best and most comprehensive. There's little risk of catching a computer virus from them because they obtain programs directly from the authors and publishers and scan all programs and disks for viruses.

• **PC-SIG.** An excellent source is the PC Software Interest Group (PC-SIG). Its collection grew out of the Silicon Valley Computer Society's library and consists of some 800M of shareware. You can purchase disks for as little as $2.49. A catalog on disk costs $7. PC-SIG also offers its complete library on CD-ROM for $179 and publishes several encyclopedic books and *Shareware Magazine*.

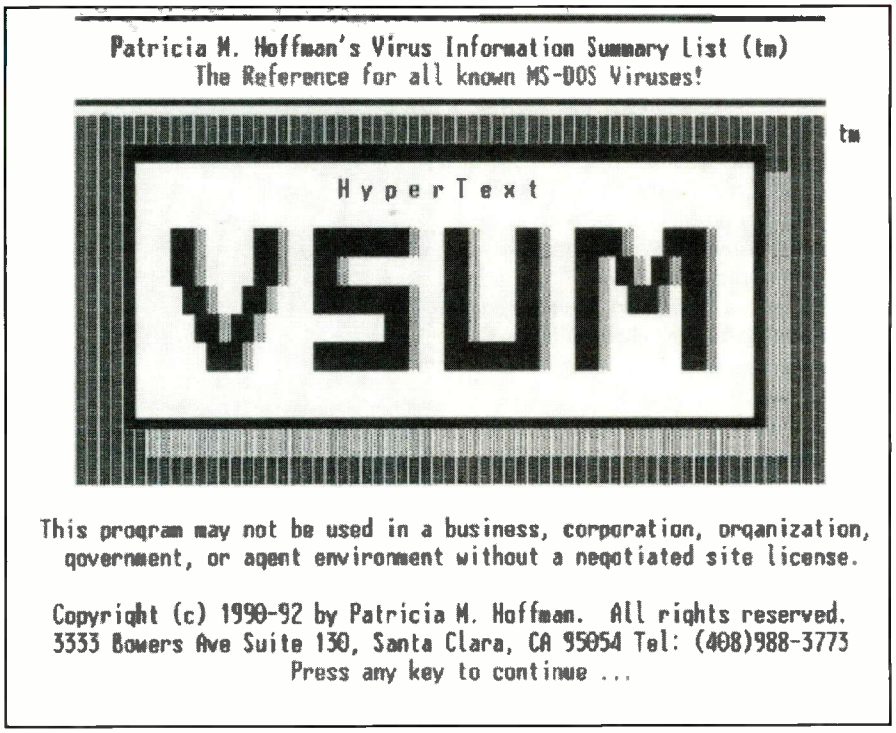
• **Public Brand Software.** PBS objectively describes each of the programs listed in its catalog to provide the facts needed for you to make comparisons. An especially useful feature of this catalog is its subjective ratings of each disk or program. Disks cost $5 each, and catalogs cost $2. The PBS software collection is also available on ZiffNet.

• **PsL.** Nelson and Kay Ford's Public (Software) Library is a smaller but highly respected disk vendor that distributes PD and shareware disks for $5 each, publishes the *Source Book of Free & Low-Cost Software* for $12.95 and offers an optional membership for $37.50 that includes a subscription to *PsL News*. The magazine includes reviews of more than 200 new and updated PsL programs each month. You don't have to be a member to order disks.

• **The Software Labs.** TSL purports to be the world's largest supplier of high-quality, virus-free software. It takes pride in its strict quality control. TSL offers disks for as little as $3.19 each and publishes a catalog with highly informative program descriptions.

CD-ROMs are popular for distributing large commercial retail software packages, but they aren't very practical for individual shareware titles.

Many BBSes offer one or more CD-ROM sections for file downloading. If you don't mind often lengthy search times, you may be able to find the files and programs you're looking for on your favorite BBS at little or no cost. Also, don't forget another source of PD and shareware software that may be close to home: your local computer users group, which may have a selection of software you can get for the cost of a floppy disk. Some user groups even purchase every disk offered by one or more shareware disk vendors.



Virus researcher Patricia Hoffman's Virus Information Summary List (VSUM) is a comprehensive shareware reference tool that provides virus characteristics, history and family trees; gives infection symptoms; shows how to remove viruses; and evaluates how competitive anti-viral software stacks up. A virus index and cross-reference data are included. Download VSUM from CompuServe and many BBSes. Registration is $30; add $10 for the program on diskette. VSUM can be obtained from Patricia Hoffman.

Shareware & Computer Viruses

Most BBS sysops and shareware disk vendors take precautions to prevent viruses from appearing in their offerings. However, be aware that some uncontrolled-distribution software can be and is infected. If you copy and run the infected software in your computer, you run the risk of infection.

The Association of Shareware Professionals (ASP) claims that the spread of viruses by BBSes and shareware is a myth because most sysops and authors work diligently to prevent viruses from infecting their offerings. Nevertheless, it pays to be safe by always checking out new software with a virus-detection program.

Available are dozens of shareware and freeware programs designed to seek out and destroy viruses. You can find them on BBSes, obtain them from disk vendors or buy them directly. Be sure the program you select has been on the market for some time and offers updates and product support, though.

If you download from public BBSes, look at Lee Jackson's *The Hack Report*, a free monthly bulletin available from on IBM Bulletin Board Forum (GO IBMBBS, library 4) on CompuServe. It may also be available on your favorite BBS. It lists the latest in hacked files, hoaxes, Trojan Horses and pirated commercial software.

Symantec has a freeware version of its commercial *The Norton Antivirus* anti-viral program, called *The Norton Virus Scan*. Central Point Software also offers a free utility, the *Central Point Anti-Virus Scan-Only System* (*CPAV-SOS*). Both are available from the publishers and many public BBSes.

Don't give in to paranoia and live in fear of viruses. You may never be bothered by one if you take basic precautions by using a virus detection and repair program. Here are some ways you can protect yourself from PC infectors:

(1) Regularly back up your data and preferably your entire hard disk. Rotate between at least two backup sets. Write-protect your hard drive when testing new software, keep critical system areas

backed up, and frequently save your files as you work.

(2) Have handy a "clean" bootable and write-protected floppy disk in the event you have to rescue your PC from a system crash.

(3) Don't boot from a floppy disk unless you're certain it's virus-free. If the floppy is infected, you can instantly contaminate your hard drive.

(4) Beware of borrowed, exchanged and pirated software, especially protected programs from which the protection has been removed.

(5) Don't let other people run programs on your computer because their floppies and files may be infected.

(6) Scan all software with an anti-viral product before installing and running it on your hard drive.

(7) Steer clear of questionable software sources. Well-established disk vendors probably are okay, since most check the software that usually comes directly from the publishers.

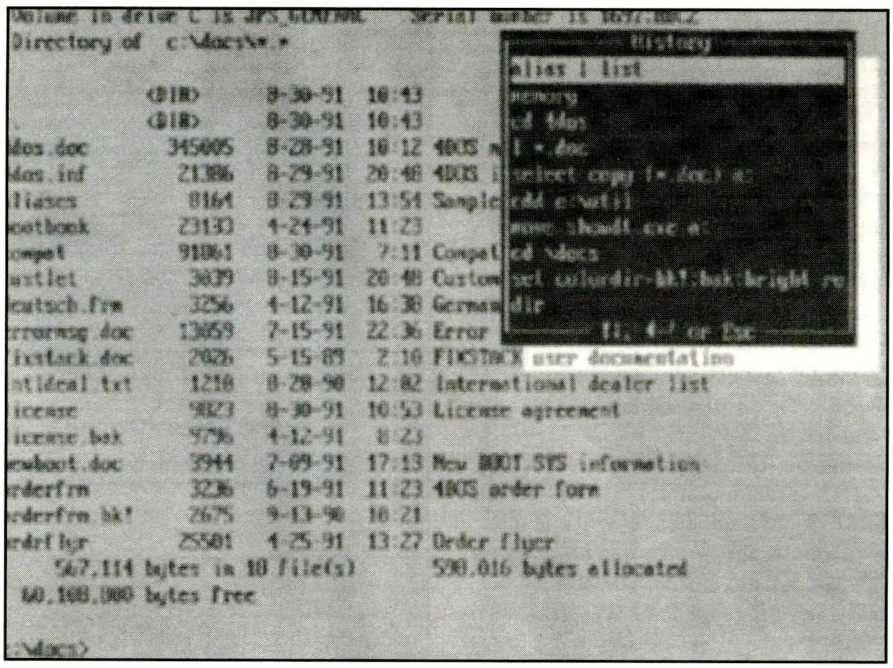
(8) Download software from BBSes only where you that know the sysop validates users and screens, scans, tests and approves software before posting it. Avoid BBSes that aren't well-tended by their sysops. For added protection, delay downloading newly uploaded BBS files for a few weeks after posting. By that time, if a program is infected it will probably be detected and pulled or sanitized.

(9) Beware of suspicious-looking BBS files, such as small ones billed as major programs and programs that have no documentation. Examine self-extracting archive files before running (dissolving) them.

Important: If you suspect a virus has invaded your PC, go slowly to avoid destroying more data. Isolate the PC from a local area network (LAN) if it's connected to one, turn off the PC and leave it off for at least 30 seconds and re-boot from a clean write-protected DOS disk. Only as a last resort, format the hard drive and re-install DOS and your applications. Then wait until you've confirmed that the viral data is really gone. If needed, get knowledgeable help.

Books & Magazines

Much has been written about shareware since the term first came into vogue, but only recently have good comprehensive shareware books appeared. Several



4DOS by shareware pioneers Rex Conn and Tom Rawson is a superior shell that improves almost all DOS commands and adds 35 new ones. Key features include command editing and history, aliasing, extended file descriptions, more-flexible wildcards, multiple commands per line, keystroke stacking and on-line help. Registration is $69 and includes a 120-page manual from JP Software, Inc.

resources that I feel are worth investigating include:

Dr. File Finder's Guide to Shareware by Michael Callahan and Nick Anis includes program reviews in selected categories and discusses going on-line with BBSes and commercial services. Callahan should know, since he's reportedly tested every shareware program he could find on more than 2,000 BBSes (Osborne McGraw-Hill, 1990, soft cover, 1,019 pages, $39.95, two 5¼" diskettes).

Glossbrenner's Guide to Shareware for Small Business by Alfred Glossbrenner has a money-saving message. It's designed to help small business owners save on computer software via the shareware route. While utilities are covered, the book emphasizes applications—word processing, accounting, database, spreadsheet and communications. Included are special discount coupons for popular shareware programs (Windcrest/McGraw Hill, 1992, soft cover, 378 pages, $27.95, one 5¼"diskette).

PC/Computing Guide to Shareware by Preston Gralla initiates the shareware newcomer and updates experienced users. Gralla has explored and sorted through thousands of computer programs to come up with some 250 top-notch offerings, which he summarizes to save you time on-line (Ziff-Davis Press, 1992, soft cover, 413 pages, $34.95, two 5¼" diskettes).

The *PC-SIG Encyclopedia of Shareware* is compiled by the PC Software Interest Group, one of the largest distributors of shareware for the IBM PC and compatibles. It describes the PC-SIG library's extensive contents (Windcrest/McGraw-Hill, 1991, soft cover, 704 pages, $19.95).

Using Computer Bulletin Boards, Second Edition, by John Hedtke introduces beginners to BBSes and shows intermediate users many useful tips and tricks. It gives practically everything you need to know to go on-line and maximize your enjoyment of BBSes (MIS Press, 1992, 422 pages, $29.95, one 3½" diskette).

The Windows Shareware Book by Michael Banks, with 34 *Windows* programs, covers each type of shareware (utilities, communications, games, etc.) and highlights shareware sources, including on-line services and BBSes (Wiley, 1992, soft cover, 400 pages, $39.95, one 5¼" diskette).

Windows 3 Shareware Utilities is compiled by the PC Software Interest

Shareware As We'd Like To See It

When it comes to software quality, I may not be an accomplished programmer, but I do know some qualities and features a good software package should possess. Here are 10 things I'd like to see included in every shareware package:

(1) Program installation should be flexible and intelligent. A program should let you install from any floppy drive to any hard drive, not just from drive A: to drive C:. It should tell you how to manually install it should automatic installation fail. The application should also detect when an earlier program version is already installed and give you the option to save or convert customization files and data.

(2) Installation should be selective and well-mannered. The program should tell you how much disk space it needs, warn you if you're low on space and let you back out at that point. If it's large, the program should let you install only the parts you need and optionally install help files, tutorials, templates and add-on modules. Installation programs shouldn't modify your existing files without warning, nor, in most cases, should they create files in the root directory.

If a new program modifies your AUTOEXEC.BAT, CONFIG.SYS, WIN.INI, SYSTEM.INI and other critical system or configuration files, it should do so optionally, back them up and tell you the filenames of the backed-up files. To be safe, make manual backups of these files before installing new programs so that you can put things back as they were, if necessary.

(3) A program should be fully functional. It's okay to offer a demo, but the widely distributed version should be fully functional to allow you to completely evaluate it, though it's fine to offer sample files, source code and special enhancements and utilities with only registered versions. Shareware programs that expire upon reaching a certain date or using the program a certain number of times limit honest evaluation.

(4) Data import and export should be easy. You should be able to import files from a variety of existing (even competing) programs and also export files in several file formats of your choice.

(5) Menus and commands should be standardized but allow a user to customize them. Menu displays and keyboard shortcuts should follow accepted conventions to avoid confusion. But users should be able to reassign keyboard shortcuts, including function keys. While many users prefer to work from menus, using a mouse, others like command-line options for major program functions and shouldn't be ignored, even in graphical-user-interface- (GUI) based programs. Optimally, a user should be given a choice of a menu-driven or a command-line approach.

(6) Color selections should be flexible. The application shouldn't assume that you have a certain video display card or monitor, or that all users prefer the same color choices. Users should be able to select display type (color versus mono) in the program setup. Preferably, they should be able to select display colors as well. A user should be able to save color selections and other program defaults in a setup or configuration file.

(7) Program exit should be clean and shouldn't upset a user's system, and open program files should be closed.

(8) Uninstallation should be smart and complete. Ideally, the installation program should have an uninstall option to remove all traces of installation and put things back to where they were, should you want to remove the program. This feature is especially important with complex *Windows* programs that modify various .INI files and stash files in directories far and wide.

(9) Program documentation should be complete. For shareware, on-disk documentation is acceptable for non-registered versions, but for a commercially marketed program, a user should get a complete, neatly printed and readable manual. Important documentation features to reviewers (and users) are clearly written and logical instructions, a pleasant layout and format, a table of contents and index, an overview (or README file) showing the program's capabilities and use, a troubleshooting guide, a technical section with error messages, customer support and upgrade information, a warranty statement and a registration form. A tutorial, command summary and quick reference sheet are helpful if the program is complex.

(10) Shareware should include a file that lists all files that are part of the package and the purpose of each. Including this information would be a nice final touch that helps a user know if he has all needed program files

Toward Better Shareware

Shareware has grown up in the past few years. The Association of Shareware Professionals (ASP) and the Shareware Distribution Network (SDN) and several individuals and firms that offer marketing resources are among those who have fostered and nourished this development. Let's look at some of these:

Group (PC-SIG) and is an all-in-one book/disk combo that covers some of the best utilities available to *Windows* users via shareware channels (Windcrest/McGraw Hill, 1992, soft cover, 224 pages, $29.95, with one 5¼" diskette).

The ShareWare Book by Bob Schenot (1992) is a download-able (280K) software developer's cookbook that contains everything you need to get started. Topics encompass market research, publicity, getting paid, distribution, resources, product protection, registration encouragement, trademarks, copyrights, licensing, business issues, support, taxes, manuals, packaging, shipping, international trade and more. Its $19.95 registration fee includes an author's kit and newsletter. It's available on CompuServe, GEnie, and BBSes. Contact Bob Schenot at Compass/New England.

Boardwatch Magazine, edited by Jack Rickard, is chock full of concise information on BBS systems. As the "guide to the world of on-line services," it includes a national listing of selected BBSes and on-line services and is dedicated to serious BBS enthusiasts worldwide. A one-year subscription in printed form costs $36. An on-line service also is offered. Information is available from *Boardwatch Magazine.*

Shareware Magazine has Dr. File Finder Mike Callahan at the helm. Affiliated with PC-SIG, it offers evaluations of IBM PC shareware, insights into shareware-industry trends and coverage of educational shareware. It's published every other month. Cost is $17.70 for a one-year subscription.

In Closing

In this article, I've provided an introduction to shareware you can use to prospect this largely undiscovered goldmine. From what you've read here, you can see that shareware holds its own very well in the face of the usually correct admonition that "you get what you pay for." But where is it carved in stone that good software has to be expensive?

• **Association of Shareware Professionals.** ASP was founded in 1987 to strengthen shareware software as an alternative to commercial retail software. Membership includes shareware programmers, disk vendors and others. One of ASP's goals is fostering professionalism among shareware

Names & Addresses

Association of Shareware Professionals
545 Grover Rd.
Muskegon, MI 49442
CIRCLE NO. 168 ON FREE INFORMATION CARD

BMUG, Inc.
1442A Walnut St. #62
Berkeley, CA 94709-1496
CIRCLE NO. 131 ON FREE INFORMATION CARD

Boardwatch Magazine
7586 West Jewell, Ste. 200
Lakewood, CO 80232
Tel.: 1-800-933-6038; BBS: 303-973-4222
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ButtonWare, Inc.
325 118 Ave. SE, Ste. 200
Bellevue, WA 98005
Tel.: 1-800-528-8866
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Central Point Software, Inc.
15220 N. W. Greenbrier Pkwy. #200
Beaverton, OR 97006
Tel.: 1-800-445-4208
CIRCLE NO. 134 ON FREE INFORMATION CARD

CompuServe
PO Box 20212
Columbus, OH 43220-0212
Tel.: 1-800-848-8199 or 1-800-848-8990
CIRCLE NO. 135 ON FREE INFORMATION CARD

Droege Computing Services, Inc.
1816 Front St., Ste. 130
Durham, NC 27705
Tel.: 1-800-677-3542
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Exec-PC
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Elm Grove, WI 53122
Tel.: 414-789-4200; BBS: 414-789-4210
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JP Software, Inc.
Box 1470
East Arlington, MA 02174
Tel.: 1-800-368-8777
CIRCLE NO. 138 ON FREE INFORMATION CARD

Ray Kaliss
The SDN Project
13 Douglas Dr.
Meriden, CT 06450
BBS: 203-634-0370
CIRCLE NO. 139 ON FREE INFORMATION CARD

PC Software Interest Group
Shareware Magazine
1030D E. Duane Ave.
Sunnyvale, CA 94086
Tel.: 1-800-245-6717
CIRCLE NO. 140 ON FREE INFORMATION CARD

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3333 Bowers Ave., Ste. 130
Santa Clara, CA 95054
Tel.: 408-988-3773; BBS: 408-244-0813
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Compass/New England
PO Box 117
Portsmouth, NH 03802-0117
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PO Box 1506
Mercer Island, WA 98040
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3767 Overland Ave., Ste. 112
Los Angeles, CA 90034
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Santa Monica, CA 90404-3063
Tel.: 1-800-441-7234
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ZiffNet
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Columbus, OH 43220-0212
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authors by setting programming, marketing, distribution and support standards for members to subscribe to and follow.

ASP standards include policies on software support, registration payments and full functionality of software. No crippling of shareware versions is permitted. Although ASP doesn't provide technical support for members' products, it has set up an "ASP Ombudsman" to mediate and resolve disputes and problems between members and customers. Information on ASP is available on the CompuServe ASP/Shareware Forum by typing "GO ASPFORUM" at any "!" prompt. Alternatively write the ASP Executive Director.

• **Shareware Distribution Network.** SDN was started to provide BBS sysops, users and authors safe and controlled national distribution of shareware programs.

SDN disseminates shareware directly to participating BBS sysops in FidoNet networks worldwide, where files are posted for downloading by other sysops and BBS users. SDN's registered member sysops are dedicated to the shareware concept, shareware registration and SDN's concept of author, sysop and user cooperation. It also acts as a gateway to other FidoNet distribution services.

A shareware author contacts and sends his program directly to SDN. which then sends it to participating distribution points via special techniques to ensure file integrity. The distribution points offer the software on their own BBSes or further distribute it. Shareware files released through SDN's network are posted at these BBSes.

There are no fees, charges or commissions to shareware authors by SDN, but authors can help SDN by occasionally remitting $35 to help defray costs. There's no fee to users. All a user needs do is check to see if a BBS has an SDN file and message base area and download as he would other files.

If you're a sysop or author and want to participate, contact Ray Kaliss at The SDN Project BBS. You can download an SDN author kit from The SDN Project BBS.

• **Droege's Sell More Software.** Sell More Software is aimed squarely at shareware authors and disk vendors. It facilitates marketing, sales and administrative activities in selling software. A business-management system, the program helps plan projects, tracks contacts with clients and prints custom letters and forms. The program also has provisions for tracking software support and products. The registered version of the program is $100 from Droege Computing Services, Inc. A shareware disk costs $5.

• **Shareware Marketing System.** Jim Hood's SMS helps shareware authors get their products into the marketplace. It's for shareware authors who need marketing ideas and a quality-ranked mailing and telephone-number list of major shareware distributors, large computer clubs, key magazine editors and selected BBS systems. The database file is in standard *dBASE* format. SMS also offers a detailed newsletter and marketing-strategy guide that covers creative tips, tricks, tutorials and traps for shareware authors. SMS is published quarterly, with minor updates within each quarter. An annual subscription costs $175. It's available from Seattle Scientific Photography.

• **Super Shareware System.** SSS is designed specifically for shareware authors. It's a comprehensive, flexible and powerful business-management system for authors to track customers, prospects, distributors, contacts, products, sales and expenses. SSS allows you to target mailings to customers, prospects and distributors using mailing-label or postcard options. SSS creates 24 reports and lets you easily enter customer registrations and print invoices with accompanying labels. You can import data in *dBASE*, delimited or SDF format and export data for use with existing software. A trial disk costs $5; registration is $65 from PractiComp. ■

Windows Clipboard, OLE & DDE

How to efficiently communicate with *Windows* programs with these powerful utilities

Microsoft *Windows* is a multitasking operating system, which means it can run two or more programs simultaneously—or appears to do so. In fact, *Windows* rarely runs just one program at a time. When you start *Windows*, it launches a shell program like the Program Manager or File Manager, that, in turn, launches other programs. The shell doesn't stop running when another program begins. Rather, it sits idle, awaiting user input.

Windows is also a messaging system, which means that programs wait for and then react to messages, which are often generated by a user's actions. A keystroke, for example, sends a stream of messages to the active program, as does a mouse movement or click. Other messages are generated by parts of the computer's hardware, such as the real-time clock and data flowing into the serial port for example.

Both its multitasking and messaging capabilities make *Windows* fundamentally different from an operating system like DOS, which runs only one program at a time. DOS programs don't wait for messages or events to occur. Instead, they request user input, either from DOS itself or from the computer's BIOS. One major problem that DOS programmers face when they move to *Windows* is adapting to a system in which their programs receive messages (sometimes hundreds of messages per minute and, conversely, sometimes none at all for hours), instead of asking for input at the appropriate times.

As soon as two applications are running simultaneously, programmers are apt to look for ways to communicate between the programs. In fact, *Windows* does have methods for inter-program communication that are entirely unknown in the DOS world. *Windows* applications can send messages to each other, just as the hardware can send messages to a program.

Inter-Application Communications in *Windows*

(A) Using the Clipboard
Data is static and cannot be changed.

(B) Embedded Objects
Client starts Server and sends current data for editing when user clicks on embedded data.

(C) Linked Objects
Client receives updated data whenever server alters data or data file.

(D) DDE Links
Client initiates communications and can send data or commands and receive data from server.

For example, suppose you wrote a communications program capable of logging into an on-line service like CompuServe and downloading stock prices automatically. Then suppose you wrote a financial-analysis package that could evaluate a portfolio and make buy and sell recommendations based on current stock prices and trends. It wouldn't take long before you'd want to communicate between the programs. The modem program could collect stock prices every few minutes perhaps and send them to the analysis program for processing. If the programs were written for DOS, you'd either have to combine them into a single package or use shared data files and some complex batch programs to make them run together. But under *Windows*, the programs could communicate simply by sending messages to each other.

Designers of a multitasking operating system can take two approaches to inter-program communication. The simplest approach is to design a way in which one program can locate another and send messages. The structure of the messages (which are usually a small block of data) could be left to the programs themselves. If two programs needed to communicate, they'd be responsible for developing a common protocol that would define how both the message types and how each would acknowledge receipt of a message.

The problem with the foregoing simple approach is that programs that wish to communicate must have some knowledge of each other and the protocol they wish to use. Programs written by one software vendor might share a common protocol, but most programs would be left to run in isolation.

A different, more-sophisticated approach is to define a protocol all programs can use. *Windows* actually has at least three such protocols, each of which has its own strengths and weaknesses.

The Clipboard

Almost every *Windows* user has transferred data from one application to another, or even within a single application, by using the *Windows* clipboard. It's the simplest, and usually easiest, form of inter-program communication to use and to understand.

When a program places data on the clipboard, usually in response to an Edit/Copy or Edit/Cut command, this data is available to any program that wants to use it. The data includes information about its own format so that, for example, a simple text editor like *Windows* Notepad doesn't try to force graphics data into text and end up with a garbled mess. If you want to see the contents of the clipboard in several different formats, experiment with the *Windows* Clipboard Viewer accessory.

One of the unusual strengths of the clipboard is that it can capture text and graphics from DOS applications and transfer text to DOS programs. Add to this *Windows*' ability to run multiple DOS programs at the same time, and you could make a pretty good case for using *Windows*, even if you didn't want to use any *Windows* applications.

Handy as the clipboard is, its data is static. You can't use it, for example, to automatically update one application with data from another application. To do this, you need a more focused form of inter-program communication, one that lets programs talk directly to each other, instead of talking to a generalized *Windows* facility like the clipboard.

OLE

Windows 3.1 introduced the first usable form of Object Linking and Embedding, or OLE. OLE capabilities in *Windows* 3.0 were provided by individual programs. In *Windows* 3.1, the code for OLE is part of *Windows* itself, not imported by specific programs in highly idiosyncratic form.

To understand OLE and its older cousin, dynamic data exchange (DDE), you first need to know the terms Microsoft chose to describe the process. An "object" in this sense is a piece of text or graphics and may include formatting information. OLE is principally used to insert graphic images, charts and spreadsheet cells into word-processor documents, but it's being expanded by developers for many other purposes. For example, a spelling or grammar checker could use OLE to capture text from a document, or a spreadsheet program could use it to insert text into a spreadsheet.

OLE communication always has a "client" and a "server" application. The server creates the object, which is sent to the client. For example, *Windows* Paintbrush can function as a graphics server, sending images to a client word processor like *Windows* Write or Microsoft's *Word for Windows*, both of which can function as OLE clients.

Once an object is inserted into a client's document, the user can (in most cases) start the server and edit the object by simply double-clicking on it. The client sends the name of the server to *Windows* along with the object. The server starts in a new foreground window, loads the object and prepares to accept the user's editing. When the user is finished, the object in its edited form is sent to the client, which inserts the new version of the object in place of the previous version.

This process overcomes one of the restrictions of the clipboard. In *Windows* 3.0, if you insert a graphic image into a word-processing document and then decide to alter the image slightly, you have a great deal of work to do to send the object back to the original application, edit it and then replace it with the new version. With OLE objects, the process is simple and virtually intuitive.

An OLE object can be linked or embedded. An embedded object is similar to a simple item pasted from the clipboard, but it also contains the name of the server application. It doesn't change until the user double-clicks on it to send it back to the server for editing. In essence, the client application saves the object in a file format the server can use inside its own document. Microsoft calls the client's file a "compound document" because it contains more than one file format.

A linked object takes up less space in the client's document and is also more interesting. The client keeps track of both the server and the file in which the server saved the original object. If the user modifies the original file, the client's data changes automatically. For example, if you link part of a spreadsheet (the server) into a word-processing document (the client) and later modify the spreadsheet, the data in your document will change automatically. If both files are open on the *Windows* desktop, the change will occur immediately. If the client document isn't open, you'll see a dialog box that asks if you want to update the data the next time you open the file.

In addition to the foregoing, links can either be automatic or manual. An automatic link updates itself constantly

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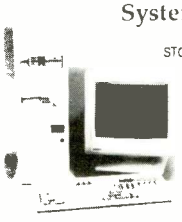

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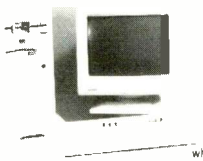

3SX33-08	386SX 33MHZ System	$359
3DX33-08	386DX 33MHz System	429
3DX40-08	386DX 40MHz System	439
4DX33-08	486DX 33MHz System	769
4DX50-08	486DX 50MHz System	959
4DX66-08	486DX 66MHz System	1089

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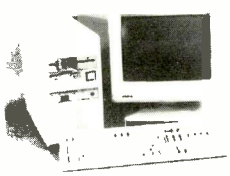

3SX33-05	386SX 33MHz System	$329
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3DX40-05	386DX 40MHz System	409
4DX33-05	486DX 33MHz System	739
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3DX40-15	386DX 40MHz System	429
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1MEGX9-70SP	1MB x 9-70 NS SIPP	45 00
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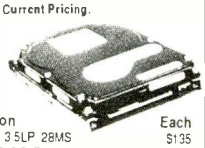

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ST3550N	452MB SCSI 3 5x1" 12MS 256K Cache	$969
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ST1120N	1 05GB SCSI 3 5HH 10 5MS 256K Cache	$1 679

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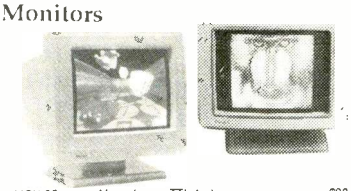
ST251-1	42MB MFM 5 25HH 28MS	$239

Monitors



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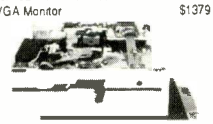
MON-08	14" Super VGA Monitor, 1024 x 768 Non-Interlaced	$359
MON-11	17" 1280x1024 Non-Interlaced Super VGA Monitor	$879
MON-12	20" 1280x1024 Non-Interlaced Super VGA Monitor	$1379

Disk Drives

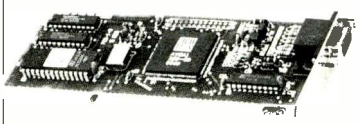


Part#	Description	Each
DDD-05	5 1/4 inch DSDD 360K beige faceplate	$49
DDH5-3	Dual Floppy Disk Drive reads both 3-1/2" and 5-1/4" Floppy Diskettes Occupies only One 5-1/4" exposed bay	$149
DDH-06	5 1/4 inch DSHD 1 2MB beige faceplate	$56
DDH-09	3 1/2 inch 720K beige w/bracket	$59
DDH-10	3 1/2 inch 1 44MB beige w/bracket	$53
DDH-11	Same as DDH-10 without 5-1/4" Mounting bracket Fits in 3-1/2" bay	$48

3-1/2" Drive Mounting Kits

Part#	Description	Each
5 25KITFD	Mounts 3-1/2" Floppy drive in 5-1/4" bay	$9 95
5 25KITHD	Mounts 3-1/2" Hard drive in 5-1/4" bay	$9 95
RAIL01	AT Drive Rail Kit	$1 99
FP-BLK	1/2 Height Black Faceplate	$2 49

Video Boards



Part#	Description	Each
IFC-32	Mono Board w/printer port XT/AT	$16
IFC-33	Color graphics w/printer port XT/AT	$19
IFC-35	BOCA Dual Graphics Adapter	$35
	BOCA dual graphics adapter supports MDA, CGA Hercules compatible and performs color emulation on a monochrome TTL monitor Parallel port can be configured as LPT1, LPT2 or disabled Includes 132 column driver software	
IFC-42	640 x 480 VGA Card	$52
	BOCA 640 x 480 - 16 color VGA card with 256K video RAM 5 year warranty	
IFC-44	640 x 480 VGA Card	$42
	640 x 480 VGA - 16 colors 256K Display Memory One Year Warranty Full driver support	
IFC-46	1024 x 768 Super VGA Card	$79
	1024 x 768 Super VGA - 256 colors 1 MB Display Memory One Year Warranty Full driver support	
IFC-48	Accelerator Video Board	$139
	11 times faster than Tseng ET 4000-based video boards! 1280 x 1024 resolution Interlaced, up to 1024 x 768 Non-Interlaced Full driver support	
VMEG	PC Logic 1 MEG VGA Card	$99
VCOLOR	16 7 Million Color VGA Card with 1MB Memory	$109
VCOLORXL	PC Logic 1 MEG VGA Card	$139
	16 7 million colors Hardware driven	

IIT Xgraphic

XGRAPHIC	IIT Xgraphic Accelerator	$229
	For PCs working with Windows or CAD applications - 1 MB high speed VRAM - Speed, up to 20 times that of Super VGA - 65 536 Colors - Resolutions up to 1280 x 960	

IIT Math Co-Processors

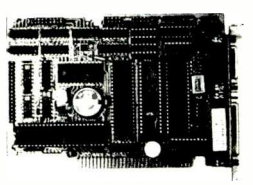
2C87-12	For 286 up to 12 5 MHz	$52
2C87-20	For 286 up to 20 MHz	60
3C87-25SX	For 386SX up to 25 MHz	62
3C87-33SX	For 386SX up to 33 MHz	68
3C87-25	For 386 up to 25 MHz	61
3C87-33	For 386 up to 33 MHz	69
3C87-40	For 386 up to 40 MHz	78

Colorado Memory Tape Back-Up Systems

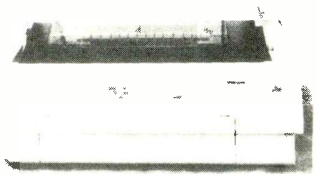
TRAKKER-120	120MB External Parallel Port Back-Up System	$389
TRAKKER-250	250MB External Parallel Port Back-Up System	$469
DJ-10	120 MEG Internal Back-up System	$169
DJ-20	250 MEG Internal Back-Up System	$259
IOMEGA250	250MB 1IN Tape Back-Up System	$289
	IOMEGA 250 MB Internal Back-Up, Fits in 3 5 inch mounting Slot Connect to Floppy Disk Controller	
PT-25 2GB	PowerTape Back-Up Internal with SCSI Controller	$1129
	2 Gigabyte Tape Back-Up Internal, 16 Bit SCSI Interface Get up to 4GB per tape with data compression	
FC-10A	Add on Controller Board for DJ-10 or DJ-20	$99
TC-15	Add on Controller Board for DJ-10 or DJ-20 with High Speed Data Compression	$235
KE-10	External Kit for DJ-10 or DJ-20	$135

Disk Controller Boards

Part#	Description	Each
IFC-14	2 Floppy Controller Board PC/XT	$13
IFC-15	Disk I/O Board Serial, Parallel, Clock, Game PC/XT	$25
IFC-24	Fixed Disk MFM/ 2 Floppy Controller AT	$55
IFC-27-2	AT 2/IDE 2/Floppy Controller	$19
IFC-28	Fixed Disk Controller Board PC/XT	$47
ST-01	8-Bit SCSI Controller Board	$29
ST-02	8-Bit SCSI/Floppy Controller Board	$47
IN-2000	16-Bit SCSI Hard/Floppy Controller Board	$189
ISAPPORT	16-Bit ISA bus SCSI Host Adapter Card for 386, 486 systems	$139

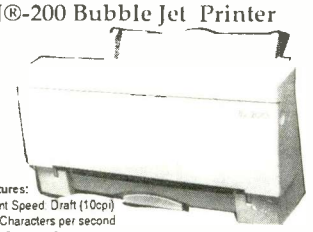


EPSON



AP2250	Action Printer 9-pin Narrow Carriage	$119
FX-1170	9-Pin Printer, Wide Carriage	$379
AP3250	Action Printer, 24-Pin Narrow Carriage	$199
LQ-570	24-Pin Printer, Narrow Carriage 225 cps - Draft, 105 cps - Letter Quality	$249
LQ-1170	24-Pin Printer, Wide Carriage 300 cps - Draft, 138 cps - Letter Quality	$649
AL-1000	Epson Action Laser 1000 Printer	$769
AL-1500	Epson Action Laser 1500 Printer	$839

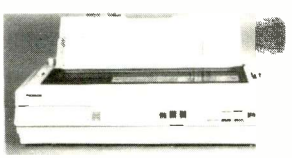
Canon BJ®-200 Bubble Jet Printer



Features:
- Print Speed Draft (10cpi) 248 Characters per second High Quality (10cpi) 173 Characters per second **Laser Quality - Bubble Jet Price!** Super High Quality (10cpi) 124 Characters per second
- Print Resolution 360 dpi 64 nozzle print head
- Standard Emulations Canon Native, Epson LQ IBM X24E
- Buffer/RAM 49KB - Parallel Interface
- Plain Paper & Card Stock (17 - 28 lb) Transparencies (Canon recommended), Envelopes
- Paper Sizes Letter Legal, A4, #10 Envelopes
- Paper Handling Standard 100-Sheet Feeder 10 Envelopes in Sheet Feeder and Manual Feed
- Size Width 13 7 Inches Height 6 8 Inches Depth 7 6 Inches Weight 6 6 lbs
- Ink Cartridge Life Rated at 450 Pages
- 2 Year Limited Warranty

BJ-200	Bubble Jet Printer	$349
BC-02	Ink Cartridge Jet	$24.99

Panasonic



Part#	Description	Each
KXP-2180	9 Pin, 80 Column, 240 CPS DFT/32CPS NLQ	$179
KXP-1654	24 Pin, 132 Column, 375CPS DFT/125CPS LQ	$599
KXP-2123	24-pin, 80 Column 240cps DFT/80cps LQ	$239
KXP-2124	24-pin, 80 Column, 320cps DFT/106cps LQ	$349
KXP-2624	24-pin, 132 Column, 300cpsDFT/100cps LQ	$419
KXP-4450I	Panasonic 11ppm Laser Printer	$1149
KXP-4410	Panasonic 5ppm Laser Printer	$659
KXP-4430	Panasonic 5ppm Laser Printer - 1 MEG RAM	$959

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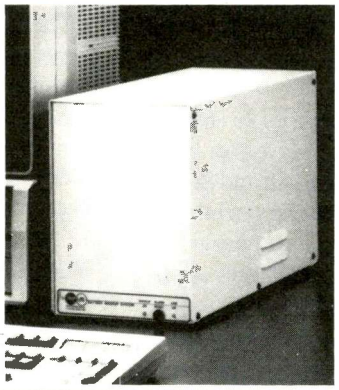
Part#	Description	Each
BC-250	250 VA, 2 Outlet	$105
BC-400	400 VA, 4 Outlet	169
BC-500	500 VA, 4 Outlet	194



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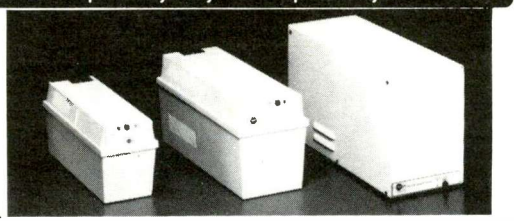
LAN Battery Back-up Systems



Same reliability as the BC Series but designed specifically for LAN's. Features remote channel output for the server shutdown. Proper cabling is available for any LAN system (not included). UL Approved

Part#	Description	Each
BC-500LAN	500 VA	$199
BC-600LAN	600 VA	269
BC-750LAN	750 VA	309
BC-900LAN	900 VA	379
BC-1250LAN	1250 VA	529
BC-4000LAN	4000 VA	2,549

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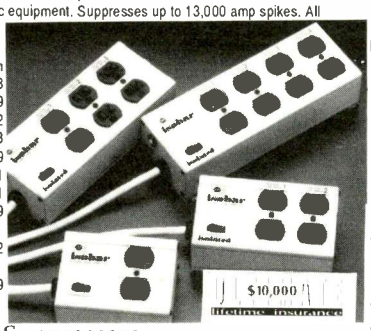
TrippLite Isobars®

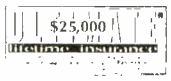
Isobars provide superior surge, RFI and EMI noise suppression and rejection with individual filter banks to safeguard against any interaction between your electronic equipment. Suppresses up to 13,000 amp spikes. All Isobars come with a lifetime warranty and UL listing.



Part#	Description	Each
IB2-0	2 outlet direct plug-in	$23
IB2-0/20	2 outlet, 20 amp, direct plug-in	39
IB2-6	2 outlet, 6 ft. cord Ultimate Warranty	32
IB4-4	4 outlet, 6 ft. cord Ultimate Warranty	43
IB4/220	4 outlet, 6 ft. cord	49
IB66	6 outlet, 6 ft. cord Ultimate Warranty	51
IB8	8 outlet, 12 ft. cord Ultimate Waranty	61
IB-8RM	8 outlet, 12 ft. cord with remote power switch	69
EUROBAR	4 outlet, 6 ft. cord, 220/240 Volt Euro connectors	52
IBR-12	12 outlet, 19" rack mountable	89

Isobar Ultra Diagnostic Surge Suppressors

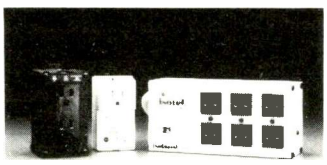
Direct plug-in premium spike and noise suppressors with sine wave tracking. Unique diagnostic circuitry advises of: improper outlet wiring, damage to surge circuitry, loss of AC power. Ultimate Warranty.



Part#	Description	Each
IB4ULTRA	4 Outlet, 6' cord, Advanced diagnostics, 2 isolated filter banks, "cascade" circuitry	$50
IB6ULTRA	6 Outlet, 6' cord, Advanced diagnostics, 3 isolated filter banks, "cascade" circuitry	$56
IB8ULTRA	8 Outlet, 12' cord, Advanced diagnostics, 4 isolated filter banks, "cascade" circuitry	$65
ISOTELULT4	4 Outlet, 6' cord, Advanced diagnostics, 2 isolated filter banks, "cascade" circuitry dataline protection (RJ11 jacks)	$55
ISOTELULT6	6 Outlet, 6' cord, Advanced diagnostics, 3 isolated filter banks, "cascade" circuitry dataline protection (RJ11 jacks)	$62
ISOTELULT8	8 Outlet, 12' cord, Advanced diagnostics, 4 isolated filter banks, "cascade" circuitry dataline protection (RJ11 jacks)	$74
IB2ULT428	2 Outlet, Direct plug-in, 15 amp	$32
IB2ULTCOPY	2 Outlet, Direct plug-in, 20 amp model for copiers	$44
IB2ULTFAX	2 Outlet, Direct plug-in, RJ11 jacks for modem/fax	$39
IB2ULTCOAX	2 Outlet, Direct plug-in, Coax jacks for TV, VCR, Satellite	$39

Modem Fax Protectors

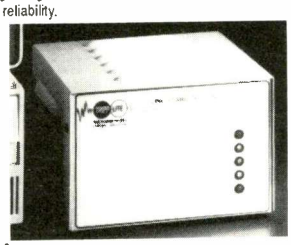
Protect your modems, telephone systems, and fax machines from telephone line spikes that damage equipment. All units exceed telephone line standards with a response time of less than 5 nanoseconds. 2 year warranty.



Part#	Description	Each
ISOTEL	Lifetime warranty. 4 outlet, 6 ft. cord and modem protector	$59
ISOTEL-8	8 outlet, 6 ft. cord and modem protector	$75
ISOFAX	ISOBLOK w/ Modem protector	$36
TSB	3 stage Modem/Fax protector	$38
MP	Economy Modem/Fax protector	$14
SMP	AC outlet w/modem/fax protector	$29
SMP-GS	Lifetime guarantee.	$35

Line Stabilizer/Conditioners

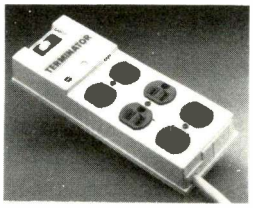
Maintain constant power levels during voltage sags and high voltage surges. Includes patented Isobar surge and noise protection and TrippLite reliability. UL listed and 2 year warranty.



Part#	Description	Each
LS-504	500 Watts, 230 Volt, 4 Outlets	$98
LS-600	600 Watts, 2 Outlets	77
LS-604	LS-600 with HI voltage regulation	98
LC-1200	1200 Watts, 4 Outlets	139
LC-1800	1800 Watts, 6 Outlets	188
LC-2000	2000 Watts, 208/220/240 Volt	243
LC-2000X	220/240 V, 2000 watts, 6 Outlets	243
LC-2400	2400 watts, 110 V, 6 outlets	243
LCR-2400	2400 watt rack mountable, 110 V, 14 outlets	287

Terminator

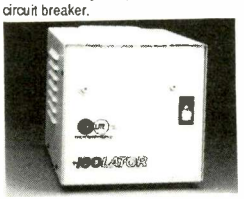
TrippLite 6 outlet surge & noise protection that fits any budget. Features MOV's, torroidal chokes, high and low frequency capacitors. An economical surge, RFI, EMI and noise suppressor with TrippLite reliability. Meets or exceeds IEEE 587 A and B specifications.



TERM-6 6 outlet, 6 ft. cord $38

Isolators

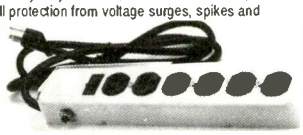
Isolation Transformer and Noise Filter. Isolator transforms your unreliable and potentially dangerous commercial power into a computer grade and safe electrical environment. Isolator's efficient operation generates much less heat than expensive, outdated ferroresonant devices. Models are available in 200, 400, and 800 watts, with lighted power switch and external re-set circuit breaker.



Part#	Description	Each
IS-200	200 watt, 13 lbs.	$89
IS-400	400 watt, 21 lbs.	129
IS-800	800 watt, 25 lbs.	169

Economy Surge Suppressor Outlet Strip

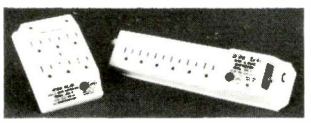
Full protection for surges and spikes. Comes with six foot heavy duty line cord, reset circuit breaker, lighted rocker switch and 3 wire grounded outlets to get full protection from voltage surges, spikes and other damaging electrical disturbances. UL listed.



EOS-6 6 outlet $6.99

Spike Block & Spike Bar

Economical, yet effective surge and noise protection with TrippLite reliability. Suppresses up to 140 joule spikes at current levels of up to 6500 amps. 2 year warranty. Meets or exceeds IEEE 587 A and B specifications.



Part#	Description	Each
SK6-6	Spike Bar, 6 outlet, 6 ft. cord	$28
SK6-0	Spike Block, 6 outlet, no cord	22

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while you work if both server and client files are open. A manual link is updated only when you tell the client to update it. If you have several links into a document, it's best to make them manual. Otherwise, the system overhead needed to keep all links up to date will bog down your computer and you won't get much work done.

Programs that support OLE (not all do) can work as clients, servers or both. The *Windows* 3.1 Paintbrush and Sound Recorder can work as servers, while the *Windows* Cardfile and Write programs can work as clients. Many larger applications can work as both.

If you want to see OLE in action, open the *Windows* 3.1 Paintbrush program and draw a small picture. Save the picture and also copy it to the clipboard. Remember that a linked object must include a file name. Therefore, you must save the picture before you can link it. Reduce Paintbrush to an icon, if you wish, but leave it open.

Next, open *Windows* Write, type a few lines and then select Edit/Paste Link. The image from the clipboard will appear, as you might expect. Double-click on the image to activate Paintbrush and use it to change the image. When you return to Write, its image will have also changed. If you can arrange Paintbrush and Write so you can see both applications at once, you can observe the changes take place.

Type a few more lines in Write and then select Edit/Paste. This time, you have an embedded object in Write, not a linked one. If you double-click on the new image, a new Paintbrush window opens. If you modify the image in it and then select File/Update, the image will change in Write.

You can experiment further with both Paintbrush and Write and learn quite a bit about how to use OLE. Look in the Paintbrush Options menu and select Omit Picture Format before you copy an image to the clipboard. Also experiment with Write's Edit/Paste Special command. It lets you select whether you want to embed (paste) or link an image into a document. It also lets you select the format you want to use.

Embedded and linked objects give *Windows* applications a great deal of power. When most major applications support OLE (many already do), you may be able to organize all your work around one central client application. It will be able to call on all your other applications, as servers, and thereby organize your work. In fact, another *Windows* 3.1 accessory will get you most of the way to that goal right now.

The Object Packager is in some respects a "universal" OLE server. You can use it to turn documents and parts of documents from almost any application into an icon you can insert into a client application's document. The Object Packager's icons are most useful for creating interactive documents. When you click on the icon, the contents of the package (an object, an animation, a sound or even a DOS command or batch file) appears on-screen. The Object Packager is less useful if you create and print documents, since only the icon will appear on the hard copy of the document, not the underlying object.

DDE

OLE is really just an extension of a communications technique that has been available in past versions of *Windows*. Dynamic Data Exchange (DDE) is a protocol that lets supporting applications send data back and forth and even run macros and other commands in each other. If OLE serves your purposes, you'll find it much easier to use than DDE. But if you really want to integrate your work, and if your applications include DDE support (all OLE-compliant applications also support DDE), you'll find it to be an extremely powerful tool.

DDE uses the same client and server terminology as OLE. The client program, which can also be viewed as the boss, uses DDE to issue commands and collect data from a server application. The client can launch the server, send it data and receive information. It can also break the DDE link when it's finished.

Assume you have a DDE client-capable financial-analysis program. You could build a macro command in this program that would launch a DDE server-capable communications program and run a macro in this program to log onto an on-line service, collect stock price data and log off the service. The analysis program would then use a DDE request to collect that data from the communications program and use it to update its own database.

Some developers have called OLE

ComputerCraft Magazine's PC & Microcontroller Data Guide

In this fifth installment of our special pull-out series, we continue with Microchip's PIC16C5x eight-bit microcontroller and move on to Intel's 8096 and Motorola's 68HC16 16-bit microcontrollers. Both of the latter two chips have 16-bit CPUs and are designed for applications in which programming complexity or the need for high speed make simpler eight-bit devices impractical.

Prepared by Jan Axelson
76 North Broadway, Hicksville, NY 11801

Microchip PIC16C5X

Summary

Devices in the CMOS PIC16C5X family are fast because they use 12-bit instructions, most of which require just one machine cycle to execute. All have user-programmable EPROM, either OTP (one-time-programmable) or UV-erasable. There are no external data/address buses, interrupt capabilities, or asynchronous serial port, although the new PIC17CXX series adds the last two of these. Digikey is a vendor.

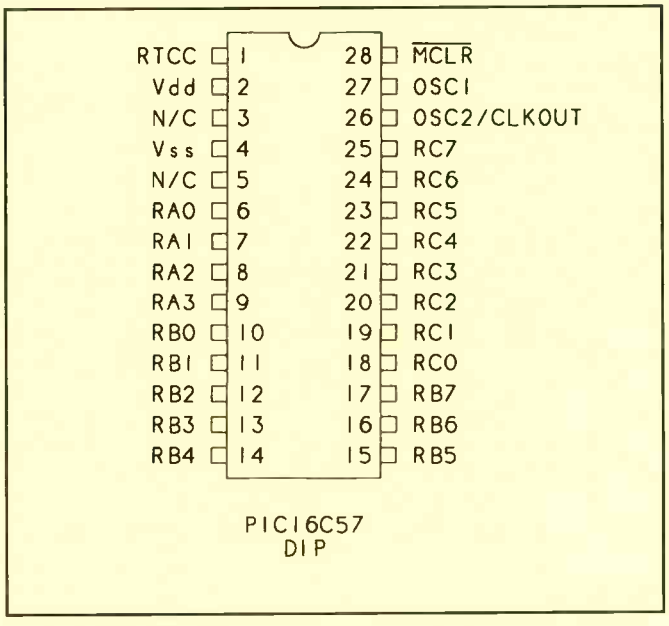
Features

Up to 2K × 12 of ROM
20-MHz clock
Up to 80 Registers
Up to 21 bits of I/O
Real-time clock, watchdog timer
33 instructions, three address modes
Four oscillator options, including low-cost and power-saving

Family Members

PIC16C57	2K × 12 of EPROM, 80 registers, 21 bits I/O
PIC16C54	512 × 12 of EPROM, 32 registers, 13 bits I/O
PIC16C55	512 × 12 of EPROM, 32 registers, 21 bits I/O
PIC16C56	1K × 12 of EPROM, 32 registers, 13 bits I/O

Packages include 18- to 28-pin DIPs and SOICs. Suffix -JW specifies UV-erasable EPROM.



PIC16C57
DIP

Pin	Function
1	Real-time clock/calendar
2	Power supply
3	No connection
4	Ground
5	No connection
6	Port A, Bit 0
7	Port A, Bit 1
8	Port A, Bit 2
9	Port A, Bit 3
10	Port B, Bit 0
11	Port B, Bit 1
12	Port B, Bit 2
13	Port B, Bit 3
14	Port B, Bit 4
15	Port B, Bit 5
16	Port B, Bit 6
17	Port B, Bit 7

18 Port C, Bit 0
19 Port C, Bit 1
20 Port C, Bit 2
21 Port C, Bit 3
22 Port C, Bit 4
23 Port C, Bit 5
24 Port C, Bit 6
25 Port C, Bit 7
26 Oscillator Output/Clock Output
27 Oscillator Input
28 Master Clear

Manufacturer

Microchip Technology
2355 W. Chandler Blvd.
Chandler, AZ 85224-6199
Tel.: 602-963-7373

Intel 8X9X

Summary

The basic 8096 and other members of Intel's MCS-96 family are intended for high-speed control applications. Features include a 16-bit CPU and up to four 16-bit timers that can operate simultaneously. A high-speed I/O unit records the times of input triggers and triggers external events at specific times. EPROM variations can program themselves and others in auto, slave and run-time modes.

Features

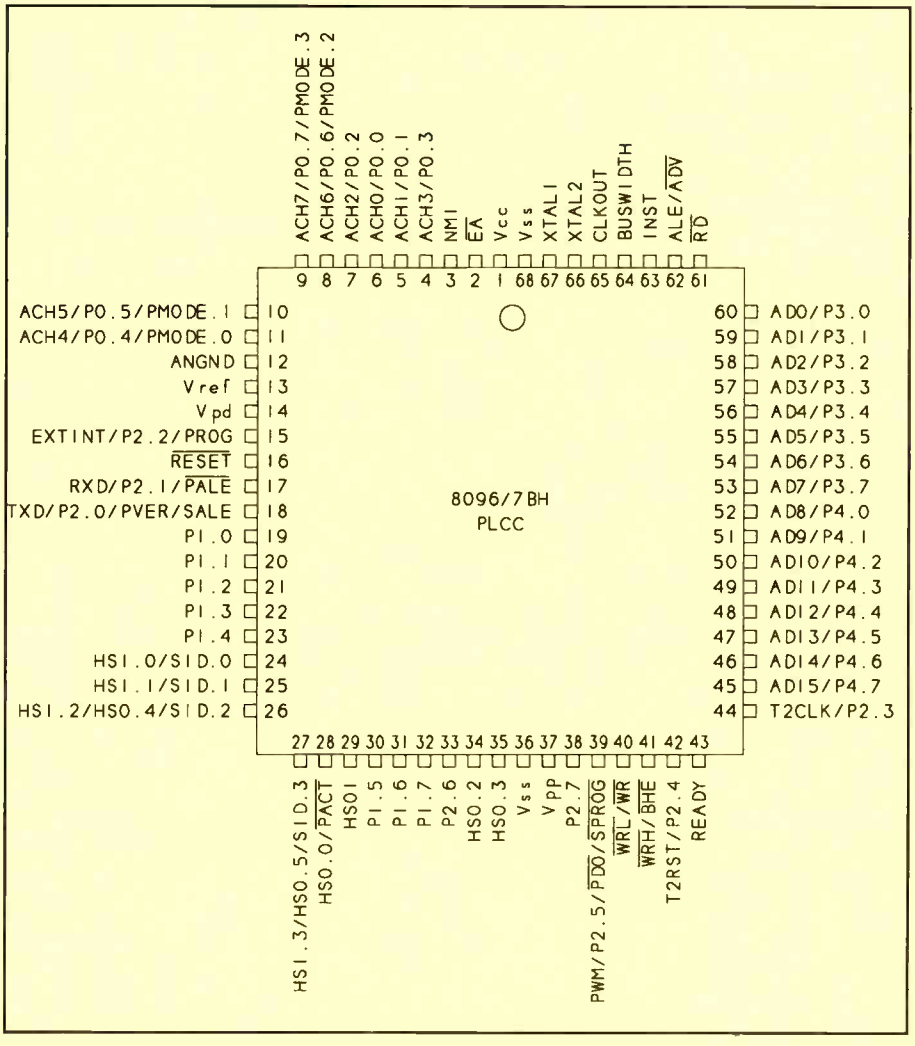
8K of ROM
232 bytes of RAM
20-MHz clock
232 registers
Serial port
20 interrupt sources, eight vectors
40 bits of I/O
Four 16-bit software timers
Two 16-bit counter/timers
Watchdog timer
10-bit A/D converter, eight channels
Pulse-width modulator output
73 instructions, six address modes

Family Members

8096BH No ROM, 40 bits of I/O
8097BH No ROM, 40 bits of I/O, A/D converter
8396BH 8K ROM, 40 bits of I/O
8395BH 8K ROM, 32 bits of I/O, A/D converter
8397BH 8K ROM, 32 bits of I/O, A/D converter
8796BH 8K EPROM, 40 bits of I/O
8795BH 8K EPROM, 32 bits of I/O, A/D converter
8797BH 8K EPROM, 40 bits of I/O, A/D converter
The 8XC196 devices are enhanced, high-performance members of the MCS-96 family. Alternativee packages include 48-pin DIP, 64-pin shrink DIP and 68-pin PGA.

Pin Function

1 Supply Voltage
2 External Memory Access Enable
3 Non-Maskable Interrupt
4 Port 0, Bit 3; Analog Channel 3 (8x95/97)
5 Port 0, Bit 1; Analog Channel 1 (8x95/97)
6 Port 0, Bit 0; Analog Channel 0 (8x95/97)
7 Port 0, Bit 2; Analog Channel 2 (8x95/97)
8 Port 0, Bit 6; Analog Channel 6 (8x95/97); Program Mode Select 2 (879x)
9 Port 0, Bit 7; Analog Channel 7 (8x95/97); Program Mode Select 3 (879x)
10 Port 0, Bit 5; Analog Channel 5 (8x95/97); Program Mode Select 1 (879x)
11 Port 0, Bit 4; Analog Channel 4 (8x95/97); Program Mode Select 0 (879x)
12 Reference Ground for A/D Converter (8x95/97)
13 Reference Voltage for A/D Converter (8x95/97)
14 RAM Standby Supply Voltage
15 Port 2, Bit 2; External Interrupt; Program Pulse (879x)
16 Reset
17 Port 2, Bit 1; Serial Input Port; Program ALE (879x)
18 Port 2, Bit 0; Serial Output Port; Slave ALE (879x); Program Verify (879x)
19 Port 1, Bit 0
20 Port 1, Bit 1
21 Port 1, Bit 2
22 Port 1, Bit 3
23 Port 1, Bit 4



24 High-Speed Input 0; Slave ID 0 (879x)
25 High-Speed Input 1; Slave ID 1 (879x)
26 High-Speed Input 1; High-Speed Output 4; Slave ID 2 (879x)
27 High-Speed Input 3; High-Speed Output 5; Slave ID 3 (879x)
28 High-Speed Output 0; Programming Active (879x)
29 High-Speed Output 1
30 Port 1, Bit 5
31 Port 1, Bit 6
32 Port 1, Bit 7
33 Port 2, Bit 6
34 High-Speed Output 2
35 High-Speed Output 3
36 Digital Circuit Ground
37 EPROM Programming Voltage (879x)
38 Port 2, Bit 7
39 Port 2, Bit 5; Pulse-Width Modulator; Programming Duration Overflow (879x); Slave Program Pulse (879x)
40 Write to External Memory; Write Even Locations Only
41 Bus High Enable; Write Odd Locations Only
42 Port 2, Bit 4; Timer 2 Reset
43 Ready Input for Longer Bus Cycles
44 Port 2, Bit 3; Timer 2 Clock
45 Port 4, Bit 7; Address/Data Bit 15
46 Port 4, Bit 6; Address/Data Bit 14
47 Port 4, Bit 5; Address/Data Bit 13
48 Port 4, Bit 4; Address/Data Bit 12
49 Port 4, Bit 3; Address/Data Bit 11
50 Port 4, Bit 2; Address/Data Bit 10
51 Port 4, Bit 1; Address/Data Bit 9
52 Port 4, Bit 0; Address/Data Bit 8
53 Port 3, Bit 7; Address/Data Bit 7
54 Port 3, Bit 6; Address/Data Bit 6
55 Port 3, Bit 5; Address/Data Bit 5
56 Port 3, Bit 4; Address/Data Bit 4
57 Port 3, Bit 3; Address/Data Bit 3
58 Port 3, Bit 2; Address/Data Bit 2
59 Port 3, Bit 1; Address/Data Bit 1
60 Port 3, Bit 0; Address/Data Bit 0
61 Read External Memory
62 Address Latch Enable/Address Valid Output
63 Instruction Fetch Output
64 Bus Width Select
65 Clock Generator Output
66 Oscillator Inverter Output
67 Oscillator Inverter and Clock Generator Input
68 Digital Circuit Ground

Manufacturer

Intel Literature Sales
PO Box 7641
Mt. Prospect, IL 60056-7641
Tel.:1-800-548-4725

Motorola 68HC16

Summary

The 68HC16 has all of the resources of the eight-bit 68HC11, but with a 16-bit CPU and other additions. The chip can access 1M each of program and data memory. For digital signal-processing, there are dedicated registers for multiply and accumulate operations. Programmable chip-select pins provide address decoding for accessing blocks of memory.

Features

Up to 48K of ROM
Up to 2K of RAM
16.78-MHz clock
Registers: one 4-bit, two 8-bit, 11 16-bit and one 36-bit
QSPI (queued synchronous serial peripheral interface)
SCI (asynchronous serial communications interface)
207 interrupt vectors
Up to 79 bits I/O
Two 16-bit timers
261 instructions, 10 address modes
Eight- or 10-bit A/D converter
Two pulse width modulation outputs

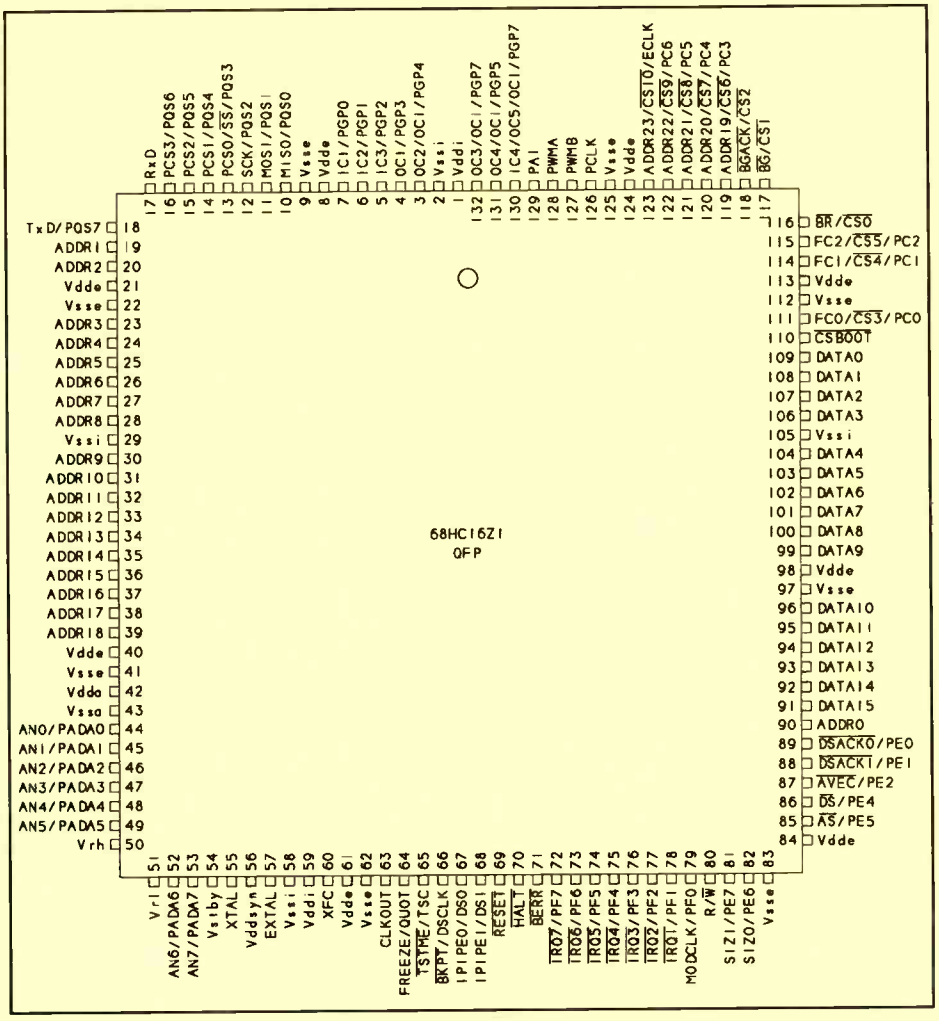
Family Members

68HC16Z1	No ROM, 1K of RAM, 46 bits of I/O
68HC16Z2	8K of ROM, 2K of RAM, 46 bits of I/O
68HC16X1	32K of ROM, 2K of RAM, 2K of Flash EPROM, 67 bits ofI/O
68HC916X1	48K of Flash EPROM, 2K RAM, 2K Block of Flash EPROM, 67 bits of I/O
68HC16Y1	48K of ROM, 2K of RAM, 79 bits of I/O, eight channels of A/D, multi-channel communication interface, time processing unit

Pin Function

1 Internal Module Power (Drain)
2 Internal Module Power (Source)
3 Output Compare 2/1; Port GP, Bit 4
4 Output Compare 1; Port GP, Bit 3
5 Input Capture 3; Port GP, Bit 2
6 Input Capture 2; Port GP, Bit 1
7 Input Capture 1; Port GP, Bit 0
8 External Periphery Power (Drain)
9 External Periphery Power (Source)
10 QSPI Master Input, Slave Output; Port QS, Bit 0
11 QSPI Master Output, Slave Input; Port QS, Bit 1
12 QSPI Serial Clock; Port QS, Bit 2
13 QSPI Peripheral Chip Select 0; Slave Select; Port QS, Bit 3
14 QSPI Peripheral Chip Select 1; Port QS, Bit 4
15 QSPI Peripheral Chip Select 2; Port QS, Bit 5
16 QSPI Peripheral Chip Select 3; Port QS, Bit 6
17 SCI Receive Data Input
18 SCI Transmit Data Output; Port QS, Bit 7
19 Address Bit 1
20 Address Bit 2
21 External Periphery Power (Drain)
22 External Periphery Power (Source)
23 Address Bit 3
24 Address Bit 4
25 Address Bit 5
26 Address Bit 6
27 Address Bit 7
28 Address Bit 8
29 Internal Module Power (Source)
30 Address Bit 9
31 Address Bit 10
32 Address Bit 11
33 Address Bit 12
34 Address Bit 13
35 Address Bit 14
36 Address Bit 15
37 Address Bit 16
38 Address Bit 17
39 Address Bit 18
40 External Periphery Power (Drain)
41 External Periphery Power (Source)

42 A/D Converter power (Drain)
43 A/D Converter power (Source)
44 ADC Analog Input 0; Port ADA, Bit 0
45 ADC Analog Input 1; Port ADA, Bit 1
46 ADC Analog Input 2; Port ADA, Bit 2
47 ADC Analog Input 3; Port ADA, Bit 3
48 ADC Analog Input 4; Port ADA, Bit 4
49 ADC Analog Input 5; Port ADA, Bit 5
50 High Reference Voltage
51 Low Reference Voltage
52 ADC Analog Input 6; Port ADA, Bit 6
53 ADC Analog Input 7; Port ADA, Bit 7
54 Standby Voltage
55 Crystal Driver
56 Clock Synthesizer Power
57 External Clock Input
58 Internal Module Power (Source)
59 Internal Module Power (Drain)
60 External Filter Capacitor
61 External Periphery Power (Drain)
62 External Periphery Power (Source)
63 System Clock Output
64 Freeze; Quotient Output
65 Test Mode Enable; Three-State Control
66 Breakpoint; Debug Mode Serial Clock
67 Instruction Pipeline 0; Debug Mode Serial Output
68 Instruction Pipeline 1; Debug Modes Srial Input
69 Reset
70 Halt External Bus Activity
71 Bus Error
72 Interrupt Request Level 7; Port F, Bit 7
73 Interrupt Request Level 6; Port F, Bit 6
74 Interrupt Request Level 5; Port F, Bit 5
75 Interrupt Request Level 4; Port F, Bit 4
76 Interrupt Request Level 3; Port F, Bit 3
77 Interrupt Request Level 2; Port F, Bit 2
78 Interrupt Request Level 1; Port F, Bit 1
79 Clock Mode Select; Port F, Bit 0
80 Read/Write Select
81 Size 1 (Indicates Bytes/bus Cycle); Port E, Bit 7
82 Size 0 (Indicates Bytes/bus Cycle); Port E, Bit 6
83 External Periphery Power (Source)
84 External Periphery Power (Drain)
85 Address Strobe; Port E, Bit 5
86 Data Strobe; Port E, Bit 4
87 Automatic Vector Request; Port E, Bit 2
88 Data and Size Acknowledge 1; Port E, Bit 1
89 Data and Size Acknowledge 0; Port E, Bit 0
90 Address Bit 0
91 Data Bit 15
92 Data Bit 14
93 Data Bit 13
94 Data Bit 12
95 Data Bit 11
96 Data Bit 10
97 External Periphery Power (Source)
98 External Periphery Power (Drain)
99 Data Bit 9
100 Data Bit 8
101 Data Bit 7
102 Data Bit 6
103 Data Bit 5
104 Data Bit 4
105 Internal Module Power (Source)
106 Data Bit 3
107 Data Bit 2
108 Data Bit 1
109 Data Bit 0
110 Boot Chip Select



111 Function Code 0; Chip Select 3; Port C, Bit 0
112 External Periphery Power (Source)
113 External Periphery Power (Drain)
114 Function Code 1; Chip Select 4; Port C, Bit 1
115 Function Code 2; Chip Select 5; Port C, Bit 2
116 Bus Request; Chip Select 0
117 Bus Grant; Chip Select 1
118 Bus Grant Acknowledge; Chip Select 2
119 Address Bit 19; Chip Select 6; Port C, Bit 3
120 Address Bit 20; Chip Select 7; Port C, Bit 4
121 Address Bit 21; Chip Select 8; Port C, Bit 5
122 Address Bit 22; Chip Select 9; Port C, Bit 6
123 Address Bit 23; Chip Select 10; E clock Output
124 External Periphery Power (Drain)
125 External Periphery Power (Source)
126 Pulse Accumulator Clock
127 Pulse Width Modulator Output B
128 Pulse Width Modulator Output A
129 Pulse Accumulator Input
130 Input Capture 4; Output Compare 5/1; Port GP, Bit 7
131 Output Compare 4/1; Port GP, Bit 6
132 Output Compare 3/1; Port GP, Bit 5

Manufacturer

Motorola Semiconductor Products Inc.,
PO Box 20912
Phoenix, AZ 85036
Tel.: 1-800-521-6274

"DDE for the masses" because it's so easy to use. If you haven't tried either, you should experiment with OLE first. But don't skip over the DDE capabilities of your major applications. It requires some cryptic-looking program statements to work, and you'll probably find some errors in the first DDE commands you write. But because data can be passed both ways, it can use the current programs on your hard disk to create new and unique applications.

For example, Microsoft *Word*, which has both OLE and DDE capabilities, also contains a complete programming language called *Word Basic* that gives users full access to DDE commands. Suppose you created a spreadsheet with *Excel* or a comparable program that could calculate loan payments given a loan amount, term and rate. You could easily create a *Word* document that would prompt for the three input quantities, send them to the spreadsheet program, retrieve the expected monthly loan amount and then place all four amounts into a form letter. And the entire process could be launched from an icon in a *Word* document that also contained icons for several other types of form letters.

The general basis of DDE is simple. *Windows* supports nine DDE commands, and their uses are generally clear. But to use it effectively, you have to know a fair amount about both client and server programs and the commands they support. Often, there's only limited information about DDE in an application's manuals but much more in its on-line help. Most major applications, even those written before *Windows* 3.1 was released, have DDE support as a client, server or both.

The goal of both DDE and OLE is to eventually do away with duplicate features in applications. If you have one major application, it should be able to get all the support it needs from other, smaller programs. And an efficient computer system would include many communication links between general programs and those that specifically support a user's special requirements. One word processor, for example, could be used for spreadsheets, graphing, presentations, communications and a host of other activities by sending requests to other programs and receiving data back from them. ■

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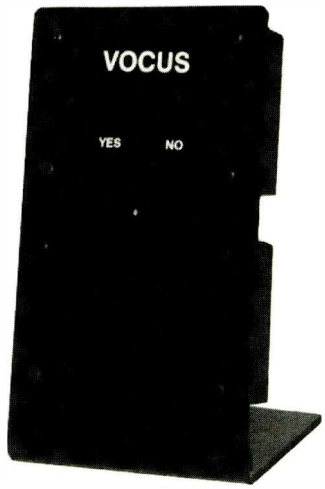
Add Voice Control to Your PC (Conclusion)

Building the Speech Input Module



Last month, I introduced you to a Voice-Controlled Utility System that I call VOCUS and that gives PCs an "ear" and a "voice" for hands-off operating convenience. Then I showed you how to build a Speech Input Module (SIM) that provides the "ear." To conclude this project, I now concentrate on a Speech Output Module (SOM) that provide the system's "voice." By combining the SIM and SOM devices, you have a system that gives your computer the ability to communicate with as much as 98% of the English-speaking population via voice from across the room.

Speech Synthesis

Basically two different approaches are commonly used to produce low bit-rate speech: frequency-domain and time-domain. In speech-synthesis technology, data bit-rates are a very important factor. Because large memory arrays take up a lot of room and are expensive, low speech data rates are essential in practical projects, particularly when a speech synthesizer is used in an embedded application.

Intelligibility of synthesized speech is generally inversely proportional to the rate at which data is provided to the synthesizer circuit. Good-quality digitally recorded voices typically require from 20K bits per second (bps) to nearly 100K bps, which is the case for time-domain synthesis. In contrast, the General Instruments SPO256 and Zernex TSP470CN frequency-domain synthesizer chips can produce intelligible speech with about 100 bps.

Time-domain synthesizers play back digitally-stored or sampled speech waveforms. On the other hand, frequency-domain synthesizers use data to actively "filter" pulse and noise sources. The resulting sounds fairly accurately model the human vocal tract.

The SPO256 and TSP470CN chips are frequency-domain synthesizers. Utilizing a 12-pole digital filter to model the human vocal tract, these devices are capable of producing 59 discrete speech sounds, called "allophones." The English language can best be represented by breaking up our words into their basic phonetic allophones, which can be sequenced by our digital vocal tract to sound like human speech.

Although the SPO256 chip can be operated from a standard microcontroller or microprocessor, creating intelligible speech directly from the written English language is very tricky because speech is difficult to emulate in software. However, much of the tedium associated with conversion is automated by an algorithm created by the Naval Research Laboratory, an enhanced version of which has been coded into a companion General Instruments CTS-256 code-to-speech coprocessor chip.

An explanation of rule-based speech synthesis theory is well beyond the scope of this article. Fortunately, you don't have to know how these chips work to be able to use them. Unfortunately, the GI chip set has become increasingly difficult to find. and when you can find them, they can be expensive. Hence, before you attempt to build the GI Speech Card, it's a good idea to locate a couple of these chips. Try your local Radio Shack store, which may still have some of them, though they haven't been stock items for some time.

An alternative to the GI chip set is the newer Zernex TSP470CN, which is considerably more sophisticated and, I feel, produces more-intelligible speech. It integrates the circuits needed with the GI chip set into a single IC. Be prepared to pay a more for this newer chip.

If you can't locate the required chips locally, you can obtain both ICs from the source given in the Note at the end of the Parts List.

About the Circuit

The General Instruments CTS256A code-to-speech processor can be operated from a parallel or serial port. In this project, the serial port is used for data transfer. Referring to the Speech Output Module schematic diagram in Fig. 7, note that serial data from the Speech Input Module's MAX-232 interface routes to pin 16 of code-to-speech microcontroller *U1*.

Crystal *X1* and capacitors *C1* and *C2*

Listing 1. Sample BASIC Program For Experimenting With Project

```
10    OPEN "COM1:9600,N,8,1,RS,CS,DS,CD,LF" AS #1
20    CLS : PRINT #1, "DO YOU WANT TO CONTINUE?"
30    INPUT #1, A$
40    IF A$="YES" THEN 20
50    IF A$="NO" THEN 100
100 PRINT #1, "THANK YOU FOR USING VOCUS" : STOP
```

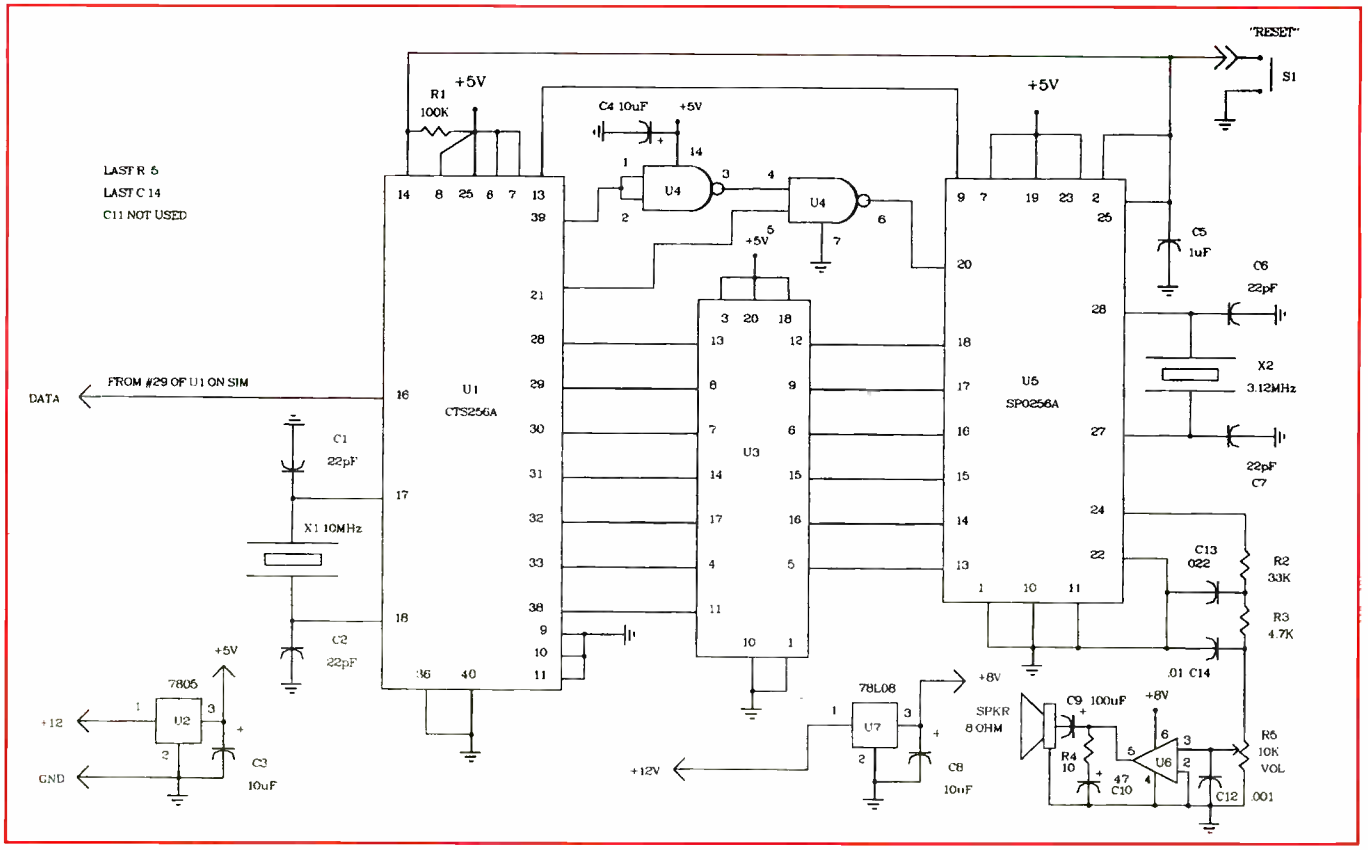


Fig. 7. Schematic diagram of General Instruments option.

form an internal oscillator/clock signal that controls software execution for *U1*. Pin 14 of *U1* is pulled-up to the +5-volt supply rail by *R1*. Working in conjunction with capacitor C5 and RESET switch *S1*, resistor *R1* provides *U1* with a reset each time the switch is pressed. Pressing *S1* causes the SOM to vocalize "okay" to indicate that the unit has properly reset and re-initialized the software.

Octal latch *U3* buffers allophone address data being transferred from *U1* to speech synthesizer *U5*. Pin 38 of *U1* controls the latching process and is connected to pin 11 of *U3*. Chip *U4* is used to enable the data-transfer sequence inside *U5* to further control transfer of allophone address data from *U1* to *U5*.

Speech synthesizer *U5* obtains its reference frequency from crystal *X2* and capacitors *C6* and *C7*. I like the sound obtained by using a 3.57-MHz crystal better than that obtained with the standard 3.12-MHz because it raises the pitch of the voice. I find the higher pitch more intelligible.

Synthesized speech audio is post-filtered by the passive filter network made up of *R2*, *R3*, *C13* and *C14*. The values of these components were selected to suit my personal tastes. Feel free to try several different values to find a combination that suits your particular tastes based on the speaker you choose and acoustics in the room in which you use your PC.

Filtered audio is applied to VOLUME control *R5*. Audio power amplifier *U6* drives the speaker through *C9*. To eliminate the tendency LM386 amplifiers have to oscillate when they aren't properly damped, *R4* and *C10* form a "snubber" network that dissipates unwanted

PARTS LIST

General Instruments Option
(Goes with Fig. 7)

Semiconductors
U1—CTS256A code-to-speech processor (General Instruments)
U2—7805 fixed +5-volt regulator
U3—74LS373 octal latch
U4—74LS00 quad gate
U5—SPO256A speech synthesizer
U6—LM386 Audio amplifier
U7—78L08 fixed +5-volt regulator

Resistors (1/4-watt, 5% tolerance)
R1—100,000 ohms
R2—33,000 ohms
R3—4,700 ohms
R4—10 ohms
R5—10,000-ohm pc-mount trimmer potentiometer

Capacitors
C1,C2,C6,C7—22-pF 50-volt disc
C3,C4,C8,C11—10µF, 16-volt electrolytic
C5—0.1µF, 50-volt Mylar
C9—100µF, 16-volt electrolytic
C10—0.47µF, 16-volt tantalum
C12—0001µF, 50-volt Mylar"
C13—0.022µF, 50-volt Mylar
C14—0.01µF, 50-volt Mylar

Miscellaneous
Printed-circuit board (see text); 10-, 3.12- or 3.57-MHz crystal, 6-32 × 1/2" spacers; 6-32 × 3/4" spacers; 6-32 × 3/8" black-oxide Allen-type button-head screws; 6-32 Keps nuts; 2" 8-, 16- or 32-ohm Mylar speaker; 3 1/2" × 2 1/2" × 1 1/4" black plastic enclosure.

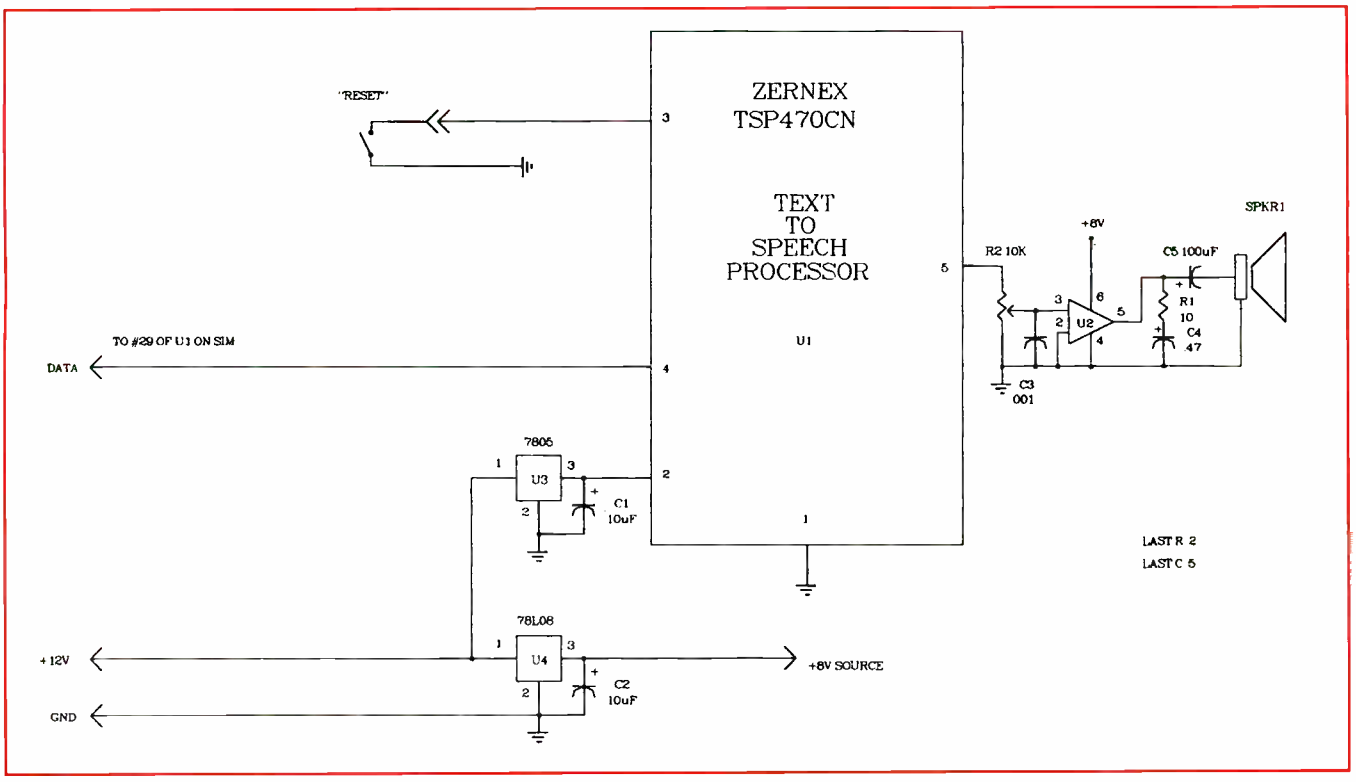


Fig. 8. Schematic diagram of Zernex option.

high-frequency oscillations in *U6*.

Power for the digital ICs is provided by fixed +5-volt regulator *U2*. Capacitor *C3* filters out unwanted switching noise on the +5-volt bus. Likewise, fixed +8-volt regulator *U6* provides clean dc to audio power amplifier *U6*. Separating the audio and digital power supplies from each other helps eliminate clicks, pops and hum.

Because the Zernex TSP470CN is fully integrated, it's very easy to understand and use. In the Fig. 8 schematic diagram of the Zernex circuit, serial data is applied to pin 4 of the IC. As with the General Instruments chip set, the TSP470CN is internally configured to receive serial data at 9,600 baud.

Reset action is provided by RESET switch *S1* at pin 3 of *U1*. Power for the TSP470CN is regulated by fixed +5-volt regulator *U3*, while power for audio power amplifier *U2* is provided by fixed +8-volt regulator *U4* . Dc filtering for the separate buses is provided by *C1* and *C2*, respectively.

Speech output level is controlled by *R2*. Capacitor *C3* removes high-frequency noise from the incoming audio signal. Resistor *R1* and capacitor *C4* form a snubber network at pin 5 of *U2* to dissipate unwanted high-frequency oscillation in *U2*. When connected to a speaker, *U2* produces more than enough audio for across-the-room listening.

PARTS LIST

Zernex Option
(Goes with Fig. 8)

Semiconductors
U1—TSP470CN text-to-speech processor (Zernex)
U2—LM386 audio amplifier
U3—7805 fixed +5-volt regulator
U4—78L08 fixed +8-volt regulator

Capacitors
C1,C2—10µF, 16-volt electrolytic
C3—0.001µF, 50-volt Mylar
C4—0.47µF, 16-volt tantalum
C5—100µF, 16-volt electrolytic

Resistors (1/4-watt 5% tolerance)
R1—10 ohms
R2—10,000-ohm pc-mount trimmer potentiometer

Miscellaneous
3 1/2" × 2 1/2" × 1 1/4" black plastic enclosure; 6-32 × 1/2" spacers; 6-32 × 3/4" spacers; 6-32 × 3/8" black-oxide Allen-type button-head screws; Keps nuts, 2" 8- 16- or 32-ohm Mylar speaker.

Note: The following items are available from U.S. Cyberlab, Inc., 14786 Slate Gap Rd., West Fork, AR 72774 (tel.: 501-839-8293 Ext. 3): CTS256A code-to-speech, $24.95, SPO256A speech synthesizer, $14.95; Zernex TSP470CN, $74.95. Also available are: a complete GI-type Speech Synthesizer Card kit, including all ICs, pc board, speaker and passive components, for $74.95 and a complete Zernex-type Speech Synthesizer Card kit, including TSP470CN, pc board, speaker and passive components, for $89.95. Add $3.80 UPS S&H for individual items, $7.25 for full kits. Checks, COD, MasterCard/ Visa accepted. Arkansas residents, add state sales tax. Allow up to four weeks for delivery.

Construction

Begin construction by using the actual-size artwork in Fig. 9 as a guide to fabricate the printed-circuit board for the SOM card. (Note that the pc boards for both options of this portion of the project are identical. Therefore, you need only one board, regardless of the option with which you choose to go, populating it according to the option of your choice.) If you prefer, you can purchase a ready-to-wire pc board from the

source given in the Note at the end of the Parts List. If you do make your own board, drill the smaller holes with a No. 68 bit and the larger holes for the trimmer potentiometer and interconnect wires with No. 60 and 57 bits, respectively.

When you're ready to wire the board, refer to Fig. 10 (General Instruments option) or Fig. 11 (Zernex option) and install and solder into place the resistors and capacitors. To avoid making wiring errors, photocopy and keep together the schematic diagram, wiring guide and Parts List for option you've decided to use and work only from these.

Make sure you properly orient the electrolytic capacitors before soldering their leads into place. If you plan on using sockets for the DIP ICs, install them now. Alternatively, exercise care when soldering the ICs into place to avoid damaging them with heat, and make absolutely certain that each IC is properly oriented and in its proper location before you solder any pin into place. Also, solder only three pins at a time for a given IC and then let a few seconds go by before proceeding to the next three pins to allow the chip to recover from the soldering heat you've applied.

If you're building the Zernex option, install only the components indicated on the Fig. 8 schematic and Fig. 11 wiring guide and specified in the appropriate Parts List. Solder short lengths of ribbon cable or No. 22 hookup wire to the five I/O pins on the TSP470CN and connect them to the pads indicated in Fig. 11. Later, after you're certain that the SOM is working properly, you'll unsolder these wires and bring them through a small hole in the SOM's enclosure.

Use a 4-40 × 3/8" screw and nut to secure the 7805 voltage regulator into place on the board. You don't need heatsink compound because the 7805 doesn't get very warm while the circuit is operating.

Finally, connect the speaker to the pads indicated in Fig. 10 or Fig. 11.

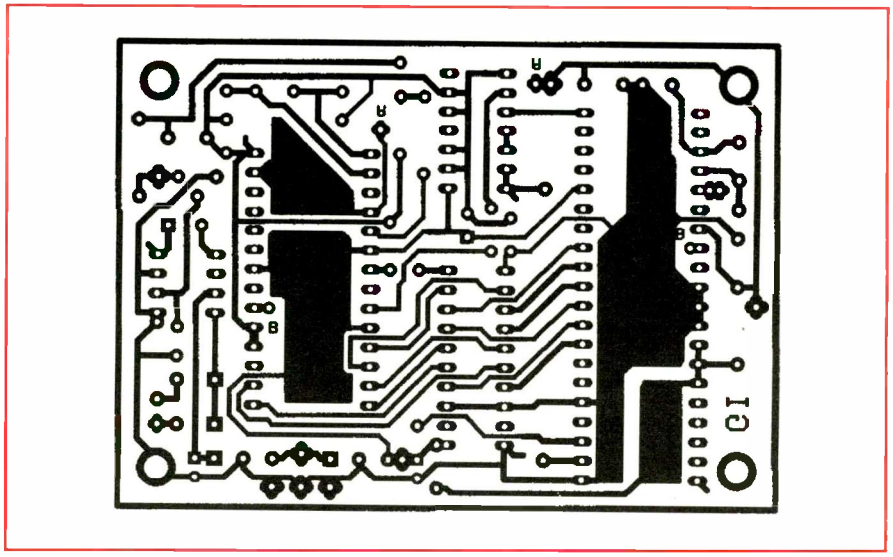


Fig. 9. Actual-size artwork for fabricating printed-circuit board for SOM. Pc boards for both options are identical.

Checkout & Use

Assuming you built the Speech Input Module last month, remove its enclosure to access the pc card. Drill a small

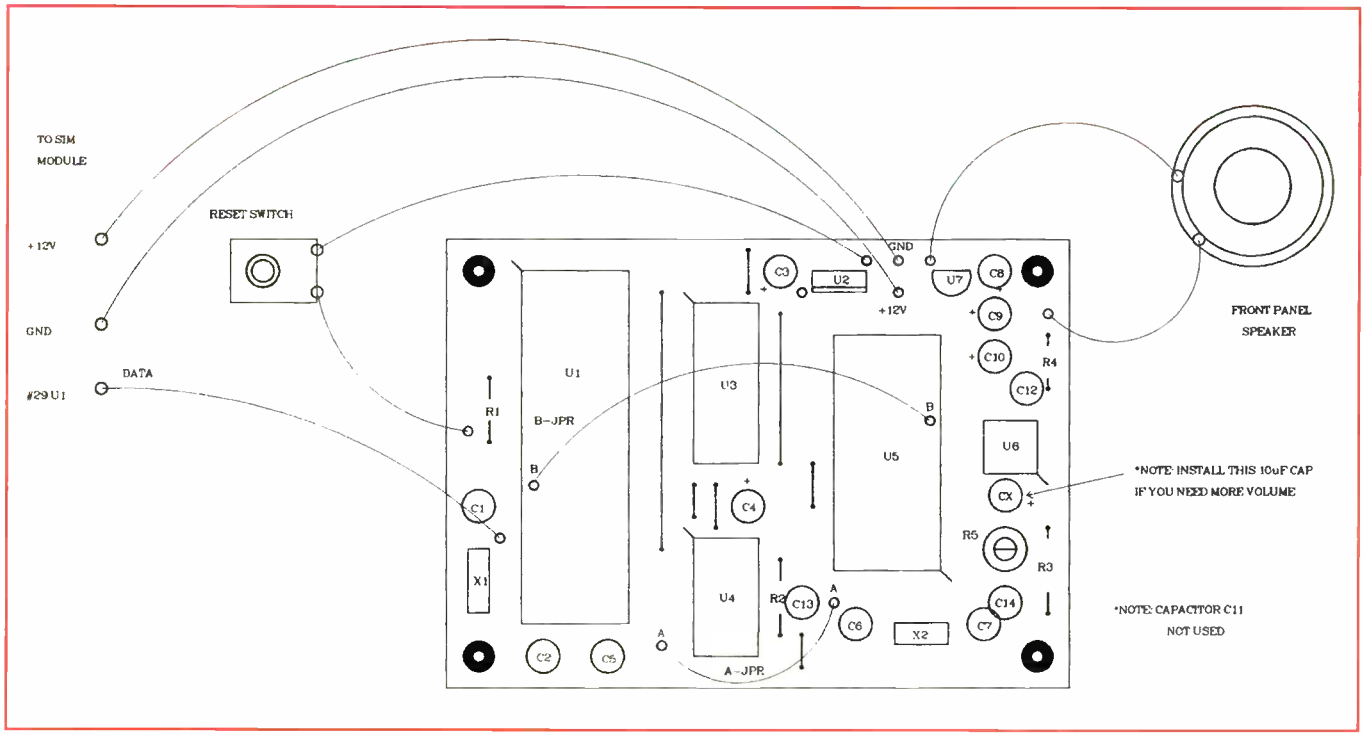


Fig. 10. Wiring guide for General Instruments option.

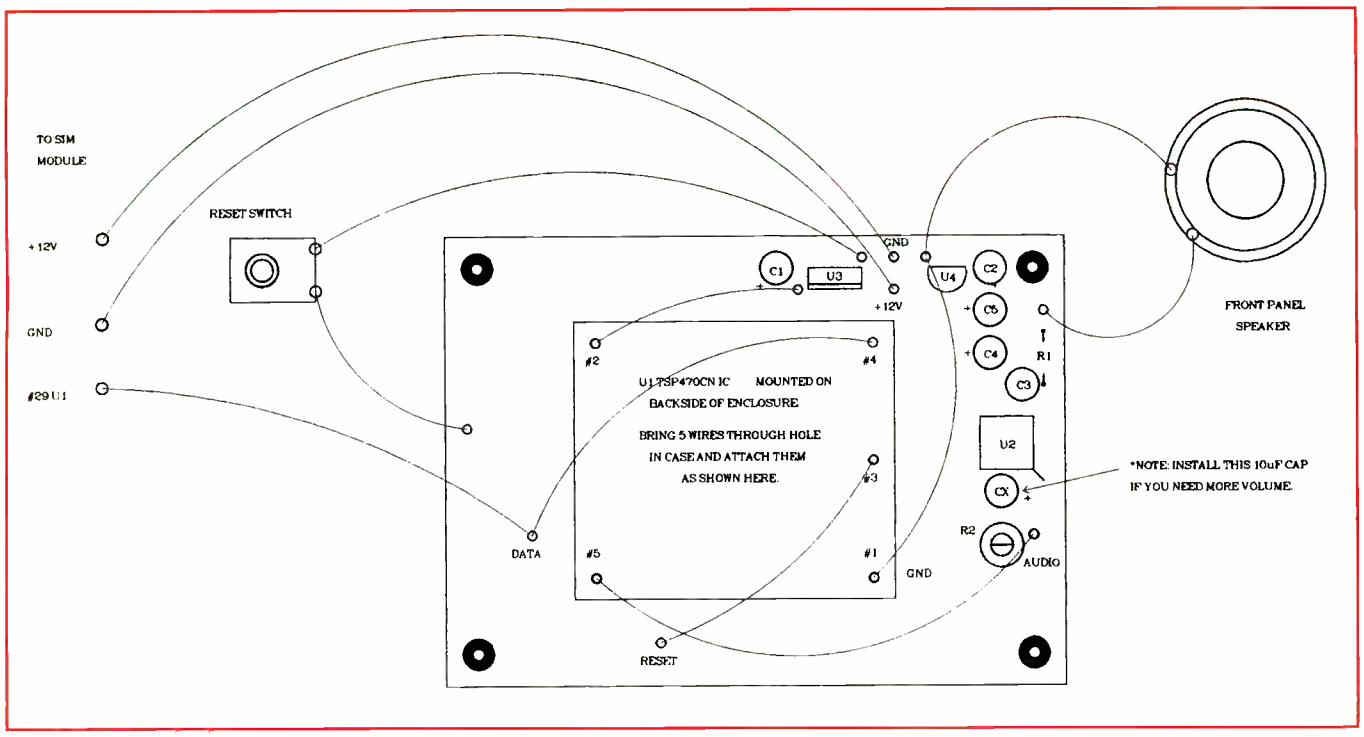


Fig. 11. Wiring guide for Zernex option.

hole through the bottom of its enclosure to provide a means for entry of the power-supply and data-input leads to pass through and solder these leads to the appropriate pads on the card according to the option you've selected.

Likewise, drill a small hole through the top of the SOM's enclosure to allow the same wires to pass through. After soldering the wires to the SOM board, double-check your work and, when you're satisfied that everything is okay, then mount the speaker into place. Use fast-setting epoxy cement or gel-type super glue, making certain that you don't get any cement or gel on the speaker's diaphragm to prevent compromising sound quality.

If you're using the Zernex option, secure the IC to the back of the plastic enclosure in the same manner as you did for the speaker. Be neat and careful as you work because it's very difficult to get the IC loose once the cement or glue sets if you need to do so!

Recheck your work one more time and, if you're satisfied that everything is still okay, connect the serial/power cable to the SIM connector. When you power up your system, you should hear "okay" vocalized through the speaker. If not, power down and do what's needed to correct the problem.

Using the VOCUS system is easy. I use mine from BASIC. As an example, key in the simple program given in Listing 1. After entering and saving this program, run it and answer the vocalized prompts as directed. It may take you a couple of tries to get the "feel" of the new system. Don't speak too loud or too close to the microphone. The project is very sensitive to vocalized sound and is meant to be operated at a distance.

Try writing a BASIC program that will put the project to work around your home or lab. Because VOCUS is a "universal" device, you can use C or any other programming language—you can even write *Windows* applications—to take advantage of the project's unique characteristics.

Consider connecting this project to your telephone. A simple matching transformer and DAA coupler will allow VOCUS to answer your telephone, direct callers to different messages, etc. VOCUS' big advantage is that it able to query a caller via "yes, no, true and false" responses. For example:

VOCUS: *Would you like to speak with Bob?*
Caller: *No.*
VOCUS: *Would you like to speak with Frank?*
Caller: *Yes.*
VOCUS: *One moment and I'll contact him.*
VOCUS: *I'm sorry, but Frank doesn't answer. Would you like to leave a message for him ?*
Caller: *Yes.*
VOCUS: *Leave your message now.*

Applications for which you'll find uses for VOCUS are virtually limitless. VOCUS doesn't have to be used as an input and output device. For example, you can use it as output-only to "proofread" ASCII text files by having VOCUS do the "reading" and vocalizing the copy to you. This relieves you of having to focus your attention on the printed matter and frees you to work on other projects while you listen. You'll almost certainly come up with applications for this project that are unique to your situation. In fact, I'll go so far as to predict that VOCUS will become one of your favorite peripherals. ■

Nick Goss

Getting Started With Programmable Logic Devices: The GAL16V8

Using these devices in digital-logic circuit designs can greatly reduce the number of IC devices needed and the amount of printed-circuit board real estate needed

After my High-Speed Multi-Channel Logic Analyzer article appeared in the September 1992 issue of *ComputerCraft*, I received a number of letters from readers who wanted more information on the GAL devices used in the project. This is no wonder because on the Logic Analyzer's main board, all standard logic was handled by seven GALs that replaced about 20 high-speed TTL ICs and greatly simplified building the project, not to mention making the project's overall size manageable.

The GAL (which stands for Generic Array Logic, trademarked by Lattice Semiconductor) is a great boost for small-scale hardware designers because it brings such benefits as:

- ***Flexibility.*** A GAL can implement both combinatorial logic functions (AND, OR, NAND, etc.) and registered logic functions (counters, shift registers, etc.) on the same chip.
- ***Space Savings.*** A GAL typically replaces between two and four standard TTL chips, trimming a large amount of circuit-board real estate when compared to other approaches.
- ***High Speed.*** GALs offer propagation delays down to as little as 7 ns. Typical GALs have a propagation delay of only 15 ns, which is faster than standard 7400- and 74LS-series logic.
- ***Reprogrammability.*** Not only are GALs programmable, giving you the ability to correct design errors and ease board layout, they can be reprogrammed up to 100 times. Erasing and programming takes only a few seconds.
- ***Low Cost.*** Standard-speed GAL16V8s (25 and 15 ns) cost only a few dollars, even in small quantities.

Though several varieties of GALs exist, I'll limit the following discussion to the GAL16V8. Rather than get bogged down with the internal details of the GAL16V8, I'll cover only what you need to know for you to use this PLD in your own designs and then look at several examples.

General Details

The GAL16V8 comes in a standard 20-pin DIP package (see Listing 1). Ground is on pin 10 and +5 volts (V_{cc}) is on pin 20. Pins 12 through 19 each connect to output logic macro cells (OLMCs). An OLMC allows these pins to act as inputs, combinatorial outputs, registered outputs and input/output pins. Pins 2 through 9 are always general-purpose inputs.

If any OLMC is configured as a registered output, pin 1 is a clock input and pin 11 is the output-enable for the registered output. If no OLMC is registered, pins 1 and 11 are general-purpose inputs. Internal to the chip is an array of AND/OR logic that's configured with each OLMC when the chip is programmed. Details of the array logic are handled by the logic compiler.

Of the several available logic compilers, all perform the function of converting a high-level design file into a JEDEC file. The JEDEC file is a standard format file that's input to a device programmer. The logic compiler we'll use is *Opal Jr.*, which is available at no cost from National Semiconductor, and supports the various GAL and PAL chips National produces. The *Opal* design file is called an "equation file" and should have the extension ".EQN."

The equation file is a standard ASCII text file that can be produced using any text editor. It must contain two sections: declaration and equation.

The declaration section should appear first and is indicated by the keyword "CHIP." The first line should look like this:

```
CHIP example 16V8
```

This gives the program the name example and indicates that you'll use a 16V8.

The next part of the declaration block is optional, but it will be needed in most cases. In this section, you assign symbolic names to each pin on the chip. For this example, this will be:

```
clk ina inb inc ind ine inf ing inh gnd
oe ioa iob ioc iod ioe iof iog ioh vcc
```

Symbolic names start with pin 1 and are assigned in numerical order through pin 20. In this case, pin 1 is assigned the name clk, pin 9 the name ini, pin 12 the name ioa and pin 19 the name ioh. If you later need to change pin assignments, you simply rearrange the names given here.

The equation section of the file is indicated by a line with the word "EQUATIONS." Below this line, the logic equation for each output pin is defined in a sum-of-products format. This means that each equation is written as groups of product terms (symbols logically ANDed together) or summed (ORed together). This is easy to see with a few examples:

```
EQUATIONS

ioa = ina * inb
```

This equation states that output ioa is defined by ina AND anb (the * is the

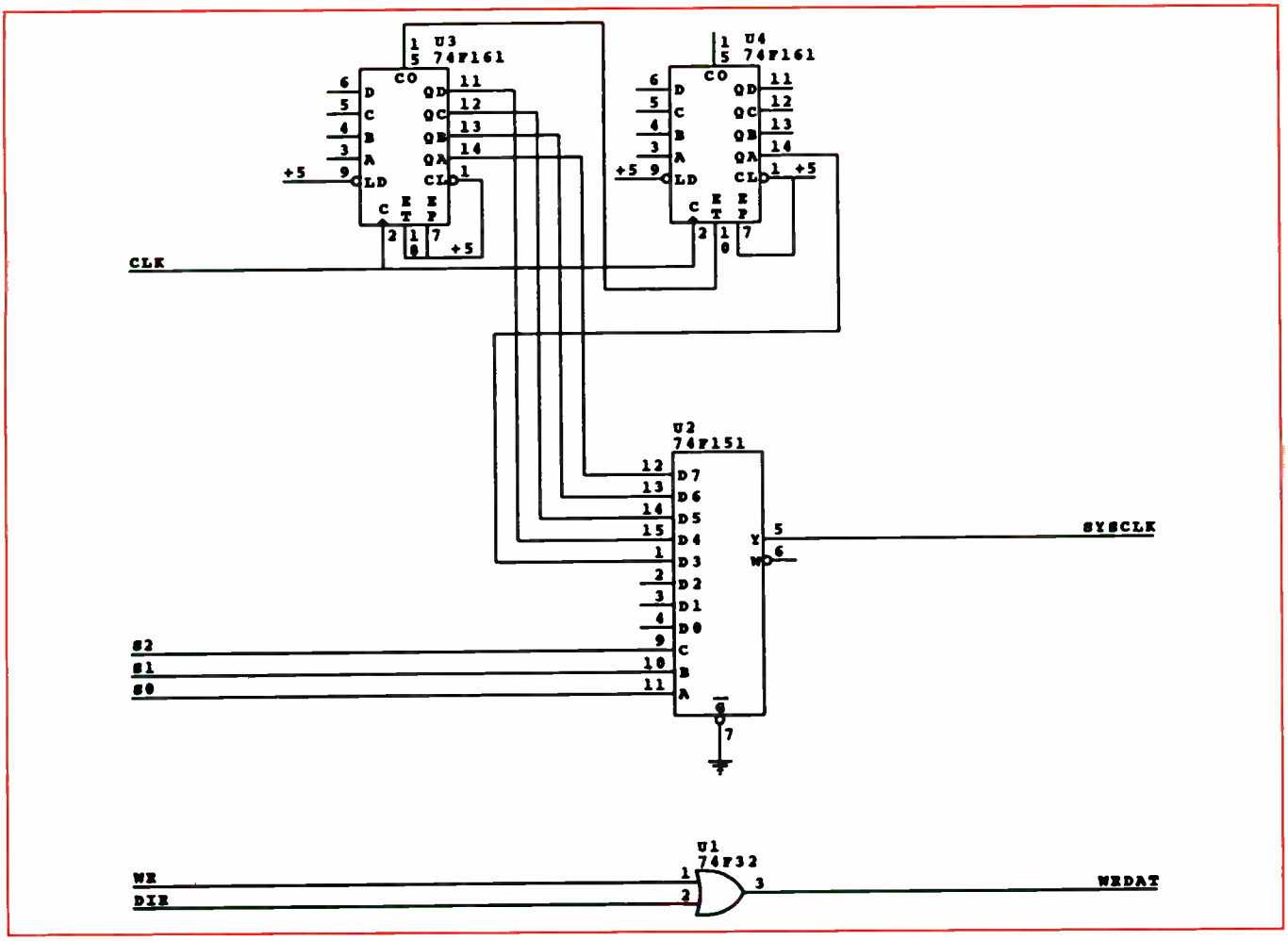


Fig. 1. TTL equivalent to GCLOCK.

AND symbol, which is a product term). This is equivalent to a two-input AND gate. Thus, ioa will be high when both ina and inb are high. A three-input OR gate would look like this:

```
iob = ina +
inb +
inc
```

The + is the OR symbol, It's a common convention to put each product term on a separate line. Here, iob would be high if ina OR inb OR inc is high. A NAND gate could be defined as follows:

```
/ioc = ina * inb * inc * ind
```

The / is used to indicate inversion. In this, case it means that ioc will go low when the expression ina AND inb AND inc AND ind is true (ina, inb, inc and ind are all high). The / can also be used on the other side of the equation as follows:

```
iod = /ina * inb * /inc
```

This corresponds to (NOT ina) AND inb AND (NOT inc) so that iod is high when ina is low, inb is high and inc is low.

You aren't limited to the level of logic of the simple examples given so far. Inputs to logic equations can come from any of the input or output pins (referred to as a feedback), and you're limited to a maximum of either seven or eight product terms in each equation. The limit depends on the configuration of the OLMC.

So far, all of the equations have been for combinatorial logic and standard AND- and OR-type logic. This is indicated by use of a plain = in each equation. The outputs can also be registered, like a D-type flip-flop, for sequential logic. For example:

```
ioe := ina
```

The := indicates that the output ioe is registered. This means that ioe will take on the value of ina on the rising edge of the clock on pin 1. Registered outputs can be used to produce such sequential devices as shift registers and counters. The following group of equations forms a two-bit counter at outputs iof and iog, with a terminal count indication on ioh:

```
iof := /iof
iog := iof * /iog +
/iof * iog
ioh := /iof * iog
```

The counter will count the sequence 0, 1, 2, 3, with iof as bit 0 and iog as bit 1. Here, ioh will be a 1 only when the count is 3, and iof will toggle on every rising edge of the clock because it will always change to its inverse each time. Too, iog will become 1 if iof is 1 and iog is 0. This is the transition of the count from 1 to 2. iog will remain 1 if iof is 0 and iog is 1. This would be the transition from 2 to 3. ioh becomes 1 only when the previous count was 2.

The counter will continue to count on each rising clock edge. A table of the

outputs will be as shown below:

iof	iog	ioh
0	0	0
1	0	0
0	1	0
1	1	1
0	0	0

The registered outputs have a common output-enable at pin 11. When this pin is low, the registered outputs are all enabled. If pin 11 goes high, all registered outputs are disabled (tri-stated). Even when the outputs are tri-stated, the register outputs are still available internally as feedbacks. So the counter would continue to work, even if the outputs were disabled.

Combinatorial outputs can each have an output-enable defined. This is limited to a single product term. For example:

```
ioa.oe = inb * inc
```

This would indicate that output ioa should be enabled when inb AND inc are high. Once you've completed the equation file, you compile it with the command line:

```
eqn2jed -n example
```

where eqn2jed is the *Opal* program that produces the JEDEC file. This will take our example.eqn file and check it for errors and, if not error-free, produce the JEDEC file example.jed. The -n in the command line tells the program to produce a new log file, rather than append to the existing log file.

The PALCE16V8

The PALCE16V8 is Advanced Micro Devices' response to the GAL16V8. The PALCE16V8 ("CE" stands for CMOS Erasable) is a GAL16V8-equivalent device. The only difference between the two devices is the programming algorithm. However, a programmer that can program the GAL16V8 may not be able to program the PALCE16V8.

Listing 1. EQN2.JED Program

```
EQN2JED - Boolean Equations to JEDEC file assembler
(Version V003)
Copyright (R) National Semiconductor Corporation
1990,1991

Document file for gclock.eqn
Device: 16V8

$LABELS 20 clk nc ext self s2 s1 s0 dir wr gnd /oe sysclk1
wrdat sysclk0 q4 q3 q2 q1 q0 vcc


Pin   Label          Type
-------------------------------
1     clk            clock
2     nc             not used
3     ext            com input
4     self           com input
5     s2             com input
6     s1             com input
7     s0             com input
8     dir            com input
9     wr             com input
10    gnd            ground
11    oe             enable
12    sysclk1        pos,trst,com output
13    wrdat          pos,trst,com output
14    sysclk0        pos,trst,com output
15    q4             pos,reg feedback
16    q3             pos,reg feedback
17    q2             pos,reg feedback
18    q1             pos,reg feedback
19    q0             pos,reg feedback
20    vcc            power

EQN2JED - Boolean Equations to JEDEC file assembler
(Version V003)
Copyright (R) National Semiconductor Corporation
1990,1991

Device Utilization:

No of dedicated inputs used          : 7/8  (87.5%)
No of feedbacks used as dedicated outputs : 3/8  (37.5%)
No of feedbacks used                 : 5/8  (62.5%)


Pin   Label          Terms Usage
-------------------------------
19    q0             1/8   (12.5%)
18    q1             2/8   (25.0%)
17    q2             3/8   (37.5%)
16    q3             4/8   (50.0%)
15    q4             5/8   (62.5%)
14    sysclk0        8/8   (100.0%)
13    wrdat          3/8   (37.5%)
12    sysclk1        8/8   (100.0%)
-------------------------------
Total                34/64 (53.1%)

EQN2JED - Boolean Equations to JEDEC file assembler
(Version V003)
Copyright (R) National Semiconductor Corporation
1990,1991

Chip diagram (DIP)

                .____    ____.
                |    \__/    |
          clk|  1          20|vcc
           nc|  2          19|q0
          ext|  3          18|q1
         self|  4          17|q2
           s2|  5          16|q3
           s1|  6          15|q4
           s0|  7          14|sysclk0
          dir|  8          13|wrdat
           wr|  9          12|sysclk1
          gnd|10          11|/oe
                |______________|
```

Listing 2. GCLOCK Program

```
; GCLK program for the logic analyzer
; this gal handles the system clock selection
;
CHIP clock 16V8

clk nc ext self s2 s1 s0 dir wr gnd
/oe sysclk1 wrdat sysclk0 q4 q3 q2 q1 q0 vcc

EQUATIONS

q0 :=    /q0

q1 :=    q0 * /q1 +
         /q0 * q1

q2 :=    q0 * q1 * /q2 +
         q2 * /q0 +
         q2 * /q1

q3 :=    q0 * q1 * q2 * /q3 +
         q3 * /q0 +
         q3 * /q1 +
         q3 * /q2

q4 :=    q0 * q1 * q2 * q3 * /q4 +
         q4 * /q0 +
         q4 * /q1 +
         q4 * /q2 +
         q4 * /q3

sysclk0 = /s0 * /s1 * /s2 * self +
         s0 * /s1 * /s2 * ext +
         s0 * s1 * /s2 * q4 +
         /s0 * /s1 * s2 * q3 +
         s0 * /s1 * s2 * q2 +
         /s0 * s1 * s2 * q1 +
         s0 * s1 * s2 * q0

sysclk1 = /s0 * /s1 * /s2 * self +
         s0 * /s1 * /s2 * ext +
         s0 * s1 * /s2 * q4 +
         /s0 * /s1 * s2 * q3 +
         s0 * /s1 * s2 * q2 +
         /s0 * s1 * s2 * q1 +
         s0 * s1 * s2 * q0

wrdat =  wr +
         dir
```

Listing 3. Comparator Program

```
; LCOMP the special trigger comparator for the logic analyz-
er
; modified comparator don't care is x=1 t=1, x=1 t=0 never is
equal
; for x=0 comparision is true when t=d - on true equ is 0
;
CHIP lcomp 16v8

clk x3 x2 x1 x0 d0 d1 d2 d3 gnd
/oe not invert t0 t1 t2 t3 equ1 equ0 vcc

EQUATIONS

t0 := x0
t1 := x1
t2 := x2
t3 := x3

equ0 =   x0 * /t0 +
         /x0 * /d0 * t0 +
         /x0 * d0 * /t0 +
         x1 * /t1 +
         /x1 * /d1 * t1 +
         /x1 * d1 * /t1

equ1 =   x2 * /t2 +
         /x2 * /d2 * t2 +
         /x2 * d2 * /t2 +
         x3 * /t3 +
         /x3 * /d3 * t3 +
         /x3 * d3 * /t3

not =    /invert
```

A sample log file is described with the first example. example.jed would be loaded by the programmer and the 16V8 will be programmed.

Design Examples

Now let's look at some examples. These examples are the GAL programs from the Logic Analyzer. The first one is the system clock-distribution chip from the Logic Analyzer. The equation file is shown in Listing 2, GCLOCK.EQN.

The first few lines of the file start with a ; and indicate comments that are ignored by *Opal*. The declaration block is exactly as discussed above. Only the chip name and the symbolic pin names are different.

Outputs q0, q1, q2, q3 and q4 form a five-bit counter (a straightforward expansion of the two-bit counter used before). This counter provides several reference frequencies at the outputs, q1 is half of q0, q2 is half of q1, etc.

With a 40-MHz crystal oscillator connected to pin 1, q0 provides a 20-MHz clock, q1 a 10-MHz clock, q2 a 5-MHz clock, q3 a 2.5-MHz clock and q4 a 1.25-MHz clock. Because outputs sysclk0 and sysclk1 use identical equa-

tions, I refer to them collectively as "sysclk."

The sysclk outputs are combinatorial. They allow the system clock to be selected from q0, q1, q2, q3, q4 or inputs self or ext. Inputs s0, s1 and s2 select which clock is output to sysclk.

From the equations, you can see that if s0, s1 and s2 are all 0, sysclk is the same as the input self. If s0, s1 and s2 are all 1, the last product term will apply and sysclk will follow q0. The final output defined in the equations is wrdat, obviously just a simple two input OR function.

The equivalent circuit to this GAL is shown in Fig. 1. Notice the savings in chip count and cost. The log file, given as Listing 2, shows the use of each device pin, the product term usage and device pinout.

The next design example is the comparator from the Logic Analyzer, shown as Listing 3. The first four equations are

Listing 4. STAGE1.EQN Program

```
; U5 on the logic analyzer first address counting stage
CHIP stage1 16V8

clk cnt mr nc nc nc nc nc nc gnd
oe tc a5 a4 a3 a2 a1 a0 valid vcc

EQUATIONS

a0 :=   mr * cnt * /a0 +
        mr * /cnt * a0

a1 :=   mr * cnt * a0 * /a1 +
        mr * /cnt * a1 +
        mr * /a0 * a1

a2 :=   mr * cnt * a0 * a1 * /a2 +
        mr * /cnt * a2 +
        mr * a2 * /a0 +
        mr * a2 * /a1

a3 :=   mr * cnt * a0 * a1 * a2 * /a3 +
        mr * /cnt * a3 +
        mr * a3 * /a0 +
        mr * a3 * /a1 +
        mr * a3 * /a2

a4 :=   mr * cnt * a0 * a1 * a2 * a3 * /a4 +
        mr * /cnt * a4 +
        mr * a4 * /a0 +
        mr * a4 * /a1 +
        mr * a4 * /a2 +
        mr * a4 * /a3

a5 :=   mr * cnt * a0 * a1 * a2 * a3 * a4 * /a5 +
        mr * /cnt * a5 +
        mr * a5 * /a0 +
        mr * a5 * /a1 +
        mr * a5 * /a2 +
        mr * a5 * /a3 +
        mr * a5 * /a4

valid := mr * valid +
        mr * a2 ; valid will latch the occurance of a2

tc :=   mr * cnt * /a0 * a1 * a2 * a3 * a4 * a5
```

Listing 5. STAGE2.EQN Program

```
; U7 on the logic analyzer second address counting
stage
CHIP stage2 16V8

clk cnt mr nc nc nc nc nc nc gnd
oe wrap a12 a11 a10 a9 a8 a7 a6 vcc

EQUATIONS

a6 := mr * cnt * /a6 +
        mr * /cnt * a6

a7 := mr * cnt * /a7 * a6 +
        mr * /cnt * a7 +
        mr * /a6 * a7

a8 := mr * cnt * /a8 * a7 * a6 +
        mr * /cnt * a8 +
        mr * /a6 * a8 +
        mr * /a7 * a8

a9 := mr * cnt * /a9 * a8 * a7 * a6 +
        mr * /cnt * a9 +
        mr * /a6 * a9 +
        mr * /a7 * a9 +
        mr * /a8 * a9

a10 := mr * cnt * /a10 * a9 * a8 * a7 * a6 +
        mr * /cnt * a10 +
        mr * /a6 * a10 +
        mr * /a7 * a10 +
        mr * /a8 * a10 +
        mr * /a9 * a10

a11 := mr * cnt * /a11 * a10 * a9 * a8 * a7 * a6 +
        mr * /cnt * a11 +
        mr * /a6 * a11 +
        mr * /a7 * a11 +
        mr * /a8 * a11 +
        mr * /a9 * a11 +
        mr * /a10 * a11

a12 := mr * cnt * /a12 * a11 * a10 * a9 * a8 * a7 * a6 +
        mr * /cnt * a12 +
        mr * /a6 * a12 +
        mr * /a7 * a12 +
        mr * /a8 * a12 +
        mr * /a9 * a12 +
        mr * /a10 * a12 +
        mr * /a11 * a12

wrap := mr * cnt * a6 * a7 * a8 * a9 * a10 * a11 * a12+
        mr * wrap
```

Listing 6. TRIG1 Program

```
; U12 on the logic analyzer first trigger timing counting stage
CHIP trig1 16V8

clk tsel trg0 trg1 trg2 trg3 mr valid cnt gnd
oe tc valtrg q0 q1 q2 q3 q4 last vcc


EQUATIONS

last :=    mr * /trg0 * /trg1 * /trg2 * /trg3 * valid

valtrg := mr * valid * tsel * last * /trg0 * /trg1 * /trg2 * /trg3 +
          mr * valid * /tsel * /trg0 * /trg1 * /trg2 * /trg3 +
          mr * valtrg

q0 :=     mr * valtrg * /q0 +
          mr * /valtrg * q0 +
mr * /cnt * q0

q1 :=     mr * valtrg * q0 * /q1 +
          mr * /cnt * q1 +
          mr * /q0 * q1

q2 :=     mr * cnt * valtrg * q0 * q1 * /q2 +
          mr * /cnt * q2 +
          mr * q2 * /q0 +
          mr * q2 * /q1

q3 :=     mr * cnt * valtrg * q0 * q1 * q2 * /q3 +
          mr * /cnt * q3 +
          mr * q3 * /q0 +
          mr * q3 * /q1 +
          mr * q3 * /q2

q4 :=     mr * cnt * valtrg * q0 * q1 * q2 * q3 * /q4 + mr * /cnt
* q4 +
          mr * q4 * /q0 +
mr * q4 * /q1 +
          mr * q4 * /q2 +
          mr * q4 * /q3

tc :=     mr * cnt * valtrg * /q0 * q1 * q2 * q3 * q4
```

Listing 7. TRIG2 Program

```
; U10 on the logic analyzer second trigger counting stage
CHIP trig2 16V8

clk carryin mr nc nc nc nc nc nc gnd
oe q5 q6 q7 q8 q9 q10 q11 cnt vcc

EQUATIONS

q5 :=     mr * carryin * /q5 +
          mr * /carryin * q5

q6 :=     mr * carryin * /q6 * q5 +
          mr * /carryin * q6 +
          mr * /q5 * q6

q7 :=     mr * carryin * /q7 * q6 * q5 +
          mr * /carryin * q7 +
          mr * /q5 * q7 +
          mr * /q6 * q7

q8 :=     mr * carryin * /q8 * q7 * q6 * q5 +
          mr * /carryin * q8 +
          mr * /q5 * q8 +
          mr * /q6 * q8 +
          mr * /q7 * q8

q9 :=     mr * carryin * /q9 * q8 * q7 * q6 * q5 +
          mr * /carryin * q9 +
          mr * /q5 * q9 +
          mr * /q6 * q9 +
          mr * /q7 * q9 +
          mr * /q8 * q9

q10 :=    mr * carryin * /q10 * q9 * q8 * q7 * q6 * q5 +
          mr * /carryin * q10 +
          mr * /q5 * q10 +
          mr * /q6 * q10 +
          mr * /q7 * q10 +
          mr * /q8 * q10 +
          mr * /q9 * q10

q11 :=    mr * carryin * /q11 * q10 * q9 * q8 * q7 * q6 * q5 +
          mr * /carryin * q11 +
          mr * /q5 * q11 +
          mr * /q6 * q11 +
          mr * /q7 * q11 +
          mr * /q8 * q11 +
          mr * /q9 * q11 +
          mr * /q10 * q11


/cnt :=   mr * carryin * q5 * q6 * q7 * q8 * q9 * q10 * q11 +
          /cnt * mr
```

for the t0, t1, t2 and t3 outputs, these outputs are latched on the rising edge of the clock from inputs x0, x1, x2 and x3. This allows the inputs to act as a multiplexed bus, first to store the t data and then to hold the x data. This saved using extra signal traces on the board.

Each GAL contains two special two-bit comparators. Two identical GALs were used to form the eight-bit trigger circuit. Since the two comparators in each GAL are functionally identical, I'll just discuss just one of them.

The output equ0 should go low when a valid comparison occurs. When the x value for each bit is 0, a valid comparison occurs when t is equal to d.

When the x abd values are 1, the comparison is always valid (equ = 0), if x is 1 and t is 0, the comparison is never valid (equ = 1). For example if x0 = 1, t0 = 0, x1 = 0 and t1 = 0, equ0 will go low only when d1 is 0. If x0 = 0, t0 = 0, x1 = 0 and t1 = 1, equ0 goes low only when d1

PAL & GAL Devices

Most simple PAL (Programmable Array Logic) devices are equivalent to a GAL, with the functions of the eight OLMCs fixed. For example, a PAL16R8 is functionally equivalent to a GAL16V8 with the eight OLMCs configured as active-low registered outputs.

By virtue of it's configurable OLMC, the GAL16V8 can functionally replace the PAL16R8, PAL16R6, PAL16R4, PAL16RP8, PAL16RP6, PAL16RP4, PAL16L8, PAL16H8, PAL16P8, PAL10L8, PAL12L6, PAL14L4, PAL16L2, PAL10H8, PAL12H6, PAL14H4, PAL16H2, PAL10P8, PAL12P6, PAL14P4 and PAL16P2. In addition the GAL16V8 can handle many configurations that can't be handled by the PALs listed above (most of 16V8s in the Logic Analyzer use a mixture of combinatorial and registered OLMC so they couldn't be replaced by any of the PALs from above).

Since GALs are reprogrammable (PALs aren't), consume less power than PALs and cost about same as PALs, the GAL16V8 and equivalents have been replaced to PALs listed above in most applications. PALs hold an advantage over GALs in the highest-speed applications. The fastest PALs have propagation delays of less than 5 ns, while delays of the fastest GALs are 7.5 ns.

is 1 and d0 is 0. The remaining equation defines the output not to be the inverse of the input invert. This is some spare logic that's used in another section of the circuit. (It saved an additional chip.)

The equation files for remaining four GALs used in the Logic Analyzer are shown in the listings for STAGE1.EQN, STAGE2.EQN, TRIG1.EQN and TRIG2.EQN (Listings 4 through 7, respectively). These programs all contain counters, with some additions. The counters use some additional input signals that can start, stop or reset the count. The counters are wider than eight bits and are chained across two devices, using a terminal count output from the first device. STAGE1 and STAGE2 combine to form a 13-bit counter, while TRIG1 and TRIG2 form a 12-bit counter. All have some additional logic. Refer to the Logic Analyzer article for the details on how these chips all work together.

GAL Programming

If you have access to a GAL programmer and a PC, get a copy of *Opal* from National Semiconductor to begin designing with the 16V8. Unfortunately, programmers that will program GALs are rather expensive. The least-expensive universal programmer (it will also program EPROMs, PALs, microcomputers, etc.) I've seen costs about $400 from XELTEK. Since I've never used this programmer, don't take my mentioning it here as an endorsement of the product. I merely mention it to let you know that such a product exists at this "low" cost.

I'm working on a GAL-only programmer kit that should cost less than $200. If you're interested in more information on it, send a SASE. To get more detailed information on the GAL16V8 and other programmable logic devices, contact Lattice, SGS and National Semiconductor at the addresses given in the Resource List box. ■

Resource List

Advanced Micro Devices
901 Thompson Pl.
P.O. Box 3453
Sunnyvale, CA 94088
Tel.: 408-732-2400 or 800-538-8450

CIRCLE NO. 162 ON FREE INFORMATION CARD

Lattice Semiconductor Corp.
P.O. Box 2500
Portland, Oregon 97208
Tel.: 503-681-0118 or 800-FAST GAL

CIRCLE NO. 163 ON FREE INFORMATION CARD

National Semiconductor Corp.
2900 Semiconductor Dr..
P.O. Box 58090
Santa Clara, CA 95052-8090
Tel.: 408-721-5000

CIRCLE NO. 164 ON FREE INFORMATION CARD

RGB
30 Wicks Rd.
E. Northport, NY 11731
(send SASE for programmer information)

CIRCLE NO. 165 ON FREE INFORMATION CARD

SGS-Thomson Microelectronics
1000 East Bell Rd.
Phoenix, AZ 85022-2699
Tel.: 1-602-867-6340

CIRCLE NO. 166 ON FREE INFORMATION CARD

XELTEK
757 N. Pastoria Ave.
Sunnyvale, CA 94086
Tel.: 408-524-1929

CIRCLE NO. 167 ON FREE INFORMATION CARD

Speed Up BASIC-52 Programs

Use assembly-language subroutines to maximize speed

The on-chip BASIC-52 interpreter in the 8052-BASIC microcontroller is still one of the best low-cost interactive development systems for getting a project up and running quickly. But one thing you don't get from BASIC-52 programs is fast execution. A line of BASIC-52 code can easily take several milliseconds to execute. This is sometimes just too long.

When BASIC-52 is too sluggish for your needs, calling an assembly-language routine can help. This doesn't mean that you have to give up on BASIC-52 entirely. You can continue to use it for the parts of your programs that aren't time-critical. BASIC- 52 can also serve as a convenient development system for loading and testing assembly-language routines in RAM and even for programming routines into EPROM.

Interfacing simple routines to BASIC is a good way to become familiar with assembly-language programming. Through experimenting with it, you can also learn a lot about the internal workings of the 8052 chip and how the BASIC-52 interpreter works.

In this article, we'll explore how and when to interface assembly-language routines to BASIC-52 programs. As a project, you'll connect a digital-to-analog converter (DAC) to the 8052-BASIC chip and write an assembly-language routine that causes a sine wave to appear at the output.

Listing 1. Very Simple Program Tests Assembly-Language Interfacing With BASIC-52

```
;BITTOG.ASM

        org     3000h   V;location where program will load in RAM
        cpl     p1.0    ;complement Port 1, bit 0 (pin 1)
        ret             ;return to BASIC-52

        end
```

The Basics

The bare 8052 chip understands just one language: the machine codes that make up the chip's instruction set. For example, the code 11100100 causes the 8052 to clear its accumulator (one of its internal registers). The 8052's data book describes the function of each code.

You can, of course, write programs without having to look up binary codes, by using a programming language. The language closest to the machine codes is assembly language, wherein mnemonics, or abbreviations, represent each of the codes. For example, the mnemonic for the above example is CLR A, which isn't too difficult to remember because it contains clues about what the instruction does.

After writing an assembly-language program and before you can run it, you must use a program called an assembler to translate your source file into an object file that contains the binary codes the chip will execute. You also must have a way of storing the codes in memory, where the 8052 can access them.

The BASIC-52 interpreter is itself an assembled program that the 8052 runs on boot-up. The interpreter reads your BASIC programs from memory and converts them into machine codes for the 8052 to execute. It does the same for the commands and statements you type at your keyboard. The interpreter program includes many modular routines that are used by BASIC, such as reading a character from the serial port, comparing two numbers and reading or writing a value in memory.

An advantage to BASIC-52 is that it permits interactive programming. Instead of the four-step process of writing, assembling, storing and finally running a program, you can type a line of code and execute it immediately. The interpreter does the work of converting what you type into the machine codes that do what you've requested. The 8052 chip doesn't directly execute the commands and statements you type. Instead, it executes the translations that the interpreter creates.

BASIC is also a much higher level language than assembly code. This means that a single BASIC statement can accomplish what would require many lines of assembly code, which simplifies the task of writing programs. The tradeoff is efficiency. The interpreter must translate each line of code as it executes it, which takes time, sometimes more than you can afford. This is when you should seek out something faster.

Assembly language isn't the only way to obtain faster execution times. Other possibilities include using a BASIC or C compiler or a faster crystal to clock the 8052. But, as a rule, these approaches won't speed up programs as dramatically as assembly language will, which can be hundreds of times faster than BASIC-52.

What You Need

To add assembly-language routines to your BASIC-52 programs, you need the following items:

- *Text Editor.* You need this for creating source files. The editor must be able to create files in straight ASCII format, without adding any formatting codes. Just about all word processors have this ability.
- *Assembler.* You need this to create an object file from your source file. Most assemblers generate the files in Intel hex format, which is convenient for EPROM programming and uploading to RAM. The assembler will also catch some programming mistakes and generate error messages for them. The

optional listing file created by the assembler is a text file that shows your source file, along with the addresses and machine codes used by the assembler.

Assemblers for 8051-family chips are widely available. Many vendors of 8051-family microcontroller boards also offer assemblers. The Sources box at the end of this article lists free and low-cost assemblers for experimenting.

· *Programming Reference*. If you're an experienced assembly-language programmer, Intel's *Embedded Microcontrollers* handbook or an equivalent user's guide from another 8052 vendor may be all you need to use as a reference. The handbook includes a programmer's guide and describes each of the 8052's instructions.

If you're just starting out with assembly-language programming, you'll probably want a more complete text that includes examples and explanations of how to put together a program. Examples can be extremely useful for seeing how to perform common tasks like generating a timing delay or handling an interrupt. My articles in the February and May issues listed several 8051/2 textbooks. Another useful resource is Pure Unobtainium's firmware flyers, which deal with a variety of 8051 programming topics.

On your BASIC-52 system, you'll need room in external memory for storing assembly-language routines. You can place routines anywhere in memory from location 2000h to location FFFFh in memory. Code memory from 0 to 1FFFh isn't available because the 8052-BASIC chip uses these locations for the BASIC-52 interpreter.

Remember that the 8052 has separate control signals for accessing code and data memory. For uploading into RAM and testing, you must use combined code/data memory, since you need data memory's WR signal to write the routine into memory and code memory's PSEN to enable the 8052 to execute the routine. Many 8052-BASIC boards include memory that can be configured in this manner.

Battery-backed RAM is convenient for experimenting, since you can easily write to it and also retain the contents when you power down. On boot-up, BASIC-52 normally clears all contiguous RAM beginning at 0h. To prevent overwriting assembly-language routines in RAM when you re-boot, set MTOP to a value that's lower than the beginning of your assembly-language routines and execute BASIC-52's PROG3 command to save the value.

```
*MCS-51(tm) BASIC V1.1*
READY
>run

          INTEL HEX FILE TO RAM LOADING PROGRAM V1.0
       Copyright 1991 Systronix Inc. All rights reserved.
    This program accepts as input an Intel hex file and stores
    it in external RAM at the addresses specified in the HEX file.

    Ready to receive the input file one line at a time. Set your
    communication software to send a line when when it receives
    the '>' prompt.

>:03300000B2902269
Validating and storing input data ...
>:00000001FF
Received an End record in line 2  ...

READY
>
```

Fig. 1. Screen display showing assembly-language routine uploading to RAM with HEX2RAM.BAS.

For permanent storage in EPROM, you can use code or combined code/data memory. Many BASIC-52 systems have an EPROM addressed at 8000h for storing BASIC-52 programs. If you don't need the entire EPROM for this purpose, you can use the free space for assembly-language routines.

BASIC-52's PROG command stores programs in sequence beginning at 8010h. So to leave the most room for BASIC programs, you should place your assembly-language routines at the EPROM's highest addresses.

You'll also need a way to load your routines from your personal computer into your BASIC-52 system's memory. All that's required here is your personal computer's communications software and a BASIC-52 program.

Systronix's BBS (tel.: 1-801-487-2778) has two very useful and free programs: HEX2RAM.BAS and HEXLOAD.BAS. HEX2RAM loads Intel hex files from your personal computer into RAM in your BASIC-52 system, and HEXLOAD does the same, but with a choice of loading into RAM, EPROM or EEPROM. Both programs are included in HEXLOAD.EXE, a self-extracting archived file you can download from file area 4 on the BBS.

On your personal computer, you can use any communications software that enables you to upload ASCII files to a remote computer. You must allow BASIC-52 enough time to process each line of text as it receives it before you begin sending the next line. If possible, configure your software to wait for a ">" prompt before sending each line. Or, you can configure your software to add a delay after sending each line or, as a last resort, use a slower baud rate.

Loading a Routine

When you have the necessary tools, you're ready to write an assembly-language routine and assemble, upload and call it. As a first attempt, we'll begin with a very simple routine to verify that the basic procedures are working.

The program in Listing 1, BITTOG.ASM, has just one function: it toggles pin 1 (Port 1, Bit 0) of the 8052. The ORG directive tells the assembler the address at which to begin loading the routine (3000h). You can change this to match whatever locations you have available in your system.

The program body's single instruction complements Bit 0 of Port 1, changing it from high to low or low to high. A RET instruction then returns control to BASIC-52.

To create and test the routine, do the following:

Use a text editor to create a file containing Listing 1.

Use your assembler to assemble the

file. A typical command line looks like the following:

```
A51 BITTOG.ASM -L BITTOG.LST -O BITTOG.HEX
```

The assembler creates two files: the listing file BITTOG.LST and the object file BITTOG.HEX. The following message (or one similar to it)

```
Assembly successful
```

means the assembler found no errors that prevented it from creating the object file. If you do see error messages, you'll have to find out what's wrong before continuing. The listing file also includes the error messages, which you can use to help you track down any problems.

Different assemblers may have slightly different syntax rules. For example, some require ORG and END to have a leading period (.ORG and .END). Check your assembler's documentation for specifics.

Successful assembly is a good sign, but it doesn't mean that a program is error-free. As in any programming language, a line of code may contain instructions that are legal but that don't do what you intended. It's a good idea to at least scan the listing created by the assembler before you try to run a routine to see if any obvious errors jump out at you.

When you're ready to load your program into RAM, boot up your BASIC-52 system, connect the serial link to your personal computer and run your communications software. Use communications software to upload HEX2RAM. BAS, in the same way you upload any BASIC-52 program from disk.

If your BASIC-52 system includes the ability to use the PROG command, you can program HEX2RAM into EPROM so that it's available when you need it.

To use HEX2RAM, run it and, at the prompt, again use your communications software to upload your object file, as Fig. 1 shows. The file will load into the locations specified by your source file. HEX2RAM will generate error messages if it has problems with the uploading.

If the file loads successfully, you're ready to test it. Connect a logic probe to pin 1 on the 8052, or set a multimeter to measure the voltage from pin 1 to pin 20 (ground) on the chip. To call your subroutine, write and run the following BASIC-52 program:

```
10 CALL 3000h
20 END
```

If necessary, change the address in line 10 to match the value in your routine's ORG directive.

Each time you run the program, you should see pin 1 on the 8052 toggle, from high to low or low to high. After toggling the bit, the routine should return you to the BASIC-52 prompt.

If the program crashes and doesn't return you to BASIC- 52, you need to reexamine your listing file to see what went wrong. Remember that the address in BASIC-52's CALL statement must match the address in your file's ORG directive. A missing RET instruction in the routine will also cause the system to crash.

Creating a Sine Wave

When you have the simple routine working, you're ready to move on to greater things. For your sine-wave project, you'll begin by generating a sine wave entirely with BASIC-52 statements. This way, you can first test the added circuits as well as the algorithm, or sequence of steps, that you plan to use to generate the sine wave. It also illustrates the speed limits of BASIC-52.

Shown in Fig. 2 is the schematic of the circuit that interfaces to the 8052. I adapted this circuit from an example in

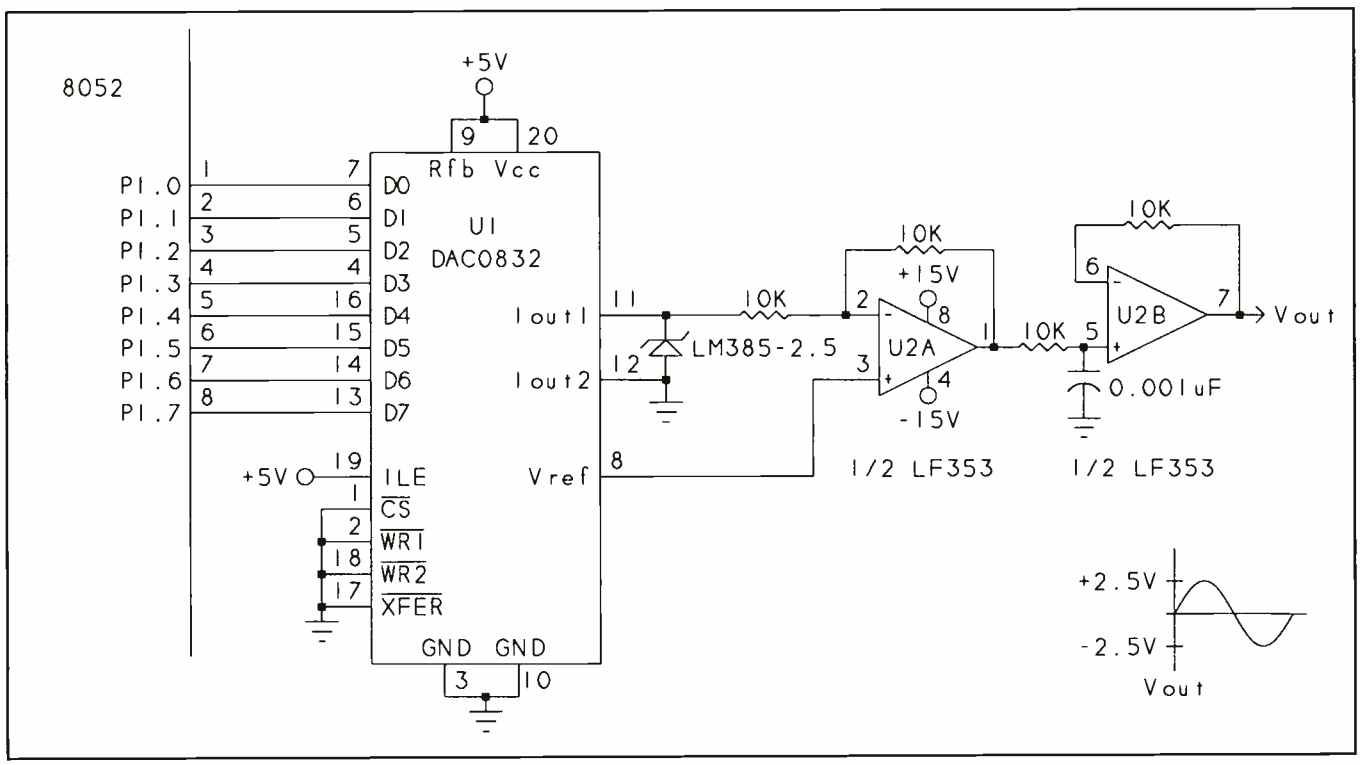


Fig. 2. By writing appropriate values to Port 1, the 8052 causes a sine wave to appear at V_{out}.

National Semiconductor's data sheet for the DAC0832. Not shown in Fig. 1 are the 8052-BASIC chip (except Port 1), system RAM and other components that don't relate directly to the sine-wave circuit.

The circuit uses all eight bits of Port 1 on the 8052. If you're using Port 1 for EPROM programming or other applications, you can connect the Fig. 1 circuit to a port on an 8255 programmable peripheral interface and write to it instead off Port 1.

Chip *U1* is a DAC0832 digital-to-analog converter (DAC) that converts data inputs D0 through D7 into an analog voltage. D0 through D7 are controlled by Port 1 (P1.0 through P1.7) on the 8052.

The DAC is configured in its flow-through and voltage-switching modes. In flow-through mode, the analog output continuously reflects the data inputs. The chip has several control signals for latching inputs and outputs, but these aren't needed by our circuit.

In voltage-switching mode, the analog output is a voltage that's proportional to the value of the byte formed by D0 through D7. An LM385 2.5-volt reference is applied across current output terminals I_{out1} and I_{out2}, and the output appears at V_{ref}. (This configuration is inverted from the device's current-switching mode, where V_{ref} is an input and I_{out1} and I_{out2} are outputs.)

Op amp *U2A* buffers the output, and *U2B* is a low-pass filter that helps to smooth V_{out}.

Listing 2 causes a sine wave to appear at V_{out} in Fig. 1. The sine wave represents the value of the trigonometric sine function for an angle that varies continuously from 0° to 360°, or 0 to 6.28 (2) radians.

Lines 50 through 70 are a loop that selects 256 equally-spaced points along one cycle of the sine wave, calculates the sine for each and stores the values in RAM. BASIC-52's SIN operator is used in calculating the values.

Sine values normally vary from +1 to −1, but line 60 adjusts the values so that they vary from 0 to 255, which is the range of inputs accepted by the eight-bit DAC. Using these values, 0 is the negative peak, 255 is the positive peak and zero crossing occurs midway between points 127 and 128.

To generate the sine wave, Lines 110 through 150 are a loop that reads each value in sequence from RAM and writes it to Port 1. After writing a complete cycle, the program loops back and begins another. The sine wave repeats endlessly, until you type Control+C.

SINE.BAS creates a perfectly good sine wave, though at a very low frequency. Using a 12-MHz crystal to clock the 8052, the frequency is only about 1 Hz, or 1 second per cycle.

To speed things up, Listing 3 is an assembly-language routine that performs the functions of lines 110 through 150 in Listing 2.

As in the original SINE.BAS, SIN.ASM copies values in sequence from RAM to Port 1, repeating the sequence after 256 writes. The routine illustrates a couple of major differences between BASIC and assembly-language programming.

One is that assembly language has no built-in FOR, DO or WHILE loops. Instead, you have to create loop structures from the instructions available. Listing 3 creates a 256-step FOR loop by loading FFh into register dpl (the lower byte of dptr), and decrementing

Listing 2. BASIC-52 Program Causes Sine Wave to Appear at V_{out} in Fig. 1

```
1       REM SINE.BAS
10      REM Calculate and store sine values for 256 equally-spaced locations
20      REM along a sine wave. The value .0246 converts a position in the
30      REM sine wave (0-255) to the radians required by the SIN operator.
40      REM The stored sine values range from 0 to 255.
50      FOR I=0 TO 255
60      XBY(3000H+I)=INT((SIN(I*.0246)+1)*127.5)+.5
70       NEXT I
80      PRINT "Values stored in RAM (3000h-30FFh)"
90      PRINT "Press Control/C to quit"
100     REM Write the values in sequence to Port 1
110     DO
120     FOR I=3000H TO 30FFH
130     PORT1=XBY(I)
140     NEXT I
150     WHILE 1=1
160     END
```

Listing 3. Assembly-Language Subroutine Creates Sine Wave With Revised SINE.BAS

```
;SINE.ASM
;Assembly-language subroutine for revised SINE.BAS
;This routine copies values in sequence from 3000h to 30FFh in external
;RAM to Port 1.
;A keypress terminates the routine and returns to BASIC-52.

            org     3100h           ;load routine above the stored values in RAM

;Begin generating the sine wave:

nextcycle   mov     dptr,#30FFh     ;put top RAM location in data pointer
nextvalue   movx    a,@dptr         ;copy sine value from data ptr to accumulator
            mov     p1,a            ;then copy from accumulator to Port 1
            djnz    dpl,nextvalue   ;decrement data pointer
                                    ;and do another if data pointer > 0
            jb      ri,return       ;at end of cycle, check serial
                                    ;receive flag and quit if set
            sjmp    nextcycle       ;if no interrupt has occurred,
                                    ;begin another cycle

;Return to BASIC-52:

return      clr     ri              ;clear serial receive flag
            ret                     ;return to BASIC
            end
```

Listing 4. Faster Response Than is Possible With BASIC-52 is Obtained by Writing Interrupt Routines in Assembly Language

```
;BITTOG2.ASM
;Illustrates assembly-language interrupt routine used with BASIC- 52.
;On external interrupt 1, Port 1, bit 0 is complemented

        org     4013h   ;vector for external interrupt 1
        cpl     p1.0    ;complement Port 1, bit 0 (pin 1)
        pop     psw     ;push psw was automatic, pop psw is not
        reti            ;return from interrupt

        end
```

dpl repeatedly until it equals zero.

In assembly language, you also don't have conveniences like BASIC-52's ability to terminate a program on Control+C. You have to add these features yourself. In Listing 3, after each complete cycle of the sine wave, the program checks the serial port's receive flag. If the flag is set, it means that the user has pressed a key, and the program returns to the BASIC-52 prompt. Otherwise, the program begins another cycle of the sine wave.

To run SINE.ASM, create the source file SINE.ASM, assemble it, and upload it to RAM as before. In SINE.BAS, edit the program by removing lines 110 through 150 and adding this line:

```
110     CALL 3100h
```

Now when you run SINE.BAS, you should again see a sine wave at V_{out}, but at a much higher frequency.

With a 12-MHz crystal, the sine wave should be around 780 Hz, or 1.28 ms per cycle. You can verify this by consulting the 8052's data book, which tells the number of machine cycles required to execute each instruction. At 12 MHz, each machine cycle is 1 μs, and one complete cycle requires 5 μs × 256 points on the wave, plus 2 μs to test the serial flag, or 1,282 μs total.

With different crystal frequencies, the output frequency will vary in direct proportion. For example, with a 6-MHz crystal, the sine wave will be half as fast.

To slow down the sine wave, you can add "do-nothing" instructions to the code. For example, adding a NOP (no-operation) instruction in the main loop will add 1 μs to the time between points on the wave, for a frequency of 649 Hz. For long delays, you can insert a timing loop that executes when each point is placed.

Listing 3 still relies on BASIC to calculate the sine values and store them in RAM. Although you can also write these parts in assembly language, doing so in BASIC is much easier and doesn't affect the frequency of the sine wave. Even if you later decide to write this part in assembly language, with BASIC you can test each section of the code as you go along.

When you have your assembly-language routine in the form you want, you can use HEXLOAD.BAS or an EPROM programmer to store the code in the EPROM. If your EPROM has different addresses than the RAM you used to test the code, you must change your ORG directive in the source file to match the new location and reassemble the file before you program it into the EPROM.

Crash-Proof Programs

It's very easy to write an assembly-language program that crashes the system and forces you to re-boot. To prevent this, you have to take care that your routines don't interfere with each other or with BASIC-52. Remember that BASIC-52 is a program in itself, and it uses many of the registers and other memory locations, both inside and outside the 8052, for its own purposes.

For example, BASIC-52 uses locations 13h and 14h in internal RAM to store the starting address of the current BASIC program in external RAM. If you overwrite these values, BASIC-52 will no longer be able to find your program. The BASIC-52 manuals list the memory locations used by BASIC. In general, you should avoid writing to these locations unless you know for certain what you're doing and how to handle the results.

Often, an assembly-language routine will alter some of the 8052's registers, either by writing to them directly or by causing a flag to be set. You're responsible for seeing that all critical values are unchanged when the routine returns control to the program that called it, whether it's BASIC-52 or another assembly-language program.

The stack is a convenient way to preserve values on entering a routine and to restore them on exiting. The stack is a special area of memory with a last-in, first-out structure, which means that you read values from the stack in the reverse order that you wrote them. Storing values in the stack area is called pushing, or placing, values on the stack. Retrieving values from the stack area is called popping off the stack.

Assembly language has PUSH and POP instructions for accessing the stack. (BASIC-52's PUSH and POP access a separate area called the argument stack.)

You can also preserve values by selecting a unique register bank for use by a routine. The 8052's 32 registers are arranged in four banks of eight, from 0 to 1Fh in internal data memory. You can access the registers by specifying the address or by selecting a register bank and specifying a register from R0 through R7 within the bank. For example, if Bank 0 is selected, R0 is location 07h, but if bank 1 is selected, R0 is location 08h.

BASIC-52 uses Banks 0, 1, and 2, but uses Bank 3 only with the PGM statement. So Bank 3 is usually free for other uses. Bits 3 and 4 of the 8052's program status word (psw) select the register bank. When you call an assembly-language routine, BASIC-52 automatically selects register Bank 0. To select Bank 3, add the following to the beginning of your routine:

```
push  psw           ;save the program status word
orl psw,#18h        ;select register bank 3
```

and this to the end, before returning to BASIC:

```
pop   psw ;restore the program status word
```

Your routine can then write to registers R0 through R7 without worrying about conflicting with BASIC.

Interrupts

BASIC-52 also includes a way of adding assembly-language routines that respond to interrupts. Normally, the 8052 stores its interrupt vectors (locations to which the program jumps on

Sources

Iota Systems, Inc.
PO Box 8987
Incline Village, NV 89450
Tel.: 702-831-6302; fax: 702-831-4629
CIRCLE NO. 172 ON FREE INFORMATION CARD

Suncoast Technologies
PO Box 5835-CAJ
Spring Hill, FL 34606
Tel.: 904-596-7599
CIRCLE NO. 173 ON FREE INFORMATION CARD

Philips/Signetics BBS
Tel.: 1-800-451-6644
CIRCLE NO. 174 ON FREE INFORMATION CARD

Pure Unobtainium
(for 8051 programming flyers)
PO Box 285
Tolland, CT 06084
Tel.: voice/fax: 203-870-9304
CIRCLE NO. 175 ON FREE INFORMATION CARD

Systronix BBS
(for HEXLOAD.EXE)
Tel.: 801-487-2778
CIRCLE NO. 176 ON FREE INFORMATION CARD

interrupts) from 03h through 2Bh in code memory. Since these locations are in ROM in the 8052-BASIC, they're not available to your programs. But built into BASIC-52 is the ability to place alternate interrupt routines from 4003h through 402Bh.

To illustrate, Listing 4 is an assembly-language interrupt routine, the origin of which is 4013h, which is BASIC-52's alternate vector for external interrupt 1. The interrupt routine toggles Bit 0 of Port 1 and returns to BASIC.

These are a few things worthy of note about Listing 4:

You must have code memory at 4013h, since BASIC-52 specifies that this location must contain either the interrupt routine or a jump to a longer routine. If the routine is longer than eight bytes, use a jump—to 4100h, for example—to prevent overwriting any interrupt vectors that follow.

BASIC-52's ON EX1 will also respond to external interrupt 1, but it will be much slower. ON EX1 has priority, and Listing 4 won't execute if an ON EX1 statement has executed in BASIC.

When BASIC-52 jumps to an assembly-language interrupt routine, it automatically pushes psw on the stack. But since popping psw on returning from the interrupt routine isn't automatic, the interrupt routine is responsible for this.

Unlike other subroutines, which end with ret, interrupt routines must end with reti.

To test Listing 4, upload it to RAM at 4013h, and execute these two lines of BASIC-52 code, to ensure that the interrupt is enabled:

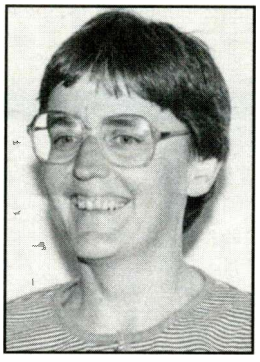
```
IE=IE.OR.84h        TCON=TCON.OR.04h
```

Now, each time pin 13 goes low, pin 1 should toggle, as it did with Listing 1.

Moving On

This has been a brief introduction to assembly-language programming with BASIC-52. In the back of the BASIC-52 manuals, you'll find many more details on these and related topics, including how to add custom BASIC commands and instructions and how to call BASIC-52 routines from assembly language. ■

You can contact me on CompuServe at 71163,3555 or by mail at PO Box 3374, Madison, WI 53704-0374. Questions and comments of interest to all may be published in this space. For a personal reply by mail, please include a self-addressed, stamped envelope.



Jan Axelson

B² Spice and *B² Logic*: Affordable Emulation Software for Analog and Digital Circuits

Though commonplace, prototypes of electronic designs don't always tell you everything you need to know about a circuit. This is where emulation software running on a personal computer can be a big help. Usually a high-ticket item, emulation software has become more affordable through the efforts of a company called Beige Bag Software, which produces *B² Spice* and *B² Logic* priced at $149 each.

B² Spice and *B² Logic* run on both the IBM PC AT/compatible and Macintosh computers. For the P/AT platform, you need a system that operates under Microsoft *Windows* 3.x and hardware that supports that environment. Each of the products is packaged in a small manila envelope and includes a user's manual and two 3½" disks, one for the PC/AT and the other for the Macintosh. For testing purposes, I used the PC/AT versions of the products.

Since each of the programs works in a graphical environment (either *Windows* or Macintosh), there are the customary pull-down menus, icons, peripheral support (printers, displays, etc.) and file and editing operations that are associated with these environments.

Emulation Software Overview

Circuit-emulation software supplies the tools you need to draw an electronic schematic diagram on your computer's video screen. After you draw a circuit, the software analyzes it for you. You create the circuit with graphical representations of resistors, capacitors, inductors, logic gates, power supplies, wires, etc. You move all these components around the screen with a mouse or other pointing device. When you finish constructing your circuit, just as in real life, you can test it to see if it works as expected.

The beauty of an emulation program is that you never have to worry about your parts supply because there's an unlimited number of components at any value you decide to use. The drawback is that if a component you want to experiment with isn't included in the package, you're out of luck (unless you can construct it from components the software does provide). For example, the programs reviewed here don't include such sophisticated items as microcontrollers.

An emulation program normally provides ways to analyze both ac and dc responses of a circuit, or in the case of logic circuits, the response to a pulse or a pulse train. Analysis of circuit performance occurs either with on your video screen test instruments or through tables and graphs.

About *B² Spice*

B² Spice is an integrated analog circuit design, simulation and analysis package. It's based on the numerical algorithms and formulas contained in *Spice*, the standard for circuit simulation developed at the University of California at Berkeley. The program features a set of devices you can customize to meet your needs and supports several kinds of analyses, including dc operating point, dc sweep, ac sweep and transient analysis.

Mimicking a workbench, *B² Spice* provides meters, power sources and electronic components. Notably absent are graphical representations of test instruments like oscilloscopes, frequency counters and the like, which competitors like Electronics Workbench offers. But although icons are missing, the functions aren't. For example, circuit waveforms are presented in windows, rather than on the face of a simulated oscilloscope.

You place *B² Spice*'s ammeters and voltmeters at appropriate places in the circuit, and—unlike in real-life—you have as many as you want at your disposal. Positioning of meters in a circuit determines the outputs of graphs and tables.

The program has three kinds of power sources: current, voltage and controlled. Current and voltage sources can be constant, pulse or sinusoidal. The controlled source can be a linear current-controlled current source (CCCS), linear current-controlled voltage source (CCVS), linear voltage-controlled current source (VCCS) or linear voltage-controlled voltage source (VCVS). The type of source you use in a circuit determines the kind of graph you'll get when you analyze the circuit.

Thirteen analog devices are available, as detailed in Table 1. For some of these devices, such as the capacitor, you enter a value. Others, such as the bipolar junction transistor (BJT), have a multitude of parameters, which you can leave at their default values or vary.

As mentioned above, *B² Spice* offers several kinds of simulations. For transient simulation, you can control the start, step and stop times of the transient. You use this simulation to generate the time response of various signals in the circuit. For example, the transient simulation can tell you the time it takes for the output of an inverter to fall below a certain level in response to a rise in input voltage (this time is called propagation delay).

For dc-sweep simulation, you can control start, step and stop values. This simulation is often used to generate the input/output characteristics of circuits.

For ac-sweep simulation, you can control start and end frequencies, as well as the number of points per decade. You use ac-sweep simulation to view circuit behavior at dif-

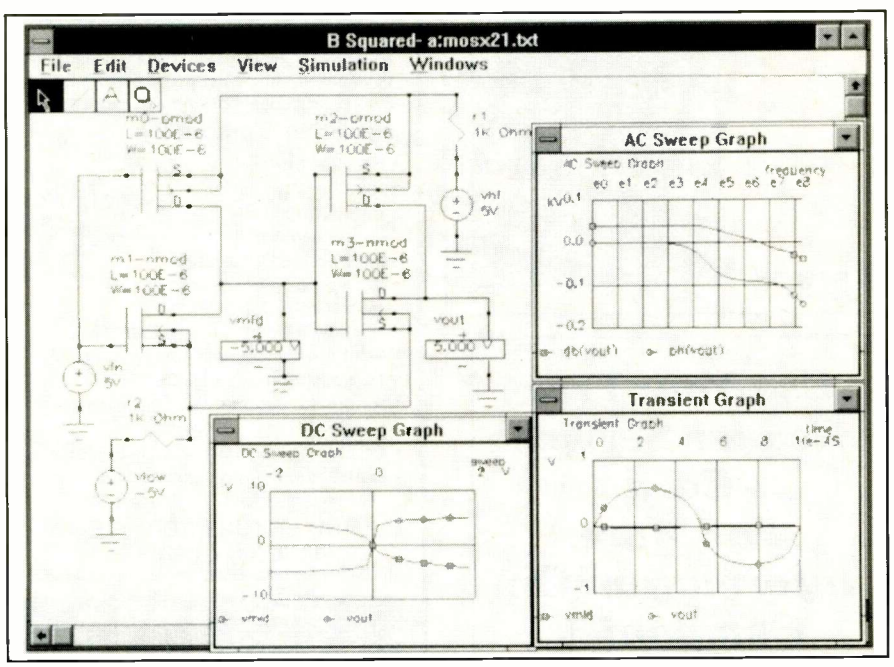


Fig. 1. A *B² Spice* screen showing the tools icons, a circuit diagram, and graphs of three different simulations.

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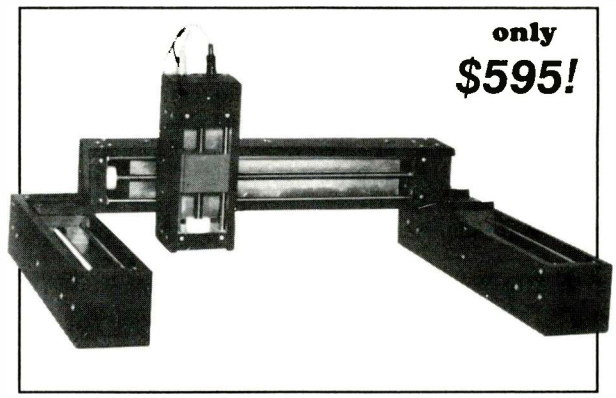

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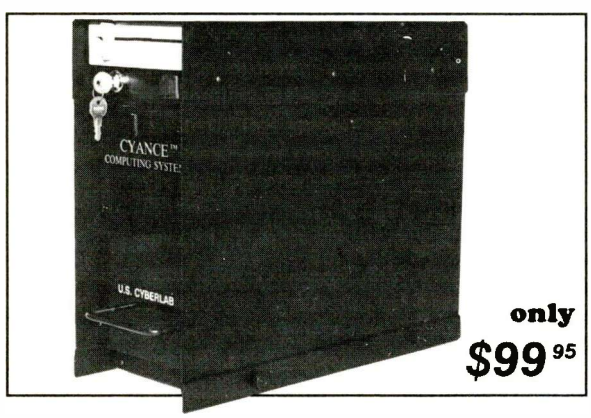

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ferent input frequencies. For example, you could analyze a low-pass filter to determine its cutoff frequency. Anytime you run one of these simulations, you're presented with either a graph or table of values produced by the circuit.

The program can perform one other kinds of simulation: operating point analysis. In this case, however, no graph or table is produced. Instead, readings on the meters placed in the circuit change to reflect the current condition of the circuit. For any of these simulations, you can vary the temperature at which the circuit is analyzed.

About *B² Logic*

B² Logic is a network editor, network compiler and digital circuit simulator, all integrated into a single program. This program includes components from three logic families: standard TTL, low-power Schottky (LS) and fast CMOS (FCT). It also provides components from a generic library.

The standard TTL library is based on the oldest technology of the three. Components from this library are slower and dissipate more power than those from the other libraries. The LS family is about the same speed as the standard library, but it consumes much less power. FCT-library components are much faster than the others and consume still less power. The generic library provides some miscellaneous building-block components (for example, an RS latch), as well as a programmable logic array (PLA), a couple of read-only memory (ROM) components and a couple of random-access memory (RAM) components.

B² Logic provides flexible control over propagation delay. The program stores minimum, typical and maximum rise and fall delays for each output pin of each component. The data is taken from the data books published by chip vendors, like Texas Instruments and the like.

B² Logic supports three signal levels and four signal strengths, giving a total of 12 different values. Levels are high, low and indeterminate; strengths are strong, resistive high impedance and unknown.

You can add custom components to *B² Logic* in any of three ways. One is a user-defined circuit, which are circuits you've built and saved and that then become devices in other circuits. A second way is to use a PLA, which is a programmable circuit that can have a maximum of 25 inputs, 25 outputs and 50 rows arranged in a PLA table. The final way to add a custom circuit is by creating a ROM that consists of a table of addresses and corresponding contents specified with hexadecimal values.

Working With *B² Spice* and *B² Logic*

Although *B² Spice* and *B² Logic* are separate programs, they have some features in common. For each program, installation is more difficult than it should be. You need to run an install routine first and then launch the *Windows* icon manually. If you're still using *Windows* 3.0, you must add the file COMMDLG.DLL, included on the program disk, to the \WINDOWS\SYSTEM directory of your hard drive.

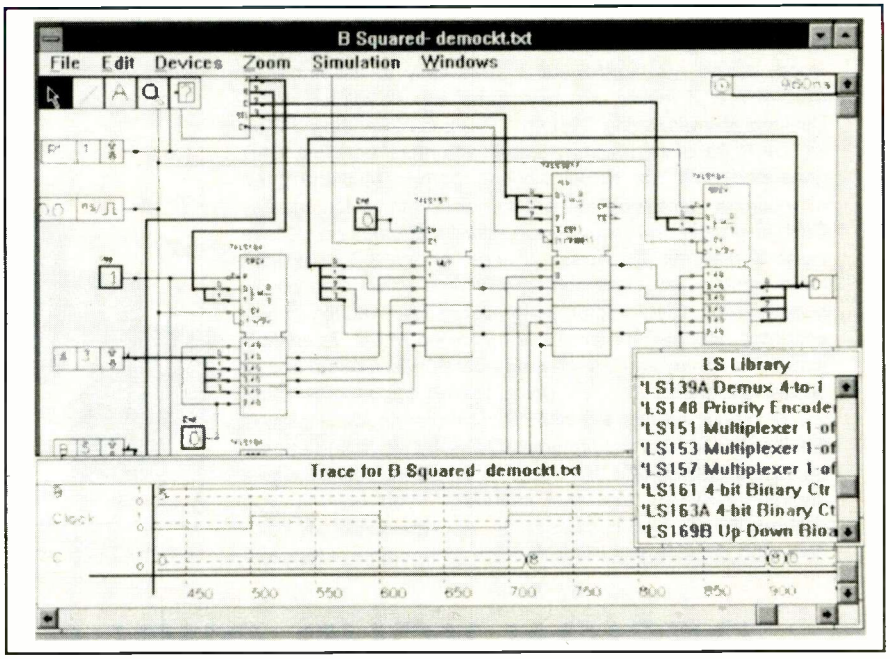

Fig. 2. A *B² Logic* screen showing the tools icons, a circuit diagram that includes wires and buses, the LS Library window, and the Trace window.

Each program uses four standard icon tools (see Fig. 1), selection arrow, crosshair (used to draw line segments that make up the wires of the circuit), typing tool (for comments) and magnifying glass (for zooming). When you start either program, you're presented with a blank grid upon which you can place circuit elements.

In working with these programs, I found it very easy to construct circuits. Components lay out easily and can be rotated to suit the design of the circuit. Connecting together components is a breeze, since the crosshair tool connects wires to components, even if you don't hit a point exactly.

Keep in mind that these separate programs cater only to their specialties. That is, analog is for linear circuits and digital is for logic circuits. You can't produce a hybrid circuit, even if you own both products.

For *B² Spice*, I followed the five tutorial lessons presented in the manual. In some cases, I couldn't obtain the desired output on the first try and needed to adjust circuit values or parameters. To build a circuit, you simply pick the appropriate components and power sources from a list contained in the Devices pull-down menu. After you lay out the components on the grid, you connect them together with the crosshairs tool.

After you construct a circuit, you can add an ammeter or voltmeter to the part of the circuit you want to analyze—for example, the output. Before you start a simulation, you must put in values for all components in the circuit. If you have identical components—for example 1,000-ohm resistors—you can place one resistor in the circuit, adjust its value to 1,000 ohms and then make copies of the component.

To run a simulation, you first select the Simulations menu. Here you have the opportunity to set up transient analysis or dc or ac sweep. You set up one or all of these by adding appropriate values to the dialog box that appears when you select the menu item.

Table 1. Devices Menu Provided by *B² Spice*

Ammeter
Voltmeter
Controlled Sources
Current Sources
Voltage Sources
BJT
Capacitor
Diode
Ground
Inductor
JFET
MOSFET
Mutual Inductor
OP AMP (Ideal)
OP AMP ('741)
Resistor
Semiconductor Capacitor
Semiconductor Resistor

After you've added all values to the circuit, you can run the simulation.

Running a simulation presents you with either a graph or table of values, depending on what you check off in the dialog box for the simulation. One or more curves can be plotted on a graph, depending on what you specify. You can graph voltage, current or power. A typical graph is shown in Fig. 1.

To customize or change the value of a component, you either double-click on the component or select the component and then select Set Properties from the Edit menu.

During or after construction of a circuit, you can save it to disk. I found this to be a mandatory procedure because the program crashed a couple of times while I was using it. To its credit, the documentation warns about this program flaw.

One of the items on the File menu is Save Spice Deck. If you choose this item, the program saves the circuit in the form of a standard *Spice* deck, which you can then use as input to other *Spice*-simulation programs.

Another item on the File menu, Save As Text, saves a circuit in ASCII format. You can then transfer the file between PC and Macintosh platforms, using such software as Apple File Exchange. This is also true for circuits developed with *B² Logic*.

For *B² Logic*, I also followed the tutorials presented in the manual. The work area for this program is slightly different from its analog cousin. As shown in Fig. 2, *B² Logic* has a library dialog box on screen, as well as a "trace" area at the bottom of the screen and a stopwatch near the top-right corner.

When you select components, you make choices about the library, number of inputs and outputs and type of bus connector. Looking at Fig. 2, you can see that some "wires" are thicker than others. These thicker wires are actually buses that can represent up to eight separate lines. This makes for a less-congested circuit diagram.

You'll notice also from Fig. 2 that *B² Logic* has one more tool than *B² Spice* does. It which looks like a question mark inside a box that lets you select the Logic Probe tool. You use it to view the signal value and strength of any wire in the circuit. To use it, you select the tool, and then depress the mouse button while the Logic Probe cursor is on a wire.

When you've completed constructing a digital circuit, you run a simulation by selecting either Step or Go from the Simulation menu. Results are displayed in the Trace window, as shown at the bottom of Fig. 2. Labels on the left side of the graph correspond to points of the circuit.

Conclusions

B² Spice and *B² Logic* are delightful programs to work with and very informative as well. The ability to view input and output voltage, current and power waveforms really enhances understanding circuit performance. Creating analog and digital circuits is fast and easy. But, just like real-world circuits, you may have to do some tinkering before you get a circuit to work correctly.

Watching the program crash every so often is a nuisance, but one you can live with if you save your work (hopefully, newer versions of these programs will eliminate this bug). At $149 each, these circuit-emulation programs aren't cheap, but they aren't all that expensive, either. For what they can do, these programs are certainly worth the price. If you're expecting to build hybrid (analog and digital) circuits, though, these aren't the programs for you. ■

Products Reviewed

B² Spice V.1.1; *B² Logic* V.2.2; $149 each
Beige Bag Software
715 Barclay Ct.
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Tel.: 313-663-4309; fax: 313-663-0725
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CIRCLE NO. 171 ON FREE INFORMATION CARD

Ted Needleman

Slogging Through the Pile

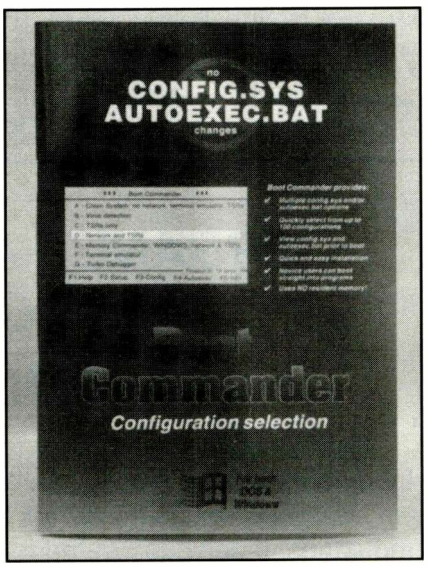
The great thing about writing a column like this one is that vendors send me loads of products to look at. The down side is that all of these vendors have a very real expectation that I'll actually look at what they send to me. While I don't review every product I receive, I make a concerted effort to at least look at what's been sent. I then decide which products I've found to be useful or just liked a lot. Sometimes, I'll review a product I'm less than impressed with because I think you'll find it interesting even if I didn't. And sometimes readers ask about certain types of products or tell me about something they're impressed with, making me feel compelled to take a look at them.

What this results in is a huge pile—actually, a bunch of piles—of hardware and software arrayed throughout my home office. Some of these piles contain products that I'll consign to the trash heap. Others are "holding" piles that contain products waiting to be written about. By far, the most voluminous piles are those products I still need to look at. So, in a valiant effort to make molehills out of the mountains, and in the process do something nice for my long-suffering wife, I'm going to try to make a significant dent in at least one of the piles this time around.

Surfeit of Riches

One of the big problems I have is not enough memory in my PC. Though I do have 8M of RAM in the 33-MHz 486 I use for my main testbed, strangely enough, it's frequently too crowded to let me run many DOS-based packages I receive. The reason for this is the number of peripherals that have accumulated in this system over the last year or so: Sound Blaster Pro sound card, CD-ROM drive and Epson GS-800C color scanner. Each of these has its own device driver that loads in as the system boots. Then, of course, there's a FILES and BUFFERS statement, a mouse driver and Smartdrive, which is needed to run Microsoft *Windows*. By the time my PC makes it past the POST procedure and CONFIG.SYS and AUTOEXEC.BAT files, I'm lucky if I have 480K of DOS memory left open. With today's software, this is frequently not nearly enough.

Until I discovered *Boot Commander*, I dealt with this problem with a rather brute-force approach. When I needed to run a package that required more memory than my standard "fully-loaded" setup provides, I created a floppy boot disk that contained MS-DOS and whatever specific FILES, BUFFERS and device drivers were the minimum necessary to run the application. This works, especially with judicious use of MS-DOS 5's DEVICEHIGH and LOADHIGH commands, which let me stuff things up in DOS' high memory area. But it's not really my idea of having come a real long way when I have to boot an 486DX system with 8M of RAM from one of a selection of floppy disks more times than not.



Boot Commander from V Communications lets you exercise control over which statements in CONFIG.SYS and AUTOEXEC.BAT files are to be executed when your computer boots up.

Then, at the last COMDEX show, I discovered a small company named V Communications that sent me a number of products to take a look at. One of these was *Boot Commander*. This is a simple program that lets you exercise control over which statements in my CONFIG.SYS and AUTOEXEC.BAT files are to be executed when my PC boots. I just edit these two files to create groups of device-driver and other statements for specific configurations and then give each group a name. To illustrate this, my system has groups for "CLEAN PC," with nothing loaded, "MOUSE ONLY," which loads only the mouse driver, "DOS HIGH AND MOUSE," which loads the HIMEM and EMM drivers and then loads MOUSE.SYS into high memory, and a few others, including "EVERYTHING."

After the machine completes its POST procedure, I get a nice menu that asks me to choose a configuration. I can use the up- and down-arrow keys to select a particular configuration or, if I hit Enter or wait a short while (I set this wait at 10 seconds), *Boot Commander* uses the configuration I specified or accepted the last time I used the PC.

Boot Commander is exceptionally easy to install and use. I had everything installed, set up and running fine within 10 minutes of opening the package.

This program is such a useful utility that Microsoft has included an almost identical function in its new MS-DOS 6. At least, it appears in the beta copies I've been receiving, though other features have come and gone during the time I've been receiving betas; so I can't guarantee this feature will make it to the ready-for-the-consumer-market shrink-wrap phase. If it doesn't, or you're not sure you want to upgrade to MS-DOS 6.0, take a look at *Boot Commander*. It solved my problems in a very easy to implement and elegant way.

Quick Notes on MS-DOS 6.0

While I'm on the subject, I've been participating in MS-DOS 6.0 beta testing (along with about half the PC users in the world, it sometimes seems). I'm sure some other *ComputerCraft* contributor will cover it in depth. So I'll just throw in my two cents about DOS 6.0. Keep in mind, that as this is being written, Microsoft still hasn't announced a release date for the product and that as beta testing has proceeded, an occasional feature, like the network conductivity functions, has come and gone. But I think Microsoft is getting pretty close to putting the product into production. So I'll share a few of my impressions in hope that it will help you decide whether or not you should consider upgrading.

Most notable in this release of the venerable MS-DOS is inclusion of on-the-fly data compression and decompression, or in the vernacular "disk doubling." Microsoft's implementation of this works pretty transparently, though it does create a new logical uncompressed disk to hold certain system files. This can be a pain if, as on one of the systems on which I installed DOS 6.0, it creates this new logical drive

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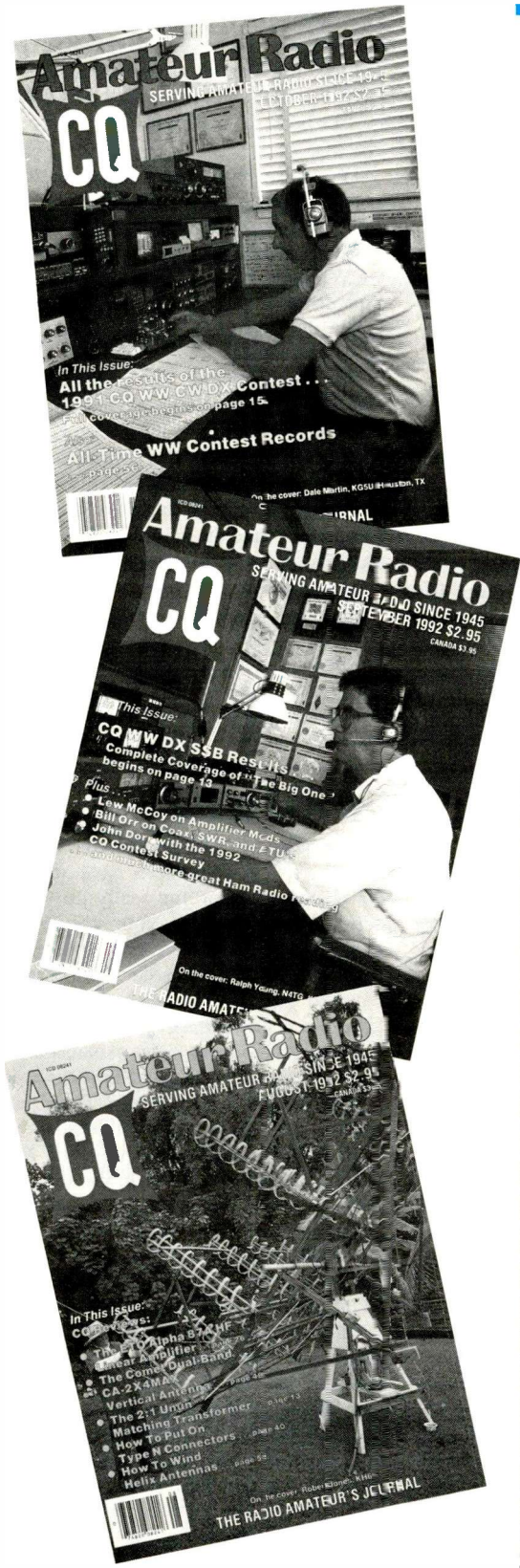

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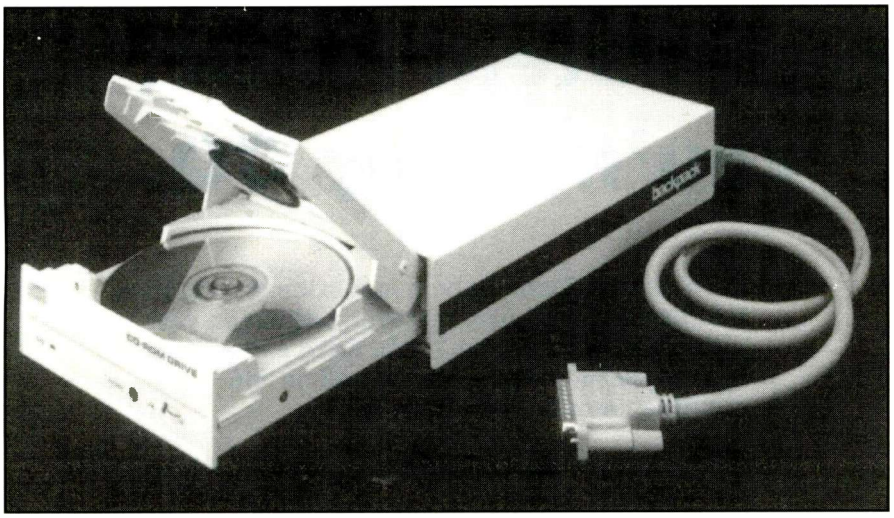

MicroSolutions Backpack CD-Rom drive plugs into a parallel printer port and features pass-through for normal printing.

where you formerly had a Bernoulli, CD-ROM or tape drive installed. It doesn't nuke this previously installed drive, but it does move its ID letter up a notch. Depending on the number of applications you have installed on this relocated drive, it can be quite a chore to edit all references to them in path statements and associations in *Windows* icons. On the other hand, *Double Disk* works well enough to have sparked a lawsuit from the people who make and sell *Stacker*, one of the more-popular disk-doubling packages.

I gained about a 30% increase in disk space on drives heavily loaded with applications, 65% to 70% on drives containing mostly text and/or graphics files and close to 100% running *Double Disk* on an empty drive. I also haven't noticed any great slow down on the drives where disk doubling is enabled, and the DOS 6.0 betas I've received all run a defragmenting utility before they compress a drive.

Microsoft has really loaded this DOS update with utilities. In addition to the disk doubler, also thrown in are anti-virus and backup software for both DOS and *Windows* environments. There are a file-transfer utility similar to *LapLink* and a memory optimizer that automatically decides what device drivers can be loaded high. If this maximizer screws up, pressing a function key while the machine boots bypasses loading the CONFIG.SYS and AUTOEXEC.BAT files so that you can edit out the error or reinstate the previous versions of these files.

Finally, there's a function built into DOS 6.0 that's very similar to the *Boot Commander* program reviewed above. It lets you selectively execute portions of your CONFIG.SYS and/or AUTOEXEC.BAT files.

Should you upgrade to MS-DOS 6.0? This is a difficult question to answer this time around. In the past, I've recommended never upgrading to an X.0 version of an operating system. But Microsoft never did bring out a numbered update to MS-DOS 5.0, and I have a feeling this may become the norm with MS-DOS. Then, again, if you're already running MS-DOS 5.0 with *Stacker* or another disk doubler, anti-virus, backup software, a memory manager like *QEMM* and a utility like *Boot Commander*, you pretty much already have all MS-DOS 6.0 offers. But, if you do decide to upgrade to this new DOS, wait three to six months to give any undiscovered bugs in the operating system a chance to surface and be corrected.

Windows Printer Speed-Up

As long as I'm discussing Microsoft, I have to admit that I've become a really big *Windows* user. Since most of my PC use these days involves text or graphics or both, most of the time my system is on, it's running *Windows*. By and large, I don't have an awful lot of complaints with this operating environment—until I have to print something. Compared to the few DOS applications I still use, printing in *Windows* seems to take forever. Since Microsoft created this problem by introducing *Windows*, it doesn't seem all that surprising that its also are the one to bring out an excellent solution: The Windows Printing System.

Available for a number of popular laser printers including most of the recent Hewlett Packard LaserJets, the Windows Printing System consists of a cartridge that installs in the left-most cartridge slot on the printer and software that includes 79 *TrueType* fonts. Installation takes about 20 minutes—3 seconds to install the printer cartridge and the rest for *Windows* to copy copies over files on the five software disks.

When installed, the combination not only speeds printing under *Windows* considerably, but it adds a few nice fillips to the process. Now, when I go to print, a voice informs me when printing is beginning and finished, and a little animated LaserJet shows each page feeding through the printer, how many pages have been printed, number of pages remaining and the estimated countdown until the print job is finished. It certainly speeds up the process.

To test the Windows Printing System, I used a 10-page *Word for Windows* document. Printing it before I installed the system took 4 minutes and 8 seconds. With the Windows Printing System installed, the time dropped to 1 minute and 34 seconds. Given the amount of printing I do, this is quite a time saver.

The documentation that comes with the Windows Printing System promises that the system will inform me where problems lie. From what I've seen, I have no doubt that it will, though I haven't encountered any problems to date. It also wouldn't surprise me to have the darn thing call the serviceman if it didn't think I was savvy enough to correct a problem.

My only criticism of the Windows Printing System is that it works only in *Windows*. Though the printer works normally when I print under DOS, it would be terrific to have the functionality and speed increase I get when working under *Windows* as I work under DOS as well.

CD-ROM Quick

The reviews of CD-ROM products you've seen here and elsewhere have probably convinced you that you really do want to add a ROM drive to your system. But you're either a complete technophobe who isn't willing to open your PC to add the required interface card (which isn't likely if you're a *ComputerCraft* reader) or you don't have any more open expansion slots or you need to add a CD-ROM drive to a laptop. So what do you do? There are a number of solutions to your dilemma.

You could use Trantor Systems' Mini-SCSI Plus cable, which plugs into your parallel port and offers an SCSI output that hooks into many external CD-ROM drives. A single-vendor solution, however, is available in the form of the backpack CD-ROM drive from MicroSolutions.

The backpack CD-ROM is one of a series of backpack peripherals that includes several different sizes of hard-disk, floppy-disk and tape drives. All backpack peripherals simply plug into the parallel port of your PC and offer a printer pass-through port into which you plug the cable that leads to your printer. All of these backpacks, including the CD-ROM

drive I reviewed, include their own 9-volt power supply.

Physically connecting the backpack CD-ROM drive to my computer took me less than 30 seconds. The unit also comes with software that installs the 8K device driver and Microsoft's MSCDEX CD-ROM extensions. Once you type INSTALL and hit Enter, the setup process is automated and takes about a minute to complete. Then all you do is re-boot, and the drive is ready for use.

The backpack CD-ROM drive has some impressive specifications, considering that it's being run off a parallel port. It provides the 350-ms access and 150K/second data-transfer rate required for use with multimedia, and it's also CD-ROM/XA-compliant so it can be used with Kodak's new Photo CD technology. Pushing on the slides of the front panel, the disc carrier pops out to let you drop a CD-ROM into place. I greatly prefer units like this that don't require a disc carrier.

At $499, the backpack CD-ROM drive costs about the same as or a few dollars more than an equivalent internal or external drive that requires installation of an interface card. But in terms of ease of installation, it's the easiest-to-install drive I've come across yet. I was up and running with it within 2 minutes of unpacking the unit.

MicroSolutions has been around for years, and I've always had very good luck with its products, going all the way back to the company's *Uniform* software package that permitted converting files from a different machine's versions of CP/M. If you're looking for the easy and quick way to add CD-ROM to your PC (or even a couple of PCs, since it's easy to move the unit between several), this is it! ■

Products Mentioned

Boot Commander, $59.95
V Communications, Inc.
4320 Stevens Creek Blvd., Ste. 275
San Jose, CA 95129
Tel.: 408-296-4224
CIRCLE NO. 120 ON FREE INFORMATION CARD

Windows Printing System, $199
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
Tel.: 206-882-8080
CIRCLE NO. 121 ON FREE INFORMATION CARD

Backpack CD-ROM drive, $499
MicroSolutions Computer Products
132 W. Lincoln Hwy.
DeKalb, IL 60115
Tel.: 815-756-3411
CIRCLE NO. 122 ON FREE INFORMATION CARD

What's New!

Disk-Duplicator Software

DiskDupe Version 4.0 from Micro System Designs copies and compares disks, using mouse-driven pull-down menus that make arcane DOS commands obsolete. This version automatically senses the disk type and the configuration of drives A: and B:. The program reads the source disk in a single pass and uses RAM (including EMS/XMS) and virtual memory to make an unlimited number of copies without rereading the master disk.

Disks that are copied frequently can be stored on a hard disk as image files to further speed duplication and save wear and tear on masters. Bad disks that could otherwise cause irrecoverable information loss are detected by *DiskDupe*'s Verify feature, a rigorous error-checking program that performs a CRC. Verify now also performs a byte-by-byte comparison with the original data as a copy is made to ensure 100% accuracy. *DiskDupe* will copy even UNIX, MIDI and high-density Mac disks. It supports all major hardware standards. $179. *Micro Systems Designs, Inc., 10062 Miller Ave., Ste. 104, Cupertino, CA 95014; tel.: 408-446-2066; fax: 408- 446-2095.*

CIRCLE NO. 22 ON FREE CARD

PC Paging Utility

Advantage Software's *PC Pager* senses when application software or DOS is waiting for input. When *PC Pager* senses that your PC has been waiting long enough (you set the time limit), it alerts you to this fact. It can send a beep through your computer, dial a telephone or page you through a pocket pager. Examples of uses include printing a long word-processing document, re-calculating a complex spreadsheet and working with a database. The current version works with DOS only, but a *Windows* version is expected soon. $30. *Advantage Software, 3713 Garrett Rd., Drexel Hill, PA 19026; tel.: 215-626-5914*

CIRCLE NO. 27 ON FREE CARD

Joseph Desposito

An 8051-Compatible Microcontroller, In-Circuit Emulators for the PIC16Cxx, 308ksps A/D Converter, and Two New DC-to-DC Converters

How would you like to have an 8051 that runs three times faster and consumes only a quarter of the power of the current crop of devices? Intel doesn't offer it, but a competitor has produced an 8051-compatible microcontroller with these features. This is just one of the items that are the subject of this month's column.

8051-Compatible High-Speed Micro

Dallas Semiconductor's (4401 S. Beltwood Pkwy., Dallas, TX 75244) new microcontroller is a drop-in replacement for the widely-used 8051. The DS80C320 High-Speed Micro increases speed by a factor of three, executing more than 6-million instructions per second (MIPS). With the High-Speed Micro, older designs can be updated without having to change processor architecture, software or development tools.

The DS80C320 maintains full compatibility with the original 8051. It uses the same instructions and is pin-compatible with the 80C31 and 80C32. Any existing software development tools, such as assemblers and compilers, can still be used with it. In addition, its internal timers can be run at their old speed, allowing real-time software to function correctly when the chip is dropped into an existing design.

Taking a cue from RISC processors, the DS80C320 uses fewer clock cycles per instruction. While the original 8051 and all of its derivatives require 12 clock cycles to perform an instruction cycle, the DS-80C320 uses only four clock cycles. This improves on the speed of the original by a factor of three, without changing the system clock. System designers need only drop the DS80C320 into an existing socket to get an immediate performance improvement, regardless of the system's clock speed. You'll typically see a speed improvement of between two and three times.

The DS80C320 runs at clock speeds of between 0 and 25 MHz. At 25 MHz, it executes more than 6 MIPS, which is substantially faster than other eight-bit microcontrollers. By offering a higher level of performance in an 8051-based solution, many older designs can be updated without changing processor families or software. Also, newer designs will be able to use familiar 8051 development tools and still achieve the performance needed for next-generation systems and applications.

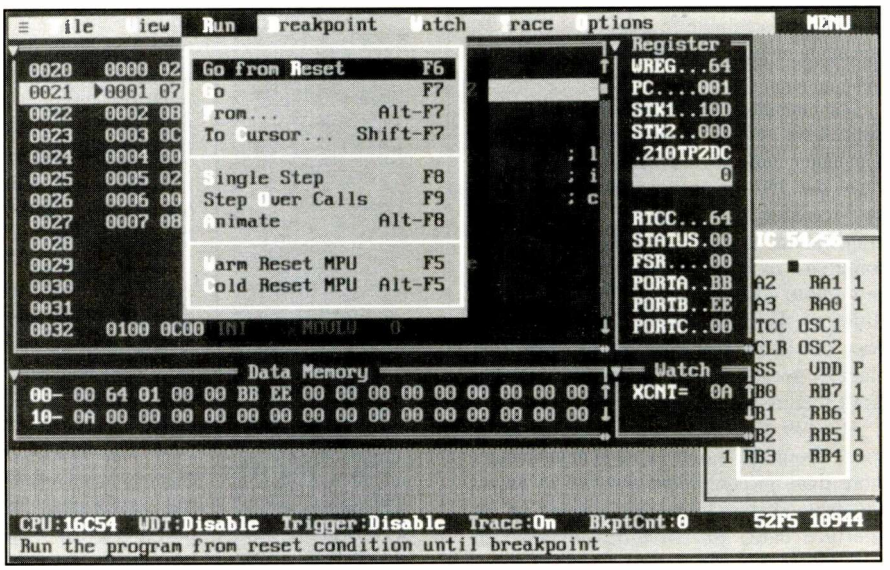

Fig. 1. Advanced Transdata ICE-16C5x low-cost non-intrusive in-circuit emulator software's windowed user interface.

Like any CMOS product, the DS80C320 draws less power when run at slower speeds. Since it's more efficient than a standard 8051, it can do the same job when it's run at less than half the frequency. At this low speed, the chip draws much less power than the standard 8051 does. By simply changing the crystal, a designer can reduce power consumption of an 80C32 design by using the DS80C320. No performance is lost when making this change. A typical 80C32 running at 12 MHz draws 15 mA. The DS80C320 will do the same job at approximately 4.8 MHz and use around 5 mA.

Applications for the DS80C320 include communications, industrial controls and portable instruments, all of which can benefit from the device's enhanced performance, reduced power consumption and peripheral functions.

Dallas Semiconductor has incorporated a number of features beyond what the 8051 and its derivatives offer. In addition to the enhanced 8052 features—including three 16-bit timers, on-chip UART, 256 bytes of RAM and four eight-bit I/O ports—the chip adds the following:

- *Dual Data Pointers.* The DS80C320 replaces the single 8051 data pointer with a pair of pointers to benefit systems that move data from one memory area to another. With dual pointers, the software can change from a source address to a destination address in one instruction.
- *Two UARTs.* The High-Speed Micro provides two on-chip serial communication ports (UARTs) that are fully independent of each other and provide both synchronous and asynchronous modes of communication. The UARTs can be run simultaneously and at different rates, if desired. This allows the DS80C320 to be used in a variety of communications applications, such as modems.
- *Power Monitor.* Traditionally, microcontroller users needed external components to provide a power-monitor function. The DS80C320 offers a built-in power monitor. When power fails, the power monitor issues an optional interrupt to the processor that informs the software when power is beginning to fail. If power drops further, the power monitor circuit generates a reset.
- *Watchdog Timer.* An on-chip watchdog timer supervises the processor and prevents the software from running out of control. If the software doesn't clear the watchdog timer prior to the user- selected time interval, the watchdog resets the processor. The watchdog interval is based on the clock frequency, which makes the time-out very precise. A wide range of software-selectable time-out intervals is available.
- *Selectable Off-Chip Communication Speed.* As performance and speed increase, programmers often have difficulty commu-

nicating with slow peripherals like LCD displays. The DS80C320 lets the programmer select off-chip communication speed. This variable-speed memory bus allows the processor to use fast RAM and then a very slow peripheral simply by changing a register value in software.

• *Additional Interrupts.* The DS80C320 provides 13 interrupt sources, compared to five on the original 8051. In place of the original two external interrupts, the High-Speed Micro provides six interrupts, eliminating the need for extra logic.

The DS80C320 High-Speed Micro is available in a 40-pin plastic DIP, 44-pin PLCC and 44-pin PQFP. In DIP package, the price is $6.50 each in 10,000-piece quantity.

Portable ICE for PIC16Cxx Controllers

Advanced Transdata's (14330 Midway Rd., Ste. 104, Dallas, TX 75244) ICE-16C5x and ICE-16C71 are low-cost non-intrusive in-circuit emulators for Microchip's PIC16C5x and PIC16C71 eight-bit RISC microcontrollers. These emulators provide an interactive development environment for debugging PIC16Cxx applications. They run on any IBM PC or compatible computer and interface transparently via a parallel port. The emulator design uses the PIC16Cxx microcontrollers for true hardware emulation, supporting RTCC, WDT, all I/O ports and special-function registers. The host PC simulates execution of all PIC instructions.

The windowed development environment, shown in Fig. 1, provides separate windows for examining source code, program memory, data file registers, watch variables, processor status, program counter and stacks.

Source level and full-symbolic debugging are available on Advanced Transdata's TASM16 and TASM71 cross assemblers, which come with the ICE package. The units provide comprehensive emulation controls, as shown in the Fig. 1 menu. As a user single-steps through execution, all updated information is highlighted for easy reference.

Both ICE-16C5x and ICE-16C71 provide a 4K (1K deep by 31 bits wide) trace buffer that captures ICE trace data and records program flow in real time. Eight software breakpoints and two hardware break triggers can be set to break on any address or external signal.

Each ICE for the PIC microcontrollers consists of a compact portable emulator unit that measures 4¼" × 2" × 1" (see Fig. 2), respective cross assembler, simulator software, emulator cable, trigger source input cable with probe clips, parallel extension cable and power adapter. The ICE-16C5x retails for $395, the ICE-16C71 for $445.

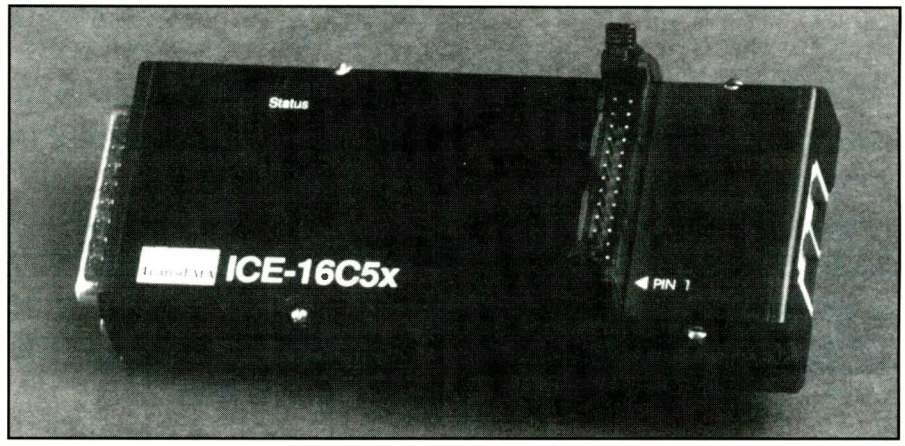

Fig. 2. Advanced Transdata's ICE-16C5x portable in-circuit emulator for Microchip's PIC16C5x microcontrollers comes with two ribbon cables and a trigger-input source cable.

14-bit ADC Works at 308ksps

Maxim Integrated Products' (120 San Gabriel Dr., Sunnyvale, CA 94086) MAX-121 14-bit serial-output analog-to-digital (ADC) converter offers fast conversion speed and low power consumption. Throughput rate is as high as 308K samples per second.

The MAX121 combines on-chip a successive approximation converter with a 400-ns track-and-hold circuit and voltage reference. It offers direct connections to the TMS320, ADSP2101, P7230 and other digital signal processors and is compatible with Motorola's SPI and QSPI synchronous serial standards. Prices start at $12 for quantities of $1,000 and up.

DC-to-DC Converter for Flash Memory

Linear Technology's (1630 McCarthy Blvd., Milpitas, CA 95035) LT1109A is a low-cost dc-to-dc converter for flash-memory programming applications for use in 3- to 5-volt converters, 5- to 12-volt converters, disk-drive power supplies, personal-computer plug-in cards, computer peripherals and battery-powered equipment.

Available in fixed 5-volt, fixed 12-volt and adjustable-voltage versions, the LT1109A is a simple step-up converter that's pin-compatible with Linear's LT-1109. The eight-pin SOIC or eight-pin DIP devices require only four external components to implement a complete dc-to-dc converter. Current drain is just 320 µA at no load, making the device well-suited for power-sensitive applications in which standby current must be kept to a minimum.

The LT1109A-12 can deliver 12 volts at up to 140 mA from a 5-volt supply, enough power to program four flash-memory chips simultaneously. The LT1109A-5 can deliver 5 volts at up to 150 mA from a 2-volt power supply. The device features a logic-controlled shutdown pin that turns off the oscillator when this pin goes low. The gated-oscillator design requires no frequency-compensation components. It operates at 120 kHz, permitting use of small surface-mount inductors and capacitors.

Pricing for the LT1109A in 100-up quantity in either SOIC or DIP packages is $2.45 each.

Linear Technology also has the LT1108 micro-power (100-A supply current) dc-to-dc converter for notebook and palmtop computers and other portable battery-powered equipment. The LT1108 is pin-compatible with the LT1173, but it has a duty cycle of 70%, which results in increased output current in many applications.

The new device can output up to 150 mA at 5 volts from an input of two AA cells or 5 volts at 300 mA from a 9-volt battery. With its extremely low quiescent current (10 µA maximum), the LT1108 is well-suited to power-conscious battery-operated systems or for peripherals and add-on cards, pagers, portable instruments and cellular telephones.

The LT1108 requires only three external components to implement a power supply: inductor, capacitor and diode. To reduce system size and weight, the device is supplied in eight-pin SO surface-mount packages and eight-pin mini-DIP. Both fixed-output (5- and 12-volt) and adjustable devices are available.

The LT1108 has an on-chip 1-ampere power switch that operates in either step-up or step-down mode. Current limiting of the device is user adjustable via a single resistor. Pricing for the LT1108 in SO-8 package is $2.90 each and in eight-pin plastic DIP is $2.50 each, both in 100-piece quantities. ■

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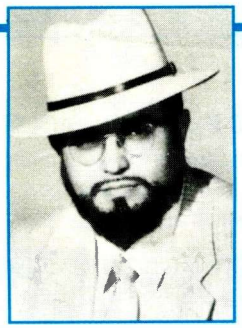

Windows Dressing

More and more products are making the move from the Mac to the PC under *Windows*. These aren't minor word processors, databases and spreadsheets that are soon to be swallowed up by the mature market for established products. They're products that have established the Mac as the platform of choice among many designers and creative talents. It's *Windows*' strike back at the Mac's continued evolution, and no matter which platform gains or loses market share, users will be the winners.

For some decision makers, this subtle shift in market equilibrium means a corresponding shift in the decision process of what to buy, of what infrastructure to commit to. Do you keep buying more Macs for creative tasks, or do you add more of the PCs the rest of the corporation is using for its mission-critical business applications? The answer depends on the value provided by each platform.

The Mac's value has come from a superior software base. (In a sense, Apple is more a software company than a hardware company. Without the software development encouraged by the Mac operating system, Apple's flagship would probably be limited to the same market segments as Atari and Amiga now have.) The PC's greatest value has come from hardware. A recent comment from a Pixar spokesperson provides a telling example of this difference. Comparing the Mac's and the PC's ability to run the software her company is developing, she praised the PC for its power. The PC seemed to render images much faster than the Mac. Remember that this is from someone working in a company that has a Mac on every desk, a company that's owned by Apple founder Steve Jobs.

In truth, this observation was a matter of perception related to the value on which each platform trades. It isn't that there aren't powerful Macs. It's just that the PC provides so much power for each dollar, which is where the PC's value lies. The Mac, on the other hand, is where all the cool software, including Pixar's own, has been developed. This is where its value lies. When you start moving that great software to the *Windows*, or especially *NT*, enviroment the PC starts to loom large. The perception is that applications run faster because it's easier to put a hotter machine on more desktops.

Clearly, Apple is pushing the envelop of its operating system—as it demonstrated at January's Mac World with *ColorSync* and other developments—out of necessity. Unfortunately (or fortunately, depending on which camp you're in), it needs to move fast to outrun the avalanche of products that are rushing to the PC.

Pixar, the folks who bring you *RenderMan*—almost everywhere except under *Windows*—are almost ready to make the move. A *Windows* beta rolls out shortly after this is written, and product is expected to ship during the summer. It will bring *Windows* users access to the software that created the ballroom in Disney's *Beauty and the Beast*, and the Terminator 2000 in *Terminator 2*. Pixar is also the creative force that produces award-winning animations like *Red's Dream*, *Tin Toy*, *Knickknack* and *Luxo Jr.*, as well as such familiar commercials as the Listerine bottles that swing through the jungle or spar in the boxing ring, the computer-generated version of the Pillsbury Doughboy, and many others. That's a lot of power.

If you can't wait until summer, Pixar is already shipping the *RenderMan* engine in a *Windows* product called *Typestry*. It's a tool that renders text for logos (including flying logos for video), presentations, letterheads, mastheads, ads, packaging, collateral material and any other application where making an impression counts.

Typestry uses text created from either *TrueType* or *PostScript* fonts and renders a surface for it just like *RenderMan* does when it creates a model from a wire frame. In fact, the program actually creates a wire frame from the font as its first step. Then it applies your choice of one of the 37 "looks" that ship with the product. The looks include wood, marble, stars sparkles, etc. You can vary their color, opacity and scaling, and you can infinitely rotate them to any orientation. Other effects are available from Pixar and third-party vendors. So, you can infinitely expand the library as well.

Typestry doesn't create a new font, but a bit-mapped image of whatever text you render. And it can apply the looks of your choice not just to a block of text, but to its background: the floor or wall on which the text sits. It has a movie tool you can use to create flying logos and includes a tweening tool. So, you can run animations of your text on *Windows* using the copy of Autodesk *Animator* that's included with *Typestry*. And you can use *Typestry* with just about any of the top layout and design packages, including *Persuasion*, *Photoshop*, *PhotoStyler*, *PageMaker*, *QuarkXpress* and others.

Pixar's goal with *Typestry* is the same one it has for its other products and services: unmatched output quality. Nels Johnson, vice president of San Francisco Canyon, developers of the *Canyon Action!* CD (recently renamed *Canyon Clipz*) says, "Typestry is a robust and powerful-font rendering and animation package. It takes a long time to render things, but it does a really nice job. And I haven't been able to blow it up."

Nothing else comes close says company president and founder Ed Catmull: "Our goal is to create images so realistic that they could be used in live-action motion pictures. Now we make the tools and systems that let thousands of people create photo-realistic pictures of whatever they choose to design." Those thousands will swell when *RenderMan* hits *Windows*. And an *NT* version will follow with support for multiprocessors. That's the type of challenge that the PC marketplace answers with lots of cheap systems.

Digital Canyon

San Francisco Canyon's own *Canyon Clipz* is another example of a recent leading-edge development that's moved to the *Windows* platform. It's a time-based multimedia application. *Canyon Clipz* is a CD-ROM disc full of *QuickTime for Windows* movie clips that aren't licensed for reuse in another production. Like any *QuickTime for Windows* product, it includes the *QuickTime* engine. And since Apple licenses *QuickTime* only to developers, you can also think of this CD-ROM as a means of distributing *QuickTime* to end users. Canyon does.

Canyon's strategy is to make *QuickTime* a viable alternative for developers who are bringing video to *Windows*. Certainly, it will be the choice of Mac video developers who want the quickest possible port of their applications to the immense PC mar-

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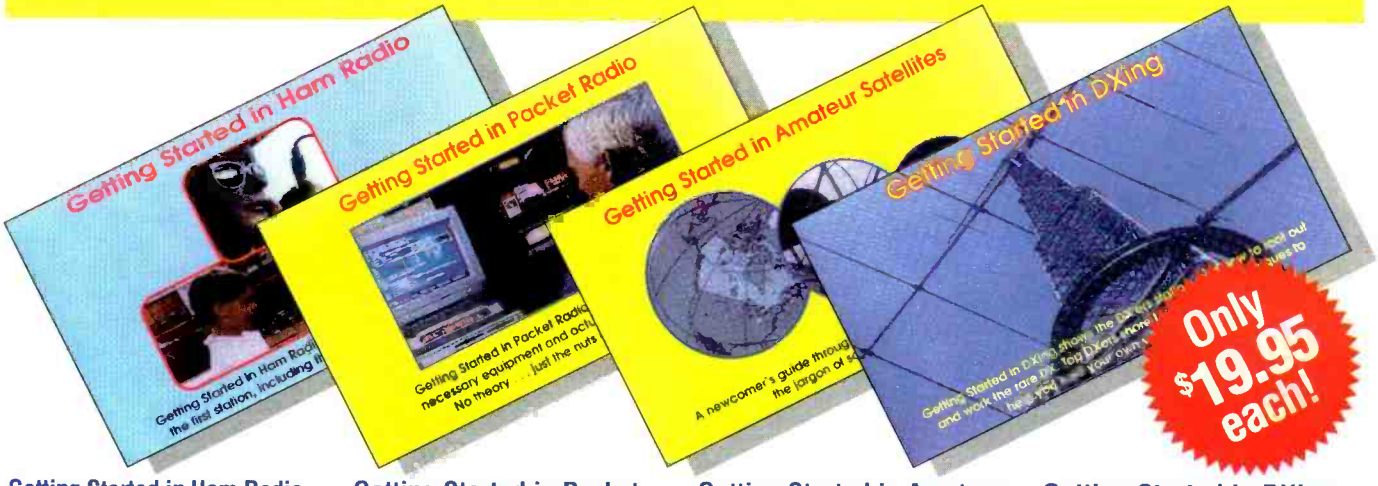

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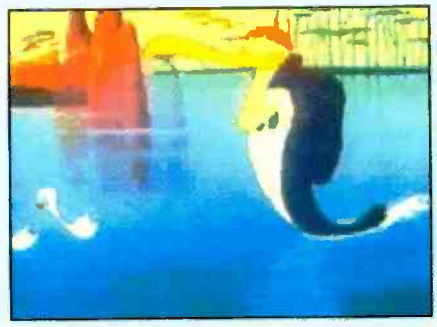

Screen shots from San Francisco Canyon's *Canyon Action!* CD.

ketplace. (The CD-ROM works on both platforms. However, it was such an early release that single-fork versions weren't yet available. So the disc contains two copies of each clip.) And *QuickTime for Windows* is getting key support. For example, Intel has announced Indeo codecs for both *QuickTime for Windows* and the Mac. However, *QuickTime* on the PC is far from the equivalent of *Video for Windows*. *QuickTime for Windows* is a from-the-ground-up original development effort, but it's a nearly identical API with the same function names and data structures as on the Mac. Furthermore, on *Windows*, *QuickTime* is strictly a playback technology, not a development tool. Apple hasn't announced an intention to support movie creation on the *Windows* platform. Only if it does will *QuickTime for Windows* become a full-fledged competitor to *Video for Windows*. For now, it's for vendors with source material on the Mac who want to sell them for the PC.

There are some disadvantages to the product. One is that *QuickTime for Windows* doesn't support OLE, MCI or *Visual Basic*. (Fortunately, Apple has announced that support is to appear in May. The company will also release a codec for Compact Video—an asymmetric lossy compressor—that's already supported on *QuickTime* 1.5 for the Mac.) Secondly, the *Video for Windows* DLLs are free if you want to sell a video product with the *Video for Windows* engine. *QuickTime for Windows* isn't free yet. Developers must buy it through the Apple Developer's program. End users can obtain it only as a licensed run-time version within a product like Canyon's.

Nevertheless, *QuickTime*'s proponents are positive. Johnson says that, where the two products directly compete, *QuickTime for Windows* is superior. "It often has faster playback," he maintains. (However, the product's speed comes because it writes directly to the hardware whenever possible. This is a technique that *Windows* seeks to eliminate.) Johnson also claims, "It has a richer set of codecs (all Mac 1.0 decompressers are supported)." He faults the codec set in *Video for Windows* for its limited selection and lack of Mac compatibility, and, he says, "they're not very good." Finally, he cites *QuickTime*'s ability to simultaneously run multiple instances in an application, "With *Video for Windows*, you must run additional copies of a program to run more than one movie simultaneously."

Coincidentally, San Francisco Canyon is also the anonymous developer of a major

Pixar's *Typestry* at Work.

Products Mentioned

Morph, $149.95 (Mac, *Windows* versions due in June)
Gryphon Software
7220 Trade St., Ste. 120
San Diego, CA 92121
Tel.: 619-536-8815

CIRCLE NO. 177 ON FREE INFORMATION CARD

Canyon Clipz, $29.95 (originally introduced at $89.95 as *Canyon Action!*)
San Francisco Canyon
300 Montgomery St., Ste. 789
San Francisco, CA 94104
Tel: 415-398-9957; fax: 415-398-5998

CIRCLE NO. 178 ON FREE INFORMATION CARD

Pixar Typestry, $299
Pixar
1001 W. Cutting
Richmond, CA 94804
Tel.: 800-888-9856 or 501-236-4000

CIRCLE NO. 179 ON FREE INFORMATION CARD

"enabling system-level multimedia technology for playing movies and displaying pictures under *Windows*." (More than this, the company wouldn't, and undoubtedly can't, say. But the word is that this is the company that Apple commissioned to develop a *quick* and *timely Windows* product.)

It's not Your Father's *Star Trek*

Bitstream has shipped three collections of "fun fonts" for *Windows* 3.1. They're in the *Li'l Bits Font Packs* and are billed as "The only typefaces with real character." They include *The Winter Holiday Font Pack, The Flintstones Font Pack* and *The Star Trek Font Pack*. The last includes the two typefaces used for credits and titling in the original series and movies, along with the typeface used for external markings on starships, and the Star Trek Pi font that includes the insignia used on crew uniforms and Klingons.

Then there's *Morph*. It isn't anybody's Klingon, *Next Generation* or otherwise. *Morph* is software that creates the type of special effects that went into *Terminator 2*, you know, the one where the Terminator 2000 melted into a checkerboard-patterned linoleum floor and changed an arm into a giant yuppie skewer. That's morphing—as in morphology—and even *T2*'s director, James Cameron, thinks it's cool. In fact, this technology was briefly mentioned, as one of the latest desktop advances during the recent Beverly Hills announcement of Digital Domain (a partnership of Tinsel Town luminaries Cameron, Stan Winston and Scott Ross, with IBM, to create the ultimate computer-based moving-image factory).

Although it's on the desktop, *Morph* is a deadly serious product. Madison Avenue is already using it in major commercials for clients like *Time Magazine* (produced by Reelworks Animation Studio, Minneapolis), Miller Lite (produced by Colossal Pictures, San Francisco) and others. That's right, they did them on a Mac—not a Cray, not a Silicon Graphics workstation—a Mac. It's even rumored that *Morph* has been used in Speilberg's Jurassic Park. If this is true, it's more than a testimonial. It's a testosteronimonial (from "testosterone" and "testimonial," a clearly macho testament).

Morph is successor to *PhotoShop* as the coolest graphics application to hit the desktop. At present, it's available on only the Mac. Although nothing's been officially announced, a company representative told me that it's due on *Windows* early this summer.

Speaking of *PhotoShop*

Years after it initially appeared on the Mac, Adobe *PhotoShop* has finally made the move to *Windows*. Version 2.5 is the latest release of the product that really started a revolution in image editing. It's about time one of the most-important software innovations in the history of desktop computing comes to the most-important desktop platform. ■

Letters (from page 3)

the boards failed in the ITT computer. These diagnostics do not allow a user to choose which mode (real, protected, enhanced) to run memory test in or to test these modes for proper operation.

William B. Higinbotham
Brookhaven, NY

Author Update

• Since my review of the new MS-DOS 6.0 appeared in the May issue of ComputerCraft, Microsoft announced availability of the operating system. In its released form, MS-DOS 6.0 no longer includes Max Compress, and Del Tree works on only the current directory, not across all directories as in the beta version of the product.

TJ Byers

More Construction Techniques

• There is another extremely important and useful option for construction techniques that was omitted from the April "Circuit Construction Techniques" article: the Vector's "Slit-and-Wrap" system that is used extensively by my laboratory. We have wired many prototype circuits with this method, including fairly large ones that contain 100 or more ICs.

The Vector system makes use of a 7"-long hand-wrapping tool with a small reel of insulated wire at one end and a special bit at the other end. Wire from the spool passes down through the tool and exits the bit. The special bit slits the wire insulation as it exits the tool (at right angles) during wrapping. The wire wraps around the square Wire Wrap post, and the insulation folds back as it's wrapped. A perfect gas-tight joint is made with just a few turns of the tool.

The Vector system is highly recommended to any serious hobbyist. Vector also makes a motor-driven tool, based on a commonly available electric eraser. For my lab, I have designed and built several motor-driven, automatic turns-counting tools, but the simple manual tool is more than adequate.

Emerson M. Hoyt
Director of Engineering
Hoyt Instruments Lab.
Beaverton, OR

Wrong Connector Brand

• I purchased a copy of *ComputerCraft*, from which I tore out the pull-out on connectors. However, it doesn't help me because I have a Commodore Plus/4 computer for which I need information.

Randy E. Casals
Durant, OK

Sorry, but ComputerCraft *focuses exclusively on IBM/compatible computers, microcontrollers and single-board computers.—Ed.*

were the *Transformers* of Saturday-morning fame; *Starblazers*, an involved and lengthy series that usually aired after school; *Voltron* in another after-school time slot; and *G-Force*, an older space adventure. While all of these titles may not have been penned completely by Japanese animators, they've all had a strong Japanese influence.

Today, anime has a following that has reached cult status. It remains to be seen whether or not mainstream America will catch its rising wave.

U.S. Manga Corps publishes anime on videocassette. A child company of Central Park Media, it has the first sample of anime on CD-ROM. The CD-ROM contains hundreds of stills from anime movies, which are images stored in 24-bit Targa format. Macintosh users can enjoy watching more than 100 *Quicktime* movie clips. PC users, however, are left out of seeing any moving scenes. However, U.S. Manga includes an image viewer for the PC. Unfortunately, the image viewer doesn't work. PC users have to call Central Park Media to get a newer version of the viewer.

In my case, the newer version was included on a separate floppy disk. This may have been done because the company knew I was intending to evaluate the product for *ComputerCraft*.

The image viewer is a shareware product designed for general-purpose image viewing. A disappointing weakness of the viewer is that it doesn't support 24-bit color. The best it can do is 32K. Yet all the anime stills are 24-bit format. So why bundle an image viewer with a product that's incapable of fully demonstrating the product? A phone call to Central Park Media technical support failed to elicit an answer to this question. The support specialist suggested that I search bulletin boards and perhaps find a 24-bit viewer of my liking.

As an experienced computer user, I already own software that could view 24-bit Targa images. So this wasn't a problem. But what of the novice user who has little idea about where to get an appropriate viewer? The company is planning a second release of anime CD. Perhaps its PC software and technical support will be better. In the meantime, fans of anime have a collection of colorful images from some of their favorite films.

Kodak Photo CD

The worlds of photography and computers keep getting closer to a common medium. A recent development by Eastman Kodak ties true-color images to the compact disc via a proprietary technique the company calls Photo CD.

Kodak's proprietary process transfers normal 35-mm slides or film onto a compact disc. You can then display the photos on a Photo CD player or any CD-ROM drive that's XA Mode 2-compatible. Older CD-ROM drives, designed before the advent of Photo CD, aren't XA-compatible, and, thus, can't be used to display these images. Also, current drives may or may not support the format, depending on when they were designed. All newer drives are marketed as supporting the format, but even some of these really don't. If you aren't sure if your drive supports the format, check your owner's manual or call the manufacturer of your drive.

The cost of transferring images to CD isn't as expensive as you might think. It varies from one service bureau to another, depending on how many images you want to transfer. The maximum capability of a CD is approximately 100 images because each image has five different resolutions. A Kodalux processing center in Dallas, TX tells me that it will transfer no more than 100 images to a single CD, at a cost of $1 per image. It will transfer no less than 10 images for $1.69 per image. (These prices were quoted in February.) Initially, 100 images seems scanty, considering that a typical CD can hold over 600 megabytes of data.

Figured into the number of images is image size. The Photo CD system will size images at five standard pixel densities: Wallet (128 ×192), Snapshot (256 × 384), Standard (512 × 768), Large (1,024 × 1,536) and Poster (2,048 × 3,072). This increases the actual number of images from 100 to 500. This many images in 24-bit color will surely eat up storage space, even on a CD.

You can append images to CD at any time. However, there's an important caveat to consider. Each time an image is transferred to Photo CD, certain directory and pointer information is written to the CD, which results in a kind of CD software overhead cost. Transferring all 100 images makes for a one-time neat-and-clean placing of overhead information. As a warning, don't append images in onesies and twosies. The repeated overhead information drastically reduces the number of possible images from the maximum 100 to

Bird's Eye View

World of U.S. Manga, $49.95
Central Park Media
250 W. 57 St., Ste. 831
New York, NY 10107
Tel.: 800-833-7456

Requirements

Memory	4M of RAM, CD-ROM Drive
Graphics	24-bit Support
Sound	N/A
Controllers	Keyboard, Mouse

Evaluation

Documentation	Poor
Graphics	Excellent
Learning Curve	Short
Complexity	Easy
Playability	N/A

In Brief: A collection of Targa stills and Macintosh *Quicktime* movies from Japanese anime. Recommend 8M of RAM, fast 386 or 486 computer and your own 24-bit image viewer.

CIRCLE NO. 150 ON FREE INFORMATION CARD

Bird's Eye View

Kodak Photo CD Access Software, $39.95
Eastman Kodak Co.
Kodak Information Center
Department E, 343 State St.
Rochester, NY 14650-0811
Tel.: 800-242-2424

Requirements

Memory	4M of RAM, CD-ROM Drive, Hard Drive
Graphics	24-bit Support
Sound	N/A
Controllers	Keyboard, Mouse

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Short
Complexity	Easy
Playability	N/A

In Brief: Kodak's software that reads its proprietary images on CD. Recommend 8M of RAM, fast 386 or 486 computer and large hard drive. Be sure your CD-ROM drive really supports XA Mode 2.

CIRCLE NO. 151 ON FREE INFORMATION CARD

a minuscule 18 or 20. It's better to save up your images until you either get 100 of them or you can't wait any longer.

Viewing Photo CD images requires software that supports the proprietary Photo CD format. Eastman Kodak offers its own Photo CD that contains the proper software and 24 sample images taken by professional photographers. As expected, the company chose some stunning and colorful images to tout its product, but there's nothing to stop anyone else from getting equally good results.

Built into Eastman Kodak's software is a very basic image manipulator that can crop, rotate, mirror and flip an image. In addition, the software can save an image to floppy or hard disk in data formats that include .BMP, .PCX and .TIF. Therefore, any Photo CD image can be saved into a non-Photo CD format and used by other image software.

The Photo CD system is quite nifty. But is it just another cool digital imaging gadget or does it have practical use? The answer depends on your photography expertise and uses for such photography. If you're into vacation or family snapshots, it's a questionable investment to buy a Photo CD player or a CD-ROM drive just to be able to display snaps in Photo CD format. On the other hand, when you look at the rather high cost of good-quality film and processing, it's almost worth it to keep your memories forever safe on Photo CD.

A family could save up its processed film until it got near 100 likable images that can be committed to Photo CD and later be used in any graphics application. Mom and dad could write a letter to grandma with a good word processor and include grayscale images of the kids straight off the Photo CD. You can almost certainly think of dozens of other uses.

For professional and amateur photographers, the answer is clear. Photo CD is a welcome medium that provides permanent, safe storage of photos and an impressive ready display system. It does so at a reasonable cost.

One frustration to many photographers is constantly having to replace fading or damaged prints in a portfolio. Photo CD banishes this problem and provides a more-elegant method of showing off one's best work.

Kodak's Photo CD system is so novel and useful that it's quickly catching on and being supported by many photo dealers and outlets. It's only drawback is that the transfer process is limited to 35-mm film and slides, leaving out the larger film formats that are popular in the professional field. Kodak says that larger film formats, up to 4 × 5, is in the works and may be available as early as the second quarter of this year. ■

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Leisure On CD-ROM

CD-ROM technology is coming along rather nicely. A compact disc can't match the superior data-access speeds of hard drives, of course, but it balances the issue as a result of its tremendous storage capacity when compared to its small physical size. As usual, computer games and other leisure products are at the forefront, pushing the technology along.

Anime

Cartoons and cell animation is a tradition here in the States. One of the more-successful pioneers of American animation is Disney Studios. It has designed its own style of life-like animation that dazzles children and adults. The recent feature-length animated film *Aladdin* speaks well for the on-going talent at Disney.

Off the shores of the US, Japanese are pioneers in their own right. World renowned for innovation, Japanese "hi-tech" found its way into animation. "Japanimation" was the buzz word assigned to the arty and surrealistic look of Japanese animation. It's a catchy name but don't let its fans hear you use it. They'll glower and inform you that the correct term to use is "anime."

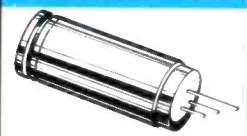
Whatever one calls it, anime is filled with hard-core science fiction, fantasy, action, violence and sex. People who aren't familiar with animation may think it odd for a "cartoon" to contain sex and violence. However, one look at American Saturday-morning cartoon tradition reveals that the only thing missing from is sex. Look beyond Saturday-morning animation, and sex abounds in American animation, as demonstrated by such films as *Wizards*, *Heavy Metal* and *Cool World*.

Japanese anime is designed not for kids, but for adults who look for action, excitement and titillation. They're generally well-plotted films that have distinctive characterizations and forceful drama. They mix mysticism, story and imagery in a stylish way that's easy to enjoy for anyone who likes animation. The genre has been slowly invading the US for some years. Some of the more-moderate examples

(Continued on page 84)

16 More Reasons To Believe In Unicorn

Collimator Pen



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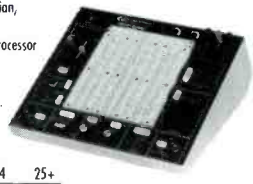

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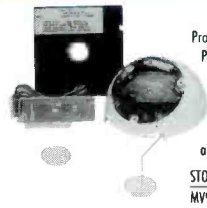

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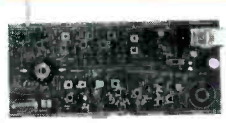

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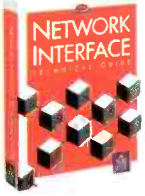

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