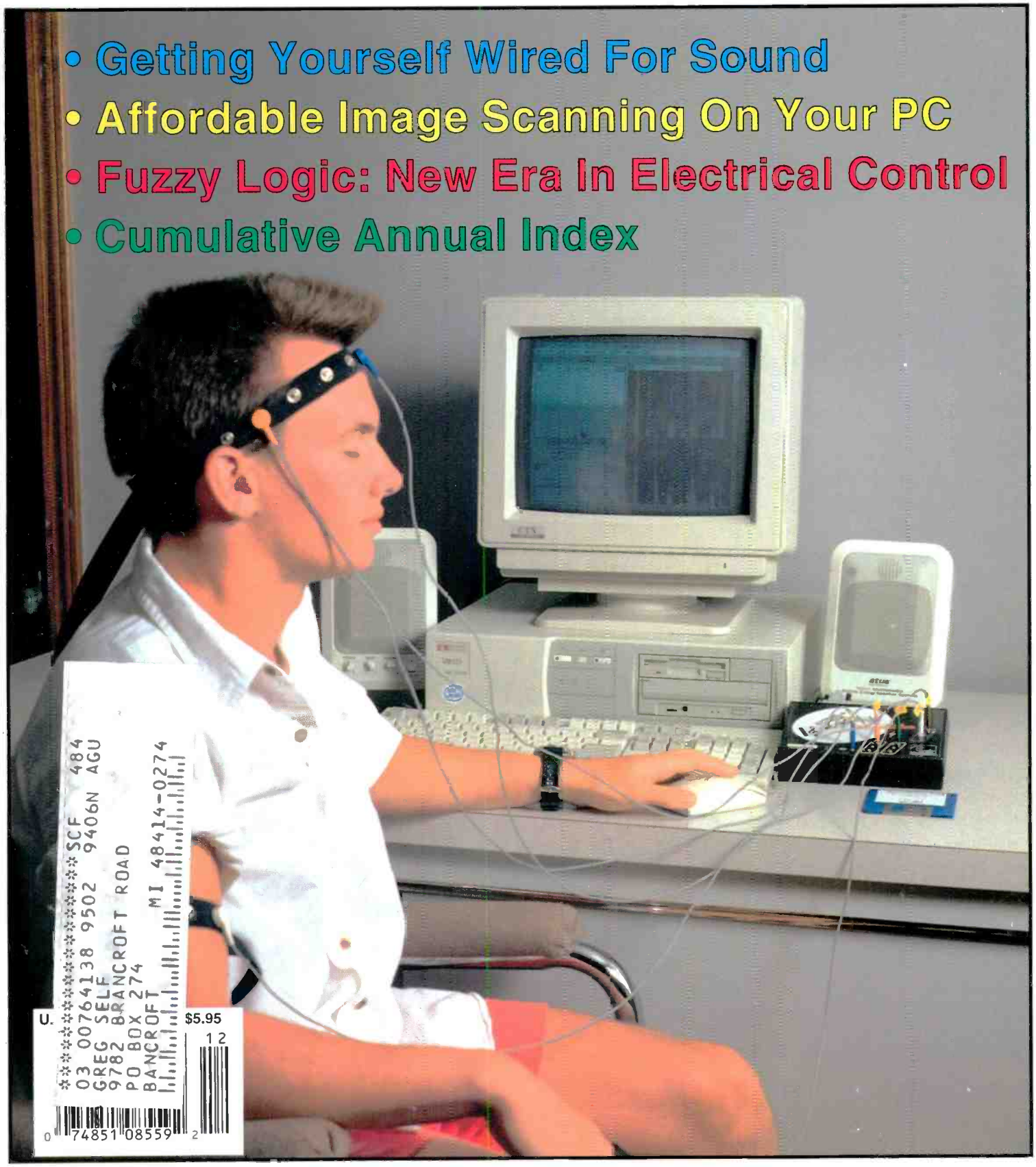
MicroComputer JOURNAL

The print forum for the MicroComputer professional and semi-professional

November/December 1994

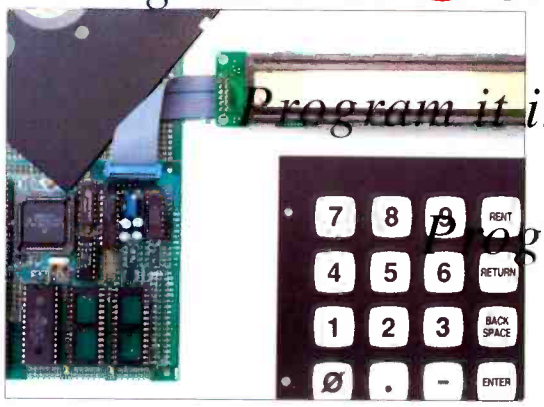
- Getting Yourself Wired For Sound
- Affordable Image Scanning On Your PC
- Fuzzy Logic: New Era In Electrical Control
- Cumulative Annual Index



U. $5.95
12
0 74851 08559 2

68HC11 Controller & Languages

Program it in **C** *or*



Program it in **Basic** *or*

Program it in **FORTH** *or*

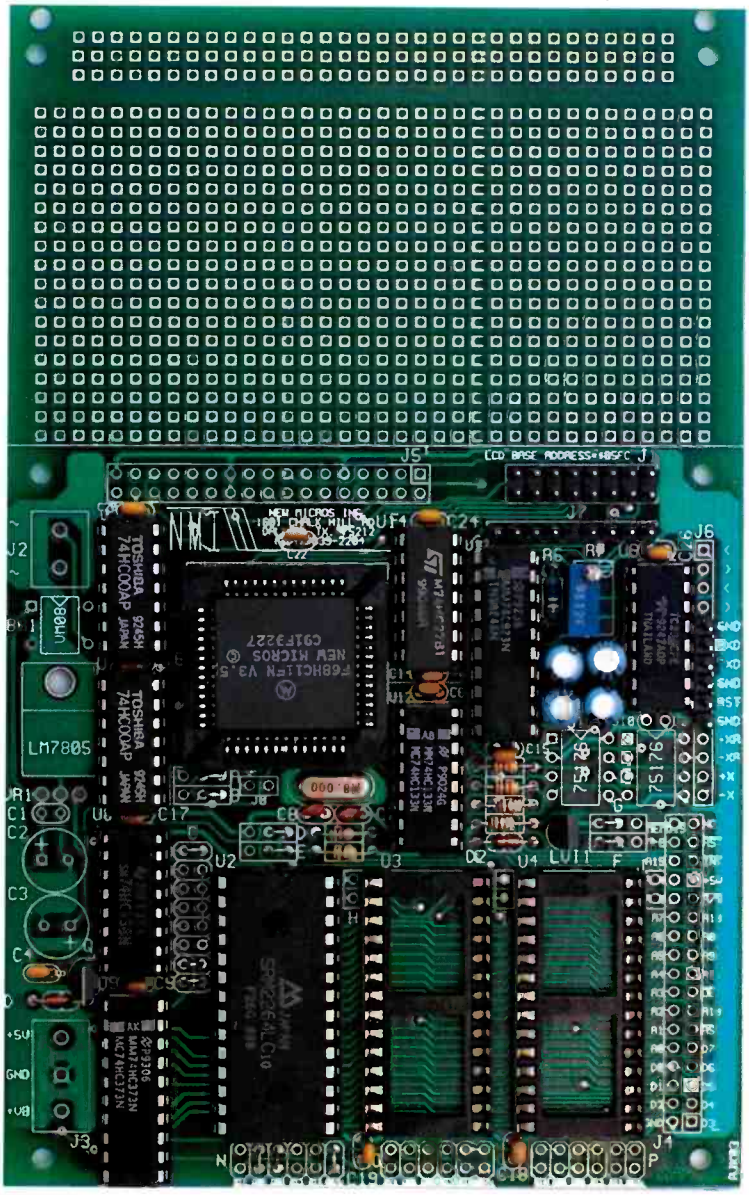
Program it in **Assembly**

$99

Low Cost Development Package: Controller + Languages + Manuals on disk included!

Package Price Breakthrough!

The NMIT-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.

SBC and utility disk - $99. Keypad and LCD not included. Great value. Call today! New Micros, Inc. 214-339-2204

NEW MICROS, INC.
1601 Chalk Hill Road
Dallas, Texas 75212
Tel: (214)-339-2204

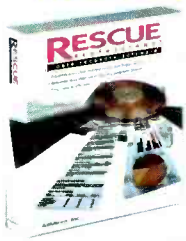
CIRCLE NO. 80 ON FREE INFORMATION CARD

Fix Any PC...FAST!

PC DIAGNOSTICS THAT REALLY FINDS THE BUGS!

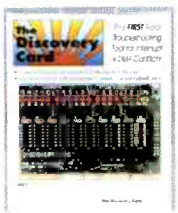
The Troubleshooter™ is the most advanced PC diagnostic software available that really finds the bugs. The Troubleshooter bypasses DOS & tests all major hardware components directly for true accuracy while other programs often give erroneous test results! Loaded with all the tests you'll need to accurately isolate the source of PC failures. Priced far below all competitors. Call now for full list of latest features!

GET DATA BACK FROM CRASHED DRIVES!



RESCUE Data Recovery Software™ is the only program to easily recover lost data from crashed floppies & hard drives even when DOS can't read them! RESCUE recovers data other recovery programs cannot. RESCUE automatically recovers DOS & Windows files including data from compressed drives. Be prepared for any problem. RESCUE is the insurance and security you need to safeguard your valuable data. Call now! Don't wait until your data is lost!

RESOLVE ANY IRQ OR DMA CONFLICT...100%



The Discovery Card™ is the first tool to accurately resolve any IRQ or DMA conflict. 18 L.E.D. lights (11 for all interrupts and 7 for all DMA) immediately report actual usage thus saving time when configuring, upgrading or debugging PC's. Software alone cannot detect DMA usage and is often wrong when reporting IRQ conflicts! Call now, save time and end the frustration!

#1 WINDOWS TROUBLESHOOTING TOOL!

Skylight™ is the #1 rated Windows diagnostic (PC Magazine) that tunes optimizes & troubleshoots Windows for maximum speed and performance. Edits all .INI files safely. Graphically displays how Windows is using memory, system resources, system metrics, G.D.I. heap usage plus much more with hundreds of reports! A must for all Windows users! Call now for full list of features!

FIX OR INSTALL ANY HARD DRIVE...FAST!

DrivePro™ provides fast, precise installation and maintenance for any hard drive. Override BIOS limitations for user-definable drive types. DOS format any size hard drive in under 30 seconds. IDE drives can be installed in less than 60 seconds. Allows the use of IDE drives with MFM/RLL or ESDI drives in the same system. Retrieves the manufacturers' recommended specs from the drive itself, plus much more! Call now for full list of features!

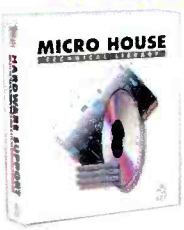
NEW! ISOLATE INTERMITTENT FAILURES!

The Alert Card™ is the only add-on card that monitors and diagnoses power and temperature changes in a PC or File Server. L.E.D. lights and an audible alarm alert you whenever a system's power or temperature goes out of a safe operating range. Ideal for troubleshooting hard to find intermittent failures in any PC. A must for every file server to pinpoint problems before they occur. Call now for complete specs!

BUILD YOUR NEXT NETWORK...FAST!

LANDesigner™ is the first network design software that makes creating and installing a network easy, fast and inexpensive! Exposes protocol violations. Issues warnings where designs lead to spec violations, installation problems or outstrip site power and cooling. Provides reports for bill of materials, installation sequence, installation time estimates, tool requirements, spare parts inventory, site energy, HVAC infrastructure and much more! Call today for full specs!

VITAL HARDWARE SPECS AT YOUR FINGERTIPS!



The Technical Library on CD-Rom™ is compiled from over 50,000 pages of technical hardware manuals! Contains complete configurations, specifications, diagrams, settings, component locations and other vital hardware technical information all at your fingertips on CD-ROM. Includes main boards, network interface cards, hard drives, controller and I/O cards. A must for any service department. Call today for special pricing!

DEBUG ANY DEAD PC...FAST!

Don't throw away expensive motherboards, use PocketPost™ to debug dead Pc's. Feature packed diagnostic add-on card displays B.I.O.S. P.O.S.T. codes and tests 9 critical bus & clock signals. 300+ page manual has all the B.I.O.S. manufacturer codes you need to isolate the source of failures. Includes detachable logic probe for optional component level testing. Call today and start saving money!

"Fix Any PC...FAST!"

CALL TODAY FOR YOUR FREE NEWSLETTER

and learn how to resolve...
- System Failures
- Drive Crashes/Data Loss
- IRQ/DMA Conflicts
- Intermittent Failures
- Overheating
- Power Problems...and more!

Free Technical Support • Next Day Shipping • Performance Guaranteed

(800) 653-4933

MasterCard VISA AMERICAN EXPRESS

International: (813) 539-7283 • Fax: (813) 531-0200

AllMicro,Inc.

18820 U.S. Hwy. 19 N, #215, Clearwater, FL 34624 CC

MicroComputer JOURNAL

Volume 1, No. 6, November/December 1994

page 84

page 90

page 96

Features

17 **Fuzzy Logic—The Next Generation of Control**
By Bud Moss
What it is, how it can change the way you think about computing and inexpensive products to get you started using it.

31 **An Industrial Counting Solution**
By Thomas D. Leitschuh
A modern approach to solving a tricky problem using a PIC microcontroller in a harsh industrial environment.

43 **Image Scanners**
By Steven Sweet
Better resolution, more colors and sophisticated support software, all at tumbling prices, put PC imaging within the reach of even the smallest business and most personal users.

55 **The Mind/MIDI Connection: Getting Yourself Wired for Sound**
By Tom Benford
Waverider Jr. converts your brain/body currents into MIDI data.

61 **Serial Ports Inside and Out**
By Jan Axelson
Inside the computer.

70 ***Windows* Fonts**
By Hardin Brothers
A background on *TrueType* Technology, a primer on type and hints on selecting and managing a font library.

75 **DriveSpace Meets DoubleSpace in Microsoft's New MS-DOS 6.22**
By Joe Peschel
Microsoft issues a new disk-compression utility and a new version of MS-DOS.

104 **Cumulative Annual Index**

Product Reviews

77 ***Micro House Technical Library*: The Ultimate Technical Reference**
By SF Sparrow

Columns

81 **Computing On the Go**
By Joe Desposito
Transmitting to the Perfect PC.

84 **GUI Guts**
By Yacco
Season's Greetings—1994 Holiday Gift Picks

90 **Microcomputer Musings**
By Ted Needleman
Products Worth a Closer Look.

96 **Multimedia**
By Tom Benford
Easy Listening and My Latest CD-ROM Picks

101 **Microcomputer Q&A**
By TJ Byers
Answers to readers questions about all aspects of personal computing.

104 **Industry Watch**
By John Hastings

Departments

4 **Editorial**
By Art Salsberg
Close Enough

6 **What's Happening!**
Latest PC News.

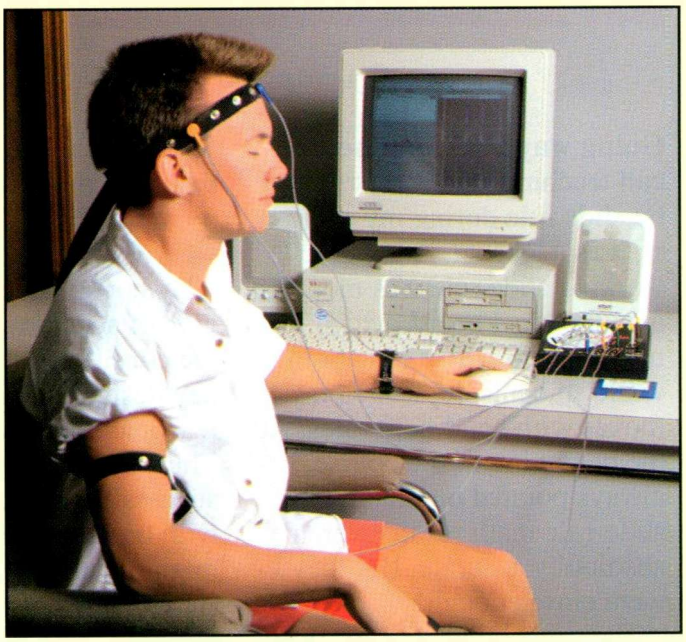
9 **What's New!**
By Joe Desposito
A roundup of new computer products.

80 **Book Reviews**
By Alexander W. Burawa

108 **Advertisers Index**

MicroComputer Journal on MCI Mail

You can contact *MicroComputer Journal* on MCI Mail directly or through an on-line service, such as CompuServe. Any questions, article proposals, comments, etc., are welcome on this electronic mail box (MCI ID No. 456-3433) or just type: ComputerCraft.



Cover Photo By Joe Abbato/The Photography Place

In This Issue

This issue introduces you to two technologies that are helping to define the cutting edge of personal-computer technology. One is using your body as the device for generating music through a unique MIDI interface to your PC. The other is "fuzzy logic," a technology that will almost certainly become the universal approach to controlling all sorts of electrically-operated devices.

In the cover photo, The Model is wired to Wave Assess' Waverider Jr. mind/MIDI interface to generate music through his PC just by thinking, flexing his muscles and pumping blood through his arteries. This unique interface, device which uses the human body as the musical "instrument," can be used for any number of things, from creating out-of-this-world music to helping you relax. Beginning on page 55, Tom tells you all about this unique new device, his experiences with it and more.

If you haven't heard of fuzzy logic yet, you soon will in a big way. It's the next evolutionary step in controlling any electrically-operated device. Taking up where Aristotelian logic in which devices are either on or off it lets any device under its control respond to the gray areas between on and off. Already a thriving technology in Japan, fuzzy logic is beginning to make inroads here. Look for fuzzy-logic control in such things as: model boats, trains and airplanes; burglar alarms; air-conditioning/heating control; ac/dc motor control; robotics; weather prediction; analyzing data for pattern trends; controlling product flow in production; and anything else that can be electrically controlled. You can get in on the ground floor of this relatively new technology right now by turning to Bud Moss' article beginning on page 17, where you'll learn about what it is, what it can do and some inexpensive hardware and software you can use to get you started.

Over the course of the past year, image scanning with a PC has become inexpensive enough for you to think seriously about making it a standard part of your PC setup, even for home use. Beginning on page 43, Steven Sweet tells you all about the new image scanner offerings of all descriptions and the software that comes bundled with them. He gives you everything you need to help you intelligently choose the scanner best suited for your needs and pocketbook.

On page 31, Thomas Leitschuh recounts his experiences in finding an elegant solution to a particularly knotty problem on the industrial front. Here, you'll find a modern approach to solving a tricky problem using a PIC microcontroller in a harsh industrial environment. Then, on page 61, Jan Axelson takes you on a guided tour of the serial port in Part 1 of her new series. Moving on to page 70, you'll learn what you need to know about *Windows* fonts from Hardin Brothers, and on page 75, Joe Peschel compares DOS 6.22's DoubleDisk disk-compression utility with the DoubleSpace utility found in earlier versions of MS-DOS 6.

Close Enough

Going way back in time, I recall teaching electronics math by slide rule during my short stint as a teacher. A gigantic working slide rule was mounted atop the blackboard, which I manipulated with a long pointer while students duplicated my moves with hand-held rules. At the beginning of the course, I always pointed out that many slide-rule math results weren't absolutely accurate. But they were close enough!

The same holds true for fuzzy logic and neural networks. Flawlessness isn't needed. Close enough is acceptable. You might think of this as viewing a motion picture or a television video screen where our tolerance of imperfections allows you to ignore them, even be unaware of them. In other cases, we can even disregard obvious inaccuracies, such as a jagged sine wave on an *el cheapo* LED oscilloscope or displays of digital numbers. They aren't perfectly formed, but they can serve well in many instances while having the advantage of being very economical.

We'll be presenting articles on these subjects from time to time (there's one in this issue) as the technologies move into practical applications. At this moment, fuzzy logic and neural networks are even being combined. National Semiconductor, for example, has a NeuFuz tool that does this. Another company in Germany, Inform, offers a NeuroFuzzy module.

By not striving for the nth degree of accuracy, cost and time are considerably reduced. The key design ingredient is to get reasonable approximations. Thus, fuzzy logic can be used successfully when working with broad ranges. That is, it might be used to control a fan's speed of low, medium, medium-high, very high. It can be used similarly to react to various temperature ranges. Another example where this technology can and is being used is to automatically determine how much water to use for a given amount of laundry in a washing machine—small, medium or large—instead of the consumer guessing which one to choose by selecting a manual switch position.

Fuzzy-logic inventor, Professor Lotfi Zadeh, calls the discipline of tolerating imprecision "soft computing." Interestingly, Japan has done more work in this field than we have. However, more and more American companies are addressing this discipline. So will we in *MicroComputer Journal*.

Art Salsberg

Seasons Greetings

Offices: 76 North Broadway, Hicksville, NY 11801. Telephone: (516) 681-2922. FAX (516) 681-2926. MicroComputer Journal (ISSN 1055-5072) is published bi-monthly by CQ Communications, Inc. Second Class postage paid at Hicksville, NY and additional offices. Subscription prices (payable in U.S. Dollars only): Domestic—seven bi-monthly issues $29.70, fourteen bi-monthly issues $59.40; Canada/ Mexico—seven bi-monthly issues US $32.00, fourteen bi-monthly issues US $64.00; Foreign—seven bi-monthly issues US $34.00, fourteen bi-monthly issues $68.00; Foreign Air Mail—seven bi-monthly issues US $87.00, fourteen bi-monthly issues US $173.00.

U.S. Government Agencies: Subscriptions to MicroComputer Journal are available to agencies of the United States government, including military services, only on a cash with order basis. Request for quotations, bids, contracts, etc. will be refused and will not be returned or processed.

Postmaster: Please send change of address notice to MicroComputer Journal, 76 North Broadway, Hicksville, NY 11801.

eXplore the Opportunities

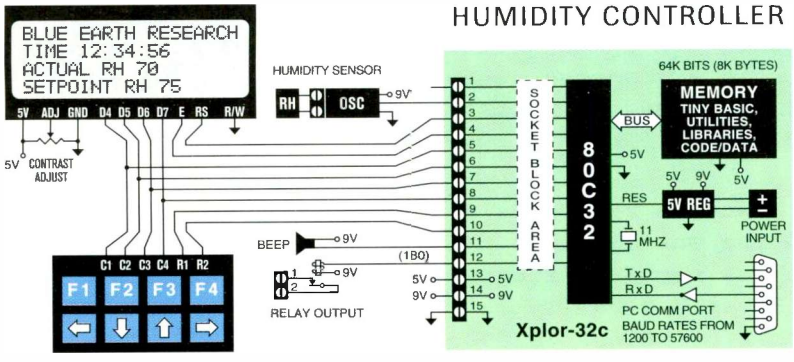
Create Your Own Automated Systems Using Xplor PDCs and Simple BASIC Programs

Xplor Personal **D**igital **C**ontrollers can propel you into the wide open frontier of computerized control and monitoring with minimal effort and cost. No mere novelty, these "mini-sports" pack surprising power and are loaded with extras that make the journey from idea to working reality fun and rewarding.

Professionals will find Xplor PDCs an efficient, economical way to add simple, yet reliable control capabilities to prototypes or full-scale production runs. Beginners and hobbyists can use PDCs to sharpen their programming skills while developing original concepts. Just identify a need and hit the accelerator – Embedded Control, Simple Robotics, PC Peripherals, Monitoring Systems, Data Logging – Xplor PDCs will take you to the far reaches of your imagination.

Built-in BASIC Language, Powerful Utilities, and Library Functions Make Programming Easy

The example below shows how easy it is to wire-up and program the Xplor-32c for a simple on/off controller application. The built-in software gives you the power to write programs like this in just minutes. Your program is stored in nonvolatile memory and will automatically execute when power is applied.

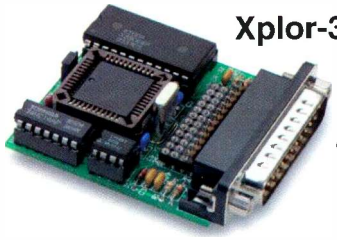


ALL YOU NEED IS A PC and a Terminal Program (Or Xplor Starter Package)

No Other Programming Equipment Required!

```
10  CALL 8132                          (LIBRARY FUNC: Initialize LCD)
20  ONTIME 200                         (Initialize 1 second interrupt)
30  PRINT "BLUE EARTH RESEARCH" ;      (Display sign-on message)

40  PRINT " \\ ACTUAL RH " ; FREQ 0 ;  (Display actual sensor frequency)
50  PRINT " \\\ SETPOINT RH " ; S ;    (Display desired setpoint value)

60  CALL 8140                          (LIBRARY FUNC: Get keypad input)
70  IF DBY 27=6 THEN S=S - 1           (Decrement setpoint if down arrow)
80  IF DBY 27=7 THEN S=S + 1           (Increment setpoint if up arrow)

100 IF FREQ 0<S THEN BIT 180=1         (If actual < setpoint then relay on)
110 IF FREQ 0>S THEN BIT 180=0         (If actual > setpoint then relay off)
120 GOTO 40                            (Loop back to repeat program)

200 PRINT " \TIME " ; DBY 51 ; " : " ; (This 1 second interrupt routine)
210 PRINT DBY 50; " : " ; DBY 49 ; : IRET  ( refreshes LCD with current time. )
```

Xplor PDCs – MORE CHOICES FOR GREATER FLEXIBILITY



Xplor-32 $59.95

Same features as the 32c less case and terminal block. Board is only 2.15" x 2.2".

Xplor-32a $79.95

with 11 channel 10-bit A/D converter.

Xplor-32d $79.95

with 24 extra digital I/O lines.

Complete Packages from $99.95

All Xplor PDCs are available in starter packages that include the Xplor board, screw terminal blocks, RS-232 cable, 9V power supply, users manual, application notes, and MSDOS format disk. The disk includes sample BASIC programs, library source code, BXA-51 and TB-QComm. The BXA-51 assembler can be used for making library changes or other assembly language programming. TB-QComm is a communications utility that allows you to load HEX files and load, edit, or save BASIC programs.

SUPPORT PERIPHERALS

To complete your projects, we offer various peripherals including a customizable 4x4 keypad, dot matrix LCD modules, X-10 power line modules, pressure, temperature, and humidity sensors, screw terminal interface boards, etc.

For more information on Xplor PDCs, or our many other Creative Microcontroller Solutions, call today for our free 28 page catalog.

BLUE EARTH™ RESEARCH

165 West Lind Ct., Mankato, MN 56001
Voice: 507-387-4001 FAX: 507-387-4008
BBS: 507-387-4007

VISA MasterCard

CIRCLE NO. 103 ON FREE INFORMATION CARD

RADIO SHACK'S REPAIR SHOP. Radio Shack launched name-brand electronics repair service in 37 U.S. markets, expecting the program to be available in all markets by year's end. The out-of-warranty service covers personal computers, VCRs, camcorders, stereo systems and answering machines. Most repairs are said to be completed in 15 days or less. A $10 deposit is credited to completed repairs. A detailed estimate costs $20, which is also credited toward the repair. The repair shop has a toll-free number for assistance in determining a general price range for the repair so that you can determine if it's worthwhile fixing. The number is: 1-800-482-6399. Brands handled include ACER, Apple, Compaq, Epson, Hewlett-Packard, IBM, Okidata, Packard Bell, and Zenith, among others.

CLASSROOM COMPUTER ADVANCES. An experimental class in computer graphics being taught simultaneously at Brown University, Cal Tech, Cornell University, University of Utah and University of North Carolina links some 100 students nationwide through real-time interactive computer video-teleconferencing. The video link is part of the National Science Foundation's Science and Technology Center for Computer Graphics and Visualization.... Lehigh University will be helping its students to get WIRED (World-wide Information Resources in Every Dorm). Three residence halls will be outfitted with high-speed networks and direct Internet connections to upgrade dial-up connections now in every residence room. Students will also be able to plug their PCs into a local-area network from their rooms to work with WordPerfect, Quattro Pro, Paradox, Borland C, instructional programs and other software. Laser printers are being installed on each LAN, too. Cost is just $45 per semester on a first-come, first-served basis.... The Alfred P. Sloan Foundation granted more than $400,000 to the Information Technologies Institute of New York University's School of Continuing Education for development of four interactive video telecourses that will be delivered into students' homes.

PHOTO CD NEWS. For a current list of compatible CD-ROM drives, locations that produce Photo CD Portfolio discs and other Photo CD product information, call 800-CD-KODAK; in Canada, 800-GO-KODAK or, for CompuServe users on the Kodak forum, GO: KODAK. For a service to transfer negatives and transparencies to Photo CD discs, call 800-242-2424 extension 36.... Desktop Photograph discs, a collection of stock photography in Photo CD format, bundles Kodak Photo CD Access software from Eastman Kodak. The first four discs of the 50-disc set are now available: Backgrounds, People, Places and Things, and Architecture and Construction. The Photo CD Access software enables users to view all photos in a "contact-sheet" format as well as converting the PCD format into .PCX, .TIFF, .BMP, .EPS, .RIFF or .WMF graphics format. For more information, contact CD Publishing, Inc. (Flower Mound, TX) at 214-724-0023.

BBS YELLOW PAGES. BBS Guide, a comprehensive reference source of computer bulletin-board systems, is available on-line. The Guide offers the user a number of features to search, in addition to name and phone number: category, keywords, networks and technical features. To access, dial 310-477-0408. Type: tbgq at log-in. Here are some BBS Yellow Page statistics: Number of BBSes, 60,000; Internet hosts, 2.2-million; FidoNet BBSes, 22,000; BBS callers, 13-million; Age of callers, 2 to 20 (23%), 30 to 39 (30%), 40 to 49 (25%).

PCMCIA FLASH SOFTWARE. PCMCIA has approved two standards for Flash File Systems: FTL and FFS. Datalight, Arlington, WA, has incorporated both file systems into a single software package, allowing either or both to be used with the credit-card-size cards. The software should be pre-installed so that the Flash memory can be accessed by the operating system. It's invisible to the end user. For more information, call 206-435-8086.

500 miles from nowhere, it'll give you a cold drink or a warm burger...

NASA space flights inspired this portable fridge that outperforms conventional fridges, replaces the ice chest and alternates as a food warmer.

By Charles Anton

Recognize the ice cooler in this picture? Surprisingly enough, there isn't one. What you see instead is a Koolatron, an invention that replaces the traditional ice cooler, and its many limitations, with a technology even more sophisticated than your home fridge. And far better suited to travel.

What's more, the innocent looking box before you is not only a refrigerator, it's also a food warmer.

NASA inspired portable refrigerator. Because of space travel's tough demands, scientists had to find something more dependable and less bulky than traditional refrigeration coils and compressors. Their research led them to discover a miraculous solid state component called the thermo-electric module.

Aside from a small fan, this electronic fridge has no moving parts to wear out or break down. It's not affected by tilting, jarring or vibration (situations that cause home fridges to fail). The governing module, no bigger than a matchbook, actually delivers the cooling power of a 10 pound block of ice.

From satellites to station wagons. Thermo-electric temperature control has now been proven with more than 25 years of use in some of the most rigorous space and laboratory applications. And Koolatron is the first manufacturer to make this technology available to families, fishermen, boaters, campers and hunters– in fact anyone on the move.

Home refrigeration has come a long way since the days of the ice box and the block of ice. But when we travel, we go back to the sloppy ice cooler with its soggy and sometimes spoiled food. No more! Now for the price of a good cooler and one or two seasons of buying ice, (or about five family restaurant meals), all the advantages of home cooling are available for you electronically and conveniently.

Think about your last trip. You just got away nicely on your long-awaited vacation. You're cruising comfortably in your car along a busy interstate with only a few rest stops or restaurants. You guessed it... the kids want to stop for a snack. But your Koolatron is stocked with fruit, sandwiches, cold drinks, fried chicken... fresh and cold. Everybody helps themselves and you have saved valuable vacation time and another expensive restaurant bill.

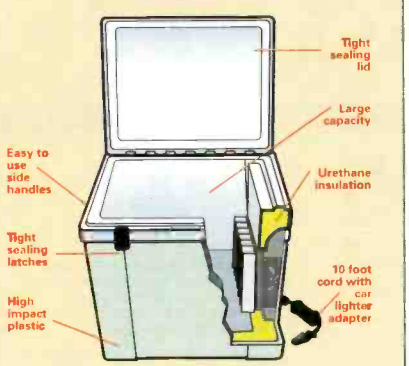
Hot or cold. With the switch of a plug, the Koolatron becomes a food warmer for a casserole, burger or baby's bottle. It can go up to 125 degrees.

And because there are no temperamental compressors or gasses, the Koolatron works perfectly under all circumstances, even upside down. Empty, the large model weighs only 12 pounds and the smaller one weighs just seven. Full, the large model holds up to 40 12-oz. cans and the smaller one holds six.

Just load it up and plug it in. On motor trips, plug your Koolatron into your cigarette lighter; it will use less power than a tail light. If you decide to carry it to a picnic place or a fishing hole, the Koolatron will hold its cooling capacity for 24 hours. If you leave it plugged into your battery with the engine off, it consumes only three amps of power.

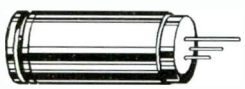
The refrigerator from outer space.

The secret of the Koolatron Cooler/Warmer is a miniature thermo-electric module that effectively replaces bulky piping coils, loud motors and compressors used in conventional refrigeration units. In the cool mode, the Koolatron reduces the outside temperature by 40 degrees F. At the switch of a plug, it becomes a food warmer, going up to 125 degrees.



Celebrating our 12th Year Of Service!!

Collimator Pen



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

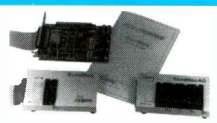
Stock#	1-9	10-24	25+
SB1052	49.99	47.49	42.74

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	21.37

Eprom Programmer



Programs all EPROMS, EEPROMS, including flash memories. Programs microcontrollers with optional adapters. Complete with software, programming module, cable & manual. Single Device programming.

Stock#	1-9	10-24	25+
ROMMAX	159.99	151.99	136.79

Eprom Eraser

Erases up to 9-28 pin or 6-40 pin eproms. Built-in presettable timer with LED interval indicatar.

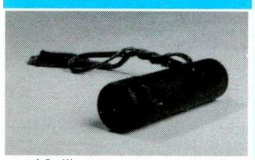
Stock#	1-9	10-24	25+
LA6T	89.99	85.49	76.94

Economy Laser Pointer

- 5 mW output (max.)
- 670nm
- 5.75" long
- 2 AAA batt. (inc.)

Stock#	1-9	10-24	25+
B500	99.99	94.99	85.49

Laser Module



- < 4.5 mW output
- 20 mm dia. x 70 mm long
- 150 meters range

Stock#	1-9	10-24	25+
LM4.5	99.99	94.99	85.49

16 More Reasons To Believe In

unicorn ELECTRONICS

Switching Power Supply

- 115/230 V input
- 41 watt
- 5v @ 3.75 A, 12v @ 1.5 A, -12v @ 0.4 A
- 7" L x 5.25" W x 2.5" H

Stock#	1-9	10-24	25+
PS1003	19.99	18.99	17.09

Electronic Experimenters Kit

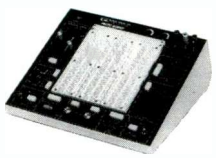
Professor Sparky, world famous inventar, takes you an an entertaining voyage into the world of electronics. No previous knowledge is needed. Choice of 110 (X1000) or 174 (X2000) problem free instructional electronic experiments.

Stock#	1-9	10-24	25+
X1000	43.99	41.79	37.61
X2000	79.99	75.99	68.39

PLUS
•
Low Prices
•
Super Selection
•
Prompt Service
•
Free Shipping
•
Order Toll Free
(800) 824-3432

Protoboard Design Station

Includes expanded instrumentation, breadboard, and power supply. Ideal for analog/digital/microprocessor circuits. Frequency and function generators, voriable outputs, logic indicators, speaker & more.

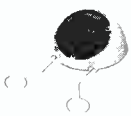


Stock#	1-9	10-24	25+
PB503	299.99	284.99	256.49

Laser Diodes

Stock#	Mfr.	Wavelength	Output	1-9	10-24	25+
LS9200	Toshiba	670nm	3 mW	39.99	37.99	34.19
LS9211	Toshiba	670nm	5 mW	59.99	56.99	51.29
LS9215	Toshiba	670nm	10 mW	109.99	104.49	94.04
LS022	Sharp	780nm	5 mW	13.99	13.29	11.96
SB1053	Phillips	820nm	10 mW	10.99	10.44	9.40

Programmable Robotic Kit



The pen mechanism included with the robot allows it to draw. In addition to drawing straight lines, it con also accurately draw circles, and even draw out words & short phrases ! MV961 comes with 128 x 4 bits RAM and 2K ROM, and is programmed directly via the attached keypad. With its built-in connector port, and the optional interface kit (WIIIBM), MV961 is ready to communicate with your PC ! The interface kit allows editing and transferring of any movement program, as well as saving and loading of programs.

Stock#	1-9	10-24	25+
MV961	79.99	75.99	68.39
WIIIBM	39.99	37.99	34.19

Robotic Arm Kit

Fascinating ond educational, with lift/lower, grab/release, and pivot left/right functions. Uses 2 C batteries (not inc.); approx. 10" long. Use YO1IBM interface to program from your PC!

Stock#	1-9	10-24	25+
YO1	43.99	41.79	37.61
YO1IBM	39.99	37.99	34.19

1/4 Ton IDC Bench Assembly Press

Rotating base plate and platen. No tools required to change plates/cutting accessories. Additional accessories available. Weighs 5.5 lbs. 10" L x 8.75" w x 9" H

Stock#	1-9	10-24	25+
PV505	149.99	142.49	128.24

Computer Care Kit

A complete computer care kit. Contains cleaning diskette, head-cleaning fluid, cleaning swabs, anti-stotic cleaner, anti-static screen wipes. SB1099 for 3.5" drives, SB1100 for 5.25" drives.

Stock#	1-9	10-24	25+
SB1099	3.99	3.79	3.41
SB1100	3.99	3.79	3.41

Vacuum Base Vise

Panavise PV381 is a versatile, portable bench vise. a half turn of the mount lever attaches or releases the powerful suction pad and allows rapid set-ups in a variety of locations on smooth, non-porous surfaces

Stock#	1-9	10-24	25+
PV381	47.99	45.59	41.03

Telephone Kit

Build this high-tech, see-thru plastic telephone. Learn theory on how telephones work. Flashing neon lamps when phone rings. Redial system and wall mount included. Comes complete with manual

Stock#	1-9	10-24	25+
PT223K	15.99	15.19	13.67

Order Line — (800) 824-3432
Fax Orders — (818) 998-7975
• International Orders — (818) 341-8833
• Technical Support — (818) 341-8833
•Min. Order – $15.00 • UPS Blue, Red, & Fed. Ex. Shipping Avail.• CA Res. Add 8-1/4% Sales Tax
• Open Mon-Fri 9:00 AM - 5:00 PM (PST) • Corporate Accounts / Quantity Discounts Available
•Call For FREE Catalog ($2.00 Outside U.S.) • We Carry A Complete Line Of Electronic Components
*FREE Shipping On Pre-Paid Orders Delivered In The Continental United States

unicorn ELECTRONICS

Unicorn Electronics
10000 Canoga Avenue, Unit C-2
Chatsworth, CA 91311

CIRCLE NO. 105 ON FREE INFORMATION CARD

Hardware

PCMCIA Floppy Storage

Accurite Technology's Travel Floppy 144 storage subsystem is a combination floppy-disk drive and PCMCIA controller. The drive is a 3½" high-density 1.44M floppy drive that connects via a slim cable to the controller, called the PassportCard. The controller features data transfer rates up to 1M per second and meets the PCMCIA release 2.10 specification with a Type II physical format. Software drivers are included. $299. *Accurite Technologies, Inc., 231 Charcot Ave., San Jose, CA 95131; tel.: 408-433-1980; fax: 408-433-1716.*

CIRCLE NO. 1 ON FREE CARD

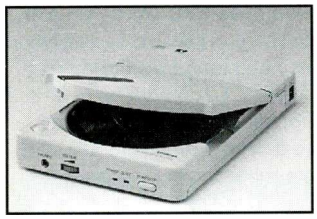
PCMCIA Audio Adapter

Apex Data's Audio Express 16-bit PCMCIA Type II audio adapter card is connected to a small, detachable microphone module, miniature speakers and line-out/headphone jacks. Compatible with DOS, OS/2 and *Windows*, Audio Express provides .WAV file recording and playback, either on its own or through multimedia functions in the operating system. $399. *Apex Data, Inc., 6624 Owens Dr., Pleasanton, CA 94588; tel.: 510-416-5656; fax: 510-416-0909.*

CIRCLE NO. 2 ON FREE CARD

Portable CD-ROM

The XM-4100A double-speed CD-ROM drive from Toshiba features a low-profile clamshell design. The unit offers 320-ms typical average access and a 300K per second data-transfer rate. Weighing less than 1.2 lb., the caddy-less XM-4100A is MPC-2-compliant and supports Kodak multisession Photo CD. Fully integrated audio and a 64K buffer are standard.



To support a range of portable computers, Toshiba offers subsystem kits for connecting the XM-4100A drive to IBM and compatible portable computers. $415. *Toshiba Information Systems, Inc., Disk Products Div., 9740 Irvine Blvd., Irvine, CA 92718; tel.: 714-457-0777.*

CIRCLE NO. 3 ON FREE CARD

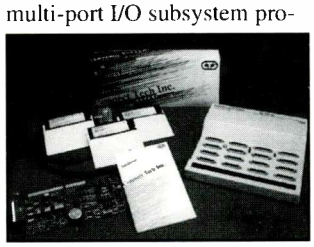
Exercise Machine Game Player

The InterACTION Series of fitness equipment from Computer Athlete enables you to become a participant in various interactive video games while you exercise. The series consists of a dual-action air bike, recumbent cycle and a manual treadmill that folds down for easy storage. Included with each unit is a computer game with five scenarios. Your motions directly correspond with your video counterpart as you compete in a cross-country run, bicycle race, rowing competition, ski race or lunar robot race. *Computer Athlete, 5193 Betonywood Pl., Dublin, OH 43017; tel.: 614-761-1059.*

CIRCLE NO. 4 ON FREE CARD

High-Speed RISC I/O

Connect Tech's Intellicon-NT960 intelligent RISC-based multi-port I/O subsystem provides 16 to 128 asynchronous serial ports from one PC slot. The NT-960 features an on-board Intel i960 32-bit RISC processor and up to 2M of RAM. The package comes with a host adapter, external module and software drivers. $1,895. *Connect Tech, Inc., 727 Speedvale Ave. W., Guelph, Ontario, Canada; tel.: 519-836-1291; fax: 519-836-4878.*



CIRCLE NO. 5 ON FREE CARD

Single-Board Controller With EEPROM

The Suncoast Technologies 70691 HEX 8031/51-based single board computer lets you upload .HEX or .OBJ files from an IBM/compatible computer directly into non-volatile 2864 EEPROM. The product can re-configure the 2864 from data memory into program memory with the flip of a switch. This reconfiguration lets you test the uploaded code on the same hardware without burning and erasing EPROM after EPROM. $59. *Suncoast Technologies, PO Box 5835, Spring Hill, FL 34606; tel.: 904-596- 7599; fax: 904-596-7599.*

CIRCLE NO. 6 ON FREE CARD

PIC16Cxx Emulation Tool

Parallax's ClearView 5x is a complete in-circuit emulator for the PIC 16Cxx series of microcontrollers. Simulator software lets you step through code, set breakpoints and modify registers on your PC.

When the PC is connected to the ClearView 5x module, the software becomes a front end, which enables you to perform realtime execution and debugging. $699. *Parallax, Inc., 3805 atherton Rd., #102, Rocklin, CA 95765; tel.: 916-624-8333; fax: 916-624-8003.*

CIRCLE NO.7 ON FREE CARD

Parallel-Port Printer Network

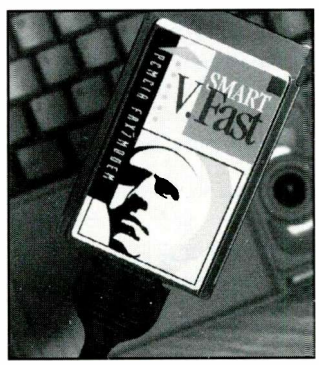
The Excellink EcoNet network modular printer-sharing network provides printer-sharing, file-transfer and spooling capabilities. The network utilizes standard modular telephone cables to create a printer-sharing network with up to 32 nodes, any of which can be computers or printers. EcoNet consists of compact transmitter and receiver modules that connect directly to the parallel port of computers and printers.

A transmitter module is dedicated to each computer, while a receiver module is dedicated to each printer. Modules are daisy-chained together with included telephone cables. A starter kit is available that includes two transmitters, one receiver, two 25-ft. cables, power supply and utility software. $199. *Excellink. Inc., 1430 Tully Rd. #415, San Jose, CA 95122; tel.: 408-295-9000; fax: 408-295-9011.*

CIRCLE NO. 8 ON FREE CARD

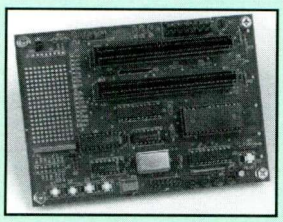
28.8K-bps PCMCIA Fax Modem

Smart Modular Technologies' ST288VFC is a V.FAST-com-



PIC Microcontroller Board

The SXT-55 microcontroller board is based on the PIC-16C5x family of microcontrollers. To expand the unit's I/O, Unified Microsystems designed the SXT-55 to accommodate two PC XT (eight-bit) I/O modules. Additionally, the SXT-55 has user-programmable switches and LEDs, TTL-level input and output lines and interface circuitry for direct connection to industry-standard LCD displays. A prototype area lets you add custom circuitry. Signals are located adjacent to the prototyping area, or they can be brought off-board with ribbon cables.



The SXT-55 can use either the PIC16C55 or PIC16C57 microcontroller. Software routines for driving PC I/O modules and LCD displays are included. $124.95. *Unified Microsystems, PO Box 133, Slinger. WI 53086; tel.: 414-644-9036.*

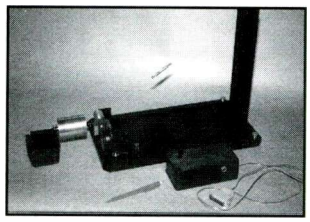
CIRCLE NO. 9 ON FREE CARD

patible PCMCIA fax/modem card that operates at 28.8K bps for data and 14.4K bps for fax. Operating power of the modem is typically 200 mA, which can be reduced to 4 mA through an on-command sleep mode. $499. *Smart Modular Technologies, 45531 Northport Loop W., Bldg. 3B, Fremont, CA 94583; tel.: 510-623-1231; fax: 510-623-1434.*

CIRCLE NO.10 ON FREE CARD

Earthquake Recorder

New from The Amateur Seismologist is the AS-2 Seismic

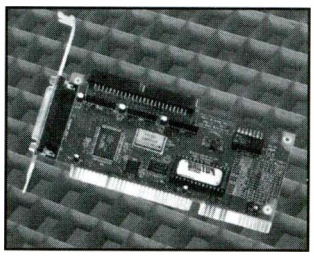


Recording System, an IBM-compatible seismic recording station. The system consists of a seismometer, computer interface and software. Purportedly, earthquakes as far away as Alaska and Japan have been recorded from Los Angeles with the AS-2. $395. *The Amateur Seismologist, 2155 Verdugo Blvd. #528, Montrose, CA 91020; tel.: 818-249-1759.*

CIRCLE NO.11 ON FREE CARD

SCSI Controller

Future Domain's TMC-1610-MCD SCSI CD-ROM kit is a 16-bit controller for CD-ROM drives. The kit contains the TMC-1610M SCSI controller, *PowerSCSI!* software and cable. *PowerSCSI!* software serves as a universal application interface, containing hard-disk support and enhanced CD-ROM drivers that support Kodak Photo-CD.

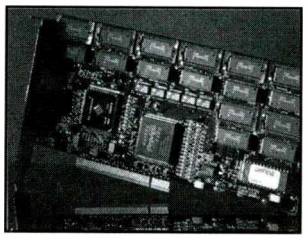


Also included is a Novell CD-ROM NLM for *NetWare* 3.11, 3.12 and 4.0 that allows file servers to use multiple CD-ROM drives. $85. *Future Domain, 2801 McGaw Ave., Irvine, CA 92714; tel.: 714-253-0400; fax: 714- 253-0913.*

CIRCLE NO.12 ON FREE CARD

PCI Graphics Accelerator

Genoa Systems' VideoBlitz II graphics accelerator for the PCI bus is based on the Weitek P9100 GUI accelerator-chip series and a new IBM contemporary palette DAC. Equipped with 2M of VRAM, the card is capable of running at a maximum resolution of 1,600 x 1,200 with up to 64K colors. It also has the ability to deliver True Color at 1,280



x 1,024 resolution. $589. *Genoa Systems, 75 E. Trimble Rd., San Jose, CA 95131; tel.: 408-432-9090; fax: 408-434-0997.*

CIRCLE NO. 13 ON FREE CARD

New Epson Notebooks

The ActionNote 700 line of notebook computers from Epson offers a choice of TFT active-color (700CX), dual-scan passive color (700C) and high-contrast monochrome (700) screens. Each model is equipped with a 486 DX/33 processor, weighs less than 5 lb. and has battery power that lasts up to 5 hours.

An NiMH battery, combined with advanced power-management features, including 3.3-volt technology, "hot swap" capability for switching batteries on the run and an easy-access battery gauge provide, for extended battery life. ActionNote 700 also features an integrated front and center trackball, PCMCIA Type II slot, 3½" 1.44M floppy-disk drive, a 2,400/9,600-baud fax modem built into the motherboard and 4M of on-board memory. Removable hard-disk drives are optionally available in configurations of 120M, 210M and 260M. $2,149/$2,749/$3,549. 700/700C/700CX.

CIRCLE NO. 14 ON FREE CARD

Dual-Interface PCMCIA Ethernet Adapter

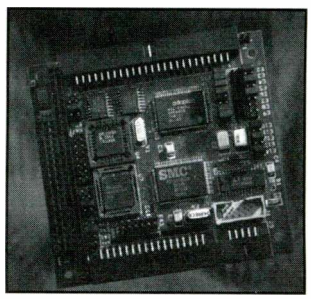
The Kingston Technology EtheRx dual-interface PCMCIA Ethernet adapter features

an interface adapter with both 10Base2/BNC and 10Base-T/RJ-45 connectors. $219. *Kingston Technology Corp., 17600 Newhope St., Fountain Valley, CA 92708; tel.: 800-435-2620.*

CIRCLE NO. 15 ON FREE CARD

SCSI-2 Adapter

Adastra Systems' SCSI-104 SCSI adapter for the PC/104 embedded bus supports fast-SCSI operation and is compatible with the industry-standard Adaptec AHA 1520 SCSI-2 interface. It comes with software support, including on-



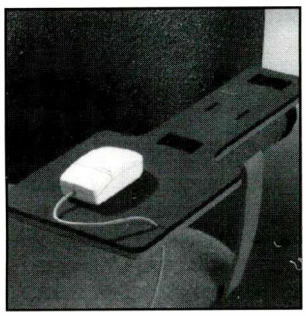
board BIOS, ASPI driver and the Adaptec EZ-SCSI utility. The adapter includes two serial ports and a PC/AT floppy-disk controller. $225. *Adastra Systems, 28310 Industrial Blvd., Ste. K, Hayward, CA 94545; tel.: 510-732-6900; fax: 510-732- 7655.*

CIRCLE NO. 16 ON FREE CARD

Mouse Arm

The Mouse Arm from Ring King Visibles combines the functions of a mouse pad and a task chair arm in a single unit. It positions the mouse in a user-friendly position and supports the user's arm for optimum comfort.

The Mouse Arm straps securely onto the arm of a stan-



dard task chair, using quick-connect buckles. According to the company, once it's in place and the mouse has been connected, the mouse actually seems to work like an extension of the user's arm. *Ring King Visibles, Inc., 2210 Second Ave., PO Box 599, Muscatine, IA 52761; tel.: 319-263-8144; fax: 319-262-0612.*

CIRCLE NO. 17 ON FREE CARD

Low-Cost Ethernet Transceivers

The Lantronix LTX-TA and LTX-2A are low-cost miniature Ethernet transceivers. The LTX-TA, for 10Base-T networks, offers a switch-selectable heartbeat function, automatic polarity correction,

LEDs for Power and Good Link indications and an RJ-45 network interface. The LTX-2A, for 10Base2 networks, also has a switch-selectable heartbeat function, a single LED (for power) and a BNC barrel connector for its media interface. $39. *Lantronix, 15353 Barranca Pkwy., Irvine, CA 92718; tel.: 714-453-3990; fax: 714-453-3995.*

CIRCLE NO. 18 ON FREE CARD

DX4/100-MHz Desktop PC

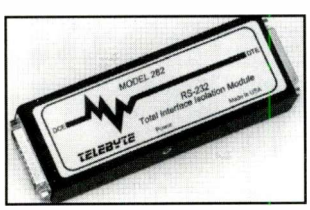
Micro Express' MicroFLEX-PCI/VL/100 100-MHz, 486-

DX4-100-based system offers both PCI and VESA local-bus technologies. The base configuration for the system includes: 16M of RAM, 420M IDE hard disk with 1M VESA caching controller, 256K of RAM cache, FM-570 super-VGA 15" video monitor; PCI video accelerator card with 2M of RAM; 3½" and 5¼" floppy-disk drives, mini-tower case, keyboard, mouse, MS-DOS 6.2 and *Windows* 3.1. The proprietary motherboard uses the Phoenix BIOS and has eight expansion slots, including three 16-bit, two VL and three PCI slots. Up to 128M of RAM is supported on the motherboard. $2,999. *Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705; tel.: 714-852-1400; fax: 714-852-1225.*

CIRCLE NO. 19 ON FREE CARD

Data Communications Opto-Isolator

The Model 282 Async Opto Isolation module from Telebyte Technology is designed to help computer equipment withstand surges, electrical noise and the effects of ground loops, while increasing data reliability. The module provides isolation for the complete asynchronous RS-232 interface. Additionally, the module can drive and receive signals from another device



located up to 1,000 feet away at rates up to 19.2K bps. Maximum data rate is 64K bps. The isolation provided between the pins of the two DB-25 connectors on the module is 1,000 volts. $300. *Telebyte Technology, Inc., 270 E. Pulaski Rd., Greenlawn, NY 11740; tel.: 516-423-3232; fax: 516-385-8080.*

CIRCLE NO. 20 ON FREE CARD

PCMCIA Diagnostics Card

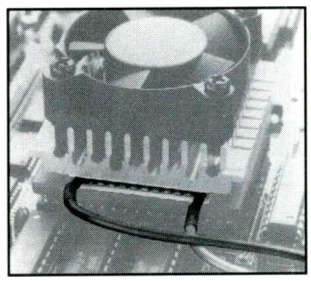
Boca Technology Group's BGM64 PCMCIA Diagnostic Card is a universal PCMCIA-interface diagnostic device that allows wrapping the data and address bus through the PCMCIA interface. Host software permits testing of all 16 bits of data on an emulated 64M address space. Reads and writes throughout this address space are possible with the

card. The host software detects open and short circuits on the data and address bus. Proper functioning of attribute memory can also be tested. The card can also emulate low-battery conditions and test for 5- and 12-volt power-supply compliance. $249. *Boca Technology Group, 21346 St. Andrews Blvd., Suite 219, Boca Raton, FL 33433; tel.: 407-750-1528; fax: 407-750- 8873.*

CIRCLE NO. 21 ON FREE CARD

Turbo Chip Cooler

Turbo Chip Cooler from Discovery Data Systems keeps CPUs almost 60° cooler than typical fan/heat sink chip coolers. The solid-state refrigerator used in Turbo Chip Cooler extracts heat from any chip, including 486, Pentium, and 68xxx. Special provided heat-conductive mounting pads allow it to conveniently



mount with any chip/heat sink combination. A single model fits all processors. $34.95. *Discovery Data Systems, 12572 Westmount Dr., Moorpark, CA 93021; tel.: 805-529-1324; fax: 805-523-8153.*

CIRCLE NO. 22 ON FREE CARD

"Green" 15" Monitor

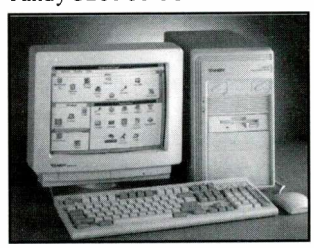
Optiquest's 200Ds 15" flat square monitor conforms with the EPA's Energy Star program and complies with the VESA DPMS energy-saving standard for computer monitors. The 2000DS features 1,024 x 768 noninterlaced resolution, 76-Hz vertical refresh

rate and 0.28-mm dot pitch. The monitor also incorporates the MPR-II low-radiation standards. *Optiquest, Inc., 20490 E. Business Pkwy., Walnut, CA 91789; tel.: 909-468-3750.*

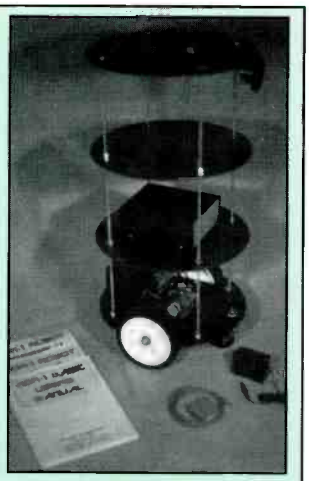
CIRCLE NO. 23 ON FREE CARD

New Tandy PCs

Radio Shack's Tandy 4100 MT 66-MHz 486DX-based mini-tower computer and the Tandy 3200 33-MHz 486SX-



Robot Kit



The ADR-1 Robot Kit from Aclypse Corp. is a complete kit for building a 27"-tall, 16-lb. robot. It features an on-board V25 computer system, voice-recognition capabilities, English speech output, power-motor drive, battery with monitoring and recharging system and remote-computer link. A peripheral interface and V25 expansion bus make it easy to add more sensors, motors and expansion cards.

The V25 computer system controls all of the robot's resources and permits the ADR-1 robot to operate autonomously without outside con- nections. The robot can communicate with other computers and terminals via an included serial cable and adapter. At the ADR operating system control prompt, you can execute BASIC programs, assembled or compiled executable programs and batch files.

The ADR-1 robot can move around in its environment with its cog-and-belt-driven motor drive. Two independent axles permit forward, reverse, left and right center rotation, and right and left turning. The robot has a dual-motor drive that can climb over and through low-level obstacles.

Supplied with speaker-dependent voice recognition, the ADR-1 responds to and executes tasks upon trained verbal commands. You can also record, modify and play back digital messages and sound effects.

Powered by a 12-volt 6-ampere battery, the ADR-1 can operate for up to 40 hours between charges. It can monitor battery condition and report on power level. $499. *Aclypse Corp., Rte. 2 Box 213H, Worthington, IN 47471; tel.: 812-875-2852.*

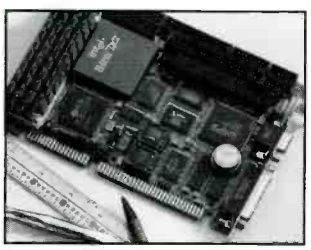
CIRCLE NO.24 ON FREE CARD

based desktop computer systems come standard with VESA local-bus video, low-insertion force sockets for upgrading to Intel OverDrive or Pentium processors, 4M of RAM, a 3½" high-density 1.44M floppy-disk drive, a mouse, a keyboard, MS-DOS 6.21 and *Windows* 3.11.

The 4100 MT has six ISA expansion slots, while the 3200 has three. The 3200 also comes with a 210M hard-disk drive and productivity software. $1,499/$999, 4100 MT/3200. *Radio Shack, 700 One Tandy Center, Fort Worth, TX 76102.*

CIRCLE NO. 25 ON FREE CARD

PC/AT Single-Board Computer

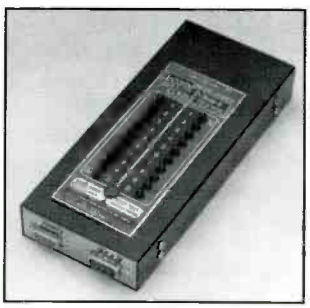


The Teknor Microsystems Viper803 486SX/DX/DX2 is a fully integrated half-size PC/AT industrial-grade single-board computer that features a PC/104 mezzanine bus, Chips & Technologies 65535 video controller, Standard Microsystems Corp. SMC FDC37C665 advanced combo I/O chip and Adaptec 6360 SCSI controller chip. Microprocessor configuration options include Intel 486SX at 25 and 33 MHz, 486DX at 33 MHz and 486DX/2 at 66 MHz. $1,195, 486SX-25. *Teknor Microsystems, Inc., PO Box 455, Sainte-Therese, QC, Canada J7E 4J8; tel.: 514-437-5682; fax: 514-437-8053.*

CIRCLE NO. 26 ON FREE CARD

Cable Tester

L-com's D-Sub 9 Cable Tester provides instant continuity testing and identification of any video or data cable equipped with nine-pin subminiature D-type connectors. Twenty LEDs verify continuity, opens and shorts between conductors and shield ground.



The tester's two operating modes are continuous scan and manual step scan. Male/female connectors on each end serve as gender changers. $179.50. *L-Com, 1755 Osgood St., N. Andover, MA 01845; tel.: 508-682-6936; fax: 508-689-9484.*

CIRCLE NO. 27 ON FREE CARD

Personal Hub

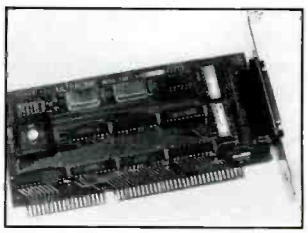
The Magnum Personal Hub from Global Data Supply connects small groups of Ethernet-compatible devices into a single 10Base-T personal network. The hub is available in two models: the five-port H50 and nine-port H90. On each model, the fifth or ninth port is a switchable RJ-45 up-link

port that enables connection to another device or to a corporate network outlet. $295/$395. H50/H90. *Global Data Supply, 1280 Alma CT., San Jose, CA 95112; tel.: 408-993-1881.*

CIRCLE NO. 28 ON FREE CARD

Slot-Less ISA Bus Expander

The Ultralink Model 120 ISA Bus Expander consists of a single PC card and cable that connects a passive ISA backplane to a host PC's parallel printer port. Up to 16 ISA I/O cards can be installed on the passive backplane. Ultralink

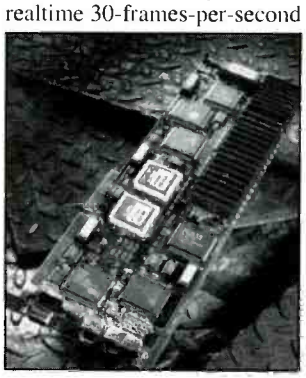


incorporates logic that expands address space and interrupt levels available on the backplane and operates at rates up to 100K per second. $159. *Ultralink, Inc., PO Box 1809, Minden, NV 89423; tel.: 702-782-9758; fax: 702-782-2128.*

CIRCLE NO.29 ON FREE CARD

Multiple Moving Images

Alpha System Lab's Mega-Motion multimedia video card enables you to display four different moving images simultaneously on a desktop PC. It also provides full image-capture capability, with realtime 30-frames-per-second



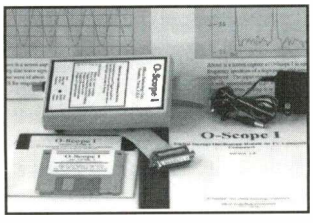
video capture at a resolution of 320 x 240. The card accepts two separate full-motion video inputs, one live and one compressed, and offers a complete array of such professional editing special effects as fades, mixes and wipes. Included on the board is an SVGA adapter, and S-Video connectors for both input and

output, as well as the SVGA connector. Adobe *Premier* is bundled with the product. $1,095. *Alpha Systems Lab, 2361 McGaw Ave., Irvine, CA 92714; tel.: 714- 252-0117; fax: 714-252-0887.*

CIRCLE NO. 30 ON FREE CARD

Digital Storage Scope

Allison Technology's O-Scope I digital storage oscilloscope module connects to PC/compatible computers via the PC's printer port and converts the computer into a digital storage oscilloscope. Trace sweeps can be frozen on-screen, saved to disk for use with other programs and output to a printer via the DOS print-screen function.



Vertical ranges are from 10 volts to 50 mV per division. Sweep ranges of 100 seconds down to 500 µs per division are available from most AT/compatibles. Analog frequency range is dc to 22 kHz for dc-coupled input and 1 Hz to 22 kHz at −3 dB for ac-coupled input.

A 128-point Fourier spectrum-analyzer mode provides frequency-spectrum information from dc to one-half of the current sample rate. There are 50 samples per division in the X1 sweep mode. In addition to the sweep, O-Scope 1 provides voltage, frequency and period calculations. $169.95. *Allison Technology Corp., 8343 Carvel, Houston, TX 77036; tel.: 713-777-0401; fax: 713-777-4746.*

CIRCLE NO. 31 ON FREE CARD

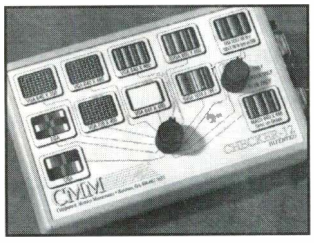
Remote-Control Presentations

Power Control from SoftMagic Corp. is a hand-held remote-control device designed to control computer presentations from up to 30 feet away from a computer. The package includes a 23-button remote-control transmitter, an infrared receiver, a serial cable, nine-pin to 25-pin serial adapter and *Windows*-based software. $195. *SoftMagic Corp., 72 Mallard Way, Waltham, MA 02154; tel.: 617-899-1458; fax: 617-899- 1458.*

CIRCLE NO.32 ON FREE CARD

Monitor Checker

Computer and Monitor Maintenance's Checker 12 hand-held, battery-operated computer color monitor pattern generator supports CGA, EGA, MACII 640 x 480 sync on green, VGA modes 1, 2, 3, 800 x 600, 1,024 x 768 interlaced, 1024 x 768 non-interlaced and 1,024 x 768 noninterlaced with sync on green. Pattern and mode are selected with a single mode switch. A color bar/eight-step grayscale pattern permits color balance and tracking to be quickly evaluated and adjusted. $295. *Computer and Monitor Maintenance, Inc., 6649-N1 Peachtree Industrial Blvd., Norcross, GA 30092; tel.: 404-662-5633; fax: 404-662-5633.*



CIRCLE NO.33 ON FREE CARD

Portable Lettering Machine

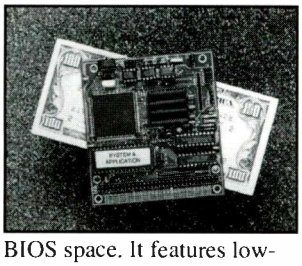
ProPartner portable lettering machine from Varitronica produces labels that measure from 0.5" to 2.25" wide. An application card simplifies design and production of such

common label applications as name tags, file folder labels, and others. Lettering ribbons are available in black, red, blue, green and white. Tape options include clear, semi-clear, white, yellow, orange, red, blue and green. ProPartner works as a stand-alone machine, but it can also be interfaced with PC/compatible computers. *Varitronica, 300 Interchange N., 300 Hwy. 169 S., Minneapolis, MN 55426; tel: 612-542-1500.*

CIRCLE NO. 34 ON FREE CARD

PC XT Board

Vesta Technology's PC86 PC XT on a PC/104 bus board supports the entire PC/XT standard, including keyboard unit, DRAM and extended



BIOS space. It features low-power operation, small size and a processing speed of 8 MHz. $199. *Vesta Technology, 7100 W. 44 Ave., Ste. 101, Wheat Ridge, CO 80033; tel.: 303-422-8088; fax: 303-422- 9800.*

CIRCLE NO.35 ON FREE CARD

Portable Barcoder With Voice Prompts

Worthington Data's TriCoder Portable Reader is a barcode reader that features customizable voice prompting to combat field workers' problems, such as illiteracy, language and dialect barriers, inadequate lighting and delays caused by the need to read prompts. The new models also incorporate all the features available on older models, including simple programming, long battery life, built-in programs, real-time clock, look-up tables and simple computer interface. The new models add a 4 x 20 display, significantly reduced size and the customizable voice prompt. $999 (256K wand model with voice prompt). *Worthington Data Solutions, 3004 Mission St., Ste. 220, Santa Cruz, CA 95060; tel.: 408-458-9938.*

CIRCLE NO. 36 ON FREE CARD

PCI Graphics Adapter

PCI Movie from VideoLogic is a multimedia and *Windows* accelerator. It combines the PowerPlay 32 digital movie accelerator, Weitek's P9100 graphics controller and an on-board connector for the VESA Media Channel. PCI Movie supports full-screen, full-motion playback, 24-bit true color, resolutions up to 1,280 x 1,024 and refresh rates up to 120 Hz. $499. *VideoLogic, Inc., 245 First St., Cambridge, MA 02142; tel.: 617- 494-0530; fax: 617-494-0534.*

CIRCLE NO. 37 ON FREE CARD

PCMCIA LAN Adapters

Thomas-Conrad's new family of credit-card-size PCMCIA LAN adapters are available in three versions: the TC4141 PCMCIA adapter for token-ring networks, the TC5141-T

PCMCIA adapter for 10Base-T Ethernet networks and the TC5141-2 PCMCIA adapter for 10Base2 Ethernet networks. The Ethernet adapters feature diagnostic LEDs that indicate link integrity and data traffic activity. $543/$234/$262. TC4141/TC5141-T/TC5141-2. *Thomas-Conrad Corp., 1908-R Kramer Lane, Austin, TX 78758; tel.: 512-836-1935; fax: 512-835-7346.*

CIRCLE NO. 38 ON FREE CARD

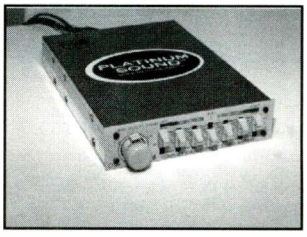
DSP Design Tool

Texas Instruments' TMS-320C5x DSP Starter Kit is a digital signal-processing design tool to give beginning and experienced users an understanding of DSPs. It combines the TMS320C50-based board with an assembler and debugger to provide a development environment for benchmarking and evaluating code in real time. $99. *Texas Instruments Inc., Semiconductor Group, SC-94078, Literature Response Center, PO Box 172228, Denver, CO 80217; tel.: 800-477-8924.*

CIRCLE NO. 39 ON FREE CARD

Computer Equalizer-Amplifier

The Platinum Sound EA-Pro from SC&T International is a 60-watt amplifier and seven-



band equalizer with low-distortion filtering. It installs in a 3½" drive bay and connects to the PC's power supply. It's claimed to work with all CD-ROM drives and all sound cards. *SC&T International, Inc., 3837 E. LaSalle St., Phoenix, AZ 85040; tel.: 602-470-1334; fax: 602-470-1507.*

CIRCLE NO. 40 ON FREE CARD

Software

Presentation Enhancer

Harvard Spotlight for Windows from Software Publishing is designed to enable users to more-effectively organize, rehearse and control the flow and delivery of their existing electronic presentations. It works with leading *Windows*-based presentation graphics packages. $129. *Software Publishing Co., 3165 Kifer Rd., PO Box 54983, Santa Clara, CA 95056; tel.: 408-986-8000.*

CIRCLE NO. 41 ON FREE CARD

Free Time Clock

SanTech Group's *TimeClok* is a program designed as a substitute for mechanical time clocks. It eliminates the need for cards and logs and automates the tabulation process. The program is activated as soon as an employee signs on to his/her computer. The employee can note specifically which client, project or particular task is being worked on and for how long. At the time of this writing, 100,000 programs were to be given away free (shipping and handling is $9.75). *Santech Group, Inc., 8885 Rio San Diego Dr., Ste. 340, San Diego, CA 92108; tel.: 619-298-6848; fax: 619-298-6849.*

CIRCLE NO. 42 ON FREE CARD

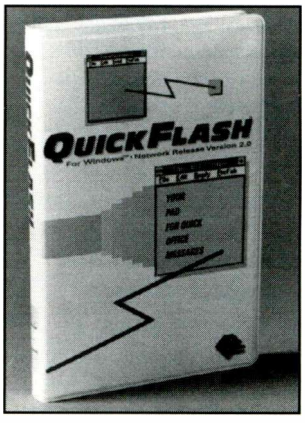
Software Suite

Soft Key's *PFS: WindowsWorks Plus* is a suite of software products that are designed for the small-business and home-office user. It includes a word processor, spreadsheet, database, address book, quick tools and communication tools. $99.95. *SoftKey Int'l., Inc., 201 Broadway, Cambridge, MA 02139; tel.: 617-494-1200; fax: 617-494- 1219.*

CIRCLE NO. 43 ON FREE CARD

Network Messaging System

QuickFlash from The ADM Group is a *Windows*-based network messaging system that permits you to send and receive messages without leaving your application. The



software supports text messages, any size screen capture, graphics drawing and printing. $249/$399. Ten users/25 Users. *The ADM Group, 477 Madison Ave., New York, NY 10022; tel.: 212-750-7400; fax: 212- 750-7419.*

CIRCLE NO. 44 ON FREE CARD

Genealogical Software

Family Ties for Windows from Individual Software is a software program designed to help you organize and create family trees. It uses a notecard-like interface and lets you import and export data into and from GEDCOM format files. The manual includes an extensive reference section with advice on how to begin researching a family tree and other pertinent information. $24.95. *Individual software, Inc., 5870 Stoneridge Dr., #1, Pleasanton, CA 94588; tel.: 510- 734-6767; fax: 510-734-8337.*

CIRCLE NO. 45 ON FREE CARD

All-Purpose Communications Software

MediaPOINT's *ZiPCOMM* 3.1 communications software package combines data, fax and e-mail transmission capabilities. The program introduces an Automatic Protocol Configuration (APC) feature that eliminates protocol setup. It also automatically detects whether an incoming transmission is data or fax and adjusts accordingly. $179. *MediaPOINT, Inc., PO Box 3039, Alhambra, CA 91803; tel.: 818-281-1599; fax: 818-300-0925.*

CIRCLE NO. 46 ON FREE CARD

Windows File Transfer

WinLynx from Rupp Technology is a PC-to-PC file-transfer utility program. *WinLynx* features include *Windows* operation, drive and directory synchronization, resource sharing and background file transfers

through a proprietary 18-wire parallel cable. An included TSR program called *RUPPnet* allows *WinLynx* to give users access to an unlimited number of peripherals connected across local area networks. $169.95. *Rupp Technology Corp., 3228 E. Indian Rd., Phoenix, AZ 85018; tel.: 602-224-9922; fax: 602-224-0898.*

CIRCLE NO. 47 ON FREE CARD

WINProbe Upgrade

Release 3.0 of Landmark Development's *WINProbe*, a diagnostic and optimization software program for *Windows* 3.x, includes new diagnostic tests for CD-ROM, PCMCIA and sound cards. There are now more than 300 optimizing tips, up from 35 in the previous version. The memory defragger and system-resource optimizer are now automated. Street price is less than $50. *Landmark Research, 703 Grand Central St., Clearwater, FL 34616; tel.: 813-443-1331; fax: 813-443-6603.*

CIRCLE NO. 48 ON FREE CARD

askSam Upgrade

askSam Systems' Release 2.0 of *askSam for Windows*, a free-form database that eliminates the need for structured fields, has new hypertext links that let you set up electronic databases of massive or complex information. Other new features include a spell checker, drag-and-drop report writing, bookmarks and searches through multiple databases.

$395. *askSam Systems, PO Box 1428, Perry, FL 32347; tel.: 904-584-6590; fax: 904-584-7481.*

CIRCLE NO.49 ON FREE CARD

Kai's Power Tools Upgrade

HSC Software's *Kai's Power Tools* 2.0 for *Windows* adds new production and image-creation tools to *PhotoStyler*, Adobe *Photoshop*, *Corel Photo-Paint* 5, *Fauve Matisse*, *Fractal Design Painter*, Micrographx *Picture Publisher* and other programs that support the Adobe standard plug-in architecture. Among other improvements are: the new version operates two to 45 times faster than Version 1.0; the human interface is more intuitive; there's now logarithmic acceleration for linear and triangular looping; and there are new filters, such as "Seamless Welder" and "Fade Contrast." $199. *HSC Software, 6303 Carpenteria Ave., Carpenteria, CA 93013-2933; tel.: 805-566-6699; fax: 805-566-6385.*

CIRCLE NO. 50 ON FREE CARD

WIN.INI Help

IniTyme from Computer Tyme is a Microsoft *Windows* .INI file manipulator that allows network administrators to mass update user .INI files. It works by creating a changes file that contains a list of context-sensitive changes you wish to apply to a target file. The target file can be either a specific .INI file or a file containing a list of .INI files. *IniTyme* then applies the desired changes to all indicated files. These files can be located across a WAN for worldwide updating. $95. *Computer Tyme, 411 N. Sherman, Ste. 300, Springfield, MO 65802; tel.: 417-866-1222; fax: 417-866-0135.*

CIRCLE NO. 75 ON FREE CARD

New DOS Menu Version

Auratek's *Access-EZ* Version 3.1 is a small (35K) DOS menuing system that allows creation of a multi-level menu structure to execute and enhance all DOS software and commands. It delivers full-screen editing and integrated move and delete functions. Macros pass keystrokes directly to any launched application. *Access-EZ* can schedule any menu item to execute at a given date and time, allowing reports and backups to execute during non-business hours, for instance. Password security is available on individual menu items, and nested submenus include several levels of global security and restricted DOS access. $50. *Auratek Int'l., 1630 N Main St., Ste. 325, Walnut Creek, CA 94596; tel.: 510-937-2929; fax: 510-937-2928.*

CIRCLE NO.83 ON FREE CARD

DOS Graphics Editor

EAGLE, from CadSoft Computers, is a powerful DOS-based graphics editor for designing printed-circuit boards on standard AT-compatible computers. This object-oriented program can layout boards up to 64" X 64" square with 1-mil resolution. Up to 255 layers are possible, and *EAGLE* supports surface-mount devices. Additional schematic-capture and autorouter modules are available. Since both fully integrate into *EAGLE*, you have to work with only a single program. The rip-up-and-retry router lets you route up to 16 layers at a time, not only in pairs. CadSoft also offers a conversion program for *OrCAD*, Tango, PADS, Schema and SUSIE netlists at no charge. $399. *CadSoft Computer, Inc., 801 S. Federal Hwy., Delray Beach, FL 33483; tel.: 407-274-8355; fax: 407-274-8218.*

CIRCLE NO. 109 ON FREE CARD

Software Upgrade

LabelWriter II from CoStar is a combination package, the hardware of which plugs into a serial port. Its background program stands ready to immediately produce labels in any quantity. Not only does it print address labels, but can also print postnet postal barcodes to speed mail and save postage costs on bulk mailings. It allows you to print labels without quitting the main program. New features include a WYSIWYG display, scalable fonts, mixed fonts, stored templates, enhanced barcode support, international character set support and PO Delivery Point Barcode support.

The *Windows* version includes the foregoing features, as well as support for ATM and *TrueType* and four inventory barcode fonts (UPC, 2 of 5, Code 39 and EAN 8 and 13 Postnet). Several printer models available. From $300. *CoStar Corp., 100 Field Point Rd., Greenwich, CT 06830; tel.: 203-661-9700; fax: 203-661-1540.*

CIRCLE NO. 118 ON FREE CARD

Schematic Capture for *Windows*

Interactive CAD's *ProCAD Advanced for Windows* Version 2.0 provides the link between schematic capture and PCB layout in a seamless real-time manner using *Windows* Multiple Document Interface (MDI). Real Time Total Integration (RTTI) is extensively used for performing such dynamic features as forward and backward annotation of reference designators across all project files, pin and gate swapping and cross-probing between schematic and PCB data files. $320 to $2,795. *Interactive CAD Systems, PO Box 4182, Santa Clara, CA 95056; tel.: 408-970-0852; fax: 408-986- 0524.*

CIRCLE NO. 154 ON FREE CARD

Video-Monitor Enhancer

DisplayMate for Windows from Sonera Technologies is software that improves video monitor picture quality, making *Windows* and all the software that runs on the computer in which it's installed look its best. The program improves sharpness and contrast, reduces certain forms of geometric distortion, minimizes or eliminates Moiré patterns and improves color and grayscale accuracy. All color modes are supported, from monochrome up through full 24-bit color.

An extensive set of test patterns is provided for evaluating and exploring color quality, balance, range and accuracy. For users who are interested in color matching, a special test pattern is provided for adjusting and matching both reflective and transmissive color samples, using a number of color models. $129. *Sonera Technologies, PO Box 565, Rumson, NJ 07760; tel.: 908-747-6886.*

CIRCLE NO. 157 ON FREE CARD

VisualBASIC to *Visual C++*

STORC Gold 2.0 from PractiSys converts *VisualBASIC* forms to *Visual C++*. With this program, developers can directly import *VisualBASIC* .FRM files into C++ projects, reusing both form design and VBX controls. $45.93. *PractiSys, 4767 Via Bensa, Agoura, CA 91301; tel.: 818-706-8877.*

CIRCLE NO.108 ON FREE CARD

File Synchronizer

MBS Technologies' *FileRunner for Windows* automates and safeguards file transfer and synchronization. It creates an "invisible network" between all of your desktop and notebook PCs. *FileRunner*'s Tru-Sync feature synchronizes any number of PCs by automatically transferring updated and new files. Data is protected with an Overwrite Safeguard feature that warns if the same file is changed on more than one computer and never permits older files to destroy current versions. A built-in data-compression option provides efficient data compression during file transfers. $99.95. *MBS Technologies, Inc., 4017 Washington Rd. #4000, McMurray, PA 15317; tel.: 800-860-8700; fax: 412-941-7076.*

CIRCLE NO. 104 ON FREE CARD

By Bud Moss

Fuzzy Logic—The Next Generation of Control

What it is, how it can change the way you think about computing and inexpensive hardware and software that can get you started using it

If you have better things to do than spending hours using mathematics to specify a control system and then days to debug and implement it, I offer a better alternative in the form of "fuzzy logic." Fuzzy logic frees you from spending days implementing a control system only to find that you've overlooked some minor (or maybe not-so-minor) aspect that requires a major overhaul of the software. It enables you to focus on the solution by releasing you from the drudgery of the solution's implementation.

In this article, I'll introduce you to the concept of fuzzy logic and present some inexpensive and simple hardware and software examples that will help get you started in using this radical new technology. But first some background is in order.

Brief Background

In 1965, Lotfi Zadeh, a Professor of Computer Science at Berkeley, developed a theory that real-world control problems could be represented at a much higher level of abstraction. Rather than using the traditional method of mathematically modeling a system, he found many problems could be solved using an approach similar to the way we humans think. Instead of specifying real-world problems in absolute terms like true and false, they're defined as varying degrees of each.

There are a couple of possible reasons why it took almost 30 years for the technical community to see the value of fuzzy logic. One is that the word "fuzzy" in our language means blurred or indistinct and, thus, psychologically turned the community away from such thinking. The other is that there's no way to analytically prove that the system operates correctly because fuzzy logic isn't based on the traditional approach of a mathematical model.

The Japanese had no such problems. The word "fuzzy" wasn't translated. Instead, it was accepted phonetically. Without the negative connotations normally associated with the name in the Western world, the Japanese progressed to the next step—experimentation. They quickly proved that the absolutes of a mathematical model weren't required.

Many products currently use fuzzy logic, most of which have been developed in Japan. More recently, the United States and other Western countries have been rapidly introducing fuzzy-logic-based products. In addition, many IC manufacturers are developing and marketing microcontrollers and coprocessors that have been optimized to perform in a fuzzy-logic environment. This trend will continue as more designers find new applications for this type of control.

What It Can Do

Fuzzy logic releases you from writing the core software for a control system. After you've designed the hardware and interfaced it to a microcontroller or computer, the software is developed using a method that closely mimics the way the human brain thinks.

Most of us remember the doohickey (now there's a very "fuzzy" word) we had when we were younger that had us insert blocks of various sizes and shapes into the correct holes. How did we do it? We certainly didn't sit down with a micrometer and protractor and specify all the characteristics of each and every block. Instead, we general-

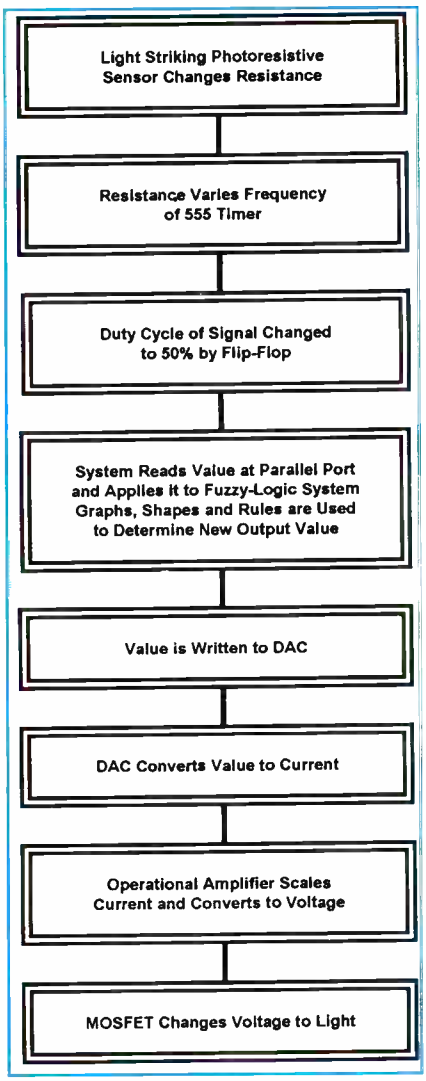


Fig. 1. System outline indicates order of operations performed in fuzzy-logic system.

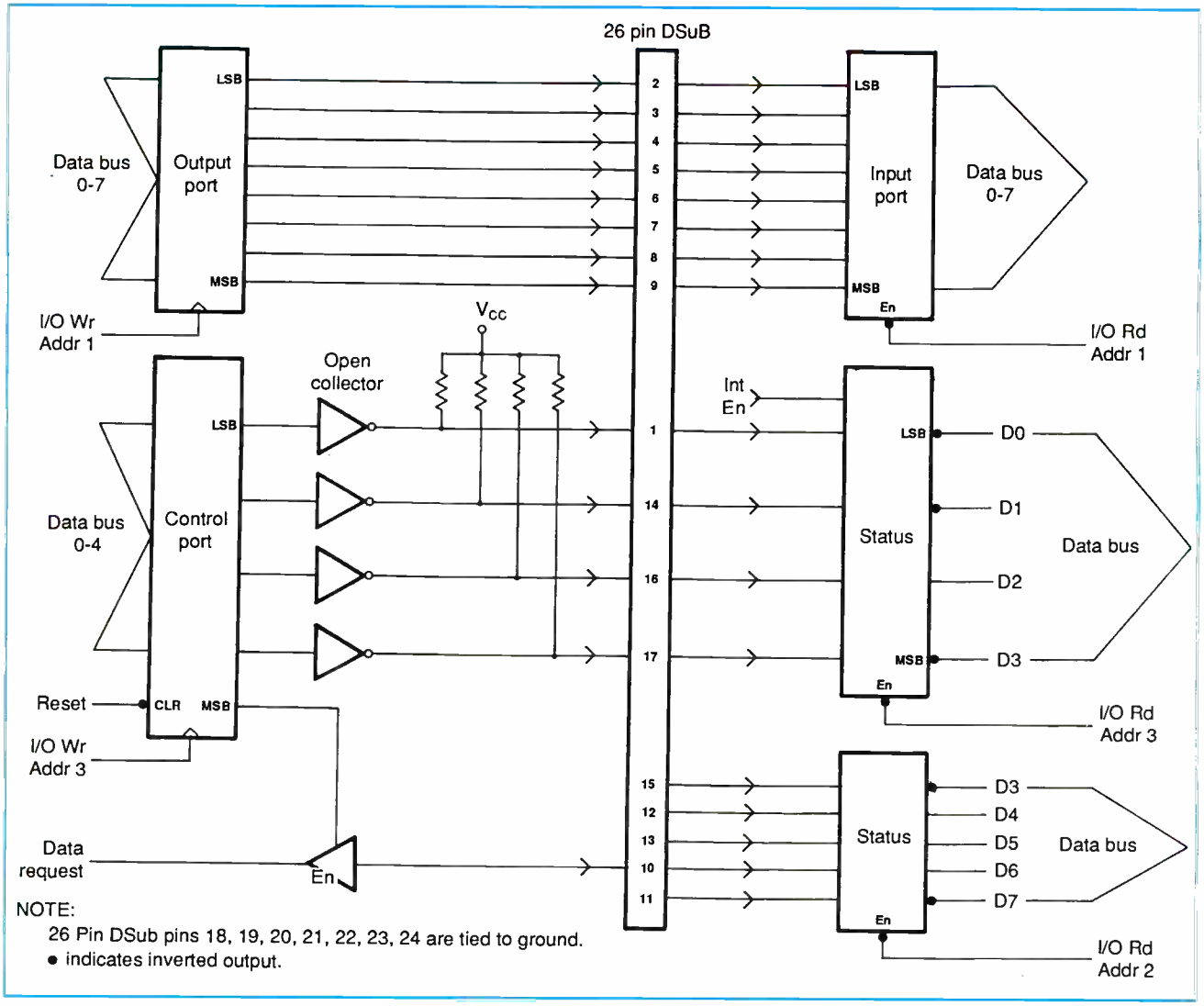


Fig. 2. Block diagram of fuzzy-logic interface circuitry

ized, basing our decisions on approximations. If the hole was small we knew to eliminate large blocks. If it was round, we discarded all that weren't round. This process of elimination continued until we determined which block was the best choice relative to all others. This is what fuzzy logic does. It lets us be imprecise, yet still arrive at the correct answer. By setting up classifications (for example, round, square, small, etc.) and specifying the rules (if the hole is small, eliminate the large blocks, and if the hole is round, don't use square blocks), the correct block can be found even if its shape was previously unknown.

I'll begin this discussion with the simplest control problem, one input and one output. An outline of the entire system is given in Fig. 1. I'll show you how the intensity of a lamp can be made to change as the light in the room varies. I'll begin with the hardware that the fuzzy system will control.

How It Works

The hardware for your fuzzy-logic setup consists of an inexpensive way to convert a non-digital value to a digital, feed it into a PC, process the data and then convert it back to a value you can use. Instead of using a plug-in card, which requires a valuable slot on your PC's motherboard, it's all done via one parallel port. All components were selected because they're inexpensive and readily available. The intent wasn't to design elegant hardware but to provide a basic circuit that demonstrates the ease of implementing a fuzzy-logic system.

• **Parallel Printer Interface.** A block diagram of the printer port's hardware is shown in Fig. 2. (See the May/June issue of *MicroComputer Journal* for a complete explanation of the parallel port's hardware.). Table 1 lists the addresses for each of the three ports.

Each parallel port consists of status, control, input and output sections. The output port transfers data to the printer. The input port could be used to test the output latch or verify that the port is present. The control port consists of four open-collector bits and a bit that enables/disables the interrupt to the processor. The status port is essentially a nine-bit input port that uses two buffers. Four of the bits are inverted just after entering the PC.

For our purpose, we use only two sections. The frequency of a signal on

pin 11 of the status port (D7) will be the input and is used to determine the amount of light striking a photoresistive sensor. The output port transfers data to a digital-to-analog converter (DAC). The other two sections, control and input, aren't needed but could be used to expand the system.

• **Light-to-Frequency Converter.** The 555 timer in the Fig. 3 circuit performs the conversion from light to frequency. The resistance of photosensor *R7* is inversely proportional to the intensity of the light striking it. As the light increases in brightness, the output frequency of 555 timer *U1* also increases. Unfortunately, the sensor's resistance not only affects the frequency of the output, but it also varies it's duty cycle. The PC loses track of the signal when it can no longer read at least one high and one low per cycle. For maximum range, edge-triggered flip-flop *U2* reduces the original frequency by half and achieves a 50% duty cycle.

The maximum frequency the PC can track depends on such factors as speed/type of PC, software used to read the port and whatever other software/hardware is in the system. The simplest way to find the upper limit is by experiment. After setting up the interface, inject a square wave from a function generator. Using the software provided in Listing 1, the limit is reached when the input and output fail to match.

• **Digital-to-Analog Converter.** After reading the port and applying the value to the fuzzy system, the circuitry in Fig. 4 converts the digital output to a value that's used to drive a light source.

Digital-to-analog converter *U3* has complementary current outputs that can be easily interfaced to several logic families. The equivalent circuit is shown in the pinout drawing in Fig. 4.

Referring to the pinout diagram, pins 5 through 12 are the digital inputs that control how much current leaves each of the DAC's outputs. Their threshold is set by the voltage on pin 1. Internally, this pin is tied to the positive supply via a constant-current source in series with two diodes. By grounding pin 1, the switch point is set to 1.4 volts, which is ideal for TTL. To interface to another logic family, change the voltage on pin 1 to the threshold required.

The current through pin 14 sets the total current that flows through the output pins. It can be fixed, as in this application, or varied over a range of 40:1. This is what gives the DAC its multiplying ability. The current at the outputs can be changed by either changing the digital input or by adding/subtracting current to/from this pin. To illustrate, the reference in Fig. 4 is 15 volts, fed to pin 14 through *R1*. This generates 1 mA (15 volts/15,000 ohms) of constant current at output pins 2 and 4. Now add a 1,000-ohm resistor to pin 14 and inject a 1-volt peak-to-peak sine wave. The current at the outputs now becomes the combination of the 1-mA fixed reference plus the additional 1-mA ac. In other words, without changing the digital data, the current varies from the minimum of 0 (reference –1 mA) to a maximum of 2 (reference +1 mA).

A resistor on pin 15 is used to cancel the error introduced by operational amplifier *U4*'s bias current. Since this precision isn't required, it was left out. If needed, the resistor's value should be close to the impedance seen by pin 14.

Capacitor *C7* from pin 16 of *U3* to the negative supply compensates the amplifier in ac-reference (multiplying) applications. When using a fixed reference, its value isn't critical, but this capacitor must be present. The value is related to the impedance seen by pin 14 of *U3*. The ratio of the capacitor's value in picofarads (pF) to the resistance in kilohms should be close to 15. If the circuit shown were to be used in an ac application, C_{comp} = 15 X R14, C = 15 X 15, C = 225 pf. For optimum performance, the value of *R14* should be as low as possible, enabling small values for C_{comp}.

The outputs at pins 2 and 4 of *U3* share the current flowing through pin 14. They're a complement of each other, such that whatever current isn't flowing through one is flowing through the other. To see how it works, I'll use pin 4.

The current through pin 4, called the true output, is minimum with an input of 0 and maximum at FFh. The amount the current changes per digital bit is determined by the equation $I_{Ref}/256$. In the circuit shown, an input

Table 1: Parallel Port Addresses

Addr Designator	Port 1	Port 2	Port 3
1	3BC	378	278
2	3BD	379	279
3	3BE	37A	27A

Note: All addresses in hex.

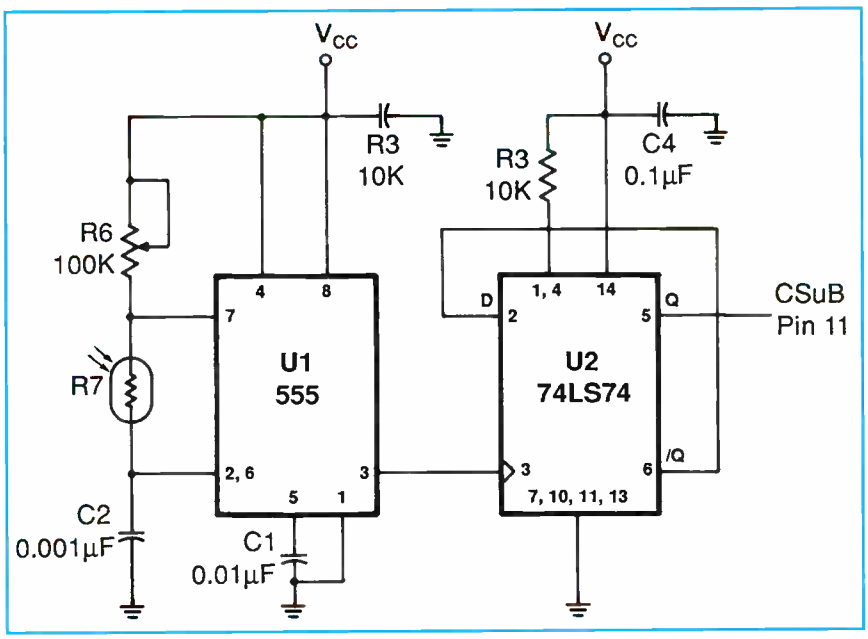


Fig. 3. Input circuitry for fuzzy-logic interface.

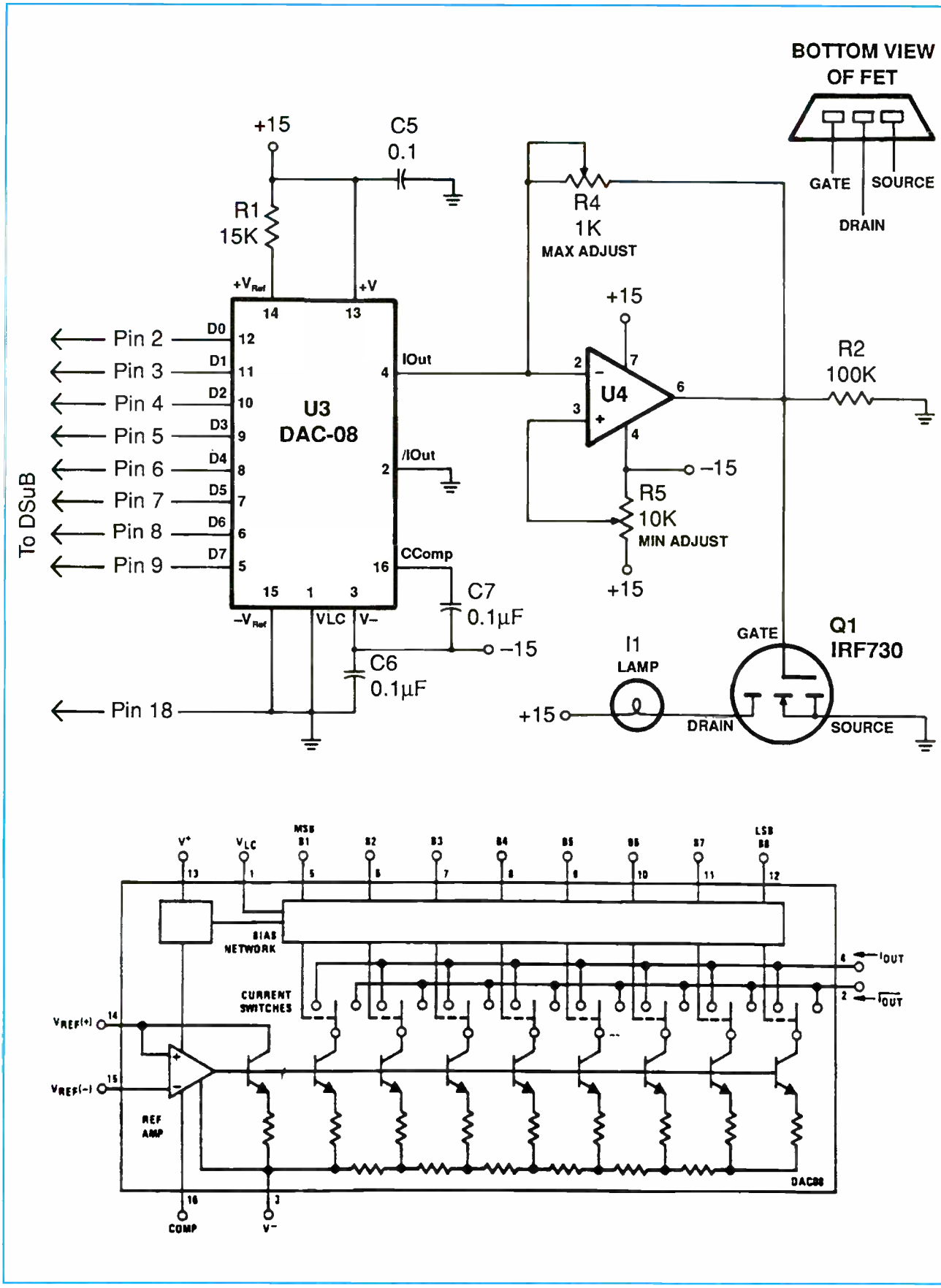


Fig. 4. Output circuitry for fuzzy-logic interface and pinout diagram for National Semiconductor DAC-08 digital-to-analog converter chip.

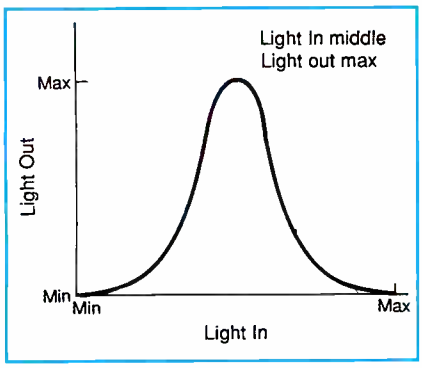


Fig. 5. An ideal output wave shape.

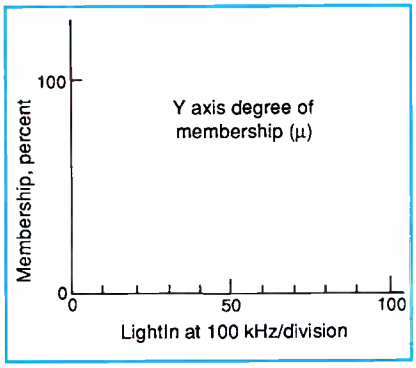


Fig. 6. Input graph for plotting degree of membership versus LightIn at 10 kHz/ division.

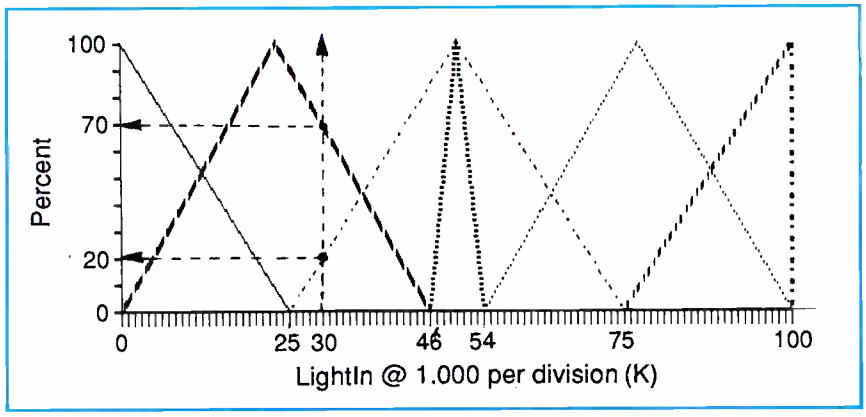


Fig. 7. LightIn wave shape.

of 0 produces 0 output current. An input of 1 generates 1 mA/256 = 3.90625 μA. You can use the current/bit to determine the output for any input. For example, 55h generates 85 X 3.90625 = 0.215 mA, FFh = 0.996 mA. Keep in mind that these are calculated values and are influenced by other factors (this is what potentiometers are made for).

Pin 2 is an inverted version of pin 4. Current is maximum with an input of 0 (all current flowing through pin 4) and minimum at FFh. Instead of adding, each bit subtracts from the output current.

• **Current-to-Voltage Conversion.** Operational amplifier *U4* converts the current from *U3* into a voltage. The purpose of this FET driver is twofold. It generates the voltage that drives the gate of the power MOSFET *Q1*. And, to keep the MOSFET in it's linear region, it permits scaling of the minimum and maximum voltages.

Recall that with an input of 0, essentially no current flows through pin 4 of *U3*. This appears to *U4* to be an infinite resistance. With no current through *R4*, *U4* becomes a voltage-follower. Thus, the voltage on pin 3, determined by the setting of *R5*, controls the minimum output. Changing the input to FFh, the 0.996-mA of reference current is pumped out of pin 4 through *R4*. The voltage generated (I X R4) adds to the voltage previously set by *R5*. The value of *R4* sets the maximum/minimum voltage range of the output. If you need greater range, simply increase the value of *R4*.

• **Voltage-to-Light Conversion.** IRF730 *Q1* is an n-channel enhancement-mode power MOSFET. Maximum safe potential from drain to source of *Q1* is 400 volts, and the MOSFET can supply up to 3.5 amperes of current. With an adequate heat sink, it can dissipate up to 75 watts of power. The major difference between these and smaller FETs is that power MOSFETs let you handle much greater power.

The MOSFET controls the power supplied to dc lamp *I1*. Although the large FET isn't needed in this particular application, with the addition of an appropriate heat sink, the circuitry could be used to drive dc motors, sirens and other high-current-drain devices. The size of the heat sink depends on the amount of power the MOSFET dissipates. In general, if you can't comfortably hold your finger on it, you need a power MOSFET that can handle greater current.

Construction

To obviate any problems that might possibly arise from use of a cable, the board-to-port interface doesn't use one. Instead, solder the DSUB connector directly to the prototype board. Place the connector as close to the edge of the board as possible and install *U2* and *U3* next to the connector.

Other than the foregoing there's nothing critical regarding construction of this project. Just be sure to keep the passive components reasonably close to their active parts and locate the power MOSFET as far away as possible from the rest of the circuitry.

Leave the port interface disconnected. Set potentiometers *R4*, *R5* and *R6* to their mid-range positions. To ensure that you don't create a ground loop, your dc supply should float in reference to earth ground (don't tie earth ground to dc ground at the supply). Apply the dc voltages, and verify that pin 5 of *U2* has a pulsing signal on it and that pins 5 through 12 of *U3* aren't tied high or low. This done, remove the dc voltages and connect the board to the port.

Run the program given in Listing 1. The step number and data (if applicable) displayed. Press Enter after each step to move to the next:

(1) The port's IREQ is disabled. Apply power.

(2) The frequency at the port is read and displayed The value displayed isn't the frequency but the number of times the bit changed during a DOS tick (approximately 54.9 ms). Place the sensor in maximum light and adjust *R6* until the displayed value is maximum. Change the light to minimum. The value displayed isn't critical, but it determines the range between lightest and darkest levels. It must be significantly less than maximum.

(3) The PC writes 0h to FFh to *U3* in a continuous loop. Verify that the voltage at the output of the op amp (pin 4 of *U4*) is varying.

(4) The PC sends a 0 to *U3*. Adjust

Table 2. Key Words

Operator	Description
IF	Begins each rule. Statements following are input conditions.
THEN	Ends the interrupt conditions that must be met for a rule to fire. Statements that follow are the output shapes to which the fuzzy values will be applied.
AND	Specifies that a rule will evaluate to true (fire) only when the input is within the overlap of two or more shapes. For example, the graph in (A) contains two shapes, S1 and S2. The rule, given below the graph, will fire only for inputs that are within the shaded area. The fuzzy values applied to the output will follow the dark outline. Technically, the AND operator designates that for a rule to fire, the fuzzy value for both shapes must be greater than 0. The value used in the output calculation is the minimum. Given this statement, IF x AND y AND z THEN ..., for the rule to fire, x, y and z, must all be greater than 0. The fuzzy value for the set (the value applied to the output) is the minimum of x, y and z.
OR	Works opposite of AND. Instead of using the overlap, a rule evaluates to true whenever the input is within either shape. This is shown in (B). Once again, the fuzzy values transferred to the output follow the dark outline. Rules can contain multiple OR statements but only one fuzzy value is used in the final calculation. Given the rule IF A AND B AND C OR D AND E AND F OR G THEN H, the fuzzy value applied to H is the maximum of each combination separated by OR. So if A = 10%, B = 0% and C = 80%, the outcome for the set of ANDs is the minimum, 0%. Furthermore, if D = 9%, E and F = 100%, the output would once again be the minimum (in this case, 9%). The fuzzy value transferred to the output depends on G. If G = 8%, the value applied to H is 9%. If G is larger than 9%, its value is used. In maximum mode (see text), the OR operator is nothing more than a rule connector. For example, the rule in (B) could be separated into two, IF S1 THEN and IF S2 THEN, with no change in the output shape. The reason for this is that only one value for each output shape is used for either the combined or separate shapes. Things change for average mode. Because all centroids are used in the final calculation, the rule that uses the OR operator would produce one centroid, the separate rules, two. Depending on whether both rules fire simultaneously, the final output may be significantly different. Essentially, using the OR operator in average mode changes the rules to maximum mode (fuzzy, isn't it?).
NOT	Inverts the shapes. What actually occurs is that the fuzzy value is found as outlined above. However, before being used, it's subtracted from 100%. Thus, if the fuzzy value is, say, 77%, it's inverted to become 33%. Graphs (C), (D) and (E) illustrate how the NOT modifier is evaluated for each operator.

Note: The operators work the same for multiple inputs. To use, visualize the inputs superimposed on each other.

RS to just before the lamp completely extinguishes.

(5) FFh is written. Adjust *R4* just before maximum brightness is reached. Press Enter to exit.

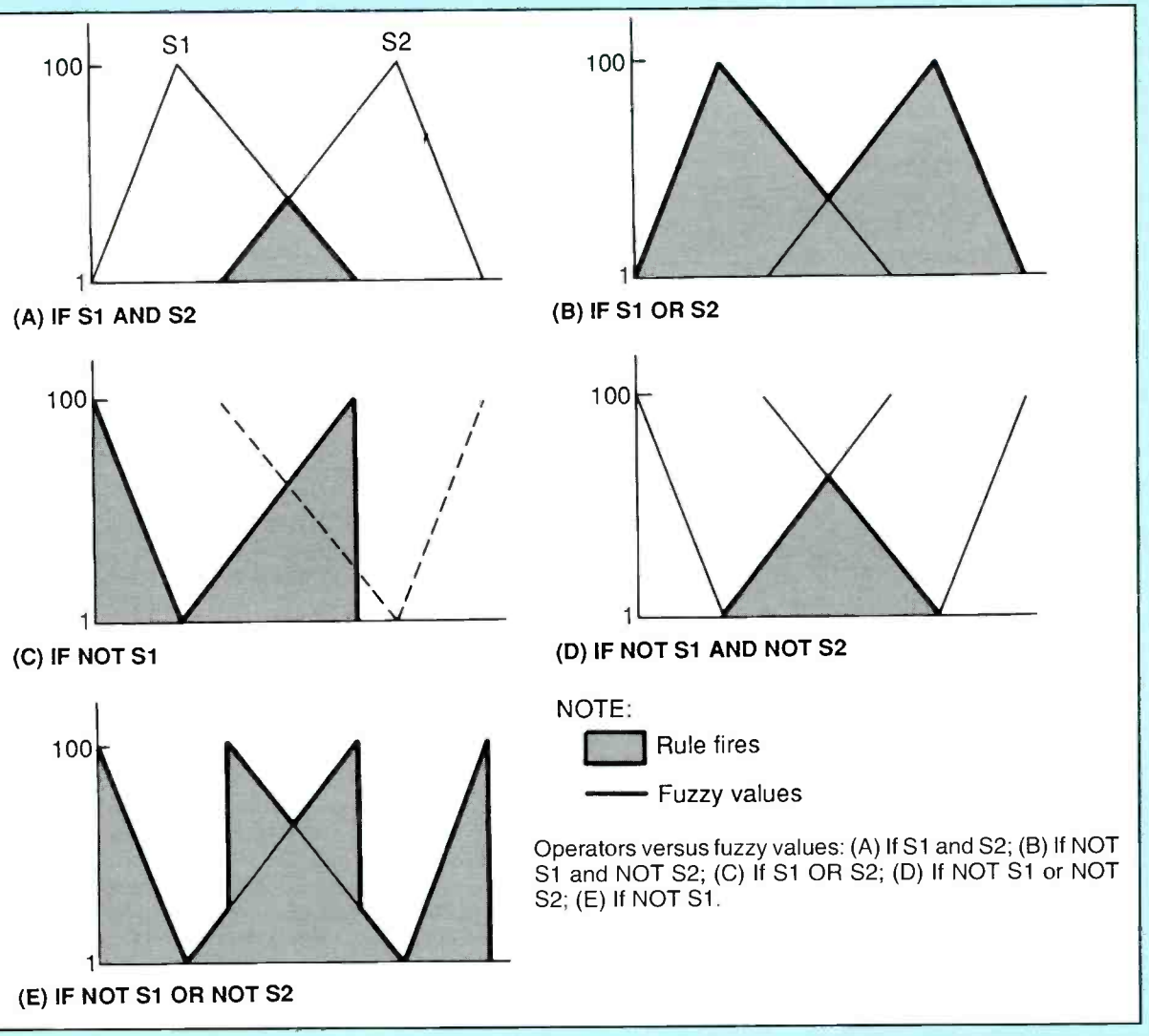
On to Fuzzy Logic

To begin this discussion on fuzzy logic, consider the following way the system could be implemented using conventional logic. Arbitrary frequency limits for the 555 timer spans from 0 (darkest) to 100,000 ohms (lightest). First, you need to specify in absolute terms, the difference between light and dark. Say the room is light when the input frequency is 50,000 to 100,000 ohms, which means that the room will be considered dark between 0 and 49,990 ohms. Is this really what you want? Is the difference between light and dark this abrupt? What you'll do is add another set, calling it Somewhat-Light and defining it as a span of frequencies.

A simple problem in our world quickly escalates into a full-blown project in the computer's. After it's all done you know the day will come when it needs to be modified. No problem. Just go back and re-specify all those values. A better way is to let fuzzy logic do the majority of work.

The first thing to do is decide what the input versus the output graph should look like. What you want is for your lamp to decrease in brightness as the room's light increases in intensity, which is easier accomplished by just reading the input, complementing it and then writing it to the DAC. This is much too simple a solution. To make things more interesting, and to demonstrate the ease of the solution, specify that the input versus the output graph must resemble a bell curve, the ideal for which is shown in Fig. 5.

• **Graphs.** Variables LightIn and LightOut each requires a separate graph. Fig 6 shows the graph for the input. The values for the *X* axis are the input values from the 555 timer. They start at 0 (room darkest) and end at 100,000 ohms (room lightest). The *Y* axis is called the degree of membership (fuzzy value). Most documenta-



Operators versus fuzzy values: (A) If S1 and S2; (B) If NOT S1 and NOT S2; (C) If S1 OR S2; (D) If NOT S1 or NOT S2; (E) If NOT S1.

tion specifies its range as 0 to 1 and annotate it as "μ".

To keep this as simple as possible, the *Y* axis will be referred to as percent of membership, with a range of 0 (no membership) to 100% (complete membership). This is the true/false axis. In conventional logic only two values would be used, true (100%) or false (0%). Fuzzy logic permits you to use these and any value between. It's like the difference between a sine wave and a pulse train. The sine wave has varying degrees of truth, while the pulse train has only true and false.

• **Shapes.** Shapes replace all the drudgery of defining and redefining values. The values contained in each set are still defined but, instead of using numbers, a shape is drawn. Each shape defines what values are contained in the fuzzy set and the weight (% membership) each has.

As an analogy, say you're driving and there's a stop sign ahead. The input shape (set) contains the distance between you and the sign. The output shape indicates the pressures applied to the brake. When the sign is 100 yards away, the distance has no membership in the input set. So no pressure is applied to the brake.

As you get closer to the sign, the more the value belongs within the input shape and, thus, the higher it's membership. This membership is transferred to the output's shape, increasing the pressure on the brake.

Most development systems limit the type of shapes that can be used to triangles and trapezoids. At first, this appears to be a limitation, which, indeed, it is. But with a little manipulation, these shapes, combined with rules, can be made to represent all real-world values.

To select input shapes, first establish what values belong in each set. This defines the base of the shape. The left-bottom is the minimum, the right, the maximum. Next, determine when the fuzzy set becomes 100% true. For example, referring to the Dark shape in Fig. 7, the room is completely dark (membership is 100%) at only one point, the shape's peak. If desired, you could replace the

triangle with a trapezoid, allowing the set to be completely true for more than one input or, for that matter, all inputs, as in the case of rectangles. Now that all the points are defined, all that's left is to connect the dots.

Overlap shapes whenever values belong to more than one set. When the input value for the Fig. 7 LightIn graph is within the dark shape, three components—VeryDark, Dark and DarkLight—interact. This is how the absolutes so common in conventional logic are prevented. Instead of specifying dark as a singular set of values, we say it consists of a varying degree of three values.

Output shapes are a little different. Instead of working with the edges, "centroids" are used. In layman's terms, a centroid is the center of gravity or the point at which the shape would balance on the end of a pin. Each centroid has an *x* and a *y* coordinate, but only the *x* value is used.

Shape selection is somewhat easier than inputs. First, determine the number of shapes required. This is dictated by the number of dissimilar areas you're attempting to control. In this system, there are three areas and, thus, three shapes. FetOff controls the leading and falling edges, FetOnOff the area between this and the peak and FetOn the peak. Next, determine what the output should do as fuzzy values vary. For example, the FetOff shape is drawn so that as fuzzy values decrease, the output increases. FetOn is the opposite, with increasing fuzzy values increasing the output. Since an equilateral triangle is used for FetOnOff, the outputs for all fuzzy value are the same, creating a line.

Position the shape by visualizing the centroid with a fuzzy value of 100%. Place it on the graph so that this point is at the desired output if this were the only shape used.

A few notes about output shapes are in order at this point:

(1) Overlapping shapes has no effect. As long as the centroids are in the same place, the overlap of the FetOff and FetOnOff shapes could be eliminated without affecting the output shape.

(2) Unlike inputs, gaps between shapes have no effect. As long as their bases are identical, a centroid's *x* coordinate is the same for equilateral triangles, trapezoids that have equal slopes and rectangles and is always in the middle of the shape.

(3) Of all the components, output shapes have the least effect.

Table 3. Initial & Additional Rules

A	IF (LightIn DarkLight) THEN (LightOut FetOn)
B	IF (LightIn Dark) OR (LightIn Light) THEN (LightOut FetOnOff)
C	IF (LightIn VeryDark) OR (LightIn VeryLight) THEN (LightOut FetOff)
D	IF (LightIn Peak) THEN (LightOut FetOn)
E	IF (LightIn VeryDark) OR (LightIn VeryLight) THEN (LightOut FetOff)
F	IF (LightIn VeryDark) AND (LightIn Dark) OR (LightIn Light) AND (LightIn VeryLight) THEN (LightOut FetOff)

• **Input to Fuzzy Value.** To see how the fuzzy value for a given input is derived for the completed graph for LightIn shown in Fig. 7, I'll use an input of 30,000 ohms.

The first step is to draw a vertical line from 30 to the top of the graph. This line intersects two shapes. Thus, the value has membership in both Dark and DarkLight fuzzy sets. To find the degree to which each belongs, draw a horizontal line from the point of intersection to the *Y* axis. This tells you that 30 has a 70% membership in the Dark set and 20% in the DarkLight set. You'd say the room is kind of dark but getting lighter.

Now that you have the fuzzy value, you can apply it to the outputs. Before doing this, you need to specify how the conversion will take place.

• **Rules.** Rules define the relationship between the input and output shapes. They're formulated much like the BASIC-language IF x THEN y statement, with a few modifications. Valid operators are AND (intersection), OR (union) and NOT (complement). Table 2 lists the operators and explains how each is evaluated.

I'll use the transmission of a car as a rules analogy. If there's no transmission (rules), the motor (input) can run all day, but it won't go anywhere (output). If you install a transmission and put it in low gear, the rule becomes: "If the motor is fast, the output is slow." Changing the gear to high, the rule changes to: "If the motor is slow, the output is fast."

In fuzzy-logic, instead of a rule evaluating to one of two values like true or false, it can have varying degrees of each. It can be somewhat true or somewhat false, depending on input conditions. For example, given the statement "If x And y Then z," the statement evaluates to true (the rule fires) as long as both *x* and *y* have some value other than 0. Each rule is a statement that specifies what input conditions must be met for the rule to evaluate to true, and, once it does evaluate to true, to which output shapes to apply the value.

Once the operators are understood, rule development is a straightforward process. Write the rules as if you're explaining to someone else how the system works. First, visualize the input graph superimposed over the final output graph. For each input shape, define what the output should do when the input is within the set. For example, Rule C in Table 3 states that if the input falls in either the VeryDark or VeryLight shape, turn off the FET. This rule controls the outside edges of the bell curve.

How many rules are required depends on the number of inputs the system has. This system has one input with six shapes. To cover all possible input conditions, a minimum of six rules is required. If the system had two inputs, each with eight shapes, 8 X 8, or 64 rules would be needed to cover all input combinations. This doesn't include rules that are added to optimize the output shape. For example, this system uses 10 rules instead of the minimum of six (see the OR operator in Table 2).

As you can see, there's a point at which the number becomes unmanageable. Typically, for systems that have more than one input, not all combinations are possible. Thus, not all rules are required. Also, the number of shapes can often be reduced and still achieve a satisfactory output.

Fuzzy Values to Crisp Outputs

As stated, an input of 30 has membership in both Dark and DarkLight. Rule A contains only the DarkLight shape. Thus, it fires. Rule B addresses both the Dark and Light shapes. Because the

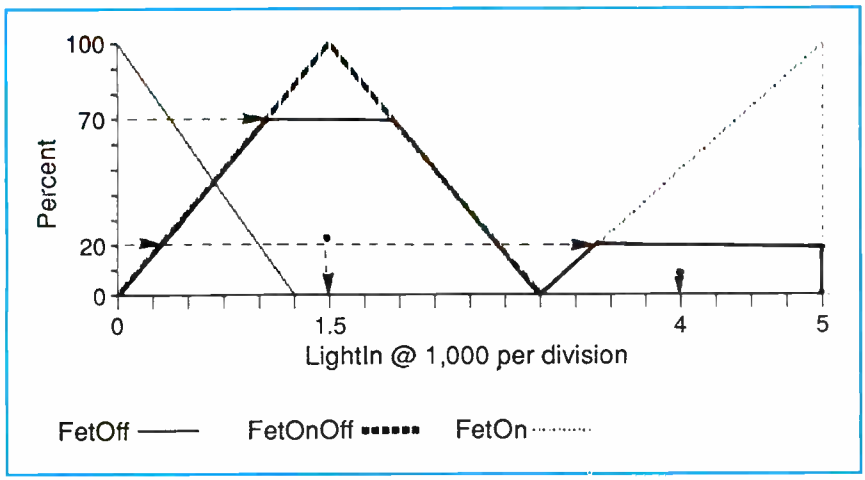


Fig. 8. LightOut wave shape.

operator is an OR, the rule evaluates to true, even though there's no value given for Light.

Next, apply the fuzzy values to the output. In fuzzy terms, you'll "defuzzify" them. The steps required from input to final output are: crisp input -> fuzzy (% membership) -> rules -> defuzzify -> crisp output. The word "crisp" refers to the inputs and outputs of the fuzzy system. You've determined that the % membership for the first rule, with an input of 30, was DarkLight at 20%. Since, there are no ANDs or ORs in the rule, this value is "defuzzied" and applied to the outputs. The process is somewhat more complex than that of converting to fuzzy values.

Referring to Fig. 8, draw a horizontal line from the 20% mark on the *Y* axis to the end of the graph. The shape you'll use is specified in the rule as FetOn. This is how the % membership is transferred. It defines the top of the area (dark outline) that's used to calculate the centroid. After finding the centroid, draw a vertical line to the *X* axis. This value, which is 4, is the output for Rule A.

If this were the only rule that fired, the gate of the FET would be set to 4 volts, which isn't exactly what you want. With an input of 30,000 ohms, the light in the room is moving toward midrange but is still somewhat dark. This is where fuzzy logic starts to work.

Due to the overlapping of the Dark and DarkLight shapes, Rule B also fires, decreasing the FET's voltage. Whenever more than one rule fires,

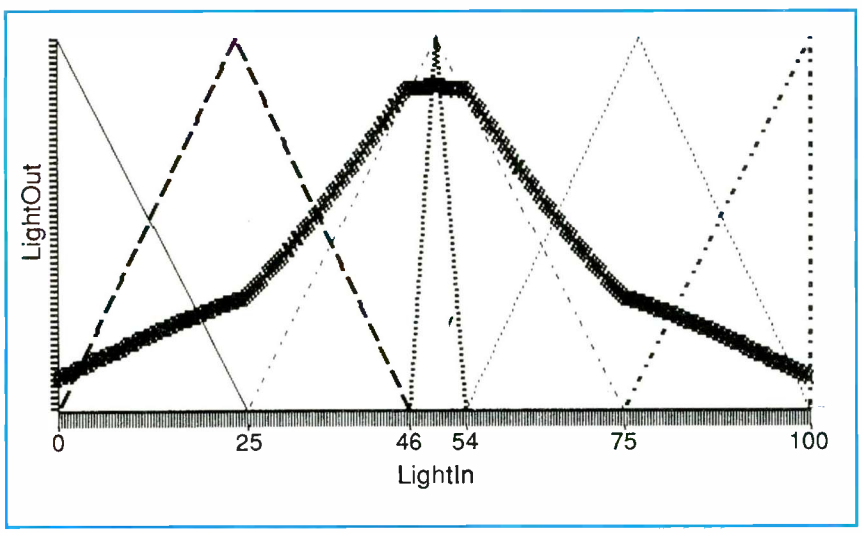


Fig. 9. Wave shape for first output.

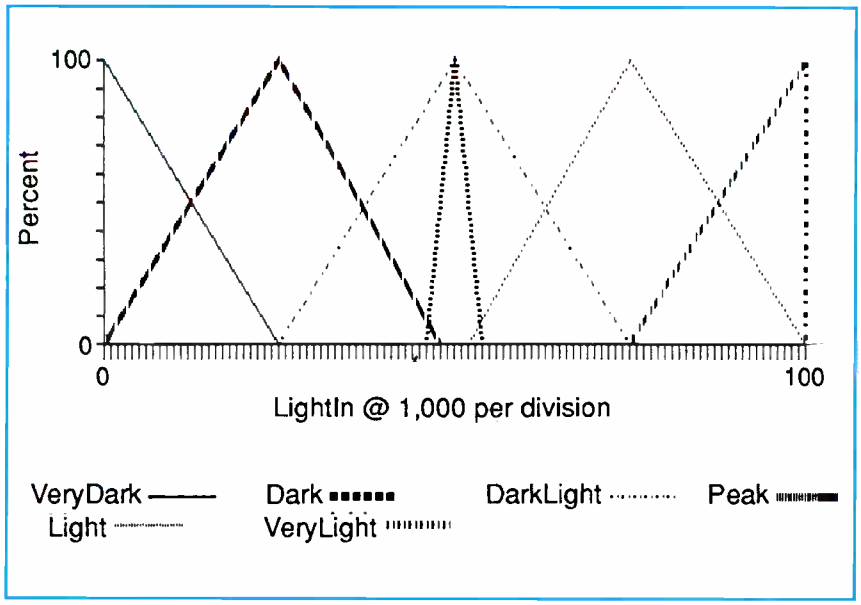


Fig. 10. Modified LightIn wave shape.

the final output is modified according to the weight of each rule that fired. An analogy would be driving a car with pressure on both brake and gas pedals. The final output, the speed of the car, depends on the amount of pressure applied to each.

Before you can find the crisp output, you must calculate the centroid for Rule B. This is done the same as above, by transferring the 70% membership to the FetOnOff shape. (Actually, because the shape is an equilateral triangle, the centroid is in the middle of the base, regardless of the fuzzy value.) Referring again to Fig. 8, the centroid is found to be 1.5 volts. Since no other rules fired, you'll calculate the final output as follows:

```
Crisp Output  = [(Crisp 1 x Weight 1) +
                (Crisp 2 x Weight2)]/
                (Weight 1 + Weight 2)
              = [(4 x .20) + (1.5 X 0.70)]/
                (.20 + 0.70)
              = 2 volts
```

Notice that the fuzzy value is used first in the calculation of the centroid and then again to determine the final output. There are a couple of reasons for this. First, regardless of the type of shape, centroids move very little.

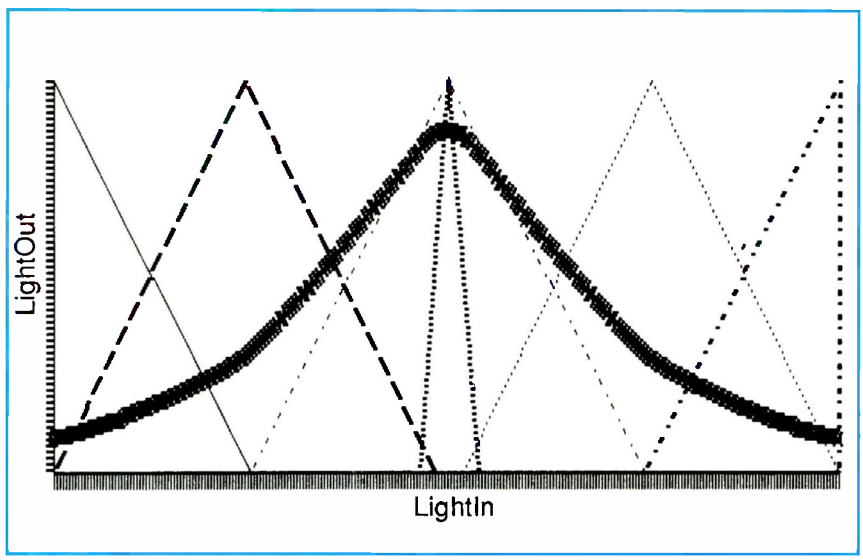


Fig. 11. Modified Output wave shape.

Table 4. Rules Fired

LightIn	Rules Firing
0	C,E
> 0 < 25	B,C,E,F
25	B
> 25 ≤ 46	A,B
> 46 < 48	A,B,D
48 - 52	A,D
> 52 < 54	A,B,D
54 < 75	A,B
75	B
> 75 < 100	B,C,E,F
100	C,E

Using the value to define the usable area permits fine adjustments to be made on the output shape. Next, it must be used in the final calculation so that the relative truth of each rule is taken into account. For example, the weights (relative truth) of Rules A and B were given as 20% and 70%, respectively.

What you want is for Rule B to affect the output more than does Rule A. To do this, you first determine the relative truth of the rule to itself, then how true this value is to total truth. This is the basis of fuzzy logic. It doesn't deal with absolute truth but, instead, with relative truth.

The foregoing is about as clear as a foggy night in London. To clear things up, I'll break the equation into two parts and use the first:

Crisp 1 x Truth 1/(Truth 1 + Truth 2)

which says

Output for the rule relative to its truth/Total truth

Total truth is used because, up front, there's no way to know what completely true is. In the above equation, 90% (20% + 70%) represents complete truth, not 100%. If 10 rules fire, each with a weight of 100%, complete truth becomes 1,000. In essence, whatever value total truth has is equivalent to 100% true.

Putting it All Together

The output versus the input graphs for the system is shown in Fig. 9. Unfortunately, you didn't meet your objective. There are two problems: the top shouldn't be flat nor should the corners be abrupt. What you need is a way to modify the system to achieve the desired output.

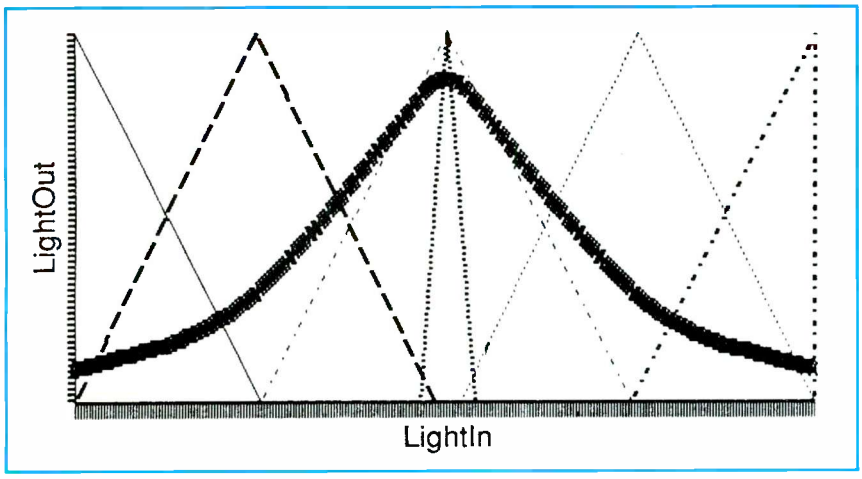


Fig. 12. Final composite output wave shape.

Break the problem into three parts: the area between 0 and 25, the area between 46 and 54 and the area between 75 and 100. Working with the first, you see the that VeryDark shape begins at 0 and ends at 25. What you'll do is add another rule that "pulls" this area toward 0 when the input is within this shape. Also, notice that the VeryLight shape controls the same portion of the output but on the opposite end. You'll fix both deficiencies with one rule.

This is a good time to explain the two ways the final output can be derived. I'll call one the maximum method, the other the average method.

Using the maximum method, only one centroid per output shape is used in the final calculation. The average does just this—averages all centroids. For example, to fix the problem, you'll specify rule C twice. With an input of 10,000 ohms, three centroids would be produced, one for Rule A, and two for Rule B. To calculate the final output do the following:

Maximum Method
Crisp Output = [(Cent A x Fuzzy A) + (Largest_Centroid B x Fuzzy B)]/(Fuzzy A + Fuzzy B)

Average Method
Crisp Output = [(Centroid A x Fuzzy A) + 2(Centroid B x Fuzzy B)]/(Fuzzy A + 2 x Fuzzy B)

At first glance, it might appear that by specifying a rule twice, you double its effect. Unfortunately, it's not this easy. Due to the interaction between all centroid/fuzzy pairs (it's that relative-truth thing), it may fix the problem, create another or have no effect whatsoever. Since it works here, we'll use it.

How should the area between 46 and 54 be adjusted? Should you modify the rules or the shapes? There's no one correct answer. As an example, say you're driving and you want to slow down. Do you let up on the gas (input), change to a lower gear (rules)

Software Availability

Minimum requirements for using the fuzzy-logic software supplied by author are: 512K of RAM, 360K floppy-disk drive, CGA/Hercules-compatible video card (Hercules card isn't supported, but a shareware emulator is available) and DOS 3or later. Two software systems are available from:

Xcentrics
PO Box 1268
McMinnville, OR 97128
Tel.: 503-434-5729

System A, at $39.95, lets you evaluate fuzzy logic and has all the capabilities outlined (graphs, rules, simulation), but it lets you generate a TSR only as outlined in the main article (input from the port's busy bit, output to the latch). The TSR ties into the DOS timer and activates at intervals you specify. The port it uses can be selected. By using it, you can find out exactly how fuzzy works. System B, at $79.95, has all the capabilities of System A plus the complete TSR feature. Each System includes an on-disk user's manual (a printed manual is available for an additional $10), program for calibration and the file needed to generate the TSR used in the article. Please add $5 to cover shipping and handling.

or step on the brake (output)? Each action achieves the same thing, just in a different way from the others. Since modifying shapes is the easiest, this is where you'll start.

If you superimpose the input graph over the output, as done in Fig. 9, you see that the area in question falls within the peak shape. In fact, the top goes flat as soon as the shape comes into existence. When the input is within this shape, Rules A and D fire. There's your problem. Both rules tell the system to turn on the FET. To fix it, you add some fuzziness, slowing down how fast the output reaches maximum.

Checking the rules, you find that Rule B uses the FetOnOff shape. If you could make this rule fire, it would provide the interaction you need. After modifying both the Dark and Light shapes shown in Fig. 10, the problem is solved. At the points of overlap, the rules "fight" each other, smoothing the transition.

The modified output is shown in Fig. 11. Although it's better, it's still not perfect. The transition with an input of 25 is still too abrupt. To smooth it further, add another rule that fires only when the input is within the area where the Dark and Very-Dark shapes overlap. The fuzzy value will be applied to the FetOff shape:

IF (LightIn VeryDark) AND (LightIn Dark)
THEN (LightOut FetOff)

Using the AND operator allows you to "zero in" on specific areas where shapes overlap. At any other time, one or more of the fuzzy values are 0. Thus, the rule doesn't fire. The same problem exists on the falling edge of the output. Instead of writing a separate rule, you'll combine both, using the OR operator, as shown in Table 4, Rule F.

The final output is shown in Fig. 12. Table 4 specifies which rules fire as the input varies. It took several tries to get the optimum shape/rule mix. However, as you can readily see, it's much easier using fuzzy logic than modifying code or manipulating equations.

Program Overview

Trying to cover fuzzy logic in a brief article is like trying to explain the way we think in a few pages of text. The only way to fully understand fuzzy logic is to apply the principles

Listing 1. Calibration Software Code

NOTE: The following listing is the minimum code required to calibrate the hardware. The only consideration was that it be as simple as possible.

```
        ;;; EQUATES ;;;

Port equ 0378h                  ;base address of port to use
                                ;Change this if different
StatusPort equ Port+1           ;addr of status port for rd
ControlPort equ Port+2          ;addr of ctrl port
Time equ 046ch                  ;Dos timer tick address low byte
GetBit equ 080h                 ;mask byte used to get bit
Dos equ 021h                    ;Dos interrupt
Screen equ 010h                 ;Bios interrupt for screen access
GetDisplay equ 0fh              ;get video mode
Cls equ 00                      ;set video mode
Display equ 02                  ;Dos display char function
PositionCursor equ 02           ;Bios set cursor function
Exit equ 020h                   ;program exit
GetKey equ 08h                  ;function to get char from keybd
KeyPressed equ 0ffh             ;key was pressed
CheckKey equ 0bh                ;function to check key pressed


;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;; CODE;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

cal segment
main proc far
assume cs:cal
org 100h

        ;NOTE: If the bit from the 555 isn't changing states,
        ;step two is skipped.

start:
    mov dx,ControlPorts
    xor ax,ax
    out dx,al                   ;set IREQ to off
    call ClearScreen
    mov dl,'1'                  ;indicate step 1
    mov ah Display
    int Dos                     ;send 1 to display
    mov ah,GetKey
    int Dos                     ;apply power then press return
    call ClearScreen
    mov cx,0fffffh              ;must check for pulse
                                ;if don't, will hang
    mov dx,StatusPort
    in al,dx
    mov ah,al
    and ah,GetBit               ;get current state of bit
CheckFor Pulse:
    in al,dx
    and al,GetBitq
    cmp al,ah
    jne PulseOk                 ;the bit changed states
    loop CheckForPulse          ;check 64k times
    jmp NoPulse                 ;bit isn't changing
PulseOk:
    mov dl,'2'                  ;indicate step two
    mov ah,Display
    into Dos                    ;send 2 to the display
    call DisplayFreq
NoPulse:
    call ClearScreen
    mov dl,'3'                  ;indicate step three
    mov ah,Display
    int Dos                     ;send 2 to the display
    call LoopWrite
    call ClearScreen
    mov dl,'4'                  ;indicate strep four
```

```
    mov ah,Display
    int Dos                     ;send 4 to the display
    mov dx,Port
    xor ax,ax
    out dx,al                   ;0 now at DAC
    mov ah,GetKet
    int Dos                     ;get a key
    call ClearScreen
    mov dl,'5'                  ;indicate setp five
    mov ah,Display
    int Dos                     ;send 5 to the display
    mov al,0ffh
    mov dx,Port
    out dx,al                   ;send ff to DAC
    mov ah,GetKey
    int Dos                     ;wait for key
    int Exit
main endp:

;;;;;;;;;;;;;; DisplayFreq ;;;;;;;;;;;;;;
DisplayFreq proc near
    mov ah,GetDisplay           ;read display mode
    int Screen
    mov ah,PositionCursor       ;going to set cursor to start
    mov dh,1                    ;line number
    mov dl,0                    ;column number
    int Screen                  ;bh has display page
    call ChkIt                  ;rets ax with value
    mov cx,4                    ;set up for rotates below
    ror ah,cl                   ;hi nibble to low
    ror al,cl                   ;again
    xchg al,ah                  ;digits right to display
    push ax

DisplayLoop:
    call ToAscii
    mov dl,al
    mov ah,Display
    int Dos                     ;char in dl to screen
    pop ax
    ror ax,1
    ror ax,1
    ror ax,1
    ror ax,1
    push ax
    loop DisplayLoop            ;send em all
    pop ax
    mov ah,CheckKey
    int Dos                     ;check for key
    cmp al,KeyPressed
    jne DisplayFreq
    mov ah,GetKey
    int Dos                     ;clear keybd
DisplayFreq endp

;;;;;;;;;;;;;; ToAscii ;;;;;;;;;;;;;;;;;
ToAscii proc near
    and al,0fh                  ;only low nibble
    add al,030h
    cmp al,03ah                 ;> 9
    jl ToAsciiEnds
    add al,07h                  ;get to A
ToAsciiEnds:
    ret
ToAscii endp

;;;;;;;;;;;;;; LoopWrite ;;;;;;;;;;;;;;;
LoopWrite proc near
    inc al                      ;next value
    mov dx,Port
    out dx,al
    mov cx,08000h
```

```
WaitABit:
        loop WaitABit              ;wait so change can be seen
        push ax
        mov ah,CheckKey
        int Dos                    ;check for key
        cmp al,KeyPressed
        pop ax
        jne LoopWrite
        mov ah,GetKey
        int Dos                    ;clear keybd
        ret
LoopWrite endp

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;
;Returns AX with the number of times the port bit changed in .0549 sec.
;  This is actually 2 times the number of cycles but because flip
;  flop divides initial frequency by 2, the value is correct.
;  Freq at 555 = value returned * DOS ticks per seconds
;  (18.20648193).
;Tieing into the DOS tick was chosen not because it's the best
;   way but, it is one of the simplest.
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
ChkIt proc near

        push ds
        xor ax,ax
        mov ds,ax                  ;need a 0 to access BIOS variables
        mov di,Time
        mov dx,StatusPort
        mov cx,GetBit              ;used to eliminate all but right bit
L0:
        mov bx,ax                  ;start with a 0
        mov si,ax
        mov ah,[di]                ;get the current dos tick
L1:
        cmp [di],ah
        je L1                      ;wait for the next dos tick
        inc ah
L2:
        in al,dx                   ;get the byte from the port
        and al,cl                  ;mask the bit
        cmp al,bl                  ;bl tracks last state of port bit
        je L2                      ;didn't change yet
        mov bl,al                  ;either 0 or bit to bl
        inc si                     ;indicate bit changed
        cmp [di],ah                ;test for Dos tick
        je  L2                     ;Dos tick didn't change
L3:
        mov ax,si                  ;return value in AX
        pop ds
        ret                        ;all done
ChkIt endp

;;;;;;;;;;;; ClearScreen ;;;;;;;;;;;;
ClearScreen proc near
        mov ah,GetDisplay
        int Screen                 ;get display mode
        mov ah,Cls
        int Screen                 ;clear screen
        ret
ClearScreen endp

cal ends
end start
```

outlined here to your own designs. All you need is graph paper and unlimited time. Since most of us don't have unlimited time, we have to find ways to use what we do have more efficiently.

The development system presented lets the computer do what it does best—number crunch—and releases you to do what you do best—create. It lets you specify the inputs and outputs (maximum of 12 input/outputs, with a maximum of eight shapes each, inputs extendible to 16) add and modify shapes, formulate rules (maximum of 140) and then test the system through simulation.

If desired, simulation can be performed manually, permitting more direct control over input values, or automatically, where the system generates a graph of any output versus any input. To help in debugging and understanding your system, the learn mode can be activated. During simulation, comprehensive data that shows the interaction between the system's components is sent to a file for your analysis. Once the system is designed, several options are open to you.

You can generate a TSR that hooks into the DOS timer and activates at intervals you specify. It reads the input data, applies this to the rules and then sends the crisp values to the outputs. The addresses and access type (memory port) are programmable.

The TSR can also be called via the PC's interrupt system. Your application sets up a table that contains the input values and performs a software interrupt. The TSR calculates and returns the crisp outputs.

Your application can be integrated into the TSR's code. The method is similar to the above. But because the TSR contains everything it needs, it runs completely in the background.

Applications for fuzzy logic are virtually endless. Some of them include:

- Control of model boats, trains, airplanes, etc.
- Home/office burglar alarm and climate control.
- Ac/dc motor control.
- Robotics.
- Weather prediction through humidity, temperature, pressure.
- Analyzing data for patterns/trends.
- Controlling product flow in production.

In general, anything that requires control or generalization is a possible application for fuzzy logic. ■

By Thomas D. Leitschuh

An Industrial Counting Solution

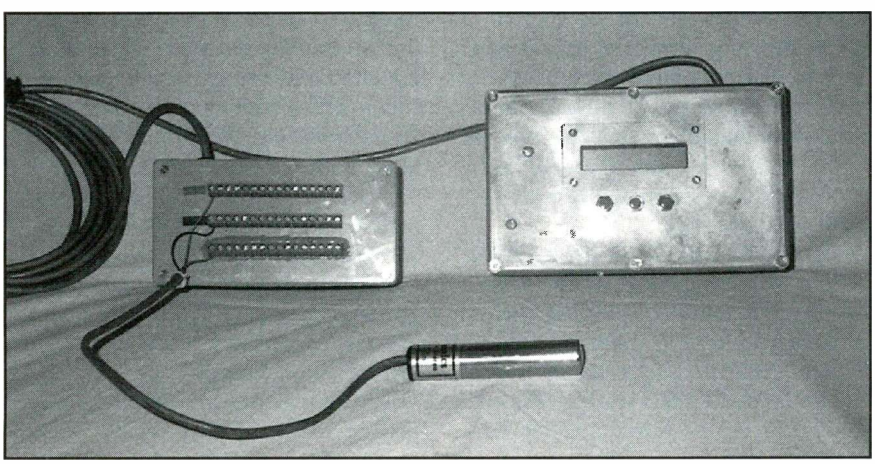
A modern approach to solving a tricky problem using a PIC microcontroller in a harsh industrial environment

In early 1985, one of my clients had a system installed in his business to count rags. It became unreliable because an IBM PC that was designed for a relatively benign office environment was utilized in harsh industrial surroundings. This system employed an Optomux serial link to reduce the number of conductors between the counting pickups and PC terminal. At the time of installation, this system seemed to be a practical, low-cost alternative to an expensive dedicated controller. Since then, the original designer has vanished, the hardware is growing old and overall stability of the machinery has deteriorated. Confidence was low among the operators, who hated the machine. When the system is down, rag-counting reverts to the old technique—counting by hand.

The system described here is the 1994 replacement that employs the minimum hardware to do the job. This application demonstrates the use of an LCD alphanumeric display, a Microchip PIC16C71 microcontroller and simple controls. The challenge was to increase reliability and simplify the user interface. Firmware replaces hardware whenever possible. As an example, the 16-byte alphanumeric LCD panel can substitute for many seven-segment numeric-only displays that each requires a separate decoder/driver. As a bonus, the LCD panel can display error and information messages in plain English. Benefits of reduced component count include less trouble with the hardware, flexibility limited only by your imagination and lower per-unit production cost. Also, firmware is easier and cheaper to duplicate than hardware.

System Overview

The machine pulls rags vertically past an array of 16 photoelectric pickups ("eyes"). Figure 1 shows an overall view of the counting process. Opaque rags interrupt infrared beams and are counted in three "lanes." Eight pickups are in lane 1 and four pickups each are in lanes 2 and 3. Results are displayed on a one-line by 16-digit LCD panel as three integers. Three reset buttons permit individual counts to be cleared for batch counting.



The photoelectric pickups are 5-volt devices that have complementary outputs. A block diagram of one pickup is given in Fig. 2. The pickup has an infrared LED, IR pickup, lens and TTL-level buffered outputs. At power-up, all high-true outputs should be low. Any broken wires to a pickup or obstruction in its path will cause an error message to be displayed on the LCD panel. This message reads "Eye ## is bad" and remains displayed until the problem is corrected. Using high-true outputs helps diagnose errors in the hardware.

Safely tucked inside a metal enclosure, the LCD panel is protected by a plastic window. If scratched or fogged by solvents, the protective Plexiglas window can easily be replaced. Using a cast-aluminum box for the enclosure provides good mechanical protection and rfi shielding. The box attaches to a vertical post at a convenient height for easy readability of the LCD panel. All circuitry is mounted to the removable front panel for ease of repair. Grommets provide some strain relief to the cable that connects the junction box to the control panel. The Photoelectric pickups are located 15 feet away from the operator. The seven-conductor unshielded cable carries V_{cc}, ground, four bits of pickup address output and one bit of pickup data in input.

The CMOS PIC microcontroller offers good noise immunity. At 25° C, input threshold is 1.4 volts at V_{cc} = 5.0 volts. No problems have occurred from noise pickup in what must be the worst-case environment for transmission of digital signals.

To minimize machine down-time, a complete replacement front panel can be soldered into place (seven wires)

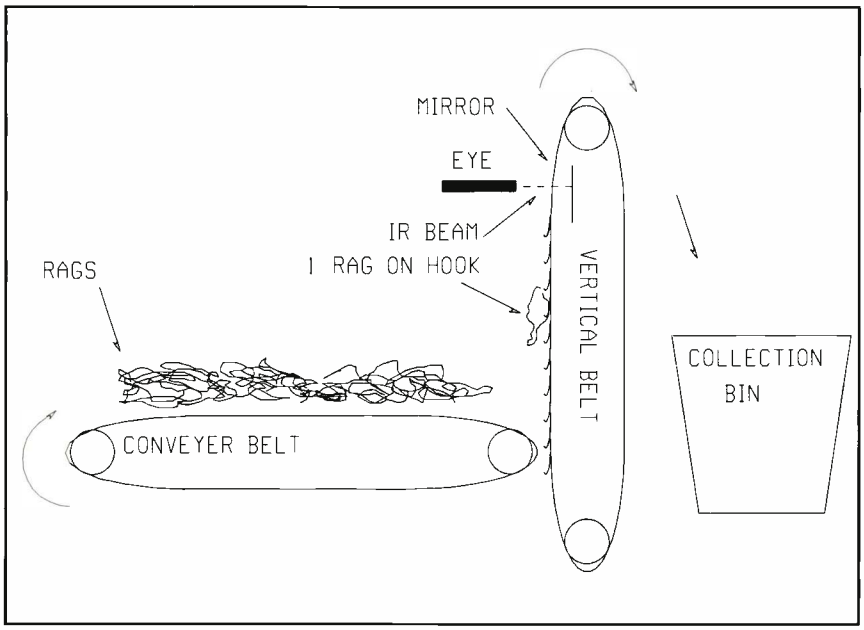


Fig. 1. This is an overall view of the process used in the industrial rag-counting application described in the main text.

and changed (six screws) in a matter of minutes. Since the location in which the project is used is in a high-vibration area, no connectors were used in assembly.

Shown in Fig. 3 is the complete schematic diagram of the project's electronics. Hardware has been minimized for reliability and simplicity. I used the PIC16C71 controller specified for *U1* to meet these requirements and minimize cost. The PIC has an RC clock mode that replaces a crystal or resonator. I chose this mode because timing isn't critical in this application.

Since there are 13 I/O pins, some multiplex scheme is needed to read 16 photoelectric pickups almost simultaneously into the processor. I used a 74150 1-of-16 data selector for *U2* to address the 16 pickups. One bit of data is returned when this four-bit address is sent out. The pickups are read very quickly in sequence. Their status is stored as two bytes of new status for later compares. This uses all five bits of Port A.

Outputs RA0 through RA3 are also used to send data to the Optrex DMC-16117 LCD panel. This display uses a Hitachi controller, which can accommodate eight-bit data in two four-bit nibbles. The LCD panel also needs a register select (RS) bit for command/data distinction and an enable (E) bit that's pulsed to a high level to write the command or data nibble into display memory. These two control lines originate from outputs RB0 and RB1, respectively.

Inputs RB5, RB6 and RB7 connect to pushbutton switches and pull-up resistors. These switches are arranged so that each clears the count on the display located immediately above the button. Though there are 16 pickups, there are only three counts. Lane 1 counts pulses from pickups 1 through 8. Lanes 2 and 3 count pulses from pickups 9 through 12 and 13 through 16, respectively.

In this machine, three batches of rags from different customers can be simultaneously but separately counted. Input RB4 connects to a DIAGNOSTIC pushbutton switch. Pressing this switch during power-up causes the unit to go into a diagnostic mode that shows the status of the 16 pickups in the 16 positions of the display. This is useful when multiple "bad-eye" indications are given and can be used for manually testing the pickups one at a time. A blank or an "X" is in each display position, depending on each pickup's state.

Diagnostic LED *D1* is driven from output RB2 during normal operation as an indication that a reading cycle of the 16 pickups is about to begin. Finally, RB3 is a motor-enable line. If the initial pickup test is okay, the motor that drives the horizontal and vertical conveyor belts, the latter with hooks that grab the rags from the former, is permitted to run. This high-true output drives an optically-isolated solid-state relay located in the machine that controls the 220-volt ac circuit for motor power. The motor runs until an emergency-stop button is pressed or power is removed.

Owing to low component count, you can use any of a number of traditional techniques for wiring the circuitry. You can design and fabricate a printed-circuit board on which to mount and wire together the various components or substitute perforated board that has holes on 0.1" centers and suitable Wire Wrap or soldering hardware. Alternatively, you can use a solderless breadboarding system. If you go the pc or perforate-board route, use sockets for the ICs. Sockets aren't an issue with the solderless breadboarding socket option.

The Software

The software (see Listing 1) for the rag counter consists of five sections: Initialization; Diagnostic; Read Eyes (Note: Listing 1 refers to the photoelectric pickups as "eyes"); Test Eyes and Report Errors; and Main Loop. Let's look at each of these sections individually.

The main loop reads the pickups, updates the three counters, looks for reset activity and delays a half-second for debouncing the buttons and pickups. Both the main loop and the test-pickups code call the same read-pickups subroutine, which is the heart of the counting system. Remember that the pickups are read in sequence by putting out an address on RA0 through RA3 and reading in that one pickup's status on RA4. A 16-bit result is cleared. Then a loop is executed 16 times to read one pickup and shift that one bit into the result, decrement the count/pickup address and repeat 16 times. This is done not to accommodate the limited I/O of the PIC16C71, but to minimize the number of connections needed between the processor/LCD panel and data-selector IC located near the pickups. Without multiplexing, 17 lines would be required. Using the 74150, only seven are needed: four address outputs, V_{cc}, ground and data input.

The next step is to note when a rag is to be counted. The principle of this

test is the same, whether or not multiplex is used. Each time the main loop is executed, 16 new bits of status are gathered and compared with 16 old bits of status from the last-read loop cycle. Any rags that first appear as logic 1s in the new status bytes but not in the old ones are added to one of the three displayed counts. This is done by XORing the old status with the new status. Any logic 1s in the result show a change in the pickup status for that bit. A logic 1 in Bit 0 tells you that a change occurred in pickup No.1, a logic 1 in Bit 15 tells you that pickup No. 16 changed.

Note that this change-of-state logic-1 bit occurs when a rag has just blocked the beam of a pickup in this cycle or a rag has just stopped blocking the beam. My program counts the rag when it first blocks the beam. A simple way of testing for this is to AND the new status with the XOR result. Since I used the high-true outputs of the pickups, a logic 1 in the new status will be a blocked pickup. ANDing this with the logic 1 from the XOR test tells me that a change occurred, giving me an indication that the change was from "no rag" to "rag." The lower eight bits of this result are tested one at a time. Any 1s present add to count 1. Even if all eight pickups register a rag at the same time, the count will be correct.

The upper eight bits are divided into two nibbles. The lower nibble is tested for 1s, and any 1s that are present are added to count 2. Count 3 is updated with any 1s from the upper nibble. The new status is saved and written over the old status for the next cycle of the main loop. The three reset inputs from the pushbutton switches are tested. If pressed, the counts associated with them are cleared. The counting system works regardless of how long a rag blocks a pickup. It's only the rising edge of a pickup bit that triggers the count.

After XORing the old and new status, ANDing with a logic-0 pickup bit is still 0. The XOR operation finds bits that have changed. Then the AND operation finds those that have a rising edge. The final part of the main loop delays for a half-second, because the pickup outputs change rather slowly. This delay debounces the reset-button inputs. If a button is held for longer than the delay time, the count is cleared at the end of each execution of the main loop. This isn't a problem because the operator will have to let go of the button to jot down the batch total and load a new batch of rags for counting.

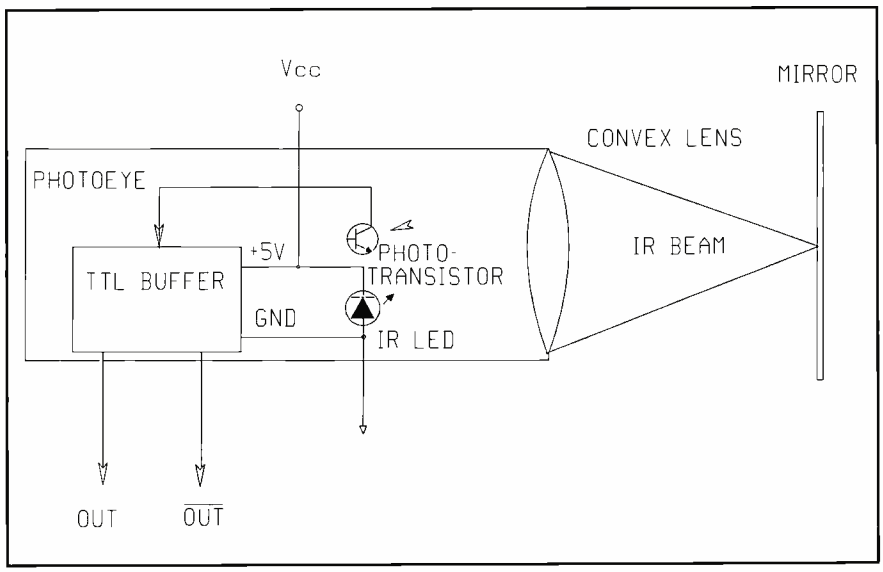


Fig. 2. This is a block diagram of photoelectric pickup device used in this project.

Some inaccuracies are unavoidable on this machine. Sometimes, a rag will be dragged up by its hook past a pickup, register as a rising edge and then slip off the hook, fall past the pickup again and generate another rising edge and fall back into the pile on the conveyer belt. Eventually, it will be picked up by another hook and be counted a third time. Though a rare occurrence, this is possible.

The operator can prematurely zero the count or forget to zero the count after a batch. In the latter case, the earlier count, if written down, can be subtracted from the two-batch total. The end user allows a 2% tolerance in the counts as an acceptable margin of error.

Initialization clears the old status so that the first execution of the loop detects only rising edges of the pickup outputs. On the PIC16C71, two registers called TRISA and TRISB have to be written with 1s or 0s for outputs. TRISA is a five-bit register and is initialized to 10h so that RA4 is an input and RA0 through RA3 are outputs. TRISB contains F0h because only the lower four bits are outputs.

The PIC16C71 uses PORTA as a combined analog/digital port. To ignore the A/D use of this port and configure it as purely digital, a 03h byte is written to the ADCON1 register. The initialization routine also clears all three counts, sends codes to the LCD panel to set it up for four-bit data transfer, checks that all pickups are logic 0 and says "hello." After a delay, the display is again cleared and the three counts of 0 are displayed.

If a pickup reads logic 1 on power-up, the message "EYE #xx is BAD" is displayed instead on the LCD panel until the condition is rectified. Sometimes, an obstruction will block a pickup or a pickup may actually be bad. Telling the user which one is bad saves time finding the trouble. If all is well, the machine motor is enabled, the user presses START and the counting process begins.

By powering up with the DIAGNOSTIC button pressed (switch closed), the LCD panel displays the status of all 16 pickups simultaneously. The motor is disabled so that one person can wave his hand past all pickups as another person watches the display. The objective at this point is to verify that all pickups are responding properly when their beams are blocked, not specific count accuracy.

The PIC has a watchdog timer that resets the CPU if a CLRWDT (clear watchdog timer) instruction isn't executed every 18 ms or so. I decided to disable this feature because if the program goes awry due to hardware failure, the counts will be left alone. If reset, the program will clear them so

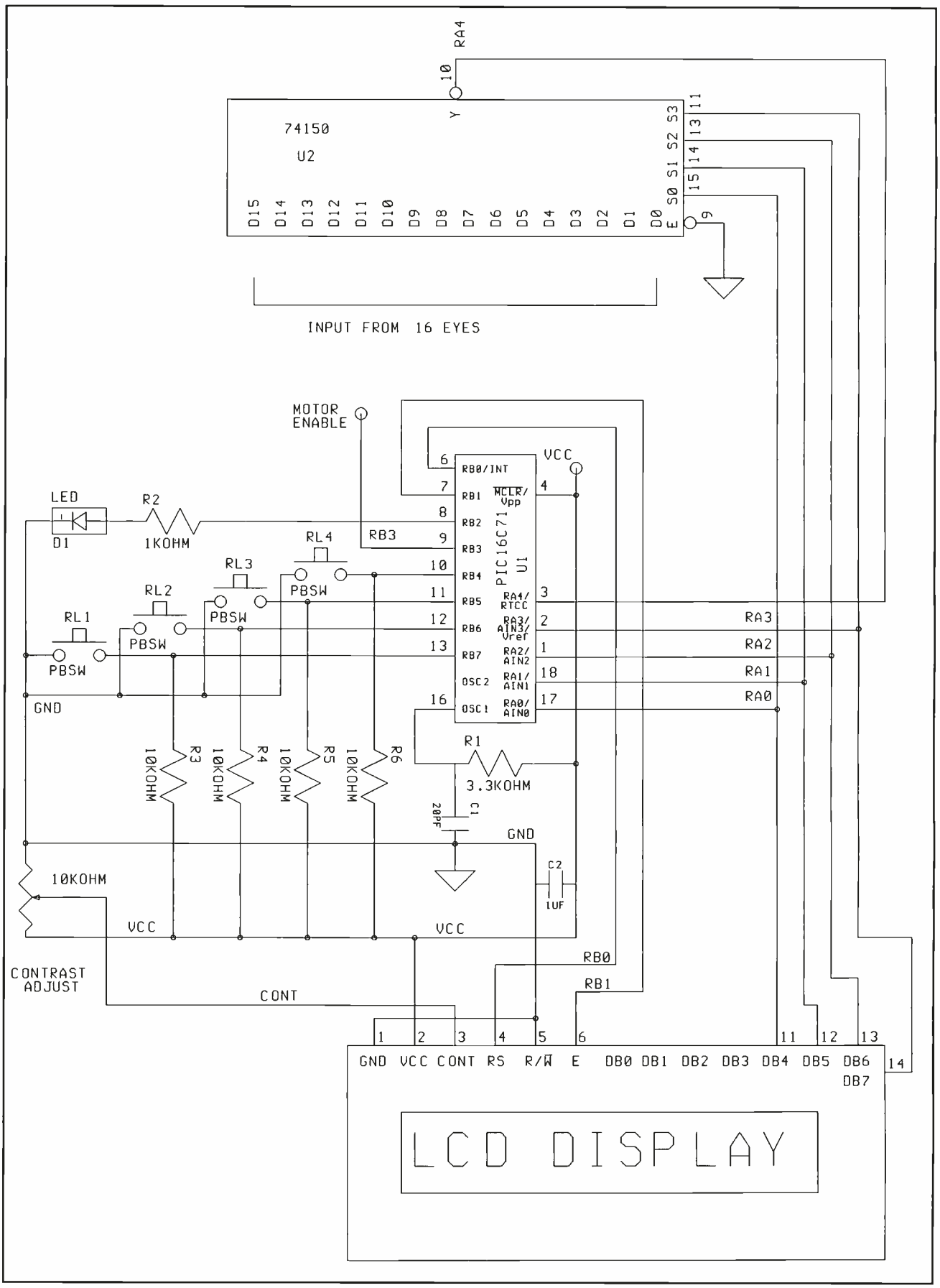


Fig. 3. This is the complete schematic diagram of the industrial rag-counting circuitry.

PARTS LIST

Semiconductors
D1—Red light-emitting diode
U1—PIC16C71 EPROM microcontroller (Microchip)
U2—74150 1-of-16 data multiplexer
Capacitors
C1—20-pF
C2—0.1-µF, 10-volt radial-lead
Resistors (1/4-watt, 5% tolerance)
R1—3,300 ohms
R2—1,000 ohms
R3 thru R6—10,000 ohms
R7—10,000-ohm pc-mount trimmer potentiometer
Miscellaneous
RL1 thru RL4—Normally-open, momentary-action pushbutton switch
Optrex DMC16117 1 X 16-character alphanumeric LCD display module; printed-circuit board or perforated board with holes on 0.1" centers and suitable soldering or Wire Wrap hardware (see text); photoelectric pickups (see text); DIP sockets for U1 and U2; suitable enclosure (see text); Plexiglas panel to protect LCD module; machine hardware; cabling and hookup wire; solder; etc.

the three counts will be lost.

Counts are stored as three 16-bit integers. Each time a rag is counted, the display is updated. I used a binary-to-BCD routine from a Microchip application note, converted the BCD data to ASCII format in four bytes and wrote the new bytes to the LCD panel each time a main loop found new rags present. A 16-byte LCD permits three four-byte counts, with two blanks between each. The PIC has 36 bytes of user RAM that are arranged as file registers. I used 21 bytes for old status, new status, counts, working registers for the BCD conversion and two delay values for the half-second routine.

To send ASCII messages to the LCD panel, I put the bytes of the message in the W (working) register and send them a byte at a time. This register is like an accumulator in the PIC. The complete code is 260 14-bit instructions. The RC oscillator runs at about 4 MHz with 3,300 ohms and 20 pF for the capacitor and resistor values in the RC timer section. Instructions are executed in about 1 µs. Most of the time is spent waiting in delay loops for debouncing and short ones for LCD display pulse timing.

The address lines to the 74150 IC for pickup multiplex also drive the data inputs to the LCD panel. Since I/O lines are at a premium with an 18-pin IC and pickup data read and LCD write never occur simultaneously, this sharing of I/O works well. Sixteen parts to count 16 asynchronous events is an example of hardware at a minimum.

Summing Up

The foregoing example of microcontroller simplicity is proof that a little bit of hardware goes a long way. Because most of the complexity in the application presented here is in the software, the machine can be reprogrammed to add new features or change the format of the display without your having to change a single wire. The PIC has an EPROM for firmware storage. So it's easily removed and reprogrammed.

This minimum hardware approach has proven to be far more reliable than an IBM PC computer with its

Listing 1. Program For Rag-Counter Application

```
LIST    C=132   ;                              SET LISTING FOR 132 COLUMNS
;       RAG COUNTER FIRMWARE  V1.0  8/2/93  LEITSCHUH 53214
;                        USE 7/24/93 SCHEMATIC
;       I/O  MAP:
;                        RA0 - RA3        ADDRESS TO EYE MUX 74150
;                                         AND DATA TO LCD DISPLAY DB4 - DB7
;                        RA4              DATA OUT FROM 74150 (1 BIT)
;
;                        RB7              CLEAR LANE 1 ( PUSHBUTTON )
;                        RB6              CLEAR LANE 2
;                        RB5              CLEAR LANE 3
;                        RB4              DIAGNOSTICS IN ( PUSHBUTTON )
;                        RB3              MOTOR CONTROL TO MACHINE ( 1 = ON )
;                        RB2              DIAGNOSTIC LED OUTPUT
;                        RB1              E ( ENABLE )  TO  LCD DISPLAY
;                        RB0              RS ( REG SEL ) TO LCD: H= DATA
;
OLDSTSL EQU     0CH         ; LANE 0-7 OLD STATUS
OLDSTSH EQU     0DH         ; LANE 8-15 OLD STATUS
NEWSTSL EQU     0EH         ; LANE 0-7 NEW STATUS
NEWSTSH EQU     0FH         ; LANE 8-15 NEW STATUS
COUNT1L EQU     10H         ; LO BYTE LANE 0-7 COUNT
COUNT1H EQU     11H         ; HI BYTE LANE 0-7 COUNT
COUNT2L EQU     12H         ; LO BYTE LANE 8-11 COUNT
COUNT2H EQU     13H         ; HI BYTE LANE 8-11 COUNT
COUNT3L EQU     14H         ; LO BYTE LANE 12-15 COUNT
COUNT3H EQU     15H         ; HI BYTE LANE 12-15 COUNT
STORE   EQU     16H         ; TEMP STORE FOR LANES 8-15
GAK     EQU     17H         ; SCRATCH REGISTER
COUNT   EQU     18H         ; FOR BCD CONVERSION ROUTINE
TEMP    EQU     19H         ; FOR BCD CONVERSION ROUTINE
HBYTE   EQU     1AH         ; BINARY IN FOR CONVERSION
LBYTE   EQU     1BH         ; BINARY IN
R0      EQU     1CH         ; BCD OUT: 2 MSD
R1      EQU     1DH         ; BCD OUT: 2 MIDDLE DIGITS
R2      EQU     1EH         ; BCD OUT: 2 LSD
D1      EQU     1FH         ; DELAY VALUE 1
D2      EQU     20H         ; DELAY VALUE 2
TRISB   EQU     86H         ; TRIS B  REGISTER ADDRESS
STATUS  EQU     3           ; FILE REG 3 = STATUS REG
Z       EQU     2           ; Z FLAG IS BIT 2 OF STATUS
C       EQU     0           ; C FLAG IS BIT 0 OF STATUS
FSR     EQU     4           ; FILE REG 4 = FSR REG
PORTA   EQU     5           ; PORT A ADDRESS  (EYE ADDR OUT; EYE DATA IN)
PORTB   EQU     6           ; PORT B ADDRESS  (DISPLAY CTRL & DIAG I/O)
ADCON1  EQU     8           ; A/D CONTROL REG #1 ADDR= 88H
;
;
        ORG     0
;
;       INIT ROUTINE :
;
MAIN    MOVLW   20H         ; RP0 BIT IN STATUS REG
        MOVWF   STATUS      ; ACCESS PAGE 1 (UPPER) FILE REGISTERS NOW
;
        MOVLW   03H         ; CONFIGURE PORTA TO ALL DIGITAL
        MOVWF   ADCON1      ; STORE AT ADDRESS 88H
;
        MOVLW   10H         ; CONFIGURE PORT A: RA4= IN; RA0-3= OUT
        MOVWF   PORTA       ; STORE AT ADDRESS 85H
        MOVLW   0F0H        ; CONFIGURE PORT B: RB4-7= IN; RB0-3= OUT
        MOVWF   PORTB       ; STORE AT ADDRESS 86H
;
        MOVLW   0           ; CLEAR W
```

```
        MOVWF   STATUS      ; ACCESS LOWER FILE REGISTERS NOW
;
        CLRF    OLDSTSL     ; LOW BYTE: OLD STATUS
        CLRF    OLDSTSH     ; HI  BYTE: OLD STATUS
        CLRF    COUNT1L     ; LANE 1 COUNT
        CLRF    COUNT1H
        CLRF    COUNT2L     ; LANE 2 COUNT
        CLRF    COUNT2H
        CLRF    COUNT3L     ; LANE 3 COUNT
        CLRF    COUNT3H
;
;        BTFSS   PORTB,4    ; SEE IF DIAGNOSTIC PB IS PRESSED
;        GOTO    DIAGS      ; DIAGNOSTIC ROUTINES
;
        CALL    DELAY       ; LET EYES STABILIZE
        CALL    DELAY
        CALL    DELAY
        CALL    INITD       ; INIT LCD DISPLAY
;
;TEST    CALL    RDEYES      ; READ EYES TO NEWSTSH & L
;        MOVF    NEWSTSL,0  ; NEWSTS LO BYTE -> W
;        IORWF   NEWSTSH,0  ; OR NEWSTS LO &HI BYTES
;        BTFSS   STATUS,Z   ; IF ALL LANES = 0, IS OK
;        GOTO    EYEBAD     ; ELSE TELL USER AN EYE IS BAD
;        CLRWDT             ; RESET WATCHDOG TIMER
;
        CALL    HELLO       ; SAY "HELLO", WAIT 2 SECONDS
        BSF     PORTB,3     ; TURN MACHINE MOTOR ON
test    goto    test
;
;   <<< END OF INIT ROUTINE >>>
;
LOOP    CALL    RDEYES      ; READ EYES TO NEWSTSH & L
        CLRWDT              ; CLEAR WATCHDOG TIMER
;
;       CHECK FIRST 8 LANES FOR RAGS
;
        MOVLW   COUNT1L     ; PUT ADDR OF COUNT1L INTO FSR
        MOVWF   FSR         ; PUT INTO FSR REG
        MOVF    OLDSTSL,0   ; OLD STS LO BYTE -> W
        XORWF   NEWSTSL,0   ; LOOK FOR BIT CHANGES
        ANDWF   NEWSTSL,0   ; LOOK FOR 0 TO 1 TRANSITIONS
        CALL    UPDATE      ; ADD ALL 1s IN W TO REG(FSR) & INC FSR
;
        MOVF    OLDSTSH,0   ; OLD STS HI BYTE -> W
        XORWF   NEWSTSH,0   ; LOOK FOR BIT CHANGES
        ANDWF   NEWSTSH,0   ; LOOK FOR 0 TO 1 TRANSITIONS
        MOVWF   STORE       ; STORE LANE 8-15 DATA
        ANDLW   0F0H        ; SAVE LANE 8-11 DATA
        CALL    UPDATE      ; ADD ALL 1s IN W TO REG(FSR) & INC FSR
;
        MOVF    STORE,0     ; GET STORED LANE 8-15 DATA
        ANDLW   0FH         ; SAVE LANE 12-15 DATA
        CALL    UPDATE      ; ADD ALL 1s IN W TO REG(FSR) & INC FSR
;
        CALL    DISPLAY     ; UPDATE 3 LANE COUNTS ON LCD
;
        GOTO    LOOP
;
; ***   ROUTINE TO READ 16 EYES  INTO NEWSTSH AND NEWSTSL
;
RDEYES  CLRF    NEWSTSH     ; INIT STATUS TO 0 FOR START
        CLRF    NEWSTSL     ; INIT LOW BYTE "    "
        MOVLW   0FH         ; HIGHEST EYE ADDRESS
        MOVWF   PORTA       ; WRITE TO PORT A (74150 IC)
;
```

```
RDLOOP  NOP                 ; 200 NS DELAY
        NOP                 ; 200 NS DELAY
        NOP                 ; 200 NS DELAY
        NOP                 ; 200 NS DELAY
        NOP                 ; 200 NS DELAY (1 uS TOTAL)
        BCF     STATUS,0    ; CLEAR CARRY BIT IN STATUS REG
        BTFSC   PORTA,4     ; TEST CURRENT EYE (1 OR 0)
        BSF     STATUS,0    ; SET CARRY BIT (MOVE EYE BIT TO CARRY)
        RLF     NEWSTSL     ; SHIFT BIT LEFT INTO NEWSTS H & L
        RLF     NEWSTSH     ; SHIFT MSB OF NEWSTSL TO LSB OF NEWSTSH
        BCF     PORTA,4     ; CLEAR CURRENT EYE BIT
        DECFSZ  PORTA,1     ; DO FOR ALL 16 LANES
        GOTO    RDLOOP      ; DO ANOTHER LANE
        RETURN              ; DONE
;
; ***   ROUTINE TO INITIALIZE LCD DISPLAY
;
INITD   MOVLW   03H         ; FUNCTION SET CMD: 8 BIT
        CALL    WRCMD
        CALL    DELAY       ; WAIT 4.1 MILLISECONDS
        MOVLW   03H         ; FUNCTION SET CMD
        CALL    WRCMD
        CALL    DELAY       ; WAIT 4.1 MILLISECONDS
        MOVLW   03H         ; FUNCTION SET CMD: 4 BIT
        CALL    WRCMD
        MOVLW   02H         ; CURSOR HOME
        CALL    WRCMD
        MOVLW   02H         ; CURSOR HOME
        CALL    WRCMD
        MOVLW   01H         ; CLEAR DISPLAY
        CALL    WRCMD
        MOVLW   06H         ; ENTRY MODE SET: INC, NO SHIFT
        CALL    WRCMD
        MOVLW   0CH         ; DISPLAY ON, NO CURSOR, NO BLINK
        CALL    WRCMD
        RETURN
;       *** CAN PUT "HELLO" MESSAGE HERE THEN WAIT 3 SEC, THEN CLEAR DISPLAY
;
; ***   ROUTINE TO CLEAR DISPLAY (BUT NOT INIT)
;
CLEARD  MOVLW   01H         ; CLEAR DISPLAY COMMAND
        CALL    WRCMD
        CALL    DELAY2      ; DELAY FOR 2 MILLISECONDS
        RETURN
;
; ***   ROUTINE TO DELAY FOR 2 OR 4 MILLISECONDS
;
DELAY   CALL    DELAY2      ; DELAY 2 mS
        CALL    DELAY2      ; DELAY 2 mS
        RETURN
DELAY2  MOVLW   03H         ; DELAY VALUE
        MOVWF   D2          ; DELAY VALUE 2
        CLRF    D1          ; DELAY VALUE 1
DLOOP   INCFSZ  D1          ; INNER LOOP WILL XEQ 256 TIMES
        GOTO    DLOOP
        DECFSZ  D2
        GOTO    DLOOP
        RETURN
;
; ***   ROUTINE TO DISPLAY 3 COUNTS ON LCD:  DATA TO RA0-3, E= RB1, RS= RB0
;       USES FSR
;       COUNTS ARE IN COUNT1H, COUNT1L THRU COUNT3H, COUNT3L
;
;       DISPLAY FORMAT: 0123456789ABCDEF
;                       1111    22223333
DISPLAY CALL    CLEARD          ; CLEAR DISPLAY TO START
```

```
        MOVF    COUNT1L,0       ; COUNT1 LO BYTE -> W
        MOVWF   LBYTE           ; PUT IN LBYTE
        MOVF    COUNT1H,0       ; COUNT1 HI BYTE -> W
        MOVWF   HBYTE           ; PUT IN HBYTE
        CALL    SENDIT          ; SEND TO DISPLAY IN ASCII @ CURSOR POS
;
        MOVLW   0C0H            ; C0= COMMAND TO ADDRESS R HALF OF DISPLAY
        CALL    WRCMD           ; SEND IT TO DISPLAY
;
        MOVF    COUNT2L,0       ; COUNT2 LO BYTE -> W
        MOVWF   LBYTE           ; PUT IN LBYTE
        MOVF    COUNT2H,0       ; COUNT2 HI BYTE -> W
        MOVWF   HBYTE           ; PUT IN HBYTE
        CALL    SENDIT          ; SEND TO DISPLAY IN ASCII @ CURSOR POS
;
        MOVF    COUNT3L,0       ; COUNT3 LO BYTE -> W
        MOVWF   LBYTE           ; PUT IN LBYTE
        MOVF    COUNT3H,0       ; COUNT3 HI BYTE -> W
        MOVWF   HBYTE           ; PUT IN HBYTE
        CALL    SENDIT          ; SEND TO DISPLAY IN ASCII @ CURSOR POS
        RETURN
;
; ***   ROUTINE TO CONVERT HBYTE,LBYTE TO BCD, TO ASCII, AND DISPLAY IT
;                               AT CURRENT DISPLAY POSITION
;
SENDIT  CALL    B2BCD           ; CONVERT HBYTE,LBYTE TO R0,R1,R2
        SWAPF   R1,0            ; PUT THOUSANDS, HUNDREDS IN W
        ANDLW   0FH             ; SAVE THOUSANDS DIGIT
        BTFSC   STATUS,Z        ; IF NON-ZERO DIGIT, CONTINUE
        GOTO    ZEROTHOU        ; SEND A SPACE FOR THOUSANDS DIGIT
        ANDLW   30H             ; MAKE AN ASCII DIGIT
THOU    CALL    WRDAT           ; SEND THOUSANDS DIGIT TO DISPLAY
        MOVF    R1,0            ; GET HUNDREDS DIGIT IN W
        ANDLW   0FH             ; SAVE HUNDREDS ONLY
        BTFSC   STATUS,Z        ; IF NON-ZERO DIGIT, CONTINUE
        GOTO    ZEROHUND        ; SEND A SPACE FOR HUNDREDS DIGIT
        ANDLW   30H             ; MAKE IT ASCII
HUND    CALL    WRDAT           ; SEND HUNDREDS DIGIT TO DISPLAY
        SWAPF   R2,0            ; PUT TENS, ONES IN W
        ANDLW   0FH             ; SAVE TENS DIGIT
        BTFSC   STATUS,Z        ; IF NON-ZERO DIGIT, CONTINUE
        GOTO    ZEROTENS        ; SEND A SPACE FOR TENS DIGIT
        ANDLW   30H             ; MAKE AN ASCII DIGIT
TENS    CALL    WRDAT           ; SEND TENS DIGIT TO DISPLAY
        MOVF    R2,0            ; GET ONES DIGIT IN W
        ANDLW   0FH             ; SAVE ONES DIGIT ONLY
        ANDLW   30H             ; MAKE AN ASCII DIGIT
ONES    CALL    WRDAT           ; SEND ONES DIGIT TO DISPLAY
        RETURN
;
ZEROTHOU        MOVLW   20H     ; ASCII SPACE CHARACTER
                GOTO    THOU    ; SEND IT
ZEROHUND        MOVLW   20H     ; ASCII SPACE CHARACTER
                GOTO    HUND    ; SEND IT
ZEROTENS        MOVLW   20H     ; ASCII SPACE CHARACTER
                GOTO    TENS    ; SEND IT
;
; ***   ROUTINE TO CONVERT HBYTE,LBYTE (BINARY 16)
;               TO R0, R1, R2  (BCD)  R1= THOU,HUND  R2= TENS,ONES
;
B2BCD   BCF     STATUS,0        ; CLEAR THE CARRY BIT
        MOVLW   10H             ; COUNTER= 16
        MOVWF   COUNT           ; NEED TO ITERATE 16 TIMES
        CLRF    R0              ; CLEAR RESULT REG'S
        CLRF    R1              ; ""
        CLRF    R2              ; ""
```

```
LOOP16  RLF     LBYTE           ; ROTATE LBYTE THROUGH CY
        RLF     HBYTE           ; ROTATE HBYTE THROUGH CY
        RLF     R2
        RLF     R1
        RLF     R0
        DECFSZ  COUNT           ; 16 TIMES YET ?
        GOTO    ADJDEC          ; DECIMAL ADJUST RESULT
        RETURN
;
ADJDEC  MOVLW   R2              ; POINT TO R2
        MOVWF   FSR             ; WITH FSR
        CALL    ADJBCD
        MOVLW   R1              ; POINT TO R1
        MOVWF   FSR             ; WITH FSR
        CALL    ADJBCD
        MOVLW   R0              ; POINT TO R0
        MOVWF   FSR             ; WITH FSR
        CALL    ADJBCD
        GOTO    LOOP16
;
ADJBCD  MOVLW   3
        ADDWF   0,W
        MOVWF   TEMP
        BTFSC   TEMP,3
        MOVWF   0
        MOVLW   30H
        ADDWF   0,W
        MOVWF   TEMP
        BTFSC   TEMP,7
        MOVWF   0
        RETURN
;
; ***   ROUTINE TO SEND BYTE IN W TO DISPLAY AS COMMAND
;
WRCMD   BCF     PORTB,0    ; RS=0 FOR COMMAND BYTE
        GOTO    WRDISP     ; REST OF ROUTINE SAME AS WRDAT
;
; ***   ROUTINE TO SEND BYTE IN W TO DISPLAY AS DATA
;
WRDAT   BSF     PORTB,0    ; RS=1 FOR DATA BYTE
WRDISP  BCF     PORTB,1    ; CLEAR E (ENABLE) BIT TO DISPLAY
        MOVWF   GAK        ; SAVE W
        SWAPF   GAK,0      ; SWAP MSN, LSN OF BYTE TO SEND; RESULT TO W
        ANDLW   0FH        ; SAVE  WHAT WAS MSN
        MOVWF   PORTA      ; PUT DATA OUT TO DISPLAY (4 BITS)
        BSF     PORTB,1    ; SET E (ENABLE) BIT TO DISPLAY
        NOP                ; WAIT 1 uS
        BCF     PORTB,1    ; CLEAR ENABLE BIT
        MOVF    GAK,0      ; GET LSN OF DATA
        ANDLW   0FH        ; SAVE WHAT WAS LSN
        MOVWF   PORTA      ; PUT DATA OUT TO DISPLAY (4 BITS)
        BSF     PORTB,1    ; SET E (ENABLE) BIT TO DISPLAY
        NOP                ; WAIT 1 uS
        BCF     PORTB,1    ; CLEAR ENABLE BIT
        RETURN             ; DONE
;
; ***   ROUTINE TO TELL USER AN EYE IS BAD
;
EYEBAD  MOVLW   'E'        ; SEND "EYE BAD" MESSAGE TO LCD AND STOP
        CALL    WRDAT
        MOVLW   'Y'
        CALL    WRDAT
        MOVLW   'E'
        CALL    WRDAT
        MOVLW   ' '
        CALL    WRDAT
```

Take control of your future with electronics training from CIE.

Learn in your own home, at your own pace.

With training from CIE, you could be working at the job you want, earning the money you deserve. CIE lets you learn electronics right in your own home, at your own speed. You can complete your CIE coursework while you're still at your current job. You can complete it as fast or as slowly as you choose. And the faster you finish, the more CIE can help you save money.

Take your place on the Information Superhighway.

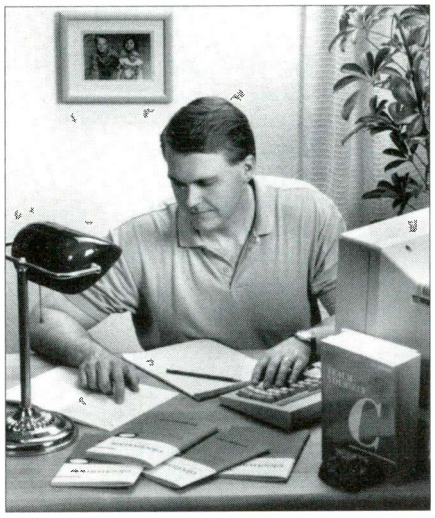
CIE training or a CIE degree will qualify you to be part of one of the hottest, fastest-growing fields around — electronics. And you'll play a major role in keeping the nation's much-discussed Information Superhighway up to speed and running smoothly.

Learn from the world leader in home-study electronics.

At CIE, we teach electronics, and nothing but electronics. We're not only the biggest home-study electronics school, but also the best. And why not? We've been teaching it for 60 years. We've graduated more than 150,000 people from over 70 countries. And we're fully accredited. That's why employers and CIE graduates alike know the value of electronics training from CIE.

Concentrate on your own area of interest.

CIE gives you 12 courses and a proven degree program to choose from. CIE training qualifies you for work in broadcast engineering, communications systems, digital logic and systems training, automotive electronics, computer maintenance, microprocessor technology, and much more. In fact, CIE pioneered the very first Electronic Laboratory course and the first Microprocessor course.



Learn electronics from the world leader, right in your own home.

Even if you're not sure what you'd like to specialize in, we can get you started on the basics. And once you've successfully completed one CIE course, you can apply academic credits and tuition credits to any new CIE courses you take. Each and every CIE course counts toward earning your degree.

A patented method of personalized instruction.

Through CIE's exclusive AUTO-PROGRAMMED® teaching method, your instructors give you prerecorded, easy-to-follow, step-by-step instructions. Some courses are geared toward beginners and some toward professionals already familiar with the electronics field.

No matter which course you take, you'll have everything you need to learn on your own at home: lesson guides, books, even lab equipment. All materials you can use at your current job or keep for your new job after you've earned your degree. *And if you ever need any help at all, just call your instructor toll-free.*

What are you waiting for?

Isn't it time you joined one of the fastest-growing professions around? Isn't it time you earned a salary well above the national average? ***Then now's the time to find out more about CIE.***

Contact CIE today for more information.

Call us toll-free at 1-800-243-6446, or call 216-781-9400. You may also fill out the attached postage-paid card or the coupon below and drop it in the mail, or fax it to CIE at 216-781-0331. We'll send you our FREE 40-page CIE home study course catalog with details on CIE courses and the CIE associate's degree.

Take Control Of Your Future.

Send me a FREE CIE course catalog and details on a CIE associate's degree.

(Please Print Neatly)

Name_____

Address_____

City_____

State, Zip_____

Phone ( ) _____

Age_____

CIE

1776 East 17th Street • Cleveland, Ohio 44114

A School of Thousands. A Class of One. Since 1934.

AO39

many connectors, disk drives and sensitivity to vibration and temperature extremes. Operating costs are low, and the system is virtually maintenance-free. The entire hardware can be replaced quickly as a module at minimal cost. In fact, for an industrial application like this rag counter, the low component count and, thus, low cost of the project make it practical to have on hand a spare electronics package should the system fail for any reason. Most important to me is that the operators of this machine now feel better about using it. They know it won't break down frequently and is simpler to use. It even says "hello" to them each morning.

Obviously, there aren't many of you—if any—who will need a rag-counting system like the one described here. I've presented this particular application basically to show you how modern technology can be implemented in a cost-effective way to solve a tricky problem in a harsh environment. I hope the idea presented here spurs you on to using PICs in your own designs, even if only to adapt my basic idea to a particular application you have in mind. ■

```
        MOVLW   'B'
        CALL    WRDAT
        MOVLW   'A'
        CALL    WRDAT
        MOVLW   'D'
        CALL    WRDAT
        MOVLW   '!'
        CALL    WRDAT
EVER    GOTO    EVER
;
;       ROUTINE TO SEND WELCOME TO USER VIA LCD
;
HELLO   MOVLW   20H         ; SPACE
        CALL    WRDAT
        MOVLW   20H
        CALL    WRDAT
        MOVLW   20H
        CALL    WRDAT
        MOVLW   'H'
        CALL    WRDAT
        MOVLW   'E'
        CALL    WRDAT
        MOVLW   'L'
        CALL    WRDAT
        MOVLW   'L'
        CALL    WRDAT
        MOVLW   'O'
        CALL    WRDAT
DELAY3  MOVLW   0           ; LONG DELAY
        MOVWF   GAK
DELAY3A CALL    DELAY
        DECFSZ  GAK
        GOTO    DELAY3A
        RETURN
;
; ***   DIAGNOSTIC ROUTINES
;
DIAGS   GOTO    MAIN        ; <<<<< DIAGNOSTIC ROUTINES >>>>>
;
; ***   ROUTINE TO ADD ALL 1'S IN W TO REG(FSR) AND INC FSR
;
UPDATE  MOVWF   GAK         ; PUT INTO TEMP STORAGE
        CALL    UPDAT1      ; CHECK 4 LSB FOR RAGS
        SWAPF   GAK,1       ; SWAP MSN,LSN OF STORED W
        CALL    UPDAT1      ; CHECK 4 LSB FOR RAGS
        INCF    FSR         ; POINT TO HI BYTE
        INCF    FSR         ; POINT TO LO BYTE OF NEXT LANE
        RETURN
UPDAT1  BTFSC   GAK,0       ; TEST LANE 0
        CALL    ADDIT       ; ADD 1 FOR LANE 0
        BTFSC   GAK,1       ; TEST LANE 1
        CALL    ADDIT       ; ADD 1 FOR LANE 1
        BTFSC   GAK,2       ; TEST LANE 2
        CALL    ADDIT       ; ADD 1 FOR LANE 2
        BTFSC   GAK,3       ; TEST LANE 3
        CALL    ADDIT       ; ADD 1 FOR LANE 3
        RETURN
ADDIT   INCF    0           ; COUNT 1 RAG IN FILE REG @FSR
        BTFSS   STATUS,Z    ; IF ZERO, MUST INC HI BYTE
        RETURN              ; ELSE WE ARE DONE HERE
        INCF    FSR         ; POINT TO HI BYTE
        INCF    0           ; COUNT 1 IN HI BYTE
        DECF    FSR         ; POINT TO LOW BYTE
        RETURN              ; NOW WE ARE DONE
;
        END
```

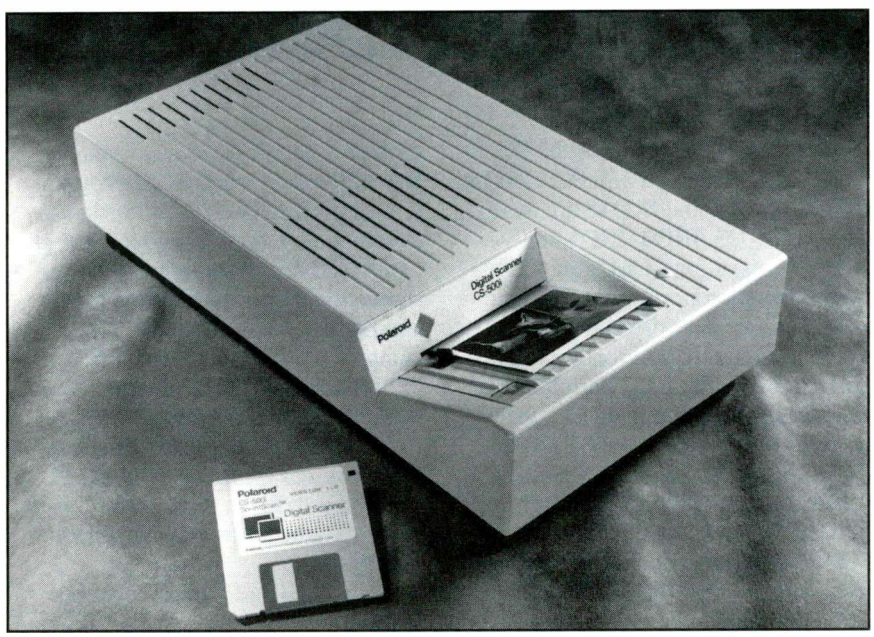
By Steven Sweet

Image Scanners

Better resolution, more colors and sophisticated support software, all at tumbling prices, put PC imaging within the reach of even the smallest business and most personal users

The world of personal computing is an ever-changing one. Frequently, items that just a year or so previously seemed to be so far out of reach for the average user suddenly become relatively low-cost standard parts of the typical PC setup. In just the past couple of years, we've seen 486 machines become "entry level" products as faster more-powerful PCs hit the marketplace, True Color graphics in all but the most basic PCs, the wave-table look-up sound card rapidly becoming must-have items, along with a good CD-ROM drive, currently now pushing the performance envelope to quadruple speed, in a multimedia setup. Let's not forget the evolution of local-bus slots and products that are sweeping aside traditional architectures, the advent of PCMCIA and even the arrival of thermal wax-transfer printing for less than $1,000. So will you be yearning for a 100-MHz Pentium PC for less than $2,000 next year? Given recent development and pricing trends, this dream is likely to become a reality in short order.

Back in 1988, when Hewlett-Packard, Apple and Microtek introduced "low-cost" flatbed scanners, these devices were associated with high cost and limited compatibility and lacked software applications to support them. In recent months, though, image scanners that only professional graphics artists could heretofore justify purchasing have begun to make a position move in the marketplace. Now graphics artists, desktop publishers, image editors and even office word processors benefit from the rapid hardware evolution, price reductions and software developments that are converging to make scanning a must-have and cost-effective technology for your desktop microcomputer. So if you're into any of the specialties that traditionally use graphics arts, chances are good that the next computer peripheral you'll be buying to attach to your computer will be an image-scanning device.



Polaroid CS-500i Digital Scanner.

Today, there are more choices than ever in desktop scanner prices for optical-character-recognition (OCR), document-imaging and desktop-publishing projects. On the high end, there are scores of models that cost $3,000 or more. Some models, like the Okidata DOC.IT, feature multiple functions, offering faxing, scanning, printing and copying in one machine for $3,999. Sophisticated film scanners are available to those who need more-specific scanning functions. Recently, a new class of scanners lets you scan business cards into your desktop PC.

Most of the age scanners discussed here are low- to mid-range products. All cost less than $3,000 and are designed to scan reflective media, such as line drawings, documents, photographs and text.

The Hookup

While many of the scanners discussed are plug and play, others require installations that involve configuring the computer's hardware interrupt number (IRQ) and Direct Memory Access (DMA) channel. Every peripheral requires an IRQ, which is the hardware line that's used to send ser-

Mustek CG-8000 ColorArtist Pro.

vice requests to the CPU in the PC. On ISA 286, 386 and 486 PCs, IRQ 9, IRQ10, IRQ11 and IRQ15 are available and IRQ3, IRQ4, IRQ5 and IRQ7 are used for COM2 and COM1 communication ports and LPT2 and LPT1 and printer ports, respectively. Some peripherals also require a DMA channel over which the peripheral transfers data to and from the system memory, bypassing the CPU. Your PC will always use DMA Channels 2 and 4, leaving DMA Channels 0, 1, 3, 5, 6 and 7 available.

Most scanners use a SCSI adapter to connect to the PC. For the PC, the SCSI connection had a history of compatibility problems. Not any more. Look for the more-compatible SCSI-2 standard, which has eliminated the old hardware compatibility problems and boosted performance. Use of the Advanced SCSI Programming Interface (ASPI) DOS Manager developed by Adaptec, which has garnered near universal industry driver standards, permits easier hookup of any SCSI scanner to the PC. The Adaptec SCSI Master 1540C Kit ($299) and Future Domain SCSI ValuePAK ($169) offer easy plug-and-play installation of up to seven SCSI devices (scanners, CD-ROM drives, hard drives, tape drives, etc.) via automatic software-controlled installation.

Some hand and flatbed scanners hook up to a PC's printer port. For instance, the bidirectional parallel card interface that comes with Epson's ES-600 or ES-800 ActionScanning Systems simply makes use of your PC's LPT2 port, while some hand scanners hook up to the LPT1 port and share the port with a printer. Such hookups usually come with software drivers that sense the presence of a scanner on the printer port so as not to interfere with printer signals.

Since most scanners fall into either the SCSI or printer-port variety, you can and should avoid using proprietary hookups that usually can result in conflicts with other hardware installations in your PC.

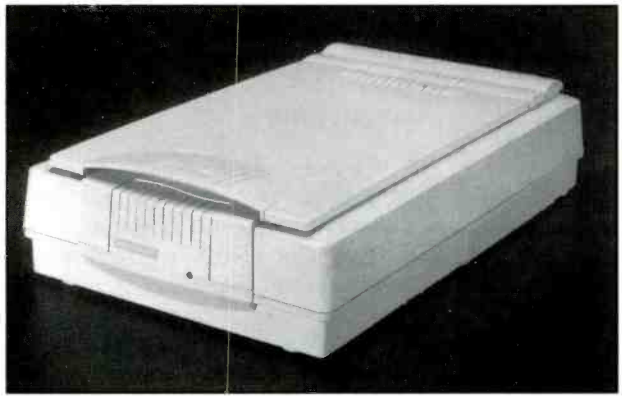
Reportedly, when *Windows* 4.0 (*Chicago*) is released in 1995, it will offer plug-and-play hardware and software support to make adding peripherals much easier for the user. Currently, when you install *Windows* on your system, the installation program checks your system's configuration. In *Windows* 4.0, the installation program both checks your system's configuration and determines what peripherals are installed and IRQs, I/O addresses and DMA channels are used and available. Through a series of questions, the program determines the setup of any new peripherals you wish to install with Windows 4.0. Microsoft will also rely on a Plug and Play BIOS chip being available for the PC to make plug-and-play setup even easier.

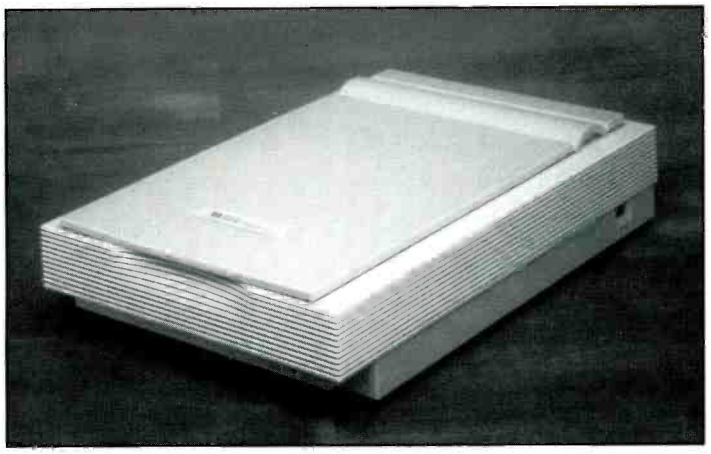
Scanning Explained

All scanners reviewed here employ charged-coupled device (CCD) photoreceptors. The CCDs are arranged in a strip along the scanning head, which moves beneath the page. A light source, usually a fluorescent

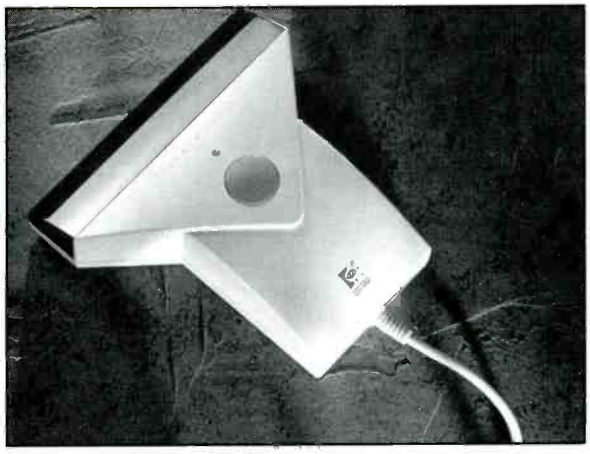
AGFA/Miles StudioScan.→

Mustek Paragon 1200. ↓

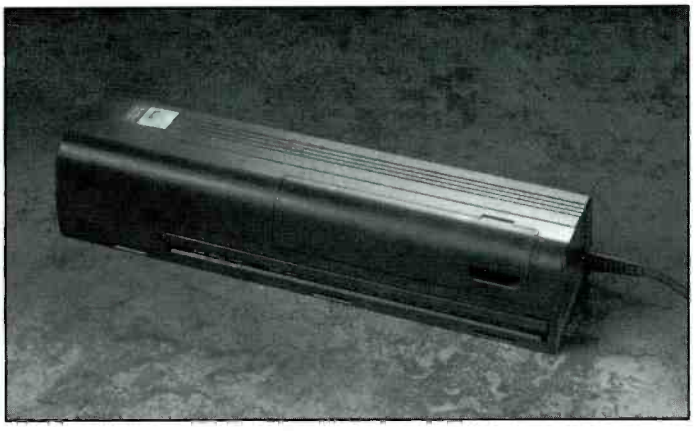




Hewlett-Packard ScanJet IICX.



Logitech ScanMan Color.



Logitech ScanMan PowerPage.

Logitech ScanMan Easy Touch.

cool-white tube, illuminates the image placed on a flat glass plate. The light is reflected onto the CCD photoreceptors, which convert it into an electrical charge. The charge varies with the intensity of the light reflected and is converted into a digital signal that the computer turns into an image it can store and display.

Scanner resolution is determined by the number of photoreceptors in the array, which is usually 300, 400 or 600. Color filters are placed in front of the array of CCDs to create up to 16.7-million variants of basic red, green and blue in a 24-bit scanner. The scanner accomplishes this with either three passes or a single pass under the image being scanned. In triple-pass scanning, the light source moves under the image, reflects off it and passes through a red, green or blue filter onto one CCD photoreceptor. After all three colors have been scanned, the three scans are superimposed to create the final image.

Several single-pass scanning techniques are used. The fastest uses a beam splitter (prism) to break the white-light reflection of the scanned image into three beams that are then read through separate CCD photoreceptors that are coated with red, green and blue filters. These are then combined into a single image for the computer to digitally store. Slower single-pass techniques include strobing through different colors of light and line-by-line switching between colored filters.

Obviously, a single-pass scanner offers less wear on the scanner's mechanical elements because the motor has to make only one pass under the image being scanned. However, a scanner must also superimpose the red, green and blue layers, convert analog to digital format and transmit the color signals to the PC. The more efficiently these tasks are handled by the scanner's processor, the faster the scan operation. As far as color fidelity is concerned, some triple-pass scanners, like Envision's ENV8100 ($799), outdo single-pass scanners. Speed tests on several scanners reportedly have shown that the single-pass Hewlett-Packard ScanJet IIcx ($1,179) was the fastest.

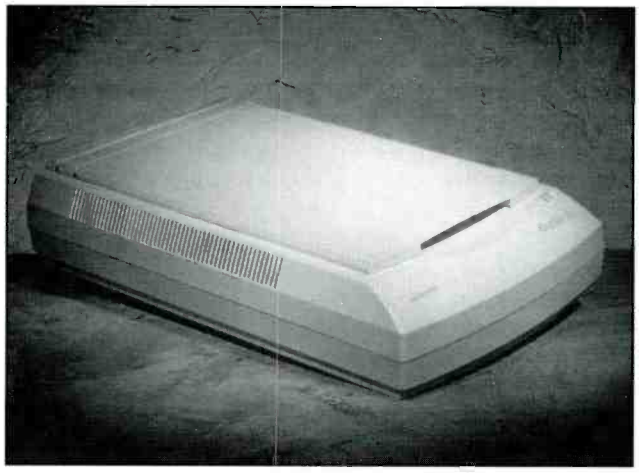
Most scanners offer optical resolutions of 300 or 400 dots per inch (dpi), which is adequate for most needs. Some units boost their dpi capabilities—and their ratings—with a software technique called interpolation. Interpolation lets some scanners offer two types of resolution: optical resolution, which is based on how many light sensors span the scanner's horizontal CCD photosensor array, and interpolated resolution, which is created by software. For example, a typical 300-dpi scanner with 300 sensors per horizontal inch, may also feature interpolation to 600 dpi, 1,200 dpi or 2,400 dpi. In such cases, the unit is relying on a software algorithm to calculate the likelihood that data should exist in certain places. The software then uses this data to fill in empty spaces and smooth out jagged edges. This type of scan takes longer at 600 dpi, creates a larger file to store the extra data and takes longer to print

PAGE SCANNERS

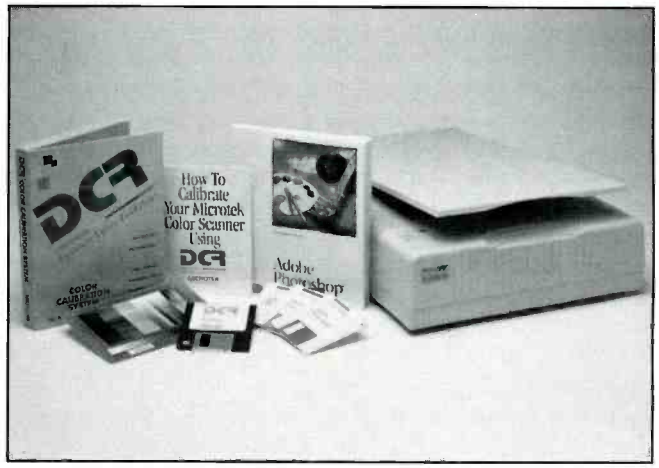
Manufacturer	Model	Price	Passes	Type	OPR	IR	Speed	Interface	Supplied Items
AGFA/Miles, Inc.	Acrus Plus	$3,950	One	256 Grayscale, 24-Bit Color	600	2,400	0.5 ppm	SCSI-2	*PC View Color, Photoshop*, SCSI Card
	Studio ScanII	995	One	256 Grayscale, 24-Bit Color	400	2,400	—	SCSI-2	*Photoshop LE, FotoTune LE, FotoLook* OCR, SCSI Card
Apple Computer, Inc.	OneScanner	895	One	256 Grayscale, B/W	300	—	—	SCSI	NA
	Color OneScanner	1,295	Three	24-Bit Color	300	1,200	—	SCSI	*Ofoto*, SCSI Card
Canon Computer Systems, Inc.	IX-4015 Color	1,175	One	256 Grayscale, 24-Bit Color	400	800	1 ppm	SCSI	Ofoto
Envisions Solutions	ENV6100	599	Three	256 Grayscale, 24-Bit Color	600	1,200	1.3 ppm	SCSI	*Image Folio, Textbridge*, SCSI Card
Technologies	ENV8100	799	Three	256 Grayscale, 24-Bit Color	800	1,600	1 ppm	SCSI	*Image Folio, Textbridge*, SCSI Card
	ENV24PRO	1,199	Three	256 Grayscale, 24-Bit Color	1,200	2,400	1.3 ppm	SCSI	*Image Folio, Textbridge*, SCSI Card
	DynamicPro 30	2,999	One	256 Grayuscale, 24-Bit Color	800	1,200	1 ppm	SCSI	*Image Folio, Textbridge*, SCSI Card
Epson America, Inc.	ES-600C	999	One	256 Grayscale, 24-Bit Color	300	600	2 ppm	Parallel Port	*Picture Publisher LE, Textbridge*, Parallel Card
	ES-800C	1,449	One	256 Grayscale, 24-Bit Color	400	1,600	2 ppm	Parallel Port	*Photoshop, Textbridge*, Parallel Card
Hewlett-Packard Co.	ScanJet IIp	895	One	256 Grayscale	300	1,200	2 ppm	SCSI	*PhotoStyler LE, AccuPage* OCR, Proprietary SCSI Card
	ScanJet IIcx	1,179	One	256 Grayscale, 24-Bit Color	400	1,600	1 ppm	SCSI	*PhotoStyler LE, AccuPage* OCR, Proprietary SCSI Card
Microtek Lab Inc.	ScanMaker IIG	649	Three	64 Grayscale	300	1,200	0.85 ppm	SCSI	*OmniPage Direct, Image Assistant, FaxMaster*, ASPI Driver
	ScanMaker IISP	799	One	256 Grayscale, 24-Bit Color	300	1,200	0.85 ppm	SCSI	*Photoshop LE, PageKeeper*, ASPI Drive, DCR Kit
	ScanMaker IIHR	1,499	Three	256 Grayscale, 24-Bit Color	600	2,400	1 ppm	SCSI	*Photoshop*, DCR Kit
	ScanMaker III	3,499	One	256 Grayscale, 24-Bit Color	600	2,400	2 ppm	SCSI	*Photoshop*, DCR Kit
Mustek, Inc.	Paragon 1200	1,995	Three	256 Grayscale, 24-Bit Color	1,200	—	4 ppm	SCSI	*Photoshop LE, Perceive* OCR
Nikon Electronic Imaging, Inc.	AX-200 Scantach	1,535	Three	256 Grayscale, 24-Bit Color	1,200	2,400	—	SCSI-2	*Photoshop* Plug-In
Relisys, Inc.	Reli 2400	1,399	One	256 Grayscale, 24-Bit Color	300	2,400	3ppm	SCSI-2	*ImagePals, Wordscan*
	Reli9600	2,699	One	24-Bit Color	600	9,600	2 ppm	SCSI-2	*Photoshop, Wordscan*, Transparency Unit
Sharp Electronics Corp.	JX-325	1,396	One	256 Grayscale, 24-Bit Color	600	1,200	0.65 ppm	SCSI-2	*Photoshop*, SCSI-2 Card
Tamarack Technology Corp.	ArtiScan 6000C	895	Three	256 Grayscale, 24-Bit Color	300	600	0.5 ppm	SCSI or Parallel	*PhotoStyler, Calera* OCR, Choice of Card
	ArtiScan 8000C	1,095	Three	256 Grayscale, 24-Bit Color	400	800	0.31 ppm	SCSI or Parallel	*PhotoStyler, Calera* OCR Choice of Card
	ArtiScan 12000C	1,699	Three	256 Grayscale, 24-Bit Color	600	1,200	0.73 ppm	SCSI or Parallel	*Photoshop, Calera* OCR Choice of Card
UMAX Technologies, Inc.	UC630 ScanOffice	999	Three	256 Grayscale, 24-Bit Color	600	1,200	0.4 ppm	SCSI	*Picture Publisher or, Photoshop LE, Windows Draw Business Card Reader, Cuneiform* OCR, SCSI Card

	UC840 ScanOffice	1,495	Three	256 Grayscale, 24-Bit Color	800	1,600	0.54 ppm	SCSI	*Picture Publisher or, Photoshop LE, Windows Draw Business Card Reader, Cuneiform* OCR, SCSI Card
	UC1260 Pro	1,395	One	256 Grayscale, 24-Bit Color	1,200	2,400	0.54 ppm	SCSI-2	*Photoshop, Kai's Power Tools, Business Card Reader, Cuneiform* OCR, SCSI-2 Card
	PowerLook	4,,600	One	256 Grayscale, 30-Bit Color	1,200	2,400	1 ppm	SCSI	*Photoshop, Kai's Power Tools,* OmniPage Direct, Transparency Adapter, SCSI-2 Card
HAND SCANNERS									
Caere Corp.	OmniScan	499	—	256 Grayscale (Eight-Bit)	400	—	—	Proprietary	*OmniPage Direct, FaxMaster, Image Assistant,* Interface Card
Envisions, Inc.	ENV Color	299	—	256 Grayscale, 24-Bit Color	800	—	—	Proprietary	*Halo Imager, Perceive* OCR, Interface Card
	ENV256	239	—	256 Grayscale	400	—	—	Proprietary	*Halo Imager, Perceive* OCR, Interface Card
Logitech, Inc.	ScanMan 256	259	—	256 Grayscale	400	—	—	Proprietary	*FotoTouch, OmniPage Direct* OCR, Interface Card
	ScanMan EasyTouch	399	—	256 Grayscale	100 to 400	—	—	Parallel Port	*OmniPage Direct* OCR, *FotoTouch*
	ScanMan Color	699	—	256 Grayscale, 24-Bit Color	100 to 400	—	—	Proprietary	*OmniPage Direct* OCR, *FotoTouch*, Interface Card
	ScanMan PowerPage (Full-Page Sheet-Fed)	799	—	256 Grayscale	25 to 400	—	—	Parallel Port	*OmniPage Direct* OCR, FotoTouch, WinFax Lite
Microtek, Inc.	ScanMaker Scooter (self-propelled)	549	—	256 Grayscale, 24-Bit Color	50 to 400	—	—	Proprietary	*Auto-Merge,* TrackPad Tracking Pad, Interface Card
Mustek, Inc.	Color Artist	695	—	256 Grayscale, 24-Bit Color	—	—	—	Proprietary	*Picture Publisher LE,* OCR Software, Interface Card
	ScanMagic	299	—	256 Grayscale, 18-Bit Color	—		—	Proprietary	*Picture Publisher LE,* OCR Software, Interface Card
	PrinScan	199	—	256 Grayscale	—	—	—	Parallel Port	OCR Software
FILM SCANNERS									
Eastman-Kodak Co.	RFS-2035[1]	7,999	—	24-Bit Color	250 to 2,000	—	[2]	SCSI	*Photoshop, PhotoStyler*
Microtek, Inc.	45T Slide Scanner[3]	7,999	One	12-Bit Grayscale, 36-Bit Color	[4]	—	—	SCSI	*Photoshop,* DCR Kit
	35T Slide Scanner	1,995	Three	256 Grayscale, 24-Bit Color	1,821	7,312	—	SCSI	*Photoshop LE*
Nikon, Inc.	CoolScan LS10 Slide Scanner	2,499 (Ext.), 2,199 (Int.)	—	24-Bit Color	up to 2,700	—	[5]	SCSI	Fractal Design *Colorstudio* CoolScan Control Photoshop Plug-In, SCSI Card
Polaroid Corp.	SprintScan35	2,495	One	256 Grayscale, 24-Bit Color	2,700dpi in 30 sec.	—	—	SCSI-2	*Photoshop*, SCSI-2 Card
3D IMAGE SCANNER									
Vidar/Truvel Systems Corp.	Desktop Imaging Studio T-3DC (Flat images and 2" Vertical Depth of Field)	6,295 (Grayscale), 8,695 (Color)	One	256 Grayscale, 24-Bit Color	75 to 900[7]	—	—	SCSI	*Photoshop LE*

Notes: [1]Handles slides and negatives; [2]Takes 30 seconds to scan full-frame 4.6M, 1m999-dpi image; [3]Multi-format scanner for film measuring up to 5" X 5"; [4]5K/10K-pixel resolution at 1,000 dpi/2,000 dpi; [5]Takes 90 seconds for a 72-dpi image, 12.5 minutes for full 2,700-dpi image; [6]Handles photos measuring up to 4" X 6"; [7]At 3,600 pixels per scan line.



Microtek ScanMaker III.



Microtek ScanMaker IIsp with DCR.

Microtek ScanMaker Scooter.

Nikon CoolScan LS10, external version.

the image. Interpolation plays a much larger role in color scanning than in black-and-white and grayscale work.

Image Acquisition

When scanners were first used, graphics artists who wanted to acquire and place an image into a project had to first leave the application in which they were working, locate and load a hardware driver, set the device options, acquire the image, save it to disk, close the hardware driver, return to the application and locate and load the image file from the disk. This was a time-consuming and tedious task. With the TWAIN image-acquisition standard developed by Aldus, Caere, HP, Eastman Kodak and Logitech, an open industry standard directly acquires image data from external sources (scanners, cameras, etc.) while the artist stays within the working application. The image manipulation, desktop publishing or OCR software needs only support the standard data acquisition manager (TWAIN), while the hardware vendor writes one TWAIN-compliant driver. TWAIN is supported on the IBM PC-compatible platform through *Windows* 3.1.

Included Software

Many of the vendors noted here bundle their scanners with a hardware interface kit that includes either image-manipulation (editing) or OCR software. Fortunately, if you plan to use your scanner for photo editing, many vendors include one of the industry's leading photo editing software: Adobe's *Photoshop* 2.5, Micrografx's *Picture Publisher* 4.0 (PC) or Aldus's *PhotoStyler* 2.0 (PC). If you're planning to use your scanner for scanning in text for word processing or desktop publishing, you'll find Xerox's *TextBridge*, Caere's *OmniPage Direct*, Calera Recognition's *WordScan Plus* or Ocron's *Perceive*. Scanners packaged with this software represent a great savings and enable you to use the devices' full potential. When shopping, check out whether you're getting a "lite" (LE) limited version or a full-featured version of the image-editing and/or OCR software with your scanner.

The current image editing software market offers some revolutionary tools to enable graphics artists and photo editors to shape reality as they want people to see it. When image-editing software first appeared in the marketplace, it was more like a "paint and touchup by pixel" kit. Now photo images are treated as objects to allow the image editor to layer, merge and move them around. Parts of photos can be manipulated as independent objects and then placed onto another photo for a desired effect. These new photo-editing tools work as vector-based (object-oriented) illustration programs. Older photo-editing tools worked as raster-based (pixel-oriented) painting programs.

Adobe's *Photoshop* 2.5 ($895) is the most widely used image editor on the Mac and *Windows* 3.1 PC platforms. It enables you to create original images using advanced painting

functions, retouch and edit photos and scanned images, make color corrections and produce four-color separations using RGB, HSL, grayscale or CMYK color values. It lacks a thumbnail manager that lets you view multiple image files simultaneously. It will handle .ESPF, .TIFF, .PICT, Photo CD, .JPEG, .GIF, .BMP, MacPaint and .RIB image files and is TWAIN-compliant.

Micrografx's *Picture Publisher* 4.0 ($595) is a popular *Windows* 3.1 product. It has three features to speed image editing: object layering of bitmap graphics, FastBits editing of a small area of a large image, and Low Resolution Image Open Option to apply changes to the whole image. It's TWAIN-compliant, supports "plug-in" special effects modules, RGB and CMYK color separation and has an EffectsBrowser effects manager and the ImageBrowser thumbnail image file-manager module. There's support for Photo CD, .JPEG, .TIFF, .GIF, .BMP, .PCX, .TGA, .EPS, .DCS files and *Windows* Object Linking and Embedding (OLE) and *Adobe Type Manager* and *TrueType* fonts. The full version provides a CD-ROM with tutorials and 300 photos.

Another reason the image-editing software programs are so widely used is that they can accommodate plug-in special effects filters like HSC Software's *Kai Power Tools* ($199) and Aldus's *Gallery Effects* ($199) that create painting effects that can emulate different art styles and textures to the scanned image.

Optical Character Recognition

An increasing application for image scanners is to import printed documents to a word processor or desktop publisher for editing, storage and future retrieval. The long hours of typing in the document have now been replaced by the use of a scanner and optical-character-recognition (OCR) software.

When a scanner scans a document, it converts the dark elements, text and graphics, on the page to a bitmap image that consists of a matrix of square pixels that are either on for black or off for white. The OCR software reads the bitmap image created, averaging out the on and off pixel zones on the page. Because pixels are larger than the details of most text, this process degenerates the sharp edges of characters,, which creates most of the problems for OCR software. Each new generation of OCR software deals with this problem to a better degree.

Mapping of the white space on the page enables the software to block off paragraphs, columns, headlines and random graphics. The white space between lines of text within a block defines each line's baseline, which is an essential detail for recognizing the characters in the text.

During its first pass at converting the images to text, the software tries to match each character through a pixel-by-pixel comparison to character templates it holds in memory. While most OCR software packages have templates of many fonts that range from 8 to 72 points in size, this technique demands identical matches for text recognition. Characters that remain unrecognized go through a more-intensive and time-consuming process called feature extraction. Basically, this calculates the text's x-height and analyzes each character's combination of straight lines, curves and bowls (hollow areas within loops,

as in the letters o and b). As the software builds a working alphabet of the new characters it encounters, recognition speed increases.

The two processes may still leave you with a few indecipherable characters that the software replaces with symbols like # or @. This may require use of a word processor to find the indecipherable characters and replace them with the correct characters. Other OCR software may launch a specialized spelling checker to search for obvious errors and locate alternatives for words that contain indecipherable characters.

Finally, the OCR software gives you the option of saving a converted document as an ASCII file or in the file format recognized by your word processor, desktop publisher or spreadsheet software. Caere's *OmniPage Direct* ($295), Calera's *WordScan Plus* ($595), Ocron's *Perceive* ($199) and Xerox's *TextBridge* ($99) are popular examples of reliable OCR software bundled with some scanner packages. Scanners bundled with this software represent great savings and let you use them to full potential. When shopping, check whether you're getting limited-edition (LE) or a full-featured software with your scanner.

Hardware Requirements

To achieve peak performance, desktop image scanners require computers with plenty of processing power. A realistic minimum configuration needed to support a scanner would be a 20-MHz 386 PC with 8M of RAM. For heavy OCR work or high-resolution color imaging, count on moving up to a minimum of a 33-MHz 486 PC with 16M of RAM.

The PC offers the color scanner four levels of color resolution. Basic VGA is four-bit color that displays 16 colors at resolutions up to 640 X 480. Super VGA is eight-bit color that displays 256 colors at up to 800 X 600 resolution. High color is 16-bit color that displays 32,000 colors at up to 1,024 X 768 resolution and is used for photographs and with color-scanning and digital video. True-color is 24-bit color that displays 16.7-million colors at up to 1,024 X 768 resolution. Use of display cards like the Hercules Graphic Station and Truevision Targa+ series ($499 to $1,300) is recommended for software that supports 16- and 24-bit color imaging. Serious photo editors should look into the VESA-compliant 32-bit local-bus (VLB) cards available for best and fastest results for their work.

If you want to work with images in SVGA or better, use a High Color accelerator card with the Sierra Semiconductor HiColor RAM DAC chip to produce 32K colors and speed up the refresh rate. To view scanned images, the configuration should include an SVGA video monitor and card capable of displaying a minimum 640 X 480 pixels with 256 colors, such as the Diamond Stealth series ($199 to $300). Ideally, you should have a 24-bit color card.

You may find that the SVGA accelerator cards available on today's market don't always live up to their name when high resolution (16- and 24-bit) image files need to be edited. Storm Technologies comes to your aid with the PhotoDSP 400 card ($399; $899 with full *Photoshop* software) designed for Adobe's *Photoshop* 2.5 for *Windows* to significantly improve the

B. G. MICRO

P. O. Box 280298 Dallas, Texas 75228
Orders Only 1-800-276-2206
Tech Support 214-271-9834
Fax 214-271-2462

VISA MasterCard

IF YOU DON'T SEE WHAT YOU NEED CALL US. 1-800-276-2206

CALL OR WRITE FOR FREE CATALOG. 1-800-276-2206

LCD DISPLAYS

OPTREX 2x16-DMC 1620H-8 Bit ASCII Input. Dim. 3 1/8 x 1 3/4 x 3/8
Char. Height .19" **$5.99**

OPTREX 2x20-DMC 20261-8 Bit ASCII Input Dim. 4 9/16 x 1 7/8 x 3/8
Char. Height .19" **$7.99**

OPTREX 1 x 16 "Backlit"-DMC16187- 8 Bit ASCII Input Dim. 3 1/8 x 1 3/8 x 9/16 Char. Height .11" **$9.95**

OPTREX 1 x 20-DMC 20171-8 Bit ASCII Input Dim. 7 3/16 x 1 5 /16 x 1/2 Char. Height . 42" **$9.95**

OPTREX 2 x 40-DMC 40218-8 Bit ASCII Input Dim. 7 3/16 x 1 5/16 x 13/32
Char. Height .19" **$9.95**

VERY EASY TO INTERFACE TO ALMOST ANY MICROPROCESSOR!

COOL IT DUDE!

Finned Heat Sink with Fan. Fits on CPU.

$11.45

DTMF

SSI-202 Decoder	**2.25**
8870 Decoder	**2.25**
5087 Generator	**2.00**
5089 Generator	**1.25**

EPROM SPECIAL

We bought a large quantity of 2708s, 2716s, 2532s, 2732s, 2764s, 27128s, 27256s, and 27512s from a computer manufacturer who redesigned their boards. We removed them from their sockets, erased and verified them, and now we offer the savings to you. Complete satisfaction guaranteed.

Your Choice	
2708.....1/20	10/8.00
2716.....1.75	10/15.00
2532.....2.00	10/17.50
2732.....2.00	10/17.50
2764.....2.00	10/17.50
27128.....2.50	10/20.00
27256.....3.00	10/25.00
27152.....4.75	10/40.00
1 Meg.....8.50	10/77.50

EPROM

8741	7.00
8742	7.00
8748	7.00
8749	7.00
8751H	12.95
8755	7.00

STATIC RAM

2016-2KK8 200 n.s.	1.00
2101-1 - 256X4 500 n.s.	.75
21L02-1 350 n.s.	.65
2102AL-4 L.P. 450 n.s.	.49
2111-1 256X4 500 n.s.	1.00
2112A-2	2.50
2114L-3 1KK4 300 n.s.	.45
2125A-2 1KK1 70 n.s.	1.00
2147 4KX1	1.00
2148	1.00
6116P-4	1.00
6117	1.20
8284	1.40
62256 32KX8	5.00
128KX8	15.00

DYNAMIC RAM

2108-4 8KX1	1.50
2118-4 16KX1-5 Volt	.70
4027-4KX1-260 n.s.	.80
4116-16KX1-250 n.s.	.40
116-16KX1-200 n.s.	.75
4116-16KX1-150 n.s.	.90
4128 Piggyback	2.00
4164-150n.s.	.49 or 9/3.50
4164-120n.s.	1.10
4164-100n.s.	1.40
TMS4416-16KX4-15 n.s.	2.75
4464-150n.s.	1.40
4464-120n.s.	1.45
4464-100n.s.	1.45
4464-80n.s.	1.45
41256-150n.s.	1.25 or 9/9.95
41256-120n.s.	1.30 or 9/10.99
41256-100n.s.	1.30 or 9/10.99
41256-80n.s.	1.30 or 9/10.99
41256-60 n.s.	1.85
1 Meg - 100 n.s.	4.40
1 Meg - 80 n.s.	4.40
414256-80 n.s. 256 x 4	4.60

SIPPS, SIMMS, & CACHE AVAILABLE

8000/80000

8001	5.20	8237	1.90	8088-2	3.25	8257	1.50
8002	2.50	8237-5	2.80	8155	2.25	8259 A	1.85
8010	4.95	8243	1.75	8156	2.25	8259C-5	2.10
8031	2.95	8250	2.95	8202A	8.00	8275	10.95
8032	3.95	(16450)	6.50	8212	1.25	8279	2.25
8035	1.00	(16550)	10.95	8214	2.00	8284	1.49
8036	4.95	8251	1.10	8216	1.25	8286	3.50
8039	1.00	8253-5	1.75	8224	1.25	8287	2.49
8085	1.55	8254	1.80	8228	1.75	8288	3.50
8086	1.55	8255	1.50			8530	3.00
8088	2.20	8255-5	1.75				

LOCAL AREA NETWORK

NETWORK

Little Big Lan

* Peer to Peer LAN to 250 nodes.
* $75 total software cost! No matter how many nodes!
* Use ARCnet, serial, parallel or Ethernet to link your computers.
* Mixed mode routing. Any combination of the above connectors is possible on any given node.
* RAM needed approx. 35-45K.
* Uses DOS version 2 and above, 3.1 and above preferred.
* Print spooling.
* Record locking via DOS SHARE.
* Open network, API provided.
* Runs okay with Windows 3.0.
* Drive A-Z can be redirected to reference any drive on any computer. LPT1-LPT3 can print to any computer.
* "Start small, grow as you grow."

$75.00

LAN CABLE

Another B.G. Micro Exclusive, 25 feet of Ethernet RG 58A/U Coax with a BNC connector, a BNC "T", and a BNC terminator on each end.

No one can beat this price.....$7.95
Additional "T".....$.99

CUSTOM CABLES

Cables also available for Little Big Lan Serial (5 Wire null modem) - $10.00 for first 6 ft. $.25 after 6 ft. (Custom cable non-refundable).

Parallel adapter $1.50

Adapt most 25 pin to 25 pin cables to meet the parallel interface requirements.

Arcnet - $.50 ft. (Twisted pair only)
Ethernet - $.50 ft. (ThinNet RG58)

NETWORK CARDS

* 16 TB Model-complies with IEEE 802.3
* Standards for 10Base-T and 10Base 2
* Works with most popular network softwares including Netware, TCP/IP, Windows for Workgroups, LANTASTIC,
* On-board 16K RAM for multiple-packet buffers
* Four LEDs to indicate link, transmit/receive, polarity/Jabber, and collision status
* Automatic polarity detection and correction of writing errors
* Jabber function (watchdog timer).
* Novel approved NE 2000 compliant.

$67.99

* NE 1000 available (Call)
* Arcnet available (Call)

SWITCHING POWER SUPPLIES

DELTA Switching Power Supply

Heavy duty switcher - A full 280 watts completely enclosed w/fan - UL and CSA approved

+ 12V @ 7 amps
+ 5V @ 37 amps
- 5V @ .75 amps
- 12V @ .75 amps

Measures:
8 1/2" x 5 15/16" x 7 3/8"

$17.95 + $4.50 shipping

MFM CARD

MFM Hard Drive Controller
6 Bit Western Digital Hard Drive/Floppy Controller.
WD1003-WA2 Brand New Full Length.

$17.95

These controllers are getting very scarce.

LINE CORD

6 Ft. 3 Wire Line Cord
IEC on one end AC on the other.
GREAT COMPUTER CORD

$1.59

MONITOR CORD

1 Ft. IEC Female to IEC Male

From monitor to power supply.

$1.49

TERMS: (Unless specified elsewhere) Add $3.25 postage, we pay balance on Orders Under 5lbs. Orders over $50.00 add .85 for Insurance. No C.O.D. Texas Res. add 81/4% Tax. 90 Day Money Back Guarantee all items. All items subject to prior sale. Prices subject to change without notice. Foreign order - US funds only. We cannot ship to Mexico or Puerto Rico. Canada, add $7.50 minimum shipping and handling. Countries other than Canada, add $15.00 minimum shipping and handling.

performance of key filters and commands. This card doesn't replace an SVGA card. Instead, it provides added power to speed up image editing when using *Photoshop* on a 486DX33 PC. The card combines dual AT&T Digital Signal Processors (DSP) and accelerated software to get the most out of the time-consuming and processing-intensive *Photoshop* image-editing operations. Storm Technology also makes a family.

Hard-disk storage capacity should also factor into your scanner evaluation. Image-editing software will usually consume between 5M to 20M of drive space, depending on the extra features and plug-in extensions you wish to use.

A 24-bit scanner is capable of reproducing 16.7-million colors. This technology composes images based on eight bits from each of the red, green and blue primary colors and, thus, requires plenty of storage space. Consider that a scanned color image requires eight bits for each pixel. At this rate, a 256-color photograph scanned at only 200 dpi consumes 3.5M of hard-drive storage space. A full-color 8" X 11" image scanned at 300 dpi would use 30M to 40M. This image at 1,200 dpi could create a file as large as 500M, not to mention the amount of time needed to transfer all this data. Fortunately, recent image-compression technology gives graphic users more efficient use of disk storage space. Using the Joint Photographers Experts Group (JPEG) compression algorithms and its Interchange File Format (.IFF) enables widespread imaging industry compliance for any image-manipulation software.

Buying Tips

Before you rush out to buy an image-scanning package, you should keep some considerations in mind. Here's a brief list of the most-important of these:

(1) Define your scanning requirements and buy a scanner based on those requirements, not on impressive speed or resolution.

(2) Consider the resolutions offered by your output devices like printers and video monitors and match to the scanner resolution.

(3) Look for a scanner that includes an interface kit and everything else you'll need to get it running.

Sources

Scanners

Acrus Plus; StudioScan
AGFA/Miles, Inc.
Business Imaging Systems
100 Challenger Rd.
Ridgefield park, NJ 07660
Tel.: 1-800-6854271

CIRCLE NO 120 ON FREE INFORMATION CARD

OneScanner; Color OneScanner
Apple Computer, Inc.
3585 Monroe St.
Cupertino, CA 95014
Tel.: 800-446-3000

CIRCLE NO 121 ON FREE INFORMATION CARD

IX-4015 Color Scanner
Canon Computer Systems
2995 Redhill Ave.
Costa Mesa, CA 92626
Tel.: 800-848-4123

CIRCLE NO 122 ON FREE INFORMATION CARD

OmniScan
Caere Corp.
100 Cooper Ct.
Los Gatos, CA 95030
Tel.: 800-535-7226

CIRCLE NO 123 ON FREE INFORMATION CARD

CardScan
Corex Technologies Corp.
233 Harvard St, Ste. 207
Brookline, MA 02146
Tel.: 800-942-6739

CIRCLE NO 124 ON FREE INFORMATION CARD

CypherScan 1000
CypherTech, Inc.
250 E. Caribean Dr.
Sunnyvale, CA 94089
Tel.: 408-734-8765

CIRCLE NO 125 ON FREE INFORMATION CARD

RFS-2035 Film Scanner
Eastman Kodak Co.
343 State St.
Rochester, NY 14650
Tel.: 800-242-2424

CIRCLE NO 126 ON FREE INFORMATION CARD

ENV6100, 8100; ENV24PRO, 256
ENV Color
Envisions, Inc.
822 Mahler Rd.
Burlingame, CA 94010
Tel.: 800-444-4223

CIRCLE NO 127 ON FREE INFORMATION CARD

ES-600C, ES-800C
Epson America, Inc.
20770 Madrona Ave., Box 2842
Torrance, CA 90509-2842
Tel.: 310-782-0770

CIRCLE NO 128 ON FREE INFORMATION CARD

ScanJet IIp, IIcx
Hewlett Packard Co.
3000 Hanover St.
Palo Alto, CA 94304
Tel.: 800-722-6538

CIRCLE NO 129 ON FREE INFORMATION CARD

Scanman 256, Color; EasyTouch; PowerPage
Logitech, Inc.
6505 Kaiser Dr.
Fremont, CA. 94555
Tel.: 800-231-7717

CIRCLE NO 130 ON FREE INFORMATION CARD

ScanMaker IIG, IISP, IIXE, IIHR, III; ScanMaker Scooter; 45T, 35T Slide Scanner; Scan-in-Dex
Microtek Lab, Inc.
3715 Doolittle Dr.
Redondo Beach, CA 90278-1226
Tel.: 800-654-4160

CIRCLE NO 131 ON FREE INFORMATION CARD

Artist Plus Color; ColorArtist Pro; Paragon 1200; ScanMagic,;PrinScan
Mustek, Inc.
15225 Alton Pkwy. Ste. 100
Irvine, CA 92718
Tel.: 714-453-0110

CIRCLE NO 132 ON FREE INFORMATION CARD

Coolscan Film Scanner
Nikon, Inc.
Electric Image Dept.
1300 Walt Whitman Rd.
Melville, NY 11747
Tel.: 516-547-4355

CIRCLE NO 133 ON FREE INFORMATION CARD

DOC.IT
Okidata Corp.
532 Fellowship Rd.
Mt. Laurel, NJ 08054
Tel.: 800-654-3282

CIRCLE NO 134 ON FREE INFORMATION CARD

CardGrabber
Pacific Crest Technology, Inc.
4000 MacArthur Blvd., Ste. 6800
Newport Beach, CA 92660
Tel.: 714-261-6444

CIRCLE NO 135 ON FREE INFORMATION CARD

CS-500 Slide Scanner
Polariod Corp.
575 Technology Sq.
Cambridge, MA 02139
Tel.: 617-577-2000

CIRCLE NO 136 ON FREE INFORMATION CARD

AVEC 1200, 2400, 4800; Reli2400, 9600
Relisys, Inc.
320 S. Milpitas Blvd.
Milpitas, CA 95035
Tel.: 800_783-2333

CIRCLE NO 137 ON FREE INFORMATION CARD

JX-325
Sharp Electronics Corp.
Sharp Plaza
Mahwah, NJ 07430
Tel.: 201-529-9593

CIRCLE NO 138 ON FREE INFORMATION CARD

PhotoDSP Accelerator Card for Photoshop
Storm Technology, Inc.
1861 Landings Drive
Mountain View, CA 94043
Tel.: 415-691-6600

CIRCLE NO 139 ON FREE INFORMATION CARD

ArtiScan 6000C, 8000C, 12000C
Tamarack Technology
1544 Centre Pointe Dr.
Milpitas, CA 95035
Tel.: 800-643-0666

CIRCLE NO 140 ON FREE INFORMATION CARD

ScanOffice 630, 840, 1260, 1260SE
Umax Technology, Inc.
3353 Gateway Blvd.,
Fremont, CA 94538
Tel.: 510-651-8883

CIRCLE NO 141 ON FREE INFORMATION CARD

T-3DGSZ, T-3DC
Vidar Systems Corp.
460 Spring Park Pl.
Herndon, VA 22070
Tel.: 703-471-7070

CIRCLE NO 142 ON FREE INFORMATION CARD

Image-Editing and OCR Software

Photoshop
Adobe Systems Corp.
1098 Alta Ave.
Mountain View, CA 94039-7900
Tel.: 415-961-4400

CIRCLE NO 143 ON FREE INFORMATION CARD

Photostyler; Gallery Effects
Aldus Corp.
411 First Ave., S.
Seatle, WA 98104-2871
Tel.: 206-622-5500

CIRCLE NO 144 ON FREE INFORMATION CARD

OmniPage Direct
Caere Corp.
100 Cooper Ct.
Los Gatos, CA 95030
Tel.: 408-395-7000

CIRCLE NO 145 ON FREE INFORMATION CARD

WordScan Plus
Calera Recognition Systems
475 Potrero Ave.
Sunnyvale, CA 94086
Tel.: 408-720-8300

CIRCLE NO 146 ON FREE INFORMATION CARD

Kai's Power Tools
HSC Software, Inc.
6303 Carpinteria ave.
Carpinteria, CA 93013-2933
Tel.: 805-566-6699

CIRCLE NO 147 ON FREE INFORMATION CARD

Perceive
Maxsoft Ocron, Inc.
4110 Clipper Ct.
Fremont, CA 94538
Tel.: 408-980-8900

CIRCLE NO 148 ON FREE INFORMATION CARD

Picture Publisher
Micrografx, Inc.
1303 Arapaho
Richardson, TX 75081
Tel.: 800-272-3729

CIRCLE NO 149 ON FREE INFORMATION CARD

TextBridge
Xerox Imaging Systems
Nine Centennial Dr.
Peabody, MA 01960
Tel.: 508-977-2000

CIRCLE NO 150 ON FREE INFORMATION CARD

(4) If the scanner is to be used for OCR, desktop-publishing or image-editing applications, insist on the full version and the latest generation of image-editing and OCR software.

(5) Ask if an automatic document feeder (ADF) is included in the price quoted. Scanners in the $5,000-and less price range usually don't include a feeder, which can tack on $400 to $1,000 to the quoted price. If you plan on heavy OCR or document scanning, an ADF is a must.

Image Scanners

A representative sampling of the various flatbed, 3D-image, slide and film and hand-held scanner packages available in today's marketplace is given in the Comparison of Image Scanners table. I've tried to research resolution quality based on optical resolution (opr) and interpolated resolution (ir) dots per inch (dpi), pages per minute (ppm) processing and SCSI or parallel hookup. All listed scanners are TWAIN-compliant and come bundled with one or more of the software packages described above.

Prices given here are mostly manufactures suggested retail. Discount, or "street," prices are available to those who shop around at computer superstores and through mail-order outlets.

While you can add a transparency adapter ($400 to $800) to a flatbed scanner, the better route is to look at the film scanners that capture images from transmissive media like slides and transparencies. These allow light to pass through the image, giving the scanner the best possible opportunity to see all the detail in the original image. All listed film scanners are TWAIN-compliant and are bundled with software.

Truly inexpensive scanning is available with use of a hand-held scanner. Tradeoffs are scanning width (usually 4" maximum) and controlled scanning speed, since your hand is the motor, that can result in low quality until you become adept with the unit. Microtek's ScanMaker Scooter offers a self-propelled hand-held scanner that provides a more-controlled and better-quality scan of the image. The light source for hand-held scanners is usually a LED source that illuminates the original image for the CCD photoreceptors to convert the image being scanned to digital media.

Most hand scanners come with a proprietary card that's very sensitive to a PC's IRQ, DMA channels and I/O address values to avoid conflicts with other installed devices. If this kind of installation isn't to your liking, look for a hand-held scanner that simply attaches to a parallel printer port. Grayscale hand-held scanners work quite nicely on even an XT/compatible without extended or expanded memory, but color hand-held scanners work best with at least 4M of free RAM.

Most hand scanners are packaged with various easy-to-use OCR and image-editing software. Stitching software is usually included to permit stitching together an image if it's wider than the scanner's 4" scan width. All listed hand scanners are TWAIN-compliant and are bundled with software for immediate use.

The newest scanners to appear in the marketplace are ones designed to scan only business cards. These come with proprietary OCR software that converts the card's information into a desktop's popular database-management software. These scanners are installed using proprietary cards that are sensitive to IRQ, DMA channels and I/O addresses.

Scanners like Corex Technologies' CardScan ($395), CypherTech's CypherScan ($395), Microtek's Scan-in-Dex ($399) and Pacific Crest's CardGrabber ($395) offer 400-dpi resolution and link the business card's information into personal contact management software like Symantec's *ACT!*.

By Tom Benford

The Mind/MIDI Connection: Getting Yourself Wired For Sound

Waverider Jr. converts your brain/body currents into MIDI data

In my continuing search for neat and unique products for multimedia and MIDI music production, I recently came upon one that turned me on because it lets *you*—or, rather, your body's minute electrical currents—turn *it* on. Of course, biofeedback devices that produce audible output have been around for quite a while and aren't exactly on the cutting edge of technology. But there's a new twist to this theme with WaveRider Jr., a new product from WaveAccess that interfaces to a PC and converts the electrical voltages produced by the brain and body into MIDI data signals.

The resulting MIDI data is controllable and modifiable over a broad range of parameters. So the creative possibilities presented by WaveRider Jr. are truly unlimited. This MIDI data can be used for any number of applications, including multimedia presentations. This gives new meaning to the phrase, "I really put myself into this production." But aside from the direct uses of this generated MIDI output, other applications in which WaveRider would be useful include biofeedback, stress reduction and performance art, to name but a few. Since MIDI data can be used to control such devices as lighting, a little imagination here could present some really interesting possibilities for other uses.

Before I describe the hardware, software and control structure of WaveRider, I should make it clear that, while being a most-intriguing and useful tool, this isn't a "miracle" device that will allow you to think of a musical passage in your mind and instantly produce it as a musical score. The technology to do this sort of thing is still a long way off. But you *can* create some very interesting music with this device and, depending on how may of the input electrodes you're using and how you have the parameters set up, you'll also have a surprising level of control over the resulting output. I'll begin by describing the physical characteristics of WaveRider Jr.

WaveRider Jr. comes with 12 leads, two armbands, two finger clips and a headband, in addition to two types of electrolyte conductive gels, software diskette, well-written manual and even a packet of Kleenex tissues. You have to supply your own serial cable and 9-volt alkaline battery. **(Photo by Abbato/The Photography Place)**

Physical Characteristics And Installation

WaveRider is currently available in two models. WaveRider Pro is the more sophisticated of the two and has four low-noise channels that read heart, brain and muscle input, plus a single channel for GSR (Galvanic Skin Response), for $1,500. WaveRider Jr., the unit I had the opportunity to work with, is basically a scaled-down version of the Pro model and retails for $750.

WaveRider Jr. features two low-noise channels for heart, brain or muscle input, along with the single GSR channel. Both models come with *WaveWare* software for *Windows*, head and arm bands, finger clips, electrode leads, electrode gel and user's manuals.

The WaveRider Jr. module comes housed inside a 6¾" X 4¾" X 1¾" black plastic box and weighs about a pound. A serial port with DB-9 connector is provided for making the con-

nection to a PC (no serial cable is furnished), and the unit is powered by a 9-volt battery (also not included). On the top of the module are seven single-contact connection jacks for attaching the electrode leads and a single red LED for indicating when the unit is in operational mode. The LED provides instant visual feedback to confirm that a satisfactory serial-port connection with the PC has been established.

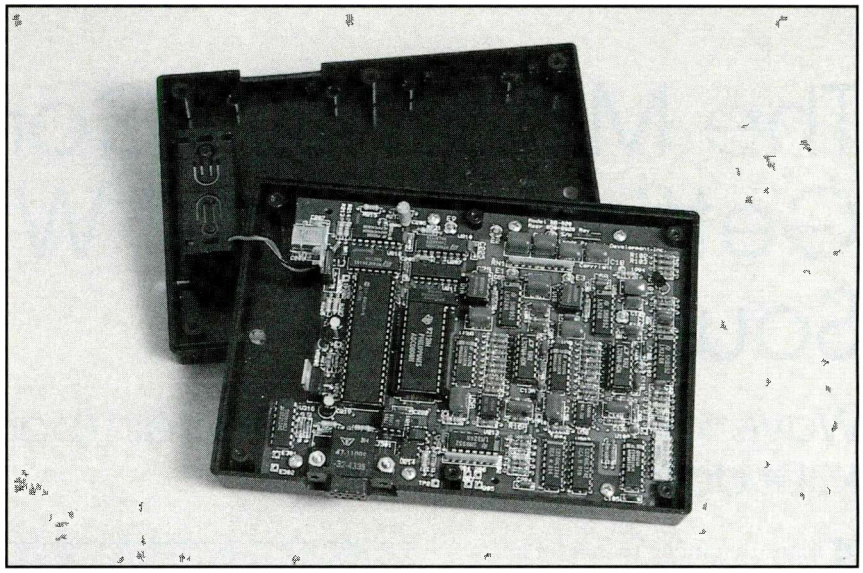
Twelve color-coded single-conductor electrode leads, each measuring 42" long, are supplied with WaveRider Jr. These are the conduits through which the body's electrical currents flow into the unit for processing. Each lead is outfitted with a dowel connector at one end and a snap connector at the other. The snaps provide the means for affixing the electrodes to the headband, armbands and GSR finger clips.

Two types of conductive electrode gels are supplied with the unit to aid in establishing good electrical connections between the scalp/skin and electrodes. This is essential to obtain the strongest possible bioelectrical signals with the least amount of noise and distortion.

Also included with the unit was a small packet of Kleenex, which was a very thoughtful touch. The tissues come in handy for wiping off any excess/remaining electrode gel after your session is over and for cleaning the headband and other contacts.

Letting my curiosity get the better of me, I couldn't resist the temptation to open WaveRider Jr.'s case to get a peek at its innards. After removing the six Phillips screws and "cracking" the case, I was amazed at how densely populated the pc board on which the circuitry is mounted is, combining several ICs with scores of discrete components. Lots of engineering and R&D time obviously went into its development, and the grade of components used and workmanship (the assembly is all hand-soldered) easily justify the price of the unit.

Installation of WaveRider Jr. consists of placing a 9-volt alkaline battery in the snap-covered compartment of the case and attaching a suitable serial cable to both the unit and the host PC. The next step is to install the software, which is done by running Setup from the *Windows* Program Manager. File copying and icon generation are fully automated. In just a couple of minutes, WaveRider Jr.'s software is fully installed and ready for use.



Inside WaveRider's plastic case is a very densely populated printed-circuit assembly with top-shelf integrated and discrete components, all wired and tested by hand. **(Photo by Abbato/The Photography Place)**

When you click on WaveRider, the main program screen is presented and the first procedure that must be completed on this initial session is to tell the software which serial port to use for WaveRider Jr.'s connection (COM1 is the default). Once this is accomplished, clicking the "On" box opens the link between your PC and WaveRider Jr. If everything is working as it should, the red LED on the unit glows and a battery-condition gauge appears on your video monitor's screen to keep you apprised of the power available to the unit.

A diagnostics menu is provided under the Options heading, which confirms the unit's operational status and gives you some additional information as well. The General Program Options settings and preferences can also be set using the appropriate menu, which you find under this toolbar's category selections, as are choices for transforming the appearance of the display, selecting colors for it and changing the serial port connection assignment, among other available options.

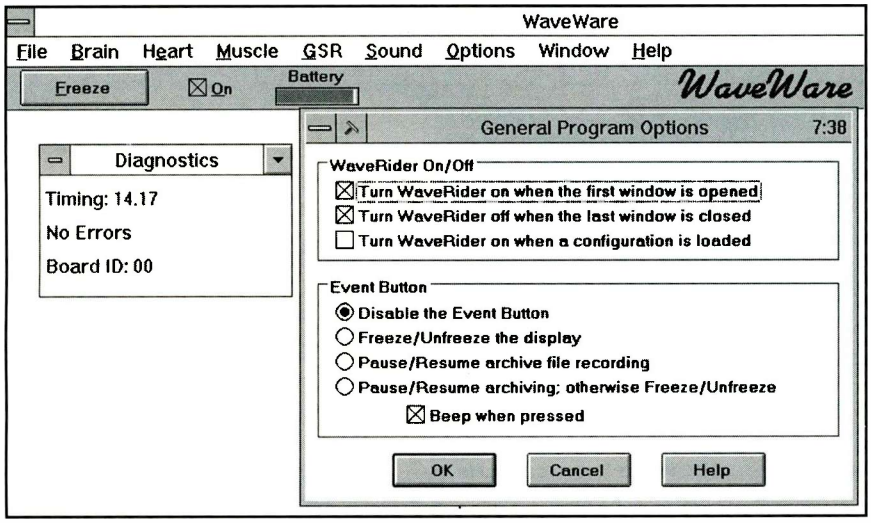
As with other well-written *Windows* programs, comprehensive on-line help is available from a selection on the toolbar as well. When a satisfactory link between WaveRider Jr. and the host PC is confirmed, it's time to attach the electrodes that get you wired up for sound. The MIDI output can be routed through the PC's internal sound card or to an external MIDI device via a MIDI port.

Reading Biosignals

WaveRider Jr. can read, process and display various biological signals, in addition to turning them into music. The four types of signals that can be read are brain (EEG), heart (EKG), muscle (EMG) and skin resistance (GSR). Signals from the brain, heart and muscles are voltages and are read using WaveRider Jr.'s A and B channels. Galvanic skin response is a change in the resistance of the body. WaveRider Jr. measures this value by passing a minute current (10 μA) of electricity through the body; these values are read using the GSR/Test channel inputs of the module.

Each lettered channel has eight gains that set the amplification of the signals. Brainwaves are the smallest signals and require the most amplification. A typical gain for brainwaves is range 7, while muscle and heart signals are roughly the same size (<2 mV), with a typical gain range of 1 or 2. The GSR channel has eight ranges of offset that set how far above 0 the window is viewed.

• **Heart/Muscle Signals.** Muscles (in-



WaveRider Jr.'s basic *Windows WaveWare* application screen, with two of the sub-menus from the Options toolbar visible. On-screen battery gauge keeps you abreast of alkaline cell's condition, and diagnostics confirm that everything is functioning properly between WaveRider Jr. and host PC. User preferences can also be set and stored using the General Program Options submenu. The software is very well written and arranged, and using it is highly intuitive and very straightforward.

cluding the heart) make waves of electricity when they contract, and WaveRider Jr. reads this as voltage that's changing with time. Typically, these waves are smaller than 2 mV, and WaveRider provides strip charts (found in the Heart and Muscle menus) to view these signals, which are usually read from the arms using the supplied armbands.

Musically, the Envelope Height to Note mode is the most interesting and is the best mode for use with heart/muscle signals. Once you're connected and have established a good signal, you open the MIDI output from the sound menu and double-click on the MIDI window to bring up the MIDI options dialog box. You then select the appropriate WaveRider channel(s) to monitor and desired MIDI channel(s) and envelope height to note from the mode choices. You then proceed to choose a voice (instrument patch) and an appropriate note range and then the scale and key. Some experimentation with the envelope height to find numbers that work best with your signal is the next order of business. Percussive sounds are an excellent place to start with these rhythmic heart/muscle signals.

• **Brain Waves.** The four ways of viewing brainwave data provided are: strip chart, fast bars, slow bars and spectrogram.

Strip chart view displays the constantly changing voltages of brainwaves plotted against time. Timebase interval and wave magnification factor are adjustable.

Fast bars display shows the frequencies of brainwaves as derived from a fast Fourier transform.

Slow bars displays the frequencies averaged over a variable amount of time.

Spectrogram displays the time-averaged frequencies of brainwaves over time. The bottom of the display is 1 Hz to 40 Hz. The brightness of the color denotes the amount of power in that frequency band. By varying the timebase, the view of the frequency domain can be varied from several minutes to an hour or more.

The properties of all the frequency transforms are controlled via the transform dialog box in the options menu, which makes it quick and convenient to change from one viewing mode to another with minimal effort. Individual variables for each transform are also adjustable.

Since the brainwave-processing capabilities of WaveRider Jr. are the most impressive and intriguing, some additional discussion is in order here.

Without a structured and coherent way to view frequencies, brainwaves look like random noise. WaveRider Jr. uses a fast Fourier transform (FFT) to extract frequencies from brainwaves, and it does this in realtime. An FFT, in effect a mathematical prism, is an analogy that makes explaining its function somewhat easier.

Just as a physical prism can split light into its individual component colors, an FFT splits a signal into the frequencies that comprise it. What the *WaveWare* software displays is, thus, the "spectrum" of the signal. So instead of a squiggly line, the signal is seen to be composed of a combination of frequencies in varying amounts.

The frequencies in brainwaves correlate with states of consciousness. Faster signals (frequencies of 14 Hz and higher) are associated with conscious thought and a busier state of mind in general, the state of consciousness known as beta. The slowest signals are the delta waves (0 to 4 Hz), associated with deep sleep and comas, followed by theta waves (4 to 8 Hz) that are predominant in the subconscious mind and hypnagogic imagery.

The alpha brainwave frequencies (8 to 14 Hz) are produced when you close your eyes and relax. Transcendental meditation, yoga, the Silva Method and other meditation techniques are useful for intentionally inducing alpha brainwave frequencies. This altered state of consciousness is ascribed by many as being the bridge between the conscious and subconscious mind. This frequency range is also regarded as being the center of creativity and the realm in which dreams are created during sleep.

What makes the alpha frequency most interesting is that you can achieve this state without losing consciousness, and you can hear easily-discernible differences in the tonal qualities and rhythmic structures via WaveRider Jr. when in the alpha frequencies.

WaveRider Jr. can help you produce alpha waves or other frequency ranges by using it as a biofeedback monitoring device. To use it in this manner, you connect the headband electrodes and select the open MIDI output from the sound menu. You then select Pass Band Power to Note mode and the appropriate WaveRider channel(s) and MIDI channel(s). In the Range of Hertz section, you'd input 8 to 12 Hz and select a voice and appropriate note range. You'd then

choose scale and key. If the note range goes from a lower MIDI note number to a higher note number, the pitch will get higher as you produce more alpha waves. Conversely, if the note range goes from a higher MIDI note number to a lower note number, the pitch gets lower as more alpha is produced.

You can experiment with the Range of % Power setting to determine the most comfortable/optimal setting.

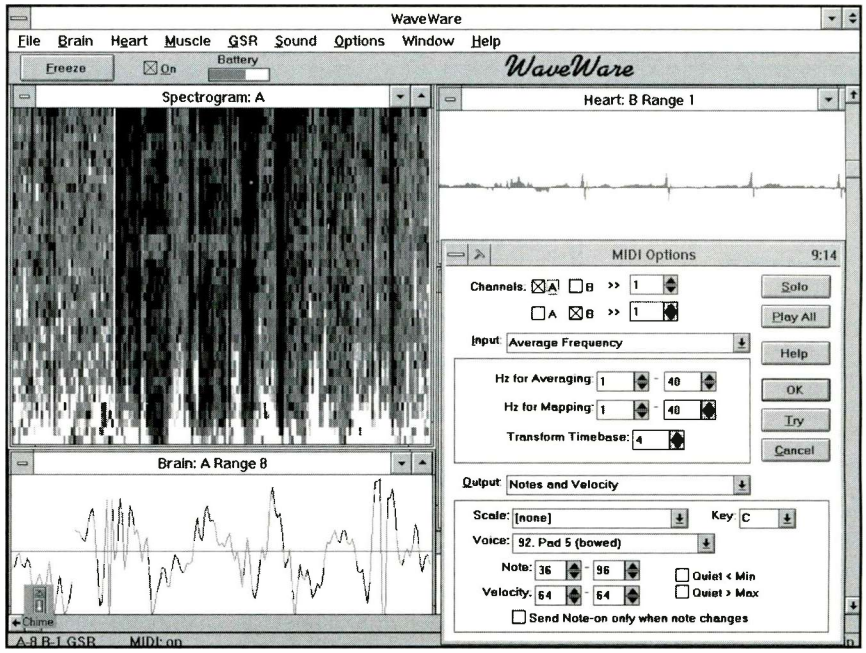
From a technical point of view, reading brainwaves is more difficult than reading other biosignals. Since muscles typically produce much more electrical current than the brain does, clenching your jaw and blinking (both muscle contractions) will contaminate the brainwave signal with muscle signals and produce artifacts. The best readings are produced when you're reclining comfortably or sitting in a comfortable chair with eyes closed. This minimizes artifacts and allows you to focus on your state of consciousness.

• **GSR.** Galvanic skin response measures the electrical resistance of the skin against a timebase. WaveRider Jr. does this by passing a minute current of 10 μA through the body. It uses a constant-current approach in which the current is held constant and fluctuations of the skin's resistivity are reflected in voltage.

The *WaveWare* software provides the ability to change the offset of this voltage and magnification and spacing of the display. The offset varies how far above the 0 line the GSR window looks. The magnification control varies the amplitude by a scale factor, stretching out the Y axis so that small fluctuations become more noticeable. The sensitivity or hardware resolution is fixed, and the spacing control changes the X axis spacing. Variations to the display are effected via the mode box.

It should be noted that the GSR isn't very well characterized, since it has been found to vary greatly with age, sex, race and time of year, not to mention the subject's arousal level. For these reasons, no valid comparisons can be made between sessions, although GSR can be used to evaluate relative levels of arousal and relaxation using the current session as a baseline.

As an example of the above, while



Spectrogram and strip-chart views for brain activity and strip-chart view for my heartbeats and MIDI configuration options window. Multiple views and multiple iterations of the same views are all possible through *WaveWare* software. Application is rich in features and feedback to permit wide configuration and preference modification to suit individual tastes and needs.

hooked up with the GSR finger pad electrodes, I took some deep breaths and the graph went down; thinking about traumatic events, problems or other highly emotional events caused the graph to rise.

The magnification factor is easily adjustable by pressing the up or down cursor key arrows, making it simple to find a comfortable scale for your current state of relaxation or arousal. You can also display GSR values numerically if you prefer a digital readout.

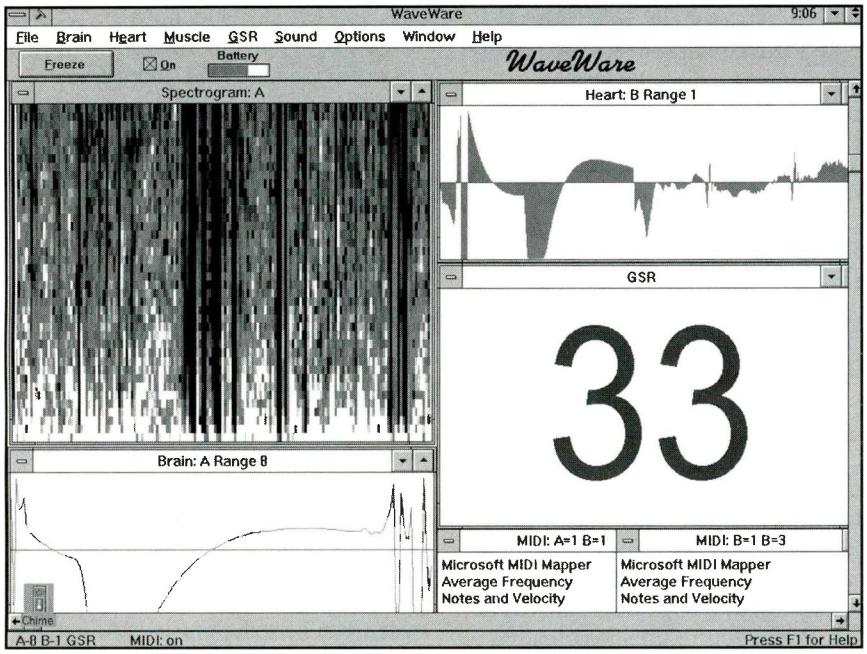
Getting Wired

Two types of electrolyte are supplied with WaveRider Jr. for making contact between electrodes and skin. One is a conductive adhesive paste for use with brainwaves. The other is a general-purpose electrolyte gel.

Skin impedance varies between individuals, depending on skin type, age, cleanliness (oils on the skin) and what products may be present to affect conductivity (for example, hairspray). The issue of conductivity is particularly crucial when making connections for brainwaves. If the electrodes are in contact with the scalp and the conductive adhesive paste is sufficient to connect the electrode to the scalp, skin impedance becomes the major factor for poor connections, which is evidenced by no signal. The WaveRider Jr. manual advises prepping the sites on the scalp you intend to use with rubbing alcohol to dissolve away skin oils, adding that a recent shampoo can help as well.

After the appropriate preparations are completed, you put on the headband strap with the cam-lock buckle facing the back of the head. Pulling the hair over the strap to keep the metal electrode buttons as close to the scalp as possible helps to establish good contact. One lead should be snapped on close to the temple and another close to the back of the head. A reference lead can be snapped on the forehead (although the forehead can be used to read the brain, most of the signals picked up by this lead will be of eye movement and not brainwaves and, hence, is used as the reference signal lead).

A small amount of the conductive-adhesive paste electrolyte should be applied beneath all three of these electrodes. If you use enough of it to make a good contact, it will feel gooey. Each of these electrode connections should then be tested using



There's no shortage of information that can be displayed with *WaveWare* software, and most can be shown in different views, as this screen capture illustrates. Upper-left window displays a spectrogram representation of my brainwaves, while window below it shows strip-chart representation of the same (notice the fall-off caused by moving the electrode leads when I opened my eyes and reached out to hit the print-screen key to do this capture). Upper-right shows my heart rate (with gain adjusted at a zoom view to show systolic and diastolic fluctuations in more detail), and window below it show GSR readings of my right index finger in digital format for that instant. The two lower-right windows show MIDI setup menu windows for both the A and B channels, with further modification being possible by clicking on any of the three choices in either window. While all this seems a bit complicated at first, much of the fun of using this gear is in playing with the settings and parameters to see how they affect the video displays and audio output.

the GSR/test channel and digital meter display from the GSR menu. When you obtain consistent readings above 800 from each of these connections, you're set to proceed.

You're then ready to pull up a strip-chart window and turn on the board. Gain should be adjusted by selecting the window and using the up-arrow key to obtain a consistent average of peaks and dips on the median line. If you don't obtain a fairly uniform display of jagged waves, the electrodes aren't making proper contact. So wiggling them and applying additional electrolyte paste may be required.

While you can use up to four channels to monitor brainwave activity simultaneously, it's advisable that you use only a single channel to begin with until you get the hang of it all It's also much easier to gain conscious control over that one variable, which is useful if you're interested in controlling the audio output to any degree.

Muscles and the heart are usually read using the arm bands. This is done by attaching the arm bands so that they're snug without cutting off circulation to the limbs. As with the headband, lead wires are snapped onto the snaps of the armbands.

If you're reading heartbeat, you can connect the inputs to different arms and the reference signal lead to either. If you're reading muscle signals, you can snap all of the electrodes onto the same arm, and you can hook up both arms to read muscle signals by adding another two inputs to your other arm. A small amount of the electrode gel (not the adhesive paste) should be applied to the underside of the electrodes you're using to ensure good contact.

At this point, you bring up the appropriate strip chart for the corresponding channel and, if the heart-signal looks inverted, switch the input order. When the strip-chart display looks correct (it spikes with each heartbeat or muscle contraction), you can raise or lower the gain by using the up- and down-arrow keys again.

GSR readings are taken from the fingers. The GSR electrode bands have Velcro, closures and they should be wrapped around the fingertips as you would an adhesive bandage strip. It isn't necessary to touch skin that has sweat glands for the GSR to function correctly. And you shouldn't use any electrolyte gel or paste for these contacts.

Snapping the lead wires to the GSR bands and connecting them to the GSR channel of WaveRider makes them ready. You have a choice of either a digital display or graph readout for GSR signal values.

Making Music

It's possible to have multiple readings going on simultaneously, with the values of each being passed to separate MIDI voices on different channels. For example, you might want to set up your heartbeat as a percussive voice (for example, melodic tom-tom on Channel 1), while your muscles could direct MIDI Channel 3 (perhaps set to a bass guitar or string ensemble). Your brainwaves could be triggering a marimba or vibes on MIDI Channel 5, while your GSR readings could be controlling a low-range flute or oboe voice on MIDI Channel 9. These voices and settings are all arbitrary and are only meant to give you an idea of what you can do once you get everything wired up and properly connected.

You must remember that the resulting sound won't be the structured music form you're used to hearing (or may be expecting). Rather, what you hear will be your own biorhythms set to definite voicings and pitches, which can be adjusted through modifying the trigger parameters and MIDI settings.

Experimentation is the order the day here, and I found myself playing with WaveRider Jr. for hours on end, fascinated by the different tonal qualities, harmonies and rhythms I could produce by changing the setting parameters and electrode positions, moving muscles and closing my eyes and

relaxing. It's a most unique experience to *be* the musical instrument rather than just playing one! To move a muscle, think a pleasant thought or cough and hear the result of these actions in a musical format is a most amazing, enjoyable and exhilarating experience and is unlike anything I've done before.

The main configuration for the sound output is done from the Open MIDI Output Command found in the sound menu. This command opens a MIDI window that allows one or more channels of WaveRider's biological signals to be used for producing music, using the MIDI capabilities of the PC's sound card or an externally-connected MIDI device.

When the MIDI window is first created, no channels are selected. Double-clicking on the MIDI window opens a dialogue box that permits channels to be selected and allows the musical scale, key, instrument and mode that's to be used for music creation to be chosen.

One of the really nice and useful features of the software is that multiple MIDI windows can be open at one time, thus creating a symphony of music originating from several types of biological signals (brain, heart, muscle or GSR), and playing up to 16 MIDI channels using a variety of instruments. The MIDI window may be minimized to occupy less space on the screen when there are several open at once. So you can keep a strip chart or spectrogram view up instead.

File Management

Everything that takes place during a WaveRider Jr. session can be archived in a file and recalled/replayed at a later time. This is accomplished by selecting the New Archive command from the file menu and giving the archive file a name. You're also prompted to specify which channels (of those already currently opened) are to have their data saved.

Once the archive file is open, you can record the biological signals at any time and pause whenever desired between recordings. Each segment of data recorded in this manner creates a separate data group within the overall file. When you're finished creating this archive file, you can close it using the Close Archive command (also available from the file menu). It can then be played back whenever desired using the Open Archive command.

Another very nice feature of the program is that it treats archived data the same as it would live signals being sent through the electrodes in real-time. This lets you take the signal data captured at an earlier session and adjust the MIDI output parameters to your heart's content (no pun intended) without having to be constantly wired up to the module. By using previously-archived session data in this manner, you can experiment with voicing, scales, keys and other tonal variants *ad infinitum* until you find the setting(s) you like best. You can play mix-and-match with the settings, saving your favorites under separate file names, too, if desired.

Summing Up

As I stated at the beginning of this article, you won't be able to "hear" Beethoven's *Fifth Symphony* in your mind and have it play for you with this gear. But you can create some amazingly relaxing and innovative musical passages by varying the MIDI parameters and signal channeling. I've also noticed that there's what I'll call, for lack of a better term, a "symbiotic resonance" that's evoked when you hear the music your body's biosignals are producing. This "resonance" can also be experienced while playing back an archived session.

As a device for monitoring and teaching biofeedback, you'd be hard-pressed to find anything else on the market that does this much for such a reasonable price. And even if you do find competitive biofeedback devices, they won't produce MIDI output.

If you're a devotee and practitioner of any meditative technique, you'll find that it's relatively easy to create soothing rhythmic patterns and flowing "new-age" musical passages with a little practice with WaveRider Jr. by selecting mellow MIDI voices (string ensembles, vibes, flutes are among my favorites) and entering a deep alpha state of mind.

For the *art noveau* performer, WaveRider Jr. can hold some very interesting live-performance possibilities as well. So there's plenty of grist for the mill of a creative mind here to play with.

If you're looking for a truly unusual and highly innovative piece of hardware, WaveRider Jr. fits the description and has my recommendation. ■

More Information

WaveRider Jr.
WaveAccess
PO Box 4667
Berkeley, CA 94704
Tel.: 800-697-8823

CIRCLE NO. 160 ON FREE INFORMATION CARD

By Jan Axelson

Serial Ports Inside and Out
Part 1

Inside the Computer

Just about every personal computer has one or more serial ports. Popular uses include interfaces to modems, mice and serial printers. Another common use is to form a link with a single-board computer (SBC) or a microcontroller circuit. This latter use permits easy uploading, downloading and testing of programs on systems that don't have their own keyboards, displays or disk drives. Serial ports are also popular interfaces to data loggers, motor controllers, EPROM programmers and just about any external device you can think of that exchanges information with a computer.

In this article, I begin an exploration of the serial port by focusing on the connector inward to the computer bus. Topics include the good and bad aspects of using serial ports; how to find and identify the ports on a computer; how to program a port for the results you want; and seven ways to use multiple serial ports without experiencing interrupt conflicts.

Serial-Port Basics

A personal computer's standard serial port sends and receives information one bit at a time, though it can both send and receive simultaneously. For a two-way link, you need just three wires, one each to carry data in each direction and a ground reference. Some applications use additional wires for control signals. In contrast, the PC's parallel port can transfer eight bits simultaneously, but it requires a separate wire for each bit.

In most respects, the standard serial port on 80x86, or "IBM-compatible" personal computers, conforms to the RS-232 standard interface for serial communications. The Electronics Industries Association (EIA) is the source of the standard, which defines the signal functions, pin locations and other characteristics of the interface. The standard has been through several revisions since its introduction in the 1960s, with the latest version being RS-232E and dated 1991.

The serial port has the following advantages over other interfaces:

(1) Every computer has a serial port. Because just about every personal computer has at least one serial port, there's nothing more to buy. Also, RS-232 ports aren't limited to one type of computer. You can use an RS-232 link to exchange information with any computer or device that has an RS-232 port.

(2) You can send data 50 feet and farther. Unlike the standard parallel interface, the cables of which are limited to 10 to 15 feet in length, the RS-232 standard was designed to be able to transmit over longer distances. Not to mention that with a modem at each end of the link, you can use the telephone network to transmit data to just about anywhere in the world!

(3) You need just three wires for a two-way link. In a parallel link, the cost of providing a wire for each bit begins to add up.

Drawbacks to the serial port include the following:

(1) If you need parallel data at the other end of the link, you must convert the serial data to parallel format. This is usually done with a special chip called a UART, although you can also simulate a UART in software or firmware (a program that runs directly from EPROM or other nonvolatile memory).

(2) Communications parameters must be identical on both ends of the link. When you transmit, you must choose a transmission rate, number of stop and start bits and whether or not to send an error-checking bit with each byte. Both ends of the link must agree on all of these. If they don't, the receiving end won't understand what's being sent.

(3) It may be difficult to find an available port. Even if a computer has several serial ports, you may not be able to find one that's free for use. Although most personal computers permit at least four serial ports, only two interrupt levels are reserved for them. When two devices share an interrupt-request (IRQ) level, you usually can't use both at the same time.

(4) RS-232 isn't intended for networks. If you want to have more than two devices connected to the same pair of wires, an RS-485 interface is a better choice.

(5) The specified maximum speed of an RS-232 link is 20,000 bits per second (20K bps). Although you can often exceed this rate, especially with shorter cables, you may have to use a different interface for some high-speed or/and long-distance transfers.

UART Essentials

In 80x86 computers, the device that controls the serial port is usually one of three popular UART chips, or a component that emulates them. The original UARTs are all from the same family from National Semiconductor. You don't have to understand everything about UARTs to use a serial port, but there are some things that I've found useful, especially when it comes to tracking down problems and dealing with interrupts.

The UART translates between serial and parallel data. The name stands for Universal Asynchronous Receiver/Transmitter. Receiver/transmitter tells you that it's a two-way interface. That is, the UART translates received serial data to parallel data, and it translates parallel data to serial data for transmitting.

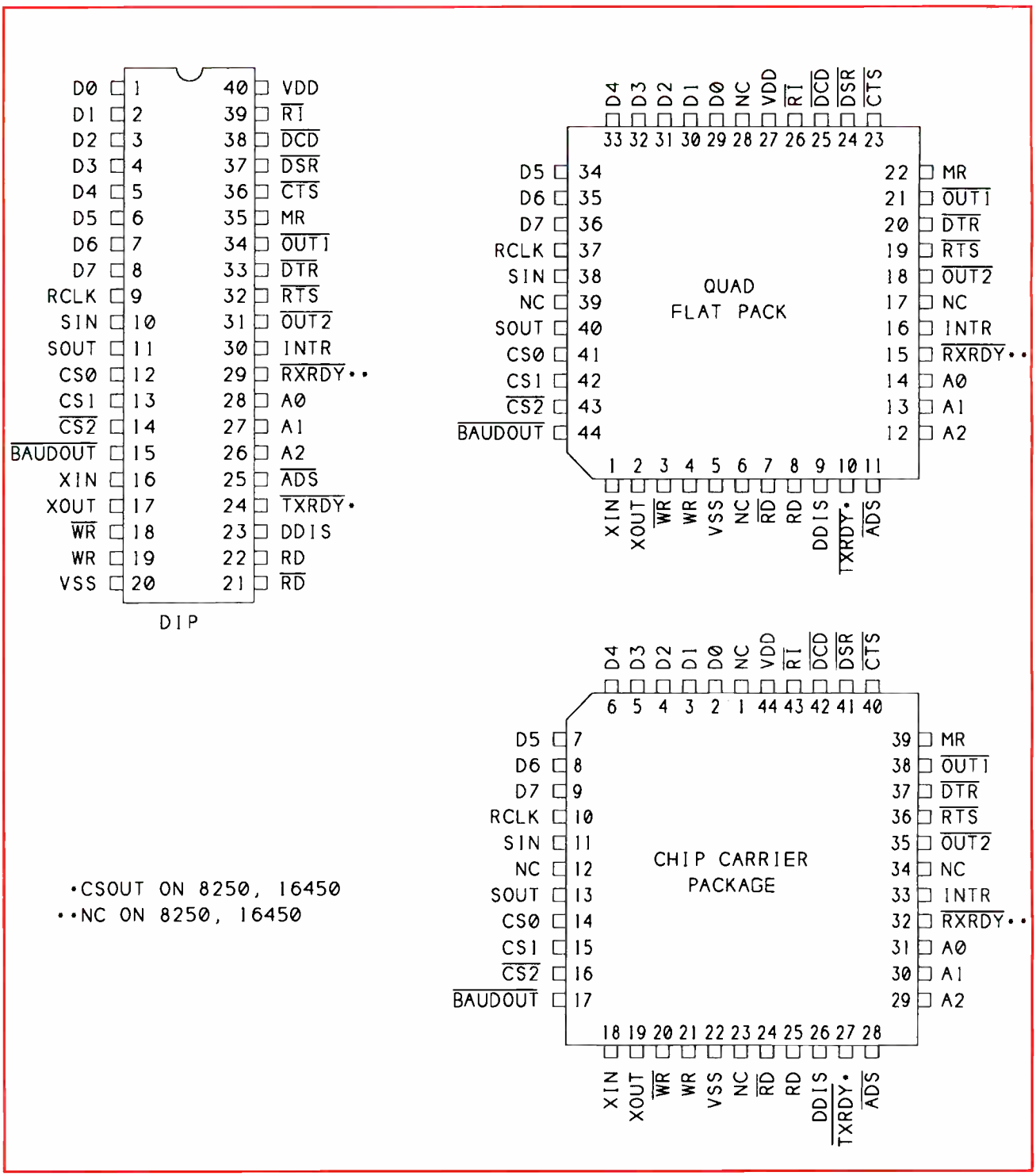


Fig. 1. Pin designations for the 8250, 16450 and 16550 UARTs. The 8250 and 16450 are available in DIP and quad flat packs. The 16550 is available in these package types, plus a chip carrier.

Asynchronous means that the devices on both ends of the link don't use a common clock signal to time transmissions. Instead, both devices must agree on a transmission rate, but each device times its transmissions independently. Since the rates at each end may vary slightly, the UART adds start and stop bits to signal the beginning and end of each byte.

In an RS-232 interface, each direction of transmission uses its own wire. With a full-duplex (two-way communication) interface, you can send and receive at the same time, while in a half-duplex (one-way communication) interface the two directions must take turns. Most serial communications with personal computers are full-duplex.

Full and half duplex may also describe which end of a link is responsible for echoing characters to the display. In this sense, full-duplex means

Table 1. Pin Functions for 8250, 16450 and 16550 UARTs.

Symbol	Signal	Input/ Output	Pin Number DIP	PLCC	QFP
A0	Register Select 0	I	28	31	14
A1	Register Select 1	I	27	30	13
A2	Register Select 2	I	26	29	12
–ADS	Address Strobe	I	25	28	11
–BAUDOUT	Transmit Clock	O	15	14	44
CS0	Chip Select 0	I	12	14	41
CS1	Chip Select 1	I	13	15	42
–CS2	Chip Select 2	I	14	16	43
CSOUT	Chip Select Out (8250 Only)	O	24	27	-
–CTS	Clear to Send	I	36	40	23
D0	Data Bit 0	I/O	1	2	29
D1	Data Bit 1	I/O	2	3	30
D2	Data Bit 2	I/O	3	4	31
D3	Data Bit 3	I/O	4	5	32
D4	Data Bit 4	I/O	5	6	33
D5	Data Bit 5	I/O	6	7	34
D6	Data Bit 6	I/O	7	8	35
D7	Data Bit 7	I/O	8	9	36
–DCD	Data Carrier Detect	I	38	42	25
DDIS	Driver Disable (Low When CPU Reads From UART)	O	23	26	9
–DSR	Data Set Ready	I	37	41	24
–DTR	Data Terminal Ready	O	33	37	20
INTR	Interrupt Request	O	30	33	16
MR	Master Reset	I	35	39	22
–OUT1	Output 1 (Non-Standard Function)	O	34	38	21
–OUT2	Output 2 (Enables IRQ Line on PC Serial Ports)	O	31	35	18
RCLK	Receiver Clock	I	9	10	37
RD	Read (Active High)	I	22	25	8
–RD	Read (Active Low)	I	21	24	7
–RI	Ring Indicator	I	39	43	26
–RTS	Request to Send	O	32	36	19
–RXRDY	Receive DMA Signaling (16550 Only)	O	29	32	15
SIN	Serial Input	I	10	11	38
SOUT	Serial Output	O	11	13	40
–TXRDY	Transmit DMA Signaling (16550 Only)	O	24	27	10
WR	Write (Active High)	I	19	21	4
–WR	Write (Active Low)	I	18	20	3
VDD	Power Supply (+5 Volts)	I	40	44	27
VSS	Ground Reference (0 Volt)	I	20	22	5
XIN	External Clock Input	I	16	18	1
XOUT	External Clock Output	O	17	19	2

Note: Leading "–" indicates active low signal.

that the receiver echoes each character it receives back to the transmitting end. Half-duplex means that the receiver doesn't echo. Therefore, the transmitting software must cause the characters to display at the transmit end, if desired.

Older personal computers use an 8250 UART. Later models may use a 16450, which is faster and adds a scratch-pad register. The 16550 is a further upgrade that adds transmit and receive buffers called FIFOs (first-in, first-out), to indicate that data is read from the FIFO in the same order as it was received. Thus, the first byte in, or received, is the first one out, or read from the buffer.

Each buffer can store 16 bytes. The buffers permit much faster data transfers. On the receive side, the CPU doesn't have to worry about reading each byte before the next one arrives. If the CPU is busy, the buffer stores the received bytes, and the CPU can read them all when it's free. On the transmit side, the CPU can write a series of bytes to the UART, and the UART will transmit them in the appropriate timed sequence.

Figure 1 and Table 1 show the pin designations and functions for all three chips. The newer chips are backward-compatible. You can use any of the three in a socket intended for an 8250. The pinouts of the 8250 and 16450 are identical. The 16550 adds two outputs, TXRDY and RXRDY, which are used in buffered DMA transfers, and eliminates one output, CSOUT, which indicates when the chip is selected. None of these are required for normal operation.

Upon being reset, the 16550 acts like a 16450. It's up to the serial-port

Table 2. Register Summary for 8250, 16450 and 16550 UARTs.

Register No.	Special Conditions	Register Name	Abbrev.	Bit Number 7	6	5	4	3	2	1	0
0	DLAB=0 Read Only	Receive Buffer	RBR	Received Data (bit 0 received first)							
	DLAB=0 Write Only	Transmit Buffer	THR	Transmit Data (bit 0 sent first)							
	DLAB=1	Divisor Latch (low)	DLL	Baud Rate Divisor Low Byte							
1	DLAB=0	Interrupt Enable	IER	0	0	0	0	Modem Status	Receiver Line Status	Transmit Holding Register Empty	Received Data Available
	DLAB=1	Divisor Latch (high)	DLM	Baud Rate Divisor High Byte							
2	Read Only	Interrupt Identify	IIR	FIFOs Enabled** 11 if FCR bit 7=1 00 if FCR bit 7=0		0	0	Interrupt ID: 011 Receive Line Status; 010 Receive Data Available; 110 Character Timeout **; 001 Transmt Hold Reg Empty; 000 Modem Status			$\overline{\text{Interrupt}}$ Pending
	Write Only	FIFO Control**	FCR	Receive FIFO trigger level**: 00 1 byte; 01 4 bytes; 10 8 bytes; 11 14 bytes		Reserved **	Reserved **	DMA Mode Select**	Transmit FIFO Reset**	Receive FIFO Reset**	FIFO Enable**
3	-	Line Control	LCR	Divisor Latch Access Bit (DLAB)	Break Set	Stick Parity Select	Even Parity Select	Parity Enable	Stop Bits: 0=1 bit, 1 =2 bits	Word Length: 00 5 bits; 01 6 bits; 10 7 bits; 11 8 bits	
4	-	Modem Control	MCR	0	0	0	Loopback Mode	$\overline{\text{Out2}}$ ($\overline{\text{IRQ Enable}}$)	$\overline{\text{Out 1}}$	Request to Send (RTS)	Data Terminal Ready (DTR)
5	-	Line Status	LSR	Error in Receive FIFO**	Transmit Buffer Empty	Transmit Holding Register	Break Interrupt	Framing Error	Parity Error	Overrun Error	Data Ready
6	-	Modem Status	MSR	Data Carrier Detect (DCD)	Ring Indicator (RI)	Data Set Ready (DSR)	Clear to Send (CTS)	Change in DCD	Falling Edge at RI	Change in DSR	Change in CTS
7	-	Scratch*	SCR	Scratch Register (no designated function)*							

*16450 and 16550 only
**16550 only

software to enable and use the buffers. Hence, just because you have a 16550 UART, this doesn't necessarily mean that your software is using all of its abilities.

Part numbers of UARTs can be deceptive. For example, the 8250A has a scratch-pad register like that in the 16450, and the buffers on some early 16550s aren't usable due to a product flaw. Additionally, recent-model computers tend not to use the UART chips at all. Instead, they contain chipsets that combine UART functions with those of other standard components.

For these reasons, the best way to detect a 16450-type UART is to look for the scratch register by writing to it and reading back what you've written. The best way to detect a 16550-type UART is to enable the buffers and try to use them. One utility that identifies and displays the UART type is MSD.EXE, included with Microsoft *Windows* and MS-DOS. On my computer, however, MSD incorrectly identified a 16450 UART as an 8250.

Inside the UART

Table 2 lists the functions and addresses of the internal registers of all three UART types. As you can see, the chip stores quite a bit of information about a port and its activity. If you're using commercial serial-port software, or even some programming languages, you don't have to worry about programming the UART's registers. The software will let you specify the characteristics you desire and takes care of the programming details for you. But knowing them, the details can come in handy when you're tracking down problems.

There are eight register addresses, but Registers 0, 1 and 2 have different functions, depending on whether you're reading or writing, or on the state of DLAB (Bit 7 of Register 3).

Register 0 is at the port's base address, with the other registers following in sequence. For example, on a computer's first serial port (COM1), Register 0 is usually at 3F8h (the "h" indicates hexadecimal), with Register 7 at 3FFh.

Upon being reset, DLAB is 0. Reading Register 0 (Receive Buffer) tells you the most-recent data received at the SIN pin, and writing to Register 0 (Transmit Buffer) causes the byte to transmit in serial format at SOUT.

Table 3. UART Divisor-Latch Settings for Common Baud Rates.

Baud Rate	Divisor Latch High Byte	(Hexadecimal) Low Byte
300	01	80
1,200	00	60
2,400	00	30
9,600	00	0C
19,200	00	06
33,400	00	03
115,200	00	01

(Divisor Latch = 115,200/Baud Rate)

Setting DLAB to 1 enables you to use the divisor latches to set a baud rate for the port. The baud rate tells you the number of possible signal changes, or logic transitions, per second in serial transmissions. Unlike high-speed modems, the UART uses no complicated encoding. Therefore, the baud rate equals the number of bits per second (bps) transmitted or received.

In a typical transmission, the UART adds one start bit and one stop bit to each byte. So, to find the number of bytes transmitted per second, you just divide the baud rate by 10.

The divisor latches hold a 16-bit value that divides the UART's crystal frequency down to the desired baud rate. Table 3 lists common values that result with the UART's standard 1.8432-MHz crystal. On some older 8250s, maximum baud rate is 57,600. Others can transmit and receive at up to 115,200 baud, with the divisor latch set to 1.

Setting or reading the baud rate is the only time you need to set DLAB to 1. After setting or reading the baud rate, you should return DLAB to 0. On reset, the baud rate is 2,400.

Interrupt Sources

When DLAB is set to 0, Register 1 (Interrupt Enable) can enable up to four interrupt sources. The interrupt sources provide a convenient way to detect errors and other situations that need attention in a serial link. When an interrupt occurs, Bits 1, 2 and 3 of Register 2 (Interrupt Identify) reveal the source.

Many programs don't use all four interrupt sources. The most-common interrupt source is Bit 0, Received Data Available. With Bit 0 set to 1, the UART generates an interrupt every time there's new data to be read. Since there's often no way to predict when data will arrive from an external device, an interrupt is an efficient way to detect its arrival. Reading the receive buffer clears the interrupt until the next byte arrives.

When Bit 1 of Register 1 is set, an interrupt occurs when the transmit buffer is empty. This signals that it's okay to send another byte.

When Bit 2 is set, an interrupt occurs when there's a transmission error, signaled by a change in Bits 1 through 4 in Register 5. The following are the four errors detected:

- **Overrun.** New data arrived at the receive buffer before the previous data was read.
- **Parity.** With parity enabled, the received data's parity bit was incorrect.
- **Framing.** A received character didn't have a stop bit.
- **Break Interrupt.** Received data has been logic 0 for longer than the transmission time for one character.

When Bit 3 of Register 1 is set, an interrupt occurs when there's a change at one of the control inputs on the serial connector.

Bits 4 through 7 of Register 6 (Modem Status) hold the status of the control inputs, and Bits 0 through 3 signal which inputs have changed since the last time the register was read. Bits 4 through 7 contain the complements of their corresponding outputs on the UART. In other words, if Bit 4 is low, the CTS pin is high.

Control Registers

Register 3 (Line Control) stores configuration information, such as the

Table 4. Conventional Port

Port Designation	Address
COM1	3F8h
COM2	2F8h
COM3	3E8h
COM4	2E8h

*Not all ports follow the convention, especially COM3 and COM4.

number of stop, data and parity bits used in each transmission. For example, for the popular settings of N,8,1, Bits 5 through 0 would be 00111.

Register 4 (Modem Control) has several important functions. Bit 3 (–OUT2) is a general-purpose output on the UART, but in 80x86 computers, this bit enables the interrupt-request (IRQ) line at the port.

Setting –OUT2 to 0 turns off the output that generates interrupt requests for the port. Even if the UART detects an interrupt, the interrupt controller and CPU will never see it. As I'll explain later, controlling this bit can eliminate some serial-port problems.

Bits 0 and 1 of Register 4 set and clear DTR and RTS on the serial connector for those applications that use these control signals. Bit 2 is another general-purpose output. This one has no standard function.

Setting Bit 4 of Register 4 puts the UART in a loop-back mode, where you can read transmitted data at the receive buffer. Loop-back permits you to test a port or test for the presence of a port by writing to it and reading back the result.

New Functions

Some of the registers and bits aren't available in all versions of the UART. The 16450 and 16550 have a scratch register that has no pre-defined function. In your own programs, you can use this register any way you want.

Other bits control the 16550's FIFOs. Setting Bit 0 of Register 2 (FIFO Control) enables the FIFOs and also sets Bits 6 and 7 of Register 2. Setting Bit 0 and then reading Bits 6 and 7 is a quick way to test for the presence of the FIFOs. On UARTs that lack FIFOs, Bits 6 and 7 will always read 0.

Most commercial serial-port software control the UART directly. Another option is to use BIOS interrupt 14h, which has services to initialize, send to, receive from and read the status of the serial port. MS-DOS's interrupt 21h, functions 03h and 04h also send to and receive from a serial port. Neither of these options uses interrupts and both are limited in what they can control. Consequently, they're rarely used.

Selecting a Serial Port

On boot-up, the computer's BIOS tests for serial ports and stores up to four 16-bit addresses beginning at address 40:00. MSD.EXE and many other diagnostic programs search for serial ports and display the addresses of those detected.

Table 4 details the conventional port addresses and interrupt levels for the four ports. The ports are referred to as COM1 through COM4 (with "COM" meaning communications). If you have more than four serial ports, the BIOS won't store the addresses of the additional ports, and many programs won't be able to access them. Some earlier BIOSes look for only the first two ports.

Also, if you have a serial port at an unconventional address, the BIOS may not find it. For example, I have a serial card that assigns address 2E8h to COM3 and 2E0h to COM4. Although 2E8h is normally reserved for COM4, the BIOS identifies it as COM3. It seems that when the BIOS doesn't find a port at COM3's normal address of 3E8h, it continues looking and assigns the next port it finds to COM3. The only software that recognize my card's COM4, with its unconventional address, are those few programs that permit me to assign any address to a port.

If you need a lot of serial ports, eight-channel serial-port expansion cards are available from such sources as Personal Computing Tools.

Since the addresses of the additional ports vary, you need to consult the documentation. Again, the ports are useless if the software doesn't recognize them or if needed IRQ levels aren't available.

Many serial ports have jumpers, switches or configuration software that enable you to select a port address and IRQ level. The amount of choice offered varies with the particular card.

To find out how many serial ports a computer has installed, you have to do more than count the RS-232 connectors on the back panel of your computer's system unit. This is because some serial devices use a COM port but don't require an RS-232 interface. One example is an internal modem, the circuits of which are on an expansion card or the motherboard. The only connector is an RJ-11 jack for the phone line.

Of course, you can also buy modems and other devices that do use RS-232. These have advantages. If your computer has no free expansion slots, an RS-232 link may be your only option. If you often use a device on more than one computer, it's easier to unplug and move an external piece of equipment than to open up two system units to remove and install an internal card.

If you have several serial devices that you use at different times, with an RS-232 interface, you can connect an external switch box or even swap the cable manually, again without having to open the computer's system unit. With this arrangement, you can select one device at a time without having to worry about interrupt conflicts that might otherwise occur.

On the other hand, internal devices are often a little less expensive and save on desk space.

Multiple-Port Problems

Just because you have several COM ports doesn't mean that you can use them all, or even use any two of them at the same time, for that matter. First of all, to use a port, your software must know its address and the IRQ level, if used.

Some programs, especially earlier ones, may offer a choice of only COM1 or COM2. Others permit up to COM4 or higher and may even let you specify the address and interrupt-request level of your port, to allow for unconventional settings. Datastorm's *ProComm Plus* is one example of a program that permits custom port and IRQ settings.

One major problem with multiple serial ports is that there are only two interrupt-request levels normally reserved for COM1 through COM4. COM1 and COM3 conventionally use IRQ4, while COM2 and COM4 use

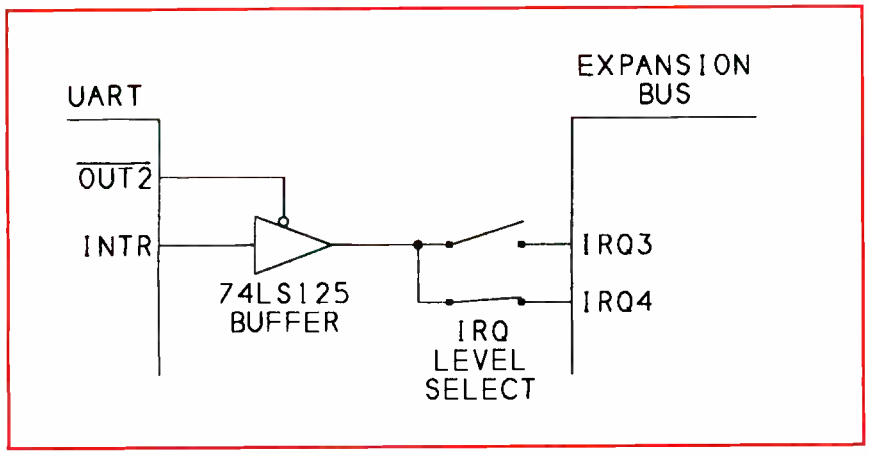


Fig. 2. Typical interrupt circuitry for a serial port. When the UART's OUT2 output is low, the output of the 74LS125 buffer follows the UART's INTR output. Switches permit a user to select which IRQ line the output drives. When OUT2 is high, the buffer's output has no effect on the IRQ line.

IRQ3. However, assigning the same IRQ level to two ports can lead to problems. In many cases, even though you can have four serial ports, you can use only two at a time. The reason has to do with the interrupt lines and the components that control them.

On the ISA (PC and AT) bus, interrupts are triggered by a rising edge or a transition from low to high. Figure 2 shows the interrupt circuitry from an older serial-port expansion card. More-recent serial ports may use different components, but they should emulate the operation of the Fig. 2 circuits. Examining the circuit helps to explain the problem encountered with shared interrupts.

The chip that drives the IRQ line is a 74LS125 buffer. You select an IRQ level by closing a switch on the expansion card to route the buffer's output to one of several IRQ lines on the expansion bus.

The input to the buffer is the INTR output of the UART, which goes high to request an interrupt. The buffer also has an enable input that's controlled by the UART's –OUT2 output.

Before a program can use serial interrupts, the software must bring low -OUT2, which causes the output of the buffer to follow its input. To make things confusing, the –OUT2 pin is the complement of the –OUT2 bit in the modem control register (MCR). To bring low the –OUT2 pin, you must write 1 to –OUT2 in the MCR register.

When the –OUT2 pin is high, the buffer's output is off, or in a high-impedance state, and interrupt requests from the UART don't affect the IRQ line. In other words, another device can use the IRQ line without conflicts from this serial port.

Problems begin to crop up when two 74LS125s are enabled and both connect to the same IRQ line. The outputs are totem-pole TTL type, where a high output has a low resistance to +5 volts, and a low output has a low resistance to signal ground.

When two outputs connect together, as they do when two serial ports share the same interrupt line, if one output tries to go high and the other tries to go low, the result is unpredictable. Chances are that the IRQ line won't be able to go high enough to generate an interrupt request, and the resulting current may even damage the components involved.

In the interest of journalistic inquiry, I connected together two 74LS125 outputs to see what would happen. The result illustrates why, in most cases, two devices shouldn't share the same IRQ level.

With both buffers enabled and both inputs low, the combined output was near 0 volt, or a valid logic low, as expected. When I brought one input high to simulate an interrupt request, the combined output drew about 60 mA and would go no higher than about 0.6 volt. This current is much greater than LSTTL's typical output current of less than a milliampere, though probably not enough to be fatal to the components. More important, with one input low, the combined output was nowhere near a valid logic high of 2 volts and, so, would never generate an interrupt.

Multiple-Port Solutions

There are some solutions to the shortage of IRQ levels. The following paragraphs describe seven ways to use multiple serial ports without causing interrupt conflicts. None of the solutions is ideal, but you should be able to find something that works for your situation.

(1) With just two devices, use COM1 and COM2. If you never need to use more than two serial devices, the easiest way to avoid problems is to use only COM1 and COM2, with IRQ4 assigned to COM1 and IRQ3 assigned to COM2. Also, be sure that you don't assign these IRQ levels to any other devices in your computer.

You can sometimes free up a serial port by using an alternate interface. For example, a PS/2-type mouse uses a built-in mouse port that doesn't require a standard COM-port address and typically uses IRQ12. A bus mouse, which connects to a special mouse-interface expansion card, also doesn't normally use a COM-port address, though it may use IRQ3 or IRQ4. (Check the documentation or jumpers.)

(2) Use external devices and connect them to a switch box. This approach lets you use one device at a time, with a manual switch to select among them. You still can have one internal device, on COM1, for example, with the switch box on COM2.

(3) Assign different IRQ levels to COM3 and COM4. If you must use two even- or odd-numbered ports at once, see if your hardware and software permit you to assign a different IRQ level for one of the ports. To change the IRQ level, the port must have jumpers, switches or configuration software that selects the desired IRQ level. Your serial-port application software must also permit you to select the IRQ level.

Possible available interrupts are IRQ7 and IRQ5, which are assigned to the parallel ports, but are often never enabled or used. Interrupts 10, 11 and 12 may also be available if you have a 16-bit (AT-bus) serial card.

(4) If two ports must share an IRQ level, use only one at a time, and disable interrupts on the unused port.

Listing 1. Program Enables/Disables IRQ Line at a Serial Port and Displays Which Interrupt Sources are Enabled at Port

```
CLS
PRINT "COM port to examine (1-4)? "
PRINT "(Enter 0 to quit)"
INPUT PortNumber
IF PortNumber > 0 AND PortNumber < 5 THEN GOSUB GetBaseAddress
END

GetBaseAddress:
DEF SEG = &H40  'get base address of selected port
BaseAddress = PEEK((PortNumber-1)*2) + PEEK((PortNumber-1)*2+1)*&H100
PRINT "Port        = COM"; PortNumber
PRINT "Base Address = "; HEX$(BaseAddress)
IF BaseAddress > 0 THEN
        GOSUB ReadMCR
ELSE
        PRINT "No port found"
END IF
DEF SEG
RETURN

ReadMCR:
MCR = INP(BaseAddress + 4)      'read modem control register
IF MCR AND 8 = 8 THEN   'bit 3 tells if IRQ line is enabled
        PRINT "IRQ line is enabled"
ELSE
        PRINT "IRQ line is disabled"
END IF

IER = INP(BaseAddress + 1)      'read interrupt enable register
PRINT
PRINT "These interrupt sources are enabled: "
IF IER AND 1 = 1 THEN PRINT " Received Data Available"
IF IER AND 2 = 1 THEN PRINT " Transmit Holding Register Empty"
IF IER AND 4 = 1 THEN PRINT " Receiver Line Status Change"
IF IER AND 8 = 1 THEN PRINT " Modem Status Change"
IF (IER AND &HF) = 0 THEN PRINT " None"

PRINT
PRINT "Select an action: "
PRINT "1 Disable IRQ line"
PRINT "2 Enable  IRQ line"
PRINT "3 Take no action"

INPUT Action
SELECT CASE Action
  CASE 1
     OUT BaseAddress + 4, MCR AND &HF7          'clear bit 3 of MCR
     PRINT "IRQ line disabled"
  CASE 2
     OUT BaseAddress + 4, MCR OR 8              'set bit 3 of MCR
     PRINT "IRQ line enabled"
  CASE ELSE
END SELECT
RETURN
```

This way, you can have two ports with the same IRQ level, as long as you don't use both simultaneously. To do this, you must disable the IRQ output on the port you aren't using. You can then use another port with the same IRQ level. You can control the interrupts with a short BASIC program, eliminating having to deal with switch or jumper settings.

Listing 1 is a BASIC program that prompts you to select a COM port to enable or disable and then performs the requested action. The program disables a port's interrupts by writing 0 to Bit 4 of the UART's Register 4 to bring high the –OUT2 output. Although you can disable interrupt requests by writing to the interrupt controller's mask register or by setting Bits 0 through 3 of the UART's Register 1 to 0, these won't remove

the problem caused by multiple drivers that use the same IRQ line.

As an example of the foregoing, assume that you have a mouse on COM1 and a modem on COM3, with IRQ4 assigned to both. Some internal modems enable interrupts on power-up. If this is the case, run Listing 1 on boot-up and answer the prompts to disable interrupts from COM3.

Then, with the mouse driver installed (usually done in the AUTOEXEC.BAT or CONFIG.SYS file), you should be able to use the mouse with all of your software, except the modem-communications software. Before using the modem, run Listing 1 and disable interrupts on COM1. You can also enable the modem's interrupts on COM3, although the communications software will almost certainly do this for you.

Running the communications software replaces the mouse's interrupt-service routine, or ISR, with an ISR intended for responding to interrupts from the modem. With interrupts from COM3 enabled, you should be able to use your modem without encountering problems. You'll have to use your keyboard for cursor control, however, since the computer will no longer receive interrupts from COM1 and the mouse's ISR is no longer installed.

On exiting, the communications software should disable COM3's interrupts and restore the mouse's ISR. Run Listing 1 again to re-enable interrupts on COM1 (and disable them on COM3 if the modem software didn't do so). You now should be able to use your mouse again. If mouse use isn't restored, reinstall the mouse driver.

If you use this technique regularly, you can revise Listing 1 by coding the desired actions into the program in place of the user prompts. You can then call your programs from a batch file so that they execute automatically whenever you run the software that requires them.

(5) Use polling instead of interrupts. If you're writing your own software, you can disable interrupts on the port and, instead, use a polled interface, where the software checks periodically for data or errors instead of relying on interrupts to signal them. Most commercial software uses interrupts because they're convenient and fast. But if your application doesn't involve high-speed transfers—if it reads sampled data once per second, for example—doing without interrupts can be a good solution. Be sure to disable interrupts, as described above, on a port that doesn't use them.

(6) Use a computer with a Micro Channel or EISA bus. Exceptions to the no-interrupt-sharing rule are serial ports designed for use on computers that have an EISA bus or IBM's Micro Channel bus, used on IBM's model PS/2. On the Micro Channel bus, the IRQ lines are active-low and use open-collector or similar outputs. On these outputs, a pull-up device always presents a resistance from the output to +5 volts. If you tie together several outputs, any one device can safely bring low the combined output.

On EISA machines, the IRQ lines can have either configuration, with rising-edge interrupts for compatibility with ISA cards and level-sensitive interrupts for EISA cards.

These solutions also require software that can identify which device requested an interrupt and jump to the appropriate ISR.

(7) Use a multi-serial-port card that permits multiple ports to share one IRQ level. Again, you'll need software that reads the UARTs' registers to detect which port was the source of an interrupt request and branches to the appropriate interrupt-service routine. Personal Computing Tools is one source for this type of serial-port card and supporting software.

Moving On

Some resources that have more on serial ports and how they work follow:

National Semiconductor's data sheets for the 8250, 16450 and 16550 are available upon request and include complete descriptions of the UART registers and chip operation.

The Undocumented PC (Frank van Gilluwe, Addison-Wesley, 1994, 915 pages + disk, $44.95, Tel.: 1-800-358-4566) is a detailed programmer's reference to personal-computer hardware. The chapter on serial ports includes assembly-language code for detecting the type of UART and a program that finds the maximum transfer rate between two computers.

Next time, I'll discuss RS-232 interfacing solutions, cables and a circuit for monitoring and control purposes using the serial port. ■

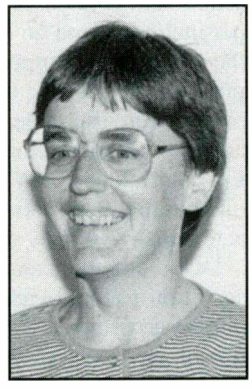
Sources

National Semiconductor Corp.
2900 Semiconductor Dr.
P.O. Box 58090
Santa Clara, CA 95052-8090
Tel.: 408-721-5000 or 1-800-272-9959

CIRCLE NO 152 ON FREE INFORMATION CARD

Personal Computing Tools
90 Industrial Park Rd.
Hingham, MA 02043
Tel.: 1-800-767-6728 or 617-740-0120

CIRCLE NO 153 ON FREE INFORMATION CARD



Jan Axelson

By Hardin Brothers

Windows Fonts

Microsoft and Apple have revolutionized how printed material looks with TrueType font technology. Here's some background, a primer on type and hints on selecting and managing a font library.

Because I failed remedial handwriting twice in junior high school, I used a typewriter whenever I could to get through high school and college. At 10 characters per inch (cpi) and 66 lines per page, the typewriter's output was highly predictable. My first computer and printer were the same, yielding 10 cpi and 6 lpi (lines per inch). The earliest Epson printers weren't capable of much more, unless they "drew" characters in a *very* slow graphics mode.

DOS computers and word processors didn't seem to add much more until laser printers, font cartridges and download-able soft fonts arrived on the scene in the mid-1980s. The font cartridges were expensive and let you preview a document on the screen of your video monitor imprecisely, if at all. Soft fonts were also expensive and required scads of hard-disk space.

The greatest limitation of both cartridges and soft fonts was their lack of flexibility. If you wanted to change text sizes, you often had to buy a new cartridge or run a font scaler that created a new font file and took up even more space on your hard disk.

Microsoft *Windows* changed the font shuffle, with vector fonts in early versions and outline fonts in *Windows* 3.1 that are generally compatible with both *Windows* and Macintosh platforms. Before I can describe how *Windows* has made fonts so much easier to store and use, a little background information is needed.

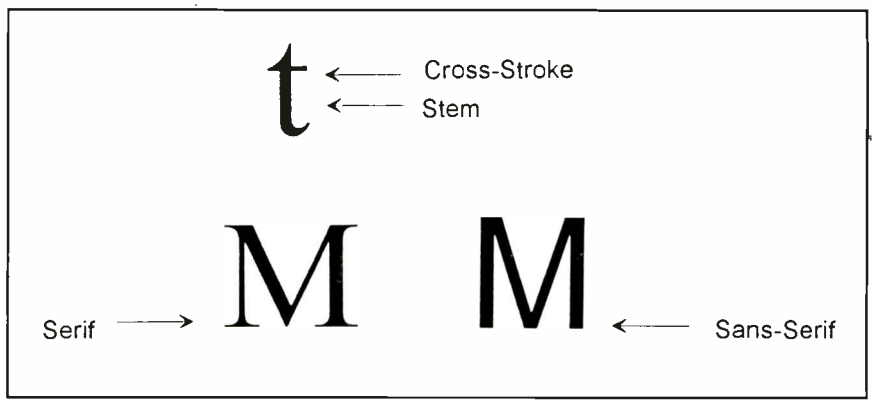


Fig. 1. Parts of a glyph, the visible part of a typeface character.

Character Sets

Every character in a document is represented by a number. If you're used to DOS, you know that there are 256 character codes that range from 0 through 255. The codes from 32, the space, through 126 can be typed directly on your PC's keyboard and represent the upper- and lower-case letters, numerals and punctuation. Codes from 0 through 31 represent both control codes, like tab and form feed, and characters that are used more often in games than in "serious" applications. Codes from 127 through 255 are often referred to as "extended ASCII" and include some symbols for European languages and characters for drawing boxes and windows on a video monitor's screen in text mode.

These 256 characters are often called the ASCII (which stands for American Standards Characters for Information Interchange) character set, but they really aren't. ASCII defines the control codes from 0 through 31 and the characters from 32 through 127. The remainder of the characters were defined by IBM in its first PCs and are sometimes referred to as "extended ASCII."

Windows has different requirements than DOS character mode. For one, the line and box characters are superfluous because a *Windows* application can do a better job of drawing with native *Windows* graphics services. For another, the DOS character set is limited in its support for non-English character sets, while *Windows* was designed to be a worldwide product with better international support.

In designing *Windows*, Microsoft essentially dumped the IBM character set (which it calls the "OEM" character set to avoid using IBM's name) and adopted the ANSI character set. The characters from 32 through 126 are the same in both cases, but those from 127 through 255 have changed, and the characters from 0 through 31 have been dropped altogether.

This leads to one unexpected behavior in some *Windows* applications. In programs like Notepad and Windows Write, you can use Alt plus a number to designate characters that are usually not capable of being typed, just as you can in DOS, but the results are different. For example, in OEM or IBM character set, character 171 is the symbol for one-half (½). In the ANSI or *Windows* character set, character 171 is the double-left guillemet, or <<, and the ½ symbol is character number 189.

So, you may well ask, what occurs if you type Alt+171 in a *Windows* application? You might expect to see the << symbol but, instead, the ½ appears! Alt plus a three-digit number produces, when possible, the same character as the same key combination produces in DOS. If you really want <<, you must type Alt+0171. The leading 0 tells *Windows* that you know what you're doing and that you're specifying a character from the ANSI set and not the OEM set.

In addition to the foregoing, *Windows* can work with two other character sets. The symbol set is used to display math equations and symbols. Vendor-specific symbol sets are used when output is sent to a device, such as a printer or plotter, that has its own built-in symbols and character sets. *Windows* can use vendor-specific character sets only if you've installed a special driver for the device.

The Character Map applet shipped with *Windows* 3.1 will show you the complete character set for each font. You'll find that a few fonts, like Terminal, contain the OEM character set but that most use the *Windows* character set. As you move the cursor around the character map, you'll see the necessary Alt+ number to use to generate each character.

The ANSI, OEM and symbol conflicts become even more confusing in *Windows NT* and in future versions of *Windows*. Microsoft has adopted Unicode, which is a method of encoding characters in two bytes instead of the usual single byte. Two bytes per character means that a complete character set has 65,536 possible characters, which will provide ample room for the writing systems of all countries that use computers, including Asian countries like Japan, Korea and China. Right now, non-Latin writing systems, like those used in Russian, Arabic, Hebrew, Hindi, Japanese, Mandarin and Korean, can't be represented without having to load unusual character sets and performing some difficult character translations.

Shapes and Lines

A typeface is a collection of characters that have a common design and, usually, a common name. For example, Courier is a well-known typeface. Since typeface names can be protected by trademark, very similar designs from different companies often have different names.

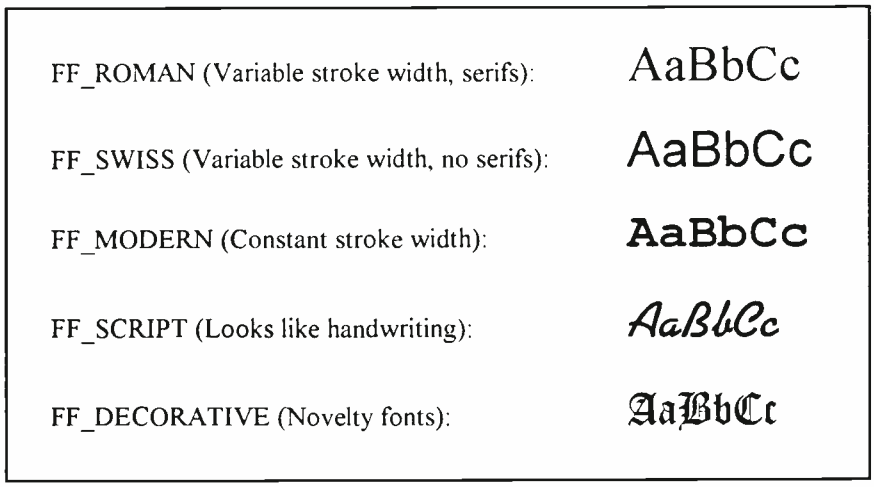


Fig. 2. Examples of the five font families into which Microsoft categorizes all typefaces.

A font is a collection of characters from the same typeface that have the same size, slant and weight. For example, 10-point Courier Bold Italic is a font from the Courier typeface.

Type designers use several different terms to describe a typeface. The most common are stem, stroke and serif. As illustrated in Fig. 1, the stem of a character is its main vertical line. A stroke is a horizontal or vertical line that's part of the character. A serif is a small cross-line that's added to the ends of the main strokes of a character.

A few typefaces use strokes of the same width, but most vary stroke width from one part of a character to another or from one character to another, as illustrated by the right and left Ms, respectively, in Fig. 1. Typefaces are also often sorted into those that use serifs (serif typefaces) and those that don't (sans-serif type faces).

Windows categorizes typefaces into five families, three of which are based on stroke widths and serifs (Fig. 2), as follows:

The FF Roman family includes typefaces that have variable stroke widths and serifs, such as Times New Roman.

The FF Swiss family includes typefaces with variable stroke widths and no serifs, such as Arial.

The FF Modern family includes typefaces that have constant stroke width, with or without serifs. Nearly all fixed-pitch typefaces (ones in which all characters have the same width) are part of FF Modern.

FF Script is a family of typefaces that are designed to look like handwriting, like Script and Cursive. FF Decorative is a family of novelty fonts, like Old English.

Windows uses this classification scheme so that it can find a logical substitute if an application requests a typeface that isn't available.

The visible part of a character is called a "glyph." The glyph of a simple upper-case H, for example, consists of two vertical and one horizontal strokes. Characters also have an invisible part, the space around each character that maintains its legibility. Both the visible and invisible parts of a character are included in its measurements.

Characters are usually measured in a point system that, in the computer industry, in which 1 point is exactly 1/72". (Prior to the use of computers, a point was very slightly less than 1/72".) In *Windows*, character heights can also be measured in twips, which are 1/120 of a point. There are 1,440 twips per inch.

Because both the visible and invisible parts of a character are included in its size, and because type designers add differing amounts of empty space around each character, fonts that have the same point size usually have different-sized characters. The amount of difference can be surprising, especially for those people who believe that all 12-point characters, for exam-

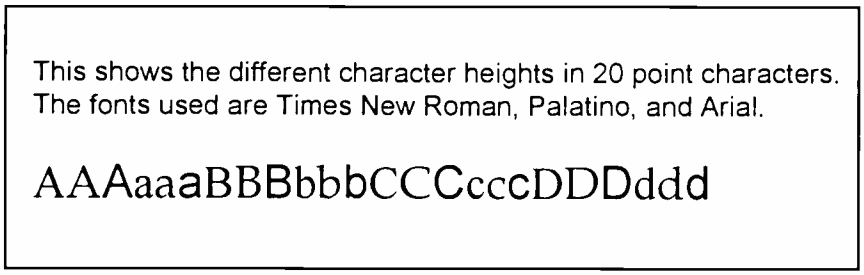


Fig. 3. As this series shows, there can be significant variations in sizes for different typefaces. The example shown includes Times New Roman, Palatino and Arial, all printed out in 20-point size.

ple, should look about the same. A good example of this is given in Fig. 3.

Other measurements are also used to describe characters and fonts. The amount of space between lines, for example, is adjustable. If you display a 12-point font with 14-point line spacing, the effect is of slightly spread-out lines that are easier to read. This spacing specification is abbreviated 12/14 and said "12 on 14" by typographers. This vertical space between character cells (the visible and invisible parts of a character) is called external leading because, to set the type by hand, you must use narrow lead strips between the rows of characters to create the extra space desired.

Other parts of a font include the baseline (the line on which almost all upper-case characters and many lower-case characters sit), the ascent or rise above the baseline, the descent below the baseline, the width of each character (including blank space on each side of it) and the height (same as point size) of the font. Height includes internal leading, which is a term used primarily in *Windows* and is the space from the top of the glyph of any character to the top of the character cell.

Characters also have overhang, which is the amount that a glyph overlaps the horizontal space of adjacent characters. Almost all Italic fonts use overhang (such as the "*T*" in the Italic "*Is*") to keep the characters from appearing to be spread out. Finally, "pitch" is a general term that describes the horizontal distance between glyphs. Fixed-pitch fonts, or monofonts, give each character the same horizontal distance, as in a typewriter. Most *Windows* fonts exhibit variable pitch, which means that the width of a given character cell depends on the width of the glyph.

Managing Fonts

Windows 3.1 can work with three kinds of fonts: raster, vector and outline. Raster fonts are stored as bitmaps with specific pixels turned on and off in each character cell. They're usually designed for a specific output device at a specific resolution. For example, all monochrome, CGA, EGA and VGA video cards include fixed-pitch raster fonts in their ROMs for display of character-mode information. It's possible to load alternate fonts into EGA and VGA adapters.

In DOS character-mode applications, you're essentially stuck with the fonts and point sizes your adapter and printer support. Most applications can't change a 10-point font, for example, into a 12-point font. Nor would those applications know what to do with different output fonts.

Windows adds some flexibility to raster fonts. It can synthesize bold, Italic, underline and strikeout characters from a raster font. It can also synthesize new font sizes by manipulating the character cells. However, the results aren't always as aesthetically pleasing as the original fonts, and the manipulations slow down *Windows*' display and print speeds.

Vector fonts are stored as a series of graphics commands. In other words, the information in the font file tells *Windows* how to draw each character as if it were a picture. Vector fonts are useful for devices like plotters that can't use raster fonts. Displaying vector characters on-screen is a slow process, and vector fonts often look thin and spindly. They were used in *Windows* 3.0 and earlier when an application needed to distort or rotate characters.

One of the advantages of *Windows* 3.1, *Windows for Workgroups*, *Windows NT* and the coming *Windows* 4.0 (also known as Chicago) is the use of outline or TrueType fonts. Microsoft and Apple developed the technology for TrueType fonts in a joint effort, in part to combat Adobe Systems' influence and market share. Adobe holds the rights to PostScript printing and display, a technology that's similar to TrueType.

A TrueType font is stored as an outline plus hints. The TrueType rasterizer, which is part of *Windows* 3.1, scales the outline to the point size that an application requests. It then uses the hints to correct any distortions that may occur.

The process of creating a character of a specific size from an outline is relatively fast and easy, but it can lead to distortions. For example, imagine that an upper-case H is being rasterized at a size that suggests that each vertical stroke should be 1.5 pixels wide. During the round-off process, the rasterizer could decide that one vertical stroke should be one dot or pixel wide and that the other vertical stroke should be two dots or pixels wide. The result would be character that's noticeably distorted.

The hints that are stored with the font should prevent the foregoing kind of distortion. The rasterizer uses the hints to prevent distortion of characters at specific, and usually small, point sizes. The hints might tell the rasterizer to use equal vertical strokes for the H, to always retain the cross-stroke of the f and to never drop the serifs from any character in the font.

Hints aren't required in TrueType fonts and are sometimes omitted from inexpensive typeface packages. Many packages use computer-generated hints. A more-intelligent rasterizer tests the typeface at each point size and creates the hints that *Windows* might need.

The best typeface packages have hand-tuned hints. After each typeface is designed, machine-generated hints are added to the font files. Then a typographer examines each character at each point size and adds additional hints to combat any distortion he or she notices. The moral of this story, of course, is to buy TrueType type-

faces that have been hand-tuned and have more than the standard machine-generated hints. You'll pay more for this luxury, but you'll also obtain much better results, especially at small type sizes.

TrueType Advantages

Microsoft lists four main advantages to using TrueType fonts over older raster and vector fonts. Each claim is mostly true, though each is also subject to some caveats.

Microsoft's first claim is that TrueType fonts are truly WYSIWYG (what you see is what you get). That is, since outline fonts lead to device-independent rasterization, you can see on the screen of your video monitor an exact replica of what will be produced on your (or anyone else's) printer. As a corollary, Microsoft claims that applications can scale and rotate TrueType fonts more easily than raster and vector fonts and that TrueType fonts are attractive at all sizes, both on-screen and when printed out in hard copy.

The last part of this claim, as I've explained, depends on how well a particular typeface has been hinted. The typefaces that Microsoft distributes, both as part of *Windows* (Arial, Courier New, Symbol and Times New Roman) and in add-on font packs, are generally of high quality. But there are other font packs that are probably worth a good deal less than their low retail prices, especially if you need to produce high-quality output.

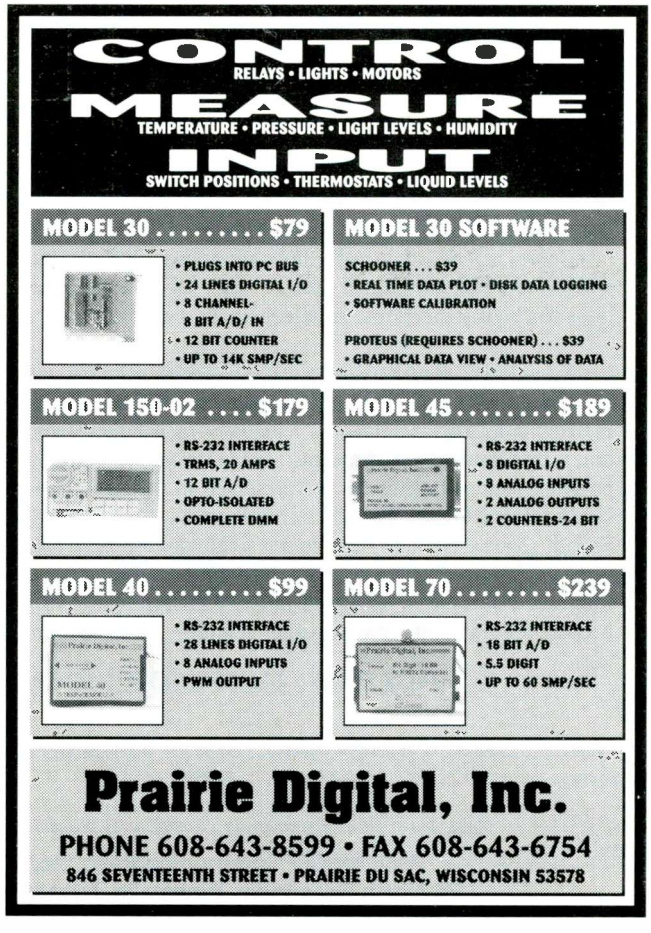
What you see isn't quite what you get, partly because a video screen isn't a printer. Most laser printers have a 1:1 aspect ratio in which each dot is the same size horizontally and vertically. Many video display systems don't have the same aspect ratio. No matter how well the rasterizer tries to compensate, it can never exactly match video and printed output.

Going further, point sizes are correct (or should be) on printed output but will rarely be correct on-screen. To keep characters legible at small point sizes, Microsoft uses a "logical inch" to measure on-screen points. Generally, a logical inch is between 1.3" and 1.4". This means that 10 points on the screen is larger than 10 points on a sheet of paper.

In general, TrueType and other outline fonts are much more WYSIWYG than raster and vector fonts, which often end up surprising and disappointing users once they're printed.

Microsoft's second claim is that TrueType offers true printer portability. You should obtain almost identical output on any printer for which you have a *Windows* 3.1 driver. Again, this is almost true. Printers have different resolution and, to change resolutions, the TrueType rasterizer has to round off dot sizes as it creates fonts in different sizes. Eventually, rounding off will create an error that will change line breaks and page breaks when you move a document to a different printer. Microsoft spends one and a half pages in its *Windows 3.1 Guide to Programming* in explaining why the output can change from one printer to another. But it doesn't explain how applications can overcome these cumulative rounding-off errors.

Microsoft's third claim is that TrueType provides document portability. Applications can embed TrueType fonts in documents. These fonts will then be rendered correctly on any other platform (such as an Apple Macintosh or a *Windows NT* workstation)



that supports TrueType technology. Once again, this claim is mostly true. Bear in mind that many TrueType fonts are marked "read only," which means that they can't be embedded and moved to another platform. (This is one of the ways TrueType distributors can protect their trademarks and copyrights.) Also, Apple and Microsoft both insisted that TrueType be backwards-compatible with their operating environments. Therefore, there exist some minor metrics differences between *Windows* and Macintosh interpretations of TrueType fonts and occasional noticeable differences in output.

Microsoft's final claim for TrueType fonts is that they're simple. They cut down on the required number of choices and compromises. From an application's point of view, this is probably correct. It's easier to use TrueType fonts for unusual effects than it is to use raster or vector fonts.

This last claim is also generally true for end users. TrueType fonts generally require less disk space and memory than other types, and they're generated more quickly. However, unless you limit yourself to the four TrueType typefaces included in *Windows* 3.1, you can quickly fill your hard disk with both shareware and commercial TrueType files. It's not unusual to find a computer with several hundred typefaces, which means almost unlimited searching and hit-or-miss experiments before you find the best typeface for a project.

Selecting Fonts

You can find dozens of books that explain the differences between font shapes, how to choose fonts for a project and how fonts affect an audience. If you do a significant amount of desktop publishing or graphic-arts work, you need one or more of these references. Look for references that explain the ins and outs of page layout as well as font selection. With a top-quality desktop-publishing program, and even with many top *Windows* word processors, you'll be able to adjust type size, leading and kerning (spacing between individual characters) to obtain the effect you want.

Most people find a font or two that they like and stick with these for most of their work. For example, many companies have guidelines for fonts and font sizes to be used in correspondence, reports and other documents. Without such guidelines, their printed output could end up looking like a font catalog instead of projecting the professional image they want.

If you like to experiment with fonts, you'll soon find that you have dozens or even hundreds on your hard drive. If you work in *Windows*, you'll probably want to concentrate on TrueType fonts unless you also use a supplemental outline type program like *Adobe Type Manager*.

No matter where you find your fonts, opt for the best, not necessarily the cheapest. As your eye for typefaces improves, you'll discover that shareware and inexpensive font collections are often worth about as much as you paid for them. Pay particular attention to the hints included with a typeface, especially for the fonts you intend to use for text. Hinting is less important for display typefaces, those used in large point sizes for headlines.

Windows, TrueType fonts, modern word processors and page-layout programs give you the tools you need to create almost any text effect imaginable. However, like all tools, they work well only after you understand the nuances and technicalities of type. One way to improve your understanding of type is to look critically at the type in fine books. Another way is to understand and experiment with the tools you have available to you. ■

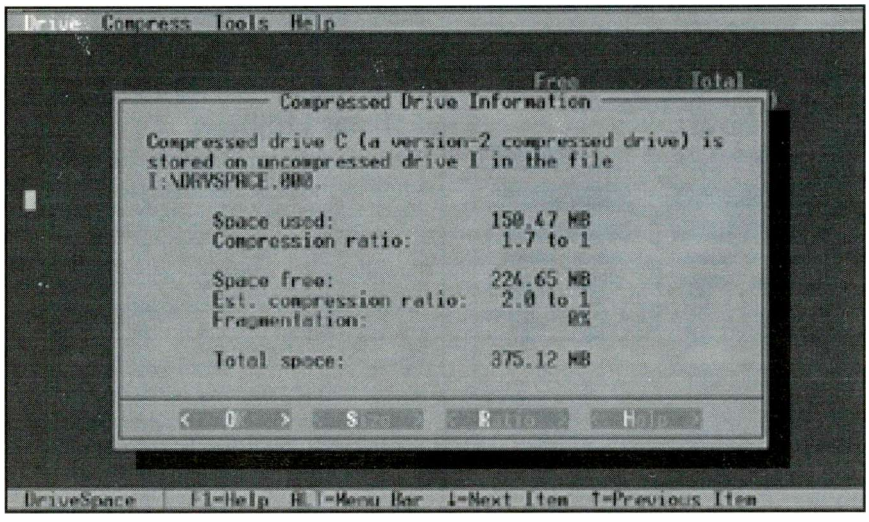
By Joe Peschel

DriveSpace Meets DoubleSpace In Microsoft's New MS-DOS 6.22

Microsoft issues a new disk-compression utility and a new version of MS-DOS

When Microsoft was found guilty of stealing secrets from Stac Electronics with regard to the disk-compression utility included in MS-DOS 6.0, it removed DoubleSpace from MS-DOS in anticipation of the judge's ruling and called its new DOS Version 6.21. Promised were a replacement disk compressor and another revision, which has become MS-DOS 6.22. The idea, one would suppose, was to get a product to market quickly and not offend Stac. After all, who would want to wind up in court again?

Sure enough, MS-DOS 6.22 with the new DriveSpace disk-compression utility showed up quickly. In fact, it showed up so fast that you'd think Microsoft had been working on this DoubleSpace replacement for quite some time or that the company wasn't all that concerned about the possibility of once again violating Stac's patents. So with MS-DOS 6.22, we now have DriveSpace to compress our disks.



DRVSPACE inherits the boring bluish sameness of the DBLSPACE utility.

What's New About DriveSpace?

On the surface, DriveSpace has the appearance and feel of DoubleSpace. Its compressed data, however, is kept in a format that's different from that of DoubleSpace, using a new MRCI (Microsoft Real-Time Compression Interface.) compression specification, MRCI2, which is incompatible with MRCI1. (Microsoft has backtracked to refer to MRCI as MRCI1.)

Naturally, the new specification is a variation on the Lempel-Ziv algorithms used by other compressors, including DoubleSpace. DriveSpace still compresses redundant data by searching for repeated character sequences and using a sliding dictionary similar to that used in DoubleSpace, and it keeps track of sequence positions with tokens. Once the files are compressed by DriveSpace, they're written to a CVF (Compressed Volume File). Sound familiar? The DRVSPACE.INI file, however, now contains an additional variable to determine which type of compressor to read: UseMRCI1=0, which is the default setting when DriveSpace is installed sans DoubleSpace. This variable instructs DOS not to load DoubleSpace compression. If the variable is equal to 1 to load MRCI1 compression, reading but not writing of unconverted DoubleSpace drives is permitted. Under the =1 scenario, DBLSPACE.BIN, DRVSPACE.BIN, DRVSPACE.INI and DRVSPACE.MR1 must be in the same directory.

Step-up purchasers receive a conversion product that makes the chore of transforming DoubleSpace into DriveSpace a whole lot simpler. A coupon for a conversion utility is included for MS-DOS 6.22 upgrade purchasers.

Since the DBLSPACE.INI is now DRVSPACE.INI, you probably correctly suspect that other DriveSpace files are so named. DRVSPACE.SYS, rather than DBLSPACE.SYS, loads DRVSPACE.BIN into memory. A quick MEM check shows the device DBLSYSH$ loaded into memory. Like its DoubleSpace step-dad, DRVSPACE consumes about 39K of upper memory when the /Move parameter is used

and is DoubleGuard installed. Look for a hidden CVF this time called DRVSPACE.00X on the host drive. As usual, this location is five logical letters away from the compressed drive.

Similarities to DoubleSpace abound to such a degree that the time required to compress a DriveSpace drive varied by seconds. My drive, with its 140M of data, compressed in 1 hour and 37 minutes, which is slightly more than 1M per minute. The ratio of overall compressibility in both cases was the same, a mediocre—at least compared to *Stacker* 4.0—1.7:1. I also expected a similarity of ratios between each compressor's treatment of individual files. Text, image, executable, system and other files, as suspected, compressed at the same ratio, using either XXXSpace.

Microsoft and Other Utilities

The utilities also appear to be the same as those in DoubleSpace. Run DRVSPACE after installation, and you have the feeling that you're using DoubleSpace. (See the accompanying screen shot.) Disappointingly, CHKDSK is still an option on the DriveSpace menu. It's not intended to work, and if you try to execute it, it suggests that you run SCANDISK. SCANDISK itself has been reworked for DRVSPACE compatibility, but it can't yet be run from the DriveSpace menu (would this be too convenient, I wonder).

When it's executed, the SYS command has been altered to copy DRVSPACE.BIN. Use SYS on the host, not the compressed drive. Likewise, FORMAT /S will copy the hidden .BIN file to a floppy if DriveSpace has already compressed the hard drive.

Possibly the most-notable failure of DriveSpace is, like in DoubleSpace, its inability to mount compressed floppies on systems without DriveSpace. Was there no time to develop a driver, perhaps similar to PC DOS's UDE driver, so that compressed floppies could be read by other systems?

Despite the similarities to DoubleSpace, several useful third-party utilities won't work with DriveSpace. Although Symantec's *Norton Utilities* 8.0 work correctly with DoubleSpace, 8.0 Speed Disk and Disk Doctor will corrupt your files. Microsoft also reports that the Diskfix /Scan and Compress option in Central Point's *PC Tools* can cause lost clusters on either XXXSpace drive. I'd avoid using *PC Tools* until Symantec releases a new utility that's compatible with DriveSpace. (Recently, Central Point and Symantec merged.)

Product Mentioned

Microsoft MS DOS 6.22, $79.95 Upgrade; $9.95 DriveSpace Step-Up from MS-DOS 6.x (MS-DOS 6.21 users should use the coupon for DriveSpace)
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
Tel.: 800-426-9400

CIRCLE NO. 119 ON FREE INFORMATION CARD

What's Next?

When the judge who presided in the Microsoft/Stac dispute ruled that Microsoft recall all versions of MS-DOS with DoubleSpace, both parties miraculously came to an agreement. They cross-licensed all of their existing compression patents and those patents received over the next five years. Microsoft agreed to pay Stac $1-million per month for 43 months and to purchase nearly $40-million of non-voting preferred stock that's convertible in the year 2004. Why the sudden pact? As one party joked, according to the transcript of a Stac/Microsoft conference call, no lawyers were around to make the comment: "That's the reason we were able to come to an agreement."

Because of this business decision, we'll never know whether DriveSpace would have survived another Stac challenge. I think it probably wouldn't have. There are just too many similarities to DoubleSpace. This bargain, though, worked out fairly well for end-users in that we won't have to surrender our copies of DoubleSpace. If we did have to make the surrender, I wonder how the judge expected to enforce his decision!

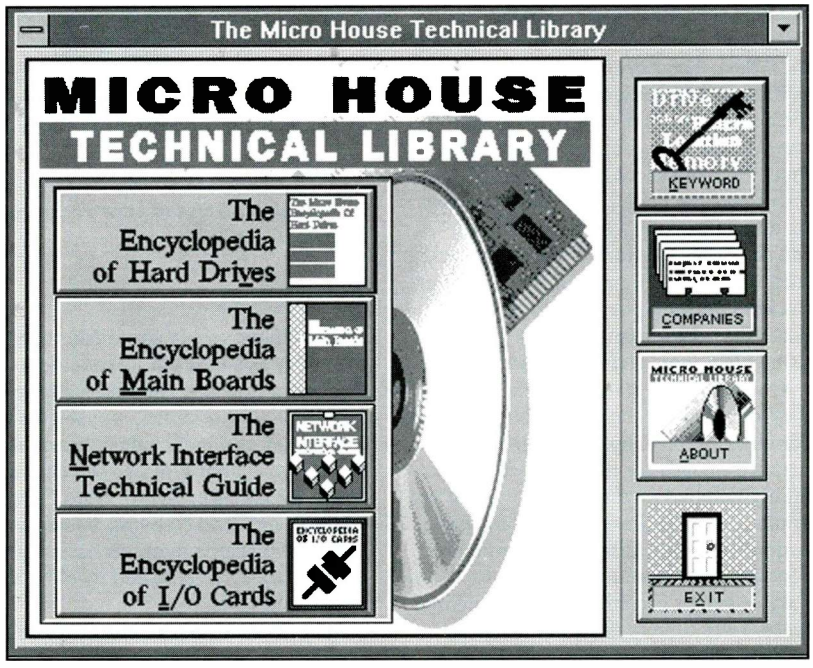
Expect one less alternative to Stacker (IBM, too, has licenses to offer Stacker-like products), and look for a compression routine from Microsoft that's capable of *Stacker*'s 2.5:1 default compression ratio. You'll probably see such a compressor incorporated in *Chicago* (which we can expect to see hit the streets under the name *Windows* 4.0), but it likely won't be called *Stacker*, despite the resemblance.

Software Review **By SF Sparrow**

Micro House Technical Library: The Ultimate Technical Reference

A forceful and inevitable consequence of computer technology is the need for accurate and voluminous technical information. Our era of high-performance electronics and high-speed information processing is called the Information Age, a practical testimony to the insatiable need for technical information. No one needs technical information more than the technician who troubleshoots computers on a daily basis.

Micro House International is a broker of technical information. For years, this company has published technical information for many different kinds of personal computers. Technical troubleshooters know of Micro House, even if some of them don't use the company's products. Now this information broker has nearly outdone itself by spinning all its technical information together and pressing it onto a CD-ROM. The combined text and graphic work is the *Micro House Technical Library*.



The *Library* consists of a trio of well-known publications by Micro House, each of which is available in hard-copy book form. Its previously separate parts are *The Encyclopedia of Main Boards*, *The Encyclopedia of Hard Drives* and *The Network Interface Technical Guide*. The *Technical Library* gives you all three publications on one CD-ROM. You get complete specifications on more than 2,100 hard drives, with more than 1,000 of them diagrammed. You can browse through more than 350 hard-drive controller cards with jumper settings, performance specifications and component locations. Move to the *Encyclopedia of Main Boards*, and you find more diagrams and configurations, miscellaneous jumper configurations that apply to more than 1,500 computer motherboards. Finally, more than 600 network interface cards are in the *Technical Library*, each supported by its own diagrams and documentation.

Installation & Documentation

The *Technical Library* is a Microsoft *Windows* application. Therefore, installation is as easy as using the *Windows* Program Manager to run the install routine. During installation, you have to decide if you want to copy part or all of the *Library* to your hard drive. Placing part of the *Library* on your hard drive speeds up data access because the most search-intensive information then resides on the hard drive. This is a good idea if you have a slower CD-ROM drive. Slower drives have access speeds of around 300 or 400 milliseconds and data throughputs of 150K to 200K per second. Check your manual for drive specifications. If you have doubts about the performance of your drive, go ahead and copy part of the *Library* to your hard drive. The cost is 10M of hard disk space.

Placing the entire Library on your hard drive yields the fastest performance. It also costs the most in terms of hard-drive usage: 110M. Though typical users don't usually have the space to spare, business users could use this method to dedicate a single PC to information access. If you're stingy about giving up hard-disk space, you can choose to run the *Library* strictly from CD-ROM. Doing so causes delays when the program is searching its database and loading graphics. Such delays range from 1 second to perhaps 10 seconds, on a well-equipped 486 running at 33 MHz and using a fast CD-ROM drive. If you have no real need for instant access, a few-second delay can be quite acceptable.

After the *Technical Library* is properly installed, you'll have to connect the "dongle." A dongle is the catch word that describes a specialized hardware

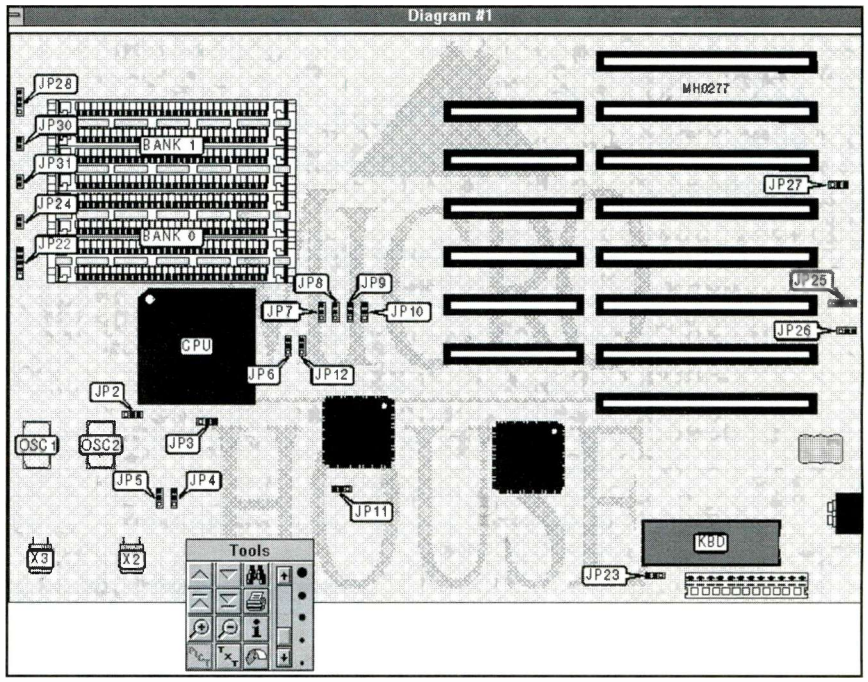
device without which your program can't run. In short, the dongle is very effective copy protection. The dongle that protects the *Library* connects to your computer's printer port. If you already have a printer attached to your parallel port, just disconnect its cable, plug the dongle into the printer port and then connect the printer cable to the dongle. Even though the dongle sits between your printer port and your printer, it won't interfere with any printing activities. Don't feel uneasy about using the dongle. Dongles are common forms of copy protection and have been in use for some years. You can remove the dongle anytime you like, but you must reconnect it before the *Technical Library* will run.

Audio & Graphics

Audio isn't produced by the *Micro House Technical Library*. It doesn't speak in a human voice through a sound card, and there are no verbose explanations of technical data. The *Library* is a pure reference publication, displaying its documents to the computer screen. Each document spreads itself on your computer screen much like you see it in the Micro House paper-and-ink books. The *Library* draws its diagrams using a style of graphics referred to as "vector." Vector graphics look like "stick" figures or line drawings, the kind drafting people used to make when they drew items by hand instead of using computers and solid modeling.

One advantage of vector graphics is that they're easier for the computer to draw, as compared to bit-mapped images. Bit-mapped images are the usually colorful, highly-detailed pictures used by paint programs, image processing software and computer games. Bit-mapped graphics contain much more information than comparable vector graphics, therefore taking much more time to draw the image on-screen. Another advantage of vector graphics is that they look the same, no matter what resolution you use to view them. This means that you get the same kind of detail at 640 X 480 pixels and at 1,024 X 768 pixels resolution. The same holds true when scaling the size of vector graphics. Detail remains good, as long as you keep the graphic large enough for human eyes to read it.

A caution exists when displaying documents in the *Technical Library*. The *Library* uses *Windows True Type* font system to display its documents. The *Library* provides its own *True Type* fonts but must use *Windows' True Type* system. Your only concern is to make sure that you've enabled *Windows* to use *True Type* fonts. You can check this by selecting the Font icon in the *Windows* Control Panel. If you don't enable *True Type*, you'll have trouble reading the text in your *Technical Library* documents.



Just one of many motherboard diagrams you can call from the Main Boards option.

Interface

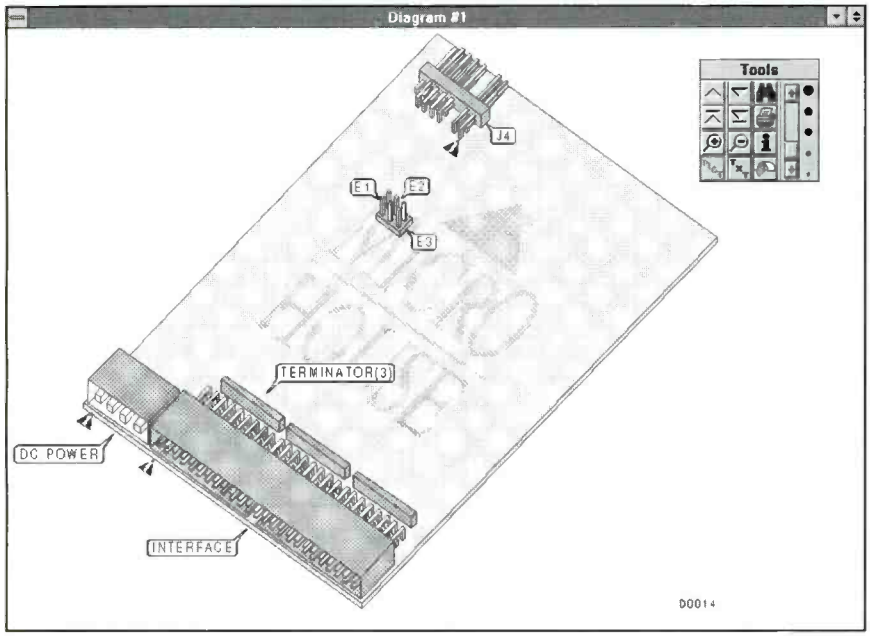
Micro House wisely chose Microsoft *Windows* as a base for interfacing to its *Technical Library*. Automatically, users have a picture-oriented, mouse-click system for accessing technical information in the *Library*. Four types of searches are ready for use: Key Word, Hard Drives, Main Boards and Network Interface Guide. All search methods have a straightforward look, accentuated by clear and readable menus.

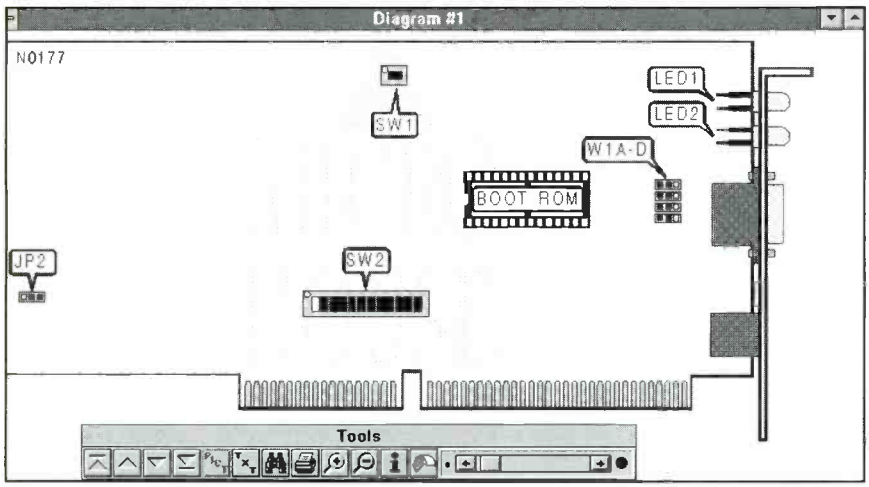
Key Word search permits up to 10 words to be used as search keys. This is a text search that scans all documents in the *Library* or can be narrowed to a single document at your request. It looks for any occurrence of the first key word plus the second key word plus the third key word, and so on until it gets all of your key words or runs out of document to search. Looking for a combination of one key word and another key word is called "and" searching. An "and" search won't return results unless all key words are found. This particular Key Word search has no provision for "or" searching, which is the complement to the "and" search. The *Library* has other search techniques that make up for lack of "or" search in Key Word mode.

The three other search modes—Hard Drives, Main Boards, Network Interface Guide—are similar in operation, differing only in the specific data being accessed. You can read or search only the text information or you can find more detailed material by looking for something very particular. Hard Drives search, for example, offers a lengthy text of interface types, directory of manufacturers, drive specifications and more. You can read this text like a book if you want to do some casual browsing. The way to get to the "meat" of the Hard Drives category is to look for a specific hard drive, hard-drive jumper settings or controller-card jumper settings. You can add search parameters like make, model, interface, encoding scheme and capacity. Likewise, a Main Boards search is pinpointed by asking for manufacturer, model, processor type and speed, I/O options or several other criteria. Once your item is found, you get not only the related text information, but diagrams, too.

The Tool Box

When you locate a desired item in the *Technical Library*, you have tools to manipulate the data. The manipulative tools are kept in a rectangular Tool Box. One tool puts related diagrams on-screen. Another toggles your screen back to text information. A scrollbar at the bottom of the Tool Box scales the screen up or down. This is where *Windows' TrueType* systems keep the text in proportion, no matter how much you scale your image. A pair of tools that resemble magnifying glasses let you select an area of your screen and then change its size. This feature is good for





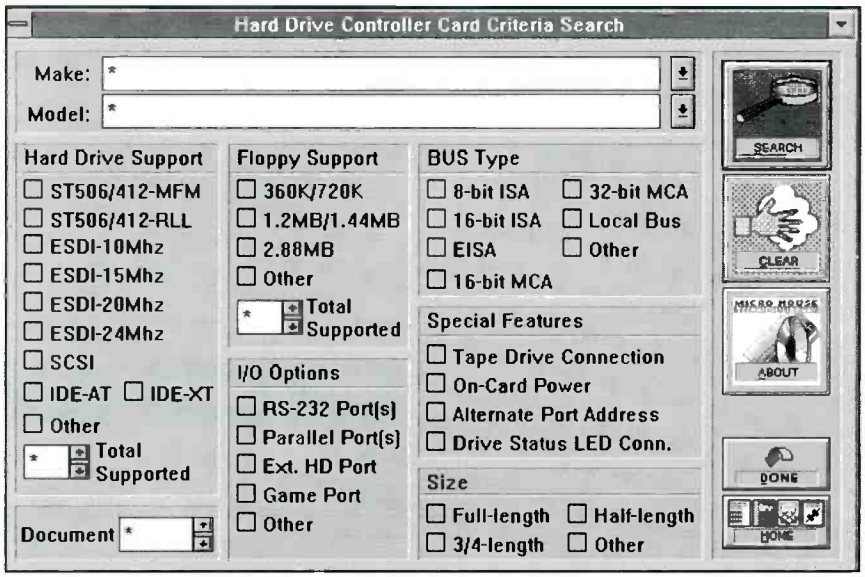
Two more examples of technical details you can call up using the Technical Library.

zooming in on complex parts of a diagram. A set of two arrows allows you to skip from one document to the next if your search entails more than one document. Another set of arrows jumps all the way to the beginning or end of a document list. Yet another tool gives you the opportunity to search for words within a current open document. Finally, you can copy any information to your printer port to obtain a hard copy.

A welcome feature of the Tool Box is its ability to automatically configure its shape. Normally, it sits near the center of your computer screen for handy usage, but the convenient Tool Box becomes a nuisance when you need to see behind it. Moving it to another part of the screen solves the problem only until you need to see that other part of the screen. Pushing the Tool Box off screen works but hampers the utility of having it on-screen. Furthermore, the Tool Box can't be minimized and relegated to the bottom of your *Windows* desktop. Even if it could, you wouldn't want to do this because utility is again sacrificed. The perfect solution to this dilemma is the one already supplied by Micro House: simply move the Tool Box to the side of your window, where it automaticall transforms from a rectangular Tool Box to a vertical Tool Box. Though it may now appear long and narrow, it's out of the way and still useful.

User Comment

A library of technical information on computer main boards, hard drives and network cards is a necessity for anyone who works on computer hardware. The *Micro House Technical Library* is a comprehensive information source with detailed diagrams, jumper settings, configuration in-



Hard Drive controller Criteria Search screen.

formation and problem-solving hints. Its data is easy to locate and ready to use. It uses the *Windows* environment to good advantage and takes care to provide data without encumbrance. For someone who installs networks and repairs computers for a living, Micro House has come up with the ultimate technical reference.

Since this report was written, Micro House has expanded its *Technical Library* to include several software drivers for various NICs and controller cards, with the option to recreate the original manufacturers diskette(s). Also added to the package are listings of multi-I/O cards (including parallel, serial, video, sound, modem memory, etc.), which are accompanied by detailed specifications. Altogether, the package adds up to a must-have technical reference library, especially now that the price has also dropped from its original $889.95 to just $599, which includes a year's subscription to quarterly updates. The package is also available without subscription for $349. At these prices, if you're doing professional troubleshooting and maintenance of PCs, you can't afford not to sign on to the *Micro House Technical Library*. ■

Product Reviewed

Micro House Technical Library, $599 with four quarterly updates; $349 without updates
Micro House International, Inc.
4900 Pearl E. Cir. #101
Boulder, CO. 80301
Tel.: 800-926-8299
Hardware Requirements: 386 (486 or better recommended), 4M of RAM, SVGA video adapter, SVGA color monitor, MPC-compatible CD-ROM drive, *Windows* pointing device
Software Requirements: MS-DOS 5.0 or later, Microsoft CD-ROM Extensions Version 2.0 or later, Microsoft *Windows* 3.1.

CIRCLE NO. 151 ON FREE INFORMATION CARD

Book Reviews By Alexander W. Burawa

Welcome to...PC Sound, Music, and MIDI

By Tom Benford
(MIS: Press. Soft cover. 306 pages. $29.95 with CD-ROM.)

This book contains just about everything you need to know to make sound on your PC, from the nature of sound to how PCs process and use sound to analog-versus-digital sound to synthesizing sound to the differences between FM synthesis and wavetable sound technologies. You'll learn about the formats used for sound files, sampling rates, eight- and 16-bit sampling sizes, file storage requirements, compression and more. By the time you get to the end of this book, you'll be something of an expert in PC sound.

Benford tells you about sound hardware devices and what they can and can't do. He also discusses the compatibility issue and features to look for when researching the purchase of a sound card. Then you'll learn about microphones, line and aux recording, basic editing techniques, mixing and playback and voice and speech recognition. There are even interviews by Tom with George "The Fat Man" Sanger, credited as the "godfather" of music for PC games and leading contemporary electronic musicians. Other topics covered in detail include MIDI and the MIDI standard; using sound in *Windows*, voice annotation, multimedia applications and speech synthesis.

This is a complete one-stop reference, containing everything you need to know to make an intelligent choice in terms of hardware, software and accessories to get you up and running. Not only are the various elements needed to produce sound on a PC described, also provided are extensive buying guides of representative products, including descriptions for more than 25 sound devices, a dozen MIDI devices and more than 50 software products, not to mention an even dozen game titles guaranteed to titillate your ears. Many entries in these buying guides contain information you won't find in ads, and all contain retail prices and short personal-use evaluations.

Lessons are used instead of the usual chapters to give the book a tutorial flavor. But don't be put off by this because the text is neither pedantic nor condescending. In fact, it's downright edifying.

Every Lesson (except Lesson 11) concludes with a glossary of the terms used in that Lesson, and an overall glossary is given in an appendix. To make this a truly one-source reference, a full list of manufacturers and publishers of PC sound products, with addresses, telephone numbers and product names is included.

If the foregoing was all you got for the modest price of this book, it would be well worth the investment. Now factor in a CD-ROM jam-packed with MIDI music files, sound-effects files and eight audio tracks by famous recording artists that comes with this book, and you'll agree that this book/disc package is a steal. So if you're planning to get into using sound on your PC or you want to know enough to make such a determination, or if you've already made the decision to upgrade your system for sound capabilities but would like to know the details about the myriad of products available in the marketplace, this is certainly the book you must have.

(Continued on page 99)

By Joe Desposito

Computing On the Go

Transmitting to the Perfect PC

Transmitting files through the air has a certain mystical quality about it. So it was with some excitement that I unpacked LapLink Wireless with AirShare. Even Rich in the office seemed excited, since he's doing his graduate thesis on wireless technology. Traveling Software sells the product for a suggested list price of $299.95. National Semiconductor, though, developed AirShare.

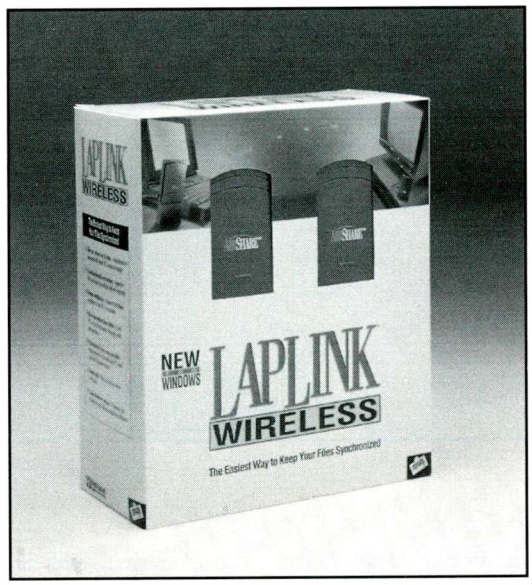
Realizing that Traveling Software traditionally does all its transfers through the serial port, I knew I was in for trouble with my old ALR PowerFlex 486. This system has just one built-in 25-pin serial port, which I use for my mouse. I could have removed the mouse and tried to make a go of it, but I didn't for two reasons. First, I intended to test *LapLink* under *Windows*. I know its possible to work with *Windows* from the keyboard, but I just didn't want to endure the hassle. Second, the 25-to-9-pin adapter I use for the mouse caused problems months ago when I tried to install *LapLink Remote* from the Hewlett Packard OmniBook 300. I figured it would be a problem again. Instead, I asked Rich if he had an extra I/O card in his parts box. He came up with an IDE controller that had two serial ports, two game ports and a parallel port, plus a page of documentation on switch settings. I decided not to mess with the card and, instead, hotfooted it over to Lorraine's, the gal with the perfect PC.

When I say "perfect PC," I use the term only in relation to *LapLink Wireless*. Lorraine has a Gate-00way 2000 4SX-33 with two serial ports and a bus mouse. Even if she had a modem, which she doesn't, she'd still have a serial port available for *LapLink*. This PC was, indeed, a perfect testbed.

Up and Running

I quickly loaded the *LapLink Wireless* software onto the Gateway PC and then stopped to ponder how I was going to get the software onto my Epson ActionNote 4000 subnotebook. Normally, it's a cinch —just connect the external drive. The drive isn't working, though. I don't know why, and I haven't taken the time to call Epson support about it, even though the number is plastered on a label right on the bottom of the ActionNote. Originally, I had intended to move the software from the floppy disk to a PCMCIA flash disk, using the PCMCIA drive on my desktop, and then stick the flash disk in the Epson computer.

Now, the only option I had was to dig out the OmniBook from the trunk of my car and use it to make the transfer to the PCMCIA disk. The OmniBook has *LapLink Remote* built in, and HP provides the necessary cable. Since OmniBook can automatically install *LapLink Remote* onto any remote PC, I installed it on the Gateway. Then I transferred the contents of the *LapLink Wireless* disk to the PCMCIA flash disk in the OmniBook, removed the flash disk and placed it in the Epson. Now I was able to



install *LapLink Wireless* on the Epson.

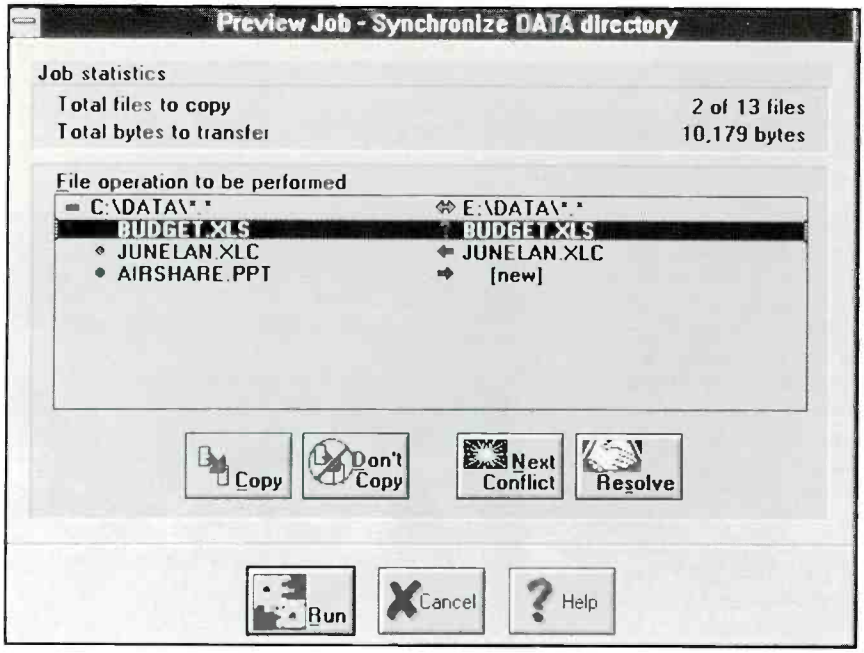
Why didn't I ditch the Epson altogether and use the OmniBook for the review? Here's why. *LapLink Wireless* comes with two AirShare modules; each has to have a power source. Traveling Software provides three different power sources in the package. One is an ac adapter that's designed to power the module connected to the desktop PC. Another source is a mouse port pass-through cable. The third is a battery pack that takes a 9-volt battery. Since I didn't have a battery on hand, the third option was out. The Epson has a mouse port and the OmniBook doesn't, which is why I chose the Epson. I could have switched the ac adapter to the OmniBook and used the pass-through connector on the Gateway.

I now had the software loaded on the desktop and the subnotebook and had an AirShare module connected to each and powered up. I was ready to transfer. To avoid any interference or transmission power problems I kept the two systems about a foot apart.

To make the connection through *Windows*, I first had to start up *LapLink Remote Access* (see Fig. 1) on each computer. Then I had to click the ON button icon on each computer. When the computers connected, I heard a series of beeps. *Remote Access* indicates how the drives and printers are mapped on each computer. At the same time, on each AirShare module, a red LED glows to indicate that the port is enabled, and a green LED glows to indicate that the PCs are linked.

With the computers connected to each other, I transferred a few files from Gateway to the Epson and *vice-versa*. Transferring files is as easy as dragging one or more files from one window of the *Windows* Program Manager to the another.

Having verified that everything was working, it

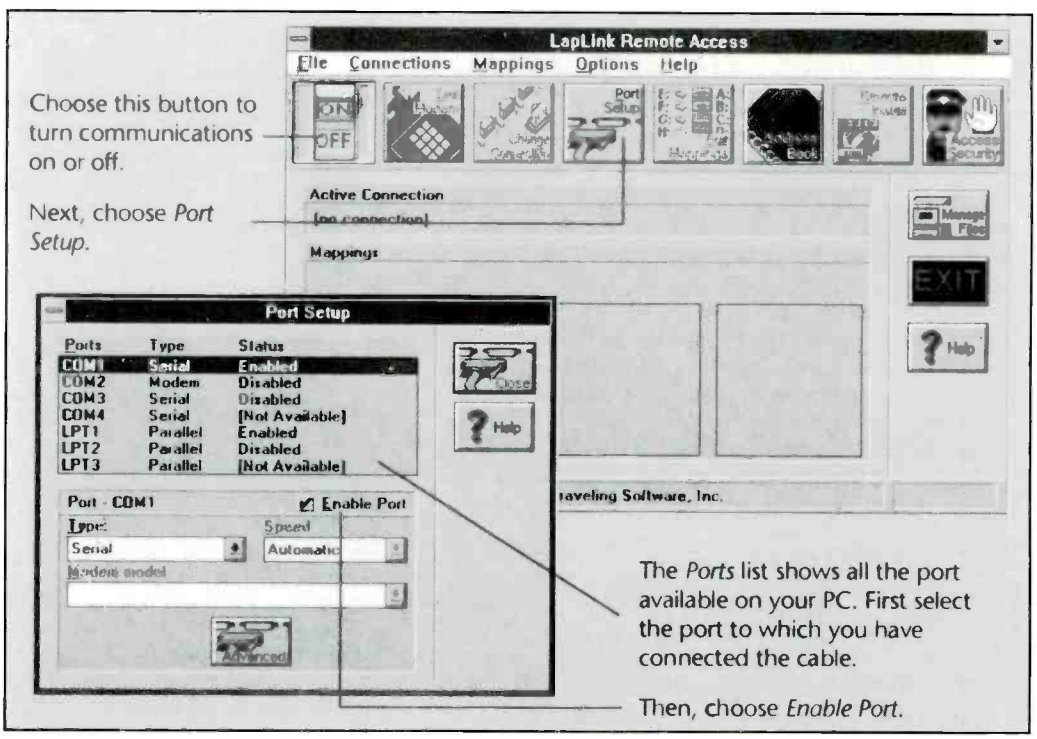


was time to see how far apart I could move the computers. I took the Epson from the basement up a flight of stairs to the kitchen and gave it a try. No luck. The manual states that the "package allows for a 30 foot connection range across conventional barriers." In the kitchen, I was directly over the computer in the basement, no more than 10 feet away. This should have worked. Undaunted, I brought the Epson back down to the basement and set it up on a desk about 25 feet away. Again, I had problems getting the two PCs to establish a link. After rotating the module attached to the Epson a bit, the computers linked up and I was able to transfer files.

Next, I loaded Microsoft *Word* on the Epson and brought up a file residing on the Gateway. No problem. Then, I loaded *XyWrite*, a program that resided on the Gateway, on the Epson, and opened an ASCII file residing on the Epson. Again, everything worked fine. This isn't a given, though. For correct operation both PCs must have sufficient memory and the proper display to run a program. Also, running *Windows* programs remotely can be done, but isn't always possible due to differences that may exist in the initialization files on each PC.

I didn't try printing from the remote PC to the printer connected to the desktop, even though you can do this. I was more interested in printing from the remote PC to a printer connected through a network to the desktop. I figured I would try this when I returned to the office.

Back at the office, I set up the I/O card for COM3, and installed it in the ALR (the mouse was on COM1 and an internal modem was on COM2). Then I hooked up the AirShare modules on the ALR and Epson and tried to connect. Both LEDs on each module went on, as they're supposed to, but the software couldn't establish the communication link. I checked out the serial port with a diagnostic program, and it passed all the tests. This problem I couldn't figure out, even after reading a troubleshooting guide included with the *LapLink Wireless* documentation. At this point, I used the *LapLink Wireless* de-in-



stall program to remove the program from the ALR machine.

You'll be interested to know that *LapLink Remote Access* works without AirShare, too. You can use a cable between the two PCs, use an infrared link or connect by modem. No matter which option you choose, the *Remote Access* program works the same way.

One of the more important programs included in the *LapLink Wireless* package, and one that I haven't touched on yet, is *Synchro Plus*. This is a file-synchronization program that creates identical directories across two PCs. I haven't felt the need to use a synchronization program, probably due to the files I work with, which are relatively small in number, though they're certainly large in size.

More About AirShare

As I mentioned earlier, AirShare isn't a Traveling Software product. It's from National Semiconductor. Any software package that accesses the serial port or uses a modem can utilize an AirShare wireless link. Based on FM radio technology, AirShare modules are designed for personal wireless connectivity. Most current r-f products are designed to address wide-area applications, such as wireless e-Mail. Other r-f implementations based on spread-spectrum technology address LAN connectivity.

Since AirShare modules operate with an internal antenna, nothing sticks out or can break off to terminate the connection. Each module has a three-position switch that's labeled A, B and C, which represent different frequencies. In order for the modules to link, each must be on the same frequency. The three-channel switch permits side-by-side use of AirShare pairs. For example, one AirShare pair can link using Channel A, while a second set, using Channel B or C, can be linked a few feet away.

The modules shouldn't interfere with other radio systems. AirShare broadcasts in the uncrowded 902-to-928-MHz frequency range. Currently, wireless LANs typically broadcast in the 2-GHz range, while most cordless and cellular telephones broadcast at frequencies below 900 MHz.

Final Comments

LapLink Wireless with AirShare is certainly a highly interesting product. But I think you have to have more than file-transfer applications in mind to purchase it. A suggestion from the User's Guide makes the most sense to me. The manual suggests that the system be set up between two PCs in a mini-network configuration. With the AirShare modules, you avoid the hassle of connecting wires between the two work areas.

The *LapLink Wireless*/AirShare combination is an attractive blend of software and hardware that makes it easy to transfer files between two PCs and synchronize those files if you need to do this. But it does help if you have the perfect PC.

Other Items of Interest

Smart Modular Technologies has added voice capabilities to its 14,400-bps PCMCIA fax/data modem. The new the ST-1414L card supports an extended command set for voice applications, including voice mail, mailbox and fax-back capabilities. The card also supports three- and four- bit ADPCM and A-law compression, enabling users to save more messages in systems that have limited disk space. Microphone and speaker interfaces are supported to permit users to record and listen to messages directly. Use of a handset is also supported. Other key features of the new card include a battery-saving ultra-low-power sleep mode and built-in DAA-line interface circuits.

Smart Modular Technologies has also developed the Serial I/O card in PCMCIA format. This card includes an internally buffered 16550 UART and an 8530 USART, a combination that provides the flexibility of either asynchronous or synchronous communication. It also provides the flexibility of configuring the asynchronous port as COM1, COM2, COM3 or COM4, while the synchronous port is fully programmable. Software eliminates the need to set any jumpers.

Configured as an asynchronous port, the Serial I/O lets you connect to external peripherals. Configured as a synchronous port, the card allows you to make high-speed data transfers with mainframes. ■

Products Mentioned

LapLink Wireless with AirShare, $299.95
Additional AirShare Modules, $99
Traveling Software, Inc.
18702 N. Creek Pkwy.
Bothell, WA 98011
Tel.: 206-483-8088

CIRCLE NO. 155 ON FREE INFORMATION CARD

ST1414L, $299
Serial I/O, $145
SMART Modular Technologies, Inc.
45531 Northport Loop W., Bldg. 3B
Fremont, CA 94538
Tel.: 510-623-1231

CIRCLE NO. 156 ON FREE INFORMATION CARD

By Yacco

GUI Guts

Season's Greetings—1994 Holiday Gift Picks

Ho! Ho! Ho. It's the holiday season again and time for giving computer gifts to all the little nerds (no insult intended) on our shopping lists, not the least of whom is likely to be yourself. Luckily, the computer industry has it's own Santa Claus. I'm talking about Bill Gates, a major influence behind all the fabulous CD-ROMs you'll be stuffing into stockings this season. His company, Microsoft, is making some of the best titles, but more than that, he's had an important role in whipping all the little elves that toil in Santa's workshops into the proper frame of mind to make others.

Bill Gates as Santa Claus?

From time to time, I hear Gates get a bad rap for dominating the software business or for not creating original software. Maybe he's not popular because he looks like a technoid geek. But we geeks and nerds have to stick together. I say that if Microsoft hasn't created any original software categories, the company is at least the most-consistent force for refining and improving software in the industry. Furthermore, the truth is that Gates has probably done as much to create opportunities for other software-development elves as anyone in the industry.

One of the more-significant ways Gates and company have done this is through promotion of the CD-ROM medium. As recently as three or four years ago, not many people were behind it. Steve Jobs became something of a laughingstock for putting a CD-ROM drive on his NeXT machines.Today, of course, CD-ROM is everywhere. It may eventually become as universal a method for publishing software as Steve Jobs envisioned when he replaced the original NeXT's floppy drive with a CD-ROM drive. One major reason for this is that the CD-ROM appeals to publishers in several ways that magnetic media and even writable optical media don't: It's cheap, it permits enormous capacities to be pressed in an instant and it can't be accidentally (or even intentionally) overwritten. And, of course, many of the new multimedia titles couldn't be economically distributed in any other way.

I suspect that his role as a publisher was one reason Gates was so persistent in championing the technology. He may also have had more than an inkling years ago into the storage requirements of the then-forthcoming graphical future of the personal computer. In any event, it seemed like he was championing CD-ROM single-handedly in the early years. If Gates didn't create CD-ROM, his support of it certainly sped up it's adoption by the industry. He also pushed forward the MPC standard that provided a platform to read CD-ROMs and encouraged the present glut of titles filled with video and multimedia.Every year, there are more and more titles to choose from. Content is improving, too. Many more CD-ROMs contain original material created specifically for this medium. They're changing the paradigm of computer software as surely as the Hollerith card automated data processing, as surely as the personal computer challenged it's centralization and as surely as the Macintosh changed its face. Interactive movie adventures, like those I've mentioned in the past (*Quantum Gate*, *Critical Path* and *Voyeur*) are among the best examples here.

Music artists are also taking their work into new areas with CD-ROM. For example, the "artist formerly known as Prince," who's decision to legally change his name to a symbol now requires me to refer to him with a phrase or larger unit of speech and who's symbol is both unpronounceable and not in any standard font, has produced a new CD-ROM. This CD-ROM is remarkable because it contains three new songs that aren't available on other media (including audio CDs), because it's filled with video, 3D images, interactive participation and games, and because it comes in a special MPEG edition for advanced multimedia systems. This version lets the users of a Sigma Designs ReelMagic MPEG card run all the full-motion video clips of Mr. Formerly Etc. blown up to full-screen size.

Incidentally, music CD-ROMs seem very likely to create their own new stars, just like music videos did. Not available at press time, but scheduled to ship before year's end, is a music CD-ROM from Bureau Development featuring a little-known New York-based heavy-metal artist, The Great Kat.

I'm Shoveling as Fast as I Can

There's still plenty of shovelware—titles that contain text and images "shoveled" onto the disc from other sources. Indeed, a growing number of titles permit steady reductions in the count of bulky tomes for which you need to build shelving.

Often, shovelware evolves slightly with addition of a search engine that gives you new ways of accessing the content or with the addition of annotations, illustrations or other collateral material. In other cases, the publishers are adding video clips and sound that take them beyond their original print medium and, sometimes, out of the realm of shovelware altogether.

Don't get me wrong. I'm not knocking plain shovelware. Some of the best titles can be characterized this way. I don't know what else to call the vast collections of sounds and images that CD-ROMs make possible, for instance. Nevertheless, they're essential to multimedia production. New releases and classics in this area include the second volume of Allegro's low-cost *InPrint Art Library*, which includes 202 retouched .TIFF photos for both *Windows* and the Mac on two CDs. Half of these photos are natural and man-made scenic images and half are graphics in 10 categories.

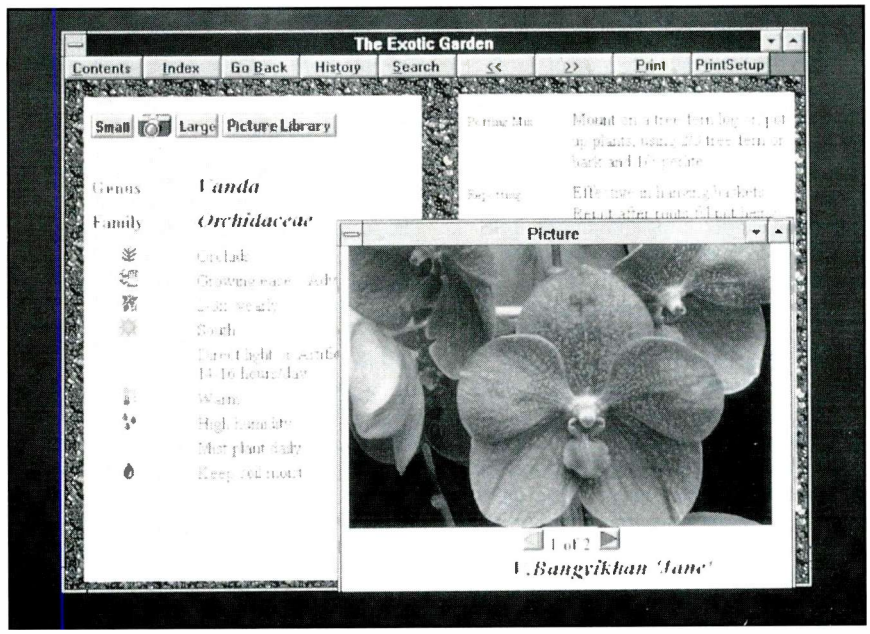
SoftKey also offers several low-cost *PaintBrush* image titles. Among them, *ClipArt Library* has

3,003 typical color clips in a variety of formats for both *Windows* and the Mac. There's nothing remarkable about the images in this collection, but it's large enough to offer some- thing for almost any need.

PhotoLibrary is a second SoftKey title. It offers 2,500 great photos in .TIFF and .BMP formats for production use with both *Windows* and the Mac (.TIFF-only, of course, for the Mac).

Another 280 art clips are included in *Business Clip Art Masterpieces*, and 250 more in *Religious Clip Art Masterpieces*. Both of these *PC PaintBrush* titles are diskette-based. Clips are provided for *Windows* and Mac in .WMF and .PICT formats. I don't think "masterpieces" is really warranted by this artwork, but the uncomplicated images in these titles certainly have wide applicability for business presentations and a variety of religious contexts. An image viewer is included.

These libraries can make great gifts for anyone who is producing multimedia, depending on type of publication and distribution involved. You should check the individual licenses that accompany each title.



The Exotic Garden CD-ROM from VT Productions is an collection of more than 500 color photos and gardening reference materials on flowering and foliage ornamental plants.

For the Artless

There may also be some people on your list who wouldn't have a clue as to what to do with clipart. If this is the case, you might want to give them a program that can help them learn about art. I don't mean art appreciation, mind you, but the *application* of art.

Fine Artist from the *Microsoft Home* line is aimed at eight- to 14-year-olds who want to learn to create animated pictures, posters, comic strips and other art. The program uses cartoon characters and a cartoon-ish interface to teach perspective and other tricks of the trade. It also includes plenty of tools, clipart and even sounds to help kids put together their first projects.*Dabbler* from Fractal Design is aimed at children, but it's also useful for adults who are seeking similar skills. The program teaches art, but with a more-polished look than *Fine Artist*. It relies much more on a traditional tutorial, as opposed to a cookbook approach for pasting together projects from components. The tutorial lessons come from two Walter Foster Publishing learn-to-draw books. The tools in *Dabbler* are more traditional and serious, yet they do share a fun approach with *Fine Artist*. A moving marking pen realistically mimics the squeak of a real one, for example.

PrintMaster Gold CD Bonus Pack is a CD-ROM title with only minor pretensions to teaching but far more in the way of canned art. This expanded version of MicroLogic Software's diskette-based product includes an "Audio Guide" to talk you through projects, but the emphasis is on a cookbook approach to assembling clips and text into banners, greeting cards, certificates, signs, posters, menus, calendars and other short-form publishing. *The Bonus Pack* nomenclature doesn't derive from just adding the Audio Guide but from huge increases in the product's libraries of *TrueType* fonts and first-quality clipart. Fonts total more than 145 in this version, not including hundreds of variations made possible by the program's font-effects tools. Art clips on the CD swell to 1,800 pieces, including 600 cartoons.

Video

One of the more-enjoyable video clips I've run across on CD-ROM is a collection of clips from Jackie Gleason's "The Honeymooners." Unfortunately, it came to me months ago, and I couldn't find it for this column. All I can do is recommend that you look for it in catalogs and stores in your neighborhood.

The *Classic Clips* video series from Starlight Productions is distributed by Advanced Support Group. If you like movies—and especially if you like movie trailers, the previews they show at theaters to entice you back to see another film —you're going to like *Classic Clips*. These are trailers from some of the best and some of the worst movies ever made. They're all captured on full-motion video with sound.

The best of *Classic Clips*, for my money, is the *Classic Clips Trailers Spectacular* with *The African Queen*, *Harvey*, *Sunset Boulevard*, *Elmer Gantry*, *The Maltese Falcon*, *Godzilla* and *The Bride of Frankenstein*, among many other greats. Alfred Hitchcock personally takes you on a hilarious tour of the Bates Motel in the *Psycho* trailer.

Other titles focus on genres. *Horrors* features such films as *Night of the Living Dead* and *The Bad Seed*. *Vicious Vixens* features *Attack of the 50 Foot Woman*, *Gun Girls* and the bizarre *Wasp Woman*. The *Science Fiction* title includes *The Day the Earth Stood Still*, *Invasion of the Body Snatchers*, *Earth Vs. The Flying Saucers*, *The Thing* and *War of the Worlds*. Each *Classic Clips* disc contains more than 30 clips, as well as the *Clip Director* AVI viewer and the *Movie Time Screen Saver* that lets you use these clips (and several still-image formats) as a *Windows* screen saver.

Environment With a View

Products that add to the esthetics of *Windows* abound. They make great low-cost gifts. Although it's not one of the main selling points of Microsoft *Windows*, I think the ability to enhance the environment with screen savers, wallpapers and audio are features that are most addicting to users. Customizing *Windows* with enhancements is a lot like decorating a home or office. It makes you feel comfortable and relaxed.

Moon Valley had one of the first huge

collections of this type on CD. The original *ROMaterial* title was accordingly billed as the "largest collection of goofball gadgets ever to be assembled under one box top." This is a fair assessment and one that might equally be applied to the company's follow-on product: *ROMaterial Again*. This second entry sports more video clips and images, principally taken from industrial and other workplace settings.

Audio clips include a melange of sounds made by people and machines on the job. There are also regional speech patterns and foreign languages and oddities like chipmunks and robots. It's everything you need to make your screen savers and wallpapers move and give speech to your icons and commands, all in ways your boss probably would never approve.

At the very low end of the cost spectrum, you can give audio-clip libraries from Sound Source Interactive that come from individual films. Titles include *Star Wars*, *Star Wars: The Empire Strikes Back*, *Total Recall* and *Star Trek*. Each title includes wonderful dialog, like the "Hope you enjoyed the ride" line from the blasted robot cab in *Total Recall*.

There are also many sound effects. The *Star Trek* title, for example, is filled with the wonderful effects that made the *Enterprise* real in a way that no TV environment ever had been before. Each title also includes a utility that helps you assign sounds to a wide variety of *Windows* events.

Another great piece of multimedia gift news is on the font front. Fonts have become a commodity, with prices only slightly above the median temperature of an Antarctic winter night. Bitstream, a top-quality font house, has published 500 fonts on a single CD for less than $50. The company once charged more than this for a single one of these fonts.

This isn't a disc that has to be unlocked on a pay-as-you-go basis, either. Every font is available in both *TrueType* and *PostScript* Type 1 formats, the two most important outline formats for production artwork and publishing. A stand-alone *Windows* mini-application, *Mini-MakeUp*, is included on-disc, too. With *Mini-MakeUp*, you can apply stretch, bend, twist, color, shade, fill and rotate special effects to your fonts.

SoftKey's original *Key Fonts* title on diskette was the first to offer large numbers of quality fonts, those with scaling and kerning hints, at fire-sale prices. Once again, SoftKey is setting a standard with the *Key Fonts Pro* CD-ROM. This $40 electronic tome includes a truly immense collection of 1,555 fonts in both *TrueType* and *PostScript* Type 1 formats. Also included in these 1,200 fonts are the extended characters required for international languages and special characters, like copyright and trademark symbols.

Hit the Road

There's a special font collection for the traveling friends on your gift list. It's not a huge collection, except in the relative sense. So, it's on diskette, not a CD, which makes it ideal for the notebook-computer user.

Font Works for Windows from Elseware has a special appeal in applications with limited storage. The program's compression technology manages to put 150 *TrueType* fonts onto just 2M of disk space. Included are *TrueType* fonts that match the metrics found in LaserJet and *PostScript* printer fonts. They provide a WYSIWYG display for printer output using these standard printer fonts. Furthermore, the font-management software in *Font Works* matches missing fonts using the Panose Typeface Matching System (licensed by Microsoft, H-P, Aldus, Lotus and others). In hundreds of cases, this system preserves line endings in exchanged documents. *Font Works* includes an editor for the *Windows* font menu and a font advisor designed by type guru Daniel Will-Harris.

Compton's New Media has a new CD offering in this area. The *AAA Trip Planner* helps a traveler find the quickest route, choose AAA-rated food and lodging and visit the most-impressive sights along the route. More than 34,000 hostelries, resorts, restaurants and attractions are in the database and available for searches based on ratings or price. There are also hundreds of maps, well over 400,000 miles of roads and 125,000 places that the program can use in plotting a trip. The program produces agendas with detailed driving directions, trip mileage, and time estimates.

What do you do for someone who has no interests and no idea where he might want to travel? It's going to be difficult to get rid of him unless you can give him reason to go. SoftKey's *Key Action Traveler* CD not only lets him select the potential vacation sites he wants to view by location, but by activities such as bicycling, cooking, skiing, cooking, paragliding, sailing, and dozens of others.

Great Vacations from Positive Software Solutions offers a similar type of travel planning in a diskette-based system. More than 500 vacations are organized by such categories as tennis, golf, cruises, national parks and festivals. The software provides information on accommodations, maps and local activities.

For international travelers, The Software Toolworks has released the fifth version of its *World Atlas*, containing the boundaries of all the latest countries in Eastern Europe. There are many other enhancements. Fifty cities have been added to the maps, as well as richer detail and four levels of zoom. Statistical data have been added for almost 150 additional cities. In addition to the CD-ROM edition, this combination atlas/almanac/fact book is also available in editions for the Mac and on diskettes.

References

In addition to its usefulness to the traveler, a world atlas makes an indispensable reference for the student and business person with international pursuits. A number of other equally useful references are available on CD-ROM. Allegro has added a new business reference. The *Multimedia Business 500* is a compendium of information on top American companies. It lists stock and financial information and the names, addresses and telephone numbers of senior executives. This is basically shovelware from *Hoover's Handbook of American Business*, augmented with financial data from *Standard & Poor's Compustat Services*. The multimedia value comes from a collection of clips of executive interviews and product presentations. Nevertheless, it's a quick way to get the basics on a lot of companies. CD-ROM references can also bring you massive amounts of culture. Bureau Development has updated it's old *Great Literature* CD for DOS and Mac with a new multimedia version called *Great Literature Plus for Windows*. Like it's predecessor, the *Plus* version contains nearly every piece of public-domain literature known to shovelware. There are lots of popular gems in its 1,900 titles and a great many more you're probably never going to want to so much as scan unless you have scholarly tastes. They're accompanied by brief author biographies, hundreds of illustrations, musical excerpts and narration. Of course, *Plus* takes advantage of the *Windows* interface, but it has also added four titles to the list of those in its predecessor.

Since it did *Twain's World*, Bureau has been developing all of it's titles for *Windows* first. It now also offers *Multimedia Monarch Notes* and *Multimedia World History*. They generally follow the same pattern as *Great Literature Plus*. *World History*, for example, includes five short films on historical figures and events, a timeline you can use to browse events and a calendar tool. The last is a neat feature. By clicking on a day, you can find any historical events that might share a birthday or other important date.

World Library also shovels lots of cul-

ture onto CDs, but as straight text. *Library of the Future*, Second Edition, *Great Poetry Classics* and *Shakespeare Study Guide* all contain vast amounts with access software for both *Windows* and DOS. There's lots of duplication in these titles. Shakespeare's poems appear in all of them, his dramas on two. There are also some curious omissions. *Tom Sawyer, Huckleberry Finn* and all of Twain's speeches are here, but not *A Connecticut Yankee in King Arthur's Court*.

WordStar's electronic edition of the *American Heritage Dictionary* has been one of my personal favorites in this category for several years. With the acquisition of WordStar, it's become a SoftKey title, and Softkey has put it on CD-ROM. Unlike the Random House CD-based dictionary though, SoftKey has taken advantage of some of the extra space to add pronunciation. Speech is growing as a use of the capacity of CD-ROM, particularly in the area of reference. But no product benefits from it more than a dictionary. SoftKey has taken an already marvelous product and raised it to a new level.

Unplain Fun

The CD-ROM also makes the best medium for titles filled with sheer enjoyment. After all, what's more entertaining than a storehouse of interesting visuals with sound and where can you store vast numbers of visuals with sound more economically than on a CD? Entertainment is also an area in which lots of work is being done to create multimedia works specifically for this medium.

My favorites in this category are the edutainment and lifestyle-leisure titles. Compton's, for example, distributes a title that I like to think of as an unusual leisure activity. It's not a game, though. It's the *Exotic Garden* (from VT Productions), a compendium of more than 500 incredible color photographs of bromeliads, cacti, ferns, herbs and edibles, orchids, palms and other flowering and foliage ornamental plants. You can locate plants by type, their common or Latin names, ease of growth, light or temperature preferences and other criteria. There's also a narrated time-lapse film that explains the flowering of plants.

With all its rich detail, *The Exotic Garden* can certainly serve as a reference for anyone interested in starting a garden, cooking with flowers and herbs or otherwise researching plant life. It can also be enjoyed simply as a stroll through a tropical botanical garden. The only thing missing is the perfume.

Movie buffs on your lists may be interested to find that Microsoft's *Cinemania* is now in a new 1994 edition. The complete text and 19,000 reviews of *Leonard Maltin's Movie and Video Guide 1994* are included, as are the 1,300 reviews and complete text of Roger Ebert's *Video Companion* and another 2,500 reviews from Pauline Kael's *5001 Nights at the Movies*. Several other sources are excerpted, as well.There are several film clips, dialog lines from 150 films, musical pieces from 100 films and in excess of 900 stills.Microsoft has two new high-quality CD-ROMs in this category. Like *Multimedia Beethoven* before it, *Multimedia Strauss* (also a production of the Voyager Company) explores the work of a musical genius through a combination of the music itself, the scores, musical background, historical and biographical notes and analysis by a noted expert. It's total immersion for anyone who's seeking either pure enjoyment or a musical education. Similar titles are available for Mozart, Schubert and Stravinsky.

The second new Microsoft title this season is *Ancient Lands*, which takes you and yours to the cradles of Western civilization: ancient Egypt, Greece and Rome. It's culture at the grass-roots level. It includes details of what the people ate, their work and their play. There are video clips and nearly 1,000 interactive articles. Each is accompanied by sound and narration—several hours in all. Difficult words are pronounced, too. This would make a perfect gift for a scholarly young person.

Care & Feeding of The CD and Its User

Lastly, there's a new category of support products that have sprung up to serve the increased interest in CD-ROM and multimedia. Aris Entertainment, for example, will help you test and tune up your Multimedia PC system with *MPC Wizard* 2.0. The disc includes benchmarks for sound-card compatibility (.WAV, CD-audio and MIDI files), as well as for CD-ROM performance. You can test your VGA configuration, too.

Aris also includes some tips and clips. The tips tell you how to fine-tune your system, and more than 120 royalty-free sample clips from Aris *MediaClips* titles start you off with your own image-and-sound library.

You can also get *MPC Wizard* as part of another Aris product called the *Multimedia Starter Pak*. It includes the *Wizard* title, the *WinTutor* 3.1 *Windows* training disc and *WorldView*, a collection of stills, audio and video clips from the NASA space program.

CD Essentials from Phoenix and *Visual CD* from Meridian are CD installation and management systems that help you to

Products Mentioned

Advanced Support Group
Starlight Productions
11900 Grant Pl.
Des Peres, MO 63131
Tel.: 314-965-5630

CIRCLE NO 161 ON FREE INFORMATION CARD

Allegro New Media
387 Passaic Ave.
Fairfield, NJ 07004
Tel.: 201-808-1992 or 800-424-1992

CIRCLE NO 162 ON FREE INFORMATION CARD

Anchor Sofware, Inc.
Box 124
Cheswick, PA 15024-0124
Tel.: 412-274-6504

CIRCLE NO 163 ON FREE INFORMATION CARD

Aris Entertainment
310 Washington Blvd., Ste. 100
Marina del Rey, CA 90292
Tel.: 310-821-0234

CIRCLE NO 164 ON FREE INFORMATION CARD

Bureau Development, Inc.
141 New Rd.
Parsippany, NJ 07054
Tel.: 800-828-4766 or 201-808-2700

CIRCLE NO 165 ON FREE INFORMATION CARD

Bitstream
Athenaeum House
215 First St.
Cambridge, MA 02142
Tel.: 800-223-3176

CIRCLE NO 166 ON FREE INFORMATION CARD

Compton's New Media
722 Genevieve, Ste. M
Solana Beach, CA 92075
Tel.: 800-862-2206

CIRCLE NO 167 ON FREE INFORMATION CARD

Deep River Publishing
PO Box 9715-975
Portland, ME 04104
Tel.: 207-871-1684

CIRCLE NO 168 ON FREE INFORMATION CARD

Discwasher
2950 Lake Emma Rd.
Lake Mary, FL 32746
Tel.: 800-223-6009 or 407-333-8900

CIRCLE NO 169 ON FREE INFORMATION CARD

ElseWare
101 Stewart St., Ste. 700
Seattle, WA 98101-1048
Tel.: 206-448-9600

CIRCLE NO 170 ON FREE INFORMATION CARD

Fractal Design Corp.
335 Spreckels Dr.
Aptos, CA 95003
Tel.: 408-688-8800

CIRCLE NO 171 ON FREE INFORMATION CARD

Individual Software
5870 Stoneridge Dr., Ste. 1
Pleasanton, CA 94588-9900
Tel.: 800-822-3522 or 510-734-6767

CIRCLE NO 172 ON FREE INFORMATION CARD

Knowledge Adventure, Inc.
4502 Dyer St.
La Crescenta, CA 91214
Tel.: 818-542-4200

CIRCLE NO 173 ON FREE INFORMATION CARD

Maxis
2 Theatre Sq., Ste. 230
Orinda, CA 94563-3346
Tel.: 510-254-9700

CIRCLE NO 174 ON FREE INFORMATION CARD

Medio Multimedia, Inc.
2643 151 Pl. NE, Bldg. 1
Redmond, WA 98052
Tel.: 800-788-3866 or 206-867-5500

CIRCLE NO 175 ON FREE INFORMATION CARD

Meridian Data
5615 Scotts Valley Dr.
Scotts Valley, CA 95066
Tel.: 408-438-3100

CIRCLE NO 176 ON FREE INFORMATION CARD

Moon Valley Software, Inc.
21608 N. 20 Ave.
Phoenix, AZ 85027
Tel.: 602-375-9502

CIRCLE NO 177 ON FREE INFORMATION CARD

Nolo Press, Inc.
950 Parker St.
Berkeley, CA 94710
Tel.: 510-549-1976

CIRCLE NO 178 ON FREE INFORMATION CARD

Phoenix Technologies
846 University Ave.
Norwood, MA 02062-3950
Tel.: 800-452-0120 or 617-551-4000

CIRCLE NO 179 ON FREE INFORMATION CARD

Softkey Software Products, Inc.
201 Broadway, 3rd. Fl.
Cambridge, MA 02139
Tel.: 800-227-5609 or 617-494-1200

CIRCLE NO 180 ON FREE INFORMATION CARD

MicroLogic Software
1351 Ocean Ave.
Emeryville, CA 94608-1128
Tel.: 800-888-9078 or 510-652-5464

CIRCLE NO 110 ON FREE INFORMATION CARD

Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
Tel.: 800-426-9400 or 206-882-8080

CIRCLE NO 112 ON FREE INFORMATION CARD

MicroSolutions
132 W. Lincoln Hwy.
DeKalb, IL 60115
Tel.: 815-756-3411

CIRCLE NO 113 ON FREE INFORMATION CARD

Positive Software Solutions
7765 W. 91 St., Ste. F3107
Playa del Rey, CA 90293
Tel.: 310-301-8446

CIRCLE NO 114 ON FREE INFORMATION CARD

Software Toolworks
60 Leveroni Ct.
Novato, CA 94949
Tel.: 800-234-3088 or 415-883-3000

CIRCLE NO 115 ON FREE INFORMATION CARD

Sound Source Interactive
2985 E. Hillcrest Dr., Ste. A
Westlake Village, CA 91362
Tel.: 805-494-9996

CIRCLE NO 116 ON FREE INFORMATION CARD

World Library, Inc.
12914 Haster St.
Garden Grove, CA 92640
Tel.: 800-443-0238 or 714-748-7197

CIRCLE NO 117 ON FREE INFORMATION CARD

install CD-ROMs, Photo CDs and audio CDs. Both make disc selection easy by cataloging and organizing each reference, photo and song.

CD Essentials has some additional features. It lets you add key-words and notes that you can use to locate discs without remembering their titles. The product also includes the Phoenix *MediaRak* that plays a variety of popular video, audio and photo file formats. Features depend on the capabilities of your sound card and include a mixer, play-list manager and module that not only plays but edits MIDI files.

CD Essentials is easy to use, too. All

controls have the look and feel of familiar consumer-electronics control panels. You fast forward by clicking on a double-arrowhead button; pause buttons have a pair of vertical bars on them; etc..

There's even a category of products for the Multimedia-challenged. For the most-critically-challenged, there's Allegro New Media's *Learn to Do Windows 3.1* with John C. Dvorak. It begins with an interactive tutorial training program that isn't unlike the one in Individual Software's *Professor Windows*. However, it also talks to you through The *Windows Explorer*, which explains functions of *Windows* menus, icons and dialogs as you click on them. In addition, you get the full text of two *Windows* books: *1-800-HELP! With Windows 3.1* and *The Complete Guide to Windows 3.1*. A search engine gives these books a big advantage over their print editions. You can search them both for more-cogent answers than with *Windows'* on-line help system.

By the way, there are also a couple of little *Windows* utilities on my list that will suit the technically-able. *WinPath* from Anchor Software lets you access the PATH and other environment variables from within *Windows*. It automates modification of the PATH in several ways, too. (Anchor also publishes *Pathman*, a utility that gives you these automated PATH tools under DOS.) Moreover, you can save and restore PATHs from files and extend them beyond the 127-byte DOS limit. *WinPath* includes a command language and DDE server, a *Visual Basic* example DDE program, sample *VB* and C code and a path-check program.

Another Anchor utility, *EnSync*, synchronizes the environment blocks of *Windows* 3.1 DOS sessions. With *EnSync*, changes made in one *Windows* DOS session are visible in another. And if you use both *EnSync* and *WinPath*, you can also synchronize the *Windows* environment with DOS sessions.

Anchor's utilities are just the ticket for power users on your lists. But what about the people on your list who go beyond being users? I have a suggestion for R&D engineers on your list, too. They're likely to find *Patent It Yourself* from the software division of Nolo Press quite useful. Instead of spending $5,000 to $10,000 on attorney fees, they can use this program to prepare and file your own patent applications.

Based on patent attorney David Pressman's book of the same name, *Patent It Yourself* lets them use *Windows* to organize and automate the entire process. It includes the book's full text, a search engine, on-line help for both legal and software questions, flowcharts and checklists and the forms and instructions needed to file a patent.

Allegro's *PC Library* is also a *Windows* CD collection of books for novice users who need help with their computers. It's a perfect gift for friends who are always calling you with support questions. Lotus *1-2-3* Release 4, *WordPerfect* 6 and DOS 6 are all among the software products covered. All told, there are more than 30 books, arranged into nine categories and more than 50 interactive videos. With numbers like these, you can't lose. If *PC Library* doesn't answer your friends' questions, it will at least keep them busy for a long, long time.

Individual has a new computer-based training title specifically for multimedia: *Professor Multimedia*. This course will make you conversant with all the basic terminology and concepts of multimedia software and hardware, and it takes you through the creation process using examples of presentations made in Asymetrix's Compel and other products.

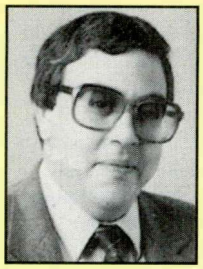
The Software Toolworks offers a title with a famous name on it: *PC/Computing How Multimedia Computers Work*, based on the book of the same name. The very-visual explanations and tours cover the most-elementary topics, including such tasks as diskette formatting and booting-up, but they often do it in considerable depth. For instance, you can see how the electron beam in a video monitor creates an image by scanning rasters.

The product's many 3D illustrations and animations are wonderfully detailed, with 70 minutes of narration, music and sound-effects accompaniment. There's also a glossary of 500 computer terms and more than 500 *Windows* tips (more or less shoveled in from some of the collections in *PC/Computing*'s vast tip issues would be my guess). This is an ideal gift for the total novice on your shopping list who's getting an MPC machine this year.

For someone on your list who has trouble wading through lessons but might need to occasionally look up a computer term, you can give Que's *Computer User's Dictionary*, Second Edition. It's a well-designed electronic lexicon that lets you look up terms or browse through lists. Moreover, terms used in definitions are hyperlinked to other definitions, and you can search for words by definition using a reverse-dictionary feature.

Last, but far from least, one of my favorite finds at the 1993 Fall COMDEX was neither a drive nor a disc, but a device to help you care for and preserve the value of both. The Discwasher CD HydroBath is a CD washing machine that spins CD-ROM or audio discs inside a sturdily-constructed containment vessel and sprays them with a cleaning solution under pressure. This solution scrubs discs clean without abrasives.

Despite my deliberate efforts to overwhelm the HyrdroBath, greasy fingerprints disappear in seconds. No sense in letting your media and equipment deteriorate when cleaning is this easy. The one drawback is HydroBath's reliance on Discwasher's proprietary cleaning solution. Perhaps experimentation would disclose alternatives among other readily-available cleaners suitable for use on CDs. Could the stuff really be that different from diluted dish detergent? ■



By Ted Needleman

Microcomputer Musings

Products Worth a Closer Look

Oh oh! The piles of stuff to be reviewed are starting to grow again. As they increase, my long-suffering wife's patience seems to decrease in direct proportion. So, this month, instead of staying with a theme for the column, I'm going to try to get as many products covered as possible. Of course, with the way I tend to run off at the word processor, it probably won't be as many as I'd hoped to cover, but maybe if I make an effort, my wife will cut me just a bit more slack.

How Good Is Cheap?

It seems that I've been looking at a lot of multimedia stuff lately. Actually, if you work (or play) with PCs, there's no getting away from multimedia. One interesting thing I've noticed is that not only are multimedia upgrade kits getting less expensive, but the components are as well.

You might expect this, but with the sound portion of multimedia, I've recently seen a number of "retro" sound cards. I use the term "retro" because these recent introductions are moving in exactly the opposite direction of the rest of the market. With wavetable cards quickly taking over a big part of the sound-card market, there are also an increasing number of very basic "bare-bones" audio cards appearing in the marketplace. A good example is the Rock-It 16 card from Advanced Digital Systems.

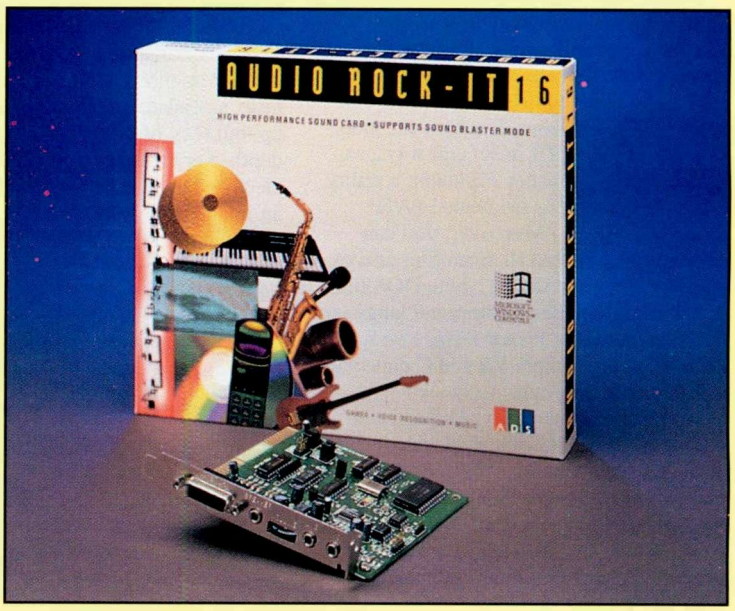
The ADS Rock-It 16 isn't only compatible with the Sound Blaster card, it uses the same Yamaha OPL-2 sound chip the original Sound Blaster did! Talk about back to the future! As a point of reference, today's Sound Blaster 16 cards use the OPL-3, and the newest cards from Creative Labs incorporate the OPL-4, which has both wavetable sampling capability and backwards compatibility with the FM synthesis OPL-3 chip.

The Rock-It 16's OPL-2 sound chip provides 11 voices and two operators compared to the OPL-3's 20 voice, four operators. What this means in real terms, though, is that the ADS card just isn't going to sound as good in many applications as a card that uses a more up-to-date chip.

That's not necessarily a bad thing! Before you accuse me of heresy, let me remind you that computer-based audio became very popular because of cards, like the original Sound Blaster and Ad Lib models were based on 11-voice technology. ADS isn't the only vendor that's betting that there's a fair amount of money possible with a basic offering. Not everyone needs 32-voice capability, or 192 sampled voices, or MIDI in and out ports. Some users just want to add sound to their games or CD-ROM-based encyclopedias. And they want to do so easily and as economically as possible.

The Rock-It 16's name is a bit of a misnomer. It might be a 16-bit audio chip, but it's usable in an eight-bit ISA slot, if you happen to have an older PC. It installs easily, and the default address (220) and IRQ7 worked fine in my test system. If you need to change them, just move a jumper. There's also a connector for an audio cable from a CD-ROM drive so that CD audio disks can play through the card. Other I/O and controls include a microphone jack, line-in jack, volume control, speaker jacks and a joystick port.

Included with the card is a pretty nice set of basic *Windows* software applications. These include an audio file player, mixer, audio-clip library and talking calculator and clock. The Rocket-16 also has recording capabilities. You can record 12-bit mono samples at up to a 22-kHz sample rate. This is somewhat less-capable than a majority of today's cards, which offer 16-bit stereo recording at up to a 44-kHz rate, but it should be adequate for many users, and the smaller sample rate eats up considerably less disk space when recording.



The ADS Rock-It sound card.

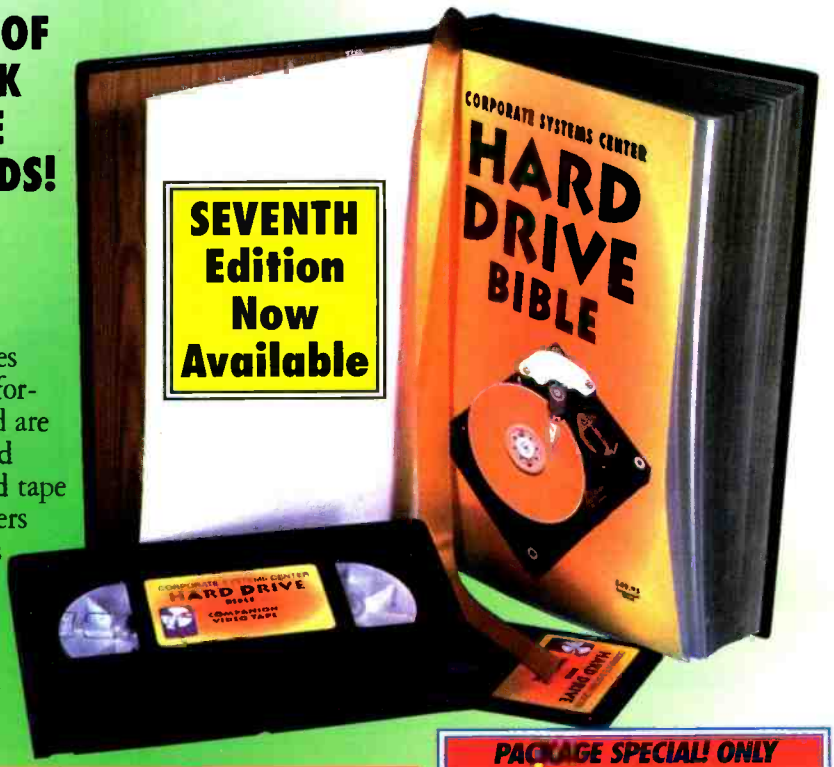
The greatest shortcomings of the ADS Rock-It 16 are its lack of a CD-ROM interface and marginal sound quality. Almost every sound card on the market these days offers an AT-style CD-ROM interface. And, lets face it, 11-voice sound quality is more suitable for games than it is for serious audio listening or even heavy-duty multimedia use. On the

THE HARD DRIVE GOOD BOOK

HARD DRIVE BIBLE

THE DEFINITIVE COMPILATION OF EVERYTHING ABOUT HARD DISK DRIVES, OPTICAL DRIVES, TAPE DRIVES AND CONTROLLER CARDS! BACKGROUND AND TECHNICAL DETAILS ON HUNDREDS OF DEVICES, ALL IN ONE BOOK!

The guys who wrote the book on hard drives now bring you years of experience and technical information in our all new Hard Drive Bible. Included are installation instructions, drive parameter tables, and setup information on hundreds of hard, optical, and tape drives. Be sure to check out the new SCSI Parameters chapter, one of many new features. Jumper settings and compatibility information on controller cards and driver software have all been revised and updated. Don't miss the benchmark chapter with performance and reliability test reports. This book and software are essential for all dealers and system integrators who install hard drives.



CALL (800) 853-9797

PACKAGE SPECIAL! ONLY $49.95

Name_____

Address_____

City_____ **State**_____ **Zip**_____

Credit Card - MasterCard Visa Amex Discovery

Number_____ **Expires**_____

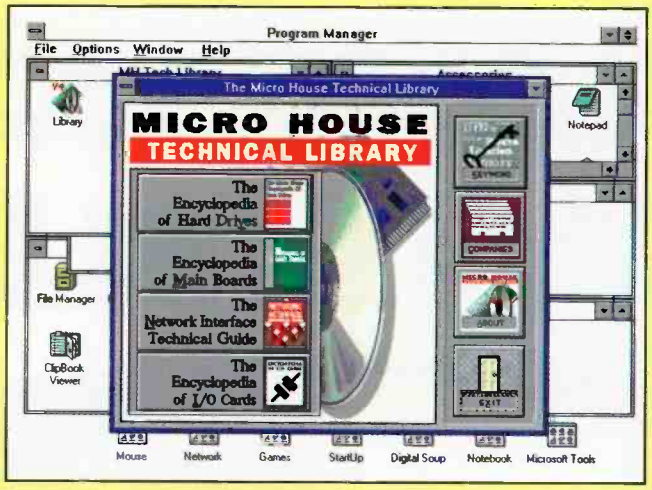
Check/Money Order Enclosed_____

Mail Orders to: CQ Communications, 76 North Broadway, Hicksville, NY 11801 or FAX (516) 681-2926

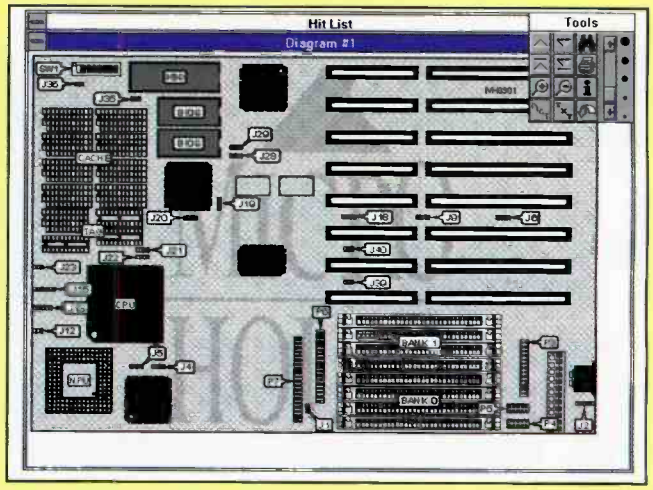
FREE SHIPPING in the continental USA

Package Includes:

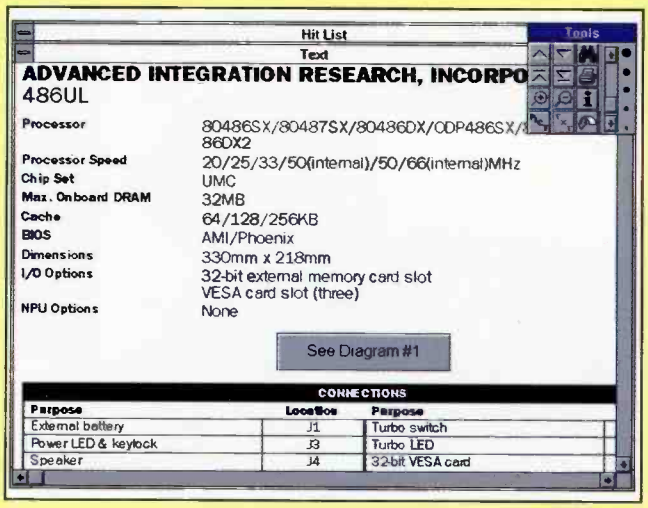
- VHS video tape with information on how drives work, installation, and troubleshooting tips.
- Huge listing of hard drive parameters and SCSI commands.
- Jumper settings for common hard drives and controllers.
- Tips on increasing drive performance through software.
- Controller card information and performance ratings.
- Compatibility issues and solutions.
- Low level, partitioning, and high level format instructions.
- Installation hints for IDE, SCSI, MFM, ESDI, and RLL interface drives.
- Free copy of CSC's drive performance test software and low level format programs.
- Free copy of Seagate's technical support software.



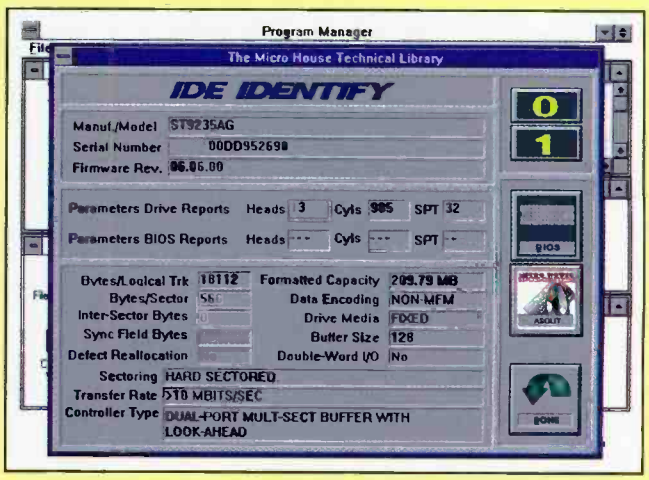
The opening screen from Micro House's *Technical Library on CD-ROM* is where you begin searching for the information you need.



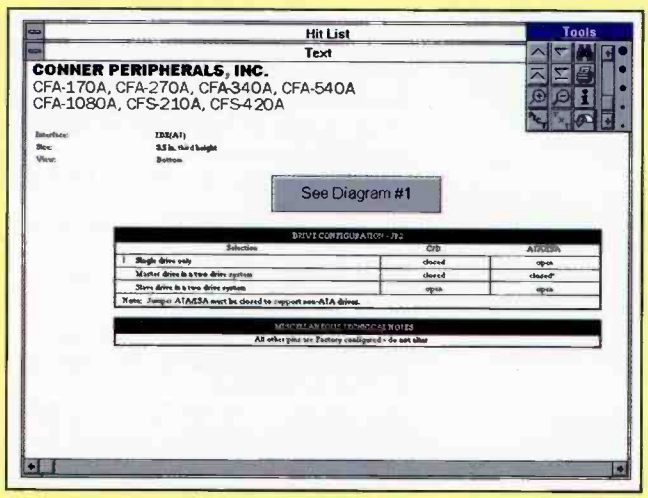
An example of a motherboard from the *Technical Library on CD-ROM.*



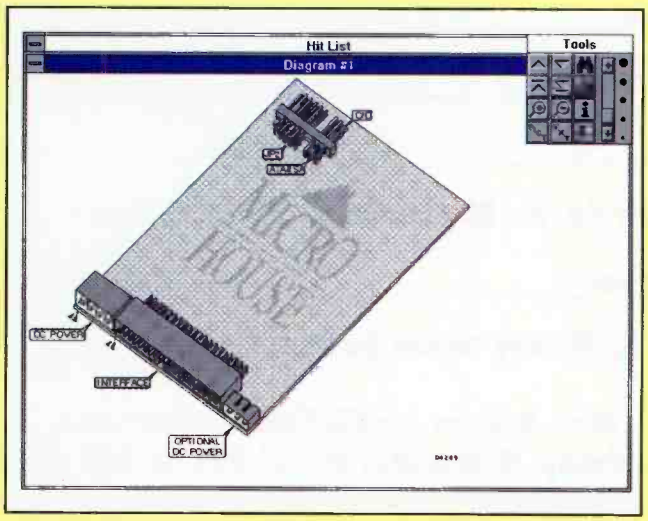
A text screen from the *Technical Library* details the specifications of one manufacturer's motherboard.



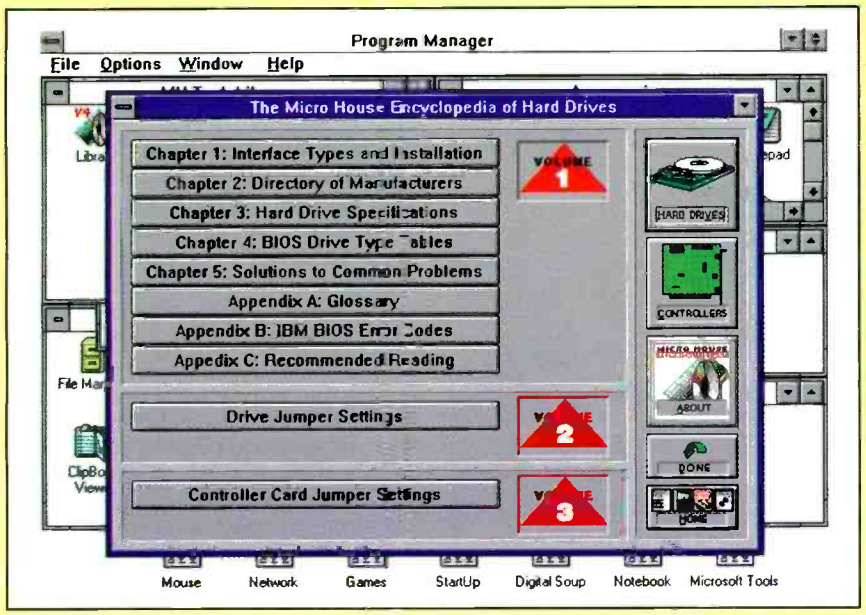
IDE Identify screen gives pertinent details for an unknown IDE hard-disk drive, including manufacturer/model number, serial number and technical information.



Basic information screen for one series of Conner Peripherals hard drives. Note the "See Diagram #1" reference that vectors you to more information.



Jumper and connector details for an on-board IDE hard-disk drive controller.



Index screen a user refers to for looking up specific topics and details in the *Technical Library*'s database.

other hand, if you already have a CD-ROM drive but no sound card, or you just want to get better game sound at as little cost as possible, the Rock-It 16 will fit the bill admirably. It's not very pretentious, but with a street price of less than $70, it doesn't pretend to be anything more than it is.

Everything You Ever Wanted To Know...

This next product I'll deal with is a very specialized one. I'm not a PC specialist at the company I work for, but I do tend to take care of those PCs used by my staff an coworkers. Yes, we do have a PC support staff, but with more than 150 people to support, the main PC guy is pretty overworked, and when we need help, we usually need it fast. While I'm not a hardware guru by any stretch of the imagination, I feel pretty comfortable most of the time scrounging around inside a PC. Add to this the morass of old equipment that's piled up over the years I've been reviewing, and it's a pretty sure bet that I probably won't be able to find the documentation I need for any piece of equipment I'm working on.

Sometimes this comes back to bite me. Recently, I added a second hard disk to the PC that sits on the floor next to my desk. The new unit was a 340M Conner drive, and the PC already had a Maxtor 340M drive that the vendor had installed. It should have been an easy installation, but after an hour of fooling around, I couldn't get the PC to recognize both drives. A call to Conner turned up the fact that not only did the second (Conner) drive need to be jumpered as a slave but that the original Maxtor drive needed to be jumpered as a master. For a change, I was able to find the documentation for the PC, but it didn't include anything on the hard disk.

A call to the vendor turned up the information that the company used three different vendors' drives in that particular model, and they couldn't find the documentation for the particular drive I had in my system! The person to whom I spoke did, however, give me Maxtor's toll-free number, and after sitting on hold for about a half-hour (at least it was on Maxtor's nickel!) a polite technical representative was able to solve my problem in about 30 seconds! Yes, the original drive did need to be jumpered (it wasn't originally), and the jumper was located in the back of the drive controller. Once the jumper was installed, everything worked perfectly. Thirty seconds of information, but it took more than three hours of calling around to locate.

It won't happen next time, now that I've got Micro House's *Technical Library on CD-ROM*. Actually, I've used Micro House's paper reference products for a couple of years, and I really love them. I keep meaning to tell you about them, having found them to be so useful. The company's *Encyclopedia of Hard Drives* would have let me solve my problem in a minute or two, if I hadn't taken it home and forgotten to bring it back to the office. The CD-ROM has this reference, as well as the vendor's similar products for motherboards and network cards. Instead of consuming volumes of large printed books, all this good stuff is on one easy-to-use CD-ROM.

Actually, the CD-ROM version, aside from being much kinder to my greatly overburdened bookshelves, is also a lot easier to use than the hard copy. Running under *Windows*, you just choose an area (motherboards, hard disks or network cards) you need to reference. Then you can search for the particular board or drive in a variety of ways. You can page through pick lists of the different vendors' offerings. Or, if you know the vendor and model number, just key them in and up comes a text screen with all of the relevant information (like connector pinouts and jumpers/settings). Other screens, accessed through button boxes, provide diagrams and schematics. All of this information can be routed to your printer so that you can generate a hard copy to work with.

I can't tell you how many products are covered in this reference because its product database keeps increasing every time I see a new version. Micro House claims that the entries go back as far as 1986 for some products. I've yet to find a motherboard or hard drive that wasn't listed, but I can't guaranty that you won't. Micro House also maintains a BBS that carries information on products that have been introduced since the last version of its ref-

Compaq's Presario 860 CDS Model 340 multimedia-ready system is built around an AMD 486SX2/66 CPU and features in the basic system 8M of RAM and a 340M hard disk but no video monitor. It comes bundled with software that offers something for everyone in the home/home-office environment.

erence shipped. You can also purchase a yearly subscription to both the paper-based and CD-ROM products.

Actually, I have only one minor criticism of the Micro House *Technical Library* and that is that it's copy protected with a parallel port pass-through key. It's not an obtrusive method of copy protection, but the idea of copy-protecting a CD-ROM, even one that costs $895, leaves me a little dumbfounded. Does Micro House actually think that anyone would bother copying a CD-ROM? Considering that the most likely purchaser of this product is a corporate PC support specialist, to whom the $895 expense is easily justified, it's highly unlikely that anyone would pirate the massive amount of information that this CD-ROM contains. My main objection to the copy protection is that, with my record of losing documentation, it's a pretty good bet that I'll eventually misplace the hardware lock. I guess I'll just have to install the lock on one machine and live with being able to run the *Library* from only that system.

If you don't need the complete *Technical Library* on CD-ROM, buying just the individual paperback hard copy sets you need will save you some money. But for anyone who must support a variety of equipment, the Micro House *Library on CD-ROM* is an absolute must, silly hardware lock and all.

What, Another PC?

I've really cut back on reviewing PCs in this column. It's not that I have any difficulty obtaining review equipment. Quite the contrary, in fact. I have several vendors' products here right now undergoing torture testing. The biggest problem I have with reviewing complete systems is figuring out what to say about them. Hardware has become so generic that there's very little to differentiate one vendor's offerings from another's. But every once in a while, something comes along that's a little bit different, and because of this, worth telling you about. A case in point are the new Presario series of systems from Compaq.

Compaq has gotten some very mixed press over the years. The company quickly built a reputation for being one of the most-innovative manufacturers with some of the best-engineered PCs you could buy. Unfortunately, these PCs were also some of the most-expensive systems on the market as well. It's only in recent years that the company, after almost going under, has been producing products that are price-competitive. Notice that I didn't use the words "cheap" or "inexpensive." Compaq systems are neither. But they are now affordable. The very-well-equipped Presario 860 CDS Model 340 I reviewed has a street price of less than $2,000. A comparably equipped PC from Gateway or Zeos will probably cost about $300 less, which isn't a large price gap.

There's one thing about Compaq that I really appreciate. If you take off the Compaq name plates from the system, you'd still know that the PC isn't one of the bargain-basement low-cost wonders. Even though Compaq systems no longer cost 30% more than similar ones, they've still managed to maintain that "Compaq feel." The mini tower case my Presario was housed in felt like you could drive a tank over it and do no more damage than maybe scratch the paint a little. There are only a few PCs that still offer this feel, and they're all from vendors that have long been thought of as making premium systems, like IBM, AST and Dell.)

For those of us who have pegged Compaq as a high-end office-systems vendor and used its systems for years in our businesses, thinking of a Compaq as a "home" PC requires a bit of view realignment. The job becomes a lot easier when you unpack the box. The first thing you notice is that there's not a great deal of Compaq's famous documentation. At least, not in paper format. But it's in there...on the hard disk, that is. Compaq has included an extensive on-line reference system that's easy to use and as excellent as its paper documentation has always been. Lots and lots of software is provided. And to make it even easier to access, Compaq has licensed Xerox Software's *TabWorks*, a really nice *Windows* front end. With the Presario 860, just about everything a home and/or SOHO (small office, home office) user would want or need is included.

Hardware-wise, the Presario 860 is based on an AMD 486SX2/66, a fast CPU that offers great performance on just about anything other than really heavy-duty number crunching. There's a ZIF socket that lets the user easily upgrade to an OverDrive Processor at a later time. The base system includes 8M of RAM and a 340M hard disk, both above the bare minimum necessary to run *Windows*.

The 8M of RAM is fine for most users. But if you can, I'd recommend a larger-capacity hard disk. I know, 340M sounds like a lot, but Compaq includes a lot of software. And even if much of it is CD-ROM-based, it still takes up a lot of space on your hard disk. Add in a few more purchased programs, and the 340M begins to look a little skimpy. With hard-disk prices as low as they are these days, the price difference between a 340M drive and a 540M drive is less than $200. If you don't go for the larger-capacity drive right up front, plan on adding a second drive soon.

Adding a hard drive won't be a difficult task. Compaq uses one of the five supplied ISA expansion slots for the Sound Blaster 16 sound card that also serves as the CD-ROM controller for the unit's SCSI double-speed CD-ROM drive. It uses a second slot for the built-in 14.4K fax modem. Three slots are open for future expansion. There are also three open drive bays, which provide plenty of room for another hard disk and/or tape drive.

The I/O is built into the motherboard and includes high-quality SVGA video support. Compaq included a super 15"

digital control monitor with my review unit, but the Presario 860 is advertised (and priced) without a monitor. The particular monitor I received would probably add another $500 to the package, though you can get a good monitor for less.

The 860 CDS is a multimedia system that includes everything you need for this purpose. The audio card is a genuine Sound Blaster 16, and though it uses FM synthesis, rather than wavetable lookup, it sounds darn good. Compaq even throws in a nice pair of speakers and a microphone. The Sound Blaster 16 provides a MIDI/joystick interface port and also acts as the controller for the CD-ROM drive.

When it comes to bundled software, Compaq doesn't give an inch to its competition. There's something in here for everyone. For dad or mom, Microsoft *Works for Windows* offers word processing, spreadsheeting and even a flat-file database. It's nowhere near as comprehensive (nor, for that matter, as difficult to learn) as Microsoft's *Office*, but it fits the bill nicely for many small-business users. Intuit's well-regarded *Quicken* lets you keep the family's finances in good order. The fax modem is supported by software that not only lets you send and receive faxes, but three different software packages let you sign on to Prodigy, CompuServe and America OnLine. You even get some free time the first month you usethese services with all of these.

Finally, on the CD-ROM side, Compaq includes Microsoft's terrific *Encarta* encyclopedia and the *Mayo Clinic Family Healthbook*. Sure, there are bundles that give you more software, but few offer more value.

In the course of reviewing this machine, I routinely ran benchmark tests, using the Landmark *Windows Speed Test* Version 3 that I've adopted as my standard. But when I considered including the results of these tests in this review, I decided that they don't really provide much of a useful addition to this particular review. Compaq's Presario 860 CDS Model 340 performed nicely, both in the benchmarks I ran on it and, more importantly, in months of using the system. My nine-year-old really loves this system and keeps asking me if I really have to return it.

For a PC that's not going to be pressed to the limits, were minor performance differences really do make a difference, it makes little sense to muddy the waters with data that really has little or no bearing on a purchase decision. If you're really going to buy one system over another because one system is a second or two faster than another in some esoteric benchmark, chances are this review has already missed its mark for you. However, if you're currently shopping for a high-quality home multimedia PC that's also very suitable for home-office use, take a hard look at the Presario 860 CDS 340. It's not the least-expensive PC you can buy for this purpose, but it just may be one of the best. Welcome back, Compaq! ■

Products Mentioned

Rock-It 16, $129 list, $69 street
Advanced Digital Systems
13909 Bettencourt St.
Cerritos, CA 90701
Tel.: 800-888-5244

Technical Library on CD-ROM, $895
Micro House
4900 Pearl East Circle
Boulder, CO 80301
Tel.: 800-926-8299

Presario 860 CDS Model 340, about $2,000 street price
Compaq Computer Corp.
PO Box 692000, M120208
Houston, TX 77269-2000
Tel.: 800-345-1518

By Tom Benford

Multimedia

Easy Listening and My Latest CD-ROM Picks

There's lots of good stuff to cover this issue. This time around, the lineup includes stereo speakers and headphones for comfortable and easy listening and a number of CD-ROMs that I found to be interesting enough to let you in on them. So, without further adieu, I'll jump right in.

Active Speaker System

There are lots of active, or amplified, multimedia speaker systems on dealer shelves these days. With such a variety of choices also comes some confusion for the prospective buyer in terms of what to buy. The three main points to consider when purchasing a set of active speakers for a multimedia PC setup are price, sound quality/power and convenient form factor, but not necessarily in this order. Of the many active speaker systems I've had an opportunity to test and work with, the ATUS (which stands for Audio-Technica U.S.) MMS557 Mini-Speakers are undoubtedly among the best sounding and nicest looking ones I've come across.

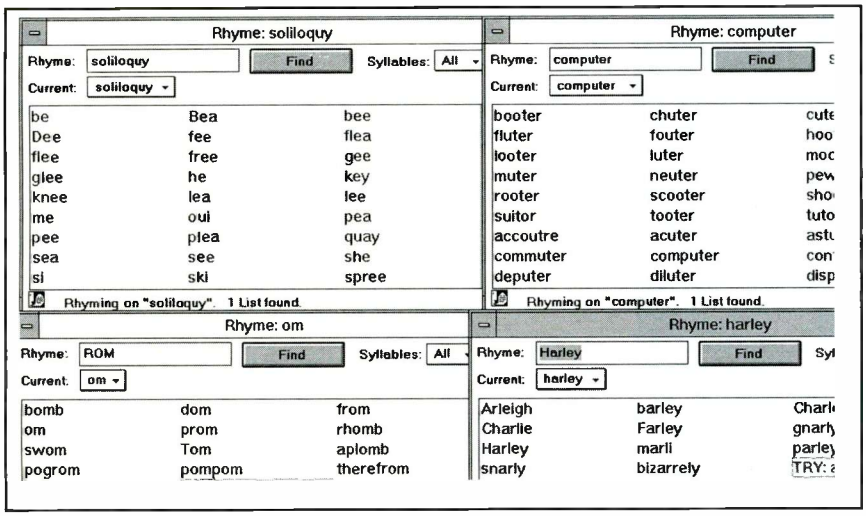
One of the features I immediately liked about these MMS557 speakers was that they have no cumbersome transformer that converts ac line power to the dc power that the internal electronic amplifiers require. A standard two-prong ac power cord is permanently attached to the "master" speaker, and an umbilical speaker cable with spade ends connects to the "slave" speaker. It's really refreshing to see a sensible arrangement like this instead of the wall transformer that's usually supplied with other amplified speaker systems.

Audio-Technica didn't stop with the good ideas there. These speakers can sit directly on a desktop, if desired. However, for better sound projection, a pair of metal desk stands is supplied to let you elevate and angle the speakers slightly. This not only helps to project the sound more evenly, but since these open-frame desk stands are great "shock absorbers" as well, you can also crank up the volume and bass boost without vibrating paper clips and other items you might have on your desktop.

Both speaker enclosures measure about 9"H W x 6"D x 5.5". They're magnetically shielded to prevent any distortion to your video monitor or other sensitive PC components.

The master speaker unit houses the built-in two-channel stereo power amplifier and has individual treble, bass and volume controls, in addition to a rocker-style power on/off switch. The speakers are nicely styled in PC "putty" color, and they're excellent for amplifying the output of CD-ROM drives, CD audio players, video games, walkman-style cassette players, MIDI tone-generator modules, etc., in addition to their multimedia sound-card amplification uses.

The MMS557 system boasts 20 watts of total output power. Its frequency range is rated at 80 Hz to 20 kHz. Dual line-level phono-jack inputs with a



Using *A Zillion Kajillion Rhymes* is as easy as clicking on the program's icon and entering the word for which you wish to find rhymes. The program's preferences can be adjusted to search for multiple-syllabic or single-syllable rhymes, and it makes a nifty add-on for anyone who has occasion to write, give monologues or just wants to have fun with words. Four rhyme-search windows are shown overlapping each other.

sensitivity of 400 mV are provided, and a cable with a 3.5-mm stereo mini-phone plug at one end and dual phono-plugs at the other end is provided for connecting to a sound card or other device that's equipped with a stereo mini-jack.

The sound from these speakers is remarkably rich and clear, without a trace of distortion, even when the volume is turned up all the way. Each of the bass-reflex enclosures houses a 4" woofer and a 3/4" tweeter that are protected by an acoustically transparent mesh grill that lets the glow of the red LED power-on indicator show through on the master unit.

Pristine sound quality, excellent tone and ample power output make the MMS557 Active Speaker System a logical choice for anyone who wants to get the most from his multimedia PC's sound card. So find a dealer who has these speaker systems in stock and give them an audition. I'm sure they'll impress you, too.

Stereo Headphones

There are times and situations when amplified speakers aren't appropriate for listening to a PC's multimedia audio output (such as in a crowded work environment, individualized training, etc.). In such cases, good stereo headphones is the way to go. Audio-Technica has you covered on this front as well with its Omniphones series of stereo headphones.

The Omniphones line consists of the ATH-P1, ATH-P3 and ATH-P5 models, each of which features a comfortable open-back dynamic design. Principle differences between the low-end P1 and high-end P5 are sensitivity, power output and price. But with a price tag of less than $30 for the best in the line, why be chintzy?

I've been using ATH-P5s for monitoring my MIDI output when working with my home studio PC and for reviewing multimedia CD-ROM titles in the office. If I had to describe these headphones in a single word, "comfortable" would be the one I'd choose.

Lots of stereo headphones have great sound, and the ATH-P5 is no slouch in this department. It features 40-mm-diameter drivers, high-energy neodymium magnets, 100-dB sensitivity and a rated frequency range of 20 Hz to 20 kHz. But what makes it a joy to use is its comfortable open-back dynamic design that lets your ears breathe. Other closed-cup headphones sound good, but they trap body heat that builds up after a short period, causing you to perspire and leading to discomfort. Such isn't the case with ATH-P5 Omniphones. Additionally, since they weigh just 2.5 ounces, you can keep them on for hours without suffering neck or ear fatigue.

The secret to the comfortable design is the way the ear pads are constructed. The headphone drivers are lifted away from the ears on a cushion of expanded cellular foam and air. This arrangement acts much like a soft pillow. The convex shape of these ear pads fits softly against the ears and provides a good acoustic seal for improved bass response. The plastic headband that connects the two earpieces offers lots of adjustment range, and the overall design is such that these headphones won't interfere with eyeglasses, if you wear them.

These are outstanding headphones for multimedia use on a PC. They're equally excellent for use with a personal or other portable music device, as well as for use with a home stereo system. In fact, a 1/4" stereo phone adapter is included with the Omniphones for connecting the 3.5-mm stereo plug (attached to a 3.3-ft. cord) to devices that have standard-size phone jacks. They're a terrific value at a truly modest price for the sound they deliver.

For those of you who are interested in studio-reference headphones, I'll be covering Audio-Technica's full-ear professional headphones in my next column.

CD-ROMs Worthy of Note

Almost daily, one or more CD-ROMs come across my desk. Some of them make me sit up and take notice. The following is a list of some of the more-recent ones in this category.

• ***A Zillion Kajillion Rhymes Disk.*** If you've ever had the need, or desire, to write song lyrics, poetry, limericks or anything else that called for a rhyming soliloquy, this CD-ROM can be an invaluable aid in getting the task done. Running under *Windows*, *A Zillion Kajillion Rhymes* is aptly named since it's a rhyming dictionary.

Created by the professional song-writing/programming team of Neil Radisch and David Goldstein, this proprietary dictionary includes common, technical literary and slang words, as well as thousands of proper and place names.

The program's search engine uses intelligent suffix and prefix stripping to instantly find single, double and triple rhymes on hundreds of thousands of words. Rhyme-search criteria can be adjusted and tailored to suit individual needs or preferences, as desired. For example, you can request the program to search for rhyming words that match on single syllables or two or more syllables. The program also automatically finds rhymes for the root of the word, but this feature can be overridden, if desired.

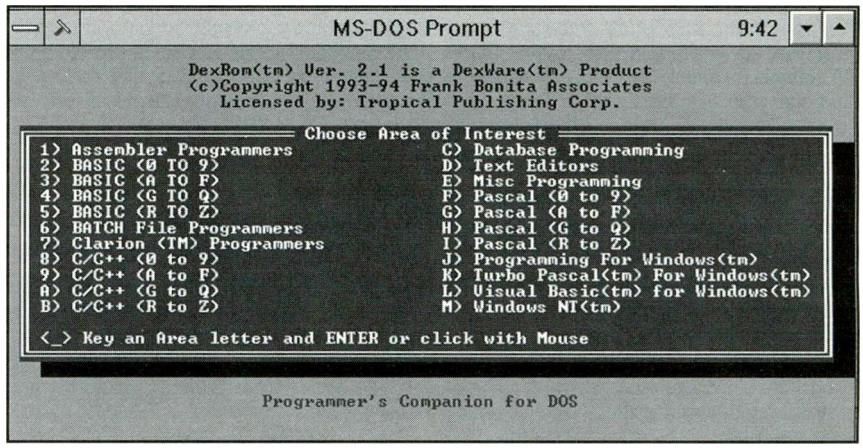
I've used this program quite a bit in my song-writing, and I've found it to be an invaluable aid in making the lyrics "work" in several instances by providing me with alternative words that rhyme. If your work or hobby pursuits deal with words, *A Zillion Kajillion Rhymes* is worth a close look.

• ***Women on Wheels CD-ROM.*** I enjoy looking at vintage motorcycles—Harleys in particular—and, of course, I always appreciate beautiful women. A new CD-ROM from Lion's Den International provides the best of both worlds. This disc is loaded with beautiful bikes, and every shot has an equally beautiful model in or on the machine. This is as close to Harley Heaven as it gets in this life!

This disc contains a total of 1,444 files, of which 1,103 are .GIF images. The other files include a catalog file that contains

This lovely lady astride a super-clean restored classic Harley-Davidson Duo-Glide "Panhead" is a typical example of the beautiful models—both human and machine—found on the *Women on Wheels CD-ROM* from Lion's Den International. The disc contains more than 1,100 SVGA .GIF image files of outstanding Harleys, complemented by gorgeous professional models

The *Programmer's Companion* CD-ROM contains thousands of utility, library, routine and tool files for virtually every popular programming language. This disc runs from DOS and features the easy-to-use *DexWare* front end for automatically locating, copying and unzipping the files. If you do any kind of programming, this disc is an indispensable tool.



concise one-line descriptions of each of the images, some text and viewer utilities. All of the images are arranged in 15 subdirectories, which makes viewing and managing such a vast image collection easier.

You'll find photography on this disc to be absolutely first-rate, with all pictures shot with studio lighting by noted Hollywood photographer Raiko Hartman. All of the ladies who appear with the bikes are beautiful professional models. And when it comes to vintage and current Harleys, you'll find them here—Flatheads, Knuckleheads, Panheads, Shovelheads and Blockheads. These bikes are the cleanest examples of restorations, stock, mild and wild choppers you'll find anywhere. So, whether you're a motorcycle aficionado or you just appreciate looking at cook machines and beautiful women, this disc is sure to please.

• ***The Programmer's Companion CD-ROM.*** Here's a CD-ROM that's jam-packed with useful tools, routines, libraries, sample files, utilities and other code tidbits that every programmer should have. Some of the must-have items contained on this disc include source code, editors, technical notes, file-format converters, ready-to-run programs, compilers and much more.

Among the programming languages covered on this disc are C/C++, BASIC, *dBASE*, Pascal, *Clipper*, *Clarion*, assembler and *Visual Basic*, in addition to special file sections on batch files, programming for *Windows*, Turbo Pascal and *Visual Basic for Windows* and even an extensive section on programming for *Windows NT*.

The files contained on this disc represent the best in shareware tools for today's programmers. This disc is a tremendous resource for anyone who is involved in programming at any level, from novice to professional.

• ***Comedy Central's Dating & Mating.*** Billed as "a desktop comedy club in a box," this new multimedia CD-ROM disc from the Time Warner Interactive Group lives up to this description fully. This disk features side-splitting stand-up comedy routines on the rituals of romance from HBO's "Comedy Central" and includes almost 50 video clips by today's hottest comedians and comediennes.

Dating & Mating is the premiere disc in this new series. It captures performances by Richard Lewis, Mark Curry, Ellen Cleghorne and Henry Cho, to name but a few comedians, at some of the best comedy clubs around the country.

Subject matter of the routines on this disc pokes fun at all aspects of relationships. Nothing is sacred—from pick-ups and first dates through courtship, sex and marriage through the divorce courts, with no stone left unturned along the way. All of the bits and bytes are funny, and some of them are outright hilarious. The material will continue to make you laugh every time you see and hear it long after first viewing it.

The program also features a special movie archive that contains nostalgic clips from classic comedy romance films—back in a time when love seemed simpler but was just as funny. An extra-special bonus feature of the software is a live-action video screen saver that permits you to create a zany, kaleidoscopic show of your favorite acts. Using it is as simple as clicking and dragging together the desired segments.

If you're looking for some light-hearted diversion to inject a little humor into your computing sessions, this disc is definitely a worthwhile addition to your CD-ROM multimedia library.

• ***Comedy Central's It's All Relative.*** If you think your family is funny, you should spend some time with this new multimedia CD-ROM from Time Warner Interactive. It's the companion release to *Dating & Mating*. The format and interface are the same. However, this time the focus of the humor is the family. Brothers, sisters, parents, aunts, uncles, grandparents...no one is spared the barbs and wit of the comics on this very, very funny disc.

As with *Dating & Mating*, using *It's All Relative* is truly a no-brainer, thanks to its straightforward interface. As you move your mouse over the tiled menu screen, the various topics are highlighted. Clicking on a topic, (for example, Aunts and Uncles), brings up a menu of comics who have bits on this topic included on the

Time Warner Interactive's *Dating & Mating* CD-ROM features stand-up comedy routines on relationships by Richard Lewis and well over a dozen other top comedy club stars. Video and audio are excellent, and the humor holds through for many repeated plays.

Funny man Kevin Meaney tells what life was like growing up in his family on the *It's All Relative* CD-ROM, along with humorous routines from Susie Essman, Jordan Brady, Cathy Ladman and other leading comics who are often seen on "Comedy Central" and at leading comedy clubs across the country.

disc. Clicking on the desired comic sets the video in motion.

It's All Relative also contains a screen-saver module that lets you select comedy performances that turn your inactive desktop into a real laughing matter when your computer is idle for a while.

Some of the featured comics on this disc include Mario Joyner, Andy Kindler, Johnathan Soloman, Bill Maher, Tamayo Otsuki, Emo Philips, Caroline Rhea, Frank Santorelli and George Wallace, and many others.

There's also a handy index of comics and their "bits" to help you go directly to a favorite performer or routine. The content is hilarious. There are 19 wacky joke categories in all and more than 60 minutes of video, which make this another must-have disc for any multimedia PC.

• **Some Things I've Done** ***Audio CD with***

(from page 80)

Book Reviews By Alexander W. Burawa

Memory Management in a Multimedia World

By Joel Powell

(The Waite Group Press. Soft cover. 271 pages. $18.95.)

The title of this book was intriguing because I've recently become an avid multimedia enthusiast. Upon reading it, however, I found the title to be a bit misleading because it might have the effect of locking out those PC users who aren't interested in multimedia applications (believe it or not, I've discovered that there are quite a few such users still around). In point of fact, this book is a must-have item for any beginner who is using a 386 or later PC and is running MS/PC-DOS 5.0 or later and *Windows*. What makes it a must-have book is that it helps the reader understand how RAM in the lower 640K is used and how it can be used even better to avoid the dreaded "out of memory" reports that naggingly show up on-screen in a system that hasn't been optimized.

Taking almost 300 pages to explain how a few lines added to AUTOEXEC.BAT and CONFIG.SYS files can eliminate or reduce to a rarity out-of-memory messages seems like a bit of overkill. But after reading everything in this book (except its index), I came to understand the method to the author's madness. By discussing the mechanics and theory involved every step of the way, the author turns the reader into a veritable expert in memory management. He does this with such subtlety that the reader isn't aware of his new expertise until he puts into practice what he has read.

Since this book is aimed at the beginning user, it opens with the almost mandatory introduction to PC memory. Unless you're really a new PC user, I'd recommend that you skip to page 17, where the text introduces DOS and memory limitations, particularly the part on the infamous 640K barrier, and then move on to the types of memory configurations section that spells out the differences between conventional and upper memory, extended and expanded memory, and the high memory area. This portion of the book isn't absolutely essential to understanding and using the material that follows, but it's worthwhile reading for those people who want to know more than how to add a few lines to two vital files.

The chapter on memory and your computer is a bit meatier and more fun to read because it gets into the mechanics of memory management and introduces you to actual hands-on operations where you can actually observe the results of your actions at the keyboard. You begin by creating a bootable disk to have handy if your actions should result in an inability to boot from your hard drive. Then you create and test batch files that store and then restore configuration files when needed. Then it's on to setting up multiple configurations in DOS 6.

Separate chapters are devoted to memory management under DOS 5 and DOS 6. If you're using DOS 6.x, skip the chapter on DOS 5. If you're still using DOS 5, read both chapters, if only to find a convincing reason why you should run out to your nearest PC software supplier and buy DOS 6 to obtain its superior memory-management utilities (not to mention other goodies that are absent in DOS 5). Rather than attempt to give a blow-by-blow description of each of these chapters, I'll just tell you that it's here where you'll find most of the procedures to use to maximize memory usage in your PC using the utilities supplied with DOS. Both chapters offer common memory prob-

(Continued on page 100)

Book Reviews

(from page 99)

lems and their solutions under four real-world scenarios simply by making changes in the AUTOEXEC.BAT and CONFIG.SYS files.

Another chapter is devoted entirely to memory management under *Windows*. Topics discussed in this chapter include: checking memory in *Windows*, comparing *Windows* and DOS memory, standard and enhanced *Windows* modes and requirements, *Windows* and expanded and extended memory, virtual memory and swap files, setting up a temporary or permanent swap file and, finally, using SMARTDrive disk caching with *Windows*. With the basics out of the way, this chapter closes with a discussion of multimedia configurations in *Windows* 3.1, which probably accounts for the "Multimedia World" in the book's title.

The lion's share of this book is written around the utilities supplied in DOS and *Windows* to optimize memory usage. There are, of course, other memory-managing programs available from third-party sources, two of the most-popular of which are the subject of yet another chapter—Quarterdeck's *QEMM* and Qualitas' *386MAX*. You'll find out why you should consider using a third-party memory manager and the system requirements, features and installation procedures for each. You're also given comparisons between *QEMM* and DOS 6 and *386MAX* and DOS 6 to give you an educated perspective on both products.

The remaining two chapters are devoted to configuration files and to IRQs, DMA and other mysteries. The first of these contains several configuration files to provide specific services and are meant to give you a starting point on which to build your own fine-tuned configurations. The final chapter is must reading for almost anyone who uses a PC because it covers some of the knottiest problems frequently encountered on the PC platform. Particularly useful is the section on troubleshooting IRQs, DMA and I/O problems.

This well-written, book is logically laid out, nicely illustrated and easy to read even for a beginner. Don't judge it by its title because it's not just for PC users who are into multimedia. Everyone who has ever encountered memory-management problems and doesn't know what to do will benefit from reading *Memory Management in a Multimedia World*.

(Continued on page 103)

Companion MIDI Files Diskette. In the January/February 1993 issue of *MicroComputer Journal* at the end of my article on General MIDI, a box mentioned my debut music CD album, which was still in production at that time. I received lots of letters and numerous orders for the album (not to mention my two books) since that announcement was published. I'm delighted to report that the album is finished and packaged and is shipping.

Titled *Some Things I've Done*, the album is an audio compact disc that features 13 easy-listening contemporary instrumental compositions I wrote, arranged and performed myself. It's the result of more than 1,500 hours of work in total. I started working on the album while writing my second book, *Welcome To...PC Sound, Music and MIDI* (MIS:Press, 310 pages, $29.95) back in April of 1993 and now, more than a year later, it's finally finished.

I used a 386 laptop PC fitted with a parallel-port MIDI interface, sequencer software and a Yamaha CBX-T3 General MIDI tone module to produce the music, which was input using a Shadow SHO-75 MIDI/guitar converter and some synthesizer keyboards. The output of the CBX-T3 was recorded directly on DAT tape on a Sony PCM-2700 DAT recorder and sent to Nimbus Manufacturing to have the compact discs produced directly from the DAT tape.

All mixing, reverb, panning and other effects were done entirely with the PC's sequencer software and inside the CBX-T3 module. No fancy compression, mastering or other "studio" processing was done. The reason for this was that I wanted to give people an accurate idea of just what's possible using General MIDI equipment and working from a home studio on a limited budget. The resulting album is one that I'm very proud of, and I've received lots of favorable comments on the music, above and beyond my fondest expectations.

I've also created a companion 3½" diskette that contains the actual Type 1 MIDI files for all 13 tunes on the album, along with a detailed text file of production notes. The album is being sold retail at numerous music outlets, but the combination compact disc and files diskette is available only by ordering directly from me. As a special offer to *MicroComputer Journal* readers, I'm offering the disc/disk combo for $24, shipping and handling included (please make checks/money orders payable to Tom Benford). I'll be happy to inscribe and autograph the jewel box (protective compact-disk case) if you wish. You'll find the ordering address in the box at the end of this column.

To those of you who ordered the album very early, thanks for your continued patience and support. I'm sure you'll find *Some Things I've Done* to be worth the wait. And I look forward to hearing comments from everyone who purchases the album/disk combination. ■

Products Mentioned

ATUS Multimedia Active Speaker System, $149.95; ATH-P5 Omniphones Stereo Headphones, $29.95
Audio-Technica U.S.
1221 Commerce Dr.
Stow, Ohio 44224
Tel.: 216-686-2600

CIRCLE NO. 67 ON FREE INFORMATION CARD

A Zillion Kajillion Rhymes Disk, $39.95
Eccentric Software
PO Box 2777
Seattle, WA 98111-2777
Tel.: 206-628-2687

CIRCLE NO. 81 ON FREE INFORMATION CARD

Women on Wheels CD-ROM, $25
Lion's Den International
2820 Howland Blvd., Ste. 5
Deltona, FL 32725
Tel.: 904-789-8101

CIRCLE NO. 89 ON FREE INFORMATION CARD

The Programmer's Companion CD-ROM, $39.95
John O'Connor Publishing, Ltd.
188 Fries Mill Rd., F-3
Turnersville, NJ 08012
Tel.: 609-875-8542

CIRCLE NO. 100 ON FREE INFORMATION CARD

Comedy Central's Dating & Mating, $49.99; *Comedy Central's It's All Relative*, $49.99
Time Warner Interactive Group
2210 W. Olive Ave.
Burbank, CA 91506-2626
Tel.: 800-482-3766

CIRCLE NO. 158 ON FREE INFORMATION CARD

Some Things I've Done Audio Compact Disc *with* Companion MIDI Files Diskette, $24 S&H included
Tom Benford
2329 Hwy. 34, Suite 201
Manasquan, NJ 08736
Tel.: 908-223-2271

CIRCLE NO. 159 ON FREE INFORMATION CARD

Microcomputer Q&A

By TJ Byers

In this column, I answer questions about all aspects of computer disciplines, both hardware and software, plus related electronics queries. Since I draw from a large source of knowledgeable contributors, feel free to ask whatever questions you may have regarding computing on the PC platform. You can write to me care of *MicroComputer Journal*, 76 North Broadway, Hicksville, NY 11801.

Zipped Files On BBS

Q. *I recently joined a local BBS and downloaded a file, but I can't get the program to work. I've tried everything, including trying to read the file using DOS Edit. The BBS system operator (sysop) said that the file is probably compressed. But I tried unzipping the file with* PKUNZIP *and it didn't work. I'm at wits end. Help!*

A. Because of their large sizes, many BBS files are compressed—generally using a program called *PKZIP*. They're easily recognized because they end with a .ZIP extension. However, since *PKZIP* has gone through several changes over the years, you may need to get the latest copy of the *PKZIP* programs to proceed. You can find these in the self-extracting file PKZ204G.EXE, which should be in the utility forum of your BBS. Download it and type:

```
PKZ204G <ENTER>
```

at the DOS prompt. The file will unpack into a lot of other files. Among them you'll see PKZIP.EXE and PKUNZIP.EXE. Next, move PKZIP.EXE and PKUNZIP.EXE to a directory that's in your DOS path, such as C:\DOS. From then on, you'll be able to decompress (or compress) files from any directory on your system. To unpack a file called TEST.ZIP, for example, type

```
PKUNZIP TEST <ENTER>
```

at the DOS prompt, and the file will expand to full size automatically.

Custom Screen Savers

Q. *Is it possible for me to create my own screen savers for use in* Windows*?*

A. You can create your own screen savers using any

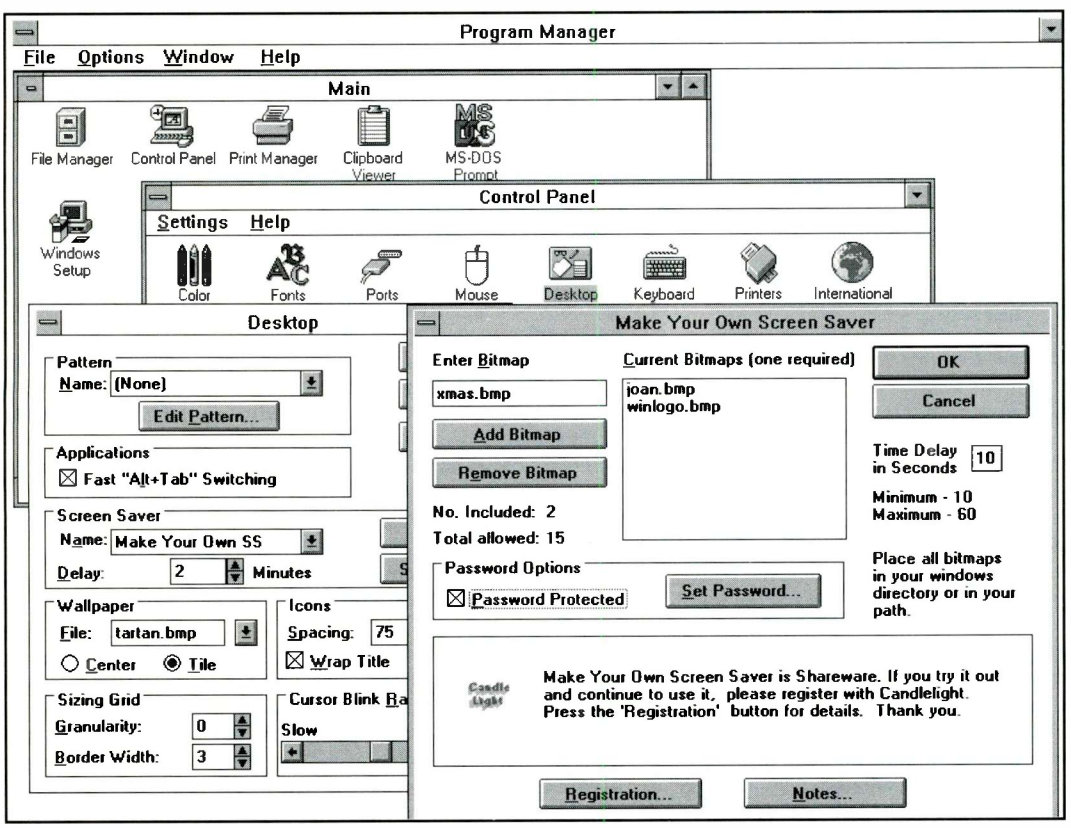


Fig. 1. You can create your own screen savers using a shareware screen-saver utility like *Make Your Own Screen Saver*. Simply draw your screens using a drawing program like *Paintbrush* and add the images to your screen-saver menu located under the Desktop icon of the *Windows* Control Panel.

drawing program—like Windows *Paintbrush*—that can save a drawing in bitmapped format. Simply draw your screen image and save it as a .BMP file in your *Windows* directory. Then, using a shareware screen-saver utility like *Make Your Own Screen Saver* (Fig. 1) or *VueSav*, add the image to your screen-saver menu located under the Desktop icon of the Control Panel. *Presto!* You have a custom screen saver. In most cases, you can create a screen-saver slide show by queing images, each of which is displayed in turn at intervals of 10 to 60 seconds (depending on the software). Such slide shows are great for unique marquees and to announce special events. Fully animated screen-saver programs are also available and generally support sound as well. However, most of the animation shareware programs like *PROJAOL* require a run-time version of *Visual Basic*, which is found as VBRUN300 on many bulletin boards and on-line services. Have fun!

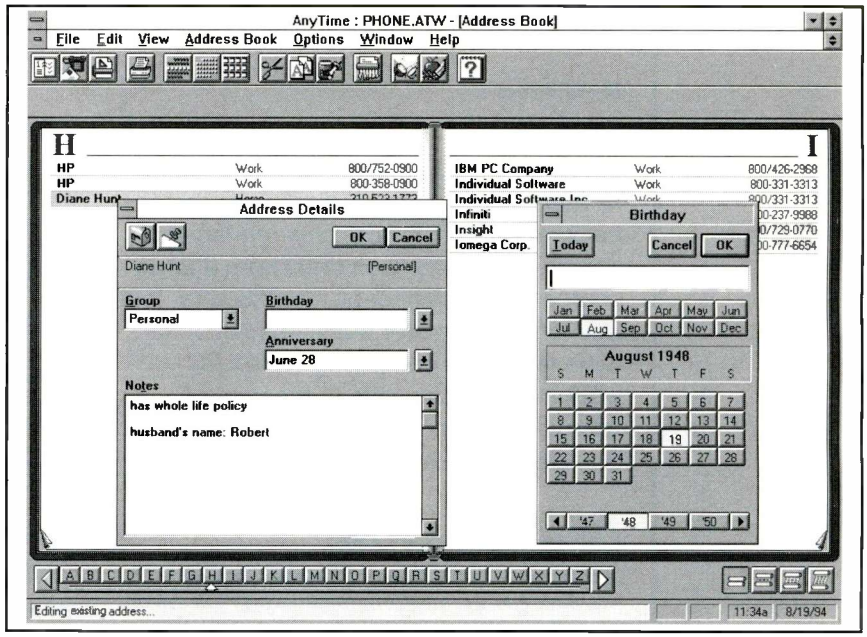


Fig. 2. Personal Information Managers (PIMs) are ideal for keeping track of anniversaries and birthdays. Most PIM software, such as *Any Time*, also have an appointment calendar, phone directory and label maker.

CGA Compatibility

Q. *I'd like to know if I can plug my old CGA monitor into my mother-in-law's monochrome PC so that it will display color until she can afford a VGA monitor and controller? The plugs appear to be identical.*

A. A CGA monitor will *not* work in place of a monochrome one. It's not the video cables, which are virtually identical and interchangeable, but the fact that the two monitors run at different frequencies. In fact, it's entirely possible to burn up the color monitor should you try the substitution!

Interlaced Video for Notebooks

Q. *How does interlacing (or noninterlacing) relate to notebook screens? In particular, how does it interact with passive-matrix and active-matrix screens? Can I, for example, buy a notebook with a noninterlaced active-matrix screen? An interlaced one? Is there much difference in quality? What's best in your opinion?*

A. For notebooks, interlacing and noninterlacing have no meaning. Interlacing was invented to display higher-resolution screens (typically 1,024 x 768) on cheap multisync monitors. The resolution of a notebook screen can't be changed. Virtually all notebooks have a fixed screen resolution of 640 x 480, which means your applications run in the VGA mode and can't run at the higher resolutions normally associated with interlacing. However, there's a technology called *dual-scan* that's used by many passive-matrix notebooks that can be confused with interlaced scanning.

With dual-scan, the screen is divided in half: top and bottom. Both halves are then scanned simultaneously (line by line) to improve contrast by a factor of two over a single-scan passive-matrix screen. Active-matrix screens are the best and the most expensive. Dual-scan passive-matrix screens are a lot less expensive, but they're nearly as good as an active matrix.

Are Generic SIMMs Reliable?

Q. *In the market for some SIMMs, I noticed that in the back of many magazines the prices are a lot lower. For example, a 70-ns 4M SIMM from Compaq, where I bought my system, is currently $200. On the street, I can get it for $150. So I called Compaq and asked why. A polite technician told me that their memory is better because it's parity memory and the pins are gold plated. Is there anything in particular I should look for when I buy memory, and do name brands really count?*

A. Actually, all SIMMs are parity capable. It's just that fewer and fewer systems use parity checking. So it's become a rather moot point. What Compaq is saying is that its SIMMs are thoroughly tested for parity *for use in its systems that use parity* (actually, just a handful of Compaq PCs still use parity checking). Moreover, not all SIMMs that fail the parity test are bad modules. Generally, the module is tagged and sent back to the vendor, who most likely will sell it for use in a non-parity system with no problem. So if you have one of the few systems that uses memory parity checking, stick with the brand name. On the other hand, generic SIMMs cost less and work just fine with nearly all desktop PCs.

Turning Off Number Lock

Q. *Is there any way to turn off NumLock during boot-up so that when my screen appears I don't have to do it manually?*

A. On my machine there's an option in the CMOS setup (an AMD BIOS) that gives a choice between NumLock on/off at boot-up. If your setup routine doesn't offer this option and you're using DOS 6.0, you can add the line NUMLOCK OFF to your CONFIG.SYS file and that'll do the trick.

Deleting DOS Files From *Windows*

Q. *While I was working in a DOS session in* Windows, *I deleted a file and prepared to continue, only to find the file was still there! This posed a problem, because deleting that file was an important step. So, I quit* Windows, *fully expecting to have to take the bull by the horns at the DOS prompt. To my surprise, the file was nowhere to be found. Loading* Windows *again confirmed the fact that I had, indeed, erased it. By now, the routine was broken, and I had to start from scratch, with the same problem. How do you erase DOS files from* Windows?

A. I wouldn't call this a bug, but it's certainly a characteristic of *Windows*. Fortunately, the cure is simple. Simply add the following line in your SYSTEM.INI file:

FileSysChange=ON

This will prevent exactly the problem described, and it doesn't affect performance or memory.

DiskSpace Vs. DoubleSpace

Q. *Can you please tell me the difference between Microsoft DiskSpace and DoubleSpace. I understand the legal differences, but I'd like to know the technical differences (if any). Also, since Microsoft doesn't support DoubleSpace, do you recommend stepping up to DOS 6.22?*

A. I've tried DiskSpace, and it appears to be stable—probably as much as *Stacker* 4.0—or DoubleSpace would have been given the same development time. However, since I've tried DiskSpace on only one machine, it didn't really get a good workout. To the best of my knowledge, Microsoft hasn't abandoned support of DoubleSpace. The company simply pulled the plug on packaging it, as per court order. But with the addition of DiskSpace, one does wonder how far and wide DoubleSpace will be supported in the future. So, given the choice, I'd upgrade to DOS 6.22's DiskSpace.

Personally, I abandoned DoubleSpace and all other disk-compression schemes in favor of a larger (340M) hard drive. It's a lot faster and extremely reliable...but it did cost me $200 more than a DOS 6.22 upgrade would have. If it sounds like I'm not a strong supporter of disk compression, you're right. With the cost of hard disks at 50 cents per megabyte and dropping (a 1.2G hard disk typically goes for just over $500), I ask, "why bother with smoke and mirrors when you can have the real thing?"

Remembering Birthdays

Q. *I'm starting a new job selling medical insurance, and I'd like to have a* Windows *database containing client names, addresses and birthdates. Do you know of one that will remind me when it's their birthdays and let me print envelopes—or, better yet, a Birthday card?*

A. What you're looking for isn't a database. It' a Personal Information Manager (PIM), such as *Lotus Organizer* or *ECCO Simplicity*. In addition to remembering anniversaries and birthdays, most PIM software include an appointment calendar, phone Rolodex and label software. My favorite is *Any Time* from Individual Software (Fig. 2). You can reach the company by dialing toll-free 1-800-331-3313. ■

Book Reviews By Alexander W. Burawa

(from page100)

Zen and the Art of the Internet: A Beginner's Guide

By Brendan P. Kehoe
(Prentice Hall Professional Technical Reference. Soft cover. 193 pages. $23.95.)

Are you planning to get connected to the "information superhighway" to cash in on all the benefits you've heard of by now but don't know how to go about it? Don't despair. This book is what you need to get you started in the complex world of cyberspace because it spells out in layman's terms what you need to know about getting connected to and navigating the information superhighway, otherwise known as the Internet. Because it assumes no prior knowledge about the Internet, it anticipates the beginner's questions. Don't misinterpret this to mean that this is a Q&A manual, which it decidedly isn't. It's just that, as I was reading it, questions that arose in my mind seemed to be answered almost immediately by following text.

Being a beginner's guide, *Zen*... logically begins with network basics and gradually builds up to much meatier topics that, ultimately, lead to you getting connected. Along the way, you'll learn about the current information society made up of more than 15-million people and organizations worldwide that are all tied together by the Internet to provide instantaneous interchange of ideas, data and more. You'll also learn technical details, like domains, Internet numbers, resolving names and numbers, the networks like Internet and more, until you finally make your first of many physical connections.

As you move on, you're given information on how to dissect e-mail addresses to take the mystery out of what might now otherwise be Sanskrit to you. Once you get to the material on basic commands, you'll learn how to create a connection, obtain a directory of files, change directories and transfer. You'll also learn about the archie server query system that provides an easy way to scan the offerings of the many anonymous sites around the world.

Each of the nine chapters in this book covers a specific topic of more-than-passing importance to the prospective Internet user. While you won't find everything you need to know in this book to become a certified expert in using the Internet (only lots of experience using the Internet might get you to this point, but don't count on it on such a complex and far-reaching resource), you'll certainly be armed with enough of the basics to get you started on a mind-boggling journey through cyberspace that will draw you back to it again and again.

There's lots to digest in this book, all of it well worth the effort to be given the opportunity to expand your personal-computing horizons almost to infinity. Much of the material in this book, on first reading it, may appear to be technobabble. But this is only because most of the terms and acronyms used throughout the book will be new to you. However, if you persevere and read to the end of the book, you'll find that most—if not all—of the confusion will be resolved. I wouldn't say that this book is an easy-read because the text makes no pretext at being amusing or folksy. It's just plain reportage, which fits well with the subject material.

This book not only serves well as a beginner's tutorial to getting connected to and using the Internet, it also functions as a handy reference source by way of its appendices, of which there are six. These cover such details as getting to other networks; retrieving files via e-mail; creating a newsgroup; items available for FTP; services available on Telnet; and country codes.

I'd recommend this book to anyone who wants to get connected to the information superhighway. Written for the beginner, it provides a relatively painless entry to a very complex resource.

Industry Watch **By John Hastings**

The AmCoEx Index of Used Computer Prices

Sales of Apple's Power Macs may get a shot in the arm later this year when the company releases a new version of the Macintosh operating system. The current version of the operating system was designed for compatibility and stability. The next version will emphasize performance. Running older Macintosh software in emulation mode, the new system is said to be twice as fast. In addition, native Power Mac software is expected to see improvements in the range of 20% to 30%.

Apple and IBM are coming closer to an agreement on what will be standard operating system features for all PowerPC-equipped computers. Once this agreement is finalized and implemented, the new Macs should be able to run OS/2 software, and the new IBM PowerPC computers will be able to run Macintosh software. Results of these discussions should reach the marketplace by next year.

Another option for operating systems may arrive next year from Novell. This networking company is

John Hastings is the president of the American Computer Exchange Corp., which has matched buyers and sellers of used microcomputer equipment since 1988. For more information contact the American Computer Exchange Corp. at 800-786-0717.

Prices For Used Computer Equipment as of July 1, 1994

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change
IBM PS/2 Model 70, 60M	$400	$700	$525	$—
IBM PS/1 486DX2/50, 253M*	1,125	1,450	1,350	–100
IBM PS/2 Model 90, 160M*	1,350	1,800	1,450	–150
IBM ThinkPad 350C*	1,900	2,400	2,200	–100
IBM ThinkPad 700	1,000	1,700	1,300	–25
IBM ThinkPad 720	1,600	2,000	1,650	–175
AST 486SX/25, 170M*	900	1,250	1,050	–50
AST 486DX/66, 340M*	1,450	2,100	1,825	–125
Dell 386/33, 100M*	800	1,100	950	–75
Dell 486DX/33, 240M*	950	1,500	1,225	–150
Gateway 386/25, 80M	500	800	625	+25
Gateway 486/33, 120M	900	1,300	925	–25
Clone Notebook 386SX, 40 M	500	900	650	–50
Clone 386/33, 80M, VGA	550	950	625	–100
Clone 486/25, 120M, VGA	800	1,250	950	—
Clone 486DX/33 ,240M*	900	1,425	1,225	–100
Compaq LTE 286, 40M	300	675	450	–25
Compaq Contura 320, 60M	500	1,000	725	–25
Compaq Contura 4/25, 120M*	1,275	1,650	1,450	–100
Compaq Deskpro 386/20e, 100M	500	800	650	+25
Compaq Deskpro 486/33, 120M*	1,300	1,750	1,350	–150
Mac Classic II, 80M*	500	825	600	–50
Mac IIsi, 160M*	700	900	800	–75
Macintosh IIcx, 80M	400	700	500	–50
Macintosh IIci, 80M	700	1,000	800	—
Macintosh IIfx, 80M	800	1,400	925	–50
Mac Quadra 700, 230M*	1,200	1,650	1,425	–125
Mac Quadra 800, 500M*	2,450	2,950	2,750	–150
PowerBook 140, 40M	900	1,400	1,025	–75
PowerBook 170, 40M	1,200	1,700	1,225	–100
PowerBook 180, 80M	1,400	1,800	1,425	–100
LaserWriterPro 630	1,600	1,975	1,700	–150*
Toshiba 1200XE	300	650	525	–25
Toshiba 1900, 120M	1,000	1,700	1,100	–25
Toshiba 3200 SXC, 120M*	1,850	2,950	2,400	–150
Toshiba 3300SL, 120M*	1,050	1,600	1,350	–125
Toshiba 5200, 100M	850	1,250	1,100	+100
HP LaserJet II	400	850	750	–50
HP LaserJet IIIP	375	950	525	–50
HP LaserJet III	750	1,100	900	–50
HP LaserJet IV	1,000	1,300	1,075	–100

*New model

reportedly working on an operating system that will compete with the as-yet-unannounced Microsoft *Windows* 4.0. The new operating system is expected to run all *Windows*, DOS and Unix software. The new operating system is expected to be less proprietary than *Windows* and very inexpensive.

Compaq's commitment to become the largest computer maker in the world has become a reality, at least for one quarter. In terms of computers shipped, Compaq and IBM exchanged places last quarter. IBM has historically been in first place and Compaq third. Apple held onto second-place position. This was a surprisingly strong finish for Apple. Many Apple customers delayed purchases during the last quarter in anticipation of the arrival of the new Power Macs.

Apple Computer is re-inventing itself this year, due to two major events. The first, the introduction of the Power Macs, is now behind the company. The second lies ahead. The company will license its operating system and ROMs to permit other computer makers to manufacture Macintosh clones. Some experts estimate this move could double Apple's revenues, quadruple profits and triple market share for the Macintosh. While the next version of *Windows* will take on more Mac-like qualities, some people say that this move is long overdue.

Sales of Apple's new Power Macs soared after the initial announcements and then dropped recently. Many users are waiting for new versions of applications that take advantage of the new RISC technology. Sales were expected to climb sharply in August, when Microsoft was expected to announce new versions of *Excel* and *Word* for the Power Macs. During the fall, new software will be available to improve the speed of *Windows* applications on the new Macs. By the end of the year, improvements to the operating system will permit older Mac software to run faster on the new machines. Early next year, two other manufactures should be selling computers that run all of this software. The most likely candidates are IBM and Acer.

All of this activity hasn't gone unnoticed by Intel, of course. While defending its older CISC technology, Intel apparently sees some virtue in newer RISC systems. The company has announced a coalition that it's forming with Hewlett-Packard to expedite incorporation of the newer technology into its future chip designs. The new chips are expected to use hardware emulation to run older software. It may take four to five years for the fruits of this effort to reach the marketplace, though. Meanwhile, many computer manufacturers fear this coalition will give Hewlett-Packard an enormous advantage. This may cause many computer makers to reconsider adoption of the IBM PowerPC chip in future models.

IBM has licensed the rights to manufacture 486-class and Pentium-class CPU chips from Cyrix and NexGen, respectively. It didn't renew its license with Intel to make these chips. The new licenses give IBM the ability to sell the chips to other computer makers, something the Intel agreement didn't permit. Some people have questioned why IBM seeks to promote a new standard with the PowerPC CPU chip yet feels the need to manufacture and sell the older technology. Experts in the industry agree that other computer manufacturers will make a transition from traditional CPU chips to the newer technology. Some of these makers fear that Intel will make some popular versions of its chips difficult to obtain for manufacturers that announce support for the newer PowerPC. To allay these fears, IBM is prepared to supply the older-technology chips during the transition periods and thereafter. This has encouraged many computer manufacturers to make plans for the new systems.

A consortium of more than 30 Taiwanese computer manufacturers has already committed to the PowerPC. The performance of the new chips is too good for them to ignore. The new motherboards cost less than anything with an Intel CPU and offer up to twice the speed. Some people are predicting a deluge of low-cost PowerPC computers to appear very soon

Prices for Used Computer Equipment as of August 1, 1994

Machine	Bid	Average Buyer's Ask	Average Seller's Close	Change
IBM PS/2 Model 70, 60M	$400	$675	$525	$—
IBM PS/1 486DX2/50, 253M	1,125	1,450	1,250	–100
IBM PS/2 Model 90, 160M	1,250	1,700	1,375	–75
IBM ThinkPad 350C	1,900	2,400	2,300	+100
IBM ThinkPad 700	1,000	1,700	1,300	—
IBM ThinkPad 720	1,600	2,000	1,725	+75
AST 486SX/25, 170M	900	1,250	950	–100
AST 486DX/66, 340M	1,450	2,100	1,725	–100
Dell 386/33, 100M	700	1,100	900	–50
Dell 486DX/33 240M	950	1,500	1,125	–100
Gateway 386/25, 80M	500	800	600	–25
Gateway 486/33 120M	900	1,300	925	—
Clone Notebook 386SX, 40M	500	900	625	–25
Clone 386/33, 80M, VGA	450	900	575	–50
Clone 486/25, 120M, VGA	800	1,250	900	–50
Clone 486DX/33, 240M	900	1,425	1,150	–75
Compaq LTE 286, 40M	300	675	425	–25
Compaq Contura 320, 60M	500	1,000	800	+75
Compaq Contura 4/25, 120M	1,275	1,650	1,300	–150
Compaq Deskpro 386/20e, 1,000	500	800	625	–25
Compaq Deskpro 486/33, 120M	1,200	1,650	1,250	–100
Mac Classic II, 80M	400	800	500	–100
Mac IIsi, 160M	700	900	725	–75
Macintosh IIcx, 80M	400	700	450	–50
Macintosh IIci, 80M	600	950	725	–75
Macintosh IIfx, 80M	800	1,400	850	–75
Mac Quadra 700, 230M	1,200	1,650	1,300	–125
Mac Quadra 800, 500M	2,450	2,950	2,600	–150
PowerBook 140, 40M	900	1,300	950	–75
PowerBook 170, 40M	1,000	1,500	1,200	–25
PowerBook 180, 80M	1,400	1,800	1,425	—
LaserWriterPro 630	1,500	1,975	1,600	–100
Toshiba 1200XE	300	650	575	+50
Toshiba 1900, 120M	1,000	1,700	1,200	+100
Toshiba 3200 SXC, 120M	1,850	2,950	2,400	—
Toshiba 3300SL, 120M	1,050	1,600	1,325	–25
Toshiba 5200, 100M	850	1,250	1,100	—
HP LaserJet II	350	850	700	–50
HP LaserJet IIIP	350	950	525	—
HP LaserJet III	650	1,000	850	–50
HP LaserJet IV	900	1,300	1,000	–75

in the marketplace.

The price of color LCD screens will spiral downward for the next two years. New technology and volume production will make color screens so inexpensive that they'll become the standard for most notebook and subnotebook computers. In addition, large color LCD screens will then replace CRT-tube-based video monitors for desktop computers. Some people predict a large folded screen will be available for portable computers. These screens will unfold to permit 17" to 20" viewing. However, the big payoff for the manufacturers has nothing to do with computers. The ultimate market is broadcast/cable television. When the appropriate price point is reached, the LCD manufacturers will own the TV market. This is the incentive that's fueling current research and development.

Each component of today's computer seems to provide greater power at less cost than ever before. CPUs are faster and less expensive, hard drives are larger and less expensive and memory costs less than ever. This trend is important due to the interrelationships between these components. Large, powerful applications wouldn't be economically feasible if hard drives and memory hadn't kept pace with CPU prices. The only component that hasn't participated in this "more for less" trend is the floppy drive. It seems to be stagnant in both price and capacity. Some large applications are being distributed on 20 to 30 floppy diskettes. CD-ROMs will solve the software-distribution problem, but most of these drives are read-only. Smaller, less-expensive optical drives will soon emerge as a new standard. These 3½" writable CD-ROMs will eventually banish floppy-disk drives to computer museums.

More News

When 386 CPU chip prices dropped three years ago, the production of 286 chips ceased. When 486 chip prices dropped last year, 386 chips disappeared in new computers. The gospel according to Intel seems to state that the price of Pentium chips will tumble this year and 486 chips will vanish. The scenario is somewhat different this time around, however.

In previous generations, the software required or beckoned for more power. Also, Intel's competitors had less production capacity than today. During the next six months, Pentium prices will surely fall. However, 486 prices may drop accordingly and continue to sell well. For the vast majority of computer users, 486 performance is adequate. In any event, the price of PCs will tumble this fall. New and used prices are expected to be 25% lower by the end of the year. Anyone who is considering a computer upgrade would be well advised to sell any unnecessary equipment as soon as possible and delay new purchases as long as possible.

The catalyst that's causing this so-called "price war" will originate not from the PC manufacturers attempting to move excess inventory but from the chip makers doing battle. The largest chip maker, Intel, fears the competition from the IBM/Motorola PowerPC chips. Currently, the PowerPC chips outsell Intel's most-powerful Pentium processor. Intel will continue slashing prices of its Pentium processor in an effort to make it more mainstream. This will force IBM, Cyrix and AMD to lower the price of 486 chips. Unlike previous PC price wars, the PC makers won't be the victims of this war, but its beneficiaries. In addition, software makers will also benefit.

The biggest beneficiary of this competition will be Microsoft. Greater sales of operating system and application software will certainly follow.

Apple Computer may also benefit from the trend in low-priced 486 chips. For a short time, Apple produced a DOS Compatible card for some specific models of its Macintosh computers. This card permitted the use of DOS and *Windows* software on a Macintosh computer. Although Apple discontinued this card in May, it's expected to introduce an enhanced version this fall. The faster card will have greater sound and networking capabilities. Due to lower 486 chip prices, the new card is expected to sell for less than $500, which is more than 30% less than the previous version of the card.

Windows 4.0 appears to be on target for release late this year. No longer running under DOS, the new version of *Windows* isn't just an interface. It's the actual operating system itself. This complete rewrite will mark the most-significant change in basic software systems since the advent of the PC. Some people estimate that the new system will generate more than $1-billion in sales for Microsoft next year.

Microsoft is expected to set the price of the next version of *Windows* at $99. This may be somewhat deceiving, however. Some analysts have already estimated that the average user will spend between $1,000 and $1,200 for hardware and application upgrades to obtain the full benefit of the new operating system. Many people beta testing the new software today feel the productivity improvements are worth the added costs.

Microsoft and the Justice Department have reached a settlement in the five-year antitrust investigation. The settlement will affect only the way Microsoft licenses its operating systems, DOS and *Windows* to PC manufacturers. It should have little short-term effect on the company, but it will encourage more competition as time goes by.

Sales of subnotebook computers have been disappointing for several manufacturers. These small systems normally weigh less than 5 pounds. Most have no internal floppy-disk drive. The Apple PowerBook Duos haven't sold as well as expected, but prices were considered the culprit. However, even after lowering prices for its Aero subnotebook to $999, Compaq hasn't realized the sales it expected. Additional price cuts may be forthcoming.

Standards were recently set for the fastest category of telephone modems available. These 28,800-bit-per-second modems may be the last of a dying breed. They approach the speed limit of most analog telephone systems. The new digital telephone systems will make modems unnecessary by transmitting all voice and data at 64,000 bps. Most modem makers are slashing prices for older 14,400-bps modems. If modems have a future, it will be through cable-TV wiring. Phenomenal speeds may ultimately be possible through this network.

When overseas shipping costs exceed the labor savings, manufacturing will come home. That is exactly what's happening in the computer industry. Due to large-scale integration, labor costs in manufacturing PCs has dropped. With less savings to be realized overseas, almost 80% of all desktop PCs are now manufactured in the U.S. Notebook and hand-held PCs are still largely made overseas.

At the Macworld exposition in Boston in August, IBM was expected to announce that it has licensed the Macintosh operating system from Apple. This system will be incorporated into the new IBM PowerPC computers, which are due later this year. In addition, Motorola is expected to license the Macintosh operating system, which it will bundle with its PowerPC-based computers. Motorola isn't expected to sell the new computer under its own brand name. Instead, it's expected that these systems will be sold by numerous smaller manufacturers who will market them under their independent labels. These new IBM computers and "clone Macs" are expected to run *Windows* applications under OS/2 and *Windows NT*.

Apple is expected to announce a new version of its hand-held Newton this fall. The new version will have a larger screen and a new, more-flexible operating system. Many people have compared the original version of the Newton to the original Macintosh. It was a learning experience that permitted Apple to determine what the market really wanted. ■

Cumulative Annual Index

January 1994 Through December 1994

Articles

Beyond Double-Speed and Single Discs: Pioneer Breaks the CD-ROM Bottleneck by Tom Benford .....Jul/Aug
Booting With MS-DOS, Multiple-Choice, by Linda Strasburg .....Jan/Feb
CD-ROMs, Rolling Your Own, by Tom Benford .....Sep/Oct
Clock, A Serial Talking, by David Williams .....Jan/Feb
Counting Solution, An Industrial, by Thomas D. Leitschuh .....Nov/Dec
Data Logger, Build a Battery-Powered, by Fred Eady .....Mar/Apr
DC-Motor Theory and Control, Small, by Steve Montgomery .....May/Jun
Diagnostic Tools, 40 PC, by Paul Buzby .....Jan/Feb
DISKCOPY Files Between Dissimilar Floppy Disks, Use a .BAT File to, by Emerson M. Hoyt .....Sep/Oct
DriveSpace Meets DoubleSpace In Microsoft's New MS-DOS 6.22 by Joe Peschel .....Nov/Dec
Expansion-Bus Guide, The Complete, by TJ Byers .....Jan/Feb
Fonts, *Windows*, by Hardin Brothers .....Nov/Dec
Fuzzy Logic—The Next Generation of Control by Bud Moss .....Nov/Dec
Genealogy On Computers by Tom Stevens .....Sep/Oct
General MIDI by Tom Benford .....Jan/Feb
Hard-Disk Compression, Exploring, by Joe Peschel .....Jul/Aug
Hard-Disk Drives, All About, by TJ Byers .....Sep/Oct
Home-Automation Telephone Interface, Build a, by Edward J. Keefe, Jr. .....Jan/Feb
I/O Operations, Use a Serial Port for, by Robert Moon .....Sep/Oct
Intel Pushes the Pedal to the Metal by TJ Byers .....Jul/Aug
Internet, Roaming the, by Hardin Brothers .....Sep/Oct
Memory Managers Give Back Unclaimed User RAM by TJ Byers .....May/Jun
Mind/MIDI Connection: Getting Yourself Wired for Sound by Tom Benford .....Nov/Dec
Monitoring and Control Purposes, How to Use a PC's Parallel Port for, by Jan Axelson .....May/Jun-Sep/Oct
Multimedia Update by Tom Benford .....Mar/Apr
On-Line Obstacle Course, The, by David T. Kruchowski .....Sep/Oct
OS/2: Taking the Plunge by Hardin Brothers .....Jul/Aug
OS/2 2.1, The Real Cost of Upgrading to, by Steven Sweet .....Jul/Aug
OS/2 2.1 and High-Speed Communications by Craig S. Stevenson .....Mar/Apr
PCMCIA: Panacea or Pandemonium? by TJ Byers .....Mar/Apr
PCMCIA: The Mouse That Roared by Joe Desposito. .....Mar/Apr
PIC16C54 Microcontroller, Getting to Know the, by Fred Eady .....May/Jun
PIC16C71 Microcontroller, Getting to Know the, by Fred Eady .....Jul/Aug
PIC16C71 and PIC16C84, Applying the, by Fred Eady .....Sep/Oct
Pointing Devices by Hardin Brothers .....Mar/Apr
Power Conditioning and Power Supplies by Hardin Brothers .....Jan/Feb
QuickBASIC for Physics-Lab Applications, Timing, by R.C. Nicklin .....May/Jun
Robot Power Systems, Building, by Steve Montgomery .....Jul/Aug
SBC Runs BASIC Programs, Miniature, by Scott Edwards .....Jan/Feb
Scanners, Image, by Steven Sweet .....Nov/Dec
Serial Ports Inside and Out, Part 1, by Jan Axelson .....Nov/Dec
Temperature, Measuring, the QADDI Way, by John Kleinbauer .....Mar/Apr
Timer, Build a Microcontroller-Based, by Fred Eady .....Jan/Feb
Tuning Up Your Computer by Hardin Brothers .....May/Jun
Utilities, Home Design & Multimedia Presentation by SF Sparrow .....May/Jun
Video Monitor, "Greening" Your, by Robert Davis .....May/Jun
Voltage Measurements, Using a Parallel Port to Make, by Eddie R. McMullen .....Mar/Apr
Windows 3.1, The Real Cost of Upgrading to, by Steven Sweet .....Mar/Apr
Wireless Links, Computer Control of by Jan Axelson .....Jan/Feb-Mar/Apr
Work Robot, Build a Real-World, Part 5, by Nick Goss .....Mar/Apr

Reviews

BBSing in the '90s by Joe Desposito .....Jan/Feb
SpinRite 3.1 Tackles Hard-Disk Disasters by Craig S. Stevenson .....Mar/Apr
A Unique Hybrid Computer: Dauphin's Desktop Replacement Model by Art Salsberg .....May/Jun
MicroHouse Technical Library: The Ultimate Technical Reference .....Nov/Dec

Columns

Computing On the Go

By Joe Desposito

New Products for Mobile Computing .....Jan/Feb
With a PDA In My Pouch, I'll Never Again Want for Organization .....Mar/Apr
Beating the Weatherman at His Own Game .....May/Jun
Moving Data From Subnotebook to Desktop is No Easy Task .....Jul/Aug
Searching for the Ultimate Connection Strategy .....Sep/Oct
Transmitting to the Perfect PC .....Nov/Dec

Editorial

By Art Salsberg

Going Home .....Jan/Feb
Slow Movers .....Mar/Apr
Sticks & Stones .....May/Jun
Charting a Course .....Jul/Aug
Computers In the Household .....Sep/Oct
Close Is Enough .....Nov/Dec

GUI Guts

By Yacco

Last-Minute Gift Suggestions .....Jan/Feb
CPU Upgrade, CPU Cooler, Recovering Hard-Drive Data, Running *Windows* Under Unix .....Mar/Apr
Where is the GUI Going .....May/Jun
Getting the Big Picture .....Jul/Aug
Seasons Greetings—1994 Holiday Gift Picks .....Nov/Dec

Industry Watch

By John Hastings

The AmCoEx Index of Used Computer Prices. .Jan/Feb-Nov/Dec

Microcomputer Musings

By Ted Needleman

Off to a Good Start . . . . . .Jan/Feb
Image Capture and the Big Picture . . . . . .Mar/Apr
Troubleshooting *Windows* Problems and Helping Kids Learn to Read Well . . . . . .May/Jun
ATI Graphics Wonder Video Card, Epson ActionPrinter 3260, Multimedia CD-ROM Titles . . . . . .Jul/Aug
Label Printing on PCs, Low-Cost Font Manipulator and an Uninstaller for *Windows* Apps . . . . . .Sep/Oct
Products Worth a Closer Look . . . . . .Nov/Dec

Microcomputer Q&A

By TJ Byers

Answers to reader questions about all aspects of computer disciplines . . . . . .Jan/Feb-Nov/Dec

Multimedia

By Tom Benford

A Professional Sound and Create-Your-Own-Music CD-ROM . . . . . .Mar/Apr
A 3D Surround-Sound Audio Card With Wavetable Synthesis for Less Than $300 and a Sampling of Multimedia CD-ROM Titles . . . . . .May/Jun
Amplified Speakers, a Unique Video-Capture Card, Making Music With Your Sound Card, Clipart on CD-ROM . . . . . .Jul/Aug
A PCMCIA Audio Card, Tech-Support Update for Xingit! Board for Gateway Pentium Users, Interesting Software on CD-ROM . . . . . .Sep/Oct
Easy Listening and My Latest CD-ROM Picks . . . . . .Nov/Dec

Advertisers' Index

R/S #		Page #
51	ACS	49
-	AES	25
63	ASA Tech	60
71	ASYS Corporation.	42
54	Ace Communications	13
55	AllMicro	1
52	Andromeda Research	109
56	BG Micro	51
53	BSoft Software	109
59	Beige Bag Software	25
72	Binary Technology	95
103	Blue Earth Research	5
57	Blue Ridge Micro	109
-	CIE	41
58	Capital Electro-Circuits	109
65	Chadwick Univ./Amer Institute.	60
60	CompuBoost	110
-	Computer Systems Center	91
-	Comtrad Industries	7
68	Design Computations	52
-	Dunfield Development	73
62	EE Tools	109
73	EMAC	15
64	Educational Laboratories	109
-	Grantham College of Engineering.	29
-	H.J.J. Co., Inc.	111
66	Highlands Electronics	109
99	ICS Electronics Corporation	83
70	International Computers	110
-	Intronics	27
101	LDG Electronics	111
-	L.S. Electronic Systems Design	35
102	Lakeview Research	69
76	Mental Automation	49
77	Merrimack Valley Sys.	15
74	Micro Computer Controls	110
-	MicroEngineering Labs	110
106	Micro House	Cov IV
78	Midwest Microtek	110
79	Mouser Electronics	52
80	New Micros	Cov. II
-	Parallax, Inc.	Cov. III
82	Prairie Digital	73
-	ProBoard Circuits	110
84	Professional Career Development.	111
85	Prologic Designs	27
86	PseudoCorp	35
97	Rigel Corporation	54
-	Saelig Company, The	79
87	Software Innovations	110
88	Software Science	110
111	Sylva Energy Systems	111
90,107	TECI	76
91	Tech Arts	79
92	Technological Arts	111
98	URDA	68
61	Ublige Software & Robotics	29
93	Ultra Link	110
105	Unicorn Electronics	8
-	Vanguard Labs	109
69	Versacom	111
94	Wheatstone Microsystems	68
95	Z-World Engineering	68
96	Zero Surge	109

We'd like to see your company listed here too. Contact Margaret Milanese at 516-681-2922 to work out an advertising program tailored to meet your needs.

SuperMart

Feature *your* products and services here for high-impact high-visibility!
Call Margaret Milanese today at 516-681-2922 or FAX 516-681-2926
for all the details you need to get your ad in the next issue!

EPROM+
PROGRAMMING SYSTEM USES PARALLEL PORT

SUPPORTS OVER 500 CHIPS

•EPROMS (24,28,32 & 40*PIN + 27C & 28F)
2708,16,32,32A,64,64A,128,128A,256,512,513,011
010,101,1001,1000,1024,2,210,020,2001,220,2048
4001,040,240, 2516,2532,2564,68764/66,TMS2716
•EEPROMS (24 & 28 PIN PLUS 28CXX)
2804,2816,2816A,2718,2864,2864A,2865,28256
•SERIAL EEPROMS* (8 PIN PLUS CXX)
9306/46/56/66,2444,2401/02/04,85XX,ER1400
•BIPOLAR PROMS * 745XXX, 825XXX
•MICRO CONTROLLERS * 8741,42,48,49,8751
87C5X,87C751/752,68705,68HC705,TMS7742
* ADAPTER REQUIRED - DIAGRAMS INCLUDED

•SOFTWARE - READ, VERIFY, PROGRAM, COPY, DISK FILE LOAD & SAVE
CHECKSUM, BUFFER EDITOR W/20 COMMANDS, HEX & BINARY FILES
•FAST! - MOST DEVICES PROGRAM IN UNDER 60 SECONDS
•RUGGED (8" X 7" X 3"), PORTABLE ENCLOSURE WITH CARRY HANDLE
•MADE IN THE U.S.A. - 10 DAY MONEY BACK GUARANTEE -1 YR. WARRANTY
•SYSTEM INCLUDES: UNIT, POWER PACK, CABLE, MANUAL & SOFTWARE

ANDROMEDA RESEARCH
P.O. BOX 222
MILFORD, OHIO 45150
(513)831-9708 FAX (513)831-7562

$289
ADD $5.00 SHIPPING $5.00 C.O.D.
VISA/MASTERCARD

CIRCLE NO. 52 ON FREE INFORMATION CARD

AFFORDABLE ENGINEERING HARDWARE / SOFTWARE

Engineering Software - PC-MSDOS

• Electronic Circuit Design	$ 49
• Schematic Drawing Program	$ 49
• PCB Design & Circuit Drawing	$169
• PC-SCOPE Oscilloscope	$ 49

PC Bus Plug-In Cards

• 24 Bit TTL I/O, 48 Bit TTL I/O	$39, 49
• 12 Bit Data Acquisition & TTL I/O	$ 89
• 16 Bit Counters & TTL I/O	$ 89

- More Hardware & Software is available -

Call or Write for FREE Catalog

BSOFT Software, Inc.
444 Colton Road
Columbus, OH 43207
(614) 491-0832
Fax (614) 497-9971

CIRCLE NO. 53 ON FREE INFORMATION CARD

AllMax+ $745
Universal Programmer

- Supports via **printer port** or **plug-in card**
- Programs PLDs, PROMs, E(E) PROMS, and microcontrollers
- Tests TTL/CMOS, DRAM/SRAM
- Supports standard **48-pin GOLD-ZIF** socket
- Lifetime Free Updates via B.B.S.
- **Two (2) year Warranty, Made in U.S.A.**

FREE PLD Compiler

CE tools *Electronic Engineering Tools*
544 Weddell Drive, Suite 6
Sunnyvale, California 94089
(408) 734-8184, 734-8185 FAX

CIRCLE NO. 62 ON FREE INFORMATION CARD

SINGLE BOARD COMPUTERS

MCß8052
• 80C52-BASIC processor • Programs eproms, eeproms, nv ram • Three 8-bit parallel ports • RS232 port • Serial printer port • Four decoded outputs • Three 16-bit timer/counters • Six interrupt sources • Expansion headers • $119 A&T

MCß8031
• 8031 processor • 8k to 32k ram/rom • +5v only operation • Two 16-bit counter/timers • Five interrupt sources • Expansion headers • $79 A&T

TO ORDER ADD $5 S/H PER ORDER.
TN RESIDENTS ADD 8.25 S.T.

BLUE RIDGE Micros
2505 Plymouth Rd. Johnson City, TN 37601
Tel: 615-335-6696•Fax: 615-929-3164

CIRCLE NO. 57 ON FREE INFORMATION CARD

8051 Development Courses

8051 Microcontroller Based Computer Design

Learn how to design and build your own 8051 based microcontroller system. Easy to follow labs guide you through designing, building and utilizing your 8051 board.

Includes the following:
** Complete Board Schematics*
** In depth study of memory, I/O, and peripheral interfacing*
** How to interface a PC to your 8051 board using RS232 port*
** Discussion of board design issues such as crosstalk and noise*

Programming 8051 Based Computers

Learn how to program an 8051 using assembly language. Complete course and labs teach everything from microcontroller initialization to advanced peripheral management.

Includes the following free software:
** 8051 Cross Assembler*
** 8051 Simulator*
** On Board Monitor*

One Course - **$19.95** Both Courses - **$29.95**
add $3.50 S/H

ELabs *Educational Laboratories*
Educational Laboratories
P.O. Box 1326 Folsom, CA 95763-1326

CIRCLE NO. 64 ON FREE INFORMATION CARD

SERIES MODE
Powerline Surge Protection

- **EFFECTIVE--** required protection for interconnected or networked equipment
- **RELIABLE--** non-sacrificial design
- **SAFE--** Uses no MOVs

Award winning Series Mode technology eliminates the destructive energy of surge voltage **and** surge current!
Call or write for full details today.

ZeroSurge Inc.
944 State Rt 12 Frenchtown NJ 08825
1-800-996-6696 FAX (908) 996-7773

CIRCLE NO. 96 ON FREE INFORMATION CARD

Capital Electro-Circuits
PRINTED CIRCUIT BOARDS

Superior Quality at Competitive Prices!

- Single Sided, Double Sided & Multi-Layer
- Prototype & Production Quantities
- Photo Plotting & Electrical Testing Services

Call us for an instant quote
Phone: (301) 977-0303
Fax: 990-6715 Modem: 990-9628
7845-J Airpark Rd. Gaithersburg, MD 20879

CIRCLE NO. 58 ON FREE INFORMATION CARD

Actual Circuit Emulation
A better method than ICE!

- **Much more power with less cost**
- **Drivers for LCD, DTMF, and more**
- **Versatile Interface Adapter on eBoard**
- **Simple expansion**
- **External power supply for 24 hour a day operation**
- **Cable, Breadboard, and Power supply**
- **All source included. Kernel, Forth, PC Debugger, Assembler and Environment.**
- **Runs independently of PC or use as a programmable PC card**

The eBoard ™

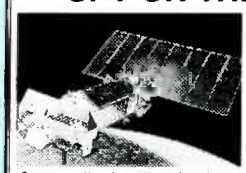
$195.95
This price is a limited time offer. Includes shipping and handling.

Object Oriented Hardware ™

Highlands Electronics
13720 LakeShore Drive
ClearLake, CA 95422
Phone 707 994-1024
Fax 707 994-5823

CIRCLE NO. 66 ON FREE INFORMATION CARD

SPY ON THE EARTH



See *live* on your PC what satellites in orbit see

Capture *live* breathtaking images of the Earth for fun or profit. Zoom in up to 20X. Send $39 check or M.O. ($45 air, $50 overseas) for our *fantastic* 12 diskette set of professional quality copyrighted programs (IBM type) that does satellite tracking, image acquisition, image processing, 3-D projections and more. Direct reception from the satellites guaranteed worldwide without a satellite dish. Schematics included for interface. For FREE information log-on to our bulletin board anytime at: (718) 740-3911.

VANGUARD Electronic Labs
Dept. C, 196-23 Jamaica Ave.
Hollis, NY 11423 Tel.718-468-2720

SuperMart

MicroComputer JOURNAL

Classified Commerial Rates: $1 per word, 15-word minimun ($15.00) prepaid. (Word count includes name and address; Zip code and abbreviation each count as one word; P.O. Box number and telephone number count as two words each.) Indicate free category heading (Computers, Software, Electronics, Video or Miscellaneous). A special heading is avaliable for a $6 surcharge. First word only is set boldface caps at no charge. Add 25¢ for each additional boldface word.
Non-Commerial Rates: FREE to subscribers, as space permits; maximun 15 words. A recent MicroComputer Journal mailing label must accompany ad. (All advertisers with P.O. box addresses must supply permanent address and telephone number. Copy is subject to publisher approval.)
Mailing Information: Copy must be received by the publisher by the 25th of the third month preceding the cover date. Send Advertising material with check or money order or credit card information (Visa or MasterCard only) with number and expiration date to: **MicroComputer Journal, Classified Department, 76 N. Broadway, Hicksville, NY 11801.**

BUSINESS OPPORTUNITIES

WANTED! *PRINTED CIRCUIT BOARD LAYOUT SPECIALISTS (USING PROTEL/CAD SOFTWARE) *EMBEDDED MICRO-PROCESSOR, ASSEMBLY LANGUAGE PROGRAMMERS. JACOBS ELECTRONICS, INC. IS A PROFITABLE, RAPIDLY GROWING MANUFACTURER OF AUTOMOTIVE ELECTRONICS, BOTH STREET AND RACE. ALL THE SECURITY OF A BIG COMPANY, BUT WITH RAPID, HIGH ENERGY CAREER GROWTH POTENTIAL. WORK WITH THE COUNTRY'S TOP PEOPLE. WE HAVE THREE WORLD CHAMPION RACERS USING OUR PRODUCTS. IF YOU LOVE CARS AND RACING YOU'LL BE RIGHT AT HOME! **FAX RESUMES TO: (915)687-5951** OR MAIL TO: 500 N. BAIRD ST., MIDLAND, TX 79701. ATTN: MIKE .

MAKE $250 DAILY CHROME PLATING AUTO AND MOTORCYCLE PARTS STARTING FROM NOTHING. Send 2 stamps for free information to: Communications Engineering, 76 Boulevard K, Hudson Falls, NY, 12839.

FREE REPORT. Turn any Computer and Modem into a Money Machine! **Millionaire reveals amazing secrets.** Call 24 hours 1-800-221-3813 Operator MC-01.

COMPUTERS

COMPUTER MONITORS. We repair all makes, models, PC compatibles & others. Flat rates, prompt turnaround, 6 month warranty. Call or write for information. MultiMedia Service, 1125 N. May, Oklahoma City, OK 73107.(405)-942-5766.

Historic and Classic hardware support magazine. ***The Computer Journal*** provides how-to information on keeping S-100, Kaypro, Z80, 6809, CP/M, and PC/XT systems running. Over TEN years of hardware, software projects. 6 issues $24. Free sample. 800-424-8825. TCJ, PO Box 535, Lincoln, CA 95648.

"CNE STUDY KIT"

CNE study kit by successful CNE contains important aids to pass those challenging Novell Corporation exams. For more information FAX (604) 988-7987.

BOOKS

ROBOT BOOKS! FREE catalog by mail! Write: COGNITIONS, Dept. 1100, 71 Widow Sweets Rd., Exeter, RI 02822.

CABLE TV

CABLE TEST CHIPS. Jerrold, Tocom, S.A., Zenith. Puts cable boxes into full service mode! $29.95 to $59.95. 1-800-452-7090,(310)902-0841.

CABLE DOCTOR

Stop the bullet and ID signals in cable lines, send $20.00 to R.R. ENTERPRISE, DEPT. M, BOX 3532, EASTON, PA 18043.

ELECTRONICS

T.V. NOTCH FILTERS AND BULLET STOPPER, FREE BROCHURE. MICRO THinc. BOX 63/6025, MARGATE, FL. 33063 1-(305)-752-9202

ROMY-16 EPROM Emulator emulates 2716-27010 ROMs or 6116-628128 RAMs in 8- and 16-bit systems. **$195**(2716-27256) or **$245**(2716-27010). Optional assembler, and ROM debugger for $100 each CPU. **Universal Microprocessor Simulator/ Debugger V2.1** simulates popular 8-bit microprocessor. Assembler, Disassembler, windowed symbolic Simulator/Debugger. $100 each CPU. **80C552 Development System $190**. Eight channel, 10-bit A/D. Watchdog timer, on-chip oscillator, RS-232 serial communication, one 8255A. 32K ROM, 64K RAM. $120 each board. Optional 40x2 LCD display $20. **J&M** Inc. 83 Seaman Road, West Orange, NJ 07052, Tel: 201-325-1892, Fax: 201-736-4567.

RESTRICTED Top Secret Hacker Information. Cellular / Cable / Surveillance / Satellite / Video-Cipher/ Books / Videos - More. Catalog - $3.00. **TELECODE** P.O. Box 6426-MJ, YUMA, AZ 85366-6426

FASCINATING kits! Lasers, voice changers, gas sensors, and more! Send $1.00 for catalog. LNS TECHNOLOGIES, 20993 Foothill Blvd., Suite 307C, Hayward, CA 94541-1511.

SOFTWARE

FREE CATALOG. Thousands of IBM, Shareware programs. Low prices, Bonuses, CD ROMS. **Prestige Distributor,** P.O. Box 27, Yaphank, NY 11980.

VIDEO

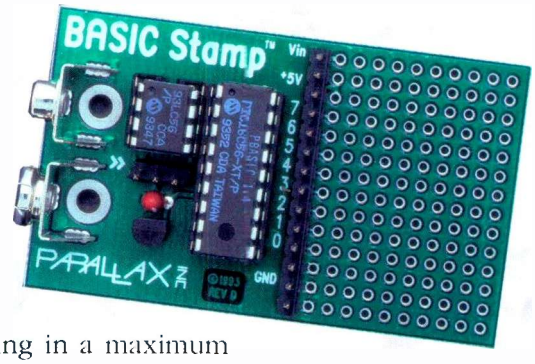
FREE PAY TV - NEED MONEY? Learn how to make money descrambling pay TV like the pro's. make up to $20,000 a month. Anyone can do it almost anywhere in the U.S.. No electronics background needed. Order the NEW BOOK, Pay TV-The Inside Scoop. Send $9.95 to A/V Publishers 16281 S.F. Mission Blvd. #407-M, Granada Hills, CA, 91344.

MISCELLANEOUS

ASIAN LADIES want correspondence for friendship, marriage. SUNSHINE INTERNATIONAL-Dept. TW, Box 5500, Kailua-Kona, Hawaii, 96745. (808)325-7707.

BASIC STAMP™

Stamp-Sized Computer Runs BASIC



The BASIC Stamp is a small single-board computer that runs BASIC programs. It has 8 I/O lines, which can be used for a variety of digital and analog purposes. The Stamp's BASIC language includes familiar instructions, such as GOTO, FOR...NEXT, and IF...THEN, as well as SBC instructions, such as SERIN, PWM, and BUTTON. Each instruction takes 2-3 bytes of the Stamp's 256-byte EEPROM, resulting in a maximum program size of 80-100 instructions. Programs execute at about 2,000 instructions per second.

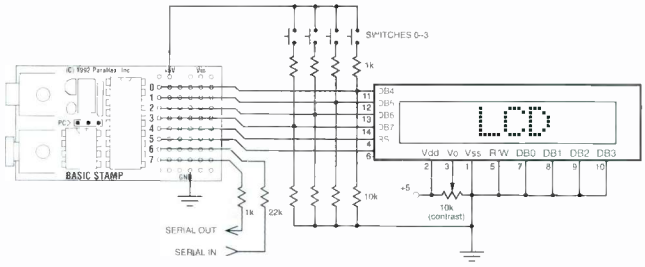
The BASIC Stamp Programming Package contains everything you need to program Stamps using your PC. The package includes our editor software, programming cable, manual, application notes, and free technical support. **The package is available for $99; Stamps are sold separately for $39.**

New Stamp Module Available Soon

A number of customers have expressed interest in a SIP-type Stamp for use in their products. So, we designed the "BS1-IC" depicted above (actual size). The BS1-IC has the same functions as the original Stamp, but without the prototype area and battery clips. We should have production units in November, depending upon availability of surface-mount parts. **Pricing will start at $29.**

Micro-Terminal

In this application, the Stamp receives serial data and displays it on the LCD. The state of the four buttons is then transmitted serially.



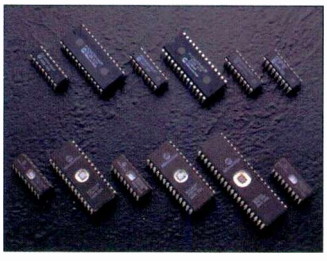
PIC®16Cxx MICROCONTROLLERS and TOOLS

In price and availability, nothing compares to PICs.

PICs are the answer to many small controller needs, especially if price is an issue. A typical PIC is the PIC16C54-RC/P; it's an 18-pin DIP package with 12 I/O lines, 512 words of PROM, and 32 bytes of RAM, all for around $4.00 in small quantities. And newer PICs have interrupts, A/D, and up to 33 I/O lines.

For the past three years, we've been helping people get started with PICs. We offer a growing line of development tools, documentation, application notes, and technical help, as well as the PICs themselves.

If you'd like information on our PIC tools, or you'd like a copy of our complete catalog, please let us know. We'll be happy to send whatever materials you need.



PIC Chips **$4 - $27**

We offer PICs in the "RC" and EPROM versions.

PIC16Cxx Programmer **$199**

Supports PIC16C5x, '71, & '84. Also PIC16C64 with 40-pin adapter.

TrueFlight for '71/'84 ™ **$299**

Programmer & flash UV eraser form development system for '71 & '84.

Impression '5x ™ **$399**

Downloader allows you to run PIC16C5x code in-circuit at 20 MHz.

PARALLAX INC

3805 Atherton Road, #102 • Rocklin, CA 95765 • USA
(916) 624-8333 • Fax: 624-8003 • BBS: 624-7101

50,000 pages of technical hardware information at your fingertips.

The Complete PC Hardware Reference.

The Micro House Technical Library on CD-ROM provides technical specifications and configuration information on over **1500** different manufacturer's products. We've taken thousands of hardware product manuals and extracted the vital information you need. Locating main boards, network interface cards, hard drives, hard drive controllers, and I/O cards (video, sound, modem, serial, parallel, CD-ROM, etc.) is now a reality. This feature rich CD-ROM even includes drivers and support software, from the manufacturers themselves!

MICROSOFT™ WINDOWS™ COMPATIBLE

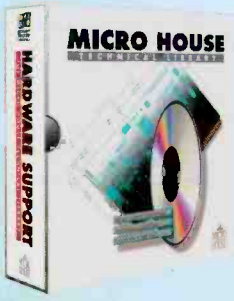
yes It runs with NetWare

AUTHORIZED NOVELL 801 COURSE — MICRO HOUSE — TRAINING PRODUCT

Microsoft is a registered trademark and Windows and the Windows Logo are trademarks of Microsoft Corporation.

Micro House is a registered trademark.

Call 800-926-8299 for a free demo and additional information!



Micro House International Inc. • 4900 Pearl East Circle • Suite 101 • Boulder, Colorado 80301 • 303 443-3388 • Fax 303 443-3323

Ref: Part# TCMCJF

CIRCLE NO. 106 ON FREE INFORMATION CARD