

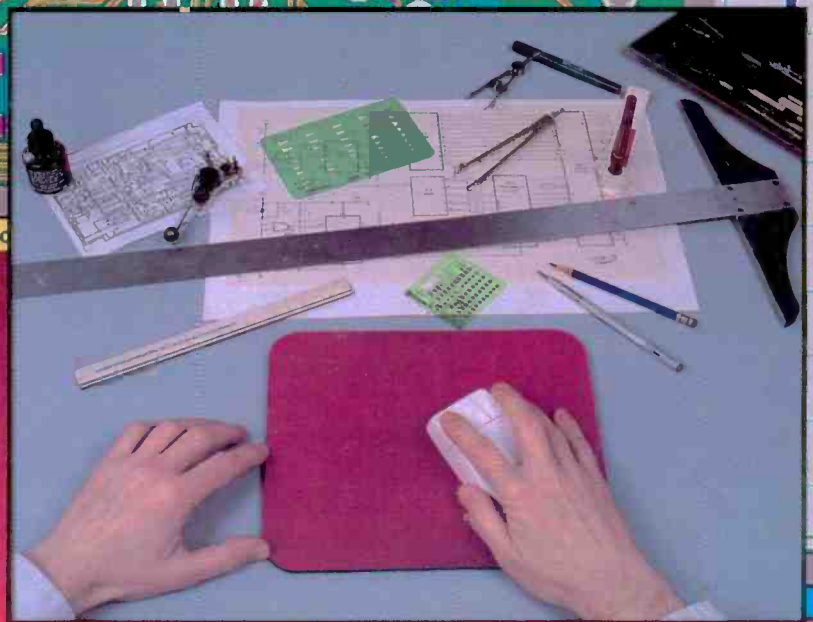
# ComputerCraft

THE PRACTICAL MAGAZINE FOR PERSONAL COMPUTERS & MICROCONTROLLERS

August 1993 \$2.95  
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- 
- New *Windows* Schematic & PCB Software
  - Add Sound Effect To Your Projects
  - "Key" Prevents Software/Hardware Piracy

ENTER:Start Select: Touching Area, ESC:Cancel



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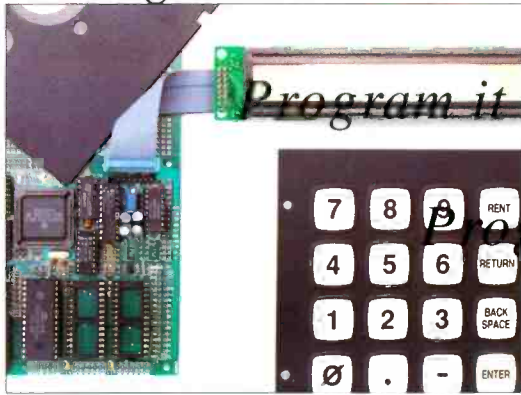
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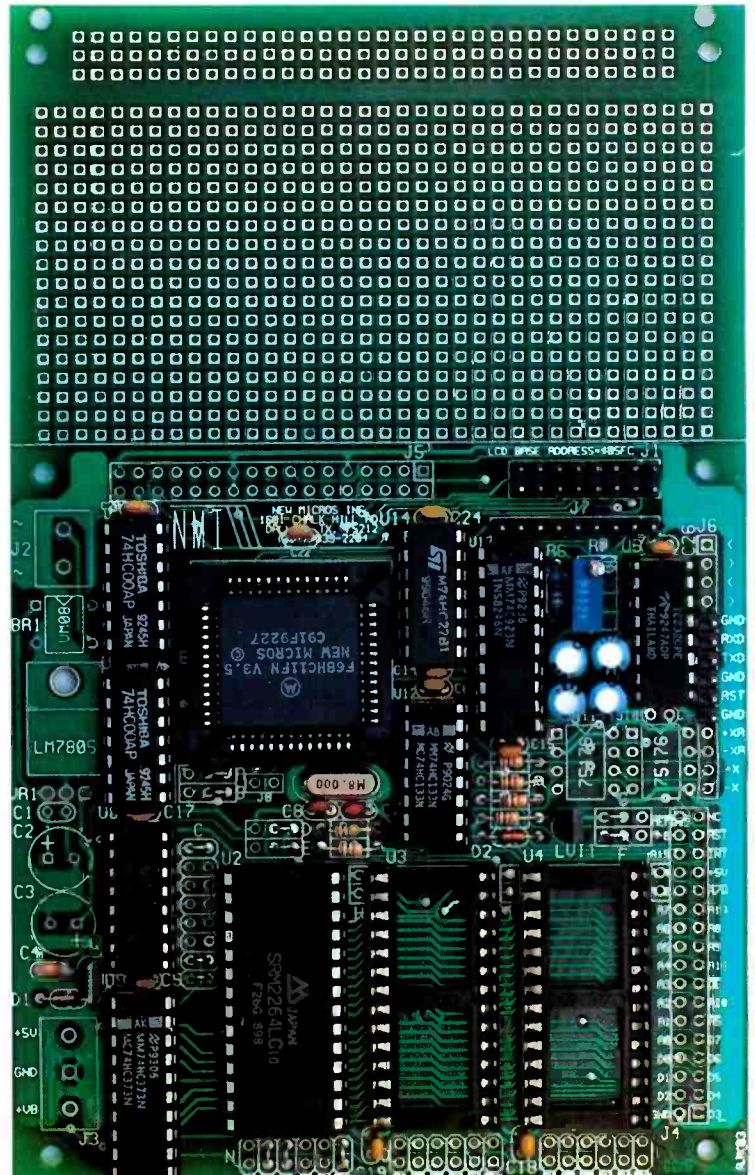
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The NMIX-0020 Single Board Computer is perfect for dedicated controller with convenient interfaces for LCD displays and keypad. Intelligent LCD's up to 2 lines by 80 characters and matrix keypads up to 4x5 can be used. The processor is the popular F68HC11 with many features, including SCI and SPI serial channels, 8-bit 8-ch. A/D, 20 available I/O lines, Watch Dog Timer, 1/2K EEPROM and Max-FORTH w/Floating Point Package embedded in 12K internal ROM. SBC expands F68HC11 providing 3 28-pin JEDEC sockets for 8-32K RAMs, ROMs, EPROMs, EEPROMs, etc. RS-232 conversion supplied. Requires external regulated supply: 5V at ~30 mA. Based on NMIX-0020 board, so many features may be added as desired by the user (or by factory - call for details & prices).

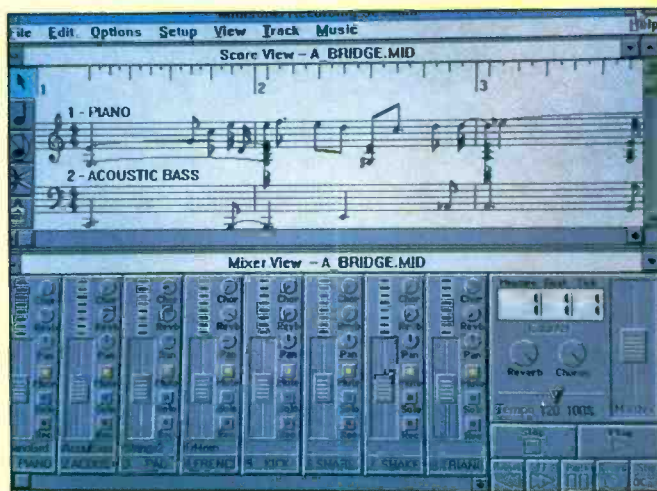
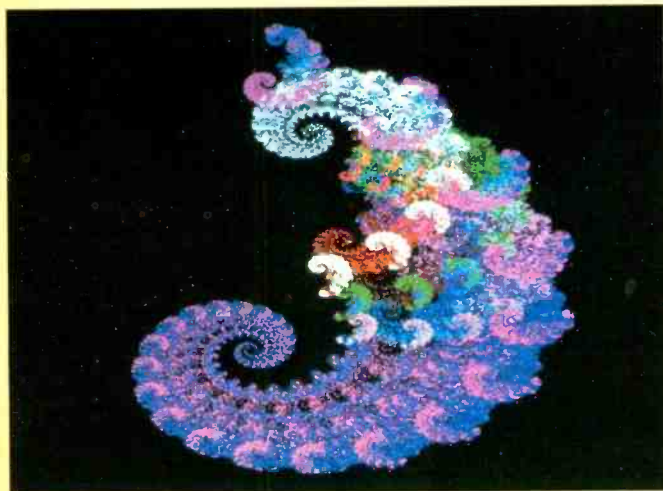
Languages supplied on accessory disk: Small C, Basic, and Assembler. FORTH resident on chip (may be disabled). Languages come with manuals on disk. Communications utility, MAXTALK included to allow PC clone to act as terminal for download and development. WIPE utility included allows internal ROM, EEPROM, WDT to be enabled/disabled, and EEPROM to be erased. Manuals on disk: UM-MAX Max-FORTH Users Manual, HM-20 NMIX-0020 Hardware Manual, Small C manuals with examples, BASIC11E9 Manual.

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**ON THE COVER:** Today's PC and software have dramatically changed how draftsmen go about drawing schematics and laying out pc-board artwork. T-squares, templates, pens, tape and pad patterns are replaced by a lowly mouse and a PC with new programs that run under Windows that reduce steep learning curves, as reviewed in our Special Report article beginning on page 20.

Cover Photo by Larry Mulvehill

## Choices

*"When you have to make a choice and don't make it, that in itself is a choice."—William James.*

**Computer owners** have a wide range of choices to make when either buying a machine or software and enhancing their systems. If you stick with an older model, it may well satisfy your limited needs or, perhaps, you can't justify spending the additional money to move into the current PC world.

Upgrading isn't necessarily cheap. For example, if you want to upgrade to a 486 system that typically would have a 120M hard drive and 8M of RAM from a 386 machine with a 40M drive and 2M of RAM, it'll cost you around \$1,100, according to the Microcomputer Managers Association. MMA further estimates that buying *Windows* software, the likely reason for such a change, would cost you about \$835. Adding in networking hardware and software, and training, service and support if this is being done in a corporate environment, would cost another \$2,000.

The Association offers a \$50 64-page booklet that includes a Lotus 1-2-3 spreadsheet on-disk for anyone who wants to calculate upgrades from a DOS-based system to a Microsoft *Windows* one. Call MMA at 908-580-9091 in Warren, NJ for more information.

An upgrade move to OS/2 or *Windows NT* would cost much more, owing to their expansive memory requirements, which means a larger-storage-capacity hard drive and more user memory.

When it comes down to it, you'll have to decide if the benefits of an upgrade warrant the expense, of course.

There are all sorts of other options for computer users to consider. Among the leading ones is the addition of a CD-ROM drive. More and more people are making this upgrade choice. Prices are expected to drop as sales volume, which hit \$4-billion in 1992 for drives and titles, increases.

Once you narrow your enhancement choice to a particular function, a buy-

ing decision still isn't easy because you hit a set of confusing options: access speed, Kodak Photo CD compatibility and data-transfer rate, among them. Then you'll have to consider the likelihood of moving into multimedia audio, which is a natural adjunct to a CD-ROM addition. Here, you will again face a number of choices.

Then, again, maybe your work points to data acquisition, local area networking, large-screen high-resolution monitor, pen plotter, mobile notebook computer or other devices to meet your needs. The choices are wide ranging.

Work-at-home, travel and in-the-office equipment and software needs differ, too. So basically, you have to customize your requirements and make the best choices you can to obtain the most benefits from them.

It's foolish, I think, to rush into buying new equipment and software just because it's in vogue. After all, every time you turn around there'll be new equipment and software that "everyone" should have because it's the latest and greatest. I don't. For example, I'm still waiting a while before upgrading to MS-DOS 6.0. I prefer to wait until the dust settles on reports from some people that their hard-disk data is being trashed while working with the new OS. Furthermore, I'm happy with my present software compression program (ITT), and so don't need the one integrated into 6.0.

*Windows 3.1* was another story. Version 3.0 was a dog. Still, more than half my programs are DOS versions. But all my new programs are *Windows* versions because the learning curve isn't as steep with them as it is with DOS-version applications. Like most people, I weighed the benefits.



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**Foreign Correspondence**

• Since I found *ComputerCraft* in a Hong Kong bookstore and think it is just the type of computer magazine I've been looking for. While other computer magazines talk about software and general issues, I believe that a lot of people like myself have more of a need for the type of hands-on information *ComputerCraft* provides. Therefore, please enter my subscription for three years.

N. Pratomo  
People's Republic of China

**Wrong Identity**

• Please note that the wrong photo accompanies the Intermatic "Side-Entry Surge Protectors" new product entry on page 84 of the February issue of *ComputerCraft*. Enclosed is the correct photo.

Mike Nikolich  
Intermatic  
Spring Grove, IL



**Writer Boosters**

• I have been reading Jan Axelson's articles for about two years. I found many useful articles that help me in my daily job as Production Engineer where I work. One of my major duties on the job is to support the electronics production department, for which I design and build automatic test equipment for my company's products.

I also read Hardin Brothers' "Getting Started in C++" article in the July 1992 issue of *ComputerCraft* and found it to be very interesting and

informative because I'm new to C programming and look forward to mastering it and ultimately moving on to C++. At present, I use Borland's C++ 2.0 compiler and associated tools.

Robert D. Harris  
Brownsville, TN

• I thoroughly enjoy your publication, especially Jan Axelson's and Scott Edwards' articles. *ComputerCraft* always has articles that are technically interesting and informative for do-it-yourselfers like me.

Daniel Derrow  
Ft. Wayne, IN

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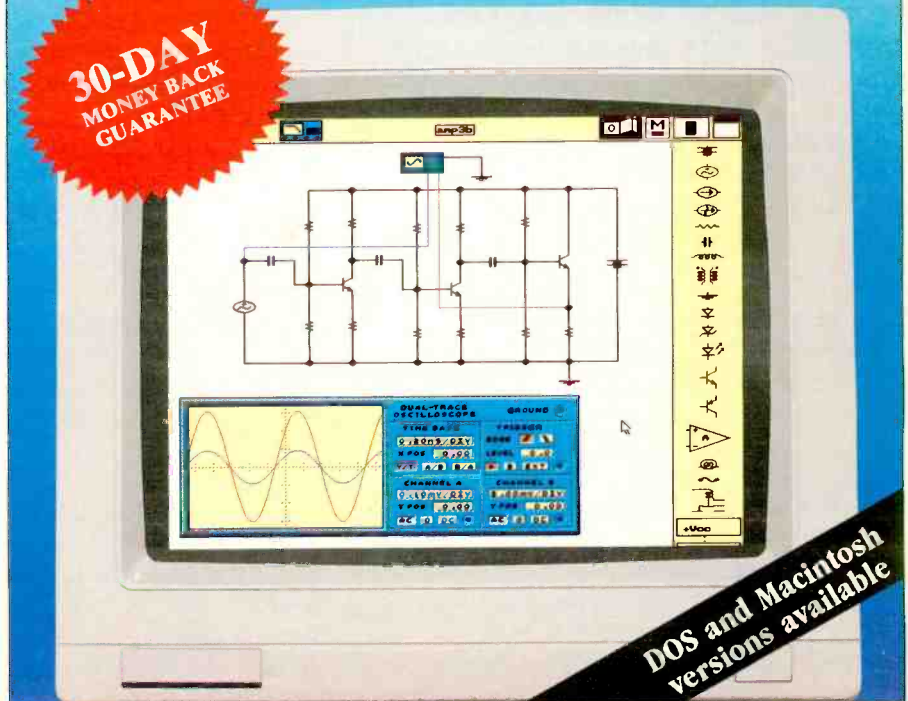
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## What's Happening!

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**LATEST OPERATING SYSTEMS.** Both IBM and Microsoft announced new operating systems. IBM's OS/2 2.1 adds enhancements that include seamless support for Microsoft Windows 3.1 such as Win 3.1 display and printer drivers, selected TrueType fonts, and launching OS/2 and DOS applications from a Windows application; 256-color SVGA device driver support; driver support for CD-ROM drives; Advanced Power Management support; PCMCIA card enabling; and MMPM/2 for multimedia applications. The long-awaited Windows NT is now at hand, too, with a May 24 debut. Let the battle be joined.

**486 HAND-HELD PC WEIGHS 2.2 LB.** Dauphin Technology (Lombard, IL) announced its Dauphin Desktop Replacement (DTR-1), a 486SLC-based hand-held computer with total DOS/Windows compatibility in a 2.2-lb. package. The \$2,500 model has a mini keyboard, 6" back-lit VGA display, standard I/O ports, pen input and built-in communication capabilities that include an internal ethernet adapter and internal fax/modem. It measures about 9" x 5-1/2" x 1-1/4", and can be hooked up to a full-size keyboard and external SVGA monitor. An IDE port allows for use of an optional external hard drive. The unit is powered by an 8-hour battery pack.

**COMPUTER LEARNING AIDS.** NEC has devised a new way to teach basic principles of computer programming to children with a new system called "Algoblock." It's a set of physical blocks that can be connected to one another manually to form a program, with each block corresponding to a program language command. Blocks are connected to a computer that executes the program, with results displayed on a monitor. Furthermore, each block has a lamp that flashes when a command is executed, enabling learners to trace programs. A debug mode allows tracing a program step by step. Popular Monarch Notes Study Guides are now available on floppy disk. They come in five volumes, covering Nineteenth and Twentieth Century literature (\$49.95 each) and the complete works of Shakespeare (\$59.95), which includes 25 study guides. Prices are about half that of printed book versions. The products are from the Bureau of Electronic Publishing, Parsippany, NJ., which also develops CD-ROM markets.

**"TOUCHSURFACE" DEVELOPER KITS.** Intelligent Music (518-434-4110) has TouchSurface developer kits available for \$250 each for GUI and input control applications. Kits come as stand-alone pointing devices or as a panel-mounted pointing device components. Both draw power from a PC's RS-232 serial port at less than 6 mA. The kit consists of a sensor that's based on thick film resistive ink technology, a measurement circuit and a microcontroller. A Windows 3.0/3.1 device driver and control panel are included. An analog interface is optional. Position is sensed by pressure from either a finger or a stylus.

**FAX FOR BBS'S.** Galacticom (Ft. Lauderdale, FL) unveiled an on-line fax add-on option for the Major BBS, providing system operators with a fax service for their users. The software is available directly from the company (800-328-1128). For an on-line demonstration, dial 305-583-7808 [N,8,1] with a modem.

**NEW INK-JET PRINTER PAPER.** Micro Format (Wheeling, IL) introduced a new paper product for use with ink-jet printers, named "Super Color." It uses a special coating on one side of the sheet that captures the colored ink, preventing it from being absorbed into the paper grain. As a result, it's said to provide a brightly colored image while using less ink. On the reverse side of each sheet, which is uncoated, is a shadow printing of the Super Color logo. Printing on this side, the image is dull with a washed-out appearance, according to the manufacturer.

**Includes AT-compatible computer plus diagnostic hardware and software!**

# Earn good money full-time, part-time, on the job, or in a new career as a PC Troubleshooter!

There's no doubt about it: Businesses spend billions of dollars on personal computers each year, even more on PC service and support. That's why Department of Labor Statistics show skyrocketing employment opportunities for PC troubleshooters — people with the hands-on skill to diagnose system failures, replace damaged chips, retrieve lost data, or troubleshoot faulty disk drives and circuit boards.

Now with NRI, you can be the one "in-the-know" when it comes to keeping today's PC systems running at peak performance. Only NRI gives you the computer, the software, and the PC troubleshooting skills to make a name for yourself in your present job, even start a money-making new career.

## Your training includes a powerful AT-compatible computer system complete with 40 meg IDE hard drive

NRI training gives you a practical understanding of today's PCs...how they work, what can go wrong, and why. Best of all, you master state-of-the-art troubleshooting skills through hands-on training with a powerful AT-compatible computer, 40 meg IDE hard drive, and professional diagnostic hardware and software — PC Tools, R.A.C.E.R., and Quicktech — all yours to keep!

As you work with your computer and software, you learn how to localize PC problems, identify faulty components, recommend system configurations, and replace the damaged parts that cause PC system failures. Plus you get hands-on experience with the diagnostic tools used by the pros to keep systems up and running in today's PC-driven business world.

## No previous experience necessary — only NRI gives you everything you need to succeed

NRI's step-by-step lessons and unique hands-on Discovery Learning projects prepare you completely for the real-world challenges of PC troubleshooting. Backed by the full support of your personal NRI instructor, you begin by covering important computer fundamentals — hardware and software essentials, system configurations, plus methods and procedures that show you how to localize PC problems to specific circuit boards or replaceable parts.

Then you move on to master vital PC system commands, using the MS-DOS software included in your course. You learn to resolve user error messages that commonly occur when working with spreadsheets, databases, word processors, and other PC applications. Then you take your skills further, discovering how to use DEBUG and assembly language programming to troubleshoot problems in PC operating systems and hardware. But that's not all...

## Train with and keep today's top diagnostic and utilities software — PC Tools

With NRI training you get first-hand experience with professional diagnostic software that makes troubleshooting PCs easy and profitable. Using PC Tools — today's top utilities software package — you

*"I've located the problem. Your data has been completely recovered."*

master skills that put you in command when it comes to retrieving lost data, handling disk drive failures, even correcting installation problems.

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## Get hands-on troubleshooting experience with in-demand diagnostic hardware and software from Ultra-X

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By the time you complete your course, you have every basic skill you need to diagnose PC system problems fast, efficiently, and

economically. Plus you have the computer, the software, and the hands-on experience you need to start making money immediately as an NRI-trained PC troubleshooter.

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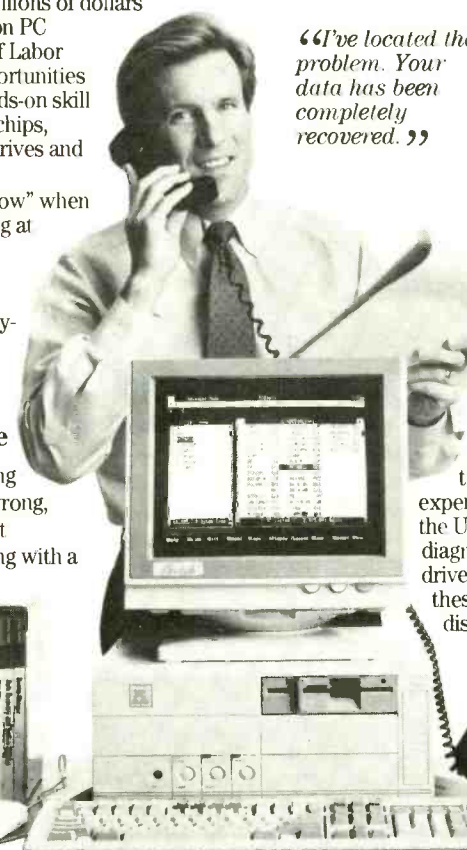
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## New PC Diagnostic Version

*Micro-Scope* Version 5.0 from Micro 2000 is an operating-system-independent PC diagnostic software package that adds in excess of 125 enhancements and additions to the features that were provided in the earlier version. These include a unique ability to low-level reformat any IDE drive. It fully tests cache memory and the cache controller system. Memory testing enhancements include the ability to test system memory, even if a PC has system memory problems that make it impossible to load the program.



The program reads and displays actual parameters for any drive type without the need for operator intervention. \$499. *Micro 2000, Inc., 1100 E. Bway., Ste. 301, Glendale, CA 91205; tel.: 818-547-0125; fax: 818-547-0769.*

CIRCLE NO. 1 ON FREE CARD

## Upgradeable PC With VESA Local Bus

Micro Express's MicroFLEX-VL is a powerful, low-cost VESA-standard local-bus PC that's been designed to be upgradeable from a 386DX/33 to a Pentium microprocessor. In addition to the entire range of Intel CPUs, MicroFLEX-VL accepts microprocessors from Cyrix and AMD and the 486DX/50 CPU. The system contains a local-bus video card that provides resolutions up to



1,280 × 1,024 pixels with high-color (32,768 colors) at up to 1,024 × 768, and true-color (6.418-million colors) at a resolution of 640 × 480.

A typical system contains 4M of RAM, 256K of cache RAM, a 120M hard drive, a 33-MHz 486 CPU, a VESA local-bus graphics card, 5 1/4" and 3 1/2" floppy drives, a 14" SVGA video monitor, a mouse, a keyboard, DOS 6.0 and *Windows* 3.1. \$1,680 as described. *Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705; tel.: 714-852-1400; fax: 714-852-1225.*

CIRCLE NO. 2 ON FREE CARD

## PC-Compatible SBC

The NMIX-0025 from New Micros is a PC-Code compatible V25-based CPU board for the 100-squared series. Features include: programmable interrupt controller; two DMA controller channels; three parallel ports; two asynchronous serial channels; eight-channel voltage comparator; timebase counter; 16-bit timer; programmable wait-state generator; 1/4K RAM internal to the processor; 1M address space; three 32-pin JEDEC memory sockets; flexible address decoding and socket assignments; battery backup for memory; and 44-pin JEDSTACK connector. This complete system is ready to run for dedicated applications. You need only supply an application program. \$250. *New Micros, Inc., 1601 Chalk Hill Rd., Dallas, TX 75212; tel.: 214-339-2204.*

CIRCLE NO. 3 ON FREE CARD

## PC Oscilloscope

CompuScope 1012 is a 10 mega-sample-per-second, 12-bit PC-based oscilloscope card that fits into any single available slot in an AT or better computer. Its 12-bit analog-to-digital conversion provides 16 times the vertical resolution achievable by eight-bit conversion. It comes with *GageScope* software that enables you to operate the card as though it were an actual oscilloscope,

without writing a single line of code. The program allows you to store, analyze and print data.

Key features include 12-bit resolution, 10-MS/s sampling rate on two simultaneous channels, 65-dB dynamic range, 768K memory depth for one channel or 384K per channel for two channels, programmable-gain input, self-calibration, programmable input coupling, internal or external trigger capability, software drivers and an ergonomic interface. \$4,995. *GaGe Applied Sciences Inc., 5465 Vanden Abeele, Montreal, QB, Canada H4S 1S1; tel.: 514-337-6893; fax: 514-337-8411.*

CIRCLE NO. 4 ON FREE CARD

## Low-Cost Ergonomic Keyboard

MiniErgo from Marquardt Switches is a scientifically designed keyboard that was developed in Germany to help reduce the growing risks and costs associated with repetitive stress injury (RSI). Designed for the comfort and productivity of PC users who do extensive word processing and data entry, the MiniErgo keyboard has a split V-shape configuration to help naturally align hands and wrists in attitudes that produce less straining. The keyboard features a non-glare surface and has generous resting areas for the hands, sculptured key caps in the standard QWERTY layout, embedded numeric keys or an optional numeric pad.



MiniErgo is compatible with AT and PS/2 and compatible systems. \$179. *Marquardt Switches Inc., 2711 Rte. 20 East, Cazenovia, NY 13055; tel.: 315-655-8050; fax: 315-655-8042.*

CIRCLE NO. 5 ON FREE CARD

## Voice-Recognition Software

Covox's *Voice Blaster* is a software application that brings powerful voice-recognition capabilities to popular sound cards and keystroke-intensive applications. Designed to increase personal productivity by adding a voice-command interface that can be tied to keyboard and mouse macros, *Voice Blaster* runs on Intel-based personal computers operating under DOS and *Windows* 3.1 environments. The system includes a toolbox of newly-revised programs and utilities for recording, editing and playing back, as well as voice-annotation software that lets you add your own recorded messages to documents.

Installed as a TSR, the *Voice Blaster* program requires 21K of user RAM and a minimum of a 286 PC (a 386 or better PC is recommended). \$120. *Covox Inc. 675 Conger St., Eugene, OR 97402; tel.: 503-334-1271; fax: 503-342-1283.*

CIRCLE NO. 6 ON FREE CARD

## CMOS Backup

*Knowsave* from Tellerware reads data from your computer's power-on CMOS memory chip and stores it on a floppy disk, to be used later in an emergency. If the back-up battery in your computer goes dead, simply replace it (*Knowsave* even gives you instructions to do this) and restore the CMOS data from your "emergency disk." *Knowsave* monitors battery condition and warns you of imminent failure. \$40. *Tellerware, 1872 Rampart Lane, Lansdale, PA 19446-5051; fax: 215-368-5072.*

CIRCLE NO. 7 ON FREE CARD

## Computer-Controlled Home

*Dynasty for Window* from Home Automation Laboratories (HAL) lets you create graphical pictures from a drawing program or scanned images and combine them with animated icons that represent lights, appliances and other control functions of your home's many subsystems. Special hardware



interfaces connect your computer to the real world, using any of several communication technologies, all coordinated by the *Dynasty for Windows* software.

X-10 signals can be used to operate lights and appliances without any re-wiring because the signals travel along the ac wiring that already exists in your home. Wireless radio signals make it possible to have home security monitoring without the need to run new wires. Hard-wire connections are also available for garage doors, temperature and daylight measurement and telephone communication. \$495. *Home Automation Laboratories, 550 Highlands Pkwy. Ste. 450, Smyrna, GA 30082-5141; tel.: 404-319-6000; fax: 404-438-2835.*

CIRCLE NO. 8 ON FREE CARD

## High-Tech Exercising

Computer Athlete's *ExerCitement!* software transforms ordinary exercise equipment into extraordinary fitness entertainment centers by simply attaching the adjustable button straps and aligning an infrared light sensor. Your exercise rate corresponds with the speed of your player, and the left and right mouse buttons allow you to navigate through the game while you work out on your exercise bike, stepper, treadmill, cross-country or rowing machine. You just pop the *ExerCitement!* game diskette into your PC, plug the interface cable into your game/joystick port, and you're off on a challenging adventure cycling down a winding road, skiing over a snowy path or rowing on open water.



This arcade-style fitness program turns the seemingly endless minutes of exercise into a fun-filled adventure through an action-packed course. Along the way, you score points by avoiding obstacles, menacing characters and knocking over competitors. \$159. *Computer Athlete Inc., 5193 Betonywood Pl., Dublin, OH 43017; tel.: 800-860-4506.*

CIRCLE NO. 9 ON FREE CARD

## Graphics BBS Program

Paragon's *DarkStar* is an entirely graphics-based BBS platform for IBM/compatible computers that offers an array of features that aren't available under current ANSI-based technology. When connected via *CommLink*, a companion communications program, *DarkStar* provides real time PCX and GIF images, icons and MOD digital audio to the terminal user through an intuitive multimedia interface. Mouse and touch-screen are supported.

*DarkStar* utilizes selective caching methods on the terminal side to permit a 2,400-bps user access to unchanged screens and menus on the BBS, at speeds approaching a 115, 200-bps throughput. \$149. *Paragon Technologies, 2409 Dogwood, Rogers, AR 72756; tel.: 501-631-9806; fax: 501-631-5976.*

CIRCLE NO. 10 ON FREE CARD

## Miniature Lightning Suppressor

Telebyte's new Model 29 single-stage lightning suppresser is compatible with COM ports on all 286/386/486-based PCs that use RS-232 and RS-422 serial interfaces. It protects ports that support long cable runs that are subject to close-proximity lightning strikes. It installs between the serial data cable and DB-9 data port. The power-handling capability of each line is rated at 600 watts peak pulse.

The Model 29 uses nine avalanche diodes that react in less than 2 ns as the active suppression devices. All diodes are

# PC's & Parts

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486/33 128K CACHE	\$459
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486/66 256K CACHE	\$649

All Boards with CPU's. All are AMI BIOS with OPTI or other C/S. Mini size fits nearly all cases. Std. power conctrs. Fax Fact #

## COMPLETE PC's

486/33DLC with 64k SRAM Cache, 4 megs RAM, 1.44 Floppy, 16Bit Dual (1:1) HD/FD controller, 1 Parallel 2 Serial Ports, 101 Key Enhanced keyboard, Mini tower case, SVGA Monitor w 1MB card, 130 meg HD.	\$995.00
--	----------

## SYSTEM OPTIONS

### DRAM

1 Meg SIMMS 3 chip	\$38
1 Meg SIMMS 9 chip	\$39
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All SIMMS are 70 ns speed. Call for faster speeds & DIP or SIP packages. Fax Fact # 1112

### HARD DRIVES

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130MB 16 MS	\$229
210MB 15 MS	\$289
245MB 14MS	\$329

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### FLOPPY DRIVES

1.44MB, 3.5 inch	\$52
1.2MB, 5.25 inch	\$55

### MONITORS

12" Amber Mono	\$89
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14" SVGA .28 Int'l'ace	\$219
14" SVGA .28 Non/IN	\$279
17" SVGA Non/IN	\$589
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SVGA Card 1M	\$89
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CIRCLE NO. 52 ON FREE INFORMATION CARD

August 1993 / COMPUTER CRAFT / 7

## DOS 6.0 Books

### Dan Gookin's Guide To Underground DOS 6.0

By Dan Gookin

*(Bantam Computer Books. Soft cover. 409 pages. \$24.95)* If you're looking for a guide to DOS 6.0, forget this book. Virtually nothing in it is specific to DOS 6.0. But if you're looking for a good guide to the inner workings of any recent version of DOS, be sure to give it serious consideration. This book isn't dedicated to the undocumented aspects of DOS, just those poorly-documented ones that can turn an appliance operator into a power user.

This book is divided into three parts: Part I contains general information about how the PC works, how DOS works and how you can maximize your use of the other two. Chapter 1 provides a detailed look at what happens when a computer is booted, both a cold and warm boot. What CONFIG.SYS is and how it works is covered in the Chapter 2, while COMMAND.COM is dissected in Chapter 3 and Chapter 4 takes a detailed look at AUTOEXEC.BAT. Chapter 5 delves into the mysteries of DOS "Devices." Chapter 6 is dedicated to the keyboard, ANSISYS, and DOSKEY.

Part II offers an introduction to using DEBUG and gives you training on the finer points of DEBUG operations. Chapters 7 and 8 deal directly with DEBUG and the hex number system. PC memory topics are covered in Chapters 9 and 10, while chapter 11 deals with disks and DEBUG. The microprocessor is examined in Chapters 12 and 13.

Part III is an advanced course in exploring the inner workings of the PC—what was once called hacking, before that word became synonymous with telecommunications criminals. Chapters 14 and 15 are devoted to exotic memory topics. Disks and files are covered in Chapter 16, while Chapter 17 is devoted to file editing with DEBUG. Finally, Chapter

18 teaches you how to program in DEBUG.

It's unfortunate that the publisher felt the need to tie this book to the new version of DOS with a misleading title. This book will stand on its own, both technically and for a "readability." If there's any justice in the marketplace, this book should be a runaway best seller.

### DOS 6.0 Handbook

By Jim Nimersheim

*(Bantam Computer Books. Soft cover. 572 pages. \$27.95)* In this new revision of the author's earlier series of books on DOS, Part I is a tutorial on the workings of DOS that's basic enough for the novice computer user but detailed enough to be useful to, say, the intermediate DOS user. Chapters 1 and 2 contain introductory material to DOS. Working with disks is covered in Chapter 3, while directories and files are the topics of Chapters 4 and 5, respectively. Chapter 6 covers devices and drivers. Fine tuning the system is the topic of the seventh chapter. The new MSBACKUP utility is detailed in Chapter 8, along with mention of BACKUP and RESTORE from earlier DOS versions. Chapter 9 is devoted to batch files, with emphasis on how to use and write them. Finally, Chapter 10 delves into the new features of DOS 6.0, particularly DEFrag and DBLSPACE.

Part II consists of a DOS command reference section. The author's writing style makes this section particularly clear and easy to read and understand, even for the more-obscure DOS commands. More than half of this book is taken up by this Part. Two appendices that deal with installation and the DOS Shell round out this volume.

Given the paucity of support documentation that Microsoft supplies with DOS 6.0, you'll probably want one or more DOS reference texts available. This volume should be among those you consider for your bookshelf.

returned to a central ground point, where a ground stud is used. Telebyte supplies a 2-foot heavy-gauge ground wire to provide a low-impedance path to the PC's frame or other known ground.

The Model 29 has both male and female connectors for compatibility with all DB-9 serial interfaces. It's available in two variations. The Model 29 is for RS-232 levels, the Model 29-1 for RS-422 levels. The latter can also be used for the new EIA-530 and MIL-STD-188-114 interfaces. Both versions measure 2.7"L x 1.2"W x 0.75"H. \$44. *Telebyte Technology, Inc., 270 E. Pulaski Rd., Greenlawn, NY 11740; tel.: 1-800-835-3298 or 516-423-3232; fax: 516-385-8184/7060.*

CIRCLE NO. 11 ON FREE CARD

### Intelligent Diagrams

*ADS Diagrammer for Windows Version 2.0* from Atlantic Design Systems is a drawing tool that lets you add intelligence to your diagrams. Unlike simple vector images, *Diagrammer's* objects know how they relate

to other objects, other diagrams and data generated by other applications. *Diagrammer* uses this knowledge to automatically maintain object connections, notes attached to shapes, hierarchical links between diagrams and OLE links to other applications. These capabilities, combined with the program's flexible drawing tools, make it easy to create flowcharts and a wide variety of other business and technical illustrations. \$295. *Atlantic Design Systems, 77 Sprucewood Dr., Gilford, NH 03246; tel.: 603-524-2943; fax: 603-524-3657.*

CIRCLE NO. 12 ON FREE CARD

### Multi-Platform WYSIWYG Publishing Package

*WiziWord 3.0 for Windows* from MEC is a multi-platform publishing product that combines WiziWord document processing, WiziDraw object-oriented drawing, WiziPlot plotting, WiziText equation editing and both text and graphics filters. Because *WiziWord* has identical file formats

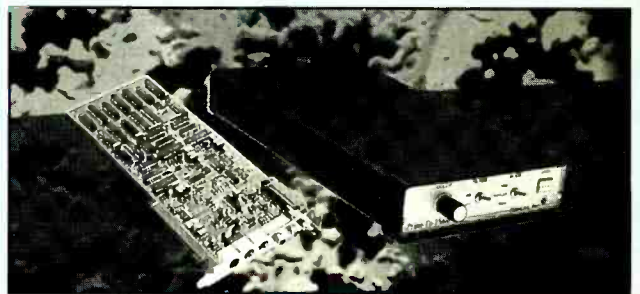
### Low-Cost Video Output

*Print To Video* from VideoLinx is a Genlock-Overlay-Encoder designed specifically for applications where conversion of computer graphics into high-quality NTSC video is essential. Animations, titles, presentations, etc., can be effortlessly converted to NTSC video because *Print To Video* is totally transparent to your system's hardware and software. With up to 262,000 simultaneous colors available at a resolution of 640 x 480

pixels. *Print To Video* exceeds the color limits imposed by feature-connector-based encoders. What sets the *Print To Video* apart from similar products is its 100% hardware and software compatibility and studio-quality video.

*Print To Video* is claimed to work with any VGA card at any color resolution. \$595/\$695, bus board/stand-alone. *VideoLinx, Inc., 987 University Ave., Ste. 10, Los Gatos, CA 95030; tel.: 408-395-9593; fax: 408-395-9594.*

CIRCLE NO. 13 ON FREE CARD



across all supported platforms, it's claimed to offer complete interoperability among supported platforms.

Topping the list of enhancement is WiziTeX, a powerful WYSIWYG equation, which is based on TeX the mark-up language developed by Donald Knuth. You can create equations by pointing and clicking on symbols and icons or by typing in the TeX language. Using the split-screen option, the visual equation is displayed above while, the TeX language is shown below.

WiziWord 3.0 also has a full-function list processor for personal databases and mailing lists. \$595. MEC, 2500 W. Higgins Rd. Ste 950, Hoffman Estates, IL 60195; tel.: 708-882-0111; fax: 708-882-8397.

CIRCLE NO. 14 ON FREE CARD

## Parallel-Port Voltage Meter

The Model ADIO10 parallel-port voltage meter from B&B Electronics has eight analog

inputs with a range of from -5 to +5 volts dc. Its conversion time is rated at less than 5 s per channel. Plugging into a computer via its parallel port, this unit is claimed to have the speed, resolution and flexibility required for use in lab experiments and with various sensors and potentiometers.



The ADIO10 can operate in three modes: Single Ended, Differential and Pseudo Differential. In Single-Ended mode, its eight input channels are converted with respect to a reference. In Differential mode, the inputs are grouped into pairs, and the voltages are converted with respect to each other. All inputs are converted with respect to a single input in Pseudo Differential mode.

The unit comes with a manual and program disk. It measures 3.8" x 2.4" x 0.9" and features 10-bit resolution. B&B Electronics, 4000 Baker Rd., PO Box 1040, Ottawa, IL 61350; tel.: 815-434-0846; fax: 815-434-7094.

CIRCLE NO. 15 ON FREE CARD

## Windows HiJaak

HiJaak PRO 2.0 is an upgrade of Inset Systems' graphics management program for Windows. It lets you view, convert, capture, enhance and print graphic images in the Windows environment. Significant portions of the previous version of HiJaak for Windows were rewritten with performance in mind. A summary of new features includes: performance increases in the speed of file loading, zooming and scrolling; an improved user interface as a result of usability tests conducted by an independent laboratory; new graphics format support for Photo CD, JPEG, TIFF 6.0, ED5, GED and Sun

raster; transparent import of more than 70 graphics formats into most major applications through compliance with the Aldus Graphics Import Filter specifications and the WordPerfect for Windows API; TWIN support for scanner and electronic-camera image devices; a HiJaak Browser preview that automatically keeps track of image files; and free color metafile clipart from a leading clipart vendor. \$169/ free upgrade for HiJaak For Windows registered users. Inset Systems, 71 Commerce Dr., Brookfield, CT 06804-3405; tel.: 203-740-2400; fax: 203-775-5634.

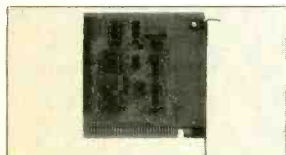
CIRCLE NO. 16 ON FREE CARD

## TouchMate Driver For DOS

Visage has a new DOS driver for its TouchMate, a computer peripheral that turns any PC monitor into a touch screen. It works with any mouse-driven DOS program. Previously,

(Continued on page 79)

# AFFORDABLE DATA ACQUISITION



MODEL 30 ..... \$79.00

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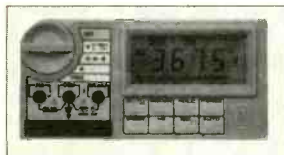
MODEL 45 ..... \$189

- RS-232 INTERFACE
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- 2 ANALOG OUTPUTS
- 2 COUNTERS-24 BIT



MODEL 70 ..... \$239

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- UP TO 60 SMP/SEC



MODEL 150-02 .. \$179

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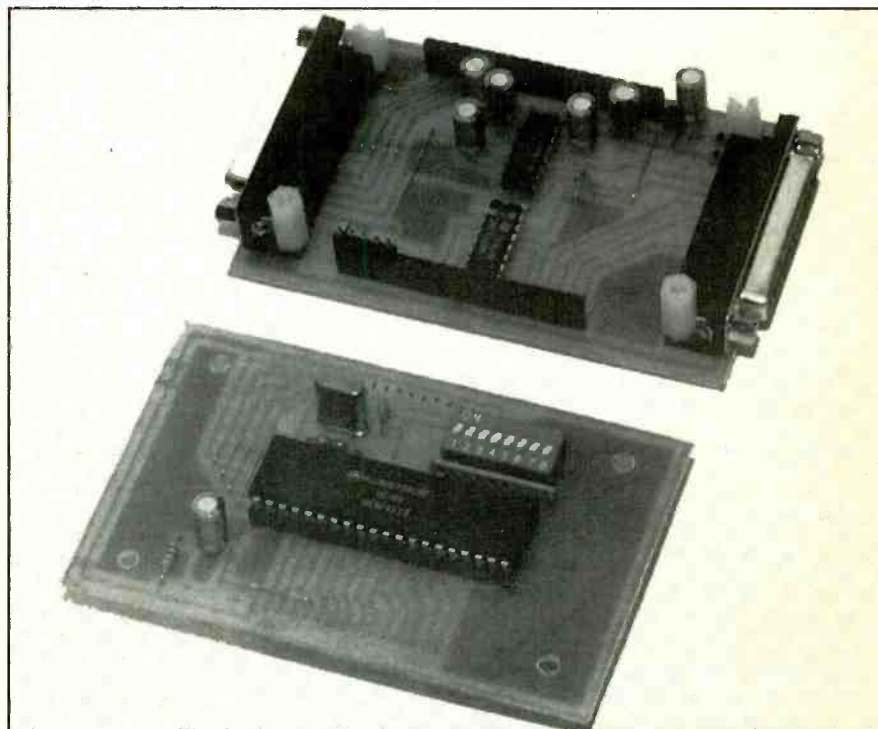
# Build a Cybernetic Key

## Protects your software and hardware from piracy

You've just developed proprietary software or hardware. Now you want to protect it from unauthorized use. At this juncture, you have several commercial options from which to choose. However, if true security is what you're after, you need look no further than the build-it-yourself Cyber Key I'll describe in these pages. By attaching this simple, inexpensive device to a serial port on your computer, you can limit and deny access to any or all of your programs to unauthorized users. In addition to providing this "lock-and-key" function, you can use Cyber Key as a data-stream encryption/decryption device and serial protocol converter.

You might be wondering why you should choose to build a cybernetic security device like Cyber Key rather than simply purchasing one of the dozens of similar such products you may have seen advertised. If you opt for a commercially available hardware key, you're almost certain to discover in short order that it's nothing more than a ROM or EPROM that contains some programming code critical to the operation of the software or hardware it's designed to protect. Cyber Key goes far beyond this basic arrangement. Because it's *intelligent*, you can use a Cyber Key in several ways that aren't possible with commercial security devices. Let's look at a few of these:

- Connecting Cyber Key to a serial port on your computer in series with a serial peripheral like a modem, printer or plotter, provides security protection for your proprietary software or hardware.
- You can access Cyber Key from within BASIC, C and assembler programs or with TSR and "hot-key" routines.
- With Cyber Key, you even get on-the-fly data-encryption functions similar to the DES (Data Encryption Standard) protocol.
- Use Cyber Key to automatically generate CRC (cyclic redundancy check) and FEC (forward error correction) codes (BCH or Reed/Solomon) for use with long-distance and wide-area data-communication networks.



• Use Cyber key as a serial protocol converter to translate control codes originally designed to work with one printer or plotter to a different format.

As you can see from the foregoing, Cyber Key could prove to be very useful to you, whether you use it in a commercial setting or simply to experiment with around your lab.

### About the Circuit

Cyber Key actually consists of two separate circuit sections, identified as the Interface and Processor cards. The schematic diagram for the complete circuitry is shown in Fig. 1. (The separate Interface and Processor sections are easier to visualize by referring momentarily to Fig. 3.)

As its name implies, the Interface Card provides direct-connect access to RS-232C data lines. The Processor Card controls the flow of data across the interface. In most instances, Cyber Key monitors the flow of data to and from the serial peripheral and monitors for certain

"key" commands. Once issued by the host computer, these commands trigger Cyber Key to either intercept and modify the data stream flowing to and from the peripheral or to supply data directly to the peripheral or host computer.

My favorite application for this project is a scheme in which the control program I wish to secure receives critical portions of its execution code directly from Cyber Key on a need-to-know basis. This technique can make the software being protected extremely difficult to "hack" because the cybernetic-exchange process is dynamic and depends heavily upon the execution stream of the program itself! When you couple this with the fact that Cyber Key's processor has an internal security bit that, once set, inhibits access to its internal program, you can develop a very secure execution environment for your program.

In the Fig. 1 circuit, MAX232 interface *U3* is converts the RS-232C signal levels that swing between +12 and -12

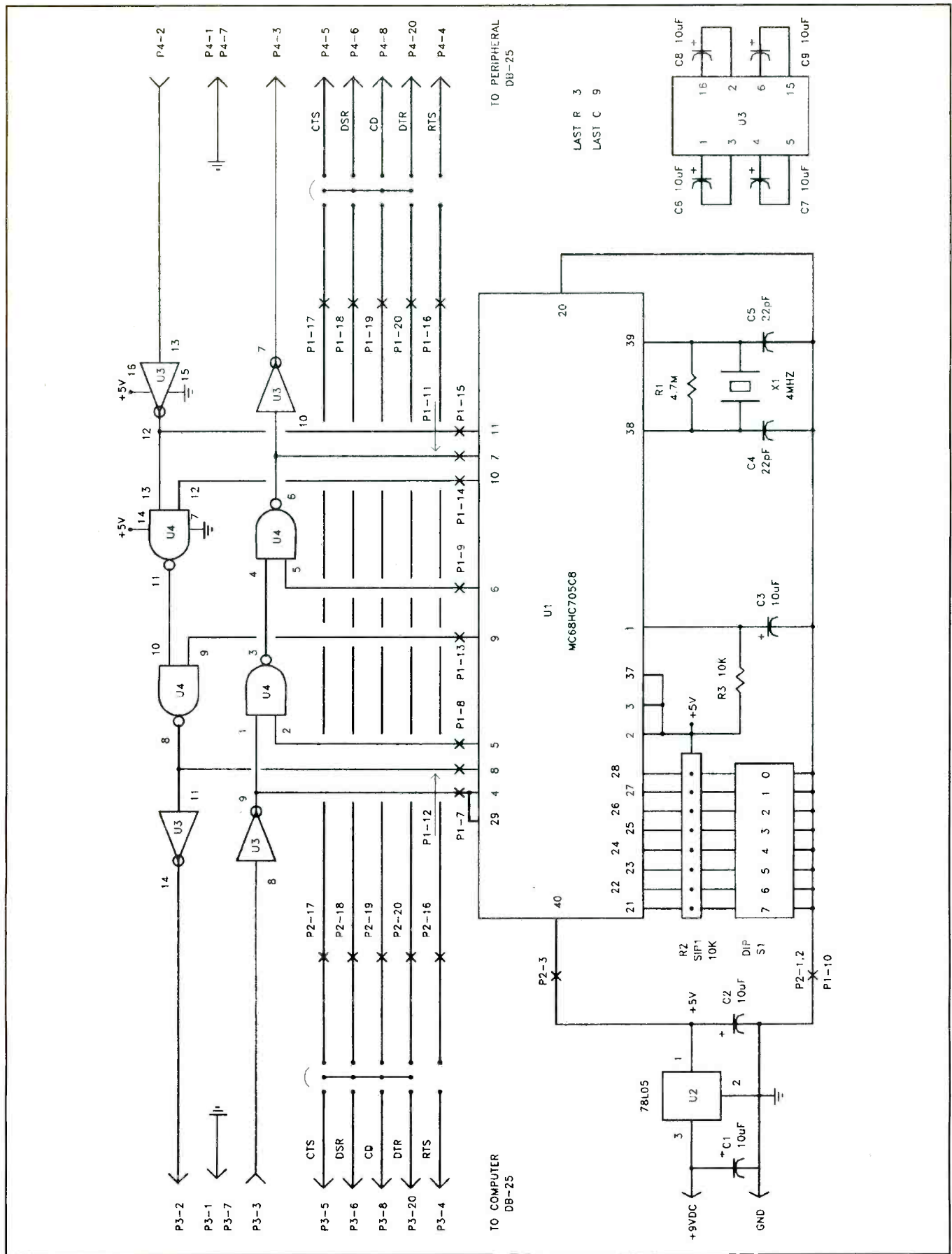


Fig. 1. Complete schematic diagram of Cyber Key circuitry. Note that it consists of two parts: Interface and Processor sections.

## PARTS LIST

### Semiconductors

- U1—MC68HC705C8P microcontroller (Motorola)
- U2—78L05 fixed +5-volt low-power voltage regulator
- U3—MAX232CPE RS-232C interface
- U4—74HC00 quad two-input gate

### Capacitors

- C1,C2,C3,C6 thru C9—10-F, 16-volt electrolytic
- C4,C5—22-pF, 50-volt ceramic disc

### Resistors (1/4-watt, 5% tolerance)

- R1—4.7 megohms
- R2—10,000-ohm eight-position SIP resistor pack
- R3—10,000 ohms

### Miscellaneous

- S1—Eight-position DIP switch;
  - X1—4.000-MHz crystal
  - P1,P2—20-position SIP connector
  - P3,P4—Pc-mount DB-25S connector
- Printed-circuit cards (2; see text); 9-volt, 100-mA dc power-supply module; 40-pin DIP IC socket; nylon spacers; machine hardware; suitable enclosure (optional; see text); hookup wire; solder; etc.

**Note:** The following items are available from Cyance Kit, 14786 Slate Gap Rd., West Fork, AR 72774 (tel.: 501-839-8293, Ext. 3): Ready-to-wire Interface and Processor pc cards, \$7.95 each; custom aluminum enclosure, \$9.95. Also available is a complete kit of all Cyber Key components, including pc boards, painted aluminum enclosure, power-supply module, connectors and electronic components except the MC68HC705C8P microcontroller, \$39.95. Other separately available items include: MC68HC704C8P microcontroller OTP (one-time-programmable) and EPROM versions for \$14.95 and \$29.95, respectively. The Cyber HC5 Development System for programming U1 is available for \$89.95. MC and Visa accepted. Arkansas residents, please add state sales tax.

volts into TTL levels that swing between 0 and +5 volts. As the various signals are converted from RS-232 to TTL levels, U4 intercepts them and allows processor U1 to monitor and control the flow of data.

MC68HC705C8P microcontroller U1 is crystal controlled by X1 and associated oscillator circuitry. A 4-MHz crystal is used to synchronize the standard RS-232C baud rates to and from the host computer and peripheral.

Eight position DIP switch S1, connected to pins 21 through 28 of U1

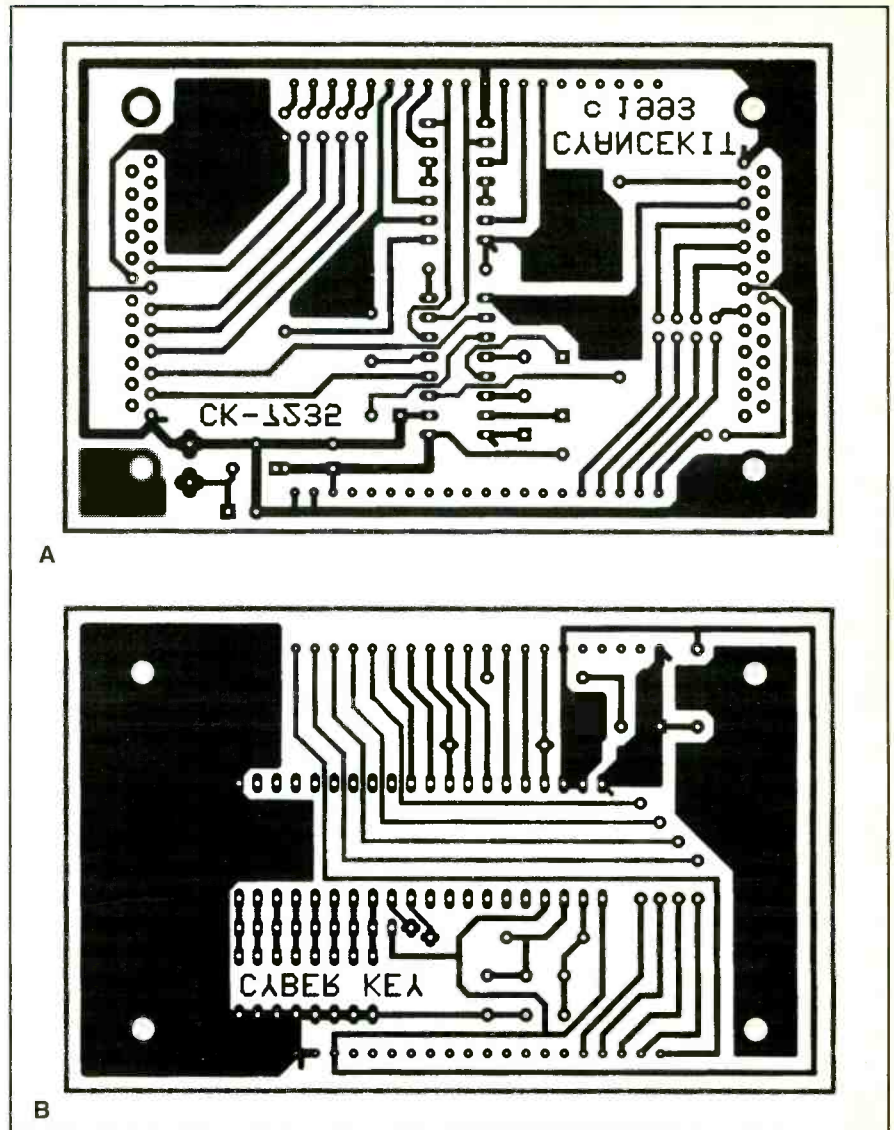


Fig. 2. Actual-size etching-and-drilling guides for fabricating (A) Interface and (B) Processor printed-circuit boards needed for project.

through SIP pull-up resistor pack R2, provides the means by which you input a serial number or ID code directly into U1. Power-on reset circuit operation is controlled by the RC action of R3 and C3, that have values of 10,000 ohms and 10-F, respectively. Regulated +5 volts is supplied to U1, U3 and U4 from fixed 78L05 voltage regulator U2.

Data arriving from the host computer at pin 2 of DB-25 serial connector P3 is monitored and controlled by pins 29 and 4 through 7. Throughput data is routed out via pin 2 of P4 to the peripheral device. Similarly, data received from the peripheral device is monitored and controlled by pins 8 through 11 of U1. Incoming data is routed through pin 3 of DB-25 connector P3.

It's important to keep in mind that not

all RS-232C equipment is configured in the same manner. In some cases, you'll have to reverse pins 2 and 3, depending on whether the peripheral being used is a modem or printer/plotter. To further complicate matters, computer serial cards can follow either of the two conventions. To use Cyber Key with the various formats, just remember to keep data inputs from your computer connected to pin 2 of P3 and the outputs to the peripheral connected to pin 2 of P4.

You can use Cyber Key by itself, without an external peripheral attached to it. In such "security" applications, simply connect Cyber Key via P3 and leave connector P4 open.

## Construction

Begin construction by fabricating the

### Collimator Pen



Output: 2.5 mW (max.); Current: 90-150 mA  
Oper. Volt: 2.2-2.5V; WL: 820nm - Infrared  
Size: 11mm dia. x 27mm long; Data sheet inc.

STOCK#	1-9	10-24	25+
SB1052	49.99	47.49	42.74

### Collimating Lens



Black anodized aluminum barrel; Glass lens with 7.5mm focal length.  
Fits 9mm laser diodes sold below.  
Easy to focus and install.

STOCK#	1-9	10-24	25+
LSLENS	24.99	23.74	2.37

### Dual Mode Laser Pointer



Weights less than 2 oz.; 0.5" dia. x 6.25" long  
WL: 670nm @ <1 mW (6mm beam)  
Switch from continuous to pulse mode.  
Uses 2 AAA batteries (inc.); 1-year warranty.

STOCK#	1-9	10-24	25+
LP35	199.99	189.99	170.99

### He-Ne Laser Tube



WL: 632.8nm (red)  
Output: 0.5 mW - 3 mW (our choice)  
Tested to mfr. specifications; 30-day warranty.

STOCK#	1-9	10-24	25+
LT1001	69.99	66.49	59.84

### He-Ne Laser Pointer



7.2" L x 1.4" W x 2.2" H; Weights just 12 oz.  
WL: 632.8nm @ <1 mW (8mm beam)  
Energized at 5kV, 1.2kV continuous.  
Inc. batteries, pouch, guide, 1-year warranty.

STOCK#	1-9	10-24	25+
LP100	199.99	189.99	170.99

### Laser Pointer



Just 0.75" dia. x 5.25" long; 670nm @ 3.5 mW  
2.5-3.5" beam @ 100 yards  
Uses 2 AAA batteries (inc.); 1-year warranty.

STOCK#	1-9	10-24	25+
LSPDINTER	159.99	151.99	136.79

# 16 More Reasons To Believe In Unicorn

### Economy Laser Pointer

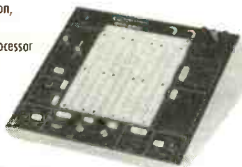


0.75" dia. x 5.6" long; Weights less than 3 oz.  
670nm @ 1.9 mW (4mm x 0.6mm beam)  
Batteries included; 1-year mfr. warranty.

STOCK#	1-9	10-24	25+
LP3	129.99	123.49	111.14

### Protoboard Design Station

Includes expanded instrumentation, breadboard, and power supply.  
Ideal for analog/digital/microprocessor circuits. Frequency and function generators, variable outputs, logic indicators, speaker & more.  
Size: 11.5" L x 16" W x 6.5" H  
Weights 7 pounds.



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P8503	299.99	284.99	256.49

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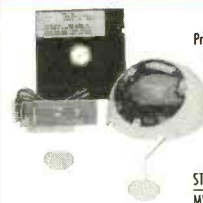
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### WAO II Programmable Robotic Kit



Programmed directly via attached keypad.  
Pen mechanism draws text and graphics.  
128x4 bits RAM and 2K ROM included.  
Uses 3 AA batteries (not included).  
Optional Apple computer interface kit includes software, cable, card, and instructions.

STOCK#	1-9	10-24	25+
MV961	79.99	75.99	68.39
WIHAP (interface)	39.99	37.99	34.19

### Laser Diodes

Stock#	Mfr.	WL	Output	Oper. Current	Oper. Voltage	1-9	10-24	25+
LS9220	Toshiba	660nm	3 mW	85 mA	2.5V	129.99	123.49	111.14
LS9200	Toshiba	670nm	3 mW	85 mA	2.3V	49.99	47.49	43.19
LS9211	Toshiba	670nm	5 mW	50 mA	2.3V	69.99	66.49	59.84
LS9215	Toshiba	670nm	10 mW	45 mA	2.4V	109.99	104.49	94.04
LS3200	NEC	670nm	3 mW	85 mA	2.2V	59.99	56.99	51.29
LS022	Sharp	780nm	5 mW	65 mA	1.75V	19.99	18.99	17.09
SB1053	Phillips	820nm	10 mW	90 mA	2.2V	10.99	10.44	9.40

### Laser Diode Module



Complete with collimating optics and drive electronics.  
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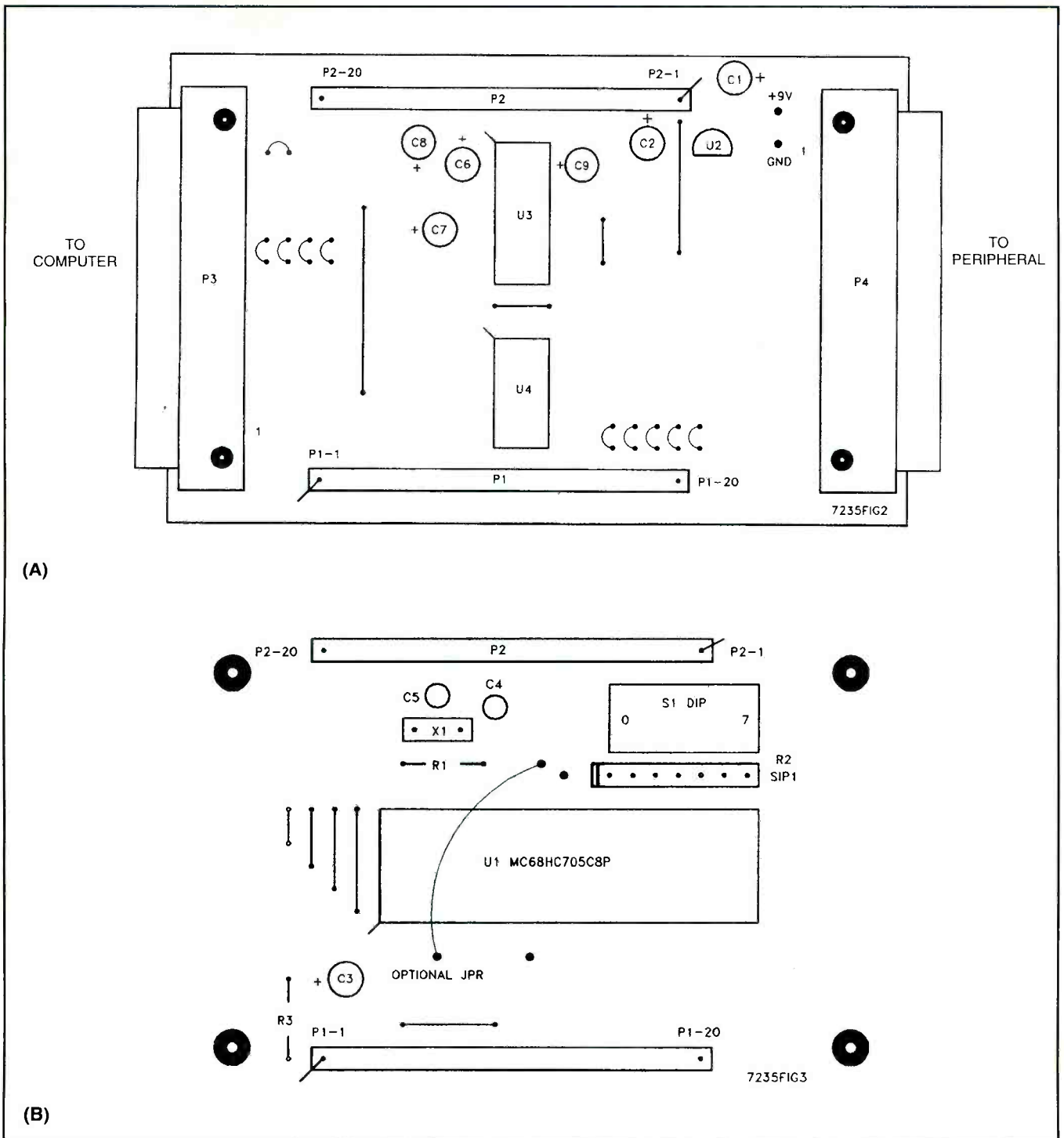


Fig. 3. Wiring guides for (A) Interface and (B) Processor Cards.

two printed-circuit boards you need, using the actual-size etching-and-drilling guides shown in Fig. 2. If you prefer to avoid having to fabricate your own pc boards, you can purchase ready-to-wire ones from the source given in the Note at the end of the Parts List.

Assuming you do fabricate your own boards, when they're ready, drill the various holes in the jumper and IC

mounting pads using a No. 68 bit, and use a No. 62 bit to drill the holes for connectors *P1* through *P4*.

When your board is ready to be populated, refer to Fig. 3 and install and solder into place strip connectors *P1* and *P2*, followed by connectors *P3* and *P4*. Then install and solder into place the various resistors, capacitors, crystal *X1* and regulator *U2*. Make certain that the

electrolytic capacitors are properly polarized and that the regulator is properly based before soldering their leads and pins into place.

You may want to use sockets for the DIP ICs. If you go this route, be sure that they're high-quality gold-plated pin sockets with machined pins. These may be more expensive than commonly available stamped-out and tin-plated



sockets, but the machining and gold plating are your assurance of long-term reliability. Don't plug the DIP ICs into their respective sockets until you've performed preliminary tests and are certain that everything is okay.

Double-check your work frequently when installing the various components. Referring back to Fig. 1, note that pins 16 through 20 of *P1* and pins 16 through 20 of *P2* can either be jumpered together or "passed-through," depending upon the particular application you have in mind. Connecting together pins 17 through 20 of *P2* forces the host computer's serial port to ignore the various handshake lines that are often used in conjunction with the RS-232C standard. Similarly, you can use pins 17 through 20 of *P1* to achieve the same effect on the peripheral.

Notice in both wiring diagrams in Fig. 3 that a few jumper wires must be installed on both circuit-board assemblies. These are indicated by solid lines on the drawings. You can use any type of solid wire for these jumpers, including cut-off component leads.

Finally, connect the 9-volt dc power-supply module to the +9V and GND points indicated on the Interface Card diagram in Fig. 2. Make certain that you connect the power supply in proper polarity. Use a dc voltmeter or a multimeter set to the dc-volts function to determine which lead of the power-supply cable is positive and which is negative before soldering them to the pc board! If you wire the power supply into the circuit in reverse polarity, you're certain to destroy one or more components when you power up the system.

With no DIP ICs plugged into the *U1*, *U3* and *U4* sockets, clip the common lead of your meter to any point in the circuit that's supposed to be at ground potential and power up. Then touch the "hot" meter probe to pin 40 of the *U1* socket, pin 16 of the *U3* socket and pin 14 of the *U4* socket and note the reading you obtain in each location. If you don't obtain a +5-volt reading in all three cases, power down and correct the problem before proceeding.

Once you're satisfied that all is well, you can proceed to final assembly. Power down and plug the DIP ICs into their various sockets. Make sure each is properly oriented and that no pins overhang the sockets or fold under between ICs and sockets.

If you wish, you can mount Cyber

Key inside a protective enclosure. You can use any type of enclosure that will conformably accommodate the circuit-board assemblies and provide means for accessing the outside world. If you wish to avoid having to machine a standard instrument or project enclosure, you can purchase a professional custom enclosure from the source given in the Note at the end of the Parts List.

## Programming Considerations

When you've finished building and checking out your Cyber Key, you must program microcontroller *U1* to get the system to respond properly. For programming, I recommend using the Cyber HC5 Development System detailed in the July 1992 issue of *ComputerCraft*. An inexpensive Development System kit is available from the source given in the Note at the end of the Parts List and is necessary to create the program you'll be using in your Cyber Key.

Begin the code-development process by determining your program requirements. Use your imagination here to take full advantage of the various features associated with the MC68HC705C8P. With on-board SCI (serial communications interface), watchdog/timer circuits, security bits, etc., the '705C8 can be powerfully configured via proper programming.

If you plan to use Cyber Key from BASIC, simply configure your serial port as you would for any peripheral. Standard RS-232C drivers are available in the C language libraries, and many routines exist for PC-based assemblers. I use a Cyber Key in conjunction with a program called VIA 2.0, a package that's perfect for creating custom hot-key and TSR routines used with this project. (VIA 2.0 is available from Portable Computing Systems, Inc., P.O. Box 870755, Dallas, TX 75287; tel.: 800-749-4917.)

There are any number of good books dedicated to serial-communication protocols that probably be of interest to you. One of my favorite titles for RS-232C interfacing is *RS-232 Made Easy* by Martin D. Seyer and published by Prentice Hall publisher. Using this book, you can quickly determine which configurations will work best for your particular Cyber Key application.

If FEC codes interest you, check-out

*Error-Control Techniques for Digital Communications* by Arnold M. Michelson and Allen H. Levesque and published by John Wiley & Sons. This book will bring you up to speed on my personal favorite, the Bose-Chaudhuri-Hocquenghem (BCH) codes that are often used in WANs. Variations on the different types of polynomial-based encode/decode schemes make excellent encryption mechanisms for Cyber Key.

Once you've structured your Cyber Key program, simply use the MC68HC705C8 assembler that comes with the Cyber HC5 Development System to create the .S19 file needed to program the '705C8. After downloading the file and programming *U1*, you'll be ready to use Cyber Key on any PC/compatible computer (or any other computer, SBC or microcontroller that has a standard RS-232C interface).

By carefully structuring your software/hardware "lock-and-key" system, you can keep your customers honest by locking-out unauthorized users and prevent the unauthorized copying of your program. Placing critical task-specific code for your program in the Cyber Key itself, you can foil even the best software pirates. The critical "holes" left in your application can be filled with only the code residing in Cyber Key itself. Furthermore, the Cyber Key ID number (entered via eight-position DIP switch *S1*) must match the serial number of the software released to a particular customer. Without the correct ID code match, Cyber Key will upload "gibberish" only and crash your application. I personally like the security-bit feature of the MC68HC705C8 family because it locks out would-be pirates at the hardware level.

If you use your imagination, you're likely to find several, if not dozens of, ways to let your new Cyber Key serve you in unique ways. If you're a software developer, this project can give you the security of knowing that would-be pirates are kept at bay.



Nick Goss

# Windows Compatibility and .INI Files

## What you can do to custom-tailor the *Windows* environment to make it work best for your equipment and computing habits

I hate to admit it, but I was ready to give up. If Microsoft *Windows* locked up once more, I was going to erase it and all *Windows* applications from my computer and just stick with DOS. Or maybe I'd buy a Macintosh and dump both DOS and *Windows*.

Judging from the mail and phone calls I receive, my frustration isn't at all unusual. But millions of people use *Windows* every day without the problems I faced. If I had been running unusual programs under either DOS or *Windows*, I might have accepted the lockups with a sense of humor, but millions of people are running the same programs I use and never have their computers lock up at all!

There can be little doubt that *Windows* is both a complex and an extremely flexible operating environment. Version 3.1 can run on AT-compatible, 386 and 486 computers; computers that are strictly IBM-compatible and those that are "pretty much" compatible. It runs on computers with ISA, EISA and MCA buses and on machines that have MFM, RLL, ESDI, IDE and SCSI hard drives. *Windows* can use EGA, VGA and super-VGA video adapters; local-bus and normal bus video and hard-drive interfaces; extended or expanded memory; and a wide range of DOS versions, including those developed by manufacturers other than Microsoft. In other words, *Windows* can adapt itself to a huge range of host environments. Once adaptation is complete, *Windows* applications (including Program Manager and File Manager) can generally go about their business without worrying about the particular hardware and software you happen to be using.

### Setting Options

*Windows*' success is based, in large part,

[Current]	Contains the name of the current color scheme
[Color Schemes]	Lists the defined color schemes
[Custom Colors]	Lists the 16 available custom colors
[Patterns]	Lists bitmap patterns for the desktop
[MMCPL]	Defines the control panel window
[ScreenSaver]	One section for each name
[Drivers.Desc]	Descriptions of multimedia drivers
[Userinstallable.drivers]	Defines multimedia drivers
[Installed]	Windows version and printers installed

Options in the CONTROL.INI file are set by the Control Panel. It has up to the nine sections shown.

on its ability to isolate the peculiarities of the computer system from each application. It adjusts to your system in two ways. First, *Windows* can sense automatically some of the information it needs about your system. Some of the sensing occurs when you install *Windows*, and other automatic sensing occurs each time you start *Windows* from DOS.

Though automatic sensing is great, it isn't enough. You're also responsible for telling *Windows* about your system and your own preferences. After all, *Windows* can't sense what colors you want to use, the kinds of printers that are attached to your computer or whether you want *Windows* to display messages in English, French Canadian or Icelandic.

You can set many of your preferences by running the Control Panel applet that's shipped with *Windows* (or running CONTROL.EXE from the *Windows* subdirectory). Each time you select a new option with the Control Panel, it's recorded for later use. Generally speaking, any changes you make are recorded in one of three files: WIN.INI, SYSTEM.INI or CONTROL.INI. Together, these files are *Windows*' equivalent of your DOS CONFIG.SYS file. If you make enough

changes to these files, or to the related files called PROGMAN.INI and WINFILE.INI, you can change the whole operation and feel of *Windows*, as well as tune it to run as efficiently as possible on your computer.

The PROGMAN.INI file controls the *Windows* Program Manager, while WINFILE.INI controls the File Manager shipped with *Windows*. You may find other .INI files in your *Windows* directory or scattered around your hard disk that are used by specific applications programs. My hard drive, for example, contains 58 different .INI files, with sizes that range from 0 to more than 14,000 bytes. These files select options and control the performance of both DOS and *Windows* applications.

There's almost no information about .INI files in the printed documentation supplied with *Windows*. But there are two lengthy files in the *Windows* directory named WININI.WRI and SYSINI.WRI. If you're having any difficulty with *Windows*, or if you want to tune *Windows* to run faster, these files will get you started.

Because both WIN.INI and SYSTEM.INI are standard text files, you can view and change them with any ASCII editor. The DOS EDIT utility and

[Settings]	Defines startup configuration
[Groups]	Sets order of groups and directory of each .GRP file
[Restrictions]	Restricts activities that can be performed from the Program Manager: NoRun= can disable the File/Run command NoClose= can disable closing Windows from the Program Manager NoSaveSettings= prevents changing settings NoFileMenu= can disable the File Menu entirely EditLevel= can disable changes of groups, icons, etc., depending on the level (0 through 4) selected

PROGMAN.INI controls the Program Manager in Windows. It has the three sections shown here.

Windows Notepad applet are good choices for changing these files, but one of the easiest editors to use is a "hidden" Windows applet called Sysedit. You can run Sysedit by selecting File and then Run from the Program Manager menus and typing Sysedit, or by simply clicking on Sysedit.Exe from the File Manager. If you find you're using Sysedit often, you can add it and its icon to one of the groups in the Program Manager.

When Sysedit runs, it loads the four essential boot-up files—CONFIG.SYS, AUTOEXEC.BAT, WIN.INI and SYSTEM.INI—into four editing windows. You can search these windows, make any changes you wish and save any changes you do make back to your hard disk. Unfortunately, Sysedit doesn't let you save backup copies of the files before you make changes. Thus, never, ever edit any of these files without making sure you have backups available. Although trouble is rare, an error in CONFIG.SYS or AUTOEXEC.BAT can lock up your computer when you boot up. Make sure you always have an emergency boot-up floppy disk before

you change either file. And an error in one of the Windows .INI files can keep Windows from loading and installing itself, perhaps locking up your computer when you try to run Windows.

Once you have backups of all four files, Sysedit is perfectly safe to use. However, if you make changes to either of the .INI files, you'll have to leave Windows completely and restart it before the changes you made take effect. This process is similar to re-booting after you make changes to your DOS configuration files.

### Making Changes

All text-based .INI files have the same format. Most files, including WIN.INI and SYSTEM.INI, are divided into sections. Each section begins with a section name in square brackets. Blank lines, which are ignored, can be used to separate sections and make a file easier to read. And you can add comments to the file by starting a comment line with a semicolon.

Inside each section, individual options are set with lines that have the for-

mat `keyname=value`. *Keyname* can be any combination of letters and digits and should be followed immediately by the equality sign (=) and the value without any intervening spaces. Some values in SYSTEM.INI are Boolean, which means that they can be written as 1 or 0, true or false, on or off, or yes or no. You can choose whichever set of values makes the most sense to you.

If you can't find settings in the on-line documentation that overcome an incompatibility on your computer or that let *Windows* run as fast as you would like it to, you can order a more-complete set of documentation for the .INI files from Microsoft. The Microsoft *Windows Resource Kit* costs \$20 and includes a technical reference manual and a collection of utility programs.

Another way you can obtain information about the options in the *Windows* .INI files is by using a nifty utility program called *WinSense* from SoftLogic Solutions, Inc. This program keeps automatic backups of your .INI files as it makes changes and lets you revert to an earlier version from either the DOS command line or within *Windows*. More importantly, it has explanations of more than 350 possible entries in the .INI files and what each one does. The extensive help file that accompanies the program contains 75 essays about *Windows* and general computer terms, along with a detailed glossary.

The best feature of *WinSense* for most users is that it makes extensive suggestions about what options you should select to fit your computer and your way of working. If you want your computer to run *Windows* (and DOS sessions from inside *Windows*) as efficiently as possible, its suggestions are invaluable. *WinSense* may have competition from other products by the time you read this, but it's the best program I've seen so far for managing .INI files.

### Changes to Make

Many .INI file settings are optional. You may or may not like how they work on your system. Others are established by SETUP when you install *Windows* and are seldom, if ever, changed. You can change some from the *Windows* Control Panel. It's safer to use the Control Panel instead of directly editing an .INI file because there's much less chance of an error rendering the file unusable.

Because the WIN.INI file generally controls the appearance of *Windows*, it

[Boot]	Specifies driver files and locations
[Boot.description]	Text used by Windows Setup
[Drivers]	Aliases and parameters for drivers in [Boot]
[Keyboard]	Selection of keyboard type and parameters
[mci]	Drivers for multimedia control interface
[NonWindowsApps]	General control for DOS sessions
[Standard]	Options for standard (80286) mode
[386Enh]	Options for enhanced (386) mode. These options can be divided into 7 sub-groups:
	Disk (swap files and disk space)
	DOS Apps (DOS sessions and virtual machines)
	Drivers (internal and installable device drivers)
	Memory (386 memory allocation and control)
	Networks (network control and compatibility)
	Ports (parallel and serial port control)
	System (Windows' own virtual machine)

SYSTEM.INI controls the *Windows* interface with hardware components and *Windows*' underlying operation. It has the eight sections listed here.

has few settings that affect compatibility. However, you may want to experiment with a few settings, especially in the section marked [Windows]. Many of the following items are used in only *Windows* 3.1 and not in earlier versions.

If you're having trouble printing from *Windows*, especially with an unusual printer buffer or other device, you can try setting `DosPrint=Yes`. This setting forces *Windows* to use your computer's BIOS for printer services instead of writing directly to the printer port.

Several settings in the [Windows] section of the WIN.INI file affect the mouse. `DoubleClickHeight=x` and `DoubleClickWidth=x` specify how far your mouse can move vertically or horizontally, in pixels, between the individual clicks in a double-click operation. By default, and if the setting isn't specified, both values are 4. But if your hand is a little shaky or your mouse seems to have a mind of its own, you can choose greater values. If you want your mouse to leave a shadow trail as it moves across the screen, try setting `MouseTrails=x`. In this case, *x* can be any number from 0 (no trail) to 7. This setting is especially helpful for laptop computers because it makes the mouse cursor easier to see.

Also, if you want to change the font used for icon titles, set `IconTitleFaceName=font` to a new font name. By default, it's set to MS Sans Serif. You can change the size of icon titles by setting `IconTitleSize=x` to any allowable point size for the typeface you choose. By default, it's set to 8. You can change one or both of these settings if you're using a high-resolution display and are tired of squinting to read icon names.

If your `Windows\System` directory is overflowing with fonts, you can move any or all of them to a new directory. If you do so, you'll also have to make changes in the [Fonts] section of WIN.INI. Each font is listed as a separate entry in the form of `Name=filename`. The *filename* can include a directory name, which you'll have to set manually.

If you have problems with non-*Windows* applications, you may want to make some changes to the [NonWindowsApp] section of SYSTEM.INI. The entry `CommandEnvSize=x` sets the amount of environment space available in each DOS session and overrides the size set with the SHELL= command in CONFIG.SYS. The value *x* can range

[Windows]	Keyboard, mouse, printer defaults, etc.
[Desktop]	Appearance of desktop and icon spacing
[Extensions]	Associates program extensions with applications
[Intl]	Date, time, and other defaults
[Ports]	Defines up to 10 output ports
[Fonts]	Available fonts
[FontSubstitutes]	Fonts to be used when others are requested
[TrueType]	Options for TrueType fonts
[MCI Extensions]	File extensions used by multimedia drivers
[Network]	Network options and settings
[Embedding]	OLE object types (see also REGEDIT.EXE)
[Windows Help]	Settings for the help window and text
[Sound]	Sounds for system events
[PrinterPorts]	Printer names and timeouts
[Devices]	Devices used by <i>Windows</i> 2.x applications
[Programs]	Directories <i>Windows</i> will search (like PATH)
[Colors]	Colors of Window elements
[Compatibility]	Work-arounds for known minor bugs

WIN.INI controls the *Windows* environment and display. As shown here, it has 17 or more sections. Also, some applications add their own sections and options to WIN.INI, although most now create .INI files of their own.

[Settings]	
ConfirmDelete=	Verify file deletions
ConfirmFormat=	Verify format commands
ConfirmMouse=	Verify drag-and-drop
ConfirmReplace=	Verify overwriting files
ConfirmSubDel=	Verify subdirectory erasure
dir1=	Current drive and directory
Face=	Font used
LowerCase=	Use Lower case for file names
MinOnRun=	Minimize when application runs
SaveSettings=	Save settings on exit
Size=	Point size of font
StatusBar=	Should status bar be shown?
Window=	Size and placement of window.

WINFILE.INI controls the *Windows* File Manager. It has just the single section shown here.

from 64 to 4096, and should be a multiple of 16. By default, it's 160, which may be too small for your way of working with your computer, especially if you use batch files that set and erase a lot of environment variables.

In the same section of SYSTEM.INI, the entry `FontChangeEnable=1` allows you to customize the screen fonts used when a DOS application runs in a window (in 386 mode). If you change the setting to 0, you won't be able to change fonts for DOS applications. Also, you can set the number of screen lines used for DOS sessions with the `ScreenLines=x` setting. By default, *x* is 25, but if you prefer to run full-screen DOS applications with 43 lines (on an EGA screen) or 50 lines (on a VGA screen), you can change this setting.

If you run *Windows* in Enhanced or 386 mode, the [386Enh] section of SYSTEM.INI contains more than a hundred settings you may want to change in order to solve incompatibility problems or just to speed up both *Windows* and DOS operations. It would take a small book to explain all of them. However, there are a few settings that I've found to be very useful.

There's probably already a line in the [386Enh] section that says `local=CON`, which tells *Windows* to create a new console device for each DOS session or application you start. On one machine that seemed to lock up only occasionally when the user left a full-screen DOS session to return to *Windows*, I added `local=EGA$` and eliminated the problem. The new line tells *Windows* that

every DOS session should appear to have its own video adapter.

If you want the File Manager's file list to always be up-to-date, even when you create or delete a file with another application while the File Manager is running, you can set FileSysChange=On. But *Windows* will run much faster if you set this option to *off* and simply refresh the display (or press F5) when you know or suspect that there has been a change.

One of the most important lines in the [386Enh] section for solving incompatibilities is named EMMExclude. If you have device drivers or other programs loaded into upper memory (between 640K and 1 M), *Windows* can normally detect them. But if it doesn't, it will crash as it tries to use the same memory space. You can force *Windows* to stay away from the device driver's memory space with EMMExclude=xxxx-yyyy. Values xxx and yyyy are the hexadecimal memory range that *Windows* isn't supposed to touch. For example, if you had a driver loaded from paragraph CC00 to CD0F and suspected that *Windows* was overwriting it, you could add the line EMMExclude=CC00-CD0F.

*Windows* tries to bypass the BIOS during disk accesses and work directly with the hard-disk hardware. But some hard-disk controllers don't work as *Windows* expects and others are actually slower during direct access. If you get hard-disk read errors from inside *Windows*, or if 386 mode is noticeably slower than standard or 286 mode, try adding the line VirtualHDIRq=off to the [386Enh] section of SYSTEM.INI.

If DOS applications complain that they don't have enough file handles when running under *Windows*, don't change the Files= setting in CONFIG.SYS. All this will do is give more file handles to DOS programs that run before you start *Windows*. Instead, set PerVMFiles=x to a larger value. The x defaults to 10, which means a DOS application will have up to 10 file handles available to it. You can set x to any number between 0 and 255, but the total of this setting and the Files= setting in CONFIG.SYS mustn't exceed 255.

One odd but fairly common problem is that *Windows* will sometimes hang your system when you try to read a floppy disk for the first time. You can sometimes correct this by always reading a floppy disk before you start *Windows*. A better and more-certain way to fix the same problem is to set IRQ9Global=true

in the [386Enh] section of SYSTEM.INI.

There are more than 100 possible additional settings in this one section of SYSTEM.INI. Some affect just networks, some configure *Windows*' built-in drivers and others change the way *Windows* allocates memory and runs your computer's parallel and serial ports. The best reference is Microsoft's own *Windows Resource Kit*. I also recommend the *WinSense* program I mentioned above, plus two books: *Windows 3.1 Secrets* by Brian Livingston (IDG Books) and *Windows 3.1 Revealed* by Robert Mullen, Paul Hoffman and Barrie Sosinsky (SAMS). The first book

is more technically oriented than the second, but some of the explanations in the second book are much more complete.

*Windows* should run well with almost all DOS and *Windows* applications. But it's up to you to find and cure any compatibility problems by setting the correct values in the .INI files. As long as you have a backup of these files, you can't hurt anything by trying new settings and seeing how they affect your computer. With a little experimenting, you'll soon find the correct settings to make your computer work as efficiently as possible. ■

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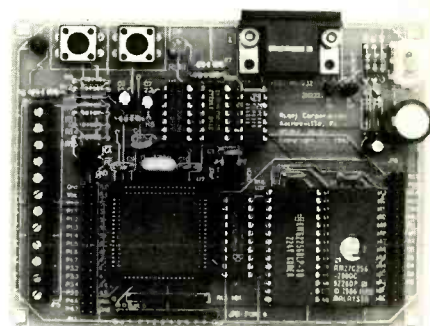
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**SPECIAL**

**REPORT:**

# New Windows Schematic & PCB Layout Software

## Schematic-capture and PCB layout software team up with Windows to let you draw schematics and design pc boards on your PC

By TJ Byers

If you work in electronics for any length of time, you're bound to end up drawing a schematic diagram or laying out a printed-circuit board or two. However, the traditional method of drawing schematics and pc-board layouts by hand is both time-consuming and prone to errors. So why not let your PC do the work for you? For as little as \$95, you can buy a program that teaches your PC how to draw schematics. For a few hundred dollars more, a printed-circuit layout program will turn your schematics into the artwork for making working pc boards.

In this article, I'll give you a look at four popular schematic-capture and printed-circuit-board (PCB) layout programs that run in the Windows environment. One is a low-cost entry-level system, the other a professional package that's suitable for CAE (computer-assisted engineering) and production work. I purposely limited these reviews to Windows applications for several reasons. Because Windows is graphically based, learning any new application is a highly intuitive process. Once you've mastered one Windows application, learning new applications is easy. Windows also has a standardized communications link that makes transferring data between applications a snap. Plus you get to share Windows' vast resource pool of printers and input devices.

Each of the products were evaluated for price, performance, features and ease-of-use. They include *EZ-Route Pro EZ-Logic for Windows*, *EZ-Route Pro EZ-Board for Windows*, *Protel for*

*Windows Advanced Schematic*, *Protel for Windows Advanced PCB*, *SuperCAD for Windows* and *SuperPCB for Windows*. I've also included separated text boxes that tell you How Schematic Capture Programs Work and How Printed-Circuit-Board Layout Programs Work—to give you a guided tour of the software by showing you how it works and which features to look for when shopping for one of these programs.

### Software Reviews

#### AMS *EZ-Route Pro EZ-Logic Professional Schematic Editor Version 2.02*

It's almost hard to believe you can buy a Windows schematic-capture program for less than what you'd have to pay for many DOS-based schematic-capture programs. But seeing is believing. For just \$129, you can buy AMS's Windows-based *EZ-Logic* schematic-capture program. As a stand-alone package, *EZ-Logic* is a perfect entry-level tool for drawing schematics on your PC. The cost is right, and if you've ever spent any time using Windows at all, you'll be drawing schematics in no time with the *EZ-Logic* package.

While it's easy to learn and easy to use, *EZ-Logic* is surprisingly limited in its communication skills, despite being a Windows application. Unlike most Windows applications, *EZ-Logic* doesn't make use of the Windows clipboard or object linking and embedding (OLE) features. The only line of communication between the *EZ-Logic* schematic-capture program and AMS's *EZ-Board* PCB layout program is via a netlist. Fortunately, *EZ-Logic* has a decent back-annotate function that reflects changes made

on the printed-circuit board back to the schematic.

Hierarchical drawings up to 1,024 pages deep are supported by *EZ-Logic*. Each sheet in the stack is stored as a separate drawing under its own file name and is linked to the sheet above and below it. You move up and down the hierarchical ladder using Hierarchy Push and Hierarchy Pop commands (you can use the + and - keys as a shortcut, if you wish). When using the Push command, for example, the current schematic is pushed aside and the schematic field that's linked to it is loaded. Only one schematic can be active at any time. To return to a previous schematic (closer to the top of the stack), you use the Pop command.

*EZ-Logic*'s component library consists of 86 separate files that range in size from 1K to 1.4M each. Altogether, it takes 10.5M of hard-disk space to hold the entire library file set. The number of devices varies considerably from file to file, with 17 files dedicated to 74XXX logic chips alone, totaling thousands of individual components.

Several of the files are very specialized. For example, one file contains the complete catalog of OKI chips, while another (much smaller) file lists chips made by Sony. Overall, the selection is diverse and well represented. Only one library file can be open at a time, and that file, or its path, must be available when the schematic is loaded. Otherwise, you get an error message and a hole in the drawing. Components are placed on the drawing by typing their names into a dialog box or by clicking on them from a pull-down library menu.

The library editor is a separate Windows application called *EZ-Symbol*. As in most schematic-capture programs, similar parts, like logic chips, are represented by one physical description the definition of which is contained in a setup table. But unlike most, *EZ-Symbol*'s setup table is really a powerful

database that contains a lot more than just a part number and a descriptor. In addition to pinout information, the database includes a corporate field that holds the private part numbers used by many corporations for inventory and manufacturing control. There's also a field for component cost. You can use this information to generate cost estimates and purchase orders right from the schematic drawing. Mechanical parts, like connectors, and device outlines are created using a proprietary programming language that employs vectors to draw the shapes on your video screen.

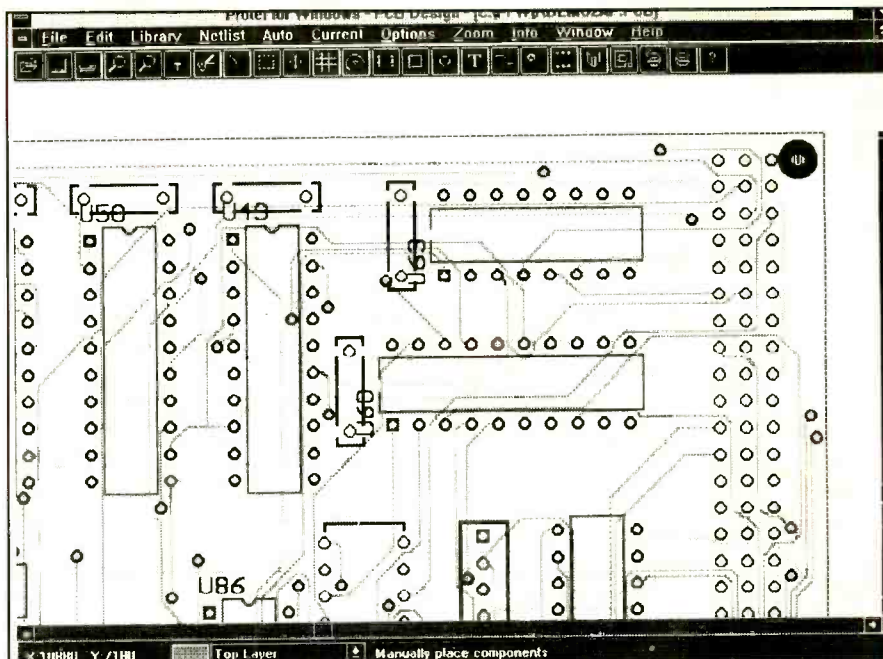
All the editing features are present, but they may be a bit tricky to use. For example, you can mirror an object mirrored only left to right, and rotation is limited to 90° increments in the clockwise direction. This means that if you want to mirror an object top to bottom, you must first rotate it 90°, mirrored, and then rotate it 270°.

As in most *Windows* applications, the most frequently used editing functions are easy to access from a toolbar that runs just above the top of the drawing. Such operations as drawing a line, adding text and zooming are but a mouse click away. You select blocks by using your mouse to enclose the selected area. And while you can delete, change and move blocks, you can't save a block to a file or the clipboard for transfer to another drawing or application. Screen pan is of the touch-and-bump variety, in which the screen jumps up, down or sideways when the cursor touches a side of the screen. This occurs only when you're using the keyboard's arrow keys, not your mouse.

### AMS-EZ-Board Printed-Circuit Board Editor Version 2.03

*EZ-Route* is an integrated family of CAD products used in design and fabrication of printed circuit boards. The *EZ-Board* program, which sells for \$295, is used to draw the actual circuit layout for an electrical design. When used in conjunction with *EZ-Logic*, the parts and logical net connections are derived from the schematic drawings. All you need do is position the parts on the board and route the electrical circuit connections between them. A companion program, *EZ-Router*, even automates the routing process, speeding up fabrication and eliminating error. A product called *EZ-Route Pro* bundles together the three programs to save you money. Instead of paying the nearly \$800 it would cost to buy the programs *a la carte*, you pay just \$695, for the modules in the integrated package.

Even if you decide not to use the *EZ-Route* schematic-capture program, you can still use *EZ-Board* to create printed-circuit boards. In fact, for very simple circuits, it's usually faster to lay out the board by hand. Simply extract the device outlines from the component library, place them on the board and wire them together using copper traces. For



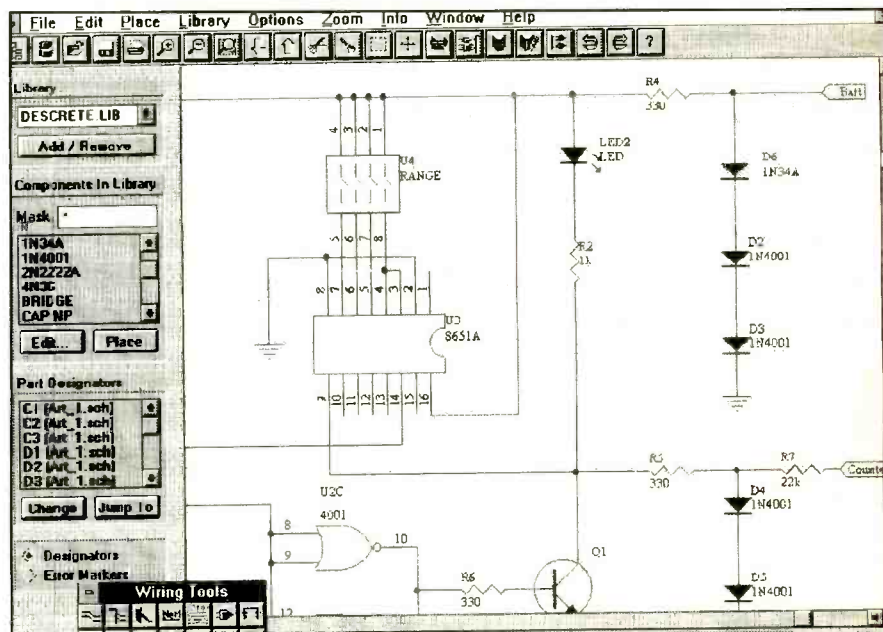
Protel for Windows Advanced PCB.

designs that are larger than you'd like to tackle by hand but still too small to warrant firing up *EZ-Logic*, you can write your own netlist using a text editor, such as the EDIT utility that comes with DOS. Once you have a working netlist, all you have to do is load it into *EZ-Board* using the Update From *EZ-Logic* command.

Parts are initially placed on the board in orderly columns along the left side of the board. The next step is to move each part to its actual position on the board and set the number of layers. Although moving parts is a manual operation, it's assisted by the netlist's ratsnest. Once all the devices are

where they belong, the board is trimmed to size. If the board has to be a certain size or shape, as is the case if it's to plug into a PC slot, the board's outline should be defined in the first step.

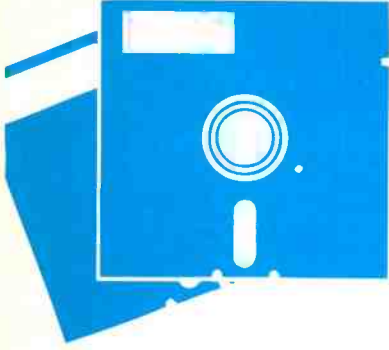
The board is now ready for routing. The manual router included with *EZ-Board* is a point-to-point router. All you have to do is click on one pad, then another, to have the router draw a track between. For this chore, *EZ-Board* provides a ratsnest-like scheduler that shows where the tracks should go. It even knows when a via is needed, and places it on the board for you. When a scheduled track is complete, the scheduler line disap-



Protel for Windows Advanced Schematic.

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pears. It's really a very simple procedure because the program does the thinking for you. All you have to do is connect the dots, something like a follow-the-dot puzzle. If you find you can't complete the routing, you can delete the tracks that are causing the problem and reroute them or add extra vias. *EZ-Board* also lets you specify curved traces, like the kind that are needed for analog layouts.

Although the manual router is smart and easy to use, routing a board with 100 ICs by hand is anything but fun. In a case like this, investing another \$295 for AMS's *EZ-Router* is a smart move. Basically, *EZ-Router* automatically does what you would do by hand. It reads the scheduler file created by the *EZ-Board* program and simply connects the dots.

It's important to keep in mind that *EZ-Router* isn't a true autorouter. It must have a routing schedule, a file generated by *EZ-Board*, before it can place a single track on the board. As the router runs, it saves to file an ASCII listing of its actions. Should the router fail to complete all connections, you can edit the file and use it as input for another router run. You can also interrupt the file for manual routing and restarted where it left off. When routing a board with mixed line widths, several files are used, one for each line width. In addition, you can exclude areas on the board where you don't want traces to pass through. However, *EZ-Board* supports only four layers, two signal and two ground planes and just two grid spacings (25 and 50 mils). Thus, this program isn't a good choice if you need to make complex or high-density boards.

## **Protel for Windows Advanced Schematic Version 1.0**

*Protel for Windows* was the first circuit-design software to run under *Windows* and is the PC-based *Windows* computer-assisted engineering software against which all others are compared. Protel's *Advanced Schematic* software for *Windows* is a complete schematic-capture program that con-

tains many drawing and editing features. It can be used by itself for drawing schematics and creating netlists. When combined with Protel's *PCB* or *Advanced PCB* layout programs, it becomes the front end of a fully automated, integrated, end-to-end design system. *Protel for Windows Advanced Schematic* lists for \$995.

*Advanced Schematic* communicates with *Protel for Windows PCB* software through four avenues. In addition to the standard forward and back annotation supported by schematic-capture programs for a long time now, there's the added benefit of *Windows'* clipboard and OLE. Unique to *Protel for Windows* is cross-probing that lets you display physical parts on the pc board by clicking on its schematic symbol.

Whether your drawing consists of one sheet or a hundred, *Advanced Schematic* treats each design as a project. Each sheet of a project is stored as an individual file in a project directory. You can open any number of sheets and edit them independently of all other sheets, limited only by available memory. You can move or copy elements from one open sheet to another using the *Windows* clipboard. Because all the files for a project are linked together through the *Windows* interface, changes in one sheet are immediately recognized by the others. For some operations, such as netlist generation and printing, an entire project (which consists of a master sheet and all associated sheets) need to be opened at the same.

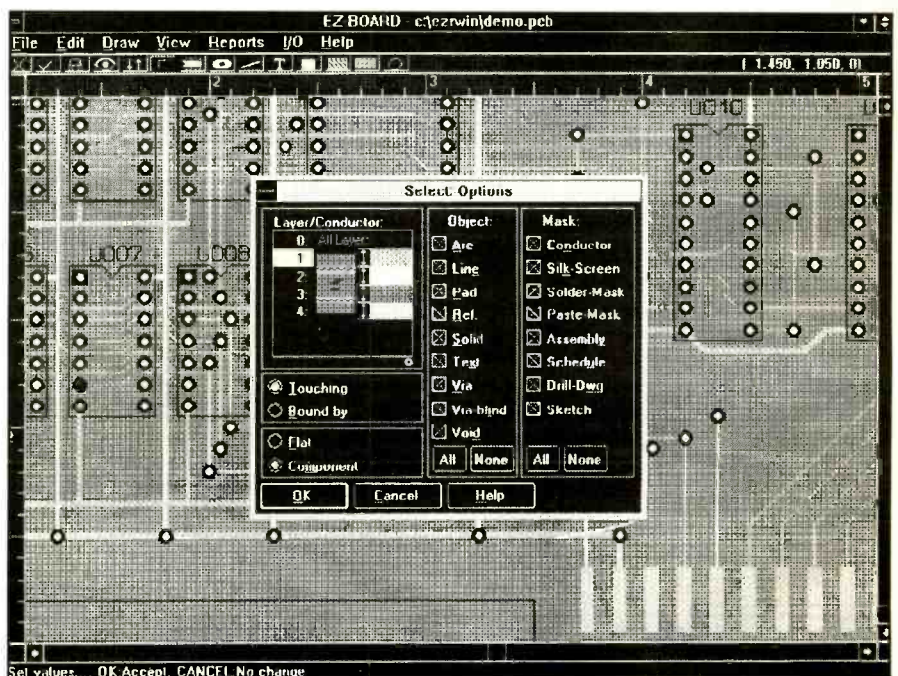
*Advanced Schematic's* component library contains about 15,000 chips and devices, spread among 76 library modules, all of which can be open at the same time, sufficient memory permitting. You place com-

ponents on your drawing by typing their names into a dialog box or clicking on them from the on-screen library directory. *Advanced Schematic* supports ANSI, DeMorgan and IEEE symbols.

Once you place a part on a drawing, its definition is copied to a separate library file attached to the drawing. The original libraries don't have to be accessed again to re-draw the schematic because the devices are retrieved from the drawing's library file. The size, font style, orientation and location of its designator text can be changed or deleted as desired.

The library editor is a separate program you start from an *Advanced Schematic* pull-down menu. Since many components share the same package, they have identical graphical depictions but exist as individual parts in the libraries. For example, a 74LS01 is identical to a SN54LS243, with the exception of the pin descriptions in the setup table. Using this method, Protel is able to store thousands of chips in a small file. So creating a new chip is as simple as filling out a new setup table and giving the part a name you wish. You build mechanical devices like connectors using such primitives as arcs, circles, etc..

*Advanced Schematic* boasts a large library of editing tools, including the standard copy, move, delete and find commands. Components can be rotated either direction in 1° increments. Block editing is supported, and you can save blocks to the clipboard for insertion in other *Windows* applications, such as *WordPerfect*. Screen panning is smooth and continuous when placing a part, which allows you to continue a wire beyond the screen's boundaries, but you'll have to



AMS *EZ-Board* PCB Layout.



use the scroll bars to move around the drawing when you're just looking.

The preference menu lets you set the default values for screen and grid colors, cursor shape, grid type, grid snap and number of undos. Undo can restore up to 16,000 deletes (50 is the default). And there's a printer setup and preview that shows you what the printed page will look like before you print an actual hard copy.

Both schematic files and libraries created in *OrCAD* can be used with *Advanced Schematic*. When you open an *OrCAD* STD 3 or STD 4 file, all the STD's drawing objects and text are available for editing, which can then be saved back to *OrCAD* STD 4 format.

You can also save *Advanced Schematic* drawings and objects in *OrCAD* format. However, a number of *Advanced Schematic*'s attributes, such as color and fonts, aren't recognized by *OrCAD*. This information won't be recognized, and the attributes will revert to an *OrCAD* equivalent.

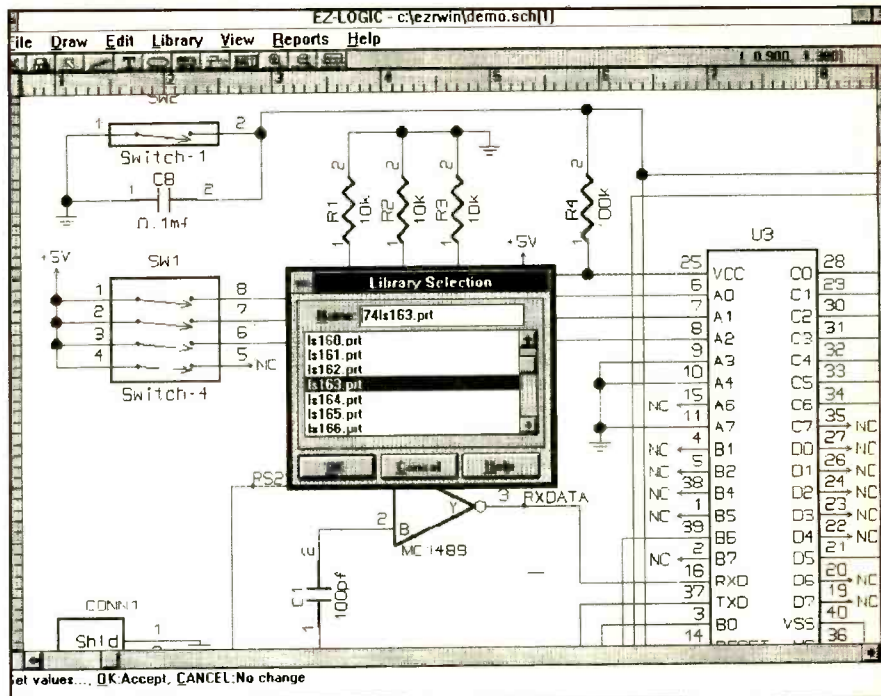
### Protel for Windows Advanced PCB Version 1.5

*Protel for Windows PCB* layout software comes in two versions. *Protel for Windows PCB* is an entry-level package that lists for a modest \$995. Though the program loads the board components from a schematic netlist, you have to place them manually. Thankfully, the autorouter is a little more automated. Clicking on one pad and then another forces the autorouter to find a way to connect the two. It's also intelligent enough to detect when you've clicked on the incorrect pads by comparing your selection to the ratsnest.

To add automation to *Protel for Windows*, you have to buy the *Advanced PCB* layout program, which lists for a healthy \$1,795. It contains all the elements of the *PCB* module, plus an auto-placement tool and two self-running autorouters. When you add in the cost of the two optional auto-place and autoroute modules, the price of a fully-outfitted *Protel for Windows* system comes to \$3,995. A hardware protection key is required for both programs.

Thanks to cross-probing and good back-annotation, transfer from schematic-capture to *PCB* layout is smooth and nearly seamless. Cross-probing is a result of operating in *Windows*, where the schematic-capture and *PCB* layout programs can be running at the same time. With cross-probing, clicking on a part in the schematic automatically brings up that part on the pc board for inspection or modification. Back-annotation automatically updates the schematic with changes made at the board level. You can start *Advanced Schematic* from within the *PCB* layout programs.

Parts are initially placed on the board in one big heap, making it difficult to pick out specific ones for placement. Fortunately, the



AMS EZ-Logic Schematic Capture.

auto-place tool that comes with *Advanced PCB* does a good job of un-piling them so that you can locate and move them more easily. Before using auto-place, you must define the board perimeter and any forbidden zones, using a special reference layer called the Keep Out layer. Auto-place won't place components inside forbidden areas, nor will tracks be routed through these areas.

For really big jobs you'll want to buy Protel's \$995 *Advanced Place* program. While \$995 may seem steep for the *Advanced Place* module, you get three levels of automatic component placement with it. In addition to the local-placement tool found in *Advanced PCB*, you get a global-placement tool that looks at the board as a whole and works out a strategy that gives the autorouter its best chance of completing an autoroute to completion. You can run global placement after you use local placement to move and lock connectors, controls and indicators in place. However, since you have to use a lot trial-and-error to find the optimal layout, it takes quite a while to run which can be several hours on large layouts.

The third auto-place mode is advanced global. It differs from the others in that it runs in the background, freeing your PC for other *Windows* work, and it lets you define the placement parameters. With the exception of grid spacing and component clearance, the other two modes' strategies are pretty much carved in stone. Both global placement modes support bypass capacitor placement that puts decoupling capacitors across the top of their associated ICs.

*Protel for Windows Advanced PCB* comes with both a heuristic and a line-probe

autorouter. Line-probe routers are similar to Heuristic routers, except that, instead of looking for repeated pin patterns, they look for the shortest distance between two points. Though they're quite fast, they're not too smart, achieving a completion rate of 80% or less in most cases. The \$995 optional *Advanced Router* adds a maze and a rip-up router to the system, plus an via optimizing routine Protel calls smoothing. *Advanced Router* can also do curved tracks, making it ideal for analog and high-frequency work.

Altogether, the routers support up to 16 signal layers, plus four middle power layers. They also support blind/buried vias and surface-mounted device (SMD) stringers (short track segments that connect the SMD to the inner ground planes).

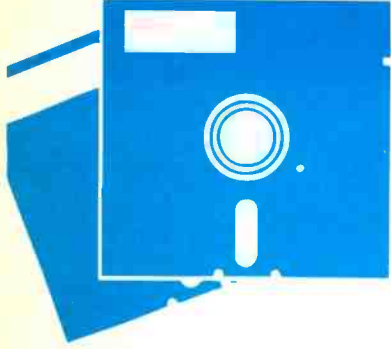
### Mental Automation SuperCAD for Windows Version 1.1 and SuperPCB for Windows Version 1.01

*SuperCAD for Windows* from Mental Automation is a low-cost schematic-capture program that's versatile, easy to learn, and extremely easy to use. You can use it as a stand-alone program or as a front-end processor for *PCB* layout. An optional netlist-conversion program (\$69) lets *SuperCAD for Windows* read and import netlists from other schematic-capture programs, including *OrCAD* and *Schem*.

*SuperCAD for Windows* comes in two versions. The \$149 introductory version includes a component library with about 350 parts, parts builder, netlist-creation program and support for digital and analog simula-

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tion (the simulation programs are sold separately). *SuperCAD+ for Windows* is a combination package that includes *SuperCAD for Windows* and a 1,600-device component library, the netlist conversion program and an auto wiring program and sells for \$249.

Although *SuperCAD for Windows* supports the *Windows* Clipboard, you can't run multiple *SuperCAD* sessions or use OLE to update changes made to a master page. To move objects from one drawing to another, you must quit the current drawing and load the destination drawing. However, you can combine drawings using the Macro command. Macro works exactly like File Load, except that it doesn't overwrite the current drawing. Instead, it merges individual drawings into one drawing.

You create hierarchical schematics by saving the different pages with a common root filename and the number of the page

(for example, XRAYP01). The maximum number of pages you can use for a hierarchical drawing is limited by the seven filename characters—the shorter the filename, the more room for page numbers. The files are linked by the netlist program, which reads in each page and generates one netlist. Physical descriptions of the components are contained in a separate file. Both files are used by the *SuperPCB for Windows* layout program.

The expanded component library that comes with *SuperCAD+ for Windows* holds 1,666 devices in 24 directories and can be purchased separately for \$59 as an upgrade for the *SuperCAD* introductory schematic editor. Most of the 1,600 parts are semiconductor devices from a wide variety of vendors, including integrated circuits from Intel, AMD and Zilog.

You place components on your drawing from a pull-down menu, which has a small built-in viewer that shows what each part looks like as you scroll through the list. Although only one library module can be open at a time, it's so easy to jump from one module to the next that it won't bother you.

Lines are just as easy to draw using the familiar click-and-drag *Windows* method. However, there's no autoplan feature in this program. You have to use the scroll bars or cursor keys to move around your drawing. Thankfully, you can suspend parts placement to scroll the screen without having to quit the Place command.

*SuperCAD+ for Windows* comes with auto-wiring that draws the wire for you when you click on the points of origin and destination. It even places junctions automatically. If auto-wiring can't find a direct path for

the wire because other devices are in the way, it simply draws around them.

You can add new devices to the component library by modifying an existing part or building one from scratch. There are two ways to create new library components. One method has you use a DOS program to generate parts from ASCII text files. The other way is to simply make a drawing using the *SuperCAD* drawing editor. However, you can't create new devices on the fly. Both of these methods require you to quit the current drawing.

The Format command converts the drawing from schematic format to library format and stores it in the library of your choice. Each library can hold up to 256 devices, but no more than this number.

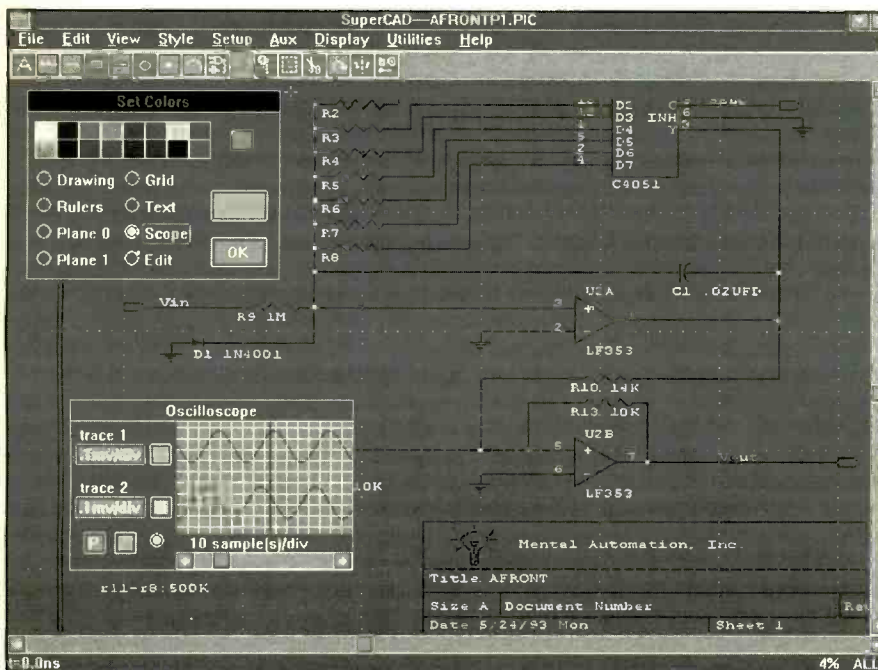
Despite its low price, *SuperCAD's* editing features are quite powerful and easy to use. The most commonly used are easily accessed from the toolbar. In the pull-down menus you find automatic incremental annotate, rubberband and a font editor that lets you change font style and size up to 38 points. But like AMS' *EZ-Logic* drawing editor, some edits take a combination of moves, such as the mirror command that mirrors only left to right, not top to bottom. To do a top-to-bottom mirror, you have to first rotate the component 90° and then return it to its proper orientation.

Some functions in the setup menu let you change only one parameter at a time, such as background color. For example, changing line or text colors requires a separate step. And the undo command removes only devices, lines and text in the order that's the reverse of the manner in which they were placed on the screen. It doesn't undo rotate or other edit commands.

If the component library were larger, I'd recommend *SuperCAD for Windows* as a better buy than *EZ-Logic* for entry-level use—despite its costing \$20—because it's easier to use. But, the larger library costs another \$60, pushing the price to beyond \$200, and it still falls short of *EZ-Logic's* huge component library. Nonetheless, it's a good entry-level program that's well worth your consideration, especially if you're considering *SuperPCB*.

## Mental Automation *SuperPCB for Windows* Version 1.01

Mental Automation's *SuperPCB for Windows* is a dynamite PCB layout program that sells for a slim \$495. The program interfaces seamlessly with netlists created by *SuperCAD for Windows* and comes with automatic placement and an autorouter. Like *SuperPCB for Windows*, Mental Automation sells an entry-level version of the *SuperPCB for Windows* for just \$149. But this trimmed-down version lacks automatic placement, its autorouter is an incremental point-to-point type, its component library contains just 50 devices and the program



Mental Automation *SuperCAD for Windows*.

supports only two layers on an 8" x 8" board.

*SuperPCB*'s interface is identical to that in *SuperCAD for Windows*. The pull-down menus are exactly the same in number and order, and their commands are similarly structured. Even the toolbar looks and works the same, so the learning curve is very short.

*SuperPCB for Windows* requires two netlists from the schematic-capture program: one for the net names and their connections and the other containing physical descriptions of the devices. The component library contains outlines for about 200 devices, including some popular connectors. You can add new parts to the library using *SuperPCB for Windows* drawing editor and the Format command.

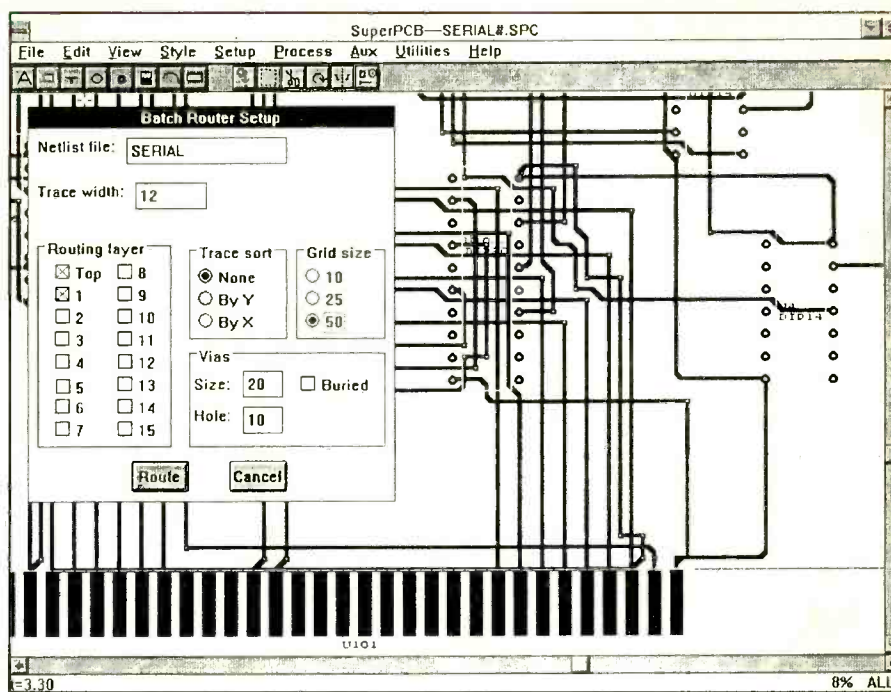
You place parts on the circuit board using the automatic-placement utility, which places parts that have a large number of mutual connections next to each other. If you define a board size, the placement utility spreads out the parts to fill the space. Or you can have the placement utility define by producing a stuffing-diagram board the size of which depends on the sizes of the individual packages. Most likely, you'll have to make changes to automatic placement, especially if the design contains connectors. Once you're satisfied with the layout, you save it in a file.

The next step is to route the board. The autorouter contains a combination heuristic/probe router that can route up to 16 signal layers. You can specify one- or two-layer (pair) routing. The router always draws traces vertically on the starting plane and horizontally on the next plane. You can toggle between planes using the + and - keys on your PC's keyboard. You create ground planes using the fill command. You define areas that are to be blocked from fill using with the rectangle, circle, and ellipses buttons located on the toolbar.

The router seems to be well-optimized and is very fast, but it seldom routes to completion. There's always a trace or two that needs manual help, but it's not that big a deal. You can also manually delete traces to make way for boxed-in tracks, manually route them and then run the autorouter again. The incremental router used by the entry-level version is also supported by the \$499 package, which is great for small hand-drawn layouts.

Grid size can be set to 10, 25 or 50 mils, and buried vias are supported. The optimize function minimizes the number of vias on a previously-routed circuit board. A moving barograph keeps you informed as to both the progress of the autorouter and the optimizer. The final step, should you decide to use it, is a smooth operation that replaces 90° trace bends with either arcs or 45° bends.

Mental Automation sells complete circuit-design packages. A starter kit, called *Introductory CAE Package for Windows*, sells for \$149 and includes introductory versions of *SuperCAD*, *SuperPCB* and a digi-



Mental Automation *SuperPCB for Windows*.

tal-stimulation program called *SuperSIM*. It permits multi-page designs and can produce one- or two-layer PCBs ranging in size up to 8" x 4" using incremental autorouting.

The intermediate and advanced circuit design products are sold under the *SuperTools for Windows* brand name. The intermediate package includes the \$149 versions of *SuperCAD* and *SuperPCB* and a utility package that adds a netlist converter and schematic-capture auto-wiring. Cost of the package is \$299, which is \$28 less than the separate programs. This is a good deal if you do occasional PCB work and don't want to sink a lot of money into software.

For the more-advanced PCB system designer, the \$695 *SuperTOOLS+ for Windows* combines the top-of-the-line versions of *SuperCAD* and *SuperPCB* with a 1,600-part component library and the netlist converter/auto-wiring utility program. This is the best bang for your buck because it can produce denser boards than *EZ-Route Pro* and it's not limited to four signal layers. Oddly, it sells for \$46 less.

## In Closing

As you can see from the foregoing, a desktop PC can, indeed, be turned into a productive tool for drawing schematic diagrams of electronic circuits and developing appropriate artwork for fabricating printed-circuit boards. The particular package(s) you select will be determined by your needs and budget. But one thing is certain, using any of the packages reviewed here in the *Windows*

environment greatly eases how you work and interact with and among the various programs and their basic elements.

## How Schematic-Capture Programs Work

Basic to any electronic design or project is a schematic diagram of the circuitry being used. A schematic is an electronic blueprint by which information is communicated to the user, other persons—and the PCB layout software.

Software that draws schematics is commonly called a schematic-capture program. Schematic-capture programs are basically CAD programs that, over the years, have evolved into special-purpose drawing applications. What sets a schematic-capture program apart from a general-purpose drawing program *AutoCAD* and *Generic CAD* is a component library that consists of a collection of commonly-used symbols that represent electrical components. Let's take a closer look at the elements that make up the typical schematic-capture package.

### Component Library

Central to every schematic-capture program is a component library that's generally made up of smaller, specialized library modules that are linked together. For example, one module might contain nothing but analog ICs, while another might hold the patterns for CMOS devices. Modular libraries are more versatile than a single large library because the structure lets you easily expand



the size of the library by simply adding new modules. Modular architecture is also a great way to save disk space because you have to load only the modules you normally use and leave the remainder on floppy disks.

Each schematic-capture program has its own way of identifying parts in the component library. Most programs try to name components by its generic names, such as 74LS27. But this isn't always possible. For example, a 15-lead resistor package may be tagged as DRPAC16, a name few would people associate with this device. Fortunately, all programs have either an on-screen device catalog or a hard-copy components catalog that shows the library symbols and their names, and many programs even have both.

Most schematic-capture programs support both ANSI and DeMorgan logic symbol. A few support the new IEEE symbols. DeMorgan logic differs from ANSI logic only in the way the input logic relates to the output. ANSI inputs are true when they're positive, but DeMorgan inputs are true when their inputs are negative. Although an ANSI 74LS02 behaves just like a DeMorgan 74LS02, use of DeMorgan logic often gives the designer insight that may ultimately result in a simpler circuit. Some programs let you toggle between ANSI and DeMorgan from the screen, while others store the symbols in the component library under separate names.

For special-purpose devices and parts that aren't included in a library, the schematic-capture program provides a component editor that lets you roll your own. You can create new devices either from scratch or by modifying an existing part. Most libraries use bitmaps for component outlines, which lets you fill in a matrix one dot at a time to draw a new component's shape. There are a few programs with more-advanced library editors that let you build components from such primitives as circles and squares.

### Drawing Features

Schematic components are placed on the screen using a display editor. You select a part highlighting its name from a pull-down

menu or by entering its name from the keyboard. With some programs, the selection process can be automated using macros (user-defined keystrokes and/or mouse clicks that are saved to memory so that they can be run again as needed) that reduces a complex retrieval process to a single keystroke. Some programs have a macro recorder that remembers the sequence as you step through it, while others have you type to create the macro file in a macro programming language.

After you select a component from the library, the editor places it on the drawing. Common to all schematic-capture programs is a grid (which may be visible or invisible) that overlays the drawing page and is used to position the cursor at exactly spaced intervals on the screen. If you try placing the cursor in a position that isn't allowed by the grid, the program moves the cursor to the nearest grid position, a move called "grid snap." Grid snap ensures that the component attaches precisely to wires and other components on the schematic with no misalignment. The density of the grid determines the resolution of the drawing. The finer the mesh, the smoother the cursor movement and the more latitude you have over placement of wires and devices. Some schematic capture programs allow you to set the granularity of the grid, while others have a fixed grid. And while most programs let you turn off the grid snap, the software may refuse to recognize two wires as being connected in this mode, even though they appear to be properly aligned.

After you place components on the page, they're interconnected using lines that represent wires. For clarity, wires are usually drawn horizontally and vertically. In the parlance of CAD, these perpendicular lines are called "ortho" (short for orthographic) lines. If you try to take a diagonal path, the drawing editor automatically converts it to one direction or the other. To draw a diagonal, ortho mode must be disabled. Most programs represent buses that consist of cables that contain several conductors as a single, heavy line with breakouts.

Because schematic-capture programs are designed to imitate hand-drawn schematics, several parameters are permanently fixed. For example, the size of the parts are pre-defined, as they would be if drawn on paper using a template. The size of the sheet is also limited to the standard drafting sizes, which range from size A ( $8\frac{1}{2}'' \times 11''$ ) up to size E ( $34'' \times 44''$ ). Standard drafting borders and title blocks are usually included, but this isn't always the case. When a schematic is too large to fit on a single sheet, the drawings can be stacked in hierarchical fashion under a single file name.

Some programs also support a linked hierarchy that lets you draw a circuit as a block diagram on a cover sheet. Each block is then drawn in detail using a stack of sheets that

define the circuits within the blocks. While each block has its own independent stack of drawings, the drawings are linked together so that you can move from one block to another without having to change files.

### Editing Features

While it's nice to have a software program that takes the drudgery out of drawing schematics, the real advantage of schematic capture is its ability to modify a circuit from the screen on the fly. Several editing tools are used for the task.

Delete and repeat are probably the most-used tools, and the two are often used together so that you can delete a number of objects without having to go back to the pull-down menu for each line or device to be deleted. If you delete something in error, you can usually replace it by using the undo command. Some undo routines restore only the last object deleted, while others remember the deletion path and can reconstruct an entire drawing, no matter how many times you used delete.

Moving components is another popular editing recreation. You move components for a number of reasons, but you usually do so to make room for new parts or make a diagram more intuitive. When you move a part, you can retain all its original connections using an editing feature called "rubberband." As the name implies, rubberbanding is a technique by which the wires connecting two components stretch to accommodate the new positions of a device. However, rubberband lines aren't ortho, which means you have to reroute them with a cleanup editor that puts skewed lines back into ortho perspective. If you wish to move a part without retaining its previous connections, you can turn off the rubberband feature, in which case, you end up with a collection of dangling wires that have to be dealt with individually.

One of the more-powerful schematic-editing tools is the block editor, which is a user-defined area on a drawing that the software treats as a single entity, no matter how many elements it may contain. Blocks may be moved, deleted or replicated. Some programs let you save blocks to a file, from which they can be called for use in another drawing. Block editing is a handy way of dealing with schematic elements that are often used in more than one drawing, such as memory banks and standard clock oscillators.

A find or search command locates parts on a schematic by name. It's most helpful when you're trying to find a part in a complex hierarchical drawing. You can also use the find function to tag key spots on the drawing for quick panning to a desired area.

### Printing A Schematic

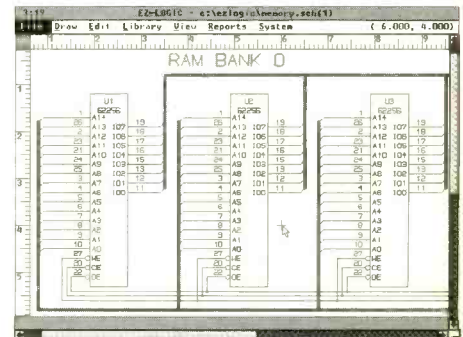
While editing a schematic on-screen is what schematic capture is all about, it's often easier to troubleshoot a design when working

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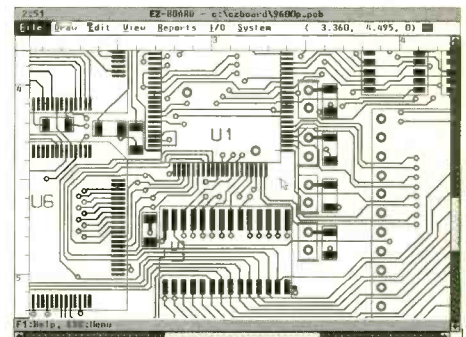
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from hard copy. This is especially true when a schematic is very large or has several hierarchical pages. Here's another place where *Windows* greatly enhances schematic-capture software with its long list of printer and plotter support. Not only does this eliminate the need to include printer drivers with schematic-capture software, you can also be assured that the *Windows* driver will be bug-free and work as advertised.

Generally, you'll be working with two types of hard-copy printout, draft quality and finished product. Draft-quality schematics are used during the drafting of the schematic because they can be quickly generated on just about dot-matrix or laser printer. The draft document diagram is then checked for errors before they become a permanent part of the design.

Schematics done on a printer are limited in size, simply because no printer made is big enough to handle an E-size sheet of paper. Consequently, the software divides the drawing into pages of  $8\frac{1}{2} \times 11$ " that you have to tape together to get the full picture. Sometimes you fit a fit schematic to the paper size by reducing the size of the drawing. But there's a limit to how small you can reduce an object before it becomes indistinguishable, and an E-size drawing printed on standard letter-size paper isn't acceptable.

Plotters, on the other hand, are available in sizes from A through E. So no splicing of pages is involved. Moreover, drawings made using a pen plotter are much sharper than those done on a printer. But be prepared to pay the piper if you opt for a pen plotter because these devices are both very slow and very expensive.

### How Printed-Circuit-Board Layout Programs Work

Until the advent of schematic-capture software, design and fabrication of a printed-circuit board was done totally by hand. Thankfully, that's no longer the case. The schematic-capture drawing includes information about the physical size and shape of the circuit devices and their electrical connections, which the pc-board software con-

verts into traces and pads on the printed-circuit board.

Software that produces printed-circuit boards is called a "printed-circuit-board layout" program. It takes four computer steps to make a pc board, beginning with the physical placement of the components on the board. After the parts are in place, the copper traces that electrically connect together the devices are laid down. Either or both of these processes can be automated or performed manually.

The pc board is then inspected for conformity with mechanical and electrical specifications, using design-rule-checking software that's built into the pc-board layout program. Violations are corrected using editing tools supplied by the layout program. After the layout is verified, the final artwork that's used to make the actual printed-circuit board is generated by a printer, pen plotter or photoplotter.

Let's look at what's in the typical printed-circuit-board layout software package.

#### Netlists

The data needed to display a schematic on the screen of a video monitor and ultimately create the printed-circuit board is contained in a disk file called a "netlist." Each schematic-capture program has its own way of organizing and formatting its netlists and lays down rules that must be strictly adhered to if the pc-board software is to correctly interpret the netlist data.

#### Component Library

As in schematic-capture programs, the component library is central to the operation of the PCB layout program. The PCB software has no idea of the function of the part it calls from the library. It's simply a mechanical device with pre-defined size and shape. For example, the outline for a 74LS00 and a 74LS02 are the same, and the PCB software treats both parts identically. It's up to the netlist to tell the program how to wire the devices.

Sometimes, the component outlines are contained in specialized library modules, such as DIP devices or connectors. At other times, the outlines are stuffed into one or two large library files. Additional components, particularly surface-mounted device (SMD) outlines, can often be purchased separately as stand-alone libraries or as upgrades to the main library, depending on the program.

A library editor lets you create your own outlines and add them to the library. You can create new parts from scratch or modify an existing outline. Connectors are particularly problematic because of the many different types on the market.

#### Component Placement

Placing components on a printed-circuit board can be tricky. Parts have to be positioned so that the copper traces can be made

between each and every component without crossing each other. What seems like a functional layout can turn out to be a dead end, which usually you find out after you've invested a considerable amount of time routing traces. Fortunately, there are automatic placement tools that can aid in the layout process.

Much of the layout work is done manually by dragging a part from one place to another. Sometimes, you can perform hand placement interactively with automatic placement, in which case, the computer gives suggestions for the best location of the parts. You have the option of accepting or rejecting the advice on a part-by-part basis.

To assist you in placing components, PCB software provides an interconnectivity pattern on-screen, called a "ratsnest," which is a jumble of skewed lines that show how each part is wired to every other part. As a part is moved, its attached ratsnest expands and contracts in length like rubber bands. The objective is to place parts so that the ratsnest lines are as short as possible. But as one part is moved to minimize its ratsnest, another part's ratsnest is lengthened to accommodate the part's new position. One way PCB layout programs enhance the use of the ratsnest is with a force vector display that tells you in which direction a part should be moved for shortest traces.

A few PCB layout programs have a placement-improvement routine that fine-tunes the pc-board layout after the parts are initially placed. The two most-popular improvement techniques are pair swapping and logic-gate reassignment.

Pair swapping seeks to improve parts placement through the interchange of neighboring components. If the exchange improves the placement value (reduces the trace lengths), the change is made. Otherwise, the components are returned to their original positions and a different pair is tried.

An excellent way to improve a PCB layout is by swapping logic gates. Considerable improvement can be made in parts placement if gates with common connectivity are put in the same IC. Some of the better swapping routines also permit pin swapping, which trades pins with the same function. For example, all four input pins of a quad NOR gate are the same and can be interchanged for best routing.

#### Trace Routing

The next step is trace routing, which the laying down of copper tracks on the pc board to achieve electrical connections among the various components in a circuit. Although you can route the traces manually, most PCB layout programs have an autorouter that does the job for you by automatic means. The autorouter uses the netlist for its routing information. It matches the parts on the board to the netlist connections and then decides which traces go where.

	AMS EZ-Route Pro	Mental Automation	Protel for Windows
<b>Schematic Capture Features</b>			
Standard Features			
Product	EZ-Logic 2.02	SuperCAD for Windows 1.1	Advanced Schematic 1.0
Price	\$129	\$149	\$995
Hardware protection key	N	N	N
Copy protected	N	N	N
<b>Drawing Features</b>			
Auto annotate	N	Y	Y
Auto pan	(a)	N	N
Diagonals in ortho mode	N	N	N
Ortho disable	N	Y	Y
Find/search	Y	Y	Y
Pull down menus	Y	Y	Y
Repeat object placement	Y	Y	Y
Supports buses	Y	Y	Y
Warns/removes duplicate objects	N	N	Y
<b>Library Features</b>			
DeMorgan symbols	N	Y	Y
Number of modules	86	24	76
Maximum number of active modules	1	1	available RAM
Screen directory	Y	Y	Y
<b>Editing Features</b>			
Placement			
Find	Y	Y	Y
Mirror	Y	Y	Y
Rotate	Y	Y	Y
Rubberband	Y	Y	Y
Undo			
Block			
Delete	Y	Y	Y
Hide	N	N	N
Move	Y	Y	Y
Save	N	Y	N
Part reference			
Adjustable font size	N	N	Y
Delete	N	N	Y
Hide	N	N	N
Move	N	N	Y
<b>PCB Layout Features</b>			
Standard Features			
Product	EZ-Board 2.03	SuperPCB for Windows 1.01	Advanced PCB 1.5
Price	\$295	\$499	\$995
Hardware protection key	N	N	Y
Copy protected	N	N	N
Maximum board size (inches)	8 x 10	32 x 32	32 x 32
<b>Netlist Features</b>			
Back annotate	Y	N	Y
Bill of materials	Y	N	Y
Front annotate	N	N	Y
Parts mask	Y	N	Y
Silkscreen masks	Y	Y	Y
Solder mask	Y	Y	Y
Drill mask	Y	Y	Y
<b>Component placement</b>			
Add on fly	Y		
Auto pan	(a)		(a)
Auto place	N		Y
Glue in place	Y		Y
Hide paths	n/a		
Opposite side	N		N
Place decouple caps	N		N
Protect zones	Y		Y
Ratsnest	Y		N
Vector force	N		N
<b>Routing Features</b>			
Autoroute	Y		Y
Heuristic	Y		N
Interactive	N		N
Lee	Y		N
Mix widths	Y		N
Nonstop	Y		Y
Pad to pad	Y		Y
Rip-up router	N		N
Auto vias	Y		Y
Curved tracks	Y		Y
Ground planes	Y		Y
Neck down	N		N
Number of copper layers	4		16
Ortho off	N		Y
Protect zones	Y		N
<b>Editing Features</b>			
Card outline	Y		Y
Change screen colors	Y		Y
Change package	N		N
Change pad	Y		Y
Change track width	Y		Y
Change via size	Y		Y
Copy	Y		Y
Delete components	Y		Y
Delete track	Y		Y
Density map	N		N
Find/search	N		Y
Gate swapping	N		N
Histogram	N		N
Macros	N		N
Move	Y		Y
Opposite side	N		N
Pair swapping	N		N
Pin swapping	N		N
Rotate	Y		Y
Rubberband	Y		Y
Save	Y		Y
Via optimize	N		Y
<b>Design Rule Check</b>			
Counts number of nets	Y		N
Counts number of vias	N		N
Reports air-gap violations	Y		Y
Reports broken tracks	N		N
Reports unconnected nets	Y		N
<b>Output Formats</b>			
Gerber	Y		Y
N/C Drill	Y		Y

# SPECIAL REPORT:



## Autorouters

The mainstay of autorouting technology is the Lee algorithm, sometimes called a maze router or flood router. The Lee router uses operator-selected cost functions to determine its routing parameters. For example, if you want all lines on the front of the board to run horizontally, you tell the router that the cost of a vertical line is very high, and the router will consider a vertical trace only as a last resort, trying all other options first. Other cost functions include maximum trace length, maximum number of vias (plated-through connections from one side of the board to the other to complete a trace run), and trace density.

PCB layout programs usually refer to the

Lee cost functions as a strategy, with names like normal, flexible and extensive. Lee routers have a very high completion rate, generally 90% or better, and are the least expensive. But they're slower than other routers. It's not uncommon for a maze router to spend hours or days wiring one pc board.

Another popular router is the Hightower or heuristic router. Some vendors call it a pattern or memory router because it's commonly used to route traces with commonly occurring pin patterns, as is the case with memory chips. It uses a simpler algorithm than a Lee router and runs much faster. What takes a Lee router an hour to do, the Hightower router can do in less than a minute. However, the completion rate is also less, particularly on complex designs.

A few PCB layout programs support both routers. Typically, you run the Hightower router first to get the bulk of the work done in a short time and follow up with the Lee router to place the traces missed by the Hightower router.

## Rip-Up Routers

Unfortunately, autorouters tend to paint themselves into a corner. Without the foresight to see that placing one trace will block the path of another, the program grinds to a halt. The solution is to get the offending trace(s) out of the way. The two solutions to this problem are rip-up and shove-aside.

Rip-up, sometimes called rip-up-and-retry, routers are cheaper and easier to use than shove-aside routers. The rip-up router identifies unconnected traces and looks for a single track that can be removed to make way for the blocked traces. The offending track is first ripped up, and the blocked trace is routed. The program then tries to find a new path for the erased track. Rip-up routers achieve very high completion rates, with a good one achieving 100% completion nearly every time.

Shove-aside routers move traces, rather than destroying them. They're most useful when a trace has a path to its destination, but the path isn't wide enough for the track. The path is made wider by shoving aside traces on either side of the canal.

## Trace Editing

After all automatic trace routing avenues are exhausted, you must resort to manual routing and editing. Several trace editing tools are available for you to do this.

The route command lets you lay down a track with your mouse. Although the trace is usually made up of straight segments with angular turns, a few PCB layout programs also support curved tracks, such as the kind used in analog circuit layouts.

Delete is most often used during the final stages of routing to remove a trace that's blocking the way of another trace. Some PCB layout programs can modify traces without deleting them. This editor lets you push and shove the trace, place and delete

vias and move segments from one layer to another while maintaining the validity of the original connection. You can also adjust the width of single traces to make them wider or narrower, as the situation demands. A useful width function is necking down, which lets you narrow a short portion of a trace so that it can squeak between the pads of an IC without creating a short circuit.

## Design Rule Checking

Design verification is a very important step because errors that pass through here end up as errors on the printed-circuit board for a designed circuit. At this final stage, errors are costly to correct. The process is known as "design-rule checking. The verification process checks to see that the tracks, vias and pads are all present and accounted for. It also looks for traces and pads that are too close together or touch each other.

## Producing PCB Layout Artwork

The ultimate goal of a PCB layout program is to produce artwork that you can use to make a functional printed-circuit board. Other artwork generated by the PCB layout software includes a solder mask, silk-screen nomenclature and a drilling template.

You can print out artwork with a dot-matrix or laser printer, pen plotter or photoplotter. Photoplotters, which are similar to phototypesetters, are the preferred choice because of their high resolution and accuracy, but they're very expensive to own and operate. Fortunately, you can save your work in a Gerber file that any PCB fabrication house can turn into negatives for a small fee.

If your PCB layout is a small enough to fit on standard paper stock, you can create a suitable negative by printing the PCB layout on a sheet of clear plastic film, like the kind used for overhead projectors, using a laser printer. While dot-matrix copies will work for some designs, their resolution (or lack thereof) forces you to watch your spacing.

## Sources

*EZ-Route Pro for Windows*  
**Advanced Microcomputer Systems**  
 1460 SW 3 St., Ste. B-8  
 Pompano Beach, FL 33069  
 Tel.: 305-784-0900; fax: 305-784-0904  
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*Protel for Windows*  
**Protel Technology**  
 4675 Stevens Creek Blvd., Ste. 200  
 Santa Clara, CA 95051  
 Tel.: 800-544-4186; fax: 408-243-8544  
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*SuperCAD for Windows*  
**Mental Automation**  
 5415 136 Pl. SE  
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# Add "Bells and Whistles" to Your Projects

## How to spice up your projects with sound effects

Adding "bells and whistles" to your projects needn't be difficult or expensive to do. In this article, I'll introduce you to an easy-to-use audio chip that produces four sound effects in a range of eight frequencies and two durations. With it, you can trigger effects singly or continuously to produce anything from an acknowledging bleep to a chirp to a space-war laser salvo. The chip requires only a power-supply, resistor, two capacitors and a speaker to operate. With its eight-bit interface, it's also simple to connect to a single-board

computer or the parallel port on a PC.

So that you get a firm understanding of how the system works, I'll discuss first the software and hardware aspects. Then I'll detail how to build the project and, finally, how to use it.

### Software

The four-function audio chip you'll be using is a programmed single-chip microcontroller that produces sound effects made up of sequences of 1s and 0s sent to its output. To make sound, all

a program has to do is turn on and off an output bit at an audible rate. Generally speaking, this rate is somewhere between 50 Hz and 10 kHz.

The outline for such a routine goes something like this:

```
begin:
    Turn speaker bit on
    Wait 1 ms
    Turn speaker bit off
    Wait 1 ms
```

Go to begin

Short as it is, you can further simplify the above routine by replacing the instructions that turn on and off the speaker with one that inverts the state of the speaker. That is, if the speaker bit is on, turn it off, and vice-versa. An exclusive-OR (XOR) operation will do the trick. The XOR of two bits works out as follows:

Bit 1	Bit 2	Output
0	0	0
0	1	1
1	0	1
1	1	0

Let's concentrate on the cases in which Bit 2 holds a 1. In the first case, when Bit 1 holds 0, XORing it with 1 produces a 1. In the second, when Bit 1 holds 1, XORing it with 1 produces a 0. So, the new sound routine could be:

```
begin:
    Put (speaker XOR 1) into speaker
    wait 1 ms
```

Go to begin

XOR offers other interesting wrinkles for sound generation. Consider that most piezoelectric transducers are rated for signals of 30 volts peak-to-peak ( $V_{p-p}$ ) or more. The signal from your output bit, however, is limited to 5  $V_{p-p}$ , since it swings between ground (0 volt) and the positive supply (+5 volts). Before you run off to design additional hardware, however, consider the signal boost you can obtain in software.

If you connect your speaker between

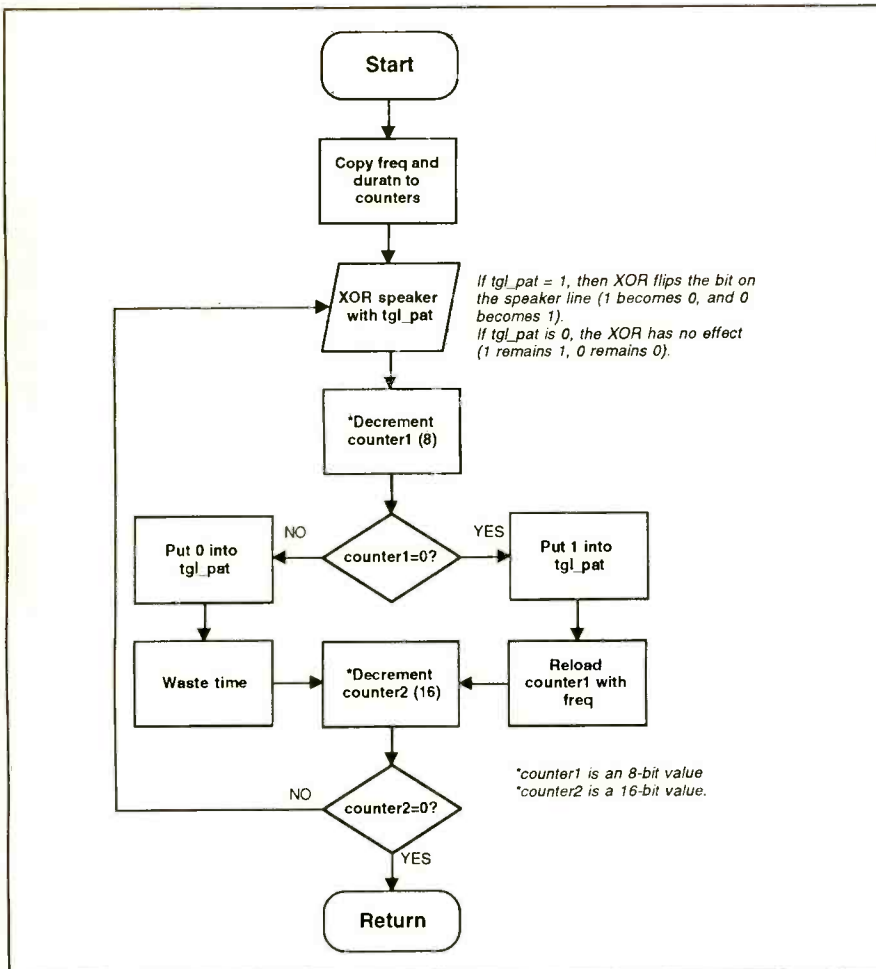


Fig. 1. Flow chart for tone-generating routine with independent control of frequency and duration.

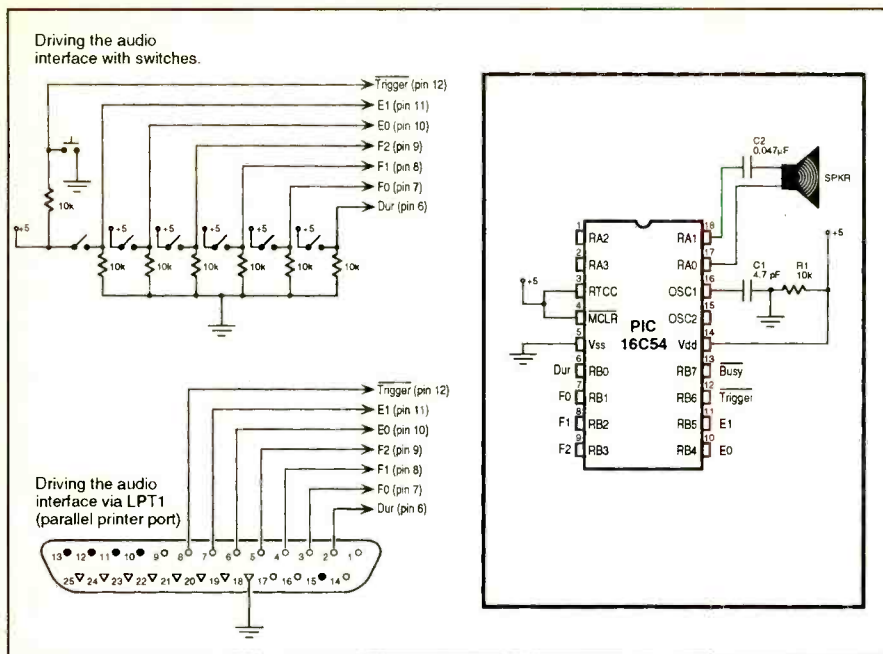


Fig. 2. Schematic diagram of circuitry used in four-function audio circuit and interface options.

two output bits, you can double the voltage swing using XOR. Begin by loading a 1 into the first speaker bit and 0 in to the second. Look what happens when you XOR them both with 1s:

$$\begin{aligned} \text{Bit 1: } 0 \text{ XOR } 1 &= 1 \quad (\text{change in voltage} = +5) \\ \text{Bit 2: } 1 \text{ XOR } 1 &= 0 \quad (\text{change in voltage} = -5) \end{aligned}$$

The changes in voltage represent the new state minus the old state. Since the new state of Bit 1 is +5 volts and its old state was 0, the change is 5 volts - 0 volt = +5 volts. Since the new state of Bit 2 is 0 and its old state was +5 volts, the change is 0 volt - 5 volts = -5 volts. Now, look at it from the speaker's perspective. The overall voltage swing is Bit 1's change minus Bit 2's change, or 5 volts - (-5 volts) = 5 volts + 5 volts = 10 volts.

In analog electronics, this kind of alchemy is commonplace. It's similar to the way a push-pull amplifier works. Other digital applications include differential signaling for serial communication, such as RS-422, and directional control of dc motors. In each case, you benefit by eliminating the need for higher power-supply voltages or split supplies with connections for +V, -V and ground.

There's another way that the unique qualities of XOR can help generate sounds. Look back at the cases in which Bit 2 holds 0. When it's XORed with Bit

1, there's no change, such that 1 remains 1 and 0 remains 0. This offers a convenient way to stop generation of the tone, either to silence the speaker or to control frequency. Since it's obvious how it would silence the speaker, let's look at the problem of frequency control.

Earlier you saw a tone-generation routine that toggled the speaker bit, waited a fixed period of time and then looped back to toggle the speaker bit. While simple, this approach isn't very flexible because it offers no control over the length (duration) nor the frequency of the tone. I'll address the duration problem first.

In its present form, the tone-generation routine is an infinite loop. It won't stop until the controller is reset or power is removed. An easy fix would be to limit the number of trips through the loop to some fixed number. Better yet, assign a variable to hold the desired number of loops and call it "duration."

```

Put 100 into duration
begin:
    Put (speaker XOR 1)
    into speaker
    wait 1 ms
    Subtract 1 from duration
    If duration is not 0, then go to begin,
    else end
  
```

By putting various values into duration, you can get tones of various lengths ranging from 0.5 to 128 cycles. (Each trip through the loop produces only half

### PARTS LIST

**Semiconductors**  
 IC1—Programmed PIC 16C54-RC  
 IC2—78L05 fixed +5-volt, 100-mA voltage regulator\*

**Capacitors**  
 C1—4.7-pF ceramic disc  
 C2—0.047-µF ceramic disc  
 C3—0.33-µF tantalum\*  
 C4—10-µF tantalum\*

**Resistors**  
 R1—10,000-ohm, 1/4-watt, 5%-tolerance resistor

**Miscellaneous**  
 SPKR—Motorola KSN1005A recommended; see Note below

**Note:** PICs programmed with the software described in this article are available for \$10 each (check or money order) postpaid from Scott Edwards, 964 Cactus Wren Lane, Sierra Vista, AZ 85635. Send comments and questions via E-mail to CompuServe mailbox 72037.2612. You can obtain blank PICs and the tools to program them from Parallax, Inc., 6359 Auburn, Ste. C, Citrus Heights, CA 95621; tel.: 916-721-8217. A package that includes an assembler and programmer costs \$199. The Motorola KSN1005A speaker is available at a cost of \$3.95 from Hosfelt Electronics 2700 Sunset Blvd., Steubenville, OH 43952-1158; tel.: 800-524-6464.

\* These components are in the Fig. 3 power supply (see text)

a cycle.) Now that the problem of controlling duration is apparently solved, I'll tackle frequency. You must provide a way to change the length of time the "wait 1 ms" line actually waits. Assuming you do, however, what happens to the duration? The longer "wait" is, the longer the overall duration.

Here's where XOR comes to the rescue again. Shown in Fig. 1 is a flowchart of a complete routine in which duration and frequency are independent of each other. Duration is controlled by a 16-bit counter, frequency by an eight-bit counter. Counter 1 (frequency) and Counter 2 (duration) each count down in a loop. If Counter 1 isn't 0, the routine loads a 0 into the toggle pattern (tgl\_pat) to be XORed with the speaker. Since a value XORed with 0 remains the same, nothing occurs. When Counter 1 reaches 0, tgl\_pat is loaded with 1s that flip the value of the speaker bit. Counter 1 is reloaded with the frequency value, and the process repeats. It continues until Counter 2 reaches 0.

With some minor embellishments, this is the routine at work inside the four-function audio chip. You could certainly

## Listing 1. Assembly-Language Listing For Four-Function Sound Chip

```

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

; Define I/O ports.
spkr    =    ra
input   =    rb
busy    =    rb.7
trig    =    rb.6

; Set origin for variables above special registers.
org     8

; Declare variables
freq    ds    1
duratn  ds    1
rate    ds    1
f_temp  ds    1
d_hi    ds    1
d_lo    ds    1
tgl     ds    1
temp    ds    1
data    ds    1
tgl_pat ds    1

; Device data and reset vector.
device  pic16c55,xt_osc,wdt_off,protect_off
reset   start
org     0

; Main program.
start   clrb    busy
        mov    !ra,#0    mov    !rb,#01111111b
        mov    data,#010101010b
        mov    data,input
        jb     trig,start
        setb   busy
        jnb   data.0,:short
        mov   duratn,#20
        jmp   :freq
:short  mov    duratn,#8
:freq   mov    freq,data
        and   freq,#00001110b
        rl   freq
        add   freq,#16
        and   data,#00110000b
        cje  data,#0,:tone
        cje  data,#00010000b,:up
        cje  data,#00100000b,:down
        goto :warble

; Set up variables for a flat tone.
:tone   mov    rate,#0
        call  Sweep
        jmp   start

; Set up variables for a chirp (rising tone).
:up     mov    rate,#255
        call  Sweep
        jmp   start

; Set up variables for a bloop (falling tone).
:down   mov    rate,#1
        call  Sweep
        jmp   start

; Set up variables for a tap or gunshot sound.
:warble cjb    freq,#00111100b,:high
        mov   rate,#00100000b
        jmp   :call
:high   clr
        mov   rate,freq
        rr   rate
:call   call  Sweep
        jmp   start

; Main sound-generating subroutine.
Sweep  mov    tgl_pat,#255
        mov   f_temp,freq
        jnz  :cont
        mov  tgl_pat,#0
:cont   mov   d_hi,duratn
        clr  d_lo
        mov  tgl,tgl_pat
        xor  spkr,tgl
:main   djnz  f_temp,:noRoll_1    mov    f_temp,freq
        mov  tgl,tgl_pat
:dur_lo sub   d_lo,#1
        jc   :noRoll_2
        sub  d_hi,#1
        jnc :return
        jnb  dc,:loop
        add  freq,rate
:loop   jmp   :main
:return ret
:noRoll_1  clr    tgl
        jmp   :dur_lo
:noRoll_2  nop
        nop
        jmp   :main

```

ly use this approach to create sounds in software, but you might like to consider this chip an easy-to-use subroutine in silicon.

### Hardware

Shown in Fig. 2 is the schematic diagram for the audio interface. It operates from any eight-bit port or bank of switches, as shown. PIC 16C54-RC/P

microcontroller IC1 is programmed with the software given in Listing 1. This type of controller is inexpensive and easy to program. (For more information on the PIC, see "Build a Miniature Scrolling Marquee" in the November 1992 issue of Computer Craft.) A source from which the programmed PIC described here can be obtained is given in the Note at the end of the Parts List.

Most of the task of generating sound is performed by IC1. Resistor R1 and capacitor C1 set the frequency of IC1's internal clock. Using a larger value for C1 slows down the clock, reducing the frequency of the sounds and lengthening their duration. Reducing the value, or even eliminating C1 raises frequency and shortens duration. The circuit still works with C1 removed because some stray capacitance always exists between

IC1's pins and ground. However, it isn't a good idea to rely on this "phantom capacitor" because its value can vary widely with temperature and individual batches of the IC.

In operation, the audio interface chip continuously watches (polls) the trigger line, waiting for the 0 that will start it up. While it's waiting, the chip keeps a 1 on the busy line. Once triggered, the chip puts a 0 on the busy line, grabs a six-bit value from the data lines and interprets the data to determine what kind of sound to make. The meanings of the data bits are given in Table 1.

If you'd like to audition the audio chip with your PC before incorporating it into a project, Fig. 2 details how to connect it to your PC's parallel port. Listing 2 is a QBASIC or QuickBASIC program that allows you to try the various combinations of effects, frequencies and durations.

Notice in Fig. 2 that the busy line on the audio chip is left unconnected. This is because this line is needed only when the chip is controlled by a relatively fast device. Then it might be necessary for the controller to check to make sure that the audio chip isn't busy before trying to trigger it. If the controller is really fast, it might also check to make sure that the busy line has gone low before letting the trigger go high again to ensure that the audio chip gets the message. None of this handshaking is needed with the relatively slow QBASIC control program.

## Construction

The first step in building this project is to either purchase or program your own four-function audio chip. (See the Note at the end of the Parts List for sources of components and programming tools.) Be sure to avoid zapping the PIC 16C54 sound chip with static electrici-

• Table 1. Data-Bit Definitions

Bits 5/4	3/2/1	0
Type of Sound	Frequency	Duration
00 = tone	000 = high	0 = short
01 = chirp	111 = low	1 = long

(chirps are rising tones, bleeps are falling tones, taps are complex noises that sound like a sharp rap on a hard surface.)

ty. Avoid wearing synthetic fabrics, leather- or rubber-soled shoes and working in a carpeted area. If you live in an area where the air is particularly dry or your workplace is carpeted, consider wearing a grounded wrist strap when working with and handling static-sensitive devices.

Getting the audio chip connected and running is simplicity itself. A small piece of prototyping board should do the trick. Just connect the chip as shown in Fig. 2. If you don't have a 5-volt dc power supply handy, you can use the arrangement shown in Fig. 3 to convert a 9-volt battery to a regulated 5-volt supply. Whatever you do, don't apply more than 5 volts to the audio chip, which has a maximum rating of 5.5 volts. Any more than this is guaranteed to damage the chip. Since you can't be too careful, you should measure the output of your power supply before connecting the integrated circuit.

Don't omit capacitor C2. It blocks dc current that would flow when the circuit is off. It also helps limit the load on the chip when the circuit is on.

While you can use almost any speaker or piezoelectric transducer with this circuit, I recommend using the unit specified in the Parts List. It's small and efficient (loud), and it delivers the full range of sound available from the chip. Although it has a somewhat bulky horn attached to it, you can detach the speak-

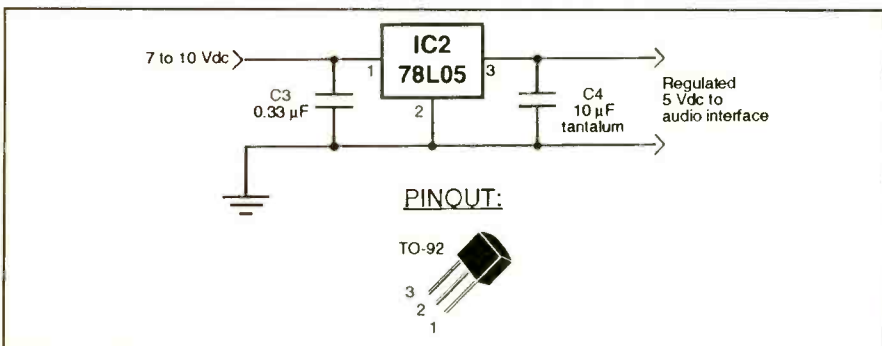


Fig. 3. Schematic details for a simple regulator you can use to power the audio chip.

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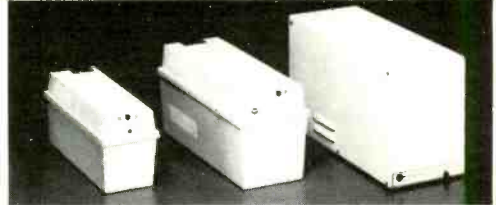
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BC-4000LAN	4000 VA	2,549

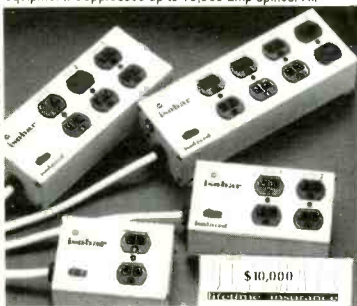


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IB4-4	4 outlet, 6 ft. cord Ultimate Warranty	43
IB4/220	4 outlet, 6 ft. cord	49
IB66	6 outlet, 6 ft. cord Ultimate Warranty	51
IB8	8 outlet, 12 ft. cord Ultimate Warranty	61
IB-8RM	8 outlet, 12 ft. cord with remote power switch	69
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IB8ULTRA	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 data line protection (RJ11 jacks)	\$55
ISOTELULT6	6 Outlet, 6' cord, Advanced diagnostics, 3 isolated filter banks, "cascade" circuitry data line protection (RJ11 jacks)	\$62
ISOTELULT8	8 Outlet, 12' cord, Advanced diagnostics, 4 isolated filter banks, "cascade" circuitry data line protection (RJ11 jacks)	\$74
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ISOTEL-8	8 outlet, 6 ft. cord and modem protector	\$75
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TSB	3 stage Modem/Fax protector	\$38
MP	Economy Modem/Fax protector	\$14
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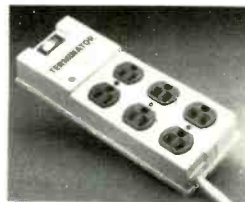
UL listed and 2 year warranty.

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



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## Listing 2. QBASIC Program For Driving Sound Chip Through LPT1 Port

```

DECLARE FUNCTION Bit.String$ (Number AS INTEGER)
DECLARE SUB Update.Trig ()
DECLARE SUB Update.Effect ()
DECLARE SUB Update.Dur ()
DECLARE SUB Update.Freq ()
DEFINT A-Z: CLS : DEF SEG = 64
port = PEEK(9) * 256 + PEEK(8) ' Automatically locates LPT1
Row = 5: Col = 25
Frequency = 0: Duration = 0: Effect = 0: Trigger = 1
PRINT : PRINT TAB(Col); "=====SOUND CHIP
DEMO=====";
LOCATE Row, Col: PRINT "Effect Frequency Duration";
LOCATE Row + 8, Col: PRINT "INSTRUCTIONS: "
PRINT TAB(Col); "Connect the sound chip as described "
PRINT TAB(Col); "in the article. Press the spacebar "
PRINT TAB(Col); "to trigger a beep tone. Press the "
PRINT TAB(Col); "first letter of the values you want"
PRINT TAB(Col); "to change (e.g., F for frequency). "
PRINT TAB(Col); "Press Q to quit."
Update.Freq
Update.Dur
Update.Effect
Update.Trig

Again:
DO
  Press$ = INKEY$
  LOOP WHILE Press$ = ""
  SELECT CASE Press$
  CASE "f", "F"
    Frequency = Frequency + 1
    IF Frequency > 7 THEN Frequency = 0
    Update.Freq
    GOTO Again CASE "d", "D"
    Duration = Duration + 1
    IF Duration > 1 THEN Duration = 0
    Update.Dur
    GOTO Again
  CASE "e", "E"
    Effect = Effect + 1
    IF Effect > 3 THEN Effect = 0
    Update.Effect
    GOTO Again
  CASE "t", "T"
    Trigger = Trigger - 1
    IF Trigger < 0 THEN Trigger = 1
    Update.Trig
    GOTO Again

  CASE " "
    IF Trigger = 0 THEN
      GOTO Again
    ELSE
      temp = INP(port): temp = temp AND 63: OUT port, temp
      temp = temp OR 64: OUT port, temp
      GOTO Again
    END IF
  CASE "Q", "q"
    END
  CASE ELSE
    GOTO Again
  END SELECT

```

```

FUNCTION Bit.String$ (Number AS INTEGER)
Number = Number AND 255
temp$ = ""
Mask = 128
DO
  IF Number AND Mask THEN temp$ = temp$ + "1" ELSE
temp$ = temp$ + "0"
  Mask = Mask \ 2
LOOP WHILE Mask >= 1
Bit.String$ = temp$
END FUNCTION

```

```

SUB Update.Dur
SHARED Duration, Row, Col, port
Dur$ = Bit.String$(Duration)
LOCATE Row + 1, Col + 25
PRINT RIGHT$(Dur$, 1)
temp = INP(port)
IF Duration THEN temp = temp OR 1 ELSE temp = temp AND
254
OUT port, temp
END SUB

```

```

SUB Update.Effect
SHARED Effect, Row, Col, port
Effect$ = Bit.String$(Effect)
LOCATE Row + 1, Col + 2 PRINT RIGHTS$(Effect$, 2)
temp = INP(port) AND 207
temp = temp OR (16 * Effect)
OUT port, temp
END SUB

```

```

SUB Update.Freq
SHARED Frequency, Row, Col, port
Freq$ = Bit.String$(Frequency)
LOCATE Row + 1, Col + 12
PRINT RIGHT$(Freq$, 3)
temp = INP(port) AND 241
temp = temp OR (Frequency * 2)
OUT port, temp
END SUB

```

```

SUB Update.Trig
SHARED Trigger, Row, Col, port
LOCATE Row + 3, Col
IF Trigger = 0 THEN
  PRINT "Trigger: Continuous "
  temp = INP(port): temp = temp AND 63
  OUT port, temp
ELSE
  PRINT "Trigger: Single (press spacebar)"
  temp = INP(port): temp = temp OR 64
  OUT port, temp
END IF
END SUB(SSN 265-11-1116)
964 Cactus Wren Lane
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(602) 459-3038 (H) 533-8066 (W)
CompuServe 72037,2612

```



er element by removing the three screws on the back, leaving you with a flat, 2"-diameter speaker. If the small metal grille comes off the speaker as you're removing the horn, simply cement it back into place.

I don't recommend using one of those piezoelectric transducers that are about the size of a watch battery. These have a very sharp resonant response, making them efficient within only a small range of frequencies, outside of which, they sound downright puny. The sound chip, on the other hand, produces a relatively wide range of frequencies.

Assemble the circuit but don't connect it to your PC or controller until you've first checked it out and are certain that your construction is absolutely on the money. To test the circuit, first supply power to it. Then move the trigger connection between ground and +5 volts. The speaker should sound when the connection is grounded and fall silent when it's connected to +5 volts. (Actually, it will probably be silenced simply by disconnecting it from ground because the inputs of the audio chip tend to float high. They "see" a 1 when they're disconnected.)

If your circuit misbehaves as you're testing it, power down and check your wiring. Make sure that R1, C1 and C2 are connected properly, and check the connections to the speaker.

Once the chip is making some kind of noise, power down and connect its interface to LPT1 on your PC. (You must use LPT1 for the connection point because the demonstration program automatically configures itself for this port to save you from searching your computer's documentation for port addresses.)

### Checkout & Use

Once you connect the circuit to your PC's parallel port (LPT1), enter and run the QBASIC program given in Listing 2. Although this program may appear to be somewhat long, it's the user interface—that makes it so. It isn't driving the sound chip. The program also illustrates one of BASIC's weaknesses—dealing with individual bits.

All lines in Listing 2 that contain logic operators—AND, OR and NOT—are there for the sole purpose of turning on and off particular bits. If you connect the sound chip to a controller and program in assembly language, you will have a much easier time writing software to get things running.

Run the program and then turn on the

sound-chip circuit. It won't hurt if you reverse this order, but your circuit may begin "squawking," based on whatever random bits are on LPT1. Also, don't worry if your circuit starts beeping before you apply power. It's receiving power from high bits in LPT1 through its signal inputs. The manufacturer builds static-protection diodes into the inputs of these chips to divert static-electricity charges to the power supply connections, where they're less likely to do damage. When power is disconnected, these diodes can divert signals to the power-supply rails, where they may supply sufficient current to power the circuit. Don't rely on this effect, however, because an input of all 0s is valid and would turn off the free power.

The program is basically self-explanatory. Just press the first letter of the parameter you want to adjust (such as "F" for frequency) and tap the space-

bar to hear the result. For continuous sounds, press "T" (triggering). Pressing "T" again takes you back to the space-bar-triggered mode.

In addition to allowing you to test the circuit, the software shows you the data required to produce a given effect. This should prove useful when writing programs to use the sound chip. In serious applications, you might use a short tone (effect 00) to acknowledge properly-entered data and a series of taps (effect 11) to signal when an error has occurred. For fun, continuous chirps, bleeps and taps (effects 01, 10 and 11) of different duration make great space-war effects. An unbroken stream of chirps sounds like alien spacecraft. A string of taps sounds like machine-gun fire. Once you feel you've exhausted all of the possibilities of the 64 preprogrammed combinations of sounds, maybe you're ready to program some of your own. ■

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# Designing Microcontroller Circuits

## Part 2: Project construction, testing and adding NV memory

Last month, I introduced a development system using the 8052-BASIC microcontroller. This month, I continue with building and testing the circuit, adding permanent program storage and performing a few simple I/O tests and experiments. I'll also include reviews of some new books for those of you who want to bone up on microcontrollers and single-board computers.

### Circuit Construction

This project is intended to be a flexible system for testing and experimenting with new ideas, rather than to be used as a rigid, unchanging design for a single application. For this reason, I recommend building it using the Wire Wrap or another construction technique that lets you alter your work, so that you can easily change or add to the basic circuits. (For more on construction methods, see my article in the April 1993 issue of *ComputerCraft*.)

These are some things to be aware of as you build the circuit from last month's schematic diagram:

Choose a circuit board with extra room. I used a Vector No. 3677 plug board, which measures 4.5" x 9.6" and has interleaved etched buses for easy connections to power and ground. Fig. 1 shows the circuits built on this board. The No. 3677-6 version of the board leaves off the gold-plated edge connector and is much less expensive than the No. 3677 plug board. Digi-Key is one source.

If your board has power and ground buses, solder IC power and ground connections directly to the buses. Be sure to wire U5's (a MAX232 RS-232 converter chip) ground connection correctly, at pin 15 (not the expected pin 8). For connections to the power supply, solder thick, AWG 22 or lower-number, wires to the buses. You can solder the other ends of the wires to banana plugs or screw terminals, or clip your power-supply leads directly to the wires.

The schematic doesn't show an on/off

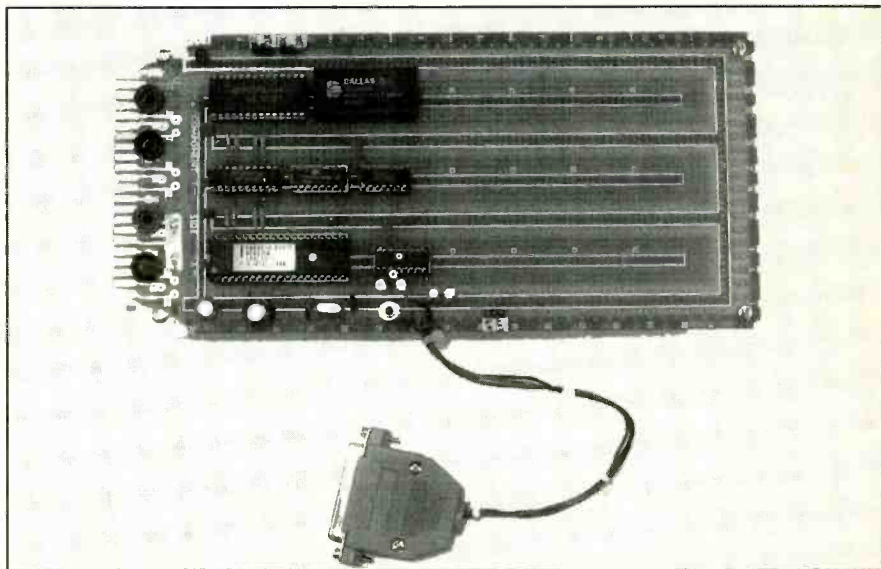


Fig. 1. The 8052-BASIC circuits wired together using the Wire Wrap technique on a Vector No. 3677 plugboard.

switch for the circuit, but you can add an spst toggle or slide switch in series with the +5-volt line if you wish.

Space decoupling capacitors C9 through C13 evenly along the board.

To minimize noise in the oscillator circuits, place XTAL1, C2 and C3 close to pins 18 and 19 of U1. Connect them with short wires. Wire the ground terminals of C2 and C3 directly to pin 20 of U1.

When you wire D1, C4 through C8, LED1 and U1 through U6, correct orientation is required. Notice that C7's positive terminal connects to ground, since its negative terminal connects to the MAX232's -10-volt output. As you wire the circuits, remember that everything is a mirror image of the way it looks on the component side of the board. If pin 1 is in the upper-left corner on the component side of the board, it's in the upper-right corner on the wiring side. Labels are helpful reminders for keeping track of the layout.

Figure 1 shows a couple of different techniques to represent connections. For example, in the reset circuit, con-

nections are drawn as direct point-to-point lines. For address and data lines, I used buses for a neater, more-compact schematic. When you wire these connections, use the signal labels as a guide. For example, the label D0 tells you to interconnect pin 39 of U1, pin 3 of U3, pin 11 of U6 and one side of R2. Other connections are also indicated by labels instead of point-to-point connections. For example, the WRITE label shows that pin 16 of U1 and pin 27 of U6 are to be connected together.

Two gates on U2 aren't used. To prevent these unused CMOS inputs from floating and possibly drawing excessive currents, wire pins 9, 10, 12 and 13 to ground or +5 volts.

Don't plug the ICs into their sockets until you've completed wiring all of the circuits.

Connections to RS-232 OUT and RS-232 IN depend on the type of serial connector you have on your personal computer or its serial cable. Connectors vary, but the most common configura-

(Continued on page 47)

# ComputerCraft Magazine's PC & Microcontroller Data Guide

In this seventh installment of our continuing series of pull-out data guides for PCs and microcontrollers, Our focus here is on the 80x86 family of microprocessors are the brains inside the millions of personal computers described as "IBM-compatible." From the original 8086, the family has grown to include chips that are faster, use less power or have other added features or/and improvements. This month's quick-reference guide introduces the 8086/8 and 80186/8.

Prepared by Jan Axelson. Copyright 1993 CQ Communications, Inc.  
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## Intel 8086/8

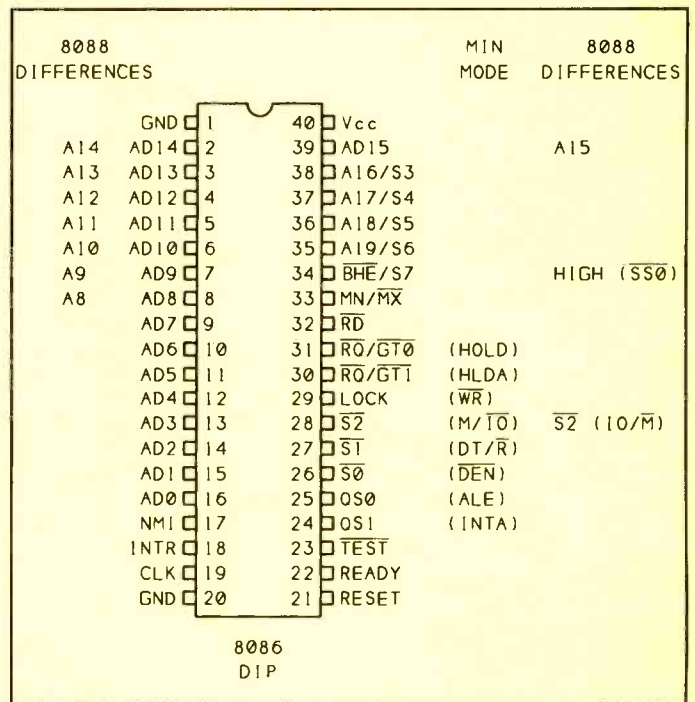
### Summary

The 8086 was Intel's first microprocessor with a 16-bit internal and external data bus, which gave it faster performance than existing eight-bit microprocessors. The 8088 is nearly identical, but it has an eight-bit external data bus. You can find 8088s inside original IBM PCs and XTs and many compatibles. Some modern hand-held computers also use 8086/8 chips.

### Features

- Up to 10-MHz clock
- Eight and 16-bit signed and unsigned arithmetic
- Binary and decimal operations
- Multiply and divide instructions
- 89 instructions
- 1M addressing ability
- Minimum mode for small embedded systems
- Maximum mode for PCs and multiprocessor systems

Signal	Pin(s)	Type	Function*
AD0-AD7	9-16	I/O	Low Address/Data Bus
AD8-AD15	2-8,39	I/O	High Address/Data Bus (8086 Only)
A8-A15	2-8,39	Output	High Address Bus (8088 Only)
A16/S3	38	Output	Address/Status 3
A17/S4	37	Output	Address/Status 4
A18/S5	36	Output	Address/Status 5
A19/S6	35	Output	Address/Status 6
-BHE/S7	34	Output	Bus High Enable/Status 7 (8086 Only)
CLK	19	Input	Clock
GND	1,20	Input	Ground
HIGH/-SS0	34	Output	High/Status Line (8088 Only)
INTR	18	Input	Interrupt Request
LOCK (-WR)	29	Output	Bus Lock (Write Memory or I/O)
MN/-MX	33	Input	Minimum/Maximum Mode Select
NMI	17	Input	Nonmaskable Interrupt Request



Signal	Pin	Type	Function
QS0 (ALE)	25	Output	Queue Status 0 (Address Latch Enable)
QS1 (INTA)	24	Output	Queue Status 1 (Interrupt Acknowledge)
RESET	21	Input	System Reset
-RD	32	Output	Read Memory or I/O
READY	22	Input	Ready Acknowledge
-RQ/-GT0 (HOLD)	31	I/O	Bus Request/Grant 0 (Hold)
-RQ/-GT1 (HLDA)	30	I/O	Bus Request/Grant 1 (Hold Acknowledge)

S0 (-DEN)	26	Output	Status 0 (Data Enable)
S1 (DT/-R)	27	Output	Status 1 (Data Transmit/Receive)
S2 (M/-IO)	28	Output	Status 2 (Memory or I/O Select) (8086 Only)
S2 (IO/-M)	28	Output	Status 2 (I/O or Memory Select) (8088 Only)
-TEST	23	Input	Wait Instruction Continues if Low

Vcc 40 Input Power Supply (+5V)  
 \*Minimum-mode functions are in parentheses.

### Related chips

CMOS versions are available (80C86/8).  
 The NEC V20 and V30 are drop-in replacements for the 8088 and 8086, respectively, that faster performance.  
 Chips & Technologies' F8680 is an entire PC/XT motherboard on a chip.

## Intel 80186/8

### Summary

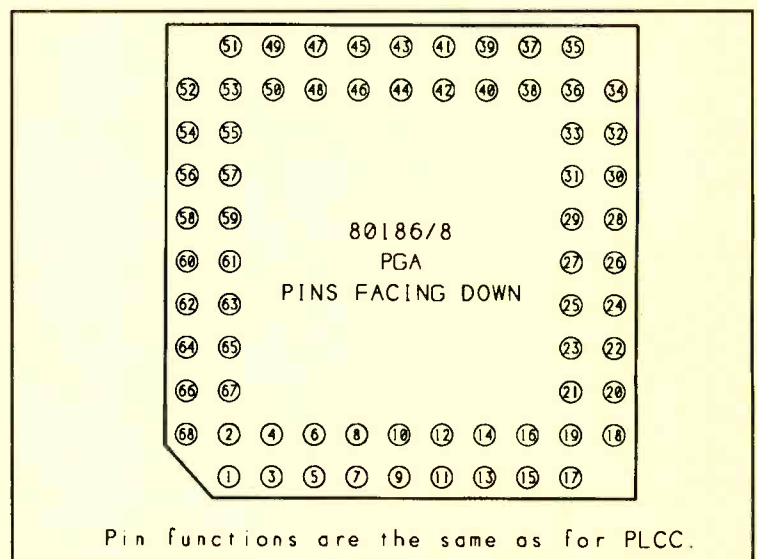
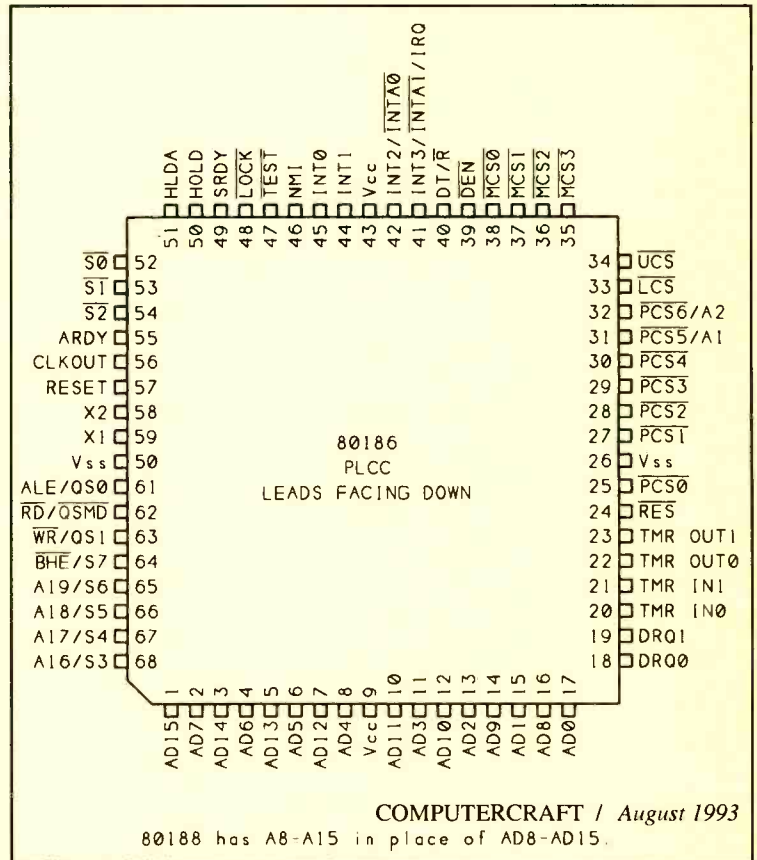
The 80186 contains an 8086 microprocessor and several peripherals on a single chip. It's intended for use in controllers, instrumentation and other embedded applications. The 80188 is identical to the 80186 except for its eight-bit external data bus.

### Features

- Enhanced 8086
- Up to 20-MHz clock
- 1M addressing ability
- Clock generator
- Two DMA channels
- Programmable interrupt controller
- Three programmable 16-bit timers
- Programmable memory and chip-select logic
- Programmable wait-state generator
- Local-bus controller
- Object-code-compatible with 8086/8
- Ten added instruction types

### Related chips

- 80C186XL is low power, 20-MHz clock.
- 80C186EA has power-save modes, 20-MHz clock.
- 80C186EB has two serial channels, power-save modes, 16 port pins, 20-MHz clock.
- 80C186EC has two serial channels, power-save modes, four DMA channels, watchdog timer, 24 port pins, 16-MHz clock.



Signal	Pin(s)	Type	Function
AD0-AD7	2,4,6,8,11,13,15,17	I/O	Low Address/Data Bus
AD8-AD15	1,3,5,7,10,12,14,16	I/O	High Address/Data Bus (80186 Only)
A8-A15	1,3,5,7,10,12,14,16	Output	High Address Bus (80188 Only)
A16/S3	68	Output	Address Bit 16/Bus Cycle Status 3
A17/S4	67	Output	Address Bit 17/Bus Cycle Status 4
A18/S5	66	Output	Address Bit 18/Bus Cycle status 5
A19/S6	65	Output	Address Bit 19/Bus Cycle status 6
ALE/QS0	61	Output	Address Latch Enable/Queue Status 0
ARDY	55	Input	Asynchronous Ready
-BHE/S7	64	Output	Bus High Enable/Bus Cycle Status 7
CLKOUT	56	Output	Clock Output
-DEN	39	Output	Data Enable
DRQ0	18	Input	DMA Request Channel 0
DRQ1	19	Input	DMA Request Channel 1
DT/-R	40	Output	Data Transmit/Receive
HOLD	50	Input	Bus Hold
HOLDA	51	Output	Bus Hold Acknowledge
INT0	45	Input	Interrupt request 0
INT1/SELECT	44	Input	Interrupt Request 1/Save Select
INT2/-INTA0	42	I/O	Interrupt Request 2/Acknowledge 0
INT3/-INTA1/IRQ	41	I/O	Interrupt Request 3/Acknowledge 1/Slave Request
-LCS	33	Output	Lower Memory Chip Select
-LOCK	48	Output	Bus Lock
-MCS0	38	Output	Midrange Memory Chip Select 0
-MCS1	37	Output	Midrange Memory Chip Select 1
-MCS2	36	Output	Midrange Memory Chip Select 2
-MCS3	35	Output	Midrange Memory Chip Select 3
NMI	46	Input	Nonmaskable Interrupt request
-PCS0	25	Output	Peripheral Chip Select 0
-PCS1	27	Output	Peripheral Chip Select 1
-PCS2	28	Output	Peripheral Chip Select 2
-PCS3	29	Output	Peripheral Chip Select 3
-PCS4	30	Output	Peripheral Chip Select 4
-PCS5/A1	31	Output	Peripheral Chip Select 5/Latched A1
-PCS6/A2	32	Output	Peripheral Chip Select 6/Latched A2
-RD/-QSMD	62	I/O	Read Strobe/Queue Status Mode
-RES	24	Input	CPU Reset
RESET	57	Output	Reset Output
-S0	52	Output	Bus Cycle Status 0
-S1	53	Output	Bus Cycle Status 1
-S2	54	Output	Bus Cycle Status 2
SRDY	49	Input	Synchronous Ready
-TEST	47	I/O	Wait Instruction Continues if Low
TMR IN 0	20	Input	Timer Input 0
TMR IN 1	21	Input	Timer Input 1
TMR OUT 0	22	Output	Timer Output 0
TMR OUT 1	23	Output	Timer Output 1
-UCS	34	Output	Upper Memory Chip Select
-WR/QS1	63	Output	Write Strobe/Queue Status 1
Vcc	9,43	Input	Power Supply (+5V)
Vss	26,60	Input	System Ground
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### Corrections

March 1993 Disk Drive Interfaces section transpose the two cable drawings on the first page with those on the second page.

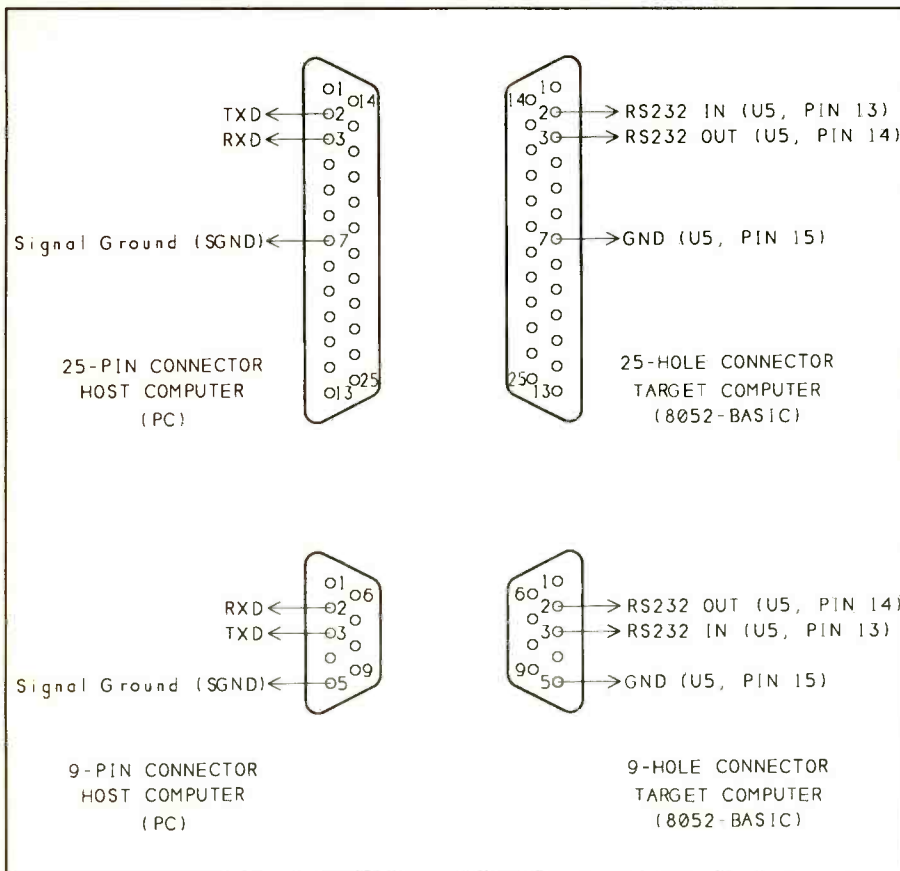


Fig. 2. Wiring diagram for serial connections to the 8052-BASIC system.

tion on personal computers is a DTE type that has a male nine- or 25-pin D-subminiature connector. For the 8052-BASIC system, you'll need a mating female nine- or 25-pin D-connector. The connection uses just three conductors.

A solder-cup-type connector permits easy soldering of the wires.

Figure 2 shows the wiring details for nine- and 25-pin connectors. Keep in mind that some computers may require additional handshaking signals.

```

Terminal - [Untitled]
File Edit Settings Phone Transfers Help

*MCS-51(tm) BASIC V1.1*
READY
>print mtop
8191

>print xtal
11059200

>10 print "hello, world"
>20 end
>list
10 PRINT "hello, world"
20 END

READY
>run

hello, world

READY
>
    
```

Fig. 3. You can use the Windows terminal accessory to communicate with the 8052-BASIC system.

BASIC-52 doesn't support these, but you can simulate them by connecting together pins 5, 6, 8 and 20 at the personal-computer end of the link. (These pin numbers are for a 25-pin connector.)

### Powering Up

To power up and test your circuit, you need: a regulated +5-volt power supply that's capable of delivering at least 0.5 ampere; multimeter capable of reading volts, ohms and amperes (just about any basic meter will do for this); and a logic probe for convenient for monitoring logic levels (or use an oscilloscope if one is available). You also need a computer with terminal-emulation software and a serial port. For terminal emulation, you can use the same software you use for modem communication with a BBS. I usually use Datastorm Technologies' *Procomm Plus*, but any good software vendor or shareware catalog will have several options. If you have *Windows*, you can use its Terminal accessory. An IBM/compatible 80x86 computer isn't required. Any computer or even a computer terminal that has a serial port and communications software will do.

The first time you power up an untested circuit, it pays to be cautious. I recommend that you exercise the following steps:

- Visually inspect the circuit. You don't have to spend a lot of time on this, but an obvious missing or mis-wired wire or component or another problem will sometimes jump out at you.
- Install U1 through U6 in their respective sockets on the board, making sure that pin 1 on each is oriented correctly.
- Set J1 to BASIC-52 (+5 volts), and set J2 and J3 to match the size of your RAM at U6.
- With an ohmmeter, measure the resistance from +5 volts to ground, to make certain that you haven't shorted together the two by mistake. My board measured 4,700 ohms with an HMOS 8052 at U1, and 13,000 ohms with a CMOS 80C52. The exact value isn't critical, but if you get a reading that's close to 0 ohm, you've connected +5 volts to ground, in which case, you must find and correct the problem before you continue.

If you suspect a problem, check the wiring of the power and ground connections, comparing the connections to those on the schematic. Be sure all components are oriented correctly. When all

checks out, you're ready to boot up to BASIC-52.

For the initial check, begin with everything powered down. I'll use the terms host computer or host system to refer to the personal computer, and target computer or target system, to refer to the 8052-BASIC board.

Interconnect the serial ports of the host and target systems with a properly configured cable. Connect, but don't turn on, the target system's power supply.

Turn on your host computer and run your communication software. Configure it for eight data bits, no parity and one stop bit. Select the appropriate serial, or COM, port, if necessary. The baud rate you select isn't critical, since BASIC-52 automatically adjusts to what you're using. To start, use a rate of 9,600 or less. Select no handshaking or flow-control options.

In *Procomm Plus*, use the line/port setup menu (ALT+P) to configure. In the *Windows* terminal, use the Settings menu.

You're now ready to power up the target system. Turn on the power supply and then press the space bar at the host's keyboard. You should see the following BASIC-52 sign-on message and prompt on your video monitor:

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

Figure 3 shows the sign-on message as it appears on the *Windows* terminal screen. If you don't see the prompt, it's time to troubleshoot. Getting the system to boot up the first time can be the most-challenging part of a project, especially when serial communication is involved. Here are some things that can help you isolate the cause of such a problem:

Try again by pressing and releasing *S1* and the space bar. If you're using a 32K RAM for *U6*, BASIC-52 requires about a second to perform its memory check after a reset occurs to respond to the space bar. With an 8K RAM, the delay is a few tenths of a second.

Double-check the easy things. Are the communications parameters correct? Did you select the correct serial port? Are all ICs plugged into their appropriate sockets, properly oriented and seated, with no pins overhanging the sockets or folded under between ICs and sockets?

Verify that pin 9 of *U1* goes high and

then low when you press and release *S1*.

Check the power and ground pins of all ICs for proper voltages.

Connect a logic probe to pin 10 of *U1*. When you press the space bar, you should see the logic level toggle as *U1* receives the ASCII code for "space" (20h). If you don't obtain this response, you probably have a problem in the setup of your communications software or in the serial cabling.

Verify that pin 30 of *U1* is toggling (at 1/6 the crystal frequency if you have an oscilloscope). This indicates that the oscillator circuit is functioning.

Verify that pins 21 through 28 and 32 through 39 of *U1* toggle as BASIC-52 performs its memory check immediately after powering up or rebooting.

If all else fails, recheck your wiring for missing or/and mis-routed wires. Sometimes there's no alternative but to go through the schematic connection by connection, checking each with an ohmmeter or audible continuity checker. When I built my prototype of this circuit, I transposed the inputs and outputs of *U3*, and it took a while to discover where the problem was.

## Basic Tests

When your system boots up, you're ready for some basic tests. You'll want to have your BASIC-52 programming manual handy as a reference as you do this.

In some ways, BASIC-52 is similar to BASIC compilers like QuickBASIC. Many of the keywords and syntax rules are similar. But BASIC-52 is closer to older interpreted BASICs like GW-BASIC and BASICA. You can key in a statement or command and execute it immediately when you hit ENTER, or you can type a series of statements and run them later as a program. If a statement begins with a line number, BASIC-52 treats it as a program line, rather than as a statement to execute immediately.

Type PRINT MTOP to find out how much external data memory BASIC-52 detected on boot-up. With an 8K RAM, MTOP is 8191, and with 32K, it's 32,767. If you prefer hex notation, type PH0. MTOP.

Special operator XTAL represents the value of the timing crystal that clocks *U1*. The default value is 11059200, or 11.0592 MHz. You can verify this by typing PRINT XTAL. Most BASIC-52

## Listing 1. BASIC-52 Instructions to Set, Clear and Read Individual Bits in Byte X

Operation	Bit #	BASIC-52 Statement
Set	0	X=X.OR.01h
	1	X=X.OR.02h
	2	X=X.OR.04h
	3	X=X.OR.08h
	4	X=X.OR.10h
	5	X=X.OR.20h
	6	X=X.OR.40h
	7	X=X.OR.80h
Clear	0	X=X.AND.0FEh
	1	X=X.AND.0FDh
	2	X=X.AND.0FBh
	3	X=X.AND.0F7h
	4	X=X.AND.0EFh
	5	X=X.AND.0DFh
	6	X=X.AND.0BFh
	7	X=X.AND.07Fh
Read	0	PRINT X.AND.01h
	1	PRINT (X.AND.02h)/2
	2	PRINT (X.AND.04h)/4
	3	PRINT (X.AND.08h)/8
	4	PRINT
	(X.AND.10h)/10h	
	5	PRINT
	(X.AND.20h)/20h	
	6	PRINT
	(X.AND.40h)/40h	
7	PRINT	
	(X.AND.80h)/80h	

functions don't use the XTAL operator. Exceptions are the real-time clock, programming commands, PWM output and LPT serial output at pin 8. For these, XTAL should match your crystal's frequency. To set XTAL for a 12-MHz crystal, type XTAL=12000000.

After typing a few commands, you may discover some of BASIC-52's line-editing abilities. While typing a line, you can correct errors by deleting back to the error and retyping. In *Procomm Plus*, if you select VT100 terminal emulation (Setup menu, Terminal Options), you can use either the delete or backspace key to delete. With the *Windows* terminal, you must use the delete key (not backspace). Many communication programs allow you re-map the keyboard so that you can select whatever delete key you wish.

Once you press ENTER, you can't edit a line you've typed unless you retype it from the beginning.

BASIC-52 treats upper- and lower-case characters the same. As a rule, spaces are ignored. Therefore, you can include spaces or not as you wish.



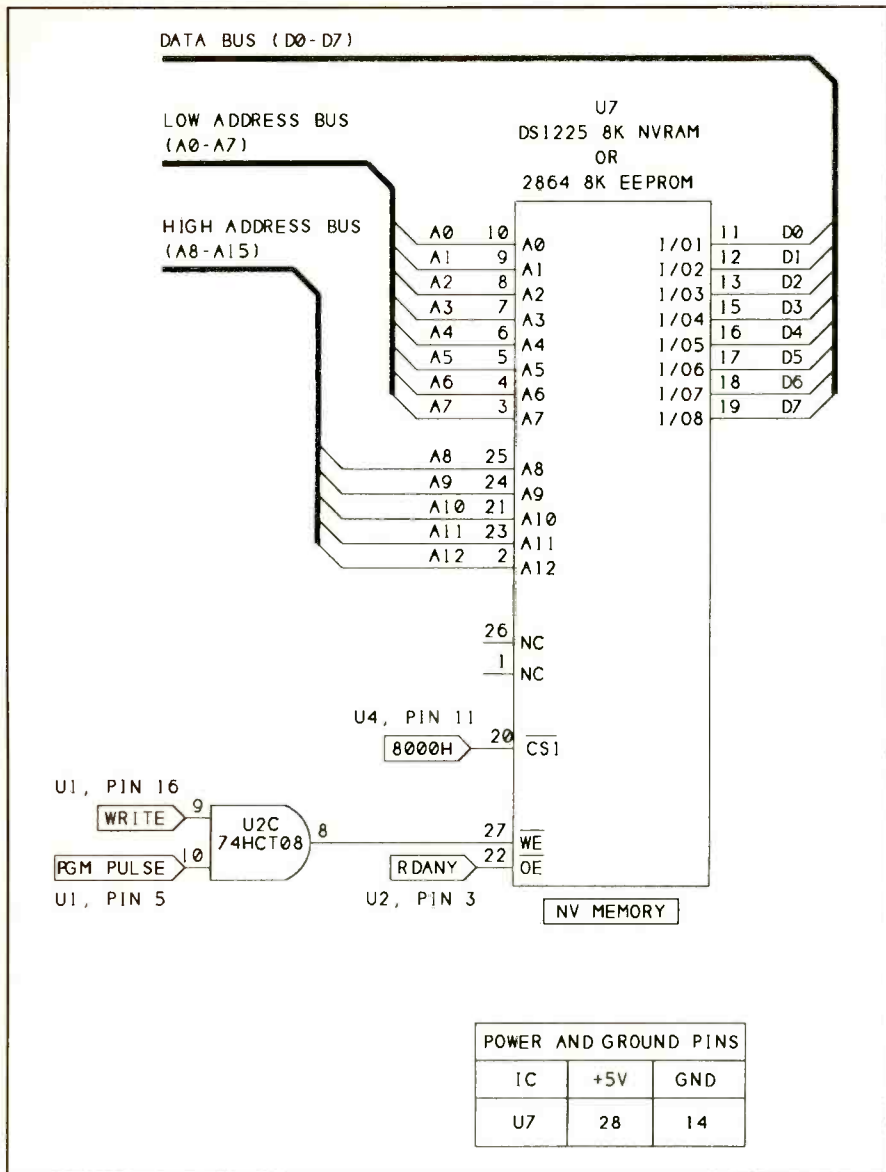


Fig. 4. Wiring diagram for adding 8K of NVRAM or EEPROM for permanent program storage.

Here's a very simple program to try:

```
10 PRINT "Hello, world"
20 END
```

Enter each of the lines, including the line numbers. BASIC-52 stores the program in RAM. To run the program, type RUN and hit ENTER. You should see this:

Hello, world

To view the program, type LIST and hit ENTER. To erase the current program, type NEW and hit ENTER. You can change individual program lines by typing the line number, followed by a new statement. To erase a line, type the

line number and press ENTER.

Now let's try some basic I/O. Connect a logic probe to monitor pin 1 of U1, or connecting the "hit" of lead a voltmeter to pin 1 and the common lead to ground. Pin 1 is Bit 0 of Port 1, or P1.0 for short. The following statement brings P1.0 low:

```
PORT1=PORT1.AND.0FEH
```

The following statement brings P1.0 high:

```
PORT1=PORT1.OR.01H
```

Your logic probe or voltmeter readings should verify these.

As the above statements suggest,

BASIC-52 has no instructions for setting or clearing individual bits, as 8052 assembly language does. Instead, you can use the logical operators AND and OR, along with a mask byte, to change one bit in a byte without affecting the others.

To clear a bit, AND the byte with a mask byte consisting of all 1s except for the bit or bits to be cleared. For example, to clear Bit 0, the mask byte is 1111 1110, or FE in hexadecimal. The result is that Bits 1 through 7 are unchanged and bit 0 is 0, no matter what it was originally.

To set a bit, OR the byte with a mask byte consisting of all 0s except for the bit or bits to be set. To set Bit 0, the mask byte is 0000 0001, or 01h, which again leaves Bits 1 through 7 unchanged but forces Bit 0 to be 1.

Listing 1 shows statements that set and clear each of the bits in a byte. Don't clear Bit 3 of Port 1 (P1.3), since BASIC-52 uses this bit in accessing external memory. If you clear it accidentally, press S/ to reset the system. You must add a leading 0 to hex numbers that begin with A through F.

You can read Port 1 as well as write to it. To display the value of the entire port, type PRINT PORT for decimal or PH0. PORT1 for hexadecimal.

If a port pin is open, or unconnected, its internal pull-up resistor will cause it to be read as 1. If you jumper a port pin to ground or bring it low by connecting it to a logic low output, it should read 0.

The logical operators and mask bytes also enable you to read individual bits. To read bit 0 only, type

```
PRINT PORT1.AND.01H
```

Listing 1 shows statements that will display the values of the other bits in a byte.

## Adding Nonvolatile Memory

One of the handiest features of BASIC-52 is its programming commands for storing programs in EPROM, EEPROM or battery-backed RAM. These commands are designed to meet the programming requirements for EPROMs, with a choice of Intel's 50-millisecond or Quick-Pulse programming algorithms. But you can use the same commands to store programs in battery-backed RAM (NVRAM) or EEPROM.

Like EPROMs, these devices provide nonvolatile storage. That is, their contents don't disappear when power is removed. Additionally, they have two advantages over EPROMs: they don't need special programming voltages, and they don't need ultraviolet light for erasure. This makes them much more convenient to use.

For these reasons, your circuit offers a choice of NVRAM or EEPROM for nonvolatile storage, with EPROM left as an option for later, if the need for it should arise. Whether you choose EEPROM or NVRAM, be sure to ask for a data sheet for the device you buy.

Figure 4 shows the added circuits for the NVRAM /EEPROM. Pinout and wiring are similar to that used for the RAM at U6. The data and 13 address lines are wired exactly the same as for U6. The chip-select input at pin 20 connects to pin 11 of U4, which is low only when addresses from 8000h to 9FFFh are selected.

Connecting output-enable of U7 to RDANY allows it to be accessed as data or program memory. This enables U7 to store assembly-language routines, as well as BASIC-52 programs. For writ-

ing to U7, AND gate U2C gives you a choice of two signals. Write is the conventional signal used to write to data memory. In addition, BASIC-52 uses a special Pgm Pulse signal when it stores BASIC-52 programs in NV memory beginning at 8000h. Either of these signals will bring low WE on U7.

Dallas Semiconductor offers NV-RAM chips that you can use at U7. These work exactly like static RAM, except that they contain a lithium cell and backup circuits that retain the RAM's contents when the main power supply is removed. The backup is guaranteed for at least 10 years. Alternatively, you can use one of Dallas's SmartSockets, which contain only the lithium cell and backup circuits and require you to plug in your own static RAM.

For U7, you can use the DS1225 NVRAM or a DS1213B or DS1213C SmartSocket with a 6264 static RAM. The -AB version of the NVRAM operates at power supply potentials that are greater than 4.75 volts and write-protects when the supply delivers less than 4.5 volts. SmartSockets employ the same write-protect voltages. -AD and -Y NVRAMs operate when the supply is delivering greater than 4.5 volts and write-protect when it's less than 4.25 volts. Any of these should work in this circuit. Access times of 250 ns or less are fine.

Don't be confused by the fact that Dallas describes its devices by the number of bits they store, rather than the number of bytes. For example, the company calls the 8K-byte DS1225 a 64K device.

You can order NVRAMs directly from Dallas Semiconductor (no minimum order required) or from JDR Microdevices and other distributors.

Your other option is EEPROM. A typical EEPROM is guaranteed for 10,000 write cycles, compared to infinite write cycles for NVRAM. EEPROMs are also slower than static RAMs. Most EEPROMs require you to wait 2 to 10 ms after writing to them before you can access them again. In spite of the drawbacks, I've included EEPROM as an option because an 8K EEPROM is costs less than a NV RAM (\$8 for EEPROM, compared to \$19 for NVRAM from one vendor). Typical part numbers for an 8K EEPROM are 2864 and 28C64.

EEPROMs have two common ways

of indicating that they're busy performing a write operation and so are unable to be accessed. In one type, when the EPROM is busy, the data outputs hold the last-written data, but with one or more bits inverted. Because BASIC-52's programming commands verify each byte after programming it, the inverted data automatically keeps BASIC-52 from programming another byte until the EEPROM is ready to receive it.

Other EEPROMs have a busy output, usually at pin 1, that goes low when the EEPROM is busy. For this type, you can tie the busy output to pin 12 of U1, which BASIC-52 checks after programming each byte.

Wire U7 in your circuit, using Fig. 4 as a guide. Use an IC socket. If you previously tied pins 9 and 10 of U2 to ground or +5 volts, be sure to remove these connections before you wire the ones shown in Fig. 4.

When you've added the circuit, you're ready to power up and try the programming commands. Begin by entering any simple BASIC-52 program or use the example given earlier.

If you used a 32K RAM at U6, you must perform an additional step before you can store a program in U7. On boot-up, BASIC-52 tests contiguous memory and sets MTOP to the highest value it finds below E000h. But BASIC-52's programming commands won't work unless MTOP is below 8000h. To enable program storage, type MTOP=7FFFh. This ensures that BASIC-52 won't try to store RAM programs, variables or strings in the area you've reserved for permanent program storage (although it doesn't prevent you from writing to the area with BASIC-52's XBY operator). If U6 is 8K, MTOP is 1FFFh, which is well below 8000h. Hence, you don't have to worry about changing MTOP.

To copy the current program from U6 to U7, type FPROG and hit ENTER. You'll see the number 1, indicating that this is the first BASIC-52 program to be stored in the device. Following a short delay, the Ready prompt should return.

PROG is an alternate command that uses a slower programming algorithm, and should work also.

If BASIC-52 is unable to program the chip, you'll see an ERROR: PROGRAMMING message displayed on-screen. If you get an error, double-check your wiring. When the programming command executes, pins 20, 22 and 27

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**Listing 2. BASIC-52 Program for Erasing U7 by Writing OFFh to Locations 8000h-9FFFh**

```

10 FOR I=8000H TO 9FFFH
20 XBY(I)=OFFH
30 IF XBY(I)<OFFH THEN GOTO 30
40 NEXT I
50 END
    
```

should toggle, along with the address and data lines.

To run a program from NV memory, you must switch from RAM mode, where BASIC-52 runs the program stored in U6, to ROM mode, where it looks in U7 for programs to run. RAM and ROM commands select the modes. When you've programmed successfully, run your program by typing ROM and hitting ENTER and then RUN and ENTER or RROM and then hitting ENTER.

You can store multiple programs, space permitting, and run each by specifying its number. For example, to run the second program stored, type

RROM2. To return to editing programs in RAM, type RAM.

Another useful command is XFER. In ROM mode, type XFER to copy the current program from ROM into RAM, where you can edit it, and then use FPROG to store the revised version in U7 if you wish.

The commands FPROG1 through FPROG6 let you to store additional information besides programs. Especially handy is FPROG2, which saves the current baud rate and also tells BASIC-52 to automatically run the first program in NV memory on boot-up. This is what allows you to disconnect the system from its host and run it as a stand-alone system.

You can also permanently store a value for MTOP in U7. If U6 is 32K, set MTOP to 7FFFh and type FPROG3. Now, when your system boots, MTOP will automatically be set to 7FFFh, and you can use the FPROG commands without problems. FPROG3 also saves the baud rate and boots to the READY prompt without requiring you to press the space bar.

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If you do use FPROG2 or FPROG3, BASIC-52 will no longer automatically detect your host's baud rate. You must use the baud rate that was in use when you used the FPROG command.

Eventually, your NVRAM or EEPROM will fill with programs, or you may just want to erase what you've stored and start fresh. Listing 2 is a BASIC-52 program that erases U7 by writing 0FFh to all locations. To use the program, key in the listing and then type RUN, following with ENTER. The READY prompt will return when erasure is complete.

If you want to add an additional 8K of NV RAM, wire another circuit exactly as shown in Fig. 4, but connect pin 20 of the new NVRAM or EEPROM to A000h (pin 10 of U4) so that it will be accessed from A000h to BFFFh.

## Storing Programs on Disk

With BASIC-52's programming commands, you really don't need to store programs on disk. Even so, disk storage is convenient, since you can save as many programs as you want without worrying about running out of NV memory. Since the programs are stored as ASCII text, you can write and edit them with any text editor and then simply upload them as needed to the target system.

Most communication software allows you to upload and download files. In *Procomm Plus*, you use the PgUp and PgDn keys. In the *Windows* terminal, use the Transfers menu.

If possible, set up your software so that it waits for the BASIC-52 ">" prompt (ASCII 62) after each uploaded line. This ensures that BASIC-52 will have enough time to process each line before the next one arrives. If there isn't enough time, you'll have missing characters or lines in uploaded programs.

To do this in Procomm Plus (V2.01), from the Setup menu, select Terminal Options then Protocol Options, ASCII Options and set the pace character to 62. Character and line spacing can be 0. Also, under Protocol Options, General Options, set Abort Transfer if CD Lost to NO, since the three-conductor serial cable doesn't include the CD line.

In the *Windows* terminal, select Settings, then Text Transfers, One Line at a Time, and enter ">" under Wait for Prompt String. Other software should have similar abilities. If not, look for options that add delays after each line or character and experiment with values for these, or use a slower baud rate if necessary.

To download a BASIC-52 program from the target's RAM to the host's disk, type LIST to list the current program, but before you press ENTER, set up your host's software to download, or receive, an ASCII file. When prompted, specify a filename. When the transfer is set up, press ENTER to send your program to the host. When you see the Ready prompt, end the transfer. You should now have a file on disk containing the program you just listed.

To erase the current program from RAM, type NEW. Now when you type LIST, no program is listed.

To restore your program by uploading it from disk, set up your host's software to upload, or send, an ASCII file, and enter the name of your previously downloaded file. As the file loads, you'll see each program line on-screen. The file will contain a READY prompt after the program listing. This causes BASIC-52 to display an error message, which you can ignore. Type LIST to view the uploaded program, and type RUN to run it.

That about does it for this time. Next month, you'll expand and experiment with more I/O applications.

## New Books

Turning to a different topic, here are some new books I've recently looked at that you might want to consider adding to your library.

For HC11 fans, there's the comprehensive *Microcontroller Technology: The 68HC11*, by Peter Spasov (1993, Regents/Prentice Hall, \$61.33, 622 pages). Designed as a text for engineers or technicians, it covers everything from basic explanations of how a computer works to examples of how to use the HC11's indexed addressing to copy a block of data or access a look-up table. This book includes much of the same material as *Motorola's 68HC11 Reference Manual*, but I often find it helpful to read two different sources, since each has its own perspective. There are many short code listings in assembly language and a chapter on C. You won't find a lot of schematics or hardware examples, however, and most of the ones there are don't include specific component designations. One interesting chapter describes three real-world HC11 applications: in car engines, cameras and printers.

A second HC11 text that I haven't yet seen is *The Microcontroller: 68HC11*, by Joseph D. Greenfield (1992, Saunders College Publishing, \$34, 420 pages).

Finally, computers are digital devices, but they often control and monitor analog circuits. *Troubleshooting Analog Circuits*, by Robert A. Pease (1991, Butterworth-Heinemann, \$32.95, 217 pages) has useful and practical tips for designing and fixing analog circuits, including circuits containing operational amplifiers, voltage and current references, regulators and transistors. The author is a senior scientist at National Semiconductor; so there's no question that he's qualified to write on this topic. The style is very informal and often humorous. There are even a few projects, including a sensitive short-circuit detector for pc boards and an active oscilloscope probe with low input capacitance.

If you can't find any of these books on the shelves of your bookstores, the stores should be able to order them. ■



Jan Axelson

# A Simple Intel BASIC-52 Extractor

**Copies an internal 8052AH-BASIC interpreter into EPROM for use with inexpensive 8032/8052 MPUs**

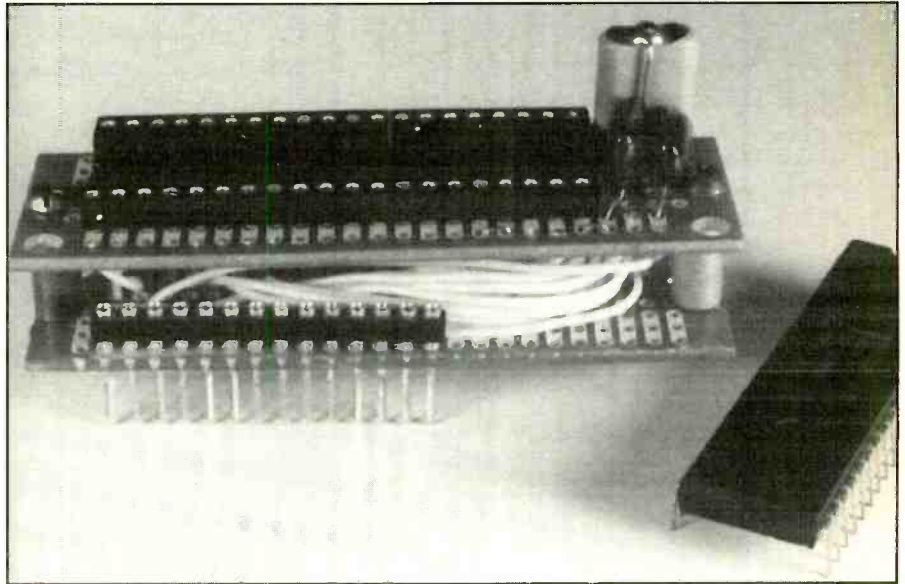
For casual users and novices, the easiest way to program a microcontroller project is with BASIC, and for simplest layout, a project can use an Intel 8052AH-BASIC MPU with an EPROM and little else. The only drawback to this arrangement is that for every project, you must buy another \$25 or so 8052AH-BASIC chip. The 8032 series of embedded microcontrollers are considerably less expensive than their 8052AH-BASIC cousins because it lacks an internal BASIC interpreter. Otherwise, the 8032 is identical to the 8052AH-BASIC, except that requires BASIC in external ROM to function. Getting the EPROM with BASIC already loaded into it is what this article is all about. Surprisingly, this isn't as difficult as you may think.

In the January 1993 issue of *ComputerCraft*, Jan Axelson discussed copying the BASIC interpreter from Intel's 8052AH-BASIC chip into EPROM. After buying and copying the first 8052AH-BASIC chip to EPROM, you can put safely away the expensive chip and use a less-expensive non-BASIC 8032/8052 chip with the EPROM into which you programmed BASIC for all future projects.

There isn't much difference between an EPROM and the ROM inside the 8052AH-BASIC microcontroller chip. The only significant difference is in the pinouts for the two devices. In this article, I'll show you how to build a small socket adapter to match the pinout of the 8052 to a 2764/A EPROM and plug this into a commercial EPROM copier. With this adapter, you can then be read and copy the EPROM as a standard 2764 device, without the need to take any intermediate steps or have on hand additional equipment.

## Building the Project

Referring to Fig. 1, you read an EPROM by feeding it an address on address bus A0 through A12 and read what comes out on data bus D0 through D7. According to



the Intel embedded-microcontrollers handbook, you can verify the internal program by supplying power and ground, putting a high or low on certain pins and then verifying what comes out on the eight-line Port 0 bus.

To make the adapter, you use a 40-pin machined-contact solder-tail IC socket and two 14-pin machined-contact Wire Wrap SIP strips. The SIP strips take the place of a 28-pin Wire Wrap socket to provide room to bundle the connecting wire between the two rows.

To make the adapter as compact as possible, you'll mount these sockets on two halves of a Radio Shack or similar experimenter printed-circuit board (see Parts List). You must also mount the small C1 and C2 silver-mica capacitors and a 4- or 6-MHz crystal (XTAL) for the 8052's oscillator. The chip needs its oscillator to be active to be able to move the ROM data around internally.

Use a sharp hacksaw to cut the pc board in half lengthwise, as shown in Fig. 2, and smooth the cut edges with a file. Then mark the centers of the strips and drill a small hole at each end of both strips, as shown. Later, when you're ready for final assembly, you'll use 4-

32 "  $\frac{3}{4}$ " machine screws and nuts and  $\frac{7}{16}$ " spacers to fasten together the two strips, as shown in the bottom drawing in Fig. 2 and the lead photo.

Plug two 14-contact Wire Wrap SIP strips into one of the pc-board strips as shown, spacing the SIP strips 0.6" apart and parallel to each other, as shown in the upper drawing in Fig. 2. As you solder the pins of the SIP strips to the pads on the pc board, make sure they're perfectly square with the pc board so that they plug into a commercial EPROM copier without difficulty.

Plug the pins of the 40-pin solder-tail socket into the holes in the other pc-board strip, offsetting is as shown in the upper drawing in Fig. 2 to make room for mounting the crystal and capacitors at the end opposite pin 1 of the socket. Solder the socket pins to the copper pads on the bottom of the pc board and install and solder into place the crystal and capacitors.

Using small-gauge solid hookup wire and referring back to Fig. 1, wire the capacitors and crystal into the circuit at the appropriate points. Then wire together the two sockets, soldering prepared lengths of wire to the pins on the

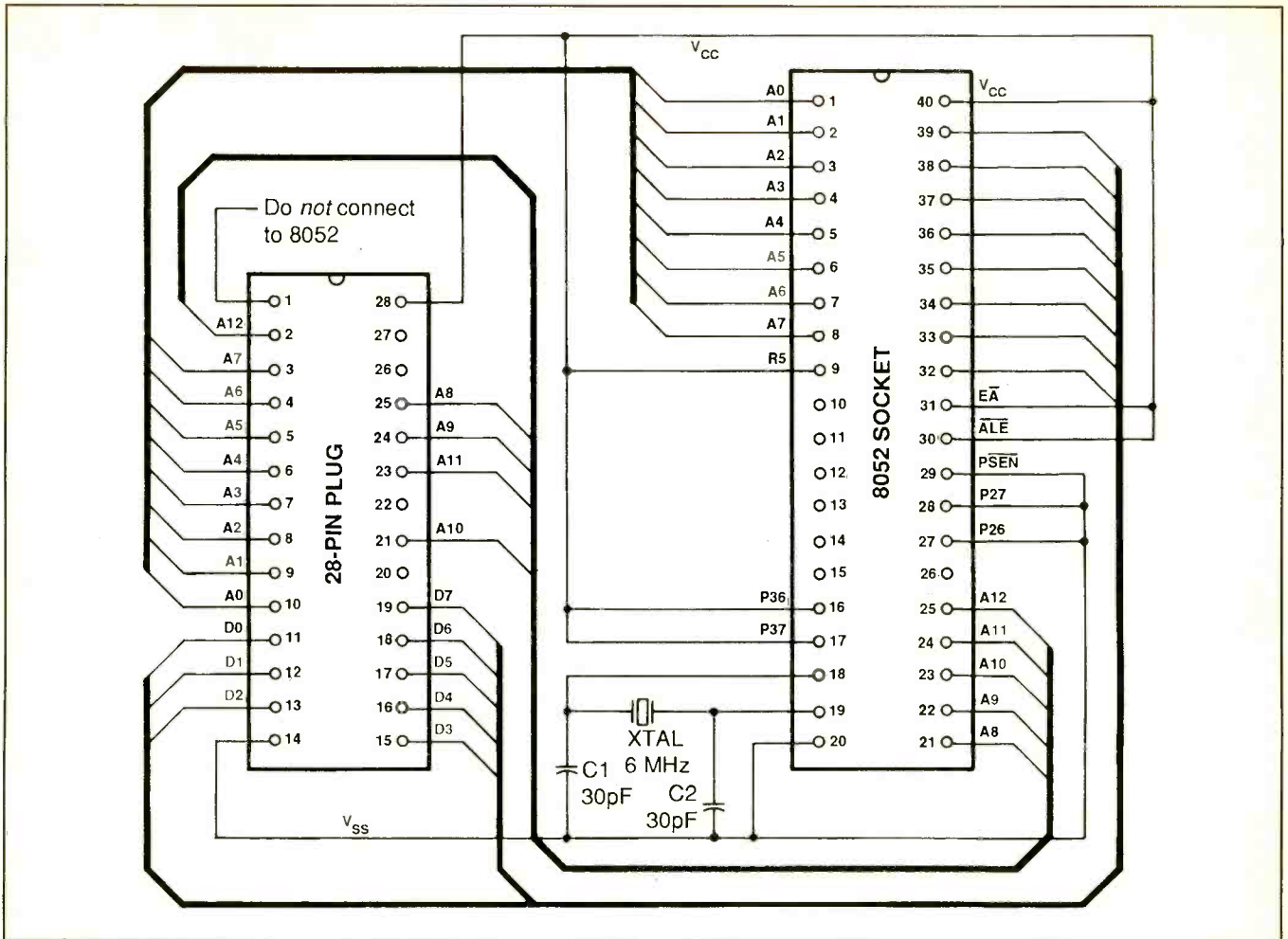


Fig. 1. Schematic details for the adapter.

### PARTS LIST

C1,C2—30-pF silver-mica capacitor  
 XTAL—6.0-MHz crystal  
 Misc.—Experimenter's printed-circuit card (Radio Shack Cat. No. 276-150 or similar); 40-pin machined-contact solder-tail IC socket; snap-able 30-position SIP Wire Wrap header;  $7/16$ " spacers (2); 4-32  $\times$   $3/4$ " machine screws and nuts; hookup wire; solder; etc.

40-pin socket on underside of the board and the appropriate pads on the SIP-strip board. Make these wires long enough to span the distance between the socket and SIP strips, with enough slack in them to permit you to fold them neatly as you bring together the two sub-assemblies during final assembly. Be sure to leave a little extra length on each wire so that when you fold them, you can route them neatly without stretching or pressing against any sharp-edged soldered points. Make absolutely certain that you haven't made a connection

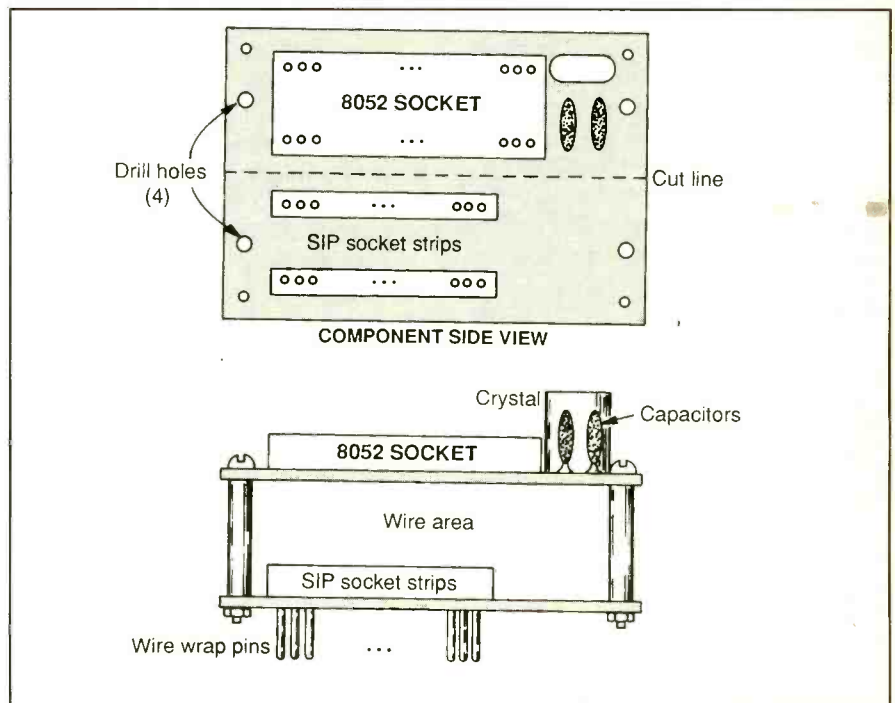


Fig. 2. Mechanical details for fabricating the adapter.

to pin 1 on the 28-pin SIP-strip socket. If you do and the 21-volt programming  $V_{PP}$  potential is applied to the circuit, you'll almost certainly destroy the 8052AH-BASIC chip!

When you're done wiring the project, bending the interconnecting wiring between the two boards as needed to make a neat assembly. Then secure the boards together with the machine hardware and spacers, as shown in the bottom drawing in Fig. 2. Neatly "dress" the wires between the two subassemblies, routing them between the plastic blocks on the SIP strips (see lead photo).

Before putting the adapter into service, completely check out your wiring with an ohmmeter or audible continuity tester. Also, double-check to make sure that no connection has been made to the pin-1 position of the SIP-strip socket arrangement.

### Using the Adapter

When you're absolutely certain that all your wiring is correct, plug an 8052AH-BASIC chip into the 28-pin socket at the top of the assembly, orienting pin 1 at the end opposite to that on which the crystal and capacitors are mounted. Plug the adapter into an EPROM copier, orienting it according to the manufacturer's instructions.

Read the 8052 in its adapter as a "2764" EPROM. This puts the 8052AH-BASIC program into the programmer's memory. Verify that the program in memory is the same as that in the 8051/2764 adapter. If all's well, remove the adapter and set it aside. Then plug a new or erased 2764 EPROM into the programmer's socket and write the program into it.

You can now store your expensive 8052AH-BASIC MPU and make as many 2764 EPROM-BASIC copies as you need.

### In Closing

With the adapter presented here, you should be able to copy the program of any other 80xx/87xx MPU. Just be sure that you wire the adapter to match the family you intend to copy. Of course, some MPU chips can't be copied. According to the Intel handbook, a part whose number ends in a "-P" suffix means that the internal program is protected and can't be verified using this adapter. ■

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# Adding Peripherals to Your PC

Dealing with the woes of adding sound cards, CD-ROM drives, image scanners and other peripherals to your PC and insights on some affordable nifty new products you might want to add to your system

As computer technology moves forward, more and more peripherals to enhance the use of the desktop PC are becoming not only available but affordable as well for the average user. A good example of this is the current crop of multimedia computers now on the market that introduce new purchasers of this equipment to sound cards and CD-ROM drives that as little as a year ago might have been considered to be expensive exotica for the average user.

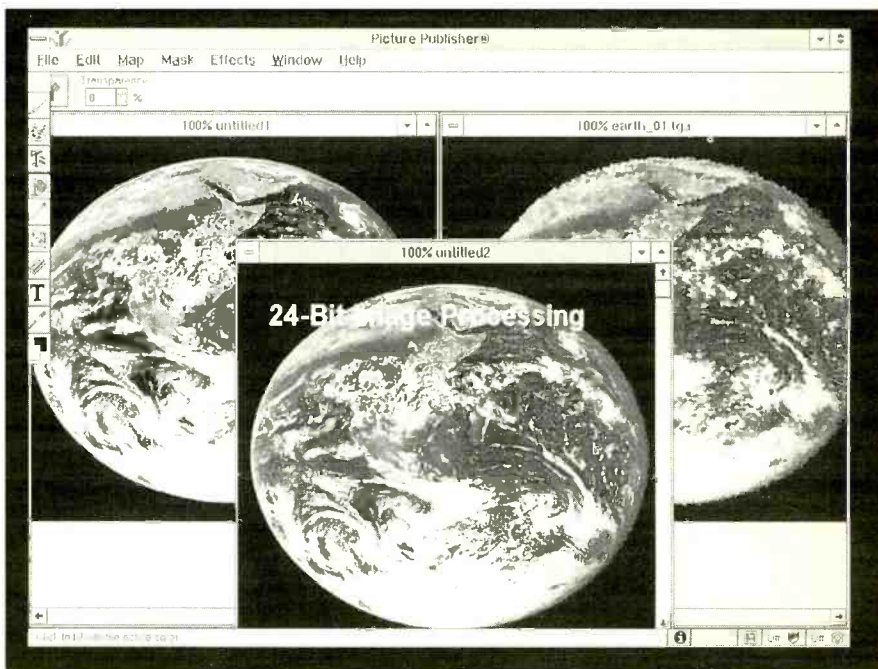
Now you can also get flatbed and hand scanners and high-resolution graphics cards capable of displaying up to 16.7-million colors for working with photo-realistic images, not to mention a bevy of sophisticated and powerful software.

Most computers come with a more or less "standard" set of peripherals that include a keyboard, a video monitor and color graphics card combo, a mouse attached to a serial port and maybe even a modem for convenient communication with other computers, BBSs and other on-line services. Most, if not all, new computers also come with bundled software to get them up and running right out of the carton. And quite a number of suppliers are offering "special" configurations that include a wide variety of hardware and software to meet specific needs, not to mention a bevy of relatively inexpensive optional add-ins and add-ons. The bottom line, though, is that it's the computer that manages whatever may be attached to it and software that's run in it. And herein lies a pitfall to the user who wants to add to his system.

In this article, I'll address the pitfalls and how you can overcome them. Then I'll outline the new products—hardware and software alike—you can add to your system to make it multimedia-capable.

## The Pitfalls

Few things are more frustrating than to install a new peripheral, turn on your



Micrographx *Picture Publisher* 3.1 screen.

system and have nothing happen. Compounding the problem, a screen of error messages that have no meaning to you may be displayed on your video screen. In most cases, the problem is caused by a newly-installed peripheral creating a conflict with another device already installed in your computer.

Four factors determine whether a new peripheral will peacefully coexist in an ISA (Industry Standard Architecture) PC. These are the base memory address, input/output (I/O) port, interrupt request number (IRQ) and direct-memory access (DMA) channel. When you install a new device in your PC and its card settings are the same as those used for a previously-installed device, one or both peripherals may not work. The result is a system that comes to an abrupt halt.

EISA (Extended Industry Standard Architecture) and MCI (IBM's Micro Channel Interface) PCs usually take

care of conflicts automatically by electronically re-configuring controller cards at the time they're installed. Because the AT-compatible ISA-bus desktop can't resolve these conflicts, it's up to you to properly configure whatever you add to your PC to avoid creating conflicts.

If your computer uses an SCSI (small computer system interface) devices, another potential conflict problem exists. Each SCSI device must be assigned a separate ID number, up to 7, manually or through software.

Most conflict problems are handled by manually re-configuring a peripheral controller card or via device-driver software setup to respond to the correct memory block, I/O port, IRQ number and DMA channel. Peripheral controller cards usually provide a DIP switching block or jumper headers that permit you to make such choices. This being the



case, it's important that you shop for whatever peripheral devices you plan on adding to your system with an eye for those that give you as many choices as possible within the four potential conflict areas. When shopping for software, the same choices should be available when configuring it for use with the peripherals you'll be using.

You can write conflict-correction routines with a text editor like the EDIT utility included in MS-DOS 5.0 or 6.0 to update the CONFIG.SYS or/and AUTOEXEC.BAT files that start up your PC and get it ready for using your applications software. The installation programs for *CorelSCSI*, Advanced SCSI Programming Interface (ASPI) *DOS Manager* and most applications software sense needed changes and give you the option of re-configuring your CONFIG.SYS and AUTOEXEC.BAT files, making a backup copy of the current files. If things don't work out, you revert back to the original files and start your installation over again.

## Dealing With Conflicts

Before installing a new peripheral, take an inventory of your system to determine how your PC currently makes use of the four potential conflict areas. Consult the manual supplied with each installed peripheral and note the base addresses, I/O ports, IRQ numbers and DMA channels you currently used. If you don't have the manuals or can't be bothered looking up the required information, you can use diagnostic software like Quarterdeck's *Manifest* and the System Info and Diagnostics utilities in Symantec's *Norton Utilities 7.0* to test your system and obtain a video display and/or hard copy of your PC's current use in these sensitive areas.

A common conflict with base-memory addresses will come into play when you upgrade your video system to display high-resolution graphics (640 x 480 with 256 colors and up). Your computer will have to be instructed via its CONFIG.SYS file that certain segments of upper memory aren't to be used, making them available to the software driver of the high-resolution graphics card you select.

Use of device-driver software and TSR (terminate-and-stay-resident) programs can quickly use up precious memory. By carefully locating this software in either lower or upper memory blocks, you can avoid creating memo-



A flatbed full-page scanner.

ry-conflict errors. Use good memory manager like the one in DOS 6.0 or Quarterdeck's *QEMM 386* to place drivers and TSR programs in upper memory to avoid such conflicts.

I/O ports are used by the CPU (central processing unit) to communicate with peripheral devices. Some of these port addresses aren't used by any standard devices (hard and floppy drives, for example) and, thus, are available to support a non-standard device. Your COM1 serial port can take port address 03F8-03FFh, while the COM2 serial port can take up the 02F8-02FFh address. Printer parallel port LPT1 usually takes up the 378-37Fh address. Addresses 000-0FFh are reserved for the system board, and ports 100-3FF are available to the I/O channel. PCs and XTs have a slightly different address configuration.

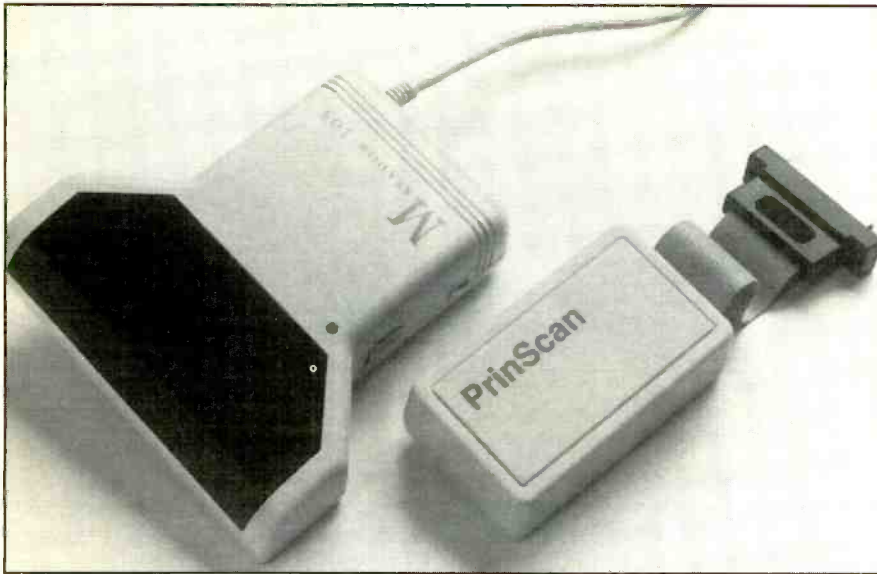
Sixteen interrupt signals are available

to the 286 through 486 CPUs in AT-compatible PCs (eight are available in a PC/XT or compatible). When evaluating IRQ use, note that some IRQ numbers are already assigned in normal computer setup. These include: IRQ for the computer's timer; IRQ1 for the keyboard; IRQ2 for the video adapter, PC network adapter; IRQ3 and IRQ4 for the COM1 and COM2 serial ports; IRQ5 for parallel printer port LPT2; IRQ6 for the floppy drive; IRQ7 for parallel printer port LPT1; IRQ13 for a math coprocessor; and IRQ14 for a hard drive.

The DMA channel controller is a specialized chip that speeds memory access by allowing data to flow from memory to a device (such as from RAM to a hard disk) without passing through the CPU. Usually, four channels are available and are numbered 0 through 3 (ATs and 386s have eight channels). When taking an



Hand scanner package with image-manipulation and optical-character-recognition software.



Mustek's PrinScan 105 hand scanner.

inventory of DMA channels, note that Channel 0 is used for memory refresh, and Channel 3 may be used for the hard drive.

Unlike a memory area that holds data, an IRQ isn't always in use. Therefore, it's possible for more than one device to

share the same IRQ number without causing problems. The caveat here, though, is that conflict-free operation can be obtained only provided both devices aren't used at the same time. The same characteristic is true for a DMA channel.

Now that you know what to look for and how to avoid creating conflicts in your PC, let's look at a few popular peripherals, some bundled with attractive software packages, that illustrate the range of choices available to ease an installation process.

## Enhancing Your System

I'll preface this capsule summary by defining the base system in which I installed the products I'll be covering in this section. I installed the peripherals on a 486 PC that has 5M of RAM, a 130M IDE hard drive, 1.2M and 1.44M floppy drives, a serial Microsoft mouse and an OptiqueST 1000 video monitor driven by a STB Powergraph X-24 accelerator card. The system operates under MS-DOS 5.0 and Windows 3.1 and uses QEMM 386 memory management. Creative Labs offers the Sound Blaster series of sound cards that, when connected to speakers and a microphone, can be the first step to making a Multimedia PC Marketing Council (MPC)-compliant computer system. The Sound Blaster Pro (\$199) includes a proprietary controller for a Panasonic CD-

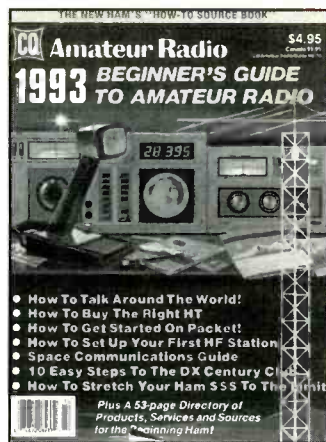
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ROM drive that has a 390-ms average seek time and 150Kb/s data-transfer rate. The card for this CD-ROM drive offers a choice of DMA0, DMA1 or DMA3; I/O port address of 220h or 240h; and IRQ2, IRQ5, IRQ7 or IRQ10 value.

A voice to .VOC file program, several sample sound files, a software controlled mixer and *Windows 3.1* audio, wave, MIDI and device drivers are included. Eight-bit stereo (22.05 kHz) and eight-bit mono (44.1 kHz), audio input and output, a game port, an on-board FM synthesizer and MIDI interface are also supported.

MediaVision's the Pro AudioStudio 16 (\$499) sound card offers record and playback of 16-bit stereo (44.1 kHz), an on-board FM synthesizer, MIDI support and a standard SCSI CD-ROM controller interface.

Installation of a MPC-compliant CD-ROM drive will make your multimedia system complete. Sony's CDU-7205 CD-ROM Laser Library package (\$595) that includes CD-ROM discs containing *Compton's Family Encyclopedia*, *Microsoft Bookshelf*, *Languages of the World*, *National Geographic Mammals*, *Mixed-up Mother Goose*, Software Toolworks *World Atlas* and the Microsoft CD-ROM EXtension driver (MSCDEX, Version 2.2). The CD-ROM drive has a rated average seek time of 530 ms and, a data-transfer rate of 150Kb/s and a 64K data buffer. The proprietary host adapter card supplied in this package makes available 19 base memory addresses, three SCSI ID numbers, IRQ2 through IRQ5 and three DMA channels from which to choose.

The MPC-compliant Toshiba TXM-3301E CD-ROM (\$695) drive offers an average seek rate of 325 ms and data-transfer rate of 150Kb/s, with a 64K data buffer and includes the Future Domain TMC-850 SCSI adapter card and MSCDEX Version 2.2 driver. The Future Domain adapter card permits you to select I/O port address CA00h, C800h, CE00h or DE00h and IRQ3 or IRQ5. Toshiba now also offers the TXM3401E CD-ROM drive (895), which has an average seek rate of 200 ms, a data-transfer rate of 330Kb/s and a 256K data buffer. This drive is also CD-ROM XA (eXtended Architecture)-compliant.

The SCSI standard allows installation of up to seven daisy-chained SCSI devices that could include a CD-ROM, scanner, tape backup, hard drive and/or optical drive attached to the one

## Sources

### Scanners

ENV 256 Bundle  
**Envisions, Inc.**  
822 Mahler Rd.  
Burlingame, CA 94010  
Tel.: 415-692-9061

CIRCLE NO. 126 ON FREE INFORMATION CARD

ES-600C (parallel bidirectional or SCSI);  
ES-800C (parallel- and SCSI-ready)

**Epson America**  
20770 Madrona Ave.  
Torrance, CA 90503  
Tel.: 800-922-8911 or 310-782-0770

CIRCLE NO. 127 ON FREE INFORMATION CARD

PrinScan 105  
**Mustek, Inc.**  
15225 Alton Pkwy.  
Irvine, CA 92718  
Tel.: 714-833-7740

CIRCLE NO. 128 ON FREE INFORMATION CARD

### Sound Cards

Sound Blaster Pro  
**Creative Labs, Inc.**  
2050 Duane Ave.  
Santa Clara, CA 95054  
Tel.: 408-428-6622

CIRCLE NO. 129 ON FREE INFORMATION CARD

Pro AudioSpectrum 16  
**MediaVision, Inc.**  
47221 Fremont Blvd.  
Fremont, CA 94538  
Tel.: 510-770-8600

CIRCLE NO. 130 ON FREE INFORMATION CARD

### CD-ROM Drives

CDU-7205 CD-ROM Laser Library  
CDU-7211

**Sony Corp. of America**  
655 River Oaks Pkwy.  
San Jose, CA 95134  
Tel.: 714-826-6410

CIRCLE NO. 131 ON FREE INFORMATION CARD

TXM3301

TXM3401

**Toshiba America, Inc.**  
Disk Products Division  
9740 Irvine Blvd., P.O. Box 19724  
Irvine, CA 92713-9724  
Tel.: 714-583-3000

CIRCLE NO. 132 ON FREE INFORMATION CARD

### Software

*OmniPage Direct*  
*OmniPage Pro*  
**Caere Corp.**  
100 Cooper Ct.  
Los Gatos, CA 95030  
Tel.: 800-535-7226 or 408-395-7000

CIRCLE NO. 133 ON FREE INFORMATION CARD

*CorelSCSI*

**Corel Systems, Inc.**  
1600 Carling Ave.  
Ottawa, Ontario, Canada K1Z 8R7  
Tel.: 613-728-8200

CIRCLE NO. 134 ON FREE INFORMATION CARD

*HALO Desktop Imager*

**Media Cybernetics, Inc.**  
8484 Georgia Ave.  
Silver Spring, MD 20910  
Tel.: 301-495-3305

CIRCLE NO. 135 ON FREE INFORMATION CARD

*Picture Publisher 3.1*

**Micrografx Corp.**  
1303 Arapaho Rd.  
Richardson, TX 75081  
Tel.: 214-234-1769

CIRCLE NO. 136 ON FREE INFORMATION CARD

*QEMM 386*

*Manifest*

**QuarterDeck Office Systems**  
150 Pico Blvd.  
Santa Monica, CA 90405  
Tel.: 213-392-9701

CIRCLE NO. 137 ON FREE INFORMATION CARD

*GO-OCR*

**Recognita Corp. of America**  
1156 Alstor Ave., Ste. F  
Sunnyvale, CA 94086  
Tel.: 408-241-5772

CIRCLE NO. 138 ON FREE INFORMATION CARD

*Norton Utilities 7.0*

**Symantec Corp.**  
10201 Torre Ave.  
Cupertino, CA 95014-2132  
Tel.: 408-253-9600

CIRCLE NO. 139 ON FREE INFORMATION CARD

### SCSI Controllers

AHA-1510  
**Adaptec Corp.**  
691 S. Milpitas Blvd.  
Milpitas, CA 95035  
Tel.: 408-945-8600

CIRCLE NO. 140 ON FREE INFORMATION CARD

TMC-850

**Future Domain, Inc.**  
2801 McGraw Ave.  
Irvine, CA 92714  
Tel.: 714-253-0400

CIRCLE NO. 141 ON FREE INFORMATION CARD

### Sound Cards

Sound Blaster Pro  
**Creative Labs, Inc.**  
2050 Duane Ave.  
Santa Clara, CA 95054  
Tel.: 408-428-6622

CIRCLE NO. 142 ON FREE INFORMATION CARD

adapter card. The ASPI *DOS Manager*, *CorelSCSI* (\$99), Future Domain's *SCSIWorks* software makes installation of SCSI devices a relatively conflict-free and painless operation.

Epson America has its Models ES-600C and ES-800C flatbed color/monochrome scanners for the PC/compatible and Mac computers. The ES-600C has a resolution of 600 x 600 with output from 50 to 600 dpi in 23 increments, while the ES-800C has a resolution of 800 x 800 with output of 50 to 800 dpi. Both scanners support a document size of up to 8.5" x 11.7" and permit you to zoom from 50% to 200% in 1% increments. You can scan an image at one to eight bits per pixel at 256 levels of gray or one to 24 bits in 16.7-million colors. The scanners support two methods of color scanning: Color Line (one pass

and Color Page (three passes).

The ES-600C comes ready for bidirectional parallel (\$1,049) or SCSI (\$1,129) interface. The ES-800C (\$1,499) is ready for both interfaces. The interface kit (\$399) contains the required connector board and cable, Caere *OmniPage Direct OCR Try Pak*, a full version of Micrografx *Picture Publisher 3.1* for IBM/compatible computers or Adobe *Photoshop* for the Mac and the Epson Apple or TWAIN-compliant (IBM) scanner driver. (TWAIN is the application program interface imaging standard that enables scanning and input of images without leaving an application.) The Adaptec ANA-1510 16-bit SCSI adapter with ASPI *DOS Manager* software provides two I/O addresses (140h or 340h) and a choice of IRQ9 through IRQ12.

Caere's *OmniPage Direct OCR Try Pak* works directly with Write (included with *Windows 3.1*), *Wordperfect for Windows*, *Ami Pro for Windows*, *Word for Windows* and *Excel for Windows*. It has a 25 half-page document scan limit, enticing you to purchase the full version for \$595. *OmniPage Direct 1.0* can read omnifont typefaces ranging from 6 to 72 point at speeds of up to 2,000 words per minute and .TIF and .PCX graphics file formats at a maximum of 400 dpi and *Windows Dynamic Data Exchange (DDE)* support. *OmniPage Pro* (\$995) contains a spell checker, foreign-character recognition and user-definable character recognition.

Micrografx *Picture Publisher 3.1 for Windows* offers professional-quality image editing and full-featured paint tools and includes device-specific drivers for non-TWAIN- and TWAIN-compliant hardware. Once you scan an image, you save it as a .BMP, .GIF, .PCX or .TIF graphic file.

Envisions has a hand scanner bundle for \$199 that includes a 256 GrayScale Hand Scanner, Recognita's *GO-OCR* software, clipart samples, a scanner pad and Media Cybernetics' *HALO Desktop Imager*. Scanning width is 4.13" (105 mm), resolution is 100 to 400 dpi at eight bits per pixel with 256 gray levels using a yellow-green lamp. The included scanner adapter card supports eight I/O addresses. DMA1 and DMA3 and IRQ3, IRQ5 and IRQ10.

*GO-OCR* translates scanned text of 6-through 24-point size at a speed of up to 1,500 words per minute into ASCII format for import to any word processor and features automatic merging of two text scans to make a full-size page scan.

*HALO Desktop Imager* is a full featured 24-bit *Windows 3.1* image editor that saves files in the .TIF, .IMG, .MSP, HALO.CUT and TWAIN-compliant formats and *Windows 3.1* Object Linking and Embedding (OLE) and the JPEG image-compression format.

Mustek's PrinScan 105 adapter plugs into a PC's parallel port and, thus, provides hand scanning without having to install an adapter card. Its \$299 package includes the Mustek Matador 105 halftone hand scanner that offers up to 400-dpi resolution at 64 levels of gray. Bundled with PrinScan 105 is *ScanKit Gray*, a grayscale image editor that supports .TIF, .PCX, .TGA, .MSP, .IMG and .CUT files and *Perceive Personal Omnifont OCR* software. ■

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# Build a Quick and Dirty Data Interface

Uses a serial port to read into your computer analog and digital signals—without complicated and costly circuitry

Have you ever wanted to read voltage, temperature or other data into your computer but shied away from the idea because of the expensive or complicated hardware or both needed to do this? If so, you no longer have a reason to think this way. I'll describe how to build a Quick-and-Dirty Data Interface—or "QADDI" for short—that makes it possible for you to read analog

or digital signals into your computer via the UART socket on its serial card.

What makes this circuit so easy and inexpensive to implement is the fact that most of the wiring you need has already been done for you on your existing serial card. To get up and running, all you have to do is remove the UART chip from your serial card to obtain an eight-bit buffered parallel input. You read

right, it's a *parallel* input on your serial card. Furthermore, it doesn't require a separate power supply.

To give you an idea of how versatile this Interface can be, I'll cite some applications in which you can use it. A small sampling includes security systems, electric-train controllers, weather stations and robotics. In fact, suitable applications for QADDI are limited

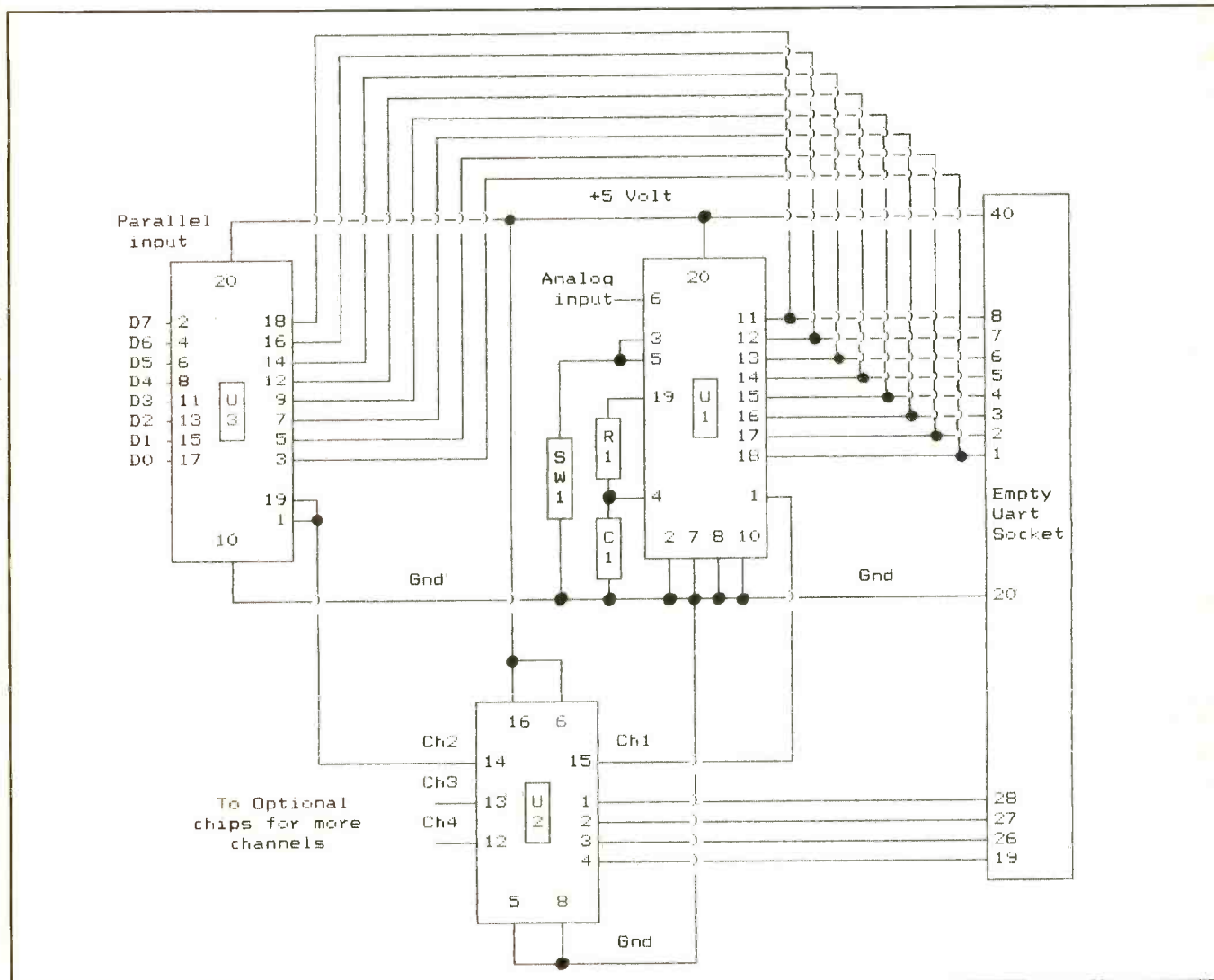


Fig. 1. Schematic diagram of Quick-and-Dirty Data Interface circuitry.

## PARTS LIST

### Semiconductors

U1—ADC0803 analog-to-digital converter

U2—74F138 one-of-eight decoder/demultiplexer

U3—74F244 octal buffer/line driver

### Capacitors

C1—150-pf ceramic disc

### Resistors

R1—10,000 ohms,  $\frac{1}{4}$ -watt, 10% tolerance

SW1—Momentary-action spst push button switch

### Miscellaneous

Perforated board with holes on 0.1" centers; sockets for all ICs; materials for tester circuit [20,000-ohm potentiometer (R1) eight 10,000-ohm resistors (R2 thru R9) and eight-position DIP switch (S1 thru S8) in Fig. 2]; 40-pin socket header or perforated board (see text); connectors as needed (see text); suitable enclosure (optional; see text); 1" spacers (4); machine hardware; hookup wire; ribbon cable; solder; etc.

only by your imagination and technical expertise. Coupling this input method with the parallel port on your computer, you can have a very versatile controller system for automated operations, with the Interface telling your computer when an action must be taken and your computer sending a signal through its parallel port to initiate action via suitable actuators.

Software programming for this project is a study in simplicity. In fact, it's so elementary that you'll be able to make immediate use of the system because all you need is one BASIC routine to read in data, using *QuickBasic* or *GWBasic*. You can use other programming languages as well, as long as you know how to make it read and display COM-port memory locations.

## About the Circuit

Owing to the fact that most of the circuitry you'll need already exists on your serial card, the circuitry for this Interface is extremely simple, as shown in Fig. 1. It provides a single eight-bit parallel input at data lines D0 through D7 of U3 and a single 0-to-5-volt analog input at pin 20 of analog-to-digital converter U1.

If you need only analog inputs, you can have up to four with the arrangement shown simply by adding as many A/D converters in the arrangement

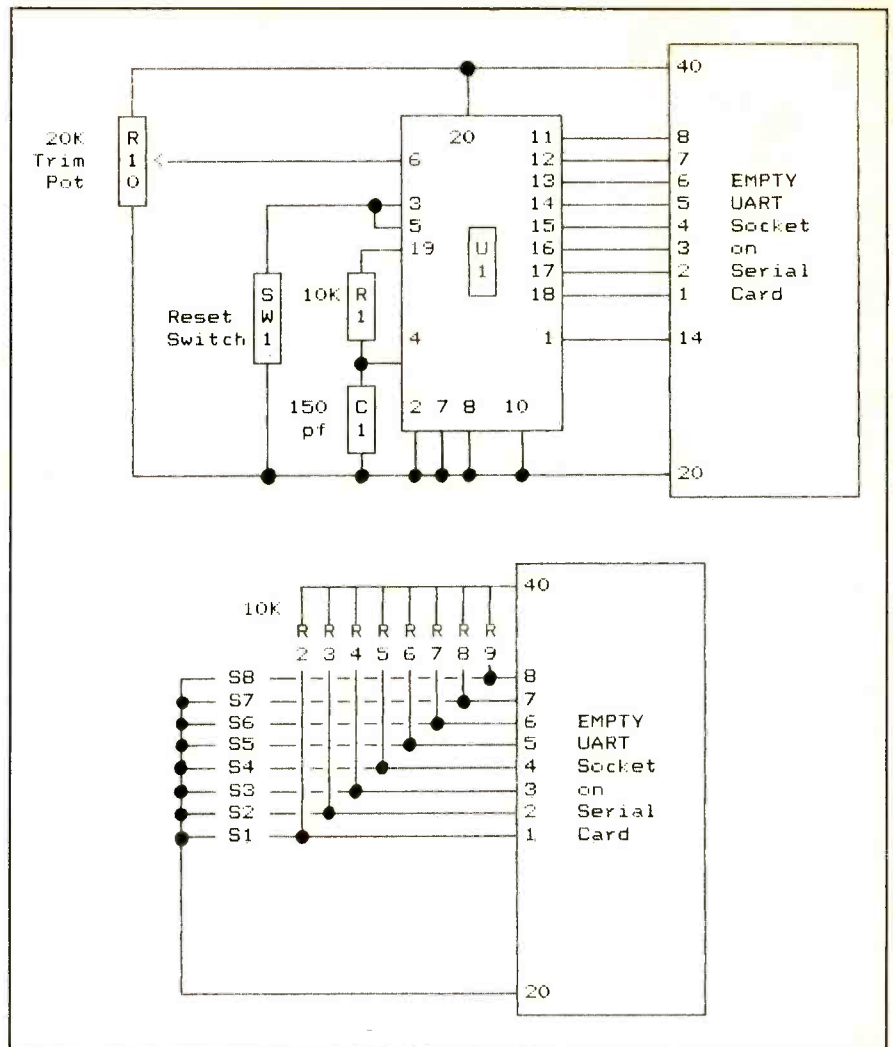


Fig. 2. Schematic details for test circuits for (A) analog input and (B) parallel digital input.

shown for U1, connecting their pin-1 outputs to Ch 2, Ch 3 and Ch 4. Alternatively, if you wanted only multiple digital inputs, you'd expand upon the input circuit by adding more octal buffer/line drivers to the system in the same manner as shown for U3, this time using Ch 2, Ch 3 and Ch 4 to process digital inputs.

This circuit substitutes for the UART that currently occupies a socket on your serial card. As you can see, only 14 pins of the 40-pin UART socket are needed to implement the Interface.

Digital inputs can be through at whatever type of connector you choose to use. Analog inputs can be through phono jacks or BNC connectors. If you want an arrangement with one each digital and analog inputs, you could run conductors from U3 to a DB-9 connector for digital input and another conductor from pin 6 of U1 to a phono jack

or BNC connector. One pin of the DB-9 connector and the common lug of the phono jack or BNC connector would be used as signal-return paths. If you wanted, say, three digital and one analog inputs, you could use a DB-25 for the digital inputs and a phono jack for the analog input. Simply choose the arrangement you think best for your applications.

## Building It

The best way to build this project is to run the conductors from the UART socket to a connector, perhaps a DB-15 type, you mount on the rear panel of your computer to which you can connect the Interface. Alternatively, you can build the circuit on a piece of perforated board that has holes on 0.1" centers and connect and disconnect it from the UART socket as needed. If you plan

(Continued on page 80)

## Low-Cost Video: Creative Labs' Video Blaster

A nice thing about the computer field is that succeeding technology is usually faster, smaller and, ultimately, less expensive. Each technological improvement is connected to previous technology. I call this phenomena the "technology chain." Video and computer imaging, like personal computers, experience the technology chain. Computer imaging and 24-bit color used to be for only business. Now home computer users can begin to reach for image capture and true color.

Creative Labs, Inc., widely known for producing the Sound Blaster series of add-in audio cards, now offers low-cost video and image capture in its Video Blaster, a full-slot card that displays real-time video, freezes it and captures it to disk. The computer market needs a device like Video Blaster. The question, though is: Does Video Blaster meet market needs?

(Although we reviewed VideoBlaster in the July issue, this is a more indepth view of the product to assist you in making a buying decision—Ed.)

### Considerations

Planning is advised before buying any product. You should be certain that your computer has the ability to support the product. Video Blaster has its own considerations. One of them is its size. Since it is a full-size card, taking up the entire length of a slot, careful thought should be given to which slot to use in your PC.

In their efforts to make smaller products, some motherboard designers place memory sockets in potentially awkward places. One motherboard I've seen has its memory sockets situated so that the last three or four expansion slots can get in the way of full-size add-in cards. Therefore, make sure your motherboard has a clear full-size slot before purchasing Video Blaster or any other full-size board.

A second consideration regards the video card and monitor you'll be using. Video Blaster is designed to work with nothing less than VGA and Super-VGA video cards and monitors. Be aware that, though the product will probably work with most video cards, it hasn't been tested with many of them. At the time I received the Video Blaster card I evaluated for this report, it had tested as compatible with Video Seven VRAM, Tseng Labs ET4000, Trident 8900CS and 9900CS, Western Digital WD90C00 and S3 controllers, which are currently used in many brands of video cards.

You can find out which controller your video card uses by checking the user man-



Watching a *Star Trek* movie while writing.

ual that came with the card. If you can't find this information in the manual, remove your video card from your PC and examine its chips. If you're still uncertain, call the manufacturer of your video card. Finally, you can call Creative Labs to see if your video card is supported. I used the ATI VGA Wonder XL24 video card for this evaluation.

A third, very important, consideration is how much user memory is installed in your PC. One might initially think that a video imaging product requires a great deal of memory. Accordingly, you may be wondering if 8M or 16M of RAM in your PC is going to be enough. Surprisingly, the problem isn't one of having enough memory, but of having too much memory. If your computer has more than 15M of RAM, Video Blaster simply won't work in it—period.

In explanation of the foregoing enigma, Video Blaster has a video frame buffer resolution of 1M × 512K bytes. It can use any 1M address space from 1 to 15. The address space it uses logically can't be taken up by something else, including computer memory. Since the card can't address anything beyond 15M, it literally forces users to limit memory to this value. This limitation has potential that might prove fatal to its use. Computer RAM continues to drop in price. Because of generally lower RAM prices, user perception about computer systems has changed.

A couple of years ago, having 8M of RAM in a computer was considered to be a luxury. Now 8M is about entry level, especially if you plan to run Microsoft Windows, OS/2 or other graphics-oriented products. Because of the gradual increase in software sophistication and steady decrease in the price of RAM, finding 16M in a home or business computer isn't unusual nowadays. Are users expected to actually remove memory from their computers to accommodate Video Blaster? The answer is a resounding "yes."

My own experience illustrates another potential problem with using Video Blaster. I upgraded to a new motherboard before I received Video Blaster. I'd stretched my bank account and purchased eight 4M memory modules, making a total of 32 proud megabytes of compact, screaming memory. My previous motherboard used 1M memory modules. After realizing Video Blaster's memory limitation, I discovered that my new motherboard wouldn't support 4M modules at anything less than 16M of total RAM. This kind of memory configuration isn't uncommon in motherboards. In short, I had to remove all eight of my 4M modules and replace them with 1M modules, which was the only way my computer could work with Video Blaster. If I had sold the 1M modules as intended, it would have been impossible for me to evaluate the product!



Free-lance model Donna Parish of Dallas, TX, (A) image captured at eight bits and (B) 24 bits. Can you tell the Difference?

You might well ask, "Why the memory limitation? Is it an error in design? Is it a method to reduce cost?" Whatever the answer may be, Video Blaster's reverse memory limitation is difficult to work with and sorely disappointing. If you're thinking about purchasing Video Blaster, its reverse memory limitation is cause for second and even third thoughts.

### Installation

The foregoing criticism aside, Video Blaster is easier to install than any of Creative Labs' previous add-in cards. After installing the device in any full-length expansion slot, I/O address and interrupt are completely software configurable. Thankfully, this eliminates jumpers and DIP switches. To its credit, Video Blaster can be set to any of several differ-

ent I/O addresses, instead of just the couple offered by Sound Blaster and Sound Blaster Pro. Likewise, available interrupt settings have gotten away from the usual values reserved for serial ports and printer ports. You now have a choice of using interrupt 10, 11 or 12 instead of the over-used 3, 4, 5 or 7.

Final installation consists of making proper connections between Video Blaster and your video card. Video Blaster comes with two cables. One serves dual jobs for video/audio input and partial control of your present video card. The other is for VGA pass-through. It uses your video card's feature connector to pass along normal VGA signals to Video Blaster, without having to take up another expansion slot just for that.

When installation is complete, a soft-

ware routine copies Video Blaster software to your hard drive. You can then configure the card and run its comprehensive confidence tests, which cover all aspects of operation, like I/O address, data acquisition and buffer addressing. Once the card passes all tests, you're on your way to real-time imaging.

### DOS Utilities

Video Blaster has two different sets of operating software and utilities. One is for DOS and command-line usage, the other for use with Microsoft *Windows*. The DOS utilities are complete in that there's a command to activate video, adjust parameters like brightness and contrast, and scale the video from full screen to a small box. The problem with the DOS utilities is that you must use a trial-and-error approach to get the video image the way you want it. Once done, though, you can build a library of batch files to produce and manipulate video and audio.

A pleasant feature of Video Blaster is that it has three video inputs and can switch from one to the other on command. When switching, it doesn't lose sync or image quality, and switching is done immediately. Thus, you can attach a VCR, TV receiver, video camera or any three video sources at the same time and jump from one to the other.

Under DOS, Video Blaster's live TV image is impressively sharp, with contrast that's as good as or better than conventional television. Scaled images appear more detailed than full-screen images, though this apparent effect may be just a trick on the human vision system.

You may encounter some problems when running live TV from the DOS prompt. First, the displayed image is overwritten when another computer program writes to the video screen. As an example, when calling *WordPerfect* from the DOS prompt, *WordPerfect* paints the computer



Capture of live CNN TV broadcast, saved at 24-bit resolution.



screen a characteristic rich blue. Parts of the TV image are visible behind the *WordPerfect* logo until the word processor begins operation in earnest. Then the video image is gone, although audio is intact.

The image is still where it belongs, only it's invisible, which can be proven by shelling from *WordPerfect* to DOS, whereupon the image reappears. Returning to *WordPerfect* again erases the video image. This problem was consistent with all my DOS applications. The way to get around it is to first start *Windows* and then run *WordPerfect* or another application from the *Windows* DOS prompt, after which you can hot key back and forth.

A second problem is that Video Blaster has trouble with video modes any greater than 640 x 480. The manual indicated that, in some cases, Video Blaster might work at 800 x 600, but it does so only under *Windows*. An addendum to the manual warned not to expect reliable operation, since 800 x 600 isn't fully supported.

With some tinkering, I got Video Blaster to run at that resolution under *Windows*, but I had much difficulty getting the image into normal aspect ratio. The 800 x 600 mode never worked reliably and doesn't work at all under DOS.

## Windows Utilities

A faster and easier way to manipulate Video Blaster images is to use the accompanying *Windows* utilities. These are copied to your hard drive along with the other Video Blaster software, but they must be installed manually under the *Windows* environment. Granted, this isn't hard to do. But Creative Labs might have spared users some trouble by performing an auto-*Windows* installation, complete with the creation of a Video Blaster Program Group.

Three utilities are for use with *Windows*. One, VBSound, lets adjust volume of Video Blaster's master volume, microphone input and audio line levels. Once set, you can lock audio levels at desired settings.

Another utility, VBWSetup, controls settings for video format (NTSC or PAL) and polarity of both horizontal and vertical sync. It also lets you select one of its three video inputs as default. Video alignment and size and position of image are also selected with VBWSetup. You can save your preferences to a configuration file so that Video Blaster starts up in a preferred state.

VideoKit, the main *Windows* utility, is where most real-time image control takes place. Under the control of VideoKit, you capture images, process them and save them to disk. You can adjust brightness, contrast, hue, saturation and aspect ratio to enhance displayed images. You dynami-

cally choose I/O address, frame-buffer address and video source. VideoKit can even invoke the VBSound utility.

## Image Capturing

Despite any fancy features and perhaps numerous bells and whistles, the main purpose of a device like Video Blaster is to capture images and save them to disk. If it does this in an acceptable manner, it becomes a tool for getting virtually any image into digital format. Video Blaster does a fair job of image capturing, when taken within the constraints of its limits. It's DOS utilities for image capturing are nonexistent, a fact not explained in the manual.

My uncertainty about the lack of DOS capturing as I was evaluating Video Blaster prompted me to place a call to Creative Labs technical support. I was assured that there's really no way to save an image under DOS, which is an unfortunate development because users who don't run *Windows* won't be able to capture images. Without image capture, Video Blaster is just an expensive TV receiver.

The first part of capturing an image is having the image presented on the screen of your PC's video monitor. Video Blaster does an excellent job at image presentation. Ostensibly, one reason for this is that it supports as many as 2-million colors. This isn't the same as 24- or 32-bit color, which sport 16.7-million different colors. But 2-million colors can look almost as good. Maybe it's difficult for the human eye and brain to see and interpret the difference between 16-million and 2-million colors when displayed in the two-dimensional format of a color video monitor.

At any reckoning, one can easily become accustomed to watching television with Video Blaster. Viewing TV this way lets you do other computer work while having a scaled TV screen neatly tucked into a corner of your monitor. If an interesting item comes up, you can quickly mouse-click on the TV image and expand it to full-screen. Furthermore, you can press a combination of keys to freeze a TV image and save it to disk in a variety of formats.

Saving an image requires that it be frozen in time, or be "captured." When Video Blaster freezes an image, an immediate degradation occurs in the quality of presentation. It appears that some color resolution is lost. VideoKit's Smooth function gets rid of scanning lines and some signal noise, but it can't make up for the significant image degradation.

Why does degradation occur? A Creative Labs technical-support person told me that Video Blaster can save images in as many as 2-million colors. During a different call to technical support, a differ-

(Continued on page 78)

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## Setting Up a Printer-Sharing Network; Playing With Chaos Theory Software; and an Image Scanner for an On-the-Road Office

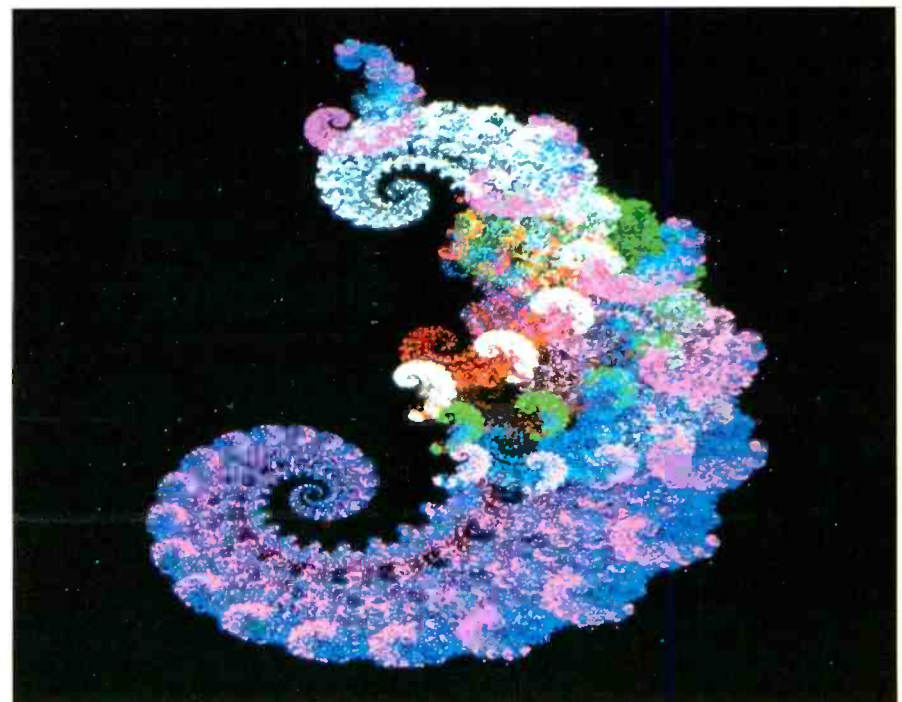
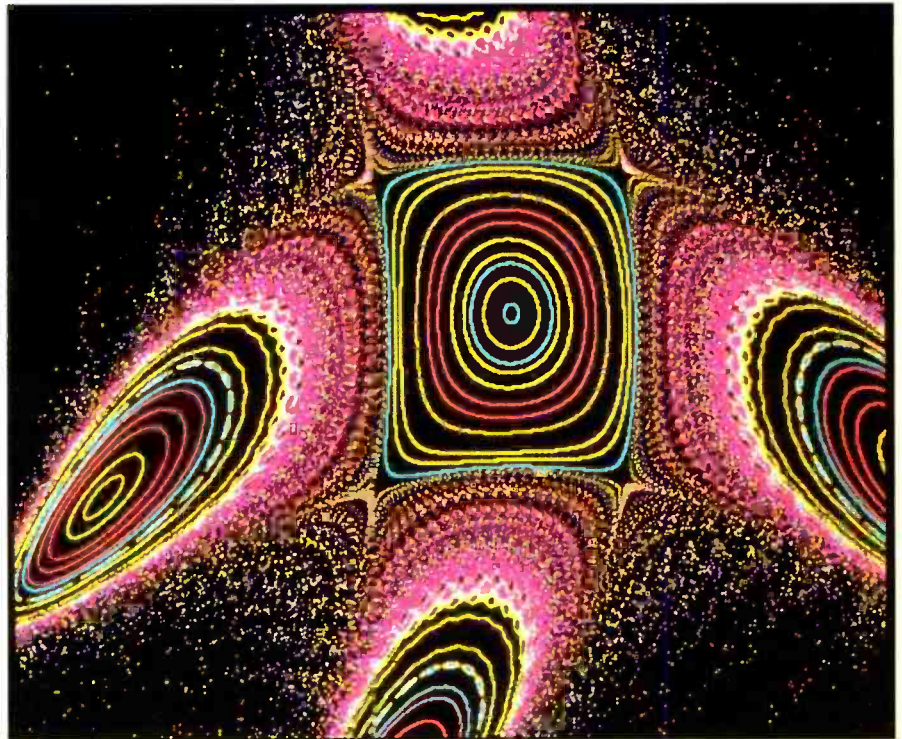
This month, I've decided to give you a look at a diverse lineup of different products that can enhance your computer system. One of these makes it possible for you to inexpensively network up to six printers and 16 PCs, another can make your time at the keyboard just plain fun (hint: it isn't a game, though the effect you obtain from it may give you as much or more satisfaction as an action game) and the last can make you more productive while on the road.

### Printer-Sharing Network

A couple of months ago, I networked the kid's PCs using *Windows for Workgroups*. As I reported back then in these pages, the installation procedure was quick and easy, and my kids (ages 8, 7, 6 and 5) have had no trouble with the concept that some of the files and programs might actually reside on "Marc's" PC or "Scott's" PC, rather than on their own systems. My primary reason for establishing a network was to give each of the kids the ability to share the two printers I have in their workroom. Most of the time, they use an Epson LQ-870 color dot-matrix printer, but my eldest occasionally likes to print out his school reports on an old LaserJet II-compatible laser printer I also have hooked up to their network.

The foregoing works fine, as long as the kids are using a *Windows* application like *Word for Windows*, *Micrografx Windows DRAW!* or Computer Support's terrific *Picture Wizard* and *Arts & Letters Apprentice* graphics programs. It gets a bit sticky, though, when they want to print from a DOS application, like the *Kids Cuts* package from Broderbund I reviewed a few months back in this column. It's possible to try a PC running DOS into a *Windows for Workgroups* network by using Microsoft's Workgroup Connection software, but configuring the network and DOS workstation isn't something even my bright eight-year-old can do by himself.

With the additional pressure of an anticipated move to a new house, where the kids will each have his PC in his own room, I decided to bring down the *Windows for Workgroup* network and take a step backward to a somewhat simpler scheme for sharing printers. Looking at the various hardware and software boxes that have piled up lately, I settled on Printer-NET from Primax. I installed it and can



Here are two stunning examples of artwork produced with James Gleick's *CHAOS*, the *Software* package from AurotoDesk Retail Products. They typify what you can do with the mathematical discipline known as Chaos theory.



Nisca's Page Portable Grayscale Scanner.

report that it's worked out fine.

As an interesting aside, while there's plenty of information on installing *Windows for Workgroups*, there's absolutely *no* information on *uninstalling* it, either in the documentation that accompanies the software or in the *Windows for Workgroups Resource Kit* that Microsoft sells. *WFW* stills runs in a single-user mode, even though the network has been disconnected. But it's annoying (and sometimes confusing) to see lots of error messages appear on-screen as the software tries to find other users and resources that were formerly shared among network users.

I eventually solved this problem with a brute-force approach by reinstalling plain-vanilla *Windows 3.1* on each of the PCs. However, it would be nice if all software suppliers would take into consideration that users occasionally have to remove their products from their systems and provide an easy, painless means for doing this automatically.

Even though the company has been around for quite a while, Primax isn't a particularly well-known brand name in the consumer marketplace. The reason for this is simple: most of the company's products carry other vendors' labels. PrinterNET is one of the company's first products to actually carry the Primax brand name. Though it doesn't provide the file- and program-sharing capabilities that a true network, like *WFW*, LANtastic and NetWare offer, PrinterNET does allow you to share up to six printers among as many

as 16 PCs. Setup takes just a few minutes, and even my kids have no problem using PrinterNet.

The PrinterNET package consists of two different kinds of units, both of which are about half of the size of a pack of cigarettes. The Computer Transmitter Unit plugs into the parallel port on each of the PCs that will share the printers. The Printer Receiver Units plug into the printers' parallel ports. This done, you just connect everything together with the cables supplied in the package.

The supplied cables are off-the-shelf four-conductor twisted-pair telephone type that use standard RJ-11 connectors that are wired straight-through with pin 1 going to pin 1, pin 2 to pin 2 and so on. If you need longer cables (you can use up to about 1,200 feet of cable for the entire network), a quick visit to your local Radio Shack store will get you cable, RJ-11 connectors and even a crimping tool to secure the connectors to the cables for a few dollars.

PrinterNET uses a very simple topology. Most users will simply daisy-chain PCs and printers, running a cable from one unit to the next. You can also use a bus topology with PrinterNET, running a backplane cable that you interconnect individual users and printer with standard modular couplers you can find in Radio Shack stores and most home centers. Even my local supermarket carries these standard modular telephone supplies.

Usually, no onboard power supply is needed to power PrinterNET because the

voltage that most parallel ports deliver is usually sufficient to drive the network. However, if you're using very long cable runs or an odd PC that has an under-powered parallel port, a 6-to-9-volt 100-mA cube-type power supply is available from Primax as an extra-cost option, though any supply in this voltage range should work, as long as the shell and tip of the connector are polarized so that they're at positive and negative, respectively.

After physical setup is finished (it took me about 3 minutes to hook up three PCs and two printers), you set up the software that's used to select a particular printer to which to print. This software can be installed as a pop-up TSR or be run as a stand-alone utility. I installed it as a TSR that's accessed by pressing the Ctrl and Tab keys simultaneously.

Another utility, PNW.EXE, installs in Windows, where it's accessed by clicking on its icon. Both the DOS pop-up and *Windows PrinterNET* programs let you assign logical names to the printers and select the printer to which a print job is to be sent. Printer Receiver Units have a small rotary switch that must be set so that each printer has a different identification number (from 1 to 6).

PrinterNET is neither fancy nor particularly sophisticated. It's a first-come, first-served kind of printer network in which printers are assigned to jobs in the order in which they arrive at a particular printer.

You can attach an optional small handheld controller to each PC's Transmitter Unit if you'd rather not use software to make a printer assignment. I didn't receive one of these controllers to test with the review package I used. This was no tragedy because I don't think such a device is particularly desirable.

A network offers more functionality than a simple printer-sharing scheme like the PrinterNET system. It lets you share most other resources, not just printers, in the system. But there are times when a full-blown network would be overkill, such as when you need to share just printers. If this is the case, buying PrinterNET doesn't lock you into paying for features you won't use.

The Primax PrinterNET works well and is reasonably priced and very simple to set up and use. If you don't need a full-blown network, PrinterNET may be just what you leave in mind.

A PrinterNET starter kit that contains two transmitters and one printer receiver, 25 foot cables and software lists \$249. Extra transmitters and printer receivers are optionally available as well.

## A Chaotic Existence

Years ago, when I was younger, smarter and more ambitious, I thought I'd like to

pursue a career in operations research, a mathematical discipline that applies advanced techniques to solving real-world problems. Operations-research techniques are used in manufacturing to determine a factory's best product mix, scheduling (PERT and critical path are both operations-research techniques) and even in the design of toll plazas on highways (using Monte Carlo simulations to determine the probability of different traffic loads). This area of applied mathematics is fascinating and useful, and I always enjoyed the limited exposure I received to it in the other math courses I took during my years at college.

There was only one problem with pursuing my mathematics career: I had no particular gift in this area. Yet, even though I still have difficulty in understanding the theory behind many areas of applied mathematics, I'm no less fascinated by how much can be accomplished with it.

One of the newest areas in mathematics is the science of Chaos theory. While I don't claim to have more than a superficial understanding of it, Chaos theory holds that many of the things we consider to be random occurrences have an underlying structure that can, at some level, be expressed mathematically, at least in gen-

eral terms. Chaos theory has developed as computers that are capable of making vast numbers of computations have become inexpensive and commonly available.

One of the more-interesting aspects of Chaos theory is that a small change in one or more of the variables that takes place during an iterative process can have a very significant effect on the final outcome.

One of the best books on this somewhat arcane area of mathematics is *Chaos: Making a New Science* by James Gleick. But reading about Mandelbrot sets, fractals and strange attractors doesn't begin to let you understand what this mathematical experience actually describes. As with so many areas of mathematics, you really need to graph expressions to really understand them.

AutoDesk, the *AutoCAD* folks, has brought out a software package that lets you do just this. James Gleick's *Chaos, The Software*, lets you "play" with many of the mathematical components of Chaos theory right on the screen of your PC's video monitor. All you need to take advantage of this package is EGA or VGA video, though the higher resolution, color and 256-color displays are used to good advantage, if available. The software will even run on a plain-vanilla PC with just

floppy-disk drives, albeit slowly.

Installing the software takes just a few minutes and is nicely automated. Then you run it simply by typing CHAOS. When you hit Enter and the program loads, you're presented with a menu that lets you choose between the various areas the program offers. Instead of just reading about Mandelbrot sets, Strange Attractors and Fractals, you can generate knock-your-socks-off graphics that demonstrate the ultimate effect of changing individual variables. The manual is outstanding, both from the viewpoint of explaining how to use the different areas of the program and the mathematics of what's going on.

I have to admit that my brain turned off very quickly trying to understand the mathematics of Chaos. Perhaps, with four young kids running around my house, I have just too much real-world chaos to deal with to be able to concentrate that deeply anymore. But you don't have to be a mathematics genius to appreciate the *Chaos* software. With a retail price of \$59.95, and a mail-order price that should be much less, the graphics this software generates on-screen will keep you entertained for hours.

Start up a Mandelbrot set and let your PC run through iteration after iteration,

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while you continually zoom in on different areas. The effect is not only breathtaking, it's almost hypnotic. And if you've ever wondered how they did some of those outstanding special effects in science-fiction movies, the Fractal Forgeries section will let you easily create your own worlds, cloudscares and even mountain ranges. But even if you're like me and never really get an understanding of Chaos mathematics, you'll enjoy just playing with *Chaos, The Software*.

If you have a teen-ager who's interested in mathematics or know one, buy *Chaos, The Software* for him or her. And after you've both spent a couple of hours watching the screen, maybe you can get him or her to explain to you what's actually happening in back of the dynamite graphics.

## Taking Your Office On the Road

I do a fair amount of traveling every year—in fact, more than I'd really like to. However, my position requires that I attend quite a few shows and conferences. So I pack my bags and hit the road. When I can't avoid this chore, I even take along a notebook computer or, if I'm fortunate enough to think of it, express ship it to whatever hotel I'll be staying at.

One of the reasons I take a notebook PC on many of my business trips is that it lets me better stay in touch with what's happening back at the office. Lots of trips involve traveling far enough from home base that there's a time zone difference, which can occasionally make it rough to coordinate with my staff. And it always seems that whenever I travel, there are files and papers back in my office that require my attention.

With my notebook PC, MCI mail and a portable modem, I can easily transfer files between where I'm staying while on the road and my office, and I can even fax documents created with my word processor from my hotel room. Until recently, though, if I had to fax a paper document, I had to find other facilities to accomplish this. A while back, I reviewed a device that lets you interface a hand scanner through a PC's (or notebook's) parallel port. But I really don't have the patience to stitch together multiple passes with a hand scanner to create a full page to get it ready for fax transmission.

Fortunately, Nisca, one of the largest OEM suppliers of hand and page scanner components, just solved this problem with its Niscan Page Portable Grayscale Scanner. An almost featureless black box that measures just 2½" x 2¾" x 12", the Niscan Page Portable is a portable battery-powered sheet-fed scanner that interfaces to a PC via its parallel printer port. There's

a pass-through feature that doesn't require you to give up being able to print hardcopy documents the way you normally do.

The Page Portable is capable of generating up to 400-dpi resolution and 256 shades of gray. When used in sheet-fed mode, this handy scanner can scan pages 8½" wide and up to 14" long. Scanning a standard letter-size page takes about 45 seconds, and while it comes with an ac power supply/recharger that you can connect to it for continuous use, the scanner can scan up to 30 pages on its fully charged internal Ni-Cd battery.

Weighing in at just under 3 pounds, including battery, the Niscan scanner weighs almost as much as some of the sub-notebook PCs that are currently available. Even so, it gives you a great deal of capability for its size and weight. If necessary, you can even convert it into a motorized full-page hand scanner by snapping off the bottom panel. When used in this manner, the scanner drives itself down a page. You just need to "steer" it to make sure that it doesn't make a left turn somewhere while it's performing a scan.

The Page Portable comes with a TWAIN-compatible driver. (TWAIN is the emerging standard for image acquisition devices like scanners and frame grabbers.) Once you install the driver, the Niscan unit will be recognized by a variety of software packages like WinFAX Pro 3.0, Picture Publisher 3.1, PhotoFinish, OmniPage Professional and others.

The scanner also has its own software, *Words & Pictures*, that provides scanner control and image editing, as well as OCR (optical character recognition). Once you've installed *Words & Pictures*, which requires Windows and takes just a few minutes, you can use these programs in stand-alone mode or access their features from the File... menu in many of your other Windows applications.

## Products Mentioned

PrinterNET, \$249 (Starter Kit)  
**Primax Electronics, Inc.**  
 250 E. Hamilton Ave.  
 Campbell, CA 95008  
 Tel.: 800-338-3693

CIRCLE NO. 145 ON FREE INFORMATION CARD

*CHAOS, The Software*, \$59.95  
**AutoDesk Retail Products**  
 11911 N. Creek Pkwy., S.  
 Bothell, WA 98011  
 Tel.: 800-688-2344

CIRCLE NO. 146 ON FREE INFORMATION CARD

Page Portable Grayscale Scanner, \$799  
**Nisca, Inc.**  
 1919 Old Denton Rd., Ste. 104  
 Carrollton, TX 75006  
 Tel.: 214-242-9696

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I found *Words & Pictures* to be easy to use and the equal of the software that frequently accompanies other scanners. The OCR engine, licensed from Recognia, delivers good accuracy, in the 90%-plus range, depending on the typeface, page layout and quality of the original document being scanned.

At \$799, the Niscan Page Portable is a little expensive for a grayscale scanner. But its ability to be used while on the road and included software make it a good buy for busy travelers and anyone who needs full-page scanning capability and doesn't want to use (or can't spare) a peripheral slot in your PC. ■

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# Traceable and Network-Ready Microcontrollers, New Synthesizer Chip, GUI Accelerator, Dc-to-Dc Converter and Dual-Output Switching Regulator

Enhanced versions of Intel's 8051 controller keep popping up. I lead off with two of them in this month's column. Neither is made by Intel.

## Traceable Microcontroller

Matra MHS Electronics Corp.'s (Santa Clara, CA) value-added version of the 80C51 microcontroller, the 80C50T incorporates, 4K of factory-programmable ROM and 64 bits of internal tag identification space that permits a user to identify the specific chip or system and to whom it was sold. According to the company, this feature gives the chip traceability, which is needed by banks, credit-card companies and telephone companies.

The main ID number is incorporated into a special-function register in the microcontroller, and the number is "laser trimmed" onto the chip during the manufacturing process. Once etched, the number can't be erased or altered in any way. The 80C50T costs about \$9 each in quantities of 5,000.

## Network-Ready Microcontroller

Standard Microsystems Corp. (Component Products Div., Hauppauge, NY) is now offering its COM20051 eight-bit microcontroller. Designed for networking embedded-control systems, the chip integrates a 16-MHz 80C32 microcontroller and a network interface based on ARC-NET and supports data rates from 5M bits/s down to 156K bits/s and data-packet sizes from 1 to 508 bytes. The controller also has real-time networking capability built into it.

This chip is targeted primarily at embedded applications, such as automobile navigation systems, factory automation systems, medical instrumentation, building automation (including security and energy management) and point-of-sale applications.

The device is packaged in a 44-pin PLCC that's compatible with the 80C32 ROM-less version of Intel's 8051 microcontroller. Pricing for the COM20051 in 100-piece quantities is \$15.31 each.

SMC is also marketing its own software package called *ControlLink* for \$495. The package includes object and source codes.

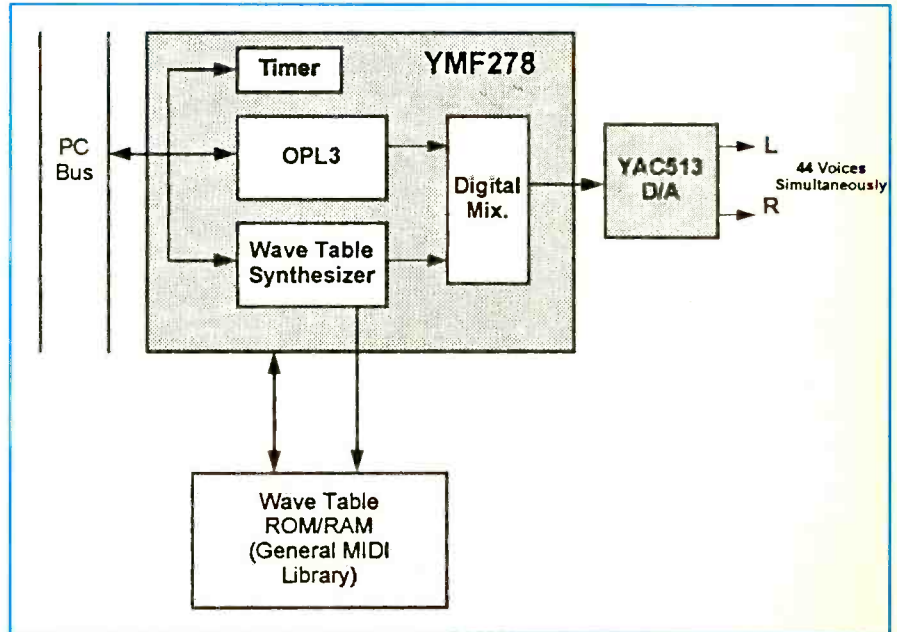


Fig. 1. Yamaha's OPL4 combines FM and wave-table synthesis on a single real-estate-saving chip.

## FM & Wave-Synthesis Chip

Yamaha Systems Technology's (981 Ridder Park Dr., San Jose, CA 95131) latest sound synthesizer chip, the YMF278 (OPL4), combines wave-table and FM synthesis on a single chip and is fully backward compatible with the company's previous generation industry-standard OPL2 and OPL3 synthesizers.

Wave-table synthesis provides more-realistic sound in some situations, and FM synthesis is preferable in others. By combining the two techniques, the new OPL4 is said to deliver the best of both worlds, at a very competitive cost.

Available in a standard 80-pin plastic quad flat pack, the OPL4 chip is claimed to be the first wave-table synthesizer to provide professional-quality sound on a footprint small enough to fit on the motherboard of a multimedia personal computer. This will give motherboard manufacturers who have designed with the OPL3 a strategic evolutionary path to the highly integrated OPL4. Other solutions require three to five components, in addition to

memory, and often require an external CPU or controller. The OPL4 is a self-contained, single-package device (Fig. 1).

Waveform data for the OPL4 can be eight-, 12- or 16-bit samples or a combination of all, depending on the instrument sound being generated. The waveform data can be stored in ROM or downloaded to memory, as needed. The standard ROM supplied by Yamaha is 2M, in a single standard 44-pin plastic SOP package.

Simultaneous generation of 44 voices is possible with the OPL4—20 FM and 24 wave. The two outputs can be digitally mixed as a single digital data stream or output separately as two individual streams.

When combined with other Yamaha Multimedia audio LSIs, such as the MMA chip, a complete MPC and Gold Sound Standard solution can be easily configured. The MMA chip is a stereo record and playback device that provides a sampling frequency of up to 44.1kHz and has built-in ADPCM compression. MIDI port, game port, DMA interface and bus decode logic.

The FM synthesizer section is a four-operator device that can be used in both

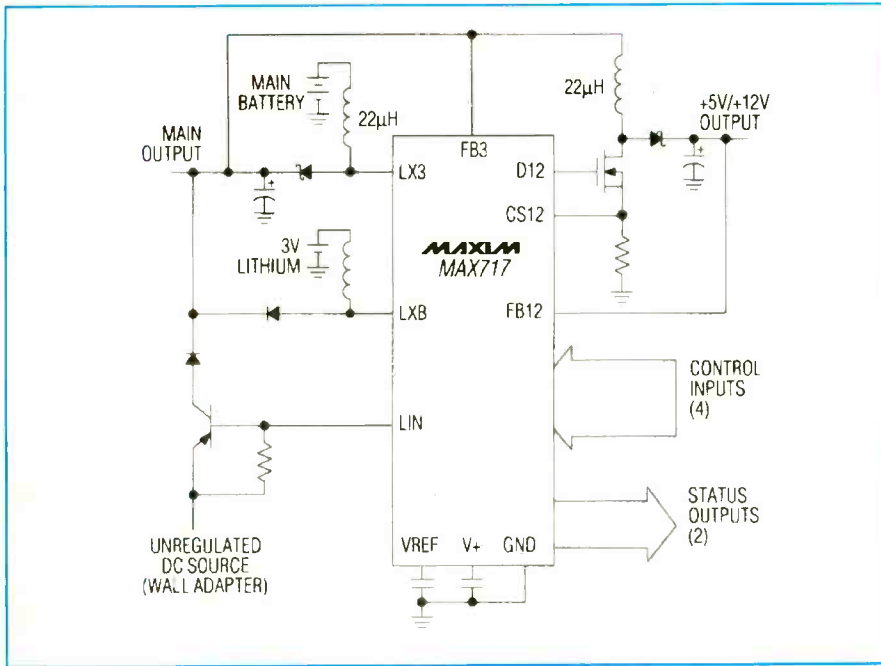


Fig. 2. Maxim's MAX717 through MAX721 dual-output switching regulators provide Vcc supply voltage and a 5- or 12-volt supply for programming 1.8-volt flash memories.

two- and four-operator modes. It's capable of providing up to 20 voices and percussion sounds.

The wave-table section of the OPL4 is self-contained and requires only the addition of external wave memory to complete the system. Stereo output of up to 24 voices with 16 levels of pan can be specified for each voice. Voice output data sampling frequency is 44.1 kHz.

Waveform data length is eight, 12 or 16 bits. External memory of up to 4M can be ROM or SRAM or a combination of both. If SRAM is used, wave data can be downloaded from the CPU. A standard general MIDI voice bank can be supplied by Yamaha in a 2M mask-programmed ROM. A full complement of 4M can deliver up to 52 voices.

The YSS225 Effect Processor, is an optional device that provides even better-quality sound, with the addition of such effects as echo, reverberation, flanging, distortion, panning and surround processing. The OPL4 can connect directly to the effect processor, which is available in a 100-pin plastic quad flat pack.

Yamaha provides a complete design package, including a demo board with the OPL4 and Effect Processor on a PC half-card, schematics and parts list. Price of the OPL4 in quantities of 10,000 is less than \$29. Price of the effect Processor in the same quantities is less than \$19.

### New GUI Accelerator

Trident Microsystems, Inc. (205 Ravendale Dr., Mountain View, CA 94043) has a

new TGUI9420 graphics accelerator for the personal-computer graphical user interface (GUI) market. The accelerator offers a combination of ISA and VL-bus support and is DRAM-based for a high-speed, yet low-cost, system design.

Trident also announced that it's bundling the TKD8001, a companion chip of the TGUI9420. The TKD8001 is a mixed signal 24-bit true-color DAC (digital-to-analog converter) combined with a dual-loop clock synthesizer.

The performance of the TGUI9420 accelerator is achieved through hardware-implemented GUI functions, zero-wait-state direct-memory write ISA bus performance, a 16/32-bit 386/486 VLbus interface, improved memory data transfer and line addressing. The chip's graphics engine offers such advanced graphics drawing operations as Pixel Blt, Line Draw, ShortStroke Vector Draw, Area Fill and Image Transfer.

The TGUI9420's micro-coded graphics engine allows developers to write software drivers optimized for their applications. Trident supports accelerated drivers for Windows 3.1, Windows NT and AutoCAD 12. Many other SVGA drivers are available based on Trident's extensive extended-resolution driver list.

Extended graphics mode support includes 640 x 480 in 32K, 64K and 16.8-million colors and 1,024 x 768 noninterlaced 256 colors. Extended text modes offer 80-column text with 30, 43 and 60 rows and 132-column text with 25, 30, 43 and 60 rows.

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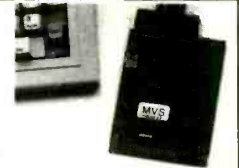
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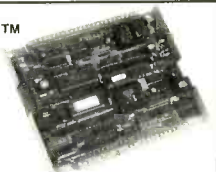
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Linear Technology's (1630 McCarthy Blvd., Milpitas, CA 95035) LT1107 dc-to-dc converter works in either step-up or step-down mode and has a quiescent current of only 320 A, making it well-suited for power-conscious battery-operated systems. Applications for the LT1107 include palmtop computers, LCD bias generators, add-on cards and peripherals, battery backup supplies, cellular telephones and portable instruments. Supply potential ranges from 2 up to 12 volts in step-up mode and up to 30 volts in step-down mode. The LT1107 is claimed to function equally well

in step-up, step-down and inverting applications.

The LT1107 is pin-compatible with Linear's LT1111, but it has a duty cycle of 70%, which enables greater output current in many applications. It can deliver 150 mA at 5 volts from two AA cells and 5 volts at 300 mA from a 9-volt battery in step-down mode.

The LT1107 has a 63-kHz internal oscillator optimized for use with surface-mount inductors and capacitors. It has a 1-ampere switch on-chip. Switch current limit can be set with a single resistor. An auxiliary on-chip gain block can be configured as a low-battery detector, linear post-regulator, under-voltage lockout circuit or as an error amplifier.

The LT1107 is available in three versions: adjustable, fixed 5-volt and fixed 12-volt designs. All are available in either eight-pin narrow DIP packages and eight-lead SO surface-mount packages. Both military and commercial temperature de-

vices are available. Pricing in 1,000 and up quantities in DIP is \$2.33.

## 1.8-Volt Flash-Memory Power

Maxim Integrated Products' (120 San Gabriel Dr., Sunnyvale, CA 94086) MAX717 through MAX721 dual-output switching regulators start and operate with inputs as low as 1.8 volts (two or three battery cells) and provide microprocessor systems with a  $V_{cc}$  supply voltage and a 5- or 12-volt supply for programming flash memories (Fig. 2). Their small size, high efficiency and low supply current makes them unbeatable for use in palmtop computers, hand terminals and other low-voltage, battery-operated and portable equipment.

These devices have the following preset main-output voltages: 3.3 or 5 volts for MAX718/MAX720, 3.0 or 5 volts for MAX719/MAX721 and 3.3 volts only for MAX717. These outputs have internal power switches that deliver as much as 200 mA of current at 87% efficiency. For the auxiliary output, selected as 5 or 12 volts, an external MOSFET can deliver more than 120 mA.

As a result of their CMOS-technology design and a unique, constant-off time, pulse-skipping control scheme, these regulators conserve battery life and occupy less circuit-board space. The internal power MOSFETs permit switching frequencies of up to 500 kHz and use of smaller external capacitors and smaller (<0.5-mm diameter) surface-mount 22- $\mu$ H inductors. Efficiencies range from 80% to 87% for outputs from 2 to 200 mA. Low 60  $\mu$ A quiescent currents help to extend battery life.

These regulators accept inputs from the main battery, a lithium backup battery or an unregulated dc voltage from a plug-in wall adapter. Space-saving integrated features let the regulators detect the applied dc, signal the microprocessor and switch automatically from battery to plug-in adapter. The adapter power is linearly regulated by an internal controller and external transistor.

Other standard features include power-fail warning and a miniature step-up switching controller that regulates the backup-battery voltage. Logic-compatible inputs allow the microprocessor to control each output independently.

A complete, preassembled surface-mount kit that features a standard MAX718 application permits evaluation of the MAX717, MAX718 and MAX719 devices. The MAX718EVKIT-SO kits are priced at \$30 each.

MAX717 through MAX721 devices come in 16-pin narrow-SO packages and are screened for the commercial or extended-industrial temperature range. Prices for these devices start at \$5.95 for quantities of 1,000 and up. ■

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## Borland and WordPerfect Windows Suites

**Borland and WordPerfect** have formed a strategic alliance to deliver office-automation applications for *Windows*. They say they'll collaborate as independent companies by sharing technology and other resources to meet market opportunities. What this actually means is that they're going to offer complementary product suites. I say it's about time. Both Microsoft and Lotus have product suites they can offer as complete solutions to corporate customers who prefer single-vendor suites as opposed to a conglomeration of best-of-breed products.

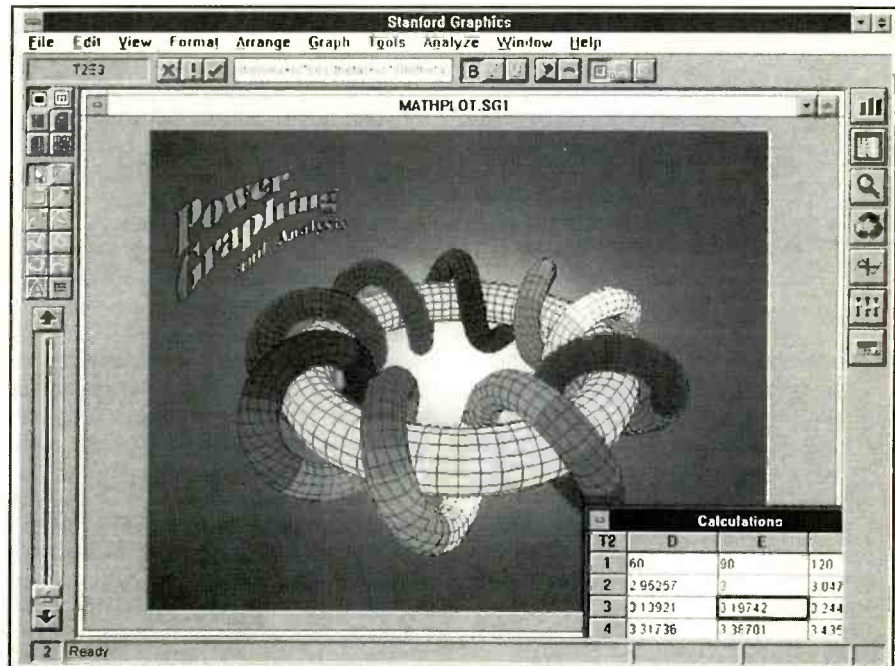
According to desktop computing's gang of two, their relationship is a direct response to customer suggestions that the companies form a team. It's probably also due to each of them asking how they could compete for the business of Fortune 1,000 companies that are seeking an integrated answer to whatever personal-productivity needs they have. IDC has reported that Microsoft sold 700,000 and Lotus 100,000 suites in 1992.

This isn't the first time Borland and WordPerfect have worked together to get a slice of the national-account pie. Borland and WordPerfect have had several successful joint deals with individual customers—even with the Canadian government. It may just help the duo survive the juggernaut from Redmond, too.

The deal is a smart move. Integrated, single-vendor solutions are more attractive these days. Price is one factor. Bundles offer more value. At a manufacturer's suggested retail price of \$595, for instance, Borland's joint suite with WordPerfect will include software with a combined MSRP of \$1,785.

However, the abundance of integrated packages isn't just due to their price—especially under *Windows*. Applications tend to be more equally matched under the coordinating influence of a GUI environment or operating system. Lotus *Ami Pro* and Microsoft *Word for Windows*, for example, are going to have differences in their features sets, but valuable innovations are rapidly duplicated. Look how quickly tool bars have permeated nearly every major application.

Furthermore, many of the strongest capabilities these applications have—things like printer support, graphics han-



A screen shot created with the *Stanford* graphics software package.

dling, DDE and OLE links, etc.—are a consequence of *Windows* services that are available to all applications. Likewise, the *Windows* interface is shared by applications. There isn't likely to be a Lotus-vs.-Paperback Software-type suit over a spreadsheet's look-and-feel, and it's equally unlikely that any application will be perceived as having a vastly superior interface. All of this lends credence to the idea that the demand for best-of-breed is giving way to market acceptance of several better-of-breed products. Under DOS, users would universally have groaned over a decision to replace *1-2-3*. If someone says the company is going to use *Quattro Pro* instead of *1-2-3 for Windows* or *MS Excel*, though, many users are likely to simply shrug.

The first integrated product resulting from the long-term strategic alliance of this pair is *Borland Office for Windows*. It will include Borland's own *Quattro Pro for Windows* 1.0 and *Paradox for Windows* 1.0, as well as WordPerfect's *WordPerfect* 5.2 for *Windows*. The alliance claims that it's the first time two major software com-

panies have combined their individual offerings into a single product. Borland boss Philippe Kahn calls it a "no compromise" solution and says it's the first software suite to combine top contenders in word-processing, spreadsheet and database—the three best-selling categories of PC software. Only *WordPerfect* 5.2's lack of true WYSIWYG makes me uneasy about this argument. I think the need to preview is an important feature in a GUI environment. Otherwise, *Office* probably does have as much claim to being a better-of-breed solution as the Microsoft and Lotus suites.

Neither Borland nor WordPerfect Corp. will have an equity interest in the other as a result of this collaboration. Their agreement is based on common technology and market goals only. But Borland and WordPerfect are sharing more than a single product. Their joint announcement listed common research and development (to provide tighter integration between the companies' software products); combined support of the Independent Database Application Programming Interface (an



NEC's 17" 5FG color video monitor is even good enough for desktop publishing and low-end CAD work at a reasonable price.

industry standard for accessing corporate data on multiple platforms and operating systems); and coordinated marketing, sales and support programs. They've already enhanced interoperability among products in the suite. When the first version of Borland *Office for Windows* ships, you'll be able to import rich text and data into WordPerfect directly from *Quattro Pro for Windows* spreadsheet notebooks.

Yet, I wonder. Is this venture really all that joint. Borland *Office for Windows* is, after all, available from only Borland. For its part, WordPerfect will offer the Workgroup Extension Pack for the Borland *Office*. It will include electronic mail, scheduling, a calendar, forms and presentation graphics—all WordPerfect products. Notice that presentation graphics are duplicated in *Quattro Pro*, which Philippe Kahn takes great pains to use for all his own presentations. Some forms applications may also create a dilemma between *Paradox* and WordPerfect's *InForms* technology. Call a spade a spade. It's a suite of workgroup applications as much as it's an extension to *Office*.

The companies make the claim that, together, the two suites provide the only complete offering of office products. But hold it! There are two suites, not one. They not only contain duplications, they're from two different vendors, and combining them amounts to a conglomeration (albeit one with very high-level modules). Borland and WordPerfect might resolve conflicts in functionality. This seems unlikely. It would require their joint research and development efforts to surmount both the selfish interests imposed by the need to market the individual products, and inter-company politics.

I'm not all that convinced that Word-

Perfect is totally committed to *Windows*, either, for several reasons. Firstly, it's difficult for an institution that's achieved spectacular success with one great idea to change its mindset. When I attended the announcement of *WordPerfect 6.0*—it ships on June 28—the focus was almost exclusively on DOS. In a way, DOS is more responsible for the success of *WordPerfect* than the company's eponymous word processor. Without the struggles inherent in that operating system and its kith, customer support might never have been important enough for its users to lift the former Satellite Software into orbit.

I also think it will be difficult for *WordPerfect* to overcome the inertia of its corporate culture, as well as DOS culture, and change direction. One insider put it to me that WordPerfect realizes *Windows* is the future but can't give loyal DOS users the impression they're being abandoned. But hold it, again! I thought Microsoft was scheduled to abandon plain old DOS itself around release seven. And even if DOS isn't exactly abandoned, how many other developers are still writing primarily for DOS? How many will be left in two years when Pentium is a common platform, and *NT* is firmly established? WordPerfect isn't going to break with its DOS heritage any time soon. As that same insider also points out, *WordPerfect* for DOS is going to remain a wonderful cash cow for years to come.

Finally, however good it is in the next release, *WordPerfect for Windows* won't be as good as it would be if the company was risking everything on its success. Take Microsoft *Windows* and *NT* as examples. *Windows* never could have risen to its present heights without the break between Microsoft and IBM. Before that, the two companies had an agreement that served to carve out and protect separate niches for *Windows* and *OS/2*. Would *Windows* be its best if Microsoft was concerned with the success of *OS/2*?

Nevertheless, the ability of these two companies to provide a solution with all of the core productivity applications you need—plus email, scheduling and a calendar to coordinate workgroups—is encouraging. If you really want integration, and minimal (if not single) vendor support, these guys do have the most complete offering of office products in town.

Borland *Office* is scheduled to arrive in the second half of June. The *Workgroup Extension Pack* is scheduled to be available in the third quarter. Incidentally, "long-term" means Borland *Office* will be offered indefinitely, as long as there's customer demand, and future versions will be upgraded to remain consistent with the most recent stand-alone versions of each product.

## Higher Education

If Harvard gets an eponymous graphics package, why not Stanford? After all, it's often referred to as the Harvard of the West. Apparently, this is the reasoning that the folks at 3-D Visions employed when they named the *Windows* version of *Graftool*, their market-leading technical charting and presentation package for DOS. So, *Stanford* is the company's technical (as well as business) 3-D charting and graphing tool for *Windows*.

*Stanford* has the same types of charts you find in programs like *Freelance*, *PowerPoint* and *DeltaGraph*—only it has more of them. It has 167 graph types based on 45 business, statistics and technical categories. They range from simple pies to six-dimensional vector plots. Six dimensions? The program displays them by substituting arrows for data points. In a storm cloud, for instance, you could show such things as velocity with the length of the arrow, direction with the direction of the arrow and temperature with the color of the arrow.

Where the competition has a good design, 3-D isn't afraid to pay homage to it. Its style sheets and templates, for example, are quite reminiscent of those in *Freelance*. "We were well-aware of *Freelance's* capabilities in this area," says marketing vice president Dave Ulmer, "and felt that was important in our package as well." It supports nearly every graphics file format, includes line-drawing tools and formats fonts. *Stanford* doesn't yet support multimedia, sound effects or video. But there are a slide show and most of the other things you expect from a high-end presentation product.

*Stanford* has its own built-in, multiple-model, four-dimensional spreadsheet engine. It can simultaneously open and interact with multiple 3-D spreadsheets. Seventy spreadsheet functions cover everything from simple math to advanced scientific and statistical calculations, such as Bessel, Gamma, Students-T, Chi-Square and Kolmogorov-Smirnov tests. Spreadsheets are essentially limited only by your system's memory. They can have up to 70-trillion cells!

If you want to use your favorite spreadsheet with *Stanford*, the program has filters for DOS and *Windows* file imports that let it get your data where it is. You don't have to create intermediate files or spreadsheets. Ulmer cites two of his graphs that have between them seven links to three 1-2-3 *for Windows* files. The data are hot linked to all three by *Stanford's* DDE and OLE capabilities. These include both OLE and DDL server, as well as client, functions. Moreover, *Stanford's* own proprietary DIL (dynamic import link) works like a

Dynamic Data Exchange for DOS. (DIL differs from *Windows* links in that you must open a file to update it.)

*Stanford's* technical-charting features go well beyond its competitors. Its three-dimensional surface plots, for example, are proportional to the underlying data values. It uses visibility algorithms and hidden line removal to plot actual data points. It can also generate a surface plot from random x,y,z triplets by interpolating mathematically correct points between them. And it has an inverse weighted distance algorithm that works like a 3-D version of a cubic spline to plot an approximation of your data's underlying function.

Similar-looking surface plots from desktop competitors, such as *PowerPoint* and *DeltaGraph*, aren't able to plot accurate 3-D surfaces based on real data. If you were to look at a small neighborhood on one of their three-dimensional surface plots, you'd find that it was covered by regularly-spaced, uniform areas. That's to say, the areas would be uniform, regardless of the data values by which they're bounded. This is because the programs ignore the x and y values. If the points go in uneven increments, or on a logarithmic scale, those programs can't accurately plot them. The x and y values are plotted as labels (that is, on a nominal scale), evenly across the data range, regardless of the actual values. This limits the program's usefulness for plotting real-world data that doesn't come in an evenly-spaced grid. Such a plot can accurately represent only contrived data that are from a regular linear series like 1, 2, 3; 2, 4, 6, 8; or 17, 34, 51. Real data aren't like this, though, and when the distances between underlying data are irregular and the areas bounded by them are regular, the graph is distorted.

The on-screen data-analysis tools in this product are formidable, too. When you rotate a plot, *Stanford* doesn't just re-draw your data at different coordinates. You can watch the data turn and catch intervening details you might otherwise miss. An Analyze menu allows you to do analysis, such as a polynomial regression through 3-D data, and plot the new smoothed data.

*Stanford's* visual data-analysis ability lets you analyze the data on the graph, instead of through a spreadsheet. Click on any point with the Intelligent Data Cursor, and you get a reading of the x,y,z data value in a little window. You can change values in this window by stretching the plot with a mouse. Changing the graph in this way changes the data only if you tell it to do so. Therefore, you can do what-ifs, in 2-D or 3-D, in any graph type.

Ulmer gave me two examples of how customers are using *Stanford*. Nestle is controlling the life of its products on the grocer's shelf with *Stanford*. It first plots

optimum shelf life based on humidity and temperature. It then uses the program's regression tool to create a model that the data tends to follow. When it introduces a new packaging material or product type, Nestle plots test data and compares them to the model to see if the new product is within its guidelines.

Financial analysts are also using the product. They prepare presentations that compare the performance of multiple investment funds over long periods of time. It's too bad 3-D hasn't included some financial functions, like discounted cash flows, into the spreadsheet. I suspect that there's a lot more that could be done with *Stanford* in this area.

This is a fairly impressive statistical tool, as well as a powerful charting and presentation package. It requires 12M of storage, 4M of RAM memory and at least a 25-MHz, 80386 processor.

### NEC 5FG

If you need a new video monitor to display *Stanford's* charts and graphs, consider NEC's 5FG. It can plot at noninterlaced resolutions up to 1,280 x 1,024. Its 0.28-mm dot pitch makes images sharp, even when there's lots of little windows filled with plots and spreadsheets squeezed onto its big 17" screen.

In today's monitor market, the 17" display is one of the faster-growing segments. You can fit it in places where a 20" or larger display won't go, and it's just the right size for graphical business applications like running *Windows*. A 17" diagonal measurement is even large enough to display high-resolution images for desktop publishing and low-end CAD applications. Yet, it doesn't cost much more than a high-quality 14" monitor.

Larger displays also generally come with additional features, and the NEC 5FG is no exception. It has built-in pincushion control, manual and auto degaussing, a digital control system with frequency memories that let you customize centering and sizing for the frequencies of any adapter and an RGB-gun intensity control for color calibration (NEC's AccuColor). It also has one fixed and two programmable color settings. You can adjust white balance to reduce the fatigue that's sometimes induced by the bluish cast of whites. (Under ordinary circumstances, the bluish cast helps you to see contrast better, but for some individuals, it also causes fatigue over time.) The monitor's input capabilities include BNC, Mac, and standard VGA connectors.

NEC engineered quality into this monitor. The 5FG's CRT has an Ivar (alloy) shadow mask that makes it less sensitive to the doming distortion that can spoil a mon-

Products Mentioned
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itor's focus. Heat usually causes doming when you turn up the brightness. Ivar distorts less than a comparable steel mask, keeps the electron beam better aligned and has a sharper focus as a result. So, Ivar makes the 5FG's picture sharper for a given level of brightness or brighter for a given sharpness. It's much more competitive with the Trinitron design, which, because it uses suspended cross-wires instead of an aperture mask, has always been insensitive to heat.

The 5FG CRT also features a flat-square design to give you a flatter image and let you use more of the active screen area without pincushioning or barreling effects. The electronics have also been changed to make the picture as wide as the new screen permits. It doesn't make sense to pay a premium price for a large monitor if it yields a no more active display area than a smaller one does. Yet cheaper monitors may not use the screen as fully, even though the CRT may be the same size and has the same flat-square design. This is because the electronics of a flat CRT are stressed more to reach its wide angle.

Low emf radiation is integral in this monitor, and it follows the MPR2 guidelines for ELF. NEC also offers an optional OCLI (Optical Coating Laboratories Inc.) lens that slides over the front of the monitor and looks completely an integral part of it. Unlike the etched screens and grainy silica coatings they replace, OCLI coatings applied to a polished-glass lens doesn't degrade focus. The lens has several coatings that reduce reflected glare and increase contrast. It also has an antistatic coating and grounding strap to reduce the effects of radiation, magnetic fields and static (such as shock, dust and dirty films). Sony offers this caliber of lens only on its high-end 20" and larger monitors. ■

ent representative said that Video Blaster saves images in no more than 256 colors. Now I wonder which answer is correct.

The fact that Video Blaster has a real-time image display that rivals that of a TV receiver or monitor would indicate that it really does support 2-million colors, at least while playing real-time imagery. However, the instant image degradation caused by simply freezing an image indicates that color resolution drops when preparing to capture.

I saved images in eight bits (256 colors) and 24 bits (16.7-million colors) as offered by Video Blaster's Windows utilities. In each case, I ran the Smooth function to filter out scanning lines. Then I examined each image using two different quality image-processing packages. One was Micrografx *Picture Publisher*, the other Aldus *PhotoStyler*.

Viewed from both packages the eight-bit images looked very much like the 24-bit images, which shouldn't happen. Anyone who works with images knows that a real 24-bit image will rank far superior in appearance to an eight-bit image. So, does Video Blaster save all 2-million of its colors in a false 24-bit format, or does it perform the same trick with only 256 colors?

Experimenting with ordinary eight-bit images reveals that images can be manipulated and saved in formats with greater color resolution. *PhotoStyler*, for example, can read a 256-color GIF image and translate it into a format that can be read as 24-

bit. But can such manipulation produce a newer image with essentially more resolution than the original? My experiments, using *PhotoStyler* and *Picture Publisher* with several kinds of image formats, showed that 256-color images translated into 24-bit images still looked like 256-color images even when displayed by 24-bit software and hardware.

Perhaps Video Blaster saves images in fewer colors than it displays, even though making the images compatible with higher-resolution formats. I can't be certain of this because my questions to Creative Labs technical support have gotten conflicting responses.

Something else may bear on the question of Video Blaster's image resolution. The board is supposed to be transparent when not in use, like any other gadget in your computer. It shouldn't interfere with normal operations. In the case of Video Blaster, the only time it should be known by your computer system is when you run Video Blaster software.

In my computer system, Video Blaster wasn't completely transparent. My video card is capable of 24-bit color in 16.7-million colors. Taking advantage of 24-bit color requires resetting *Windows* to run in 24-bit mode, using software drivers designed for the video card. As soon as *Windows* comes up in 24-bit mode, the computer screen gets cluttered with signal noise, snow and blurred text. The display is so much disrupted that it isn't usable.

When I disconnect Video Blaster, nor-

mal undisturbed video is restored. Technical support responded to my query about this by saying that Video Blaster works in only 256-color modes or less. The problem with this answer is that I wasn't running Video Blaster at the time. I was simply running *Windows* when Video Blaster was properly installed in my PC.

Further experiments revealed similar results when running *Windows* in 16-bit Hi-Color mode that handles about 32,000 colors. Again, I wasn't attempting to run Video Blaster, only *Windows* in 16-bit mode.

It seems that Video Blaster lacks total transparency, as indicated by my experiments. This resulted in another problem during the evaluation. Anytime I wanted to examine an image on a 16- or 24-bit basis, I had to shut down my computer, disconnect Video Blaster and reconnect my video card in normal fashion. Evaluation of Video Blaster sometimes required parallel comparisons of eight-bit versus 24-bit results. Thus, I've connected and disconnected Video Blaster many times, which requires power cycling.

### Summary

Video Blaster is one of the competitors for low-cost computer video. Its real-time presentation is excellent when compared to its price, making it a nifty tool for watching scaled TV under *Windows*. Its DOS utilities are more of a high-level programming language than anything else and are difficult to use. They can view images but not capture them. Thus, the DOS utilities are mostly useless. The *Windows* utilities are very good and easy to use, but they're offset by limited resolution, lack of transparency and of true 24-bit support.

If you want something to view TV programs on your computer, Video Blaster works well enough, but you might consider the cheaper, more-practical route of buying a small color TV receiver. If you want image capture and don't mind being limited in color and resolution, Video Blaster will probably fill your needs. Above all, remember that your computer can't have any more than 15M of RAM or Video Blaster won't work.

Finally, if you're looking for something that will grow with your computer system, maybe you should wait for Creative Labs to make a better version of Video Blaster.

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## Graphics Accelerator

ATI's Graphics Ultra Pro provides high-performance CAD, *Windows*, Multimedia Video, UNIX and O/2 graphics for professional users. Using ATI's mach32 Graphics accelerator Chip, it exceeds 25-million Winmarks, features enhanced drivers and is supported by hundreds of applications that use IBM 8514/A, VGA, VESA and other ATI drivers. It displays 1,280 x 1,024 images at a 74-Hz vertical refresh rate with 256 colors.

The card accelerates multimedia and video (AVI) under *Windows*. Direct color modes eliminate color conflicts. Hardware-assisted image scaling provides full-screen playback without dropping frames, while maintaining audio synchronization. Up to 2M of video memory is supported. \$395. *ATI Technologies Inc., 3761 Victoria Park Ave., Scarborough, ONT, Canada M1W 3S2; tel.: 416-756-0718; fax: 416-756-0720.*

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## Savings-Bond Calculations

*EEBond* is an inexpensive computer program from MNR Software that you can use to compute the value of Series EE Savings Bonds up to six months in advance. The program maintains a database of Series EE and Series E bonds and Savings Notes. All you do is enter the serial number and date of purchase, and the program takes it from there, auto-

matically determining the worth of your bonds for the next six months.

To coincide with the publication of the latest tables-of-redemption values, *EEBond* is updated every six months. The update, which requires no further data entry, cost \$10 to registered users. \$20. *MMR Software, PO Box 7116, Washington, DC 20044; tel.: 703-243-0552.*

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## Development Board

The eBoard from Highlands Electronics has a 6502 microprocessor at its heart and is supported by a development system that consists of a cross-assembler, assembly-language debugger and board-resident Forth language. Because the cross-assembler and debugger run on a PC, development is extremely fast, compared to working with these tools directly on the 6502. The cross-assembler is written to compile 4K of object code in 1 second. With the debugger running while the 6502 has been stopped, you're able to read, write and modify eBoard's memory and devices, without disturbing your application environment. It has a central input and output kernel to simplify attaching your application to the system. *Highlands Electronics, 13720 Lake Shore Dr., Clear Lake, CA 95422; tel.: 707-994-1024.*

CIRCLE NO. 20 ON FREE CARD

## New Golden RETRIEVER

Above Software's *Golden RETRIEVER* is a document manager that helps you create, store, track and search for documents and data files. The software organizes electronic documents and data files into six on-screen file drawers and an unlimited number of file folders. This replicates the way a paper document would be filed in *Windows*.

With *Golden RETRIEVER*, you collect in one file drawer or file folder all related letters,

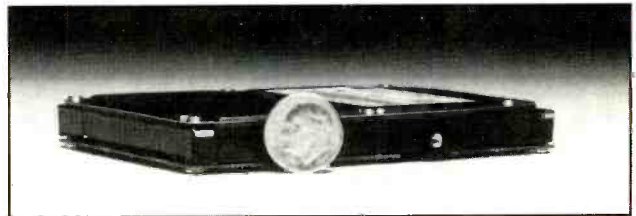
## Small-Size, Big-Capacity Hard Drive

Toshiba's MK-152FCV is a 2 1/2" hard drive with 126M storage capacity and a mere 1/2" height. This diminutive drive is ideal for use in today's sub-laptop computers. It offers a fast 15-ms average access time, a data-transfer rate and a 128K cache buffer.

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weighs only 4.9 ounces, consumes about 1 watt of power from a single 5-volt supply and spins up to operational speed in a fast 3 seconds. The MK-152FCV is designed to withstand up to 100G of non-operational shock and has a rated MTBF of 150,000 power-on hours. *Toshiba America Information Systems, Inc., 9740 Irvine Blvd., Irvine, CA 92718; tel.: 714-583-3000.*

CIRCLE NO. 21 ON FREE CARD



## Windows From The Keyboard

By Nicholas Baran

(*John Wiley & Sons. Soft cover. 302 pages. \$16.95.*)

This is the book for anyone who isn't totally hooked on using a mouse with a PC. The author shows you how to employ the keyboard for issuing *Windows* commands to make operations much faster. Sure, you need a mouse with which to draw and drag, but in many cases it's a very inefficient mode of operation, often forcing you to wend your way through menus and sub-menus.

Starting with an overview of how to navigate with *Windows*, Baran then takes you into six popular applications for *Windows* key-stroking methods: *WordPerfect for Windows*, *Ami Pro for Windows*, *Word for Windows*, *Quattro Pro for Windows*, *Excel for Windows* and Lotus

1-2-3 for *Windows*. He illustrates how to work from both documents and menus, heavily supported by excellent screen illustrations.

An excellent appendix summarizes, in reference-table format, general *Windows* keyboard strokes and application-specific strokes. Much of the strokes make use of Alt and Ctrl keys in combination with letters or a function key.

If you're a fast typist, you'll love the opportunity to work the keyboard without hardly taking time out to move around a mouse. If you're a true power user who can't stand slow-downs, you'll also welcome the practical guidance offered here. And even if you're just the ordinary computer user who operates in *Windows*, you'll relish speeding up operations for routine tasks by using basic keyboard strokes.

This book is a treasure for all *Windows* users.

spreadsheets, memos, proposals, reports, presentations, database records and other files generated by any *Windows* or DOS application. The program supports user-friendly filenames of up to 256 characters in length, complete with full punctuation.

Enhancements include file-save and file-open intercepts that bring up *Golden RETRIEVER* when another application attempts one of these operations; file record, which adds a "version" field; the ability to customize *Windows* desktop and accessories; the ability

(Continued on page 81)

**Table 1. Locations of a Serial Card in Memory**

Port	Hexadecimal	Decimal
COM1	03F8	1016
COM2	02F8	760
COM3	03E8	1000
COM4	02E8	744

**Table 2. Details for Using More Than One Channel**

	CH1	CH2	CH3	CH4
COM1	1016	1017	1018	1019
COM2	760	761	762	763
COM3	1000	1001	1002	1003
COM4	744	745	746	747

on doing multiple experiments at different times, the preferable approach is to use the connector arrangement so that you don't have to open your system unit for each new experiment.

Begin by checking your serial card to see if its UART is socketed or soldered into place. If you have a card with an empty socket for a second serial port, you're ahead of the game because you can use it as a dedicated experimenter-port Interface. If the UART is soldered into place, your best bet is to replace the card with one that has a socketed UART. Purchasing a new serial card costs for \$20 or so is a lot cheaper than trying to build the Interface from scratch when you consider that it would cost you about \$30 for just a blank prototyping card and would have to add in the cost of the buffering and address-decoder chips you'd have to buy to implement the circuit.

You need a 40-pin socket header or a piece of perforated board that's two or more rows larger than the size of a 40-pin UART chip. If you use a header, you can wire directly to it. Alternatively, if you use perforated board, you'll have to plug prototyping pins into the hole locations that will align with pins 1 through 8, 19, 20, 26, 27, 28 and 40 of the UART socket and pass some thick bus wire down through them to plug into the positions on the UART socket or solder directly to the serial card.

Referring to Fig. 1, use Wire Wrap or other small-diameter prototyping wire to point-to-point wire the circuit on a separate perforated board. Don't forget to provide wiring for the ground returns

**Listing 1. BASIC QADDI Test Program**

```

10 cls                Clear the screen
20 V=INP(1016)        Read input value from memory
30 PRINT V;           Print the value to the screen
35 FOR I=1 to 1000    Wait a while so I can read it
40 NEXT I
50 GOTO 10            Start again
    
```

of any input signals you'll be using. Use ribbon cables for any digital data signals and any two-conductor cable for analog signals you'll have as inputs. Don't plug the ICs into the sockets on your Interface board until after you've conducted voltage checks and are certain that your wiring is okay.

If you wish, house the circuit-board assembly inside an enclosure that has sufficient panel space on which to mount the input connectors you'll be using, RESET switch SW1 and an entry point for routing the cable that goes to the connector on your computer that carries the lines to the UART socket on your serial card.

After mounting the connectors, use ribbon cable to interconnect the digital input signal lines to their connector(s) and two-conductor cable for any analog inputs you'll be using. Line the hole you drilled for the cable that goes back to your computer and feed the free end of the cable through it. Connect and solder the conductors of the computer cable to the appropriate points on the circuit board. Then use 1" spacers and suitable machine hardware to mount the circuit-board assembly into place.

With the project wired and ready for testing, build a simple tester to use during the setup procedure to verify that your circuit is operating properly. You can wire the tester circuitry, shown in Fig. 2, on a piece of perforated board. When you wire this circuitry, keep in mind that the only things that will be on the tester board will be potentiometer R10, resistors R2 through R9 and switches S1 through S8. The remainder of the circuitry is shown simply to show you where to temporarily connect these components to those in the Fig. 1 circuit.

### Checkout & Use

With no ICs in the sockets on the circuit-board assembly, plug the cable that goes back to your computer into the connector that goes to the UART socket on your serial card. Clip the common lead

of a dc voltmeter or multimeter set to the dc-volts function to any convenient point that's supposed to be at ground potential on the Interface board. Power up your computer and, after it has booted, touch the "hot" meter probe to pin 20 of the U1 and U2 sockets and pins 6 and 16 of the U3 socket. If you don't obtain a +5-volt reading at any of these points, power down your computer and correct the problem.

If everything appears to be okay, power down your computer and plug the ICs into their respective sockets on the Interface board, making certain you orient them properly. Then temporarily connect your test circuit to the circuit-board assembly, as detailed in Fig. 2, and power up your computer.

You must prepare your system to accommodate the Interface by setting the COM port for proper operation. Table 1 lists the decimal locations of a serial card in memory. If you use the Interface on a port other than COM1, change 1016 (in the software) to one of the numbers listed in Table 1. Setting your serial card so that your computer can see it is the same as if you were going to use it for a modem or a mouse. Consult the information that came with the serial card.

Next, key in and run the BASIC program given in Listing 1 to ensure proper operation. To stop the program, hit Ctrl-Break. Make sure you have your serial card set for the same COM port as the program. If you're using COM1 or COM2, make sure your mouse software isn't active.

After keying in Listing 1 (omit the comments given in the second column during entry), save it with the filename TEST.BAS. If you're using DOS 3.1, make sure GWBASIC is in the PATH statement in your AUTOEXEC.BAT file. Then type: GWBASIC TEST.BAS and hit Enter. If you're using DOS 5, use the QBasic that came with it. Hit RESET switch S1 on the Interface and adjust the potentiometer on your test-circuit board until you see numbers in the upper-left

**Listing 2. BASIC Program for Testing More Than OneChannel**

```
10 CLS
20 V=INP(1016)
30 W=INP(1017)
40 X=INP(1018)
50 Y=INP(1019)
60 PRINT V:
70 PRINT W:
80 PRINT X:
90 PRINT Y:
100 FOR I=1 TO 1000
110 NEXT I
120 GOTO 10
```

**Listing 3. BASIC Program for Reading a 0-to-5-Volt Input**

```
10 CLS
20 A=INP(1016)
30 V=A * 5 / 255
40 PRINT V:
50 FOR I=1 TO 1000
60 NEXT I
70 GOTO 10
```

of your video monitor that vary from 0 to 255. If fail to obtain this response from the system, something is wrong. Power down and correct the problem.

Test the parallel (digital) data input by changing the ON/OFF combination of switches S1 through S8 on the test-circuit board. If the numbers displayed on your video monitor change when you change switch settings, the project is operating properly and you can proceed to putting it into service. Power down your system and remove the test-circuit board.

If you're using more than the one parallel or/and one serial inputs, each additional channel you use must have the same address plus 1, as detailed in Table 2. To test out such a system, you'll have to key in and run the BASIC program given in Listing 2. I know this is very crude programming, but it takes little time to enter and understand it. If you run this program with a single-channel Interface installed in your system, all four outputs will be the same.

Finally, if you wish to read a 0-to-5-volt analog input, key in and run the BASIC program given in Listing 3. With a little programming, you can use the linear analog input to monitor many things. ■

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This is an unusual package. It's actually a starter kit for the latest version (7.0) of *WordStar* for DOS. As such, it includes a 3 1/2" disk that contains the full word-processing program, minus some advanced capabilities, such as a thesaurus, page previewing, graphics integration and more-extensive printer support. (An upgrade to include these features is available for \$89.)

This book teaches you the basics of using this popular DOS word processor, which features drop-down menus and mouse-use capabilities. It's crisply written and nicely illustrated. At its price, the package is certainly worthwhile getting if you're not already locked into a high-power word processor or wish to explore working with a fine DOS one.

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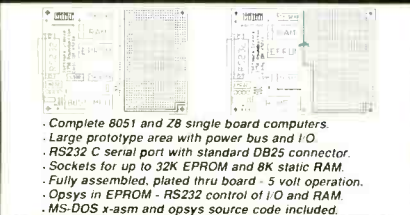
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the Italian Renaissance. *Renaissance Masters* Volume 1 concentrates mainly on late gothic to early Renaissance periods. Volume 2 covers the High Renaissance, Mannerist and Baroque periods. Both volumes display paintings, sculpture and architecture by artists like Da Vinci, Botticelli, Michelangelo, Raphael and Titian. Each CD stores more than 1,300 images, with detailed data cards about each artist and a little background music that puts you into the mood of the time.

Reviewing *Renaissance Masters* is made easy due to its Microsoft *Windows* interface. You can walk through the entire database of art keyed to the artist who created it, the media of creation, a particular object, the title of a specific work, the date of a work or even the school someone attended. Browsing is controlled by data cards that present a concise textual identification of the work or, according to user choice, display a panel of images from which to choose.

If you didn't get much exposure to the arts during your school years, as many of us experienced, Ebook provides an essay on each volume of the *Renaissance Masters*. The essay acquaints you with the significance of the Italian Renaissance, helping you to understand and perhaps appreciate what you're looking at.

Besides excelling as informative tools for personal education, *Renaissance Masters* Volumes I and II are superb reference source. One can simply study the art and artist for many hours and is bound to retain some of the information. Both reference works are easy to use and can be very entertaining.

### Music Mentor

The Italian Masters had no monopoly on innovation. Music, part of every cultural art, has spawned compositions of such power, grace and majesty that they're labeled nothing less than genius. If you're interested in music, whether it's baroque or modern, *Music Mentor* can help you attach musical reins to your computer and drive it into the world of musical art. Published by Midisoft, *Music Mentor* is a music learning and entertainment environment that combines graphics and MIDI-generated sound with interactive activities to ease the sometimes daunting task of learning music. This product offers an entertaining introduction to basic music concepts, along with a short look at Western music history.

*Music Mentor* begins with a step-by-step tutorial of music basics: melody, rhythm, harmony, timbre, texture and form. It does so in a way that's simple to grasp, even for someone like me who can play a few licks on a guitar but can't make much sense of music notation. An example of *Music Mentor's* effective elementary approach is

shown by its definition of the musical melody, "...a succession of pitches that is perceived by the mind as a unity." It goes on to explain that a melody, therefore, is more than just a series of pitches one strings together, but that the pitches must create an overall impression in the listener's mind. This kind of talk gets your thoughts going in the right direction and prepares you for the hands-on approach used by *Music Mentor*.

As you progress through music basics, you can hear what's being taught through an MPC-compliant sound card or MIDI keyboard. You can see what's being taught by following visual movement of musical notes on your computer screen in standard musical notation. The software acts like a guiding instructor, laying a foundation on the history and evolution of music and notation, and then moving to the more-complex considerations of scale.

Playing a significant role in the learning process is the documentation supplied with the program. It's well-written and easy to follow. Even when setting up the software, one finds a rare explanation of MIDI mapping and how to set your own sound card to work perfectly with *Music Mentor*. Evidently well-considered in its preparation, the documentation and software can't and doesn't replace dedicated time and thoughtful reason given to the tutorials. Music is the kind of subject that takes intelligent study sessions over a period of time. So it is when learning with *Music Mentor*. If you want the system to work for you, you have to work for it.

After some time, you'll probably want to start making attempts at composition or, at least, do some experimentation. Midisoft has something for this, too. *Recording Session* is the companion to *Music Mentor*. It integrates with *Music Mentor* in the Microsoft *Windows* environment so that you can study and create music without a lot of MIDI software and hardware readjustments. *Recording Session* lets you play and edit all 262 songs in *Music Mentor's* tutorials. Together, *Music Mentor* and *Recording Session* comprise a learning combination that's cost-effective and useful.

### Bible-Study Software

Literature is another form of art. As intense as any other kind for art, it offers a fascinating opportunity to create a world of people and places, all within the confines of the printed page. An example of great literature is the written work that claims to be the inspired word of God, the *Holy Bible*. Logos Research Systems has produced an electronic version of the ancient writings. The product is called *Logos Bible Study Software*. Bible study programs aren't at all new since the advent of the personal computer.

But few of them have migrated to the Microsoft *Windows* platform. Computer users who like to study the *Bible* now have a powerful search-and-retrieve system, fast access to various *Bible* translations, clear marking of Strong's numbers, English definitions to Greek and Hebrew words and more than a half-million cross-references. Besides the potential for more *Bible* versions, other additions include four Greek texts, a Hebrew text and *Nave's Topical Bible*.

Logos takes advantage of Dynamic Data Exchange feature in *Windows*, the ability to transfer information from one document to another without actually opening the other application. DDE works with only *Windows* applications, though. For non-*Windows* word processors, Logos can export its wealth of information to an ASCII file. Then any word processor or generic application can make use of it.

Logos has a flexible search system that accepts plain English-like statements. For example, the entry "Jesus or Christ within 4 Paul" retrieves every reference of Jesus Christ within 4 verses of Paul. The text search system can help you find even vague references to scripture that have faded from memory and makes allowances for spelling

#### Bird's Eye View

*Renaissance Masters* Volumes I and II, \$99.95 each

**Electronic Arts**  
1450 Fashion Island Blvd.  
San Mateo, CA 94404  
Tel.: 800-245-4525

#### Requirements

<b>Memory</b>	2M of RAM, <i>Windows</i> 3.0, CD-ROM Drive
<b>Graphics</b>	<i>Windows</i> SVGA
<b>Sound</b>	<i>Windows</i> MPC
<b>Controllers</b>	Mouse, Keyboard

#### Evaluation

<b>Documentation</b>	Good
<b>Graphics</b>	Good
<b>Learning Curve</b>	Short
<b>Complexity</b>	Easy
<b>Playability</b>	N/A
<b>In Brief:</b> In-depth look at the varied works of the Italian Renaissance Masters. Recommend <i>Windows</i> 3.1, fast 386 or 486 computer, 4M of RAM and sound card for better performance. Make sure CD-ROM drive is MPC-compliant.	

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### Bird's Eye View

*Music Mentor with Recording Session*, \$149.95

**Midisoft Corp.**  
PO Box 1000  
Bellevue, WA 98009  
Tel.: 206-881-7176

### Requirements

**Memory** 2M of RAM,  
*Windows 3.0*  
**Graphics** *Windows VGA*  
**Sound** MPC-Compliant Card

### Evaluation

**Controllers** Mouse, Keyboard  
**Documentation** Excellent  
**Graphics** Good  
**Learning Curve** Medium  
**Complexity** Medium  
**Playability** N/A

**In Brief:** An excellent tool for learning, composing and recording MIDI music. Recommend *Windows 3.1*, fast 386 or 486 computer, 4M of RAM, sound card and MIDI keyboard for better performance.

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### Bird's Eye View

*Logos Bible Study Software*, \$149  
**Logos Research Systems**  
26 W. Rte. 70, Ste. 270  
Marlton, NJ 08053  
Tel.: 609-983-5766

### Requirements

**Memory** 2M of RAM,  
*Windows 3.0*, Hard Drive  
**Graphics** *Windows EGA, VGA*  
**Sound** None  
**Controllers** Mouse, keyboard

### Evaluation

**Documentation** Good  
**Graphics** Good  
**Learning Curve** Medium  
**Complexity** Medium  
**Playability** N/A

**In Brief:** Powerful *Windows Bible* study program with Strong's numbers and original language lexicons. Recommend *Windows 3.1* and fast 386 or 486 computer for better performance.

CIRCLE NO. 155 ON FREE INFORMATION CARD

errors. Too, it can search on Strong's numbers. The ability to see and search Strong's numbers is particularly useful. Strong's numbers greatly facilitate the task of tracing down original words and phrases. You can then use the Greek and Hebrew lexicons to get the original import of a particular biblical rendering. Then, if you need to make notes, you can do so within Logos, attaching your notes to particular references.

Computer Bible students will enjoy the tools provided by Logos. Without a large in-

vestment in time, they can organize personal Bible study and get more done in the same amount of study time. Whether you're a Bible scholar, Christian fundamentalist or curious observer, you can use Logos. In honor of the Holy Scriptures, Hebrews chapter 4 verse 12 says, "For the word of God is quick, and powerful, and sharper than any two-edged sword..." Maybe a joining of computer technology, Microsoft *Windows* and *Logos Bible Study Software* can make studying the word of God a little quicker.



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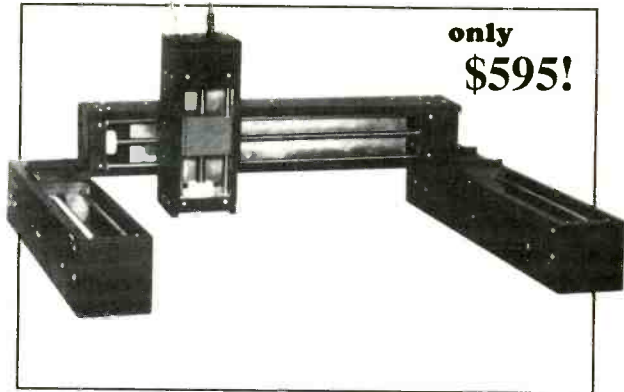
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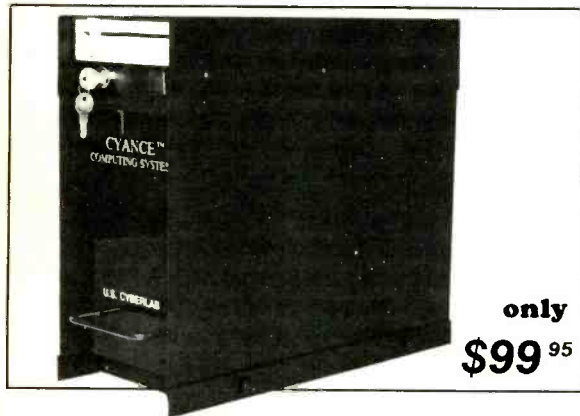
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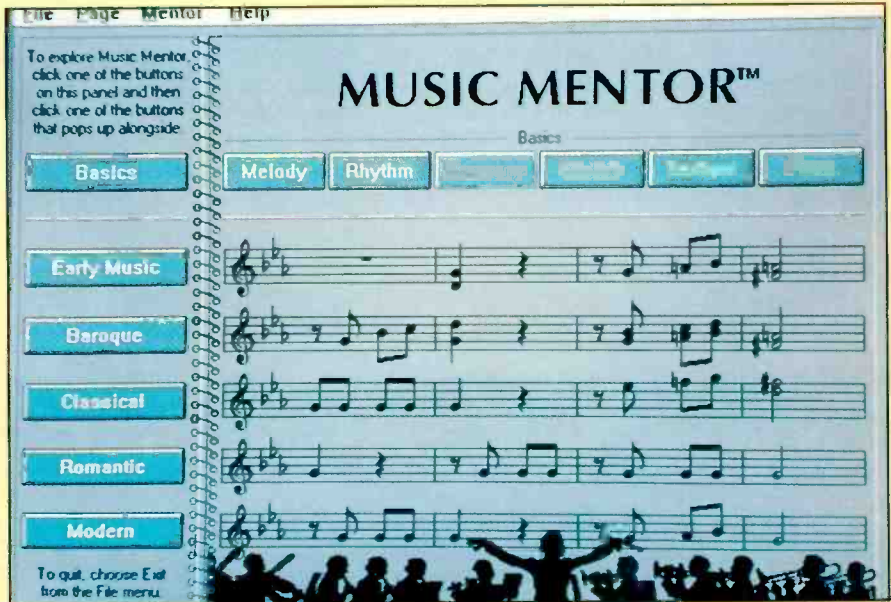
## Arts and Leisure

An undeniable part of civilization is the aspect that addresses human non-materialistic yearnings. Call them spiritual values, if you like. It seems that every civilization, no matter how ancient or remote, has some kind of artistic pursuit. Let's look at three productive intersections of computer technology and the arts.

### Renaissance Masters

The term "Renaissance," adopted from the French equivalent of the Italian word "rinascita," literally meaning "rebirth," describes the radical and comprehensive changes that took place in European culture during the Fifteenth and Sixteenth Centuries, bringing about the demise of the Middle Ages and embodying, for the first time, the values of the modern world. The consciousness of cultural rebirth was itself a characteristic of the Renaissance. Italian scholars and critics of this period proclaimed that their age had progressed beyond the barbarism of the past and had found its inspiration, and its closest parallel, in the civilizations of ancient Greece and Rome.

The "rebirth" of art in Italy was connected with the rediscovery of ancient philosophy, literature and science and the evolution of empirical methods for study in these fields. Increased awareness of classical knowledge created a new resolve to learn by direct observation and study of the natural world. Consequently, secular themes became increasingly more important to artists. With the revived interest in antiquity came



Playing the basics with *Music Mentor*.

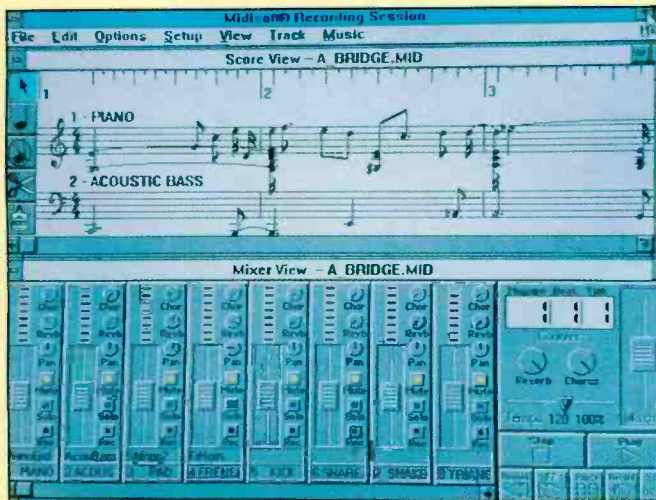
a new repertoire of subjects drawn from Greek and Roman history and mythology.

The models provided by ancient buildings and works of art also inspired the development of new artistic techniques and a desire to recreate the forms and styles of classical art. As the social role of the artist changed, so did attitudes toward art. Art was valued, not merely as a vehicle for religious and social didacticism, but also as a mode of personal expression to be judged on aesthetic

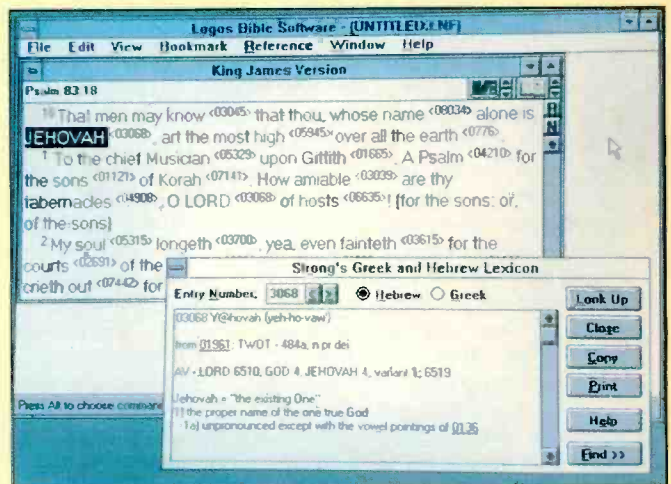
grounds. Although the evolution of Italian Renaissance art was a continuous process, it's traditionally divided into three major phases: Early, High and Late Renaissance.

Ebook, a publisher of CD-ROM software, makes two compact-disc volumes that explain and explore the explosion in art, innovation and individualism that characterized

(Continued on page 84)



Engineering panel of *Recording Session*.



One of the rare mentions of the Divine Name, KJV, from *Logos Bible Study* software.

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## VIDEOS WITH MUSIC

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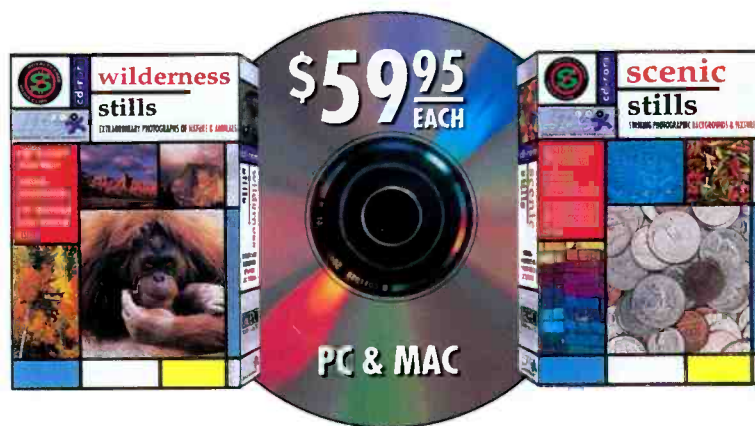
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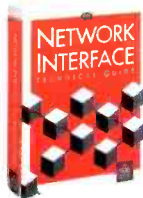
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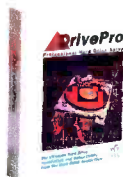
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