DR DOS 6.0: Better Than MS-DOS 5.0?

ComputerCraft

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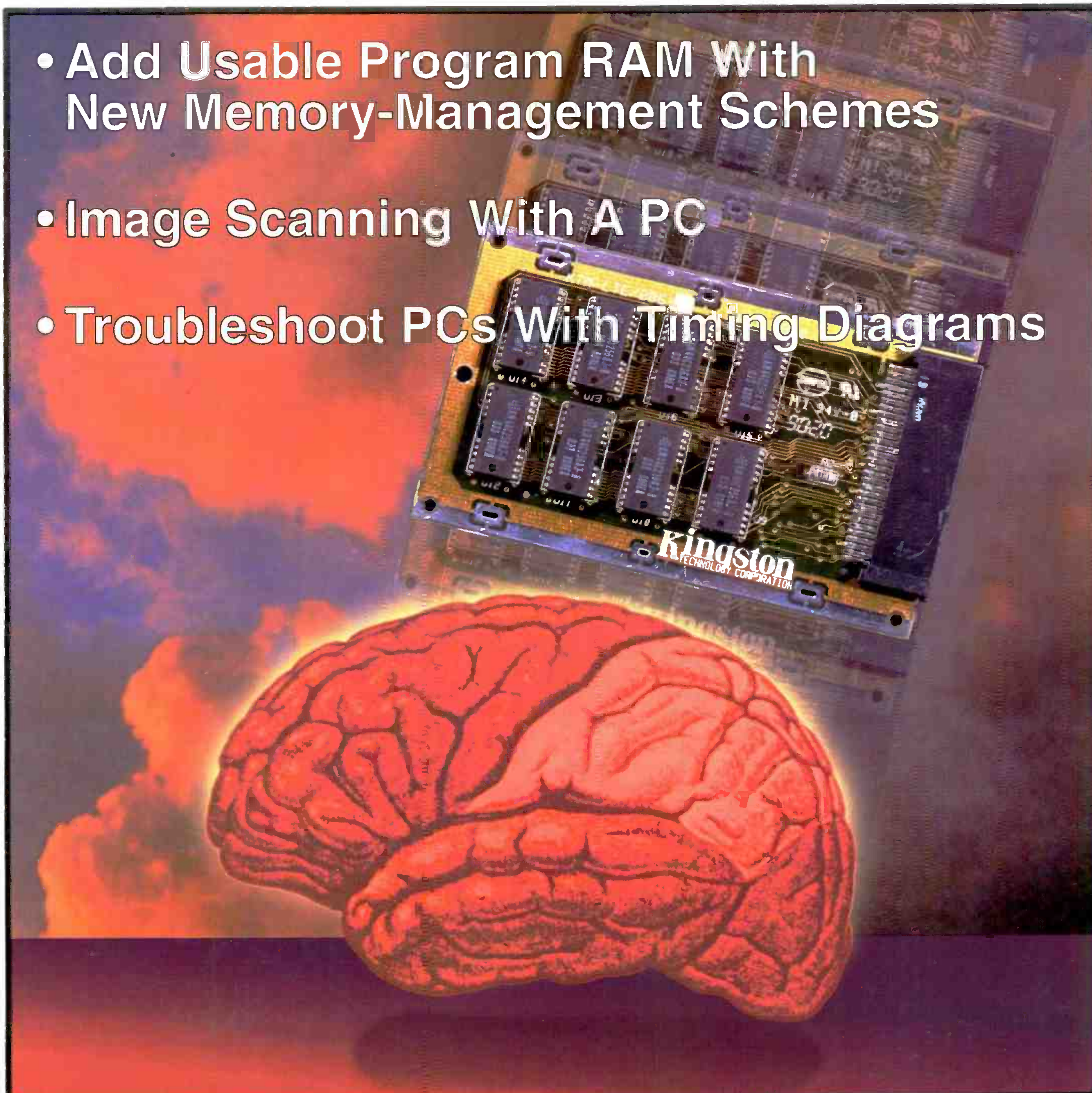

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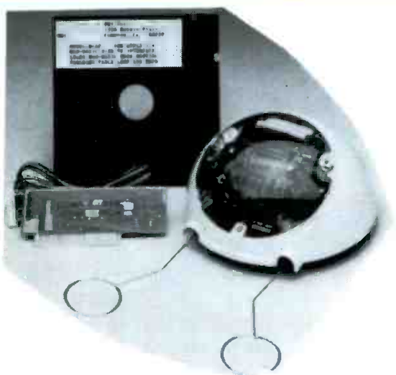
LASER DIODES

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

WAO II PROGRAMMABLE ROBOTIC KIT

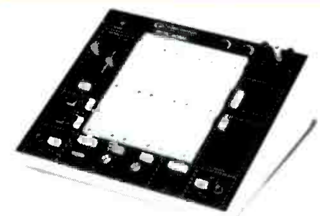


The pen mechanism included with the robot allows it to draw. In addition to drawing straight lines, it can also accurately draw circles, and even draw out words and short phrases. WAO II comes with 128 x 4 bits RAM and 2K ROM, and is programmed directly via the keypad attached to it. With its built-in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

- Power Source - 3 AA batteries (not included)

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

PROTOBOARD DESIGN STATION



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

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

IDC BENCH ASSEMBLY PRESS

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

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

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

COLLIMATING PEN

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

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

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

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

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

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

LASER DIODE MODULE

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

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

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

STOCK #	DESCRIPTION	1-9	10-24	25+
LDM135-.5	*.5 mW Laser Diode Module*	179.99	170.99	153.89
LDM135-1	*1 mW Laser Diode Module*	189.99	180.49	162.44
LDM135-2	*2 mW Laser Diode Module*	199.99	189.99	170.99
LDM135-3	*3 mW Laser Diode Module*	209.99	199.49	179.54

COLLIMATING LENS

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

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

DUAL MODE LASER POINTER

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

STOCK #	DESCRIPTION	1-9	10-24	25+
LP35	*Dual Mode Laser Pointer*	199.99	189.99	170.99

He-Ne TUBES

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

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

POWER SUPPLY

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

STOCK #	PRICE
PS1003	$19.99

ROBOTIC ARM KIT

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

STOCK #	PRICE
YO1	$43.99

AVOIDER ROBOT KIT

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

STOCK #	PRICE
MV912	$43.99

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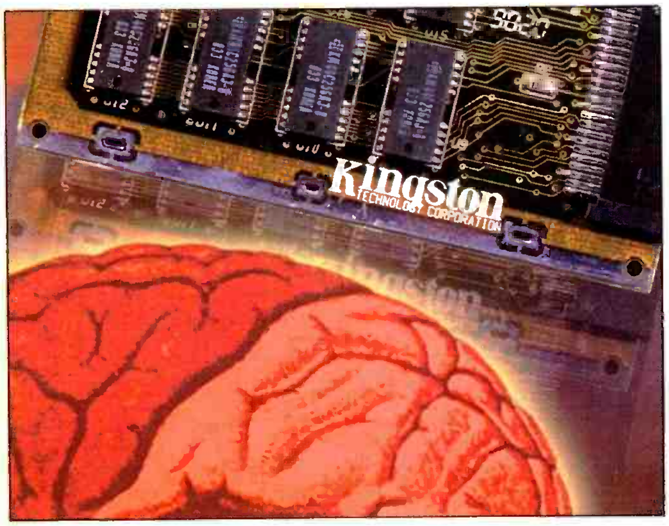
ComputerCraft

Volume 2, No. 6 June 1992



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84

ON THE COVER: Add-in software products manipulate and manage use of working RAM to give application programs the room they often need, just as if it was possible to add more memory beyond DOS's 640K barrier.

Cover art courtesy of Kingston Technology Corp., Fountain Valley, CA.

Editorial

ISO's Battle Factory Parts Practices

Independent service organizations (ISOs) and associations have rallied to support Image Technical Services Inc., *et al*, in a legal battle with Eastman Kodak Co. over a manufacturer's right to refuse to sell parts or service literature to an independent service company.

Kodaks' friends include Digital Equipment Corp., Hewlett-Packard, Prime Computer, Unisys, Wang, the Computer and Business Equipment Manufacturers Association and the Motor Vehicle Manufacturers Association, who filed Friend of the Court briefs on behalf of it.

Although the case, now before the U.S. Supreme Court, concerns copier and other office equipment parts, the suit's principle can be extended to any other manufactured product, including computers and peripherals, of course.

ISOs originally sued Kodak in 1987 when the manufacturer stopped selling repair parts to them or to consumers, charging Kodak with restraint of trade. The suit was dismissed in a San Francisco District Court, scoring a victory for Kodak. On an appeal in 1990, Kodak lost. Last year, Kodak appealed that decision to the U.S. Supreme Court, which agreed to hear arguments. A decision is expected before year-end, which might be to send the case back to a lower court.

A case with similarities occurred in the automobile aftermarket industry. Here, car radio retailers, distributors and installers challenged Chrysler Corporation's practice to include autosound equipment as a standard feature in some of their automobiles, without deducting the cost if a consumer didn't want the product. The U.S. Court of Appeals in Philadelphia went against the big auto maker on this, overturning a lower court's decision. A three-judge panel noted that Chrysler would be restraining competition and could sell an inferior product at an exorbitant price.

It's clear that some manufacturers want to own the aftermarket action for their factory output, whether it's servicing or an ancillary product. I would hope that the courts don't allow them to weaken independents, which I'm convinced would increase end-user costs and make it less convenient to obtain service. Competition is what keeps everyone on their toes, to the benefit of all. The last thing we need is more monopolists.

Art Salsberg

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Reader Feedback

• I've very much enjoyed your articles on microcontrollers. I just can't seem to get enough on the subject. Keep those articles coming.

Richard C. Forman
Irvine, CA

• Congratulations on your excellent magazine. I am an electronics technology educator and an avid analog and digital experimenter. I find your publication well thought out, easy to understand and of high technical quality.

Before we get too puffed up with our great digital technical expertise, consider this analogy. Compared to a digital computer, my analog golden retriever is far superior in snatching a thrown Frisbee from midair. Perhaps some day in the distant future we will reach a point where we will become intelligent enough to build a microcontroller with a hybrid digilog molecular memory unit where each bit of each byte will be an analog variable. Maybe then we can build a better golden retriever. Until then, I must be content with my present dog and my Von Neumann-based computer system that is maybe just a little bit smarter than a planarium worm.

Vic Numbers
Portland, OR

• When I first found *ComputerCraft* on the newsstand, I obtained all back issues, just to be sure I didn't miss anything. It fills a void left by the sudden demise of *PC Resources*, which was the one magazine that had useful "hands-on" information. It is nice to see some of the writers from it back. Although I do not have the time to do breadboarding (despite once having a ham radio license and building equipment from scratch), I appreciate practical articles.

The recent article on building serial data communication cables was helpful. In my work, which involves data acquisition from blood-pressure monitors via a serial port, I have had to build several cables.

The kind of articles that are most helpful to me are "hands-on" upgrades. Keep it up. Most of my work is with MS-DOS computers.

Ronald J. Kallen, M.D.
Highland Park, IL

• I have greatly enjoyed your series of articles on various aspects of microprocessor design and use. It has really boot-strapped my understanding of single-board controllers and facilitated my experimentation with them at my workbench in our laboratory.

J.D. Roberts Jr., M.D., M.S.

Disappointed

• I was disappointed with the comments about *WordPerfect* 5.1 versus *XyWrite* in the January issue. The author complains, "When we tried the built-in *WordPerfect* Help utility, we couldn't locate an indication under Copy command for copying text multiple times." It's there, all right. The steps are: F1, C (three times), Ctrl-F4 (twice)—seven entries in total. The same is true about the comments on instructions for macros. Again using F1 and "M," the author would have found that by entering Ctrl-F10, up would come help screens that give required information.

On the other sidebar about using the equation editor, I found that, contrary to the comments made, the STACK command was not necessary. Using the curly brackets alone was sufficient to bring everything into line. Also, there was a complaint about being unable to put limits on the right of the integral sign, but that is exactly where they show up in the example given, which is where they belong.

William Templin
Mississauga, Ontario, Canada

The article wasn't about one word processor versus another. It concerned using one for the first time and weighing learning-curve difficulties against another powerful word processor with which the author had some experience.—Ed.

New Spec Boosts Portable Battery Life. Intel and Microsoft introduced a software specification that extends battery life of portable computers by up to 25% during full-on conditions. The interface spec, Advanced Power Management (APM), was endorsed by 37 companies, and complements existing power management designs. Supporting a portable computing initiative further, Microsoft announced an MS-DOS ROM version.

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Pen Computing. GeoWorks enters the pen computing arena with a new pen-based, graphical operating system, called "Pen/GEOS." It's aimed at low-cost handheld computers in an anticipatd under-$500 device market....GO Corporation's PenPoint operating system gets a boost with "SafetyPen" utilities from Slate Corp., headquarted in Scottsdale, AZ. Slate teams with Day-Timers, a major maker of business planner-organizers. The first product from this collaboration is Pen Scheduler software. Slate also announced password security and a backup utility using PKZip data compressions.

Microsoft Services Hearing-Impaired. Microsoft announced direct access for hearing-impaired customers through a new Telecommunications Device for the Deaf (TDD) service. Effective Jan. 27, 1992, it provides access to the same tech product support and customer services as the normal-hearing customer. The direct TDD phone line is 206-635-4948 during regular operating hours (6 a.m. to 6 p.m. PST).

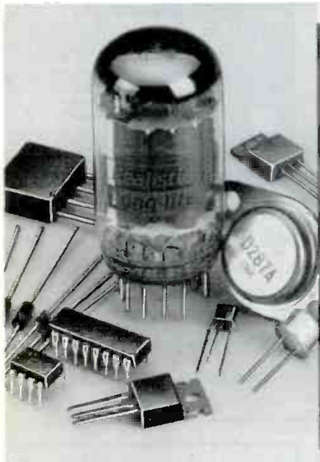
New EIA Standards Catalog. The Electronic Industries Association (EIA) is making available free of charge a new, 108-page catalog of all its standards, specifications and other EIA publications. Call Global Engineering Documents for the free catalog or other technical documents at toll-free 1-800-854-7179.

Baseball Statistics Software. The new "Rotisserie" Scout baseball program from Computer Sports World (702-294-0191) gives a user the ability to access statistics in a variety of categories for player comparisons. It can show a player's performance at any point during the season. Information can be kept up-to-date by downloading data each week using CSW's "Stats Service."

New Windows Software. Windows version 3.1 upgrade was a best-seller before it ever came out. With some 9-million people owning Windows 3.0, it's sure to be grabbed up by most of them at only $49.99. Beta testers (there were about 12,000 of them) we've spoken to say it has many worthwhile improvements...."Virtual Monitors" from Baseline Publishing (901-682-9676) is a new low-cost ($39.95) productivity tool for Microsoft Windows. Its allows users to open serveral applications at once without screen clutter from various windows, icons and boxes.

RADIO SHACK

THE PARTS PLACE℠



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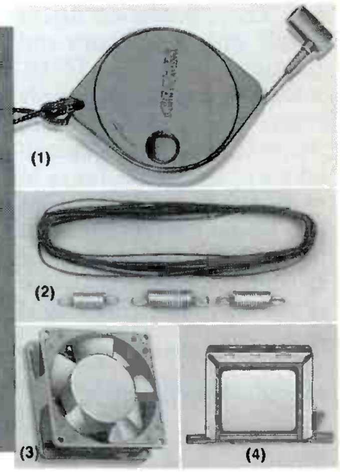

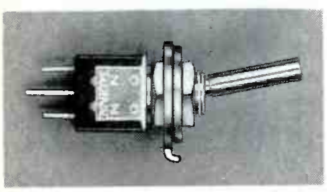

Micromini Toggle Switches. Reliability at low cost. Rated 3A at 125VAC. ¼"-dia. stem.
SPST. #274-624 .... **2.29**
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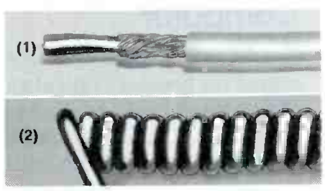

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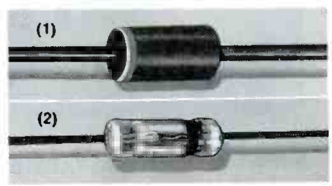
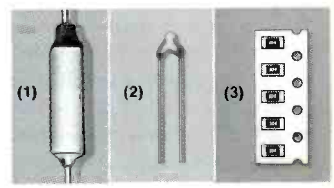
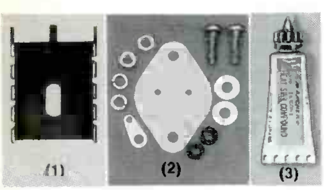


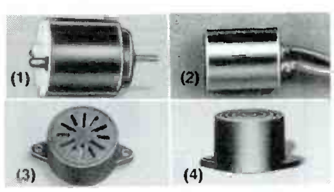
(1) 1N914/4148 Switching Diodes. Popular silicon type. Rated 75 PIV. #276-1122 .... **Pkg. of 10/99¢**
(2) 1N34 Germanium Diodes. Hard-to-find signal diodes. Rated 60 PIV. #276-1123, **Pkg. of 10/99¢**



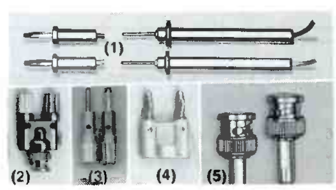
(1) Thermal Fuses. 128° C., #270-1321. 141° C., #270-1320. 228° C., #270-1322 .... **Each 1.19**
(2) Thermistor. Resistance is proportional to temperature. #271-110 .... **1.99**
(3) Surface-Mount Resistors. 200 pieces, 15 popular values! Rated ⅛ watt, 5%. #271-313 .... **Set 4.99**



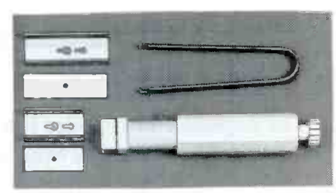
(1) TO-220 Heat Sink. Ideal for PC board use. #276-1363 .... **89¢**
(2) TO-3 Mounting Hardware. Complete kit. #276-1371 .... **99¢**
TO-220 Mtg. Kit. #276-1373 .... **99¢**
(3) Heat Sink Grease. Assures maximum heat transfer. #276-1372 .... **1.59**



(1) 1½ to 3VDC Motor. Use in solar power demos. #273-223 .... **99¢**
(2) Electret Element. #270-092, **2.99**
(3) 12VDC Magnetic Buzzer. A more pleasing tone! #273-026 .... **2.19**
(4) "Ding-Dong" Chime. Classy entry alert. 6 to 18VDC. #273-071 .... **8.99**

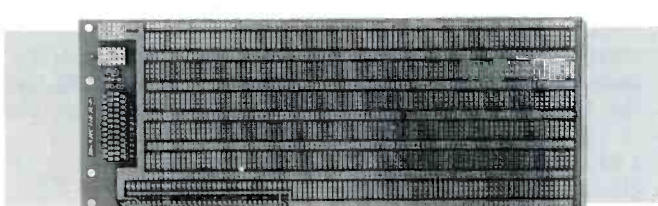


(1) Coiled 6-Ft. Test Leads. Why put up with tangles? #278-750 .. **Set/4.99**
(2) Posts to BNC. #274-715 .... **8.95**
(3) Posts to Bananas. #274-716, **4.95**
(4) Stackable Dual Inline Banana Plug. Versatile! #274-717 .... **2.99**
(5) 6-Ft. BNC-to-BNC. #278-964, **5.99**

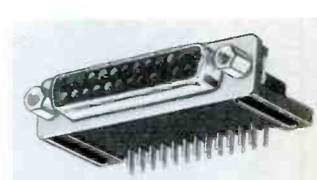


IC Inserter/Extractor Kit. Why risk bending or breaking pins on expensive chips? This kit makes it easy to install and remove any DIP-style IC from 6 to 40 pins. Both tools are groundable to prevent static "zaps". #276-1581 .... **6.95**

UL-Listed DVM. Micronta® makes electronics testing a snap! Autoranging, ½" LCD digits, bar graph to spot peaks, data hold to freeze display, continuity sounder, diode-check. #22-186 .... **69.95**



PC/XT Experimenter's Circuit Card. This premium-quality prototyping board fits a computer's XT expansion bus connector. Features durable epoxy glass construction and plated-through holes on standard 0.100" centers. Accepts D-sub connector shown at right. 3⅞ x 10¹⁄₁₆ x ¹⁄₁₆". #276-1598 .... **29.95**



Right-Angle D-Sub 25 Female Connector. Ideal for use with PC/XT circuit card at left. Radio Shack also stocks a big selection of D-sub and IDC-type connectors for computer hookups. #276-1504 .. **2.49**

Since 1921 Radio Shack has been the place to obtain up-to-date electronic parts as well as quality tools, test equipment and accessories at low prices. Nearly 7000 locations are ready to serve you—NOBODY COMPARES

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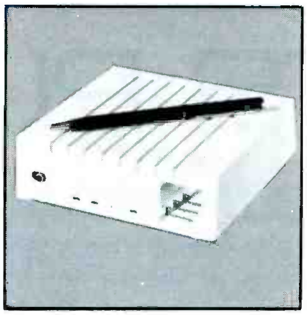
CIRCLE NO. 78 ON FREE INFORMATION CARD

Portable Hard Drives



Parallel Peripherals Technology has a new line of 2½" IDE portable hard drives targeted for the laptop/notebook market. These miniature drives weight only 1.5 pounds and measure 5" × 5" × 1.5". Installation consists of simply plugging a supplied cable into the portable computer's parallel port. The drives range in capacity from 40M to 360M and feature access time of 22 ms and data-transfer time ranging from 4M to 6M/second. Prices range from $499 to $1,999. *Parallel Peripherals Technology Inc., 260 W. Arrow Hwy., San Dimas, CA 91773; tel.: 714-394-7244; fax: 714-394-7242.*

CIRCLE NO. 31 ON FREE CARD

Windows Monitor

The ViewSonic 7E Super VGA monitor boasts a 17" flat-square screen with the image area extending from edge-to-edge and with 0.31-mm dot pitch. It supports resolution from 640 × 480 to 1,024 × 768 noninterlaced and is designed to work with XGA, UVGA, 8514/A, SVGA and VGA video control boards. It operates in any IBM/compatible or Macintosh II. Scanning frequencies range from 31 kHz to 60 kHz horizontal and 50 Hz to 90 Hz vertical. For a flicker-free image, the 7E has an ultra-high 72-Hz refresh rate at all resolutions and is FCC Class B approved. $1,199. *Viewsonic, 12130 Mora Dr., Santa Fe Springs, CA 90670; tel.: 310-946-0711; fax: 310-946-1618.*

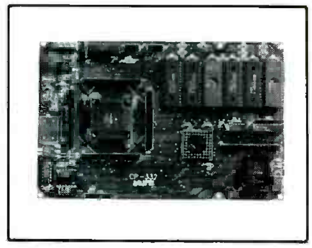
CIRCLE NO. 32 ON FREE CARD

Radio Shack 50-MHz 486

The Tandy Model 4850 EP features Intel's new 50-MHz 486 DX2 microprocessor that doubles the internal speed of the processor to 50 MHz, adding built-in math coprocessing capabilities and providing a performance gain of up to 70% over 25-MHz Intel 486-based systems. Fully configured, the 4850 includes 4M of RAM (expandable to 32M), one 3½" 1.44M floppy drive that supports 2.88M floppies, 15-ms 120M IDE hard drive with cache, Super VGA (512K expandable to 1M), mouse, MS-DOS 5.0, *Windows* 3.0, and MS *Works*. An open 5¼" bay is available for a CD-ROM drive or other peripheral. $2,699. *Radio Shack, 700 One Tandy Center, Fort Worth, TX 76102.*

CIRCLE NO. 33 ON FREE CARD

Single-Board Computer

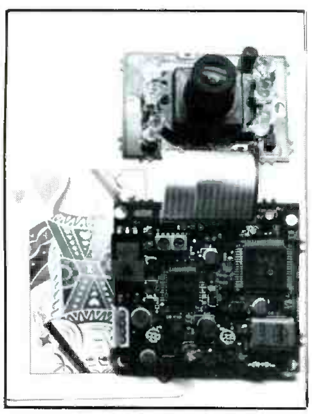


The Allen Systems CP-332, designed for process-control applications. is based on the Motorola 68332, a 32-bit microcontroller. It has both parallel and serial I/O, an optional analog daughter board and a socket for a 68881 floating-point processor. The fully assembled board features 256K of EPROM and 256K of RAM. A bare board is also available. The CP-332 measures 5½" × 8½". $750. *Allen Systems, 2346 Brandon Rd., Columbus, OH 43221; tel.: 614-488-7122.*

CIRCLE NO. 34 ON FREE CARD

Video Cameras

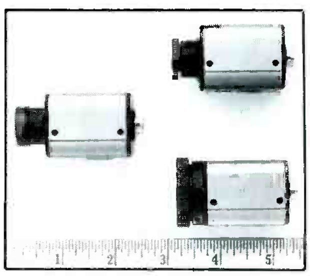
The Supercircuits PD-2ex is a micro video camera that weighs only 2.3 ounces and is less than



2" square. It produces 240 lines of resolution and features 2 to 80K lux light capability, with automatic exposure control. The camera uses CCD and VSLI technology and produces standard NTSC output. A wide-angle multi-element f/2.0 lens is included. $197. *Supercircuits, 1403 Bayview Dr., Hermosa Beach, CA 90254; tel.: 310-372-9166; fax, 310-372-0717.*

CIRCLE NO. 35 ON FREE CARD

The Chinon CX-200 family of micro video cameras is another design based on CCD technology. Measuring 2.12" × 1.38" × 1.26", the CX-200 weighs 2.64 ounces. All three versions produce 240 × 249-pixel pictures. A built-in electronic auto iris automatically compensates for lighting between 2 and 100K lux, while the electronic shutter automatically adjusts between $\frac{1}{60}$ and $\frac{1}{15,000}$ second. Versions differ only in lens



configuration. *Chinon America Inc., Industrial Products Div., 1065 Bristol Rd., Mountainside, NJ 07092-1248; tel.: 908-654-0404; fax, 908-654-6656.*

CIRCLE NO. 36 ON FREE CARD

The EDC-1000 from Electrim Corporation measures 2" × 2" × 1.1" and weighs 4 ounces and produces output of 192 × 330 × 8-bit image data into computer memory (TIFF or PCX files). Up to 30 images per second can be captured. The new EDC-1000 interfaces to IBM/compatible computers and features computer-controlled exposure time, near linear response over wide dynamic range, asynchronous image capture, time-delay-integration compatibility, direct access to frame buffer data,

and integrated software with linkable routines. $400. *Electrim Corp., PO Box 2074, Princeton, NJ 08543; tel.: 609-683-5546.*

CIRCLE NO. 37 ON FREE CARD

Improved HP PS Cartridge

The new HP LaserJet PostScript Cartridge Plus for LJ III series printers is said to provide authentic Adobe PostScript Level 2 and can switch between PostScript (PS) and HP PCL 5 modes. HP's earlier PS cartridge required that the printer be powered down to insert or remove the cartridge to switch modes. PS Level 2 offers speed and convenience advantages over Level 1. It can accept compressed data, which takes less time to transfer from the computer to the printer.

Level 2 can also speed printing of complex documents by providing separate caches for fonts, forms and patterns so that only information that changes from page to page need be interpreted by the printer. Users can access more downloadable fonts or create more complex graphics than they could previously. An upgrade path is available for owners of the earlier Level 1 cartridge. $695. *Hewlett-Packard Co. Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014; tel.: 800-752-0900.*

CIRCLE NO. 38 ON FREE CARD

Free Catalogs

For Industrial PCs

The PC Compatible Source-Book is 24 pages and has more than 400 IBM/compatible PC related products. Targeted primarily at scientists and engineers who are looking for products that offer industrial reliability at commercial pricing, it includes computers, laptops, motherboards, CD-ROM drives and numerous peripherals, all built for industrial use. *Industrial Computer Source, 10180 Scripps Ranch Blvd., San Diego, CA 92131-1298; tel.: 619-271-9340; fax: 619-271-9340.*

CIRCLE NO. 39 ON FREE CARD

PC Products Catalog

Dalco's free 76-page lists and describes such devices as PC components, power systems, networking products and accessories for disk drives, switches, buffers, cables and connectors. Dalco also makes custom cables. *Dalco Electronics, 223 Pioneer Blvd., Springboro, OH 45066; tel.: 800-445-5342; fax, 513-743-9251.*

CIRCLE NO. 40 ON FREE CARD

Instrumentation

Global Specialties' new 16-page color catalog contains listings for PC instrumentation and data acquisition products. It features virtual instruments on a card and analog and digital I/O cards for IBM/compatible computers. The catalog also contains several pages of accessory-item listings that simplify application interfacing. *Global Specialties, 70 Fulton Terr., New Haven, CT 06512; tel.: 800-572-1028.*

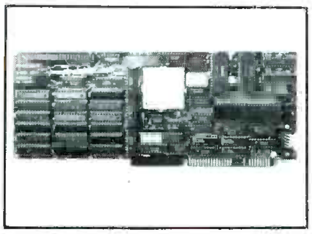
CIRCLE NO. 41 ON FREE CARD

Inexpensive UPS

The Patriot series uninterruptible power supplies from Best Power Technology feature full-time lightning and surge protection backed by UL 1449, high-voltage protection, full-time emi/rfi filtering, automatic shutdown kits and software and status indicator and alarms. 250 VA, $169; 450 VA, $279. *Best Power Technology, Inc., PO Box 280, Necedah, WI 54646; tel.: 800-356-5794; fax, 608-565-2929.*

CIRCLE NO. 42 ON FREE CARD

Hi-Fi Stereo PC Sound

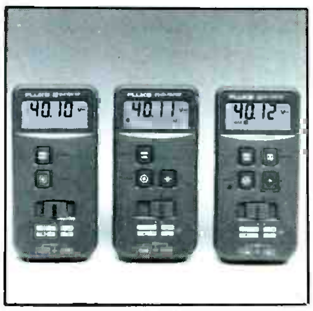


Digimetrie's PC-DSP-56K-ST is a fast audio-signal coprocessor board for IBM/compatible computers. Built around Motorola's DSP 56001 digital signal processor, it operates at 10 MIPs and has a clock rate of 20 MHz (33 MHz optional). The standard version comes with 576K RAM. Its real-time acquisition/restitution system uses 16-bit AD/DA converters. You can sample two channels simultaneously at a programmable frequency up to 100 kHz. A MIDI facilitates exchange of data with musical instruments that have compatible dialog systems.

The board's software environment can be used to readily develop applications in C and Pascal. An extensive signal-processing library eliminates the need to learn the assembly language. *French Technology Press Office, Inc., 401 N. Michigan Ave, Suite 1760, Chicago, IL 60611; tel.: 312-222-1235; fax: 312-222-1237.*

CIRCLE NO. 43 ON FREE CARD

Inexpensive DVMs



The new Fluke Series 10 multimeters measure dc and ac voltage in five ranges from 4 to 600 volts, and resistance in six ranges from 400 to 40M ohms. Model 11 adds the "V-Chek" function that automatically tells the user if the circuit is open, continuous, or if voltage is present. When the meter detects potentials greater than 4.5 volts, the meter switches from continuity/ohms to volts and displays either ac or dc voltage, whichever is greater. The unit also checks capacitance ranging from 400 μF to 9,999 μF. Model 12 has all features of Model 10/11 and adds Min/Max recording with a relative time clock. The Min/Max function records highest and lowest voltages, and an internal clock records the time when the minimum and maximum occurred during a 100-hour period. The unit will capture and provide a symbolic display of opens or shorts as brief as 250 μs. Display is 3¾ digit LCD; size is 5.55"H × 2.75"W × 1.35"D; weight is 10 ozs. $70/$80/$90, Models 10/11/12. John Fluke Mfg. Co., Inc., P.O. Box 990, Everett, WA 98206-9096; tel.: 206-347-6100; Fax: 206-356-5116.

CIRCLE NO. 44 ON FREE CARD

New Books

Encyclopedia of Shareware, 4th Edition

(Windcrest/McGraw-Hill. Soft cover. 679 pages. $19.95.)

This tome consists of a brief introduction and thumb-nail descriptions of more than 2,000 programs. The programs are arranged in over 100 categories that run from "Accounting, Billing" to "Writing and Composition Aids." In addition to a short discussion of the program, each listing includes any special requirements needed by the program and the author registration fee.

There's also a list of authorized dealers by state, as well as a glossary and cross-reference indices. Helpful? In less than a minute, I located a program that appears to be what I need for my sideline business. Several shareware vendors had told me that no such program exists. The book is well-organized and thorough. If you buy shareware, even occasionally, this one is for you.

Programmer's Technical Reference

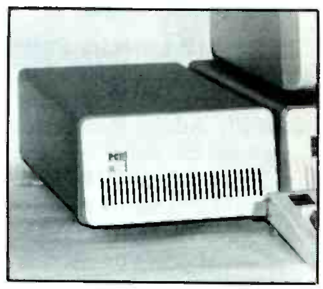
By Robert L Hummel

(Ziff-Davis Press. Soft cover. 761 pages. $49.95.)

Programmers will love this tome that covers virtually everything that they might want to know about the 80x86 processor and 80x87 coprocessor series. The book is divided approximately equally between 15 chapters and four appendices. Chapter topics include the 80x86 family, data types, processor architecture, memory structure and management, input/output, instruction encoding and timing, interrupts and exceptions, combining 16- and 32-bit code, debugging, math coprocessors, numeric fundamentals, coprocessor instruction set, processor initialization, incompatibilities and bugs, and protection and task switching. The appendices consist of an instruction set reference, coprocessor instruction reference, opcode matrix, and additional resources.

There are no obvious omissions, the book is beautifully designed with easy-to-spot subheadings, the material is logically organized, and the author's writing style is clear and easy to understand. Programmers will want this one as a wonderful technical reference they'll refer to again and again; readers with a more casual interest might be overwhelmed by it.

Expansion Chassis



PC Horizons has a new PC-XTRA with five available slots for IBM/compatibles. It has special features that make it usable with Tandy 1000 systems. To keep cost down, it uses the system power supply. The PC-XTRA SP holds any option that fits into the computers system's slots. No modifications are required to either operating system or application programs. PC-XTRA SP connects directly to the system bus. It measures 9¼" wide and has the same height and depth as an XT. $349. *PC Horizons, Inc., 1710M Newport Circle, Santa Ana, CA; tel.: 714-953-5396.*

CIRCLE NO. 46 ON FREE CARD

(Continued on page 78)

CIRCLE NO. 90 ON FREE INFORMATION CARD

Memory Management

Part 2

Memory-management resources in MS-DOS 5.0 and DR DOS 6.0 and evaluations of more-efficient add-in memory managers

Last month, we introduced you to the means by which you can move as much of software resources you use into high memory beyond the 1M DOS limit to free up as much memory as possible in the critical lower 640K for running memory-hungry applications. This time around, we conclude with descriptions of the resources available in Microsoft MS-DOS 5.0 and Digital Research DR DOS 6.0 and evaluations of add-in products that take memory management beyond what's possible with these two operating systems.

DOS Memory Services

The more-recent DOS versions have added memory-management services. DOS operating systems from Microsoft and Digital Research now have so many features that they've forced some of the products in this category out of the marketplace.

They also compete with each other on these features. While the most familiar and frequently used DOS commands are shared among DR DOS, MS-DOS and such vendor versions as PC DOS, many of the memory-management commands tend to be more different than similar. The XMA drivers required by certain PS/2 hardware, and available in PC DOS and DR DOS, but not in MS-DOS, are one case making this point.

MS-DOS's DEBUG program has several commands for mapping and allocating expanded memory that are lacking in DR DOS's SID debugger. More frequently used commands—for managing XMS, managing EMS, loading code into the HMA and loading code into UMBs—also differ, as the following examination of the two competing DOS systems shows.

MS DOS 5.0

MS-DOS memory management is divided between two drivers: HIMEM.SYS and EMM386.EXE. HIMEM provides the XMS services, and EMM386 manages EMS and upper memory. Both drivers load from the CONFIG.SYS file, and the division of memory space between XMS and EMS is fixed as the computer starts. A configuration command in DOS can be used to direct the operating system to create the link that joins the upper and conventional areas of memory and loads much of its kernel into the HMA.

The commands DEVICEHIGH and LOADHIGH load TSRs, network redirectors, drivers and basically any resident code into upper memory. Both commands require the presence of EMM386.EXE or an equivalent EMM. DOS can deliver roughly 617K (±4K, depending on machine architecture) of conventional memory by loading processes into as much as 128K of upper memory.

Switches for EMM are limited to a few common functions, such as specifying the location of the page frame and including or excluding memory ranges. HIMEM's switches, likewise, provide few alternatives—principally, XMS through INT 15 and a variety of A20 handlers to accommodate the addressing schemes of different BIOSes. DOS itself can't shadow a BIOS in RAM, but if the feature is provided by a computer's built-in logic, HIMEM.SYS can sometimes recover the memory circuits used by re-mapping them into extended memory.

In addition to its XMS and EMS memory managers, DOS provides one memory utility and a few services, scattered throughout its other commands and facilities, such as those in DEBUG. The DOS MEM command, for example, displays locations of allocated and free memory, as well as loaded programs. It can be run to check the results of a configuration change after rebooting.

Built-in MS-DOS memory managers are among the few that don't support either recovery of video memory or relocation for at least some system resources. DOS has a number of resources that take from small to moderate amounts of memory. Many managers can free additional conventional memory by relocating some of these areas to upper memory. The BUFFERS resource, for instance, requires 528 bytes for each of its sector buffers.

Larger drives may require 40 or more buffers; the DOS User's Guide recommends 50 buffers for drives over 120M. This may explain why BUFFERS is the most peripatetic of resources among managers that move them into upper memory.

Earlier versions of DOS provided a /X switch that moved these buffers into expanded memory. But /X is no longer a part of DOS 5.0. Instead, DOS 5.0 automatically moves this area into the HMA, along with the DOS kernel. The LASTDRIVE resource requires approximately 100 bytes for each drive-table entry it creates, while the FILES and FCBS resources each use about 53 bytes per entry.

Some DOS facilities do have the ability to relocate parts of themselves into extended or expanded memory. The /X parameter moves FASTOPEN's name cache from conventional to expanded memory. The /E and /A switches move the RAM disk created by RAMDRIVE.SYS into extended and expanded memory, respectively. SMARTDRV.SYS normally puts its cache into extended memory, but the /A parameter can be used to put it into expanded memory instead.

The visual MS-DOS interface, DOSSHELL, includes a task switcher that can seemingly fit several applications into memory at one time. DOS can execute only one program at a time, but the shell makes it possible to keep a number of tasks in progress simultaneously by suspending all except the one currently in use. A suspended task can later be resumed at exactly the same point at which it was interrupted. DOSSHELL also has provisions that allow you to specify the minimum conventional- and extended-memory requirements for the applications it juggles in and out of memory.

DR DOS 6.0

DR DOS's MemoryMAX feature is a set of drivers that create EMS, XMS and UBMs; provide access to the HMA; and relocate TSRs and operating-system drivers. A full range of memory-management functions is supported for 386 and 486 systems. XMS is supported for all systems with extended memory if they use any 286 or later processor. If 286 systems have Chips & Technologies NEAT ChipSet, or an AMD 286LX processor, upper memory is available.

EMS is available for 286 machines if they have an EMS 4.0 or EEMS adapter installed. To maintain compatibility with IBM PS/2s, and PC DOS, EMS 4.0 is also available for the IBM extended-memory adapter (XMA). DR DOS is compatible with *Windows*, and VCPI is also supplied.

On 286 computers, MemoryMAX uses the HIDOS.SYS driver to relocate its kernel to upper memory or HMA, access portions of upper memory on machines with supported chip sets and support UMBs on expanded-memory adapters. EMM386.SYS provides extended- and expanded-memory management for 386 and 486 computers. It can also load the DOS kernel high or into HMA, and it supports *Windows* in all modes. However, upper memory must be disabled to support *Windows* in standard mode. The EMMXMA.SYS driver supports EMS 4.0 for 286-based PS/2s with an XMA card.

MemoryMAX delivers a maximum of 627K without tapping video space. You can add as much as 96K in video addresses to conventional memory for text applications. This memory is configured by the MemoryMAX drivers, but it can be switched on and off by the MEMMAX DOS command. The MEMMAX command also enables and disables both lower conventional and upper memory.

DR DOS manages memory principally from the CONFIG.SYS start-up file. The configuration command, HIDOS, directs the system to load as much of the kernel as possible into upper memory. HIDEVICE and HIBUFFERS load system resources there. HIINSTALL loads TSRs high.

Two more DOS commands are available for memory allocation. HILOAD is the equivalent of the HIINSTALL configuration command, except that it's used from the command line. Similar to the Microsoft version, the DR DOS MEM command displays memory statistics: how much of each type of memory is available and details on the processes using it. It can be run after rebooting to check the results of a new configuration.

Because it's an operating system, DR DOS can also provide some memory-related services. For example, it can use memory management to do a single-pass DISKCOPY or DISKCOMP on a computer with only a single floppy drive. Its task switcher preferentially uses available extended or expanded memory over slower disk space. There's also an interactive CONFIG.SYS that allows you to have multiple memory-management configurations. Of course, you can also add this feature to other versions of DOS with add-on utilities like BOOTCON from Modular Software Systems 1-800-438-3930.

This DOS allows both its operating-system kernel and TaskMAX task switcher to run from either UMB or HMA. The DR DOS task switcher further helps exploit memory resources by managing up to 20 tasks from either the command line or a graphical shell. If there's insufficient extended and expanded memory, DOS swaps background programs to a mass-storage device.

Product Reviews

QEMM-386 6.01, $99.95
Quarterdeck
150 Pico Blvd.
Santa Monica, CA 90405
Tel.: 213-392-9851
CIRCLE NO. 107 ON FREE INFORMATION CARD

QEMM provides XMS and EMS services. Both types of memory are shared dynamically from a common pool. Its memory manager replaces both HIMEM.SYS and EMS providers like *Windows*' EMM, EMM386.SYS. It replaces HIMEM.SYS, but it can work with it if necessary. As an example, it can access memory beyond 16M on Compaq computers. (This requires Compaq's version of HIMEM.) It supports all three forms of the XMS: UMB, HMA and EMB.

Quarterdeck's memory manager fills unused regions of upper memory with UMBs for loading TSRs and drivers high. It recovers shadow RAM provided by Chips & Technologies LEAP, NEAT and SCAT ChipSet and equivalent Top Memory (Top384) in Compaq and Compaq compatibles from Micronics, Trillion and others. If upper addresses are unpopulated, *QEMM* shadows BIOS code into mapped memory.

QEMM keeps a library of Microchannel adapters that it uses to configure upper memory in IBM PS/2 machines. It also backfills conventional memory. *QEMM* supports *Windows* in all modes, including standard mode, but you can also disable its built-in EMM and use it with an external substitute like EMM386.SYS—without losing its other features. It also supports applications with VCPI.

Not only does *QEMM* load TSRs and device drivers high, but also most DOS resources: BUFFERS (DOS 4 excepted), FILES, FCBS and LASTDRIVE. Unfortunately, only those drive-table entries used with the DOS SUBST command can be loaded high.

QEMM installation includes a choice between loading upper memory manually or with its OPTIMIZE utility. OPTIMIZE tries to determine what TSRs and drivers can be loaded high and then where it's best to locate them. Installing *QEMM* automatically revises the CONFIG.SYS, AUTOEXEC.BAT and nested files and optionally creates a separate "response file" that substitutes for direct changes to those files. The response file allows changes to be made for nested batch files that can't be changed directly (public batch files on networks, for example).

The forgoing notwithstanding, this program offers so many alternative configuration scenarios that you many find yourself wanting still more automation.

One of *QEMM*'s options, SQUEEZEF, extends UMBs into the EMS page frame while programs load high. Like the 386MAX FlexFrame and QMAPS Load-extend features, this scheme allows excess code to temporarily load into the EMS page frame during TSR installation.

If you need still more upper memory space, there's STEALTH, a feature newly added in Version 6. Quarterdeck claims that its STEALTH technology can reclaim 20K to 115K of memory address space from the system BIOS area above F0000. Some of this may be in areas that simply contain no code or data, but there are frequently one or more areas that aren't used after a computer boots.

STEALTH comes in two flavors. STEALTH F is closest to the technology in *NETROOM*. An EMS page frame must be present to access the BIOS. Like NETSWAP(4), STEALTH F places a page frame over a memory area and switches between two sections of memory, as required. Since STEALTH F maps the EMS page frame over a BIOS area (the video BIOS at C0000), you have to re-map memory every time an interrupt call occurs. STEALTH F copies the BIOS into the page frame and makes the BIOS visible there. Then it puts EMS back.

The F option is a little faster than the M option, but has more compatibility issues. If it doesn't work, STEALTH tries to use its M mode. STEALTH M leaves the BIOS in place, maps UMBs over it and then uses 386 translation tables to bank switch between the UMBs and BIOS.

With STEALTH, *QEMM* can recover up to 620K of DOS-program area under DOS 5.0. Total upper memory available for TSRs and drivers may reach 211K. Quarterdeck says this configuration can give *Windows* an extra 8K-24K of memory. QEMM can only recover about 570K of conventional memory from DOS 4.0, but it adds the same 211K of upper memory and recovers the 64K of HMA that DOS 5.0 uses.

QEMM can add unused video regions to conventional memory—704K, with the 64K below the VGA/EGA monochrome region, or 736K, with the 96K below the EGA/VGA color-text region. The VIDRAM command provides this memory, depending on monitor type, and only if a VGA or EGA adapter is installed (RAM must occupy the addresses). Once installed, it traps and prevents attempts to change from text to graphics modes. This inhibits crashes, yet still allows you to manually switch modes.

There's an OVERRIDE modifier for VIDRAM that lets you use mapped memory, too. However, while OVERRIDE and its own additional options let you precisely control VIDRAM, they also make it a little more complicated. In addition, *QEMM* allows you to optionally LINK free upper memory to the conventional memory space when needed and UNLINK it when no longer required.

Another utility, EMS2EXT, can switch between expanded and extended memory to provide access to EMS handles for older extended-memory programs like VDISK that can't directly access addresses above real memory. They acquire extended memory logically through BIOS calls to INT 15 (the original cassette I/O interrupt), and the EMS page frame can provide the required access. Programs that use the XMS or VCPI don't need EMS2EXT (for example, *NETROOM* EMS2EXE). *QEMM*'s XMS.COM program can configure the EMS handle "EMS2EXT" on-the-fly for use by EMS2EXT.

Quarterdeck includes three utilities that provide diagnostics: Manifest, QEMM.COM and LOADHI. They can help you to optimize manual installation of the memory manager and diagnose memory conflicts.

QEMM.COM switches on and off memory manager QEMM.SYS from the command line. However, from either the command line, using option parameters, or from within Manifest, via its easy menu system, it provides a number of reports on the first megabyte of memory. The Summary report includes the status of the memory manager, amount of available EMS and location of the page frame. The Type report lists memory areas and their sizes and uses. The Accessed report indicates regional read and write activity.

Data for the Analysis report are collected dynamically by *QEMM* while applications run and actually access memory. It suggests which areas of memory should be placed in INCLUDE and EXCLUDE statements and which are available for use. The Memory report shows how the manager has allocated all of the system's memory to conventional, upper and expanded memory. Except for Summary and Memory, all reports are available as either lists or memory maps.

In addition to *QEMM* reports, Manifest lists conventional and upper memory regions, including the category of program code or system features that reside in each. It also lists specific hardware features, CMOS contents, drivers and memory-management commands that are found in the start-up files.

The LOADHI command (used to load program code high) also produces a report that breaks upper memory into address ranges. It lists the addresses in use, what code is loaded at each and how much memory remains available for loading additional code. It can quickly suggest where to load a program or reveal why something might have failed to load.

QEMM is available by itself, but it also comes bundled with Quarterdeck's *DESQview* operating environment as *DESQview 386*. *DESQview 386* provides virtual-machine abilities similar to those provided by the *Windows* environment.

If options give you a thrill, nothing has more than *QEMM*. There are enough to make you dizzy. It should come as no surprise, then, that QEMM's documentation is good enough to help you understand the competition's products. Exceedingly complete, and almost uniformly clear, perhaps two of its paragraphs demand an inordinate amount of inference. But they're for obscure features of interest principally to programmers who understand them. Of course, compatibility and robustness are also issues. Radical solutions entail more risk. *QEMM*'s broad array of options is important because it gives you many chances to play with the tradeoffs.

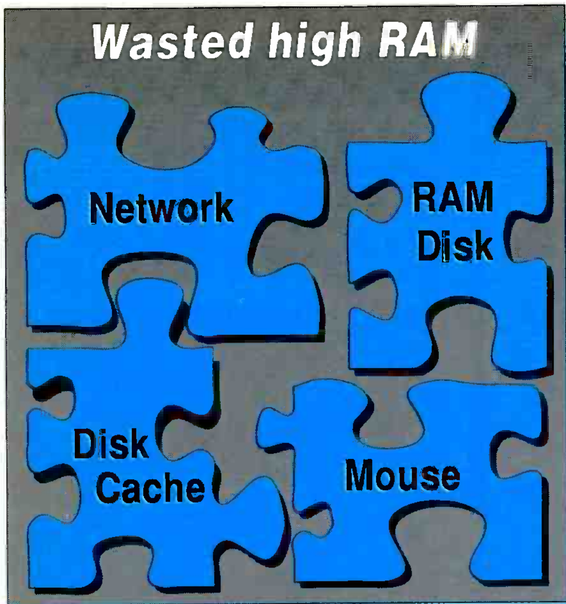
386MAX Version 6.0, $99.95
BlueMAX, $124.95
ASQ 1.3, $5 fee or
On Compuserve: GO PCVENA
Qualitas
7101 Wisconsin Ave., Ste. 1386
Bethesda, MD 20814
Tel.: 800-733-1377 or 301-907-6700

CIRCLE NO. 108 ON FREE INFORMATION CARD

386MAX provides XMS and EMS services, allocating all memory dynamically from a common pool (shared-memory allocation). It can replace HIMEM.SYS, EMM386.EXE (the DOS 5.0 EMM) and EMM386.SYS (the *Windows* EMM); provides UMBs for loading TSRs and drivers high; provides optional instancing; backfills conventional memory; and supports applications with VCPI, DPMI and VDS. The company claims that it's the first utility to provide DPMI host services for DOS applications.

Furthermore, *386MAX* increases the contiguous UMB area by re-mapping a VGA BIOS from C0000 itself, rather than allowing a built-in shadowing feature to move it to E0000. Its backfilling can increase conventional memory to 704K, with the 64K below the monochrome buffer, or to 736K, with the 96K below the CGA buffer. However, it doesn't allow you to switch these for use with monochrome and color-text VGA applications.

It can alternately recover the 32K mono-



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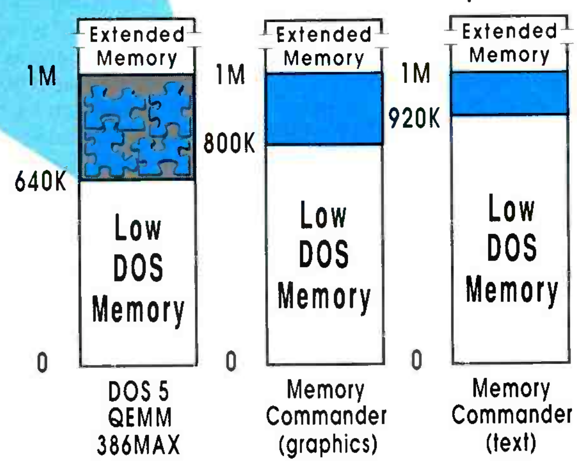

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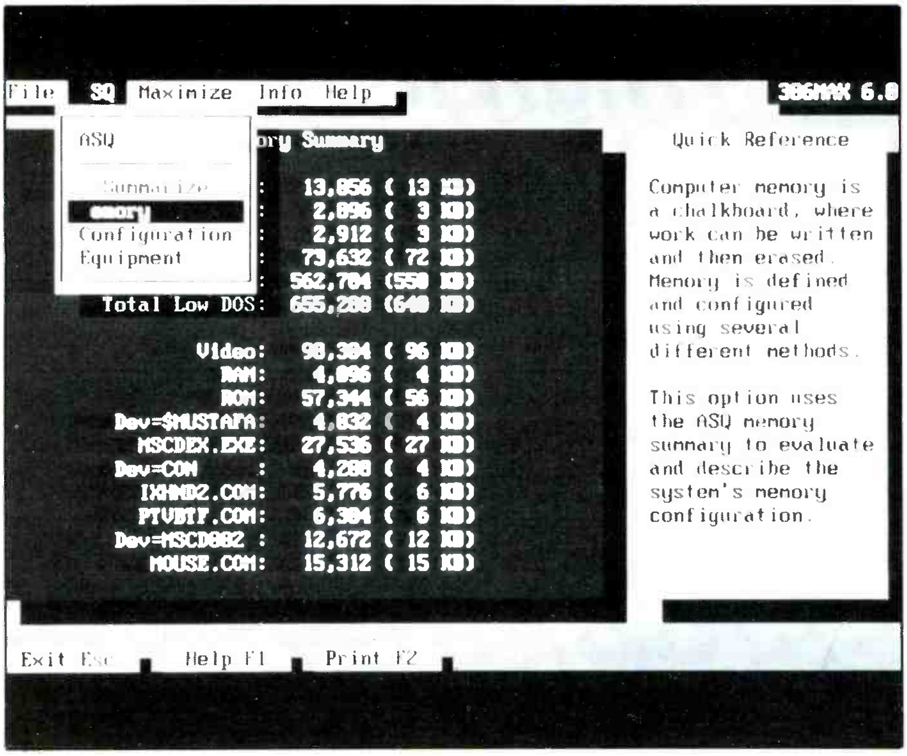


Status screen for Qualitas' "386MAX" memory manager.

Facts Box

DR DOS 6.0
Digital Research
Box DRI
70 Garden Ct.
Monterey, CA 93942
Tel.: 408-647-6675

CIRCLE NO. 109 ON FREE INFORMATION CARD

MS-DOS 5.0
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
Tel.: 800-323-3577 or 206-882-8080

CIRCLE NO. 110 ON FREE INFORMATION CARD

MS-DOS 5 Installation & Optimization Video Course
Microsoft University
10700 Northup Way
Bellevue, WA 98004-1447
Tel.: 206-828-1507

CIRCLE NO. 111 ON FREE INFORMATION CARD

chrome area at B000 for upper memory if the VGA BIOS can be placed elsewhere. It can shadow both system and video BIOS in extended memory. If a computer has Chips & Technologies or Compaq-style top memory shadowing, *386MAX* will optionally recover that RAM for its pool. Another feature, Virtual High DOS, allows you to reuse the same free UMB memory in every *Windows* 3.0 DOS session. Also, *386MAX* automatically locks out instancing of cache programs.

MOVE'EM, Qualitas' 286 memory manager, has been rolled into *386Max* with 6.0. It provides management through Chips & Technologies' ChipSets. Or it works on any PC, including 8086-based systems, with an EMS 4.0 adapter. Owners of *MOVE'EM* (or earlier versions of either MAX can upgrade to the new MAX for under $30.

One of the things that sets *386MAX* apart is its suite of utilities. They're integrated by MAX, the menu-driven shell, and include: an automatic installation program and an update installer; STRIPMGR to undo the work of the installers; 386UTIL for mapping memory; the Qcache upper-memory disk cache; the 386DISK RAM disk; ASQ, a combination system analyzer; Maximize for optimizing installation; and the STEALTH-alternative, ROMSearch, for recovering unused sections of ROMs.

Some of these utilities are obviously intended to aid in installation when automatic installation isn't satisfactory. ASQ 1.3 reports on all types of memory, as well as on how programs are using each. It also reports on the processor, video system and other relevant hardware. It includes a tutorial on memory management, as well as SnapShot, a utility that records instantaneous system information. Incidentally, ASQ is also distributed free by Qualitas. Anyone who wants a copy can obtain it through Compuserve, users groups and bulletin boards or directly from the company (by paying a nominal shipping and handling fee).

Maximize is one feature that you'll use during every installation if you load programs high. It analyzes start-up files; finds TSRs and drivers and the best region to load modules when UMB space is fragmented; determines the optimal for loading modules into upper memory; and modifies the start-up files, including CONFIG.SYS, AUTOEXEC.BAT and nested batch files.

Automatic program re-ordering can increase the number of applications that will fit in UMB space because TSRs can take much more room to initialize themselves than they do to remain resident. For example, FASTOPEN requires approximately 60K to initialize itself but reduces to a resident size of about 2K. If it follows a program that leaves less than 60K, it can't install itself, even though it needs only 2K to run. By installing it before other programs reduce available UMBs below 60K, it may be possible to load as much as 58K of additional TSRs after it.

386MAX further stretches memory while loading programs high with a feature called "FlexFrame." Like the *QMAPS* Loadextend and *QEMM* SQUEEZEF features, FlexFrame gives programs temporary use of the EMS buffer during initialization.

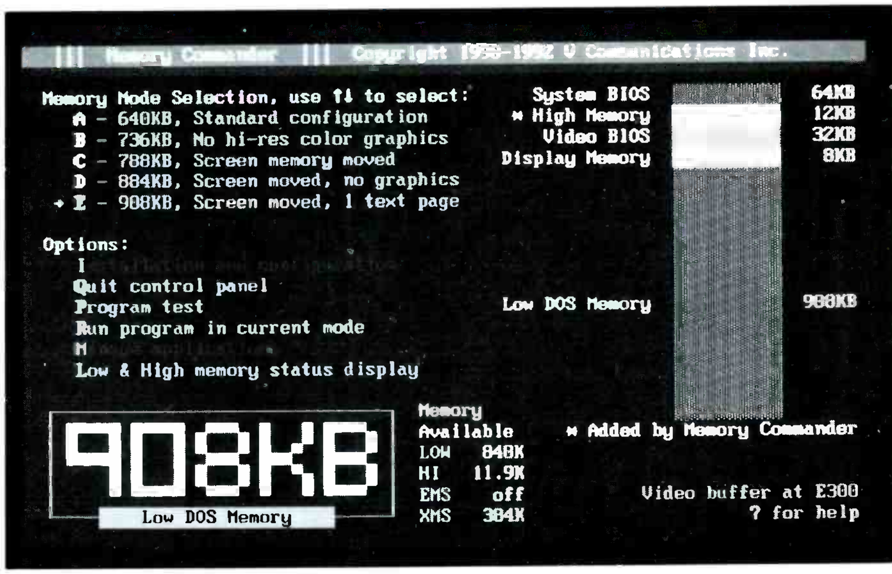
ROMsearch may not work for every system, but like Maximize, you'll want to give it a try. It tests all areas of system ROM, and anything that's not used—-POST, filler, other diagnostics and setup program—is recovered. However, BIOS services aren't re-mapped to areas of extended memory, as they are in some other managers. This is because, Qualitas states, that doing so can cost a 10% or more performance hit. Also, accessing BIOS without going through system interrupts can cause conflicts. Instead, fragments are recovered in-place. This works if Maximize can find the right-size application to fill each hole. The maximum amount of space *386MAX* provides for a VGA-graphics system is 224K of UMB and 640K of conventional.

The bigger advantage of *386MAX* is rock-solid reliability. Qualitas restrained ROMsearch to better serve network environments. As a result, ROMsearch doesn't change the BIOS location, and it may not recover as much BIOS area as some technologies, but its recovery mechanism isn't likely to cause a crash, either. Qualitas also has an unqualified advantage for some developers. If you want memory-management for Borland's protected-mode debugger, the MAX products alone are compatible.

BlueMax has all of the *386MAX* features, including the ability to read IBM's Microchannel Architecture (MCA) Adapter Description Files (ADFs). This information is used to run Adapter Description Programs (ADPs) that configure the PS/2's adapters for optimal exploitation of upper memory.

BlueMAX also takes all the areas you don't need out of the 128K PS/2 BIOS. You're typically left with just 40K of BIOS, and that's compressed to the top of upper memory. The rest is recovered for UMBs. Compatibility is ensured by maintaining a compression file for each version of PS/2 BIOS.

BlueMAX has been optimized for 386 and 486 PS/2s. As a result, it's well-suited to them. Microsoft says you can get a total of 865K real memory on a PS/2 model 70 running DOS 5.0; 621K conventional and 244K UMB. The PS/2 BIOS-compression files in *BlueMAX* are also highly reliable, making *BlueMAX* a good choice for LANs. And *BlueMAX*, like *386MAX*, can be used with Borland's protected-mode debugger without a problem.



Status screen for V Communications' "Memory Commander" memory manager.

Memory Commander 2.11, $99.95
MegaMiser, $99
V Communications
4320 Stevens Creek Blvd., Ste. 275
San Jose, CA 95129
Tel.: 800-648-8266

CIRCLE NO. 112 ON FREE INFORMATION CARD

Like other utilities in this class, *Memory Commander* provides typical EMS and XMS services. It loads TSRs, drivers and pre-DOS 4 DOS BUFFERS into UMB memory; provides optional instancing for TSRs and drivers; supports programs with VCPI and VDS; and provides additional contiguous main memory. It also offers a few of its own extras, some of which have already been mentioned. In addition, it provides shadow RAM from extended memory.

Memory Commander can further boost performance with its own video accelerator. It uses extended memory to backfill main memory to a full 640K if the appropriate low addresses aren't physically filled with RAM. Both its own RAM disk and a replacement for the ANSI.SYS console driver are built-in.

What really makes *Memory Commander* different, though, is the way you use it. Under normal circumstances, *MC* isn't manually configured like other memory-management software, even to customize it. And you never have to edit a CONFIG.SYS or AUTOEXEC.BAT statement to include or exclude regions of memory. The program does this automatically through a special control panel, after installation.

The control panel lets you add each TSR or driver to a built-in database that specifies the location where code is to be loaded and other requirements, such as *Windows* instancing, for example. If you must make a rare change for something like a network driver, it's made using the control panel's menus.

Because it's installed before you configure it, *MC* is able to walk you through trial-and-error tests that determine the optimal mode for running each application you use. Once you make a selection, based on those test results, and put it into the database, *MC* automatically allocates one of five memory models to the application whenever it runs. You don't need to run a utility before or after an application, and you get the greatest amount of memory possible for each.

Memory Commander's five operating modes provide from 640K to 920K of conventional memory for a VGA system. For a VGA-graphics application, V Communications asserts, you can generally improve conventional memory to 700K and still have 100K of UMB space. *Memory Commander*'s best case is 896K for VGA and 928K for CGA. If you're only running text mode, it adds another 24K to either of those figures giving *MC*'s largest model. This is a whopping 952K of main memory—more than any other memory manager! However, if an application writes directly to the video buffer, some modes have a performance penalty. Obtaining optimum performance may require switching to 640K of conventional memory.

The next version of *MC*, 3.0, is expected to add a feature similar to Quarterdeck's STEALTH, called "virtual ROM" (V-ROM). Both technologies hide almost all of the BIOS. Whenever the BIOS is required, either switches to the ROMs or to shadow RAM in extended memory, if implemented. There's a significant difference in how the code is accessed, though. V-ROM uses protected mode to directly access the moved BIOS code. You don't need to tie up 64K for the EMS page frame. If you don't require EMS, you're free to use the area for more TSRs, drivers or conventional memory.

V Communications is also preparing to ship a hardware memory-management product for the 286. At $99, the *MegaMizer* can compete against motherboard upgrades for a range of machines.

Memory Commander benefits have a good fit at both ends of the user spectrum. Due to its menus, standard memory models, simple trial-and-error tests, bootless memory reallocation and excellent documentation, *MC* is among the better choices for novice users. Program development is another noteworthy application for it.

Since compilers are text-based applications and tend to use DOS services and BIOS calls, they can benefit from the huge conventional-memory models this utility provides and still give full performance. In some cases, developers may have no alternative for acquiring needed space.

NETROOM 2.1, $99
HEADROOM, $129.95
Helix Software Co.
4709 30 St.
Long Island City, NY 11101
Tel.: 718-392-3100

CIRCLE NO. 113 ON FREE INFORMATION CARD

NETROOM has just about as much control over memory as you can get. It replaces HIMEM.SYS for XMS and HMA memory. It also provides both UMB and EMS memory. TSRs, drivers, DOS BUFFERS, DOS FILES and COMMAND.COM can be loaded high using revisions to the CONFIG.SYS and/or AUTOEXEC.BAT files.

The program runs on 386 and 486 machines, 286 computers with a Chips & Technologies NEAT ChipSet and any machine with EMS hardware, including old EMS 3.2 boards. (Not all features are supported for EMS 3.2 hardware. The CUSTOMIZE function and creation of UMBs both require EMS 4.0 or built-in support from a processor or ChipSet.) *NETROOM*'s RAM-MAN/386 utility provides EMS services on any 386 and 486 and any 286 with the Chips & Technologies NEAT ChipSet.

You can also load drivers and some TSRs with NETSWAP4. Helix says that "loading out" (that is, using NETSWAP4), combined with loading high, can give you a total of at least 704K for TSRs and drivers (776K with BIOS compression, 800K with compression and monochrome video).

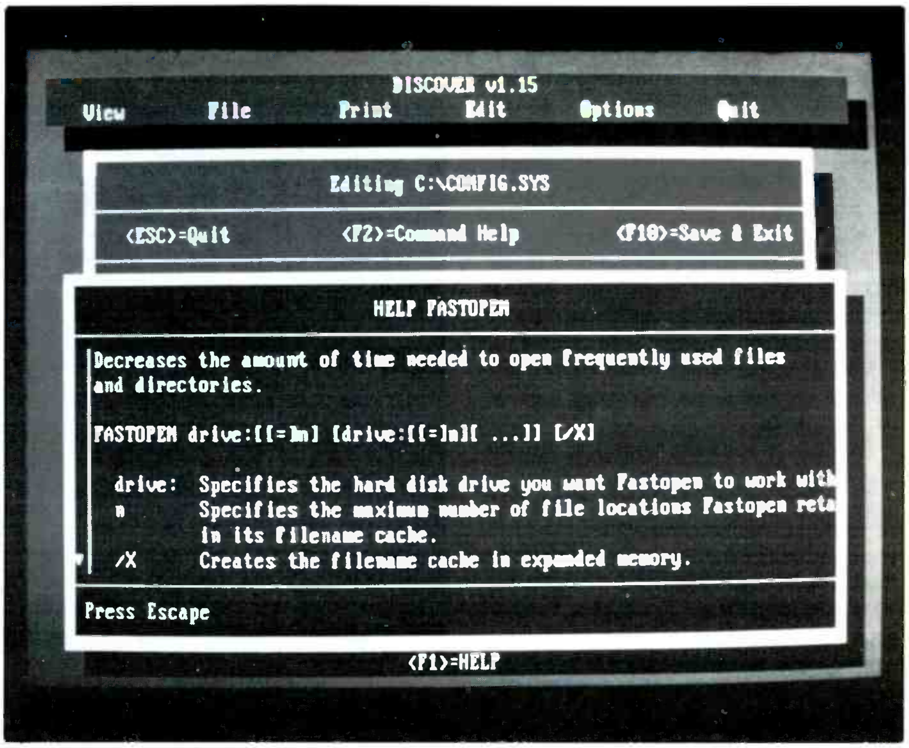
Does this mean you can have more than 1M of DOS-addressable real memory? Surprisingly, if you're willing to pay a performance penalty, the answer is yes. You could run PC Tools, NetWare and a CD-ROM drive without using any conventional space.

The virtual machine created by NETSWAP4 (or NETSWAP, a 64K version for EMS 3.2) also gives *NETROOM* the ability to load drivers high from the command line instead of from the CONFIG.SYS file eliminates the need to reboot when adding to a configuration.

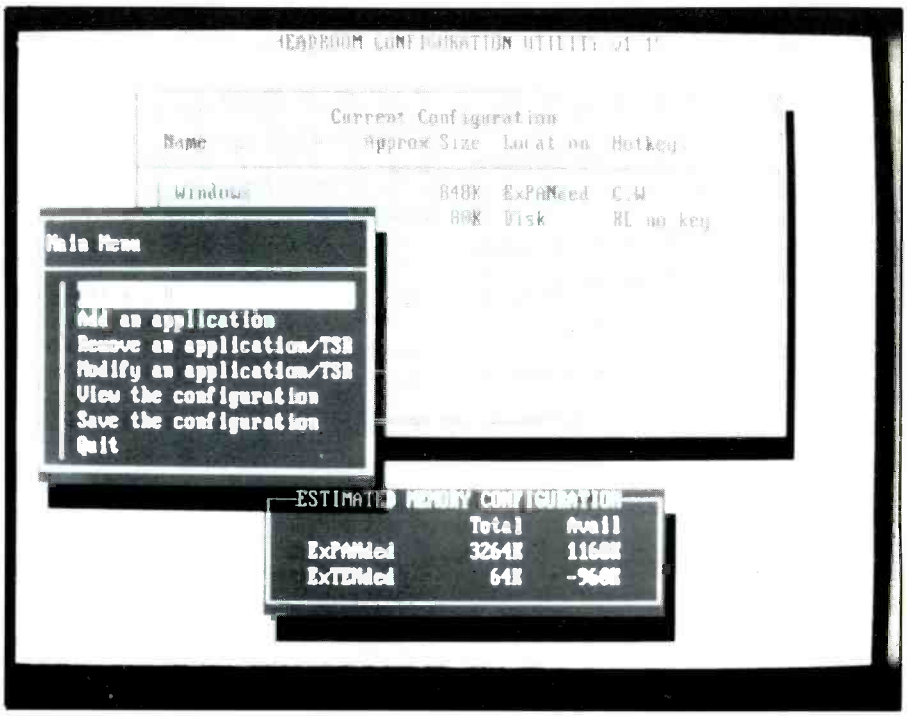
NETROOM can be installed automatically, and it normally allocates all memory from a shared pool. But a vast array of parameters alternately allows you scalpel-like precision in controlling memory resources. Sometimes that's necessary. For example, *NETROOM*'s RAM-MAN/386 retains some control over UMBs in *Windows*' enhanced mode. As a result, it's recommended that XMS, not EMS, be used to load high when running enhanced mode. Its tools permit you to do this. It's fortunate that, although *NETROOM* is a very technical product, its documentation is, largely, quite readable.

Automatic installation is rather sophisticated. *NETROOM* ferrets out not just the TSRs and drivers in AUTOEXEC.BAT, but also those in nested batch files. Its DISCOVER module provides both a memory map and an editor for modifying CONFIG and AUTOEXEC files. You can use it to find available memory regions and add them to UMBs in XMS or EMS memory. If a computer has an EMS 4.0 card or hardware shadow RAM, DISCOVER can recover those memories, too. *NETROOM* claims to be more clever than most EMMs at excluding such areas as hard-to-detect token ring cards.

EMS frames are automatically created



Helix Software's "Netroom" memory-manager Discover screen.



Helix's "Headroom" Configuration Utility screen.

for RAM-MAN/386 by the CUSTOMIZE routine. CUSTOMIZE automatically finds the optimum fit for loading TSRs and drivers high and places the required commands into the AUTOEXEC.BAT and CONFIG.SYS files. It also exercises the system BIOS and finds areas that can be recovered for UMBs. As a result, *NETROOM* frequently compresses the BIOS down to 32K. Under DOS 3.x or 4.x, it then moves the system BIOS, together with the 32K of video BIOS, into HMA. This gives you an additional 96K of UMB.

You have a choice with DOS 5.0, since it can also be loaded into HMA, and HMA can hold only one program. Of course, you want to conserve as much memory as possible. Therefore, load the larger program into the HMA and the smaller high. On systems without VGA BIOS, DOS 5.0 is bigger; so the system BIOS is automatically moved into UMBs. If DOS 5.0 is smaller than the combined system and VGA firmware, move DOS into upper memory.

As a third option, *NETROOM* will place other drivers, such as bus-mastering drivers that can't operate in upper memory, into the HMA. Either load strategy leaves only 32 bytes (not K bytes, just bytes) of reserved upper memory for the DOS reset vector.

QEMM and *MC* also leave the jump table in addition to the reset vector. But Helix avows it's never encountered a complaint about a program failing because modern programs use interrupts instead of the jump table. Helix even does it on PS/2s, but the software turns off BASICA automatically, unless you override it. (IBM's built-in BASICA is the principal jump-table user.) Helix has named this compression-and-relocation technology "Quantum."

For 286 machines that don't have appropriate chip sets, *NETROOM* includes an EMS2XMS utility that creates UMBs for DOS 5.0 by using an EMS adapter. EMS2XMS is required with such a hardware configuration only if you want to use the DOS LOADHIGH and DEVICEHIGH commands, but not if you want to use *NETROOM*'s XLOAD.

Conventional memory can be backfilled to 704K for monochrome or 736K for CGA, but only on systems using these adapters. This curb on adapters is imposed by one of *NETROOM*'s few handicaps. This is the lack of a utility to restore memory to the video buffer when switching applications between text and graphics modes on an EGA or VGA adapter. The program can also move a 32K VGA BIOS, usually at C0000, to B0000. Such a move can interfere with some super-VGA graphics, it but won't cause the system to bomb. *NETROOM* prevents this by marking the memory-translation tables as read-only.

NETROOM has been designed with networks in mind—literally. As a result, it's a good choice for workstations. It provides roughly the same conventional memory as most other managers. In addition, it can provide a huge amount of EMS memory for relocating even the largest network redirector into its virtual mind. This means more conventional memory is actually free for application software.

Its smaller VM can sometimes run the relocated code with no performance degradation, despite providing a second upper-memory space. (There isn't a performance loss if programs and drivers in UMBs don't communicate directly with the network driver or other drivers in the VM.) There are other options for networks and plenty of advice, including a special appendix.

Maximizer 3.3, $49.95
Max8, $149
Softnet Communications
15 Hillcrest Dr.
Great Neck, NY 11021
Tel.: 516-829-2977

CIRCLE NO. 114 ON FREE INFORMATION CARD

Maximizer provides UMB management that can load TSRs and drivers into upper memory and provide optional instancing of them. It can also load the DOS BUFFERS high. It doesn't provide EMS services, however. Nor does it replace HIMEM.SYS; rather, it works in conjunction with it to actually map XMS into UMBs.

Maximizer also reclaims unused video buffer area as main memory: 64K video for monochrome, 96K for CGA and color text. It can shadow BIOS ROMs in extended RAM, too. Lastly, *Maximizer* maps out unused ROM code and replaces it with RAM. Individual maximums are 736K of conventional memory and 256K of UMB. (Note that these maximums aren't available simultaneously; maximizing conventional memory takes 96K from upper memory.)

For those exceptional programs that know how to use them, *Maximizer* also supports memory control blocks (MCBs) that are basically UBMs that DOS maintains in a linked list. MCB-aware applications software like *FoxBase+* can use them as additional data space.

This utility does everything from the AUTOEXEC.BAT file, not CONFIG.SYS like most of the competition. As a result, you don't have to restart the system to change a memory configuration. Unfortunately, there's no method of unloading. It doesn't have automatic installation but does have an interactive menu that allows you to experiment and on-line help. Once configured, you set it permanently.

Maximizer also works on 286 systems with a Chips & Technologies NEAT or SCAT ChipSet to provide high loading into physical memory at UMB addresses. Systems without these logic chips can use SoftNet's proprietary Max8 board ($149 with software). The current version of *Maximizer* doesn't support either VCPI or DPMI and, thus, can't coexist with programs like Lotus *1-2-3* Version 3.1. However, DPMI Version 0.9 will be included in *Maximizer*, beginning with Release 3.0.

Maximizer's low overhead of just 47K is a big advantage on small-minded machines. All but 500 bytes is loaded into extended memory. Its documentation is quite clear and includes a number of examples for network users. Finally, its lack of an EMM (and ability to work with HIMEM.SYS and EMS386.SYS) actually offers a compatibility advantage with *Windows*.

QMAPS, 2.0, $99.95; net license, $99%
UMB Pro, $79.95
Quadtel Corp.
3190-J Airport Loop
Costa Mesa, CA 92626
Tel.: 714-754-4422

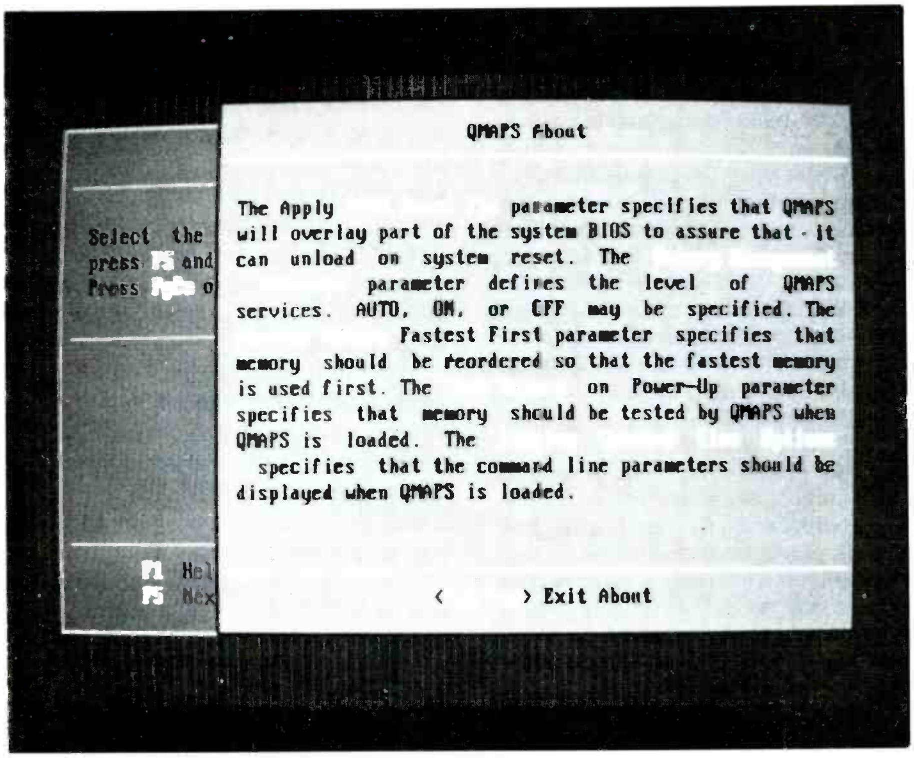
CIRCLE NO. 115 ON FREE INFORMATION CARD

QMAPS gives full EMS and XMS services with some choices. You can have either a shared pool from which both types of memory are allocated automatically or individual memory resources for each. It can completely replace HIMEM.SYS or defer to it, as you prefer. The utility's principal memory functions let you load TSRs and drivers into UMBs. It can also provide shadow RAM in extended memory, if required—not only for video and system BIOS, but for any adapter-card BIOS that isn't bridled by its timing.

Both VCPI and VDS are supported. *QMAPS* supports shared-memory allocation, which is compatible with *Windows*' enhanced mode, but it isn't compatible with *Windows*' standard mode. (Many EMM programs, including the EMM386.EXE shipped with DOS 5.0, aren't fully compatible with *Windows* in this mode.) In *Windows*' real mode, it supports only large-frame EMS.

Unused video-buffer areas can be moved to conventional memory by *QMAPS* to provide 704K (monochrome) or 736K (CGA or color text). Or the buffers can be used to provide additional UMB areas: 32K for either monochrome or color monitors attached to EGA or VGA adapters. The QMAPS.EXE control program moves video buffers when the video mode changes, provides a map of memory and controls EMS support and other features.

QMAPS has a few other long jumps on its flowchart. For example, you can run a SMARTMOVE utility after the installation program to do an analysis that deter-



Information screen for Quadtel's "QMAPS" memory manager.

mines what's in conventional memory and find the best fit for loading TSRs and drivers high. Then it puts QLH (Qadtel Load High) commands into CONFIG-.SYS, AUTOEXEC.BAT and AUTOEX-EC's embedded batch files. You can also load programs high from the command line with QLH, or use it without parameters to display the memory map of a configuration.

The Loadextend feature, like the *386MAX* FlexFrame and *QEMM* SQUEEZEF features, extends UMBs into the EMS page frame while programs load high. This lets a program load into memory that's just large enough for its resident size, so long as its excess code fits into the 64K of an EMS buffer during initialization.

Quadtel is a relatively recent entrant in utility software, but it has long been building the EMS drivers that end up in computers from Tandy, Hewlett Packard, Phillips, Dell, AST, ALR, Wang, IBM and others. It's the number-one supplier of hardware EMS memory managers in the world, and its code is in system-logic chip sets from Chips & Technologies, Western Digital, Headland, TI, VLSI and National Semiconductor. This is the reason *QMAPS* can automatically recover fallow ranges from physical memory used for a computer's built-in shadow RAM. Furthermore, the company claims that its inside information gives it a performance advantage and that *QMAPS* lets programs that make extensive use of EMS functions run faster.

On the other hand, an engineering focus may also be why the manual is so tersely technical that many users are bound to have a tough time with it.

The current *QMAPS* method for recovering unused address ranges from BIOS memory space is the primitive trial-and-error use of an INCLUDE command in the CONFIG.SYS file. While *QMAPS* currently doesn't have a feature similar to *QEMM*'s STEALTH, Quadtel president Scott Daniels says, "We definitely have an answer to STEALTH," and "It is well in the works."

QMAPS comes bundled with three utilities collectively known as QUADTOOLS. They include a disk cache, RAM disk and print spooler. They have the advantage of being configurable from within the *QMAPS* installation program. Consequently, command-line parameters aren't required.

QMAPS provides fairly complete and precise control over memory resources and includes some powerful features. However, using special features or modifying its automatic configurations, requires both a degree of expertise and the ability to make a number of inferences from its documentation and text files. It also isn't a complete replacement for EMM386.EXE or EMM386.SYS, since *Windows* won't run in standard mode with the *QMAPS* memory manager loaded.

UBM Pro supports both 286 and 386 computer architectures, but it provides only UMB and XMS support (including HMA). If a system already has EMS memory, *Pro* can use it for UMBs and doesn't interfere with the operation of *Windows*. Both large-frame and small-frame EMS can be supported by it.

The principal advantage of *Pro* is that it saves 275K over QMAPSD, using a mere 2K to 4K of main memory. Like *QMAPS*, it has both the SMARTMOVE and Loadextend features as, well as QUADTOOLS. As a replacement for HIMEM.SYS, Quadtel believes its move-block XMS function to be slightly faster at copying data between conventional, or UBM, and extended memory. It also supports the fast-gate-A20 function, found on some systems, that can speed transitions to extended memory by circumventing the keyboard controller.

UMB Pro can't convert extended memory into UMB, as can *QMAPS*. It must obtain memory from shadow RAM, EMS provided by a chip set or an EMS adapter. Both shadow RAM and EMS provided by chip sets are supported by physical upper memory. It's this memory that *UMB Pro* must use if an EMS adapter isn't present.

Fortunately, Quadtel's experience in providing original-equipment manufacturers (OEMs) with EMS firmware allows it to recognize the memory capabilities of 22 different chip sets, including all C & T ChipSets, Headland's HT12 and many others. "We're a BIOS company; so we work with a lot more chips than the competition," says its company president. It's a significant advantage on 286 systems. However, you must first provide a hardware-type parameter garnered from a table located on your software distribution disk or *Pro*'s CHIPSET utility.

UMB Pro's manual configuration parameters let you make precise allocations of memory. While it's a technical product, its familiarity with a wide assortment of logic chips improves the likelihood it will support a 286 machine.

Turbo EMS 6.0, $99.95
InfoSpotter, $79.95
Remote RX, $129.95
RenaSonce Group., Inc.
5173 Waring Rd., Ste. 115
San Diego, CA 92120
Tel.: 619-287-3348

CIRCLE NO. 116 ON FREE INFORMATION CARD

Turbo EMS provides expanded memory and access to upper memory on any AT-type system, including 286 machines with Chips & Technologies ChipSets and any PC with an EMS 4.0 or EEMS board installed. It also works with EMS 3.2 boards if they have an EMS 4.0 driver.

Turbo even provides reduced services on a PC that doesn't have a board or chip set by using emulation. Only EMS services can be emulated, however. It simply isn't possible to relocate code into UMBs without a board or a chipset that implicitly has shadow RAM. Physical memory has to come from somewhere other than conventional memory. (There would be no advantage if UMBs used conventional memory.)

Many common services are provided. Among them are: TSRs and drivers that can be relocated to UMBs; ROM that can be shadowed; VCPI support; expansion of conventional memory to 736K for color-text applications (by recovering part of the video buffer); and adding to UMB any unused chunk of upper memory—including areas of the BIOS.

Turbo EMS also has some extensions. It provides menu-driven installation and configuration for 386 and 486 processors. It can optimize the fit when loading programs high. And it can run on really small machines, even old laptops that have just a pair of floppies. It requires only 256K of main memory and DOS 2.0 or later to run, and it can page EMS from any type of disk drive instead of extended memory. (As you can imagine, replacing RAM with a floppy drive provides considerably reduced performance.)

RenaSonce is still selling *Turbo EMS*, but probably not for long, according to partner Pat Bryan. "We're still developing the product as long as there's a demand for it, but we think that DOS is going to replace this category," says Bryan, who serves as VP and general manager. Most of the company's development effort is going into a new diagnostic product line that includes *InfoSpotter*, a system-diagnostic program, and *Remote RX*, a diagnostic with built-in remote communications.

Diagnostics

Infospotter, Remote RX, QAPlus, System Sleuth, Kickstart and like programs are all designed to diagnose troubled hardware. They include diagnostics that show you the memory installed in a computer and often the adapters and controllers at upper-memory addresses. Access to the latter information can be especially critical when installing memory-management software.

Some of these utilities also provide a list of the programs in memory and drivers and other processes installed in upper memory. They can be very useful when troubleshooting difficult installations and become indispensable if you configure systems for others where documentation isn't handy.

Conclusion

Despite the note of pessimism at RenaSonce, most EMM developers are going to continue evolving their products for the foreseeable future. Quarterdeck, for one, can't do without *QEMM* for *DesqVIEW 386*. (And it's about to assume additional importance with support for *X Windows* on commodity personal computers.) As for the rest, market opportunities haven't dried up yet. For one thing, memory on the next generation of personal computers will increase dramatically.

Workstations are already moving to 256M configurations. When it becomes common, much of those huge memories (by today's standards) will begin to migrate to the desktop personal computer. Advanced processors will also be on the scene. To remain a viable competitor against alternatives like OS/2, Unix, *New Technology* (*NT*), the forthcoming Pink, and others, new techniques will have to be developed for DOS. So far, as you can see, reports of its impending death have been premature.

If DOS vendors adopt more radical tools for their own arsenals, the competition will get hotter for third-party utilities. Leading developers are already working hard to stay ahead, as the current crop of products shows, and they display an encouraging breadth of creative approaches. This is always good news for users who can depend on advances in technology to produce additional features, increased reliability, more compatibility and, perhaps, even lower prices.

On the other hand, if OS/2, *NT* or some other system comes along to replace DOS tomorrow, it's a sure bet that the memory sophisticate still stands to benefit from knowledge that helps to configure memory. You have only to look at all the memory-management options that Microsoft *Windows* provides for DOS applications and ask yourself if those thousands of applications are going to go away anytime soon to determine the odds.

Yacco

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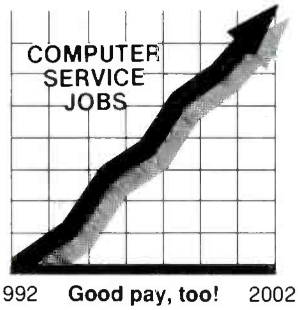

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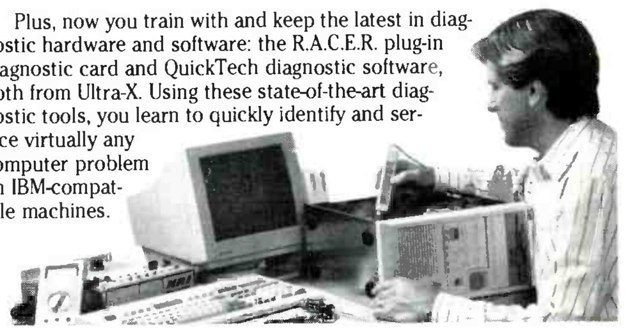

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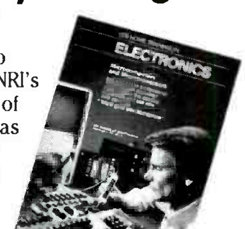

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Image Scanning With a PC

Hardware and software that dress up word-processing and desktop-publishing documents and presentation demonstrations with captured photos, line art and text

For some users, a scanner is an essential accessory. A scanner lets you "read" all or part of a printed page that contains a photo, line art or even text into your computer's memory. With support software, you can then edit a photo or line-art image captured with a scanner and save it for later merging with word-processing and desktop-publishing documents or use it to generate presentation graphics. With other software, you can have your computer read a graphics image scanned into memory and turn it into ASCII text that you can then save and use like any other text file.

For other users, a scanner is an interesting fun toy. They may use a scanned logo to create new business forms and stationery. More often, they may share images with other users on several different bulletin boards and information services. With a scanner, you can turn almost any photograph or drawing into a piece of computer art.

Even if you don't have a scanner, you've probably looked at several models at computer stores or shows and wondered how they work and whether you could justify buying one.

Scanner Types

Four kinds of scanners are commonly available. At the low end are hand-held scanners that can "see" black, white and shades of gray. Hand-held scanners usually have a sensor about 4½" (a half-page) wide. Available monochrome hand scanners are distinguished by their sensitivity, number of gray shades they can sense and amount of software included in the package.

Color hand scanners are usually a couple hundred dollars more expensive than the monochrome variety. As the name suggests, a color hand scanner can sense separate colors, usually in a single pass over the original. A few available hybrid hand scanners can scan a color image in three or four passes with the help of color filters.

Full-page or flatbed scanners look similar to an office photocopying machine. With this type of scanner, you place an original document, which can usually be as large as legal-size paper, face down on a plate of glass. An 8"- or 8½"-wide sensing arm moves under the glass to "read" the entire page at once. Like their smaller hand-held cousins, flat-bed scanners are available in both monochrome and color versions. Top-of-the-line flat-bed scanners include a page feeder so that multiple pages can be scanned and processed automatically. Page feeders are usually useful only if you're employing a scanner as part of a visual document storage-and-retrieval system or if you have a need to turn large numbers of pages into text.

Hand-held and full-page scanners are based on the same technology. As the scanner moves across the page, a special intense light illuminates a narrow strip of the original document. Next to the light is an array of sensors, usually CCDs (charge-coupled devices), that create individual voltages that signal the amount of light reflected from each small portion of the page. These voltages are converted into digital data values and sent to your computer through a dedicated interface card. Software running on the computer collects the data and turns it into an image on your screen and, eventually, into a graphics data file.

Scanner Characteristics

A scanner's resolution power is a function of the size of each sensing area. Normally, scanners have resolution selections of about 100, 200, 400 and 800 dots per inch (dpi). The lower resolutions are most useful for text and simple line drawings because flaws in the original or dust between the original and the sensor are unlikely to appear in the final image. The higher resolutions are most useful for scanning photographs and other high-quality graphics images.

A scanner's sensitivity is measured by how many different levels of gray or color values it can sense in any given document area. Most scanners have settings for text and line drawings (where each dot will be either on or off), as well as for gray-level or full-color documents. Finally, a full-page scanner's speed is measured by how quickly it can move the sensor across the page. A hand-held scanner's speed is determined by how quickly it allows you to move the scanner across the page without causing a read or data overflow error.

Because standard serial ports are too slow, most hand scanners attach to a dedicated interface card that must be installed in an expansion bus slot inside a computer. Full-page scanners either have a dedicated interface card or connect to a SCSI port, depending on specific make and model.

A little math demonstrates how fast data rates must be to make a scanner's reading speed acceptable. Let's assume you want to scan a full-page document at 400 dpi resolution. One square inch of scanned area will have 400 × 400 = 160,000 dots. An 8" ×

10″ document has 80 square inches or 160,000 × 80 = 12,800,000 dots. If you want 256 gray levels (or 256 colors), every dot will be represented by one byte (eight bits or one byte has 256 possible values). So the computer you use with the scanner will have to receive 12,800,000 bytes from the scanner. If you want to complete the scan in 10 seconds, the computer must be able to receive and manipulate about 1.2 megabytes per second.

The above example reveals another problem with scanners that many users don't think about. Data from a couple of high-resolution scans at a full 256 gray levels will soon overwhelm most data-storage devices. If you're willing to scan at lower resolution or with reduced sensitivity, the amount of data drops considerably. A 200-dpi scan at 16 gray levels or colors produces just over 1.5M of data:

200 × 200 = 40,000 dots per square inch;
80 square inches × 40,000 = 3,200,000 data points per page;
16 gray levels = 0.5 byte per dot;
3,200,000 × 0.5 = 1,600,000 bytes per page.

Many full-page scanners have the ability to do a quick scan or preview scan that displays a very rough image of the page. You can use the rough image to define the part of a page that interests you and then reduce the data requirements by seeing just that section of the page appear on the screen. If you want to copy only a small chart from a full page, there's no reason to capture the entire page first if software and scanner have a quick-scan option.

Using a Scanner

Full-page scanners are particularly easy to use. After you set one up on your desk, plug its adapter card into your computer and install the necessary software, you're all set. You simply put the page to be scanned into the scanner and run the software, and your page appears on the screen, ready for any processing you need to do.

Hand scanners are much more difficult to use skillfully. After you've started the software, you drag the scanner over the page while holding down a button usually located on the side or top of the scanner. Some hand scanners have a button you press once to scan and again to end a scan, which eliminates the need to hold down the button as you drag it down the page.

"Hand scanners are much more difficult to use skillfully."

The quality of the image stored in your computer at the end of a scan depends on whether you can move the scanner in a straight line and at a constant speed. You might think that moving the scanner over the page should be simple. If you do, try this: Place a sheet of paper on your desk; hold a pencil in your fist as if you were going to stab something with it; and place the point of the pencil at the top of the paper and pull it slowly towards the bottom. It should take you about 5 seconds to draw a line down the entire page. When you're done, use a ruler to see how straight the line really is and whether it runs parallel to the edge of the paper. When you use a hand scanner, any sideways motion or twists of the scanner will result in distortions in the final image.

If you stand up when you use a hand scanner, you'll do a much better job of producing a distortion-free image. Several companies sell plastic frames that help in guiding a scanner in a straight line over a page. Alternatively, you can use any straight-edge with a thickness of ¼″ or so to guide your scanner as you drag it across the image being scanned.

You must also start your scan above the image to be captured and end it below the image area. Uneven movements at the beginning and end of the scan that produce distortions will then be outside the area of the image you wish to capture.

If you want to scan a full page with a hand scanner, you must make two passes. You scan the left side of the page first and then the right side. You then use software to put the two halves together in a process that's sometimes called "stitching."

Keeping the scans straight and free of distortions is doubly important when you want to stitch together two scans because the software uses matching shapes in the separate scans to decide how to create the final full-page image. *CAT ImageLINKS* from Computer Aided Technology simplifies stiching together the two halves of a scanned image. It comes with a special template that's used during scanning of alternate halves of an image and then automatically matches the pattern on the template halves to seamlessly stitch them together to create a single image.

Scanner Software

Once you create an image, how you manipulate it depends on the software you use. Most scanners come bundled with software specific to the hardware. There are also a number of third-party image and text-manipulation programs you can use.

If you need to save a graphics image, the process is usually quite simple. The software will probably let you cut and erase extraneous objects that appear in the scan. It may also let you rotate, re-size or stretch the image on the screen, perform pixel-level editing, change colors and gray scales or soften or enhance the contrast of the image. Most programs either support a mouse for doing the real work or run under Microsoft *Windows*.

The most important feature in these programs, in my opinion, is the File Save command. You should be able to save a scanned image in a variety of file formats, including PCX, TIF and EPS (Encapsulated PostScript), as well as one or more compressed formats. If the file is in a popular format, you'll be able to import it easily into advanced word-processing and desktop publishing programs. If it isn't, you'll have to invest in a separate file-conversion utility before you can use the image in your applications.

> "If you want your computer to read a page as text, you need an OCR program."

If you want your computer to read a scanned page or part of a page as text, you need an OCR (optical character recognition) or ICR (intelligent character recognition) program. There's really no difference between the two. Several scanners come bundled with such a program.

Reading seems like such a natural activity to us that it's sometimes difficult to believe computers and software have a very difficult time identifying individual letters and numerals. In fact, some type styles make it difficult for a computer to tell where one letter stops and the next begins. So expect that your software will misread some characters and words, especially if you use a hand scanner.

Most modern OCR software is advertised as "omni-font," which means that it identifies characters by their general shapes, not by trying to match each character to a table of outlines. Make sure that the software you use is also "trainable," which means that you can tell it how to identify characters it finds ambiguous and that it will remember your hints at a later time.

An OCR package claimed to be 99% accurate may or may not be sufficient for your purposes. A full page of typewritten, single-spaced text contains about 4,000 characters. A program that's 99% accurate will correctly identify 3,960 of those characters, which sounds great. But it will fail to identify 40 characters. Do you really want to find and correct 40 mistakes on each page you scan? Actually, many modern omni-font packages are 99.9% accurate (four mistakes on our hypothetical page) and contain a spelling dictionary to help you find and correct errors. But nothing will help you find an error in a column of numbers or similar data.

If you use a hand scanner with typical OCR software, it may take an average of 10 minutes to scan in a page with a hand scanner, stitch together the halves, run an OCR package and proofread the page. A flat-bed scanner and OCR software are more accurate and faster because stitching isn't needed and fewer letters will be distorted and misinterpreted. High-end page scanners and OCR systems are much more accurate and can be useful in offices that need to convert a lot of paper documents to computer data formats. But you still need a trained operator to find and correct mistakes.

The moral is that scanners are very good if you want to capture images and are barely acceptable to good at capturing and interpreting text. Because of their large storage requirements, almost all scanner software packages will be a lot happier and more efficient if your computer has a large block of expanded or extended memory available, along with a lot of free hard-disk space.

Selecting a Scanner

Before you purchase a scanner, you must have some idea of how much you'll use it. If you intend only occasional use, buy a simple monochrome model. A hand scanner is great if you have a need to import small pieces of clipart or logos to add to a desktop-published document. If you need to convert paper documents to computer text, you'll be much happier with a monochrome full-page scanner and good OCR software. You probably won't need a color scanner, whether hand-operated or full-page, unless you want to import pictures into a paint program or add color clipart to presentation graphics.

When you shop for a scanner, you have only a few things to consider beyond the basic configuration. What kind of software do you want bundled with the scanner, and what are you willing to pay for separate software? If you're planning to purchase separate OCR or/and image-handling software, make sure it's compatible with your choice of scanner.

Nothing is more irritating than having to start one program to perform a scan, then start a second program to work with the scanned image. Most OCR and many image-manipulation programs have the "smarts" to work with the most-popular scanners.

Another important consideration for a scanner (any accessory, for that matter) is how it fits into your computer system. Scanners usually need a group of I/O addresses and a hardware interrupt or IRQ line. If you select a scanner and adapter board that give as much leeway in selecting both I/O addresses and IRQ, you should be able to avoid conflicts with both the boards already in your computer and with any boards you'll install in the future.

Probably the most-popular grayscale hand scanner is Logitech's ScanMan. You should be able to find it for less than $200. The best-known full-page grayscale scanner is Hewlett-Packard's ScanJet Plus, which is generally priced at less than $700. Both products have many worthy competitors; so you should find several brands from which to choose when you go shopping for a scanner.

If you need a color scanner, expect to pay $500 to $800 for a hand-held model. A full-page color scanner ups the ante to the neighborhood of $1,500 and more.

Top-of-the-line scanners designed to meet heavy OCR use demands and high-end OCR software may cost you $5,000 to $10,000, depending on your particular requirements.

Closing Thought

Scanners are a worthwhile investment for some people and just a lot of fun for many others. If you understand the limitations of current affordable technologies and are willing to accept the scanner's shortcomings, and if you have the necessary expansion slot and extra memory to support a scanner, you'll enjoy having one attached to your computer. You'll probably be surprised at how often you'll find a use for it. I particularly enjoy being able to scan images from royalty-free graphics arts books instead of buying disk after disk of clipart for desktop publishing. You may find other uses for the newest accessory on your computing desk. ■

A PC Micro-Development System

Lets you use your IBM PC/compatible computer as a microcontroller development system

The PC that sits on your desk can be used to do a lot more than what you've likely been using it for. If you're into working with microcontrollers, it can be used in conjunction with the build-it-yourself Cyber HC5 Micro-Development System described here to add another dimension to its use. With the system we're about to describe, you can directly program and evaluate your own processor designs without having to purchase expensive equipment. Based on the popular Motorola MC68HC705Cx series of microcontrollers, the Cyber HC5 makes the development process fun, fast and easy to do.

With a PC/Cyber HC5 Micro-Development System, you can develop applications limited only by your imagination and the amount of effort you're willing to devote to a project. Among the diverse things you can do is create the ultimate thermostat for your home, design a new robotics device, even design a new consumer product you might have been thinking about designing for years, to name just a few.

The Preliminaries

If you're new to the microcontroller development process, you may at first find it to be extremely intimidating. Persevere, though, and you'll soon be designing a whole battery of microcontroller applications.

The first thing you should know is the difference between microcontrollers and microprocessors. Basically, microprocessors (the so-called "brains" around which personal computers are built) use external memory. In most cases, they're designed to be used with data and address buses and other peripheral devices. Microcontrollers, on the other hand, usually have internal memory and are designed to directly interface with input and output control lines, rather than having to work through address and data bus-based peripheral interfaces.

Though some people perceive them to be limited in terms of computing ability and the number and variety of operations they can perform, these are the greatest strengths microcontrollers have to offer. By tightly coupling the internal processor directly with sensors and actuators on input and output lines, microcontrollers often provide the most cost-effective and versatile solutions to applications in real world problems.

Since you'll be using the Motorola MC68HC705C8 series of microcontrollers, contact Motorola to obtain a kit of documentation materials. Included will be product documentation and free MC68HC705C8 assembler and Programmer programs. You can obtain this documentation package by writing to: Literature Distribution Center, Motorola Inc., P.O. Box 20912, Phoenix, AZ 8036-0924. Request the Technical Data Book and Applications Guide for the MC68HC705C8. Include a SASE with postage for 1 pound of material.

The documentation you receive will bring you up to speed on the MC68HC705C8. It details some design examples based on the device and gives lots of ideas for implementing your own designs.

About the Circuit

The MC68HC705C8 was designed to "self-program," using a ROM-based "boot-strap" routine. Originally, EPROM-based microcontrollers had to be programmed with a separate, usually expensive, programmer.

Some microcontroller versions had sockets mounted directly on top of the IC to receive a preprogrammed

EPROM. The idea was simple. You developed the program code that suited your application and then plugged it onto a special version of the processor. Later, when you debugged your code, the manufacturer would transfer it into a "masked" ROM. For low-volume runs, this process was time-consuming and expensive and, thus, not very practical.

By developing a microcontroller that could program itself (transfer ROM code directly into its own internal EPROM), Motorola now allows you to program one device or thousands in a very cost-effective manner. The "bootstrap" ROM routine, located inside the MC68HC05C8 package, handles details for programming the internal EPROM. All you need to facilitate the process is the hardware to interface the MC68HC705C8 with your computer, which is the task of the Cyber HC5.

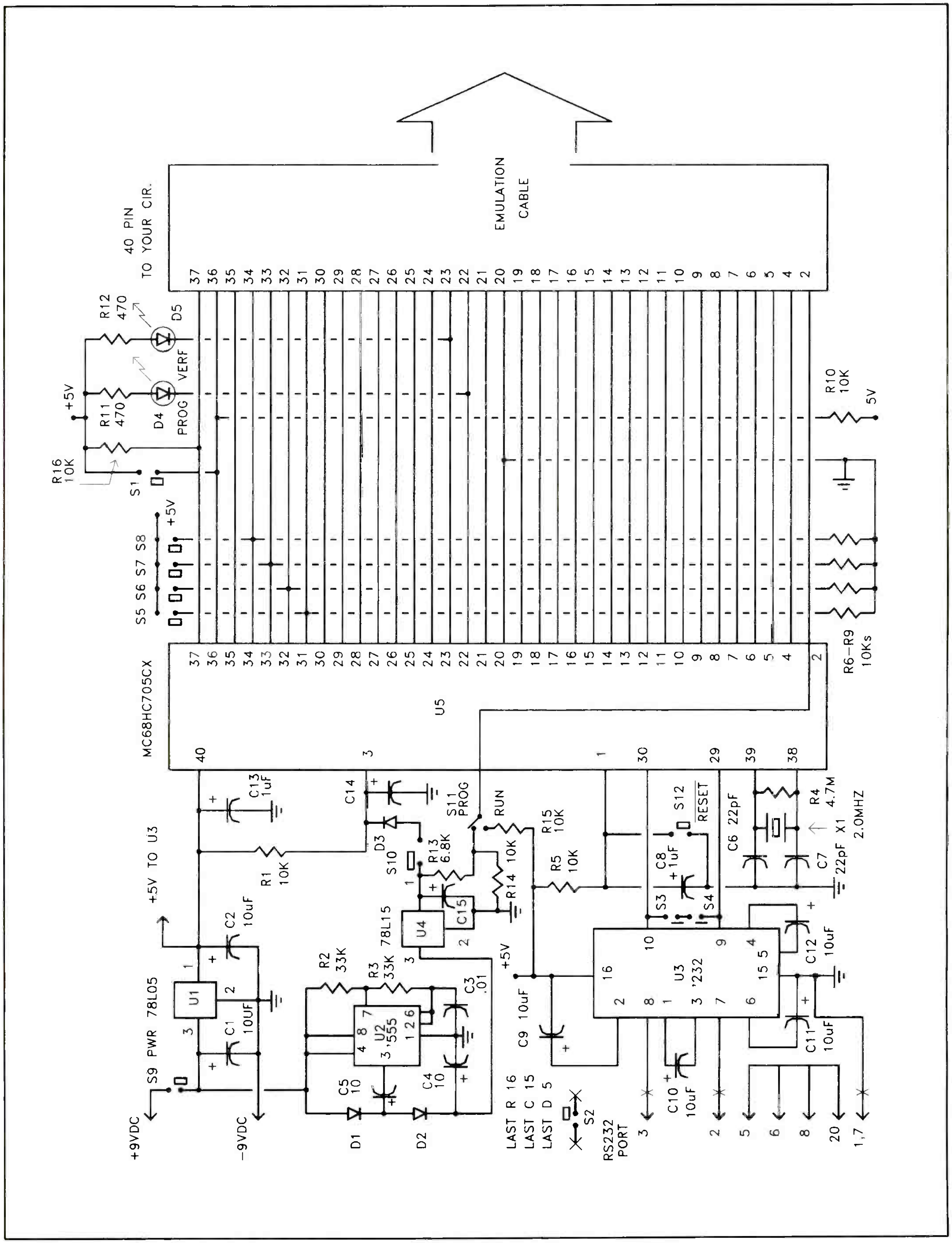


Fig. 1. Complete schematic diagram of circuitry used in the Cyber HC5 Micro Development System.

PARTS LIST

Semiconductors
U1—78105 fixed +5-volt regulator
U2—NE555 oscillator/timer
U3—MAX-232 RS-232 interface
U4—78115 fixed +15-volt regulator
U5—MC68HC705C8E EPROM version
D1,D2,D3—1N4148 signal diode
D4—Red light-emitting diode
D5—Green light-emitting diode
Capacitors
C1,C2,C4,C5,C9,C10,C11,C12,C14, C15—10-μF, 16-volt tantalum
C3—0.01-μF, 100-volt Mylar
C6,C7—22-pF, 100-volt ceramic
C8,C13—1-μF, 16-volt tantalum
Resistors (¼-watt, 5% tolerance)
R1,R5,R10,R14,R15,R16—10,000 ohms
R2,R3—33,000 ohms
R4—4,700,000 ohms
R11,R12—470 ohms
R13—6,800 ohms
R6 thru R9—Three elements inside 10,000-ohm SIP network
Miscellaneous
PS1—9-volt, 100-mA dc plug-in power supply
X1—2.0-MHz crystal
S1 thru S8—Eight-position DIP switch
S9 thru S12—Dpdt slide switch
SK1—40-pin IC socket
ZIF1—40-pin ZIF (zero-insertion force) socket
CONN1—DB-25 male connector
Printed-circuit board (see text); suitable enclosure (see text); three-conductor shielded cable; 25-conductor ribbon cable and IDC connectors for emulation cable; solder; etc.

Note: The following items are available from U.S. Cyberlab, Inc., Rte. 2 Box 284, Cyber Rd., West Fork, AR 72774; tel.: 501-839-8293 or 1-800-232-9865: Ready-to-wire pc board, $19.95; complete kit of all parts for Cyber HC5, including pre-cut case and front panel, $89.95. Also available is complete Cyber Lab Breadboarding System for all microcontrollers/microprocessors, $89.95. Add $4.95 for P&H per order. Arkansas residents, please add 5% sales tax. MasterCard and Visa welcome.

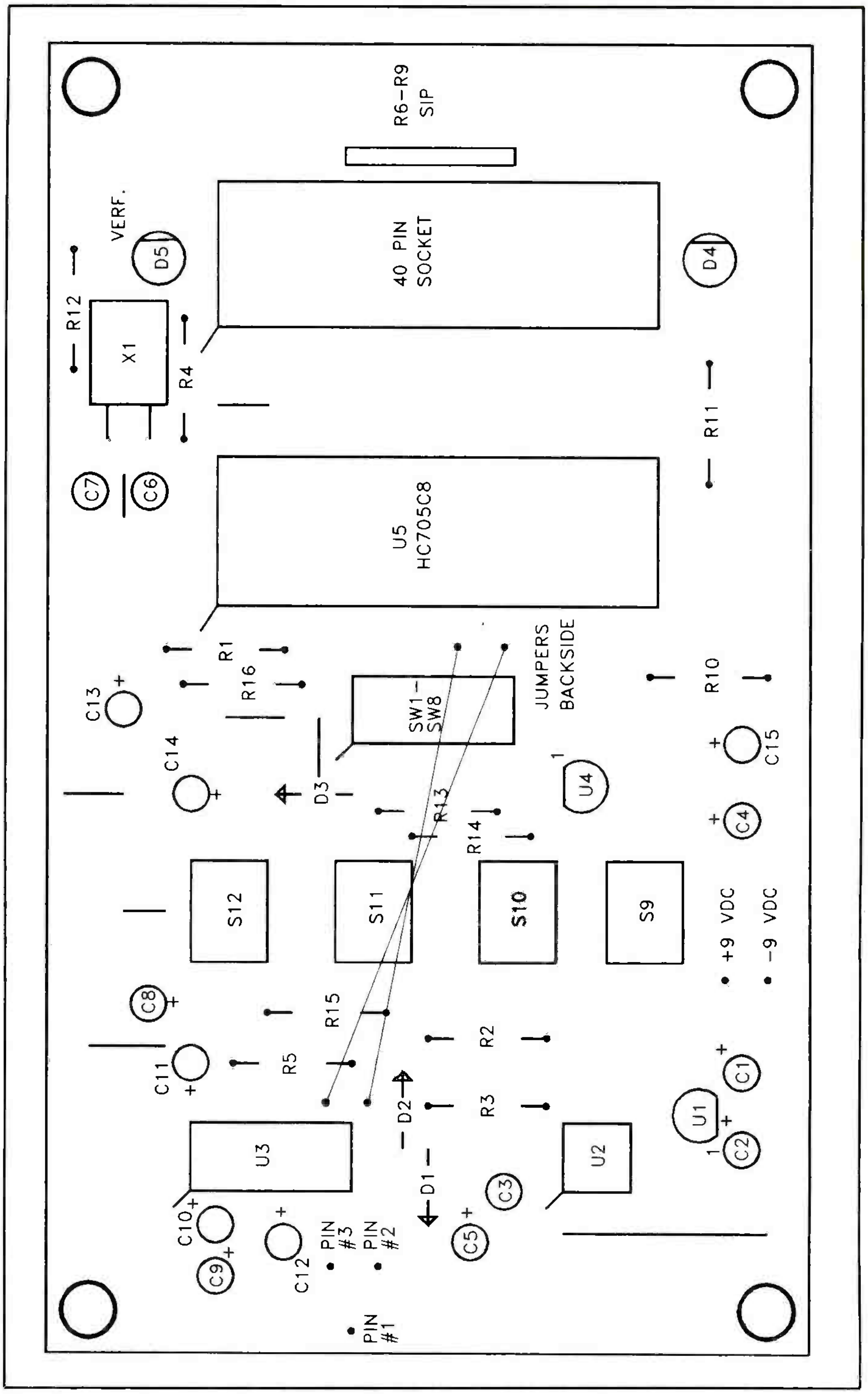


Fig. 2. Actual-size etching-and-drilling guide for the Cyber HC5's pc board.

Shown in Fig. 1 is the complete schematic diagram of the circuitry used in the Cyber HC5. Power is supplied to the circuit from a plug-in external 9-volt dc module. The +9 volts is applied to the circuit through POWER switch *S9* and is regulated to +5 volts by regulator *U1*. Unregulated +9 volts is also applied to oscillator *U2*.

Regulated +5 volts from *U1* supplies *U5* and RS-232 interface *U3*. Unregulated +9 volts powers voltage doubler *U2*. The output of *U3* is held to a constant +15 volts by regulator *U4*, which supplies V_{pp} to *U5*.

Chip *U3* and charge-pump capacitors *C9* through *C12* form a self-contained RS-232-to-digital interface. Crystal *X1*, a 2-MHz device, controls *U5*'s internal clock circuit and permits communication with the host computer at 4,800 baud.

With an MC68HC705C8 plugged in the *U5* ZIF socket and power applied to the circuit, a voltage across *R5* rapidly brings high *C8* and forces a hardware reset at pin 1 of *U5*. Setting *S11* to PROG, causes *U5* to sample the input at its pin 2 and "sees" a voltage greater than V_{dd} (+5 volts). This tells the microcontroller to go into self-programming mode.

In self-programming mode, *U5* executes the internal "bootstrap" communication routine that subsequently reads the input at Port D on pins 31 through 34 of *U5*. These pins are controlled by the settings of *S5* through *S8*.

"Load program via SCI to RAM and execute mode," causes *U5* to begin downloading the required program and data from the host computer through *U3*. Later, when prompted by the control program running on your host computer, you set *S10* to PROG to place +15 volts on pin 3 to program the internal EPROM. If it's necessary to reset the above process, set *S12* to RESET to short pin 1 to ground and force *U5* to reset.

Transfer of data to and from *U5* can be visually monitored via light-emitting diodes *D4* and *D5*. These LEDs light to provide visual verification of the PROGRAM and VERIFY functions.

As you can see, almost every pin on the MC68HC705C8 plugged into the *U5* socket is connected to a 40-pin IC socket shown to the right. This socket allows you to connect a ribbon cable from the Cyber HC5 to your prototype hardware, eliminating the need to remove *U5* from the Cyber HC5 every time you wish to test it. Simply move *S15* to RUN and then use *S12* to reset the device. It automatically begins executing the new program internally and operates as though it's installed in your prototype unit.

Construction

Though you can build the Cyber HC5 on perforated board that has holes on 0.1" centers, using suitable Wire Wrap or soldering hardware, you'll be much better off if you use a printed-circuit board. You can fabricate your own pc board using the actual-size artwork shown in Fig. 2. Alternatively, you can purchase a ready-to-wire board from the source given in the Note at the end of the Parts List.

Wire the pc board exactly as shown in Fig. 3. Begin populating it by mounting and soldering into place the DIP IC sockets, followed by the resistors, capacitors and jumper wires. If you, wish, you can plug the ICs into their respective sockets now or wait until after you've conducted your preliminary voltage checks and are certain that all wiring is correct.

Note that the SIP that contains *R6* through *R9* can be an eight- or nine-pin type. During mounting, simply fold the pins that aren't used under the SIP on the top side of the pc card.

When you install *S9* through *S12*, be sure to space them vertically and horizontally across the board. Use the front-panel cutouts in Fig. 4 to line up the switches for a neat appearance.

Mount and solder into place 78L05 regulator *U1*. Then use a dc voltmeter or the dc-volts function of a digital multimeter to check the output of the powered 9-volt dc supply module. Mark the polarity of each lead. Unplug the supply from the ac line and plug the conductors of its output cable into the polarity-correct holes in the pc board and solder them into place.

Make two or more same-size photocopies of the front panel artwork shown in Fig. 4 and trim them to size. Then use rubber cement or contact spray (Scotch No. 77) to adhere one copy to the front panel of the enclosure. Use this to transfer the hole dimensions to the front panel of the enclosure.

Use a hot knife to cut the switch and IC holes and a slot at the bottom of the enclosure to accommodate the 40-con-

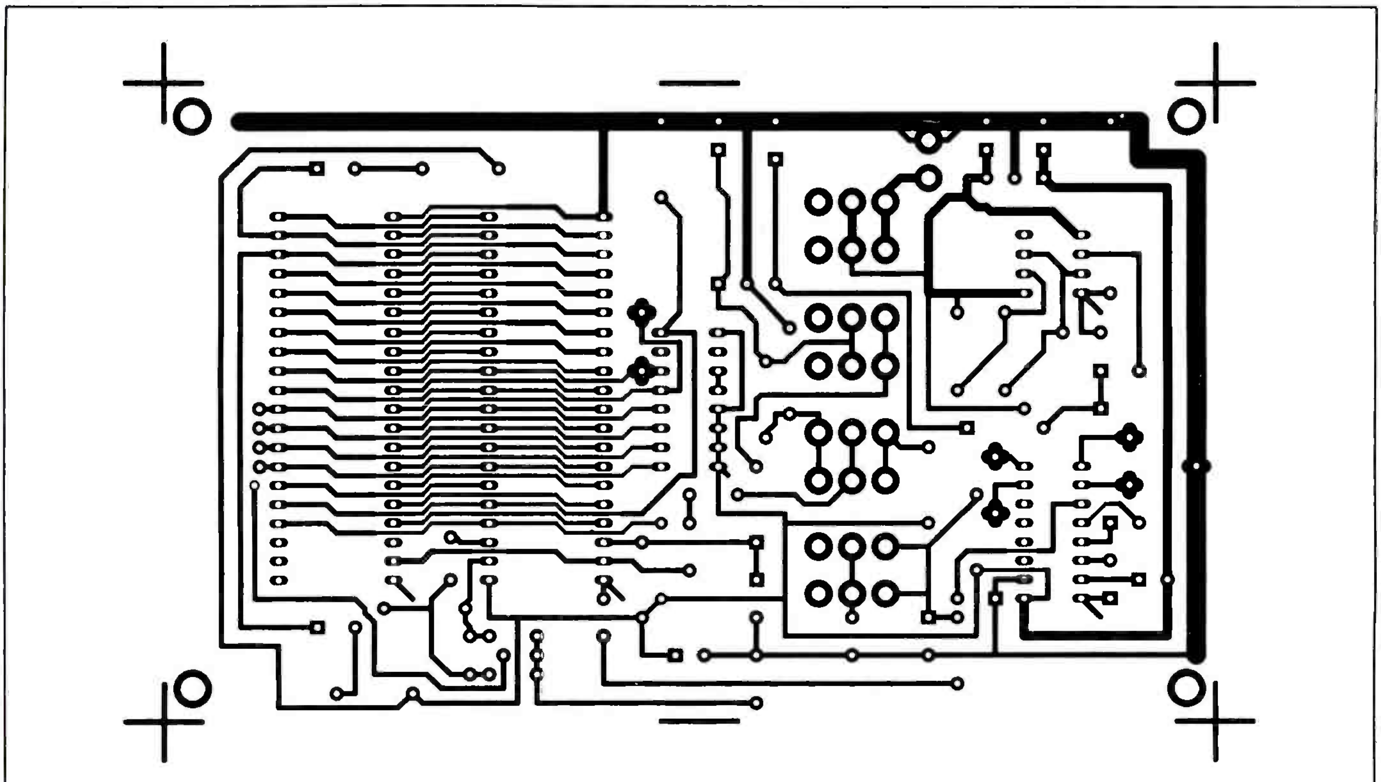


Fig. 3. Wiring guide for the pc board.

ductor ribbon cable option. (A hot-knife is a small razor-sharp knife fitted to the end of a soldering iron and is used to cut precise holes in plastic. If you don't already have one, you can obtain a hot knife from a hardware store. It's a good investment. You'll use it whenever you build a project that requires a home-machined plastic enclosure.)

When using a hot knife, work very carefully. If you haven't used a hot knife before, start by making the holes a little under-size until you're comfortable with the cutting process. (A pre-cut enclosure can be obtained from the source given in the Note at the end of the Parts List if you wish to avoid having to machine your own.) You can trim to final dimensions later. When you're finished using it, always remember to thoroughly clean the tip of your hot knife, allow the knife to cool and stow it safely for the next time you need it.

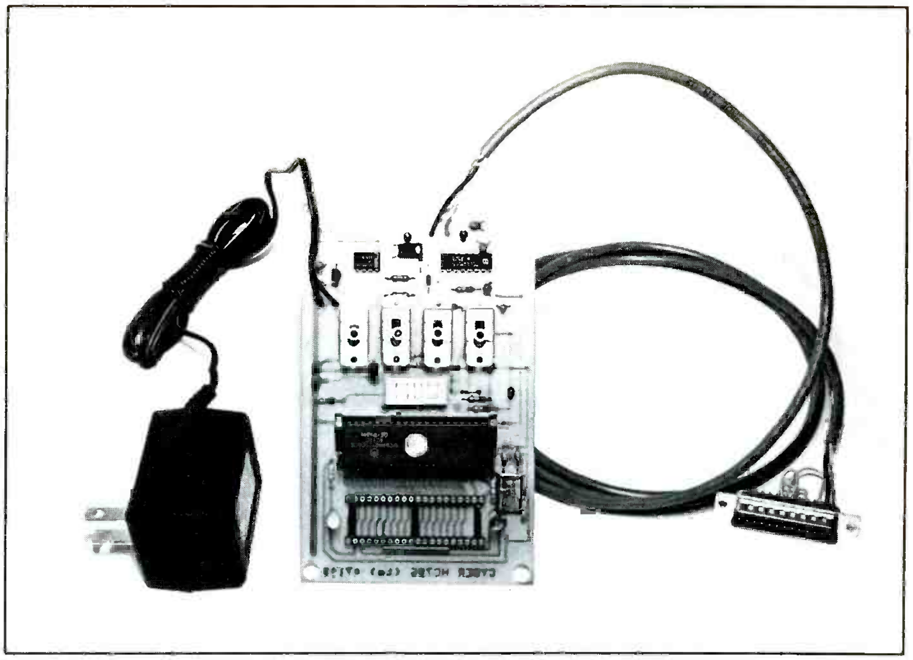
Test fit everything in the enclosure. When you're satisfied with the hole sizes and spacing, peel away the first photocopy of the artwork from the front panel of the enclosure. Trim the second photocopy, (or the membrane applique for the front panel provided with the kit, if you purchased it) for a perfect fit on the enclosure's front panel. Then use spray adhesive to secure the artwork in place.

It's sometimes useful to run a No. 2 pencil around the inside of the front panel holes, where the edge of the front panel applique meets the black plastic. This masks the cut marks and blends the front panel into the enclosure for a factory-finished appearance.

Now assemble the RS-232 interface cable and connector. Referring back to Fig. 1, note that you must connect together pins 5, 6, 8 and 20 using No. 22 hook-up wire. Connect the RS-232 cable to pins 1, 2, 3 and 7, as detailed. Depending upon your particular host computer serial interface configuration, you might have to swap pin 2 and 3, as in a "null" cable arrangement.

When you finish wiring the connector, run the serial cable through the hole at the top of the Cyber HC5 case and solder its conductors to the pc board, as shown in Fig. 3.

As an option, you may want to install a 40-conductor ribbon cable between the 40-pin IC socket and your project. In this case, you should use a 40-pin IDC header at both ends of the emulation cable. Using this option allows you to plug the Cyber HC5 cable into the 40-pin processor socket on your project. When you finish programming and debugging your software, move the programmed MC68HC705C8 from the *U5* socket on the Cyber HC5 to your project.



Assembled Cyber HC5 is ready to be installed in its enclosure.

Designing a Project

Before you learn how to use the Cyber HC5, you should become familiar with the design process you'll be using. The procedure is as follows:

Step 1. No matter how simple or sophisticated a project, begin by conceptualizing it in your mind. Don't put too many limitations on your first thoughts. You'll use Step 2 to filter out what can and can't reasonably be accomplished. Sketch out your ideas and concepts on paper, deciding on the basic hardware you need in addition to the MC68HC705C8. Check the Motorola documentation examples to get a "feel" for how your software will be structured. Be creative, and spend as much time as you can in thinking through each of your project's features and where they'll lead.

Decide on which features are musts and which are "bells and whistles". Include the latter only if the hardware makes them feasible and you can afford to include them. If this is your first time around with this thinking process, don't worry about making mistakes. Every product you've ever seen and every project ever designed goes through changes between conceptualizing them and bringing them to fruition.

Step 2. Now turn on your design "filters." Draw a schematic diagram of your project, using the MC68HC705C8 documentation. Use the design examples provided to determine what to do with pins on the processor that aren't used. If you don't initially understand how a particular processor function or peripheral works, the documentation should clear the air.

With schematic finished, build the project. (The Cyber Lab Breadboarding System mentioned in the Note at the end of the Parts List is an ideal test-bed to use during this stage. With it, you can quickly breadboard your circuit and interface it directly with the Cyber HC5.)

Take your time building the prototype. Keeping in mind that it may require extensive modification as it evolves, it's important to keep your work modular so that sections of the circuit can be changed and enhanced without affecting the entire system.

Step 3. If you're familiar with BASIC, Fortran, COBOL or other programming language, you have a good head-start on things. Programming experi-

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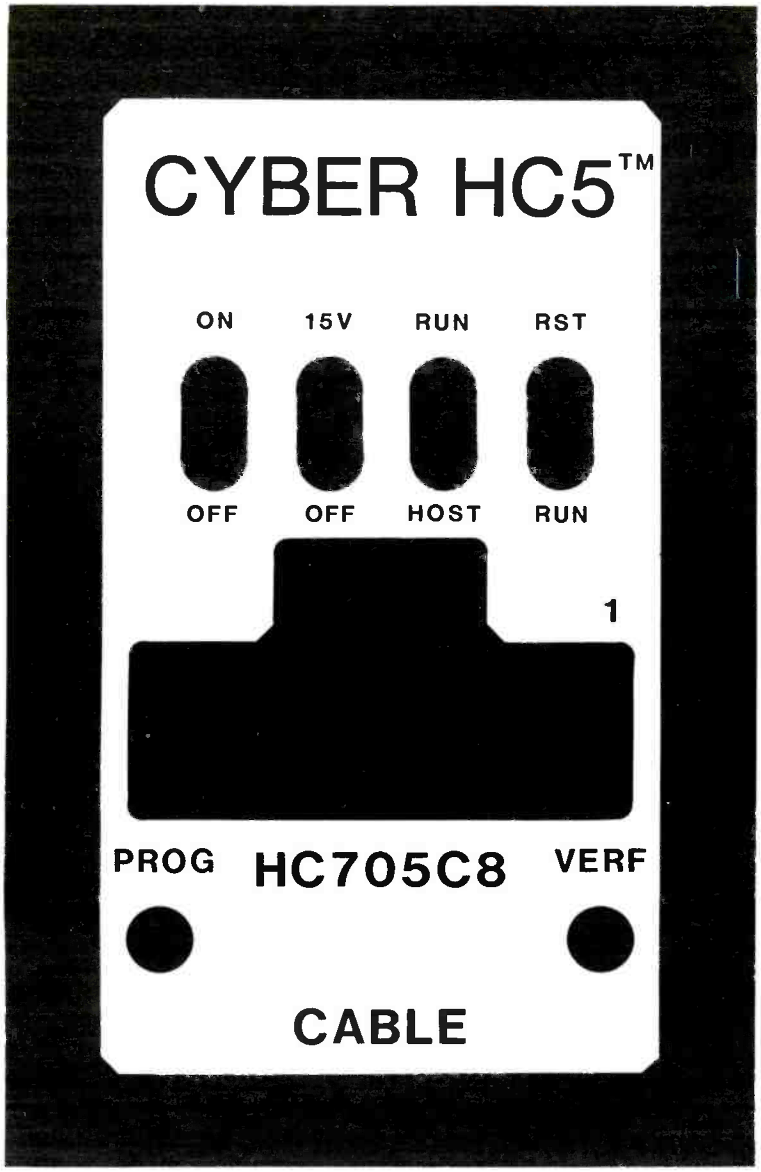


Fig. 4. Actual-size artwork for the front panel of the Cyber HC5 enclosure.

ence in any of these high-level languages is helpful. Machine language, machine code, assembler and assembly language are all names commonly applied to what you're about to become involved with. Don't rush things. Use the Motorola documentation to carefully work your way through the example listings, and use the exact listings from the book if you feel they're applicable in your particular project.

Assembly language gets its "tough" reputation because of the amount of detail involved. By taking your time to work through each instruction (called the "single-stepping process"), you'll catch most of the errors you'll make before you "burn" a defective program into EPROM. *Never* assume anything when working in Assembler! If a particular detail isn't completely clear to you, don't assume the processor can sort it out.

I often write a very simple input/output routine for my new projects. Using the Cyber HC5 it's an easy matter to re-program my MC68HC705C8 each time I make a substantial change to the control program. Keeping my programs modular, (dedicating individual sections, or blocks of memory, to particular functions) makes it easier for me to debug my programs.

If you know how to program in C, a C compiler is available for the MC68HC705C8. The C language is almost ideally suited to this application. I highly recommend making the move to C if you haven't already done so.

Motorola provides all new users of the MC68HC705C8 a freeware version of its '05 Assembler. Although it isn't the most powerful assembler you can get, it's free. If you don't receive a copy of the assembler with your documentation package, call Motorola's Freeware BBS (512-891-3733) and download it. You must set your modem to 300, 1,200 or 2,400 baud. Download using KERMIT, Xmodem or any other protocol Freeware BBS supports. Details for operating the assembler and programmer programs are included.

Step 4. Begin programming your first device by plugging in the Cyber HC5 and setting its POWER switch to OFF. Then, connect the DB-25 connector to the serial communications port on your host computer.

The next step is very important and *must* be done each time you use PROG7. Use the DOS MODE command to configure your serial port. It may be necessary to copy MODE from your DOS disk or directory to the disk or directory that contains your assembler and programmer programs. Key in MODE COM1:4800,N,8,1 and press ENTER to open your serial port at the proper baud rate for the PROG7 program. Make sure your serial card is configured as COM1, or change the card or command.

Next, run the PROG7 freeware program. Select <C> from the main menu to check the Cyber HC5 connection to your computer *without* the MC68HC705C8 plugged into the *U5* socket on the Cyber HC5. Turn on power to the Cyber HC5 and set *S1* in the eight-position DIP switch to open and leave it there from now on. (Switch *S1* will always be open when you use the Cyber HC5 for programming the MC68HC705C8.) Switch *S2* isn't connected to anything and isn't used in the Cyber HC5. Close switches *S3* and *S4*. This shorts or "loops-back" serial port data from the computer to the host. (Make sure the MC68HC705C8 isn't plugged into the *U5* socket during this test.)

Select the loop-back test from the PROG7 menu and press ENTER. Whatever you now type on your computer's keyboard should be "echoed" on the screen of your video monitor.

Table 1. MC68HC705C8 Operating Modes Using Cyber HC5

S5	S6	S7	S8	Mode
On	X	X	X	Execute program in RAM at $0051
Off	Off	On	Off	Load program from host to RAM and execute
Off	On	On	Off	Dump EPROM contents to host
Off	On	On	On	Secure EPROM and Dump to host

If echoing doesn't occur, you might have to transpose the connections to pins 2 and 3 on your DB-25 connector.

With the Cyber HC5 echoing all characters, you can begin your programming session. The following is the procedure for programming the EPROM in the MC68HC705C8.

(1) Set the positions of the DIP switch as follows: *S1* to open; *S2* to open; *S3* to open; *S4* to open; *S5* to open; *S6* to open; *S7* to closed; *S8* to open. This configures *U5* to accept data from the host computer and automatically program itself.

(2) Set the POWER switch to OFF.

(3) Set the RESET switch to RST.

(4) Set the V_{pp} switch to OFF.

(5) Set the HOST switch to HOST.

(6) Plug the MC68HC705C8 into the *U5* ZIF socket. Make certain pin 1 is in the correct position.

(7) Set the POWER switch to ON.

(8) Set the RESET switch to RUN.

(9) Use the PROG7 program to select the "blink" check. (PROG7 prompts use different switch numbers than Cyber HC5.)

(10) The two LEDs should begin to blink and then stop after about 16 seconds to indicate that *U5* is ready to be programmed.

(11) Select <L> to load your assembled program and then <F> for file. Be sure to select <F> to flush the <O> ROM buffer first. Then select <R> to read your file to be programmed to <O> ROM. The assembler will generate a file called "myprog. S19," where *myprog* is the name you gave to your program. The .S19 extension means the program contains the "S" record file data that's a Motorola standard used to exchange binary data between devices. PROG7 uses this data to program the MC68HC705C8.

(12) Select <P> to program *U5* and <O> to indicate ROM. Select to <B> blank-check *U5* (to make sure it has been erased prior to programming it. With a blank MC68HC705C8 plugged into the *U5* socket, select <P> to program and <B> to "blast" the device. Carefully follow PROG7's menu. When it asks you to apply the +15 volts, move the V_{pp} switch to the +15 volts position. When programming is done, set the V_{pp} switch back to OFF.

(13) The program automatically verifies the contents of *U5* and compares it with the myprog.S19 data, which should match. If it doesn't, repeat the above process. When you're done, power down.

Step 5. With a programmed MC68HC705C8, you can decide whether or not you want to physically move it from the Cyber HC5 to your hardware project or use the 40-conductor emulation cable on the Cyber HC5 to test *U5* in-place. If you want to use the Cyber HC5 in the emulation mode, connect the 40-conductor cable and header to the 40-pin socket on your hardware project. (Be sure to connect and reconnect this cable each time you program. In some cases, the programming process could interact with your hardware to affect the process.)

Next, set the RESET switch on the Cyber HC5 to RST and the HOST switch to RUN. Apply power to your hardware and then the Cyber HC5. When you're ready to view execution of your program, set the RESET switch to RUN and watch as *U5* automatically begins executing your program.

Step 6. Debugging your project will often be the most time-consuming part of the design process. Testing, testing and more testing is the order of the day. Each time you find a "bug," repeat Steps 3, 4 and 5. If you keep at it, you'll get it.

At this point, you should be aware of some other Cyber HC5 operating modes. Table 1 lists the modes the MC68HC705C8 can be forced to assume by setting the positions of *S5* through *S8* accordingly. "Load program from host to RAM and execute" is the mode used to program *U5*. PROG7 works by downloading a byte-transfer routine to *U5* and executing it.

Other modes exist for the MC68HC705C8, but aren't used with the Cyber HC5. I think you'll find you can do about anything you want using the PROG7 routine. Just be sure to use the MODE COM1:4800,N,8,1 command line before running PROG7; otherwise, you'll chase your tail for hours.

Although you may find it a little difficult to program at first, persevere because the HC705C8 provides you with a powerful microcontroller for your designs. This inexpensive chip lends itself well to high-volume applications. Contact Motorola about mask-ROM parts and pricing. ■

Nick Goss

Timing Diagrams

How to use these informative aids in designing and troubleshooting computer circuits

Timing diagrams are drawings that describe how a microcomputer, memory or other peripheral IC communicates with the world external to it. They show what happens and when as data, program instructions and other information pass into and out of a chip. They're one of the many useful pieces of information you'll find on an IC's data sheet.

You can build, repair, use and even design circuits without consulting a timing diagram. Many people do just that. However, knowing how and when to use timing diagrams can make circuits easier to design, more reliable in use and quicker to troubleshoot. Here are a few situations where timing diagrams can be beneficial:

- You've purchased one of the many popular boards that contain a microcontroller, memory and other basic system components and are wondering if you can substitute a 350-ns EPROM in place of the 250-ns chip supplied with the board.
- You'd like to use a circuit design you saw in *ComputerCraft* but would like to use a higher- or lower-frequency crystal to drive the microprocessor and wonder about what effect doing so will have on the other components in the circuit.
- You're designing your own microcontroller circuit and want to know how to connect RAM, EPROM and other devices to the microcontroller.
- You've replaced a memory chip with what appears to be an identical chip, but the circuit no longer works and now want to know what's wrong.

In this article, I'll introduce you to timing diagrams and how to decipher them and include examples of how to use the diagrams in analyzing circuits. Though the focus will be on basic circuits that use eight-bit microcontrollers, the same principles also apply to other digital circuits.

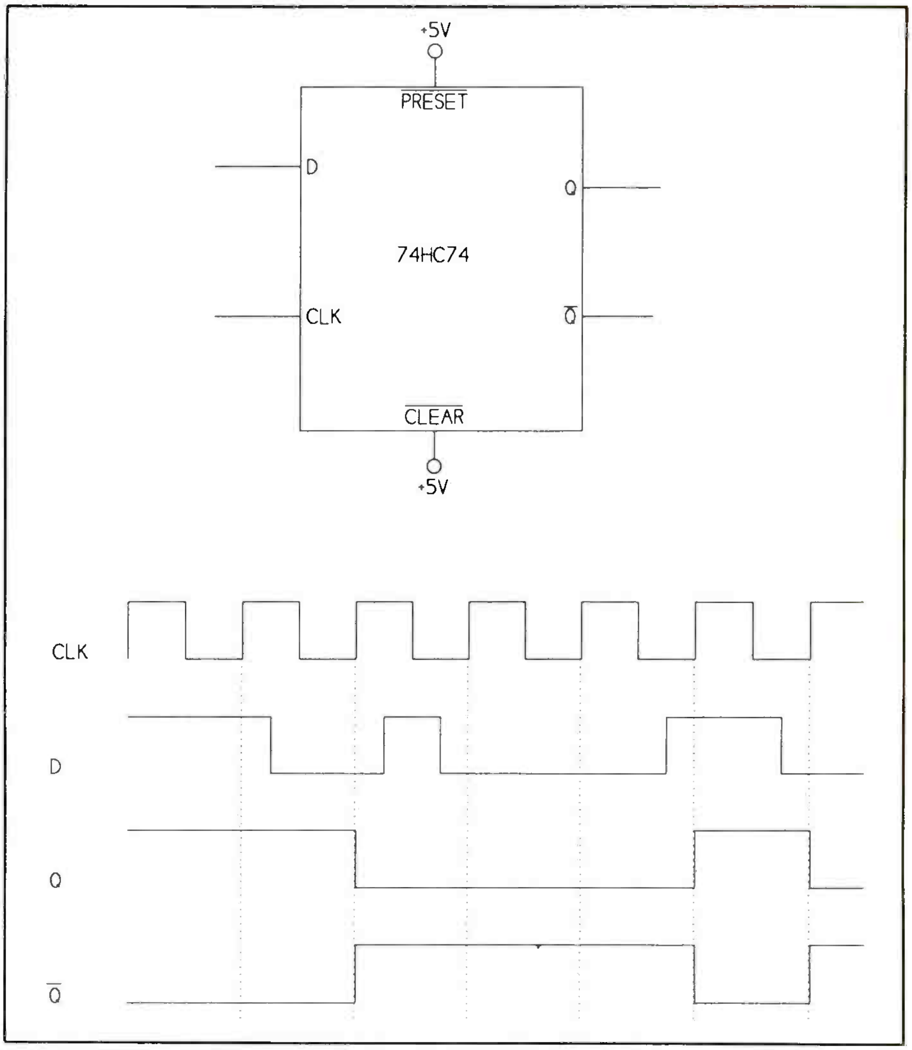


Fig. 1. A 74HC74 flip-flop is a synchronous device, since its Q outputs change state only on the rising edge of CLK.

The Basics

To understand a timing diagram, you must know a little about the internal workings of microcomputers. Internal operations in most popular microcomputer chips, including microcontrollers, are synchronous. That is, they're controlled by a frequency source, or clock signal.

The 74HC74 flip-flop shown in Fig.

1 is an example of a basic synchronous circuit. The D input may change at any time, but the logic level at D passes to the Q outputs only on the rising edge of CLK. The outputs are thus synchronized to the clock input.

The outputs of the flip-flop may appear to switch instantly as the clock changes state. In reality, there's a small delay, called the propagation delay, between when CLK goes high and when the outputs switch. According to its data sheet, typical maximum propagation delay for the 74HC74 is 20 ns.

The data sheet specifies other requirements that must be met for the flip-flop to operate properly: the CLK pulses must be at least 16 ns wide, and D must be stable for at least 20 ns before CLK goes high. In many circuits, however, these requirements are easily met, and you don't have to concern yourself with them.

In microcomputer circuits, operations are synchronized to a signal usually referred to as the master clock, which derives from a crystal or other frequency source that connects to the computer chip.

Because computer chips are more complex inside than is a simple flip-flop, their timing requirements are more complex. One important specification of EPROMs and other memory chips is the address access time. This is the amount of time a chip requires between when it receives a request for a byte of data and it places the byte on its output pins for the requesting device to read. Current common access times for EPROMs are between 100 and 450 ns. As technology improves, devices with shorter access times become available.

When a microcontroller or other microcomputer chip wants to read a byte from an external EPROM, it typically places the address it wants to read on its address outputs and toggles control pins that tell the EPROM to place the requested byte at its data outputs. Following a short delay, the microcontroller latches the byte into its internal memory for processing.

The control signals ensure that everything occurs in the correct timed sequence and allow the EPROM enough time to produce the data before the microcontroller tries to read it. Timing diagrams can help you to choose components that will work together without timing conflicts.

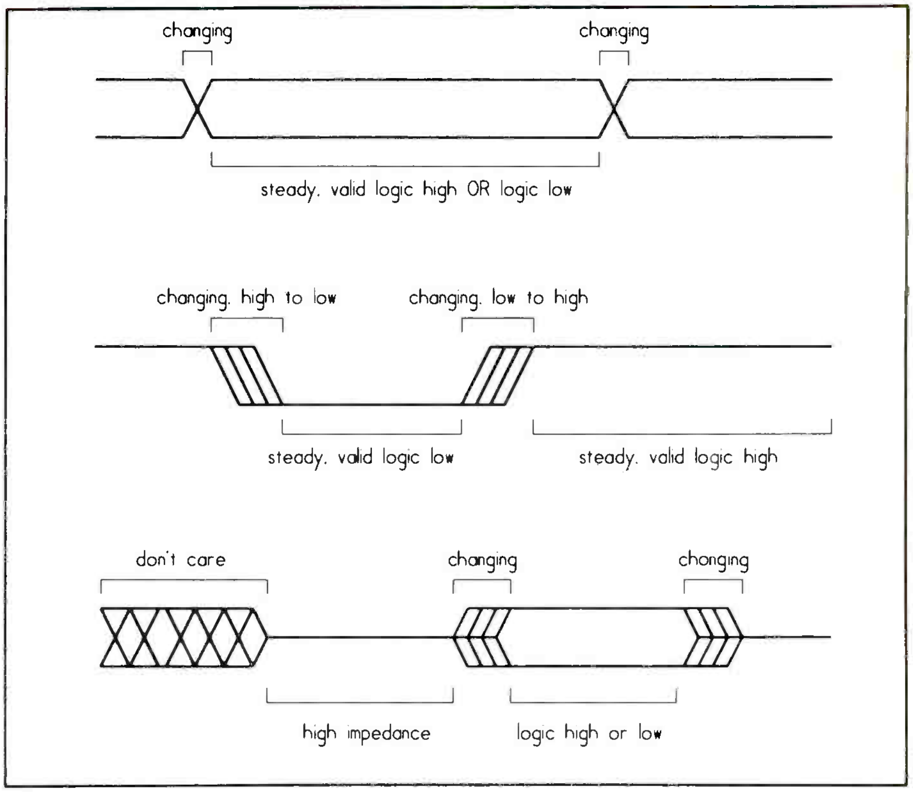


Fig. 2. The basic signals used in timing diagrams for microprocessors, memory and other computer chips.

Figure 2 illustrates the basic symbols used in timing diagrams, along with their meanings. The symbols indicate when a signal is, or must be, a logic high, logic low, valid logic level (either high or low) unstable (changing) or high impedance. In a complete diagram, labeled arrows point to critical timing relationships among the signals, and a chart specifies maximum or minimum times (or both) for these relationships. Exact drawing styles may vary slightly from source to source, but most follow a format similar to the one shown.

EPROM Timing

Figure 3 shows a basic microcontroller circuit with an Intel 8031 microcontroller, Texas Instruments 27C256 32K EPROM and 74HC373 octal latch. The EPROM contains 32,768 (7FFF hexadecimal) memory locations, each of which holds a byte of information. The locations are addressed from 0 to 7FFFh in memory. On power-up, the 8031 reads and executes the instructions stored in the EPROM, beginning at location 0.

Pins DA0 through DA7 on the 8031 form a multiplexed data/address bus. Both data and address bytes appear on these pins at different times. The pins act as outputs when they hold an address or data to be written, and as inputs when the microcontroller reads data. (Data is meant here in a general sense to mean stored information, whether it's used as a numeric quantity, program instruction or another value.) The multiplexed bus saves pins on the component package. Without multiplexing, the 8031 would need eight more pins.

Before it can execute an instruction, the 8031 must first request the instruction from the EPROM. Reading a byte from the EPROM involves several actions by the 8031 and EPROM. Figure 4 is a timing diagram that describes a read operation from the 8031's point of view. Figure 5 does the same from the EPROM's point of view.

What occurs during a read operation at ALE, PSEN, DA0 through DA7 and A8 through A15 on the 8031 is illustrated in Fig. 4. Though this diagram is for the 80C31BH-1 version of the chip, it's similar to timing diagrams for other 8031-family chips. Critical timing relationships are labeled and

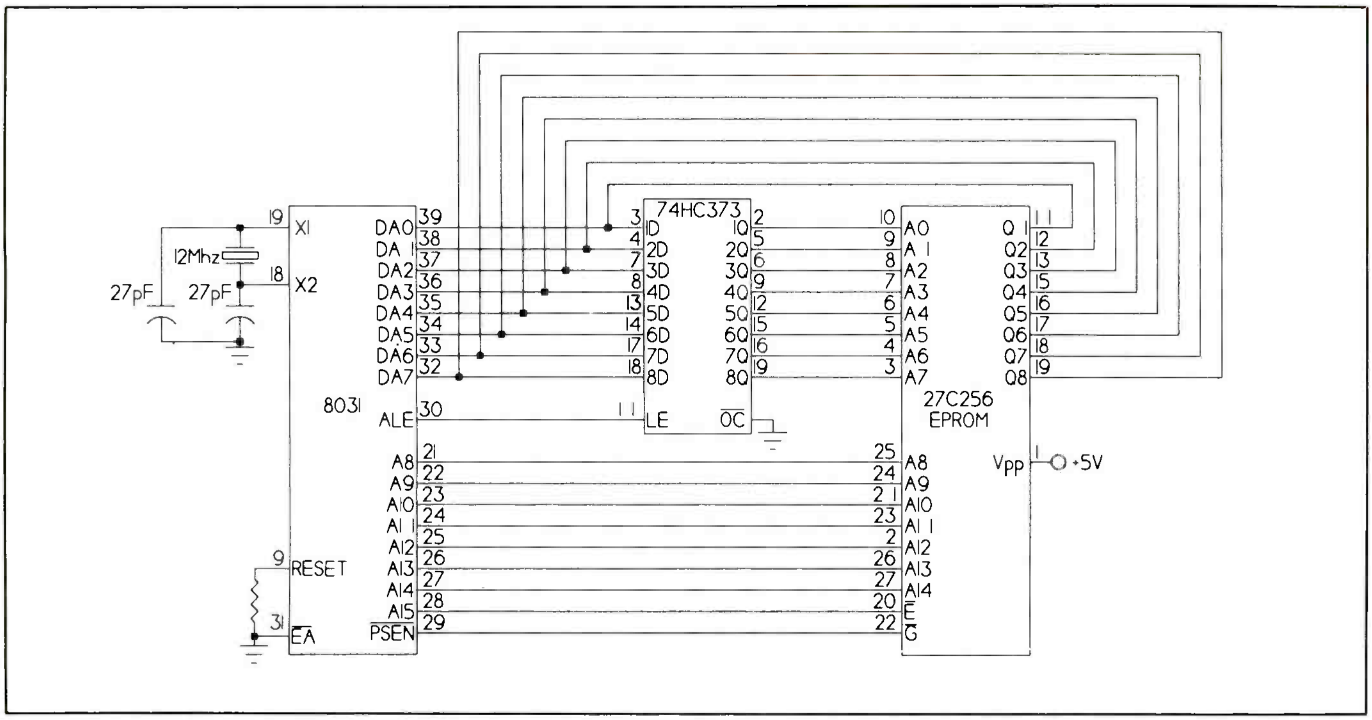


Fig. 3. In this circuit, the 8031 microcontroller executes a program stored in the 27C256 EPROM. A 74HC373 octal latch presents the lower address byte to the inputs of the EPROM.

described in the chart below the diagram. Since DA0 through DA7 all follow the same timing, one signal represents all eight pins. The same is true for A8 through A15.

Figure 5 shows what happens during a read operation at A0 through A14, E, G and Q1 through Q8 on the EPROM. The chart includes values for devices with five different access times. As with the 8031, a variety of timing relationships are defined and described.

To get the two components to work together, you must make sure the requirements of both devices are met. The following is what occurs when the 8031 in Figure 3 reads a byte from program memory:

The 8031 first pulses ALE and PSEN high and places an address on DA0 through DA7 and A8 through A15. This address tells the EPROM what location the 8031 wants to read. The EPROM requires 15 address lines to address each of its 32,768 locations. The 8031's top address bit, A15, controls E (chip enable or chip select) on the EPROM. The EPROM is selected whenever A15 is low, which occurs whenever the 8031 addresses a location from 0 to 7FFFh.

The 8031's ALE (address latch enable) controls LE (latch enable) on the '373 latch. When ALE is high, the logic levels at DA0 through DA7 pass through to A0 through A7 on the EPROM. When ALE goes low, the current logic levels at DA0 through DA7 are latched to 1Q through 8Q, and these outputs won't change until ALE goes high again. The latch thus holds the lower address byte for the EPROM's A0 through A7. This type of latch is called a transparent latch, since it's invisible to the EPROM when LE is high. A short time after ALE goes low, DA0 through DA7 change to a high-impedance state.

When E goes low, the EPROM fetches the data stored at the address specified on A0 through A14. When the 8031 brings low PSEN and, thus, G, the EPROM places the requested byte on Q1 through Q8, where the 8031 reads it. Bringing high E or G completes the read operation, and the 8031 can then execute another program read or a different operation.

Using Timing Diagrams

The 27C256 EPROM is available in five access times: 120, 150, 170, 200, and 250 ns. Which can you use in the Fig. 3 circuit? For the EPROM to work with the 8031, it must be able to output the requested byte by the time the 8031 expects to read it. The timing diagrams tell which ones can do so.

Because timing diagrams contain a lot of information, sorting through all of the signals and timing relationships with their cryptic names may seem a daunting task. But there are a few important pieces of information you can learn to look for and use without too much trouble.

When choosing components, the most important signal in Fig. 5 is ta(A), access time from address. The chart shows that on a the -12 version of the EPROM, Q1 through Q8 hold valid, stable data 120 ns after a stable address is available on A0 through A14 (assuming other device requirements have also been met). The other versions of the EPROM require more time, up to 250 ns for the -25 version.

Different manufacturers may use different names for the address access time, but the data sheet for any memory chip should specify this value. Parts vendors should also provide it along with the part number, and the access time is often printed on the face of the device as well. Sometimes the access time is abbreviated, with -25 indicating 250 ns, for example.

Let's now look at how the EPROM's

access time relates to the requirements described by the 8031's timing diagram in Fig. 4.

The EPROM's access time is TAVIV, or address to valid instruction in. The chart and diagram shows that with a 12-MHz clock, the 8031 must see valid, stable logic levels on DA0 through DA7 by at least 312 ns after it places an address on A0 through A15.

What about the effect of the 74HC373 latch? It does cause a short delay between when the 8031 places the lower address byte on DA0 through DA7 and when that byte is available at A0 through A7 on the EPROM. Because the '373 is a transparent latch, DA0 through DA7 pass straight through the latch when ALE is high. The only delay is the '373's propagation delay, which its data sheet specifies as typically 18 ns. This brings the maximum allowable access time for the EPROM down to 294 ns.

Since all EPROM access times in Fig. 5 are less than 294 ns, any of the EPROMs listed would work in our circuit. Even the 250-ns device has a comfortable 44-ns margin of safety.

All of the values in the above example assume that the 8031 is clocked at 12 MHz. What happens if you speed up the clock? The "Variable Osc" column in Fig. 4 gives formulas for calculating values for clock frequencies other than 12 MHz. For example, with a 16-MHz clock, TAVIV would equal 5TCLCL – 105. TCLCL equals 1,000 divided by the crystal frequency in megahertz, or 1,000/12 for a 12-MHz clock.

At 16 MHz, TAVIV equals (5,000/16) – 105, which works out to 208 ns. With the '373's propagation delay figured in, the maximum EPROM access time at this clock speed is 190 ns; so only an EPROM with an access time of 170 ns or less would work reliably here.

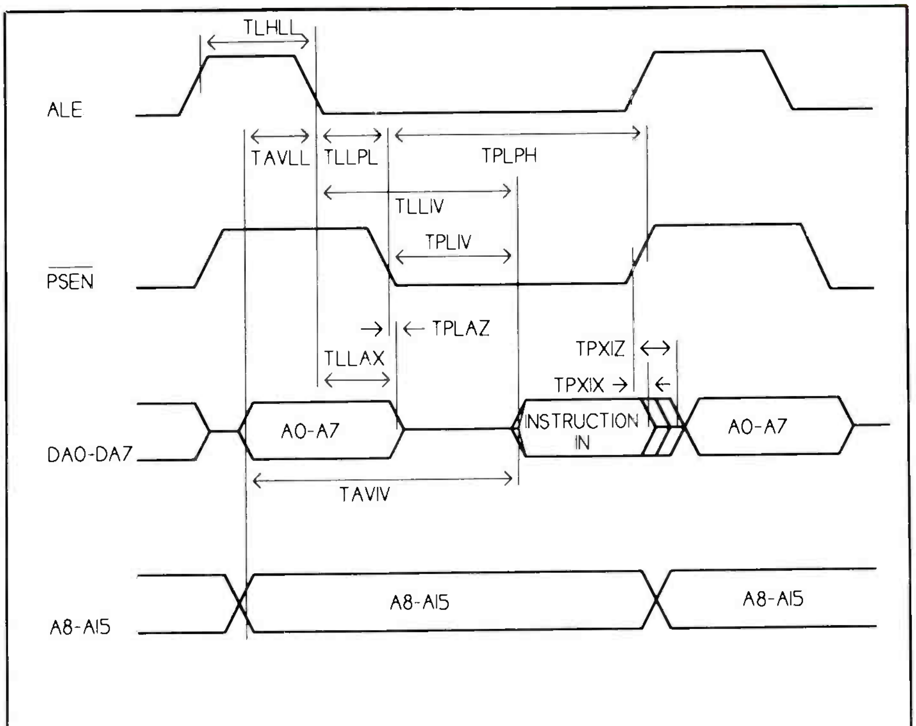
What if you use a slower crystal to clock the 8031? With an 8-MHz clock, the same formula gives a value of 520 ns, which would allow you to use an EPROM as slow as 450 ns.

Timing characteristics can vary with load capacitance, supply voltage, temperature and other conditions. So it's a good idea to leave room for such variations when selecting components. In the 16-MHz example above, a 200-ns EPROM might work most of the time, but it could fail if temperature variations cause the crystal frequency to increase. Or some 200-ns EPROMs might work in a circuit, while seemingly identical ones don't, due to individual differences in the components.

If you run into problems like these in a circuit, timing conflicts could be the cause. If so, a slower clock or faster peripheral chips may be the solution. It often costs little or nothing to use components with access times at least 10% shorter than the timing diagrams require.

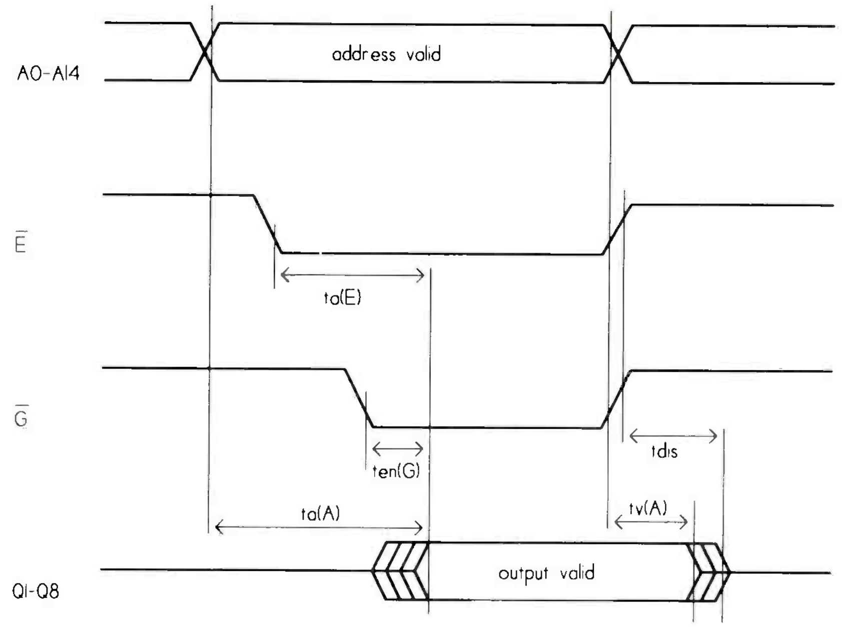
Timing diagrams include much more information than just the access time. For example, for a 250-nanosecond EPROM, Fig. 5 shows that E and G should be low for 250 and 100 ns, respectively, before Q1 through Q8 are read. If you examine the diagrams carefully, you'll see that A15 and PSEN on the 8051 meet these requirements at 12 MHz.

For RAMs and other read/write chips, data sheets include corresponding diagrams for writing to the chip.



SIGNAL	PARAMETER	12Mhz OSC MIN	12Mhz OSC MAX	VARIABLE OSC MIN	VARIABLE OSC MAX	UNITS
1/TCLCL	Oscillator frequency			3.5	16	Mhz
TLHLL	ALE pulse width	127		2TCLCL-40		nanosec.
TAVLL	Address valid to ALE low	28		TCLCL-55		nanosec.
TLLAX	Address hold after ALE low	48		TCLCL-35		nanosec.
TLLIV	ALE low to valid instruction in		234		4TCLCL-100	nanosec.
TLLPL	ALE low to PSEN low	43		TCLCL-40		nanosec.
TPLPH	PSEN pulse width	205		3TCLCL-45		nanosec.
TPLIV	PSEN low to valid instruction in		145		3TCLCL-105	nanosec.
TPXIX	Input Instr hold after PSEN	0		0		nanosec.
TPXIZ	Input Instr Float after PSEN		59		TCLCL-25	nanosec.
TPLAZ	PSEN low to address float		10		10	nanosec.
TAVIV	Address to valid instruction in		312		5TCLCL-105	nanosec.

Fig. 4. A timing diagram for external program-read operation of Intel's 80C31BH-1.



SIGNAL	PARAMETER	27C256-12 MIN	27C256-12 MAX	27C256-15 MIN	27C256-15 MAX	27C256-17 MIN	27C256-17 MAX	27C256-20 MIN	27C256-20 MAX	27C256-25 MIN	27C256-25 MAX	UNITS
$t_{a(A)}$	Access time from address		120		150		170		200		250	nanosec.
$t_{a(E)}$	Access time from chip enable		120		150		170		200		250	nanosec.
$t_{en(G)}$	Output enable time from $\overline{G}$		55		75		75		75		100	nanosec.
t_{dis}	Output disable time from $\overline{G}$ or $\overline{E}$	0	45	0	60	0	60	0	60	0	60	nanosec.
$t_{v(A)}$	Output data valid time after address change, $\overline{E}$, or $\overline{G}$	0		0		0		0		0		nanosec.

Fig. 5. A timing diagram for the read operation of a Texas Instruments 27C256 EPROM.

For EPROMs, the write diagrams are used only for EPROM programming; so they aren't relevant in circuits where the EPROM is a read-only device. Timing diagrams are also provided for directly reading and writing to port pins and serial I/O and accessing any other inputs and outputs a chip has.

For internal functions, such as reading from an on-chip EPROM, there are no timing diagrams, since there's no interface to design. This is a good reason to use devices with on-chip memory and other functions whenever possible!

Another EPROM Interface

Although most microcontrollers perform the same basic functions, different device families vary in exactly how they do so. Different families use different control signals, and even similar devices may vary in their timing diagrams.

Figure 6 shows our same EPROM connected to a Motorola 68HC11 microcontroller. Figure 7 is a timing diagram for the 68HC11. Like the 8031, the 68HC11 has a multiplexed data/address bus, and the waveforms for DA0 through DA7 and A8 through A15 are similar to those on the 8031. The high address byte appears on A8 through A15, and DA0 through DA7 hold the lower address byte first, followed by data. The 'HC11's AS output latches A0 through A7 through the '373 in the same way that ALE did on the 8031.

Unlike the 8031, which executes its program beginning at 0, in normal operation the HC11 begins program execution at FFFEh,FFFFh. For this reason, the EPROM in Fig. 6 is addressed at 8000h-FFFFh. (Since the starting address is at the top of the EPROM, the first program instruction is typically a jump to a lower address.) To access the EPROM at these addresses, A15 must be high. So A15 is inverted before it connects to the active-low E on the EPROM.

The HC11's Eclk output is similar to, but the inverse of, the 8031's PSEN. So Eclk is also inverted. Eclk and R/W are NANDed, which results in the

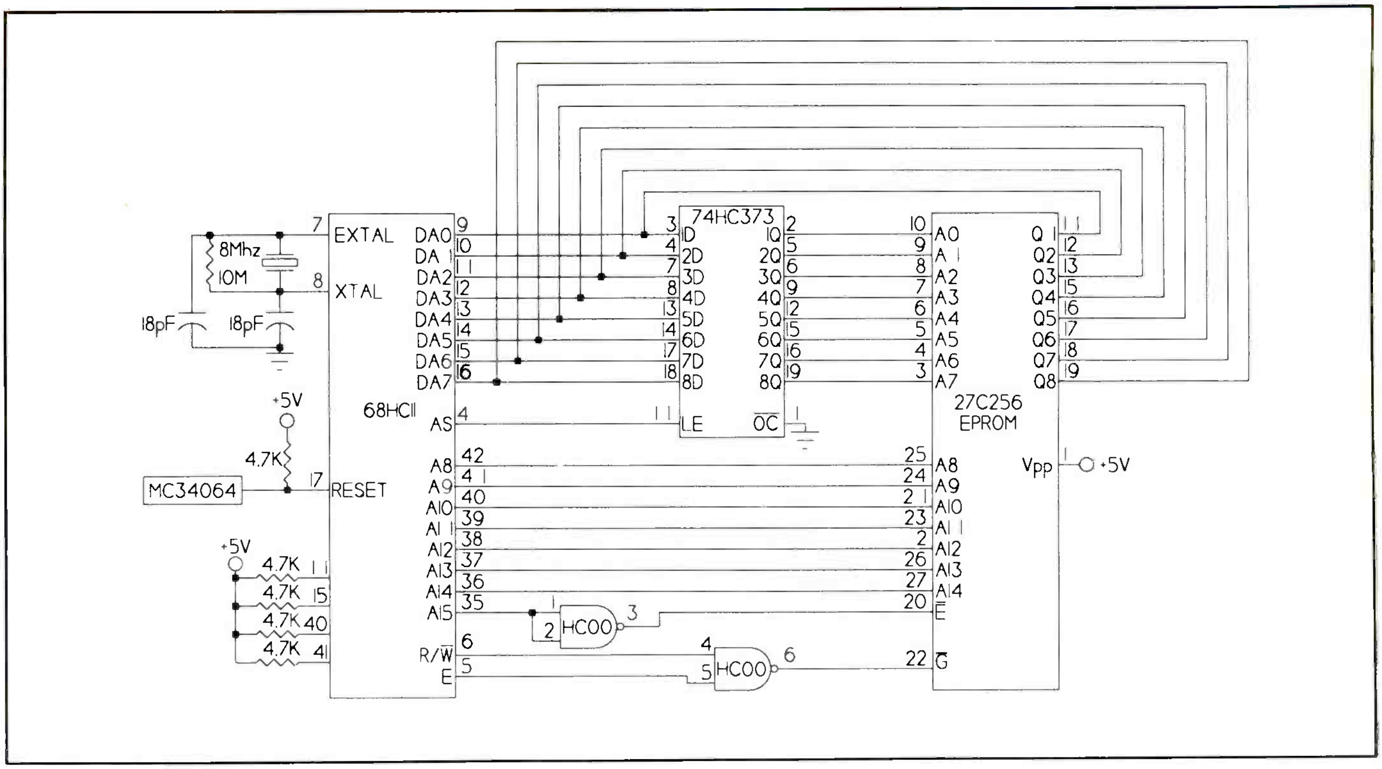


Fig. 6. This circuit is similar to the one in Fig. 3, except that it uses a 68HC11 microcontroller instead of an 8031.

EPROM's G input going low only when R/W and E are both high.

On the HC11, Eclk is defined as one-quarter the HC11's crystal frequency, so an 8-MHz clock results in a 2-MHz Eclk. (Motorola calls this signal E, but I use Eclk to avoid confusion with the EPROM's E input.)

In Fig. 7, the relationship labeled tACCA (MPU address access time) has the same function as TAVIV on the 8031. From the chart, an 8-MHz crystal requires an EPROM access time of 296 ns or less. So a 250-ns EPROM will work here also.

Notice that the HC11 specifies tACCA as a minimum value, while the 8031 specifies TAVIV as a maximum, yet both describe the same timing relationship. Whether you call it a minimum or maximum depends on how you look at it. In one respect, tACCA and TAVIV are the shortest (minimum) time the microcontroller will wait between placing an address and reading the requested byte. That is, the microcontroller won't try to read the byte until at least the minimum specified time has passed.

Looking at it another way, tACCA and TAVIV are the longest (maximum) time that an EPROM can wait before responding to a request to read a byte. If the EPROM doesn't place the byte on Q1 through Q8 by the specified time, the microcontroller may not read it correctly. Either way, the EPROM's address access time must be less than that of the microcontroller. Whichever way you look at it, it would be nice if the chip manufacturers would agree on a single convention and stick with it.

Substituting Parts

Often, popular ICs are offered by a variety of manufacturers. For example, *IC Master* lists 16 sources for 27C256 EPROMs. Most, if not all, are offered in the same 28-pin package and pinout. Is it safe to assume that all components with similar designations and descriptions are identical, except for access times? Once in a while, there are subtle differences that can cause problems when you substitute components.

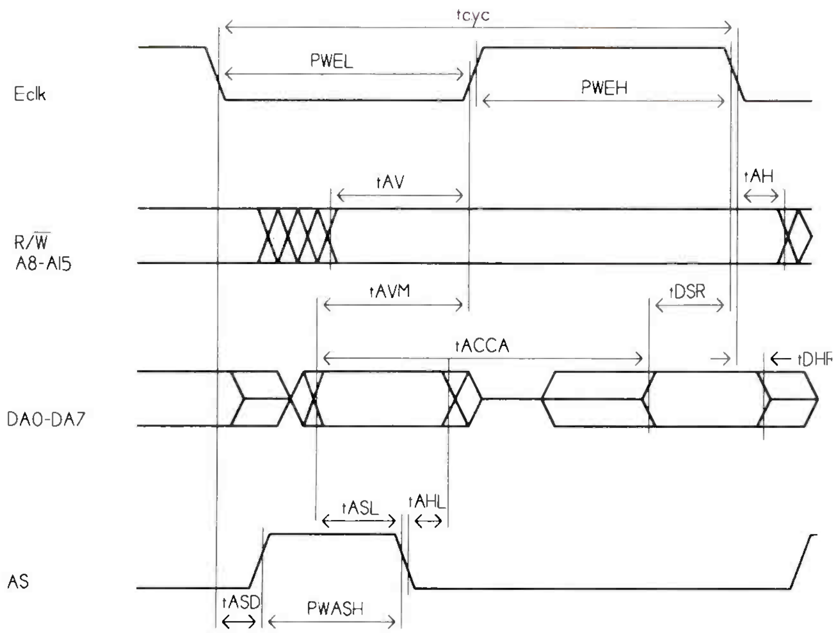
For example, in a microcontroller circuit I once built, I found I could write to many, but not all, static RAM chips. On checking the timing diagrams, I discovered that some RAM chips required the data to remain on the data bus 10 ns after their WE (write-enable) pulse was brought high, while others had no such requirement.

To get the circuit to work with all RAM chips, I had to change the microcontroller/RAM interface by AND-ing two control signals, so that WE was brought high before data was removed from the data bus. This modified interface met the timing requirements for all of the RAM chips. Without the timing diagrams, I may have come up with theories, even found a solution by trial-and-error, but I never would have known for sure what was causing the problem.

Timing Diagram Software

As faster components and circuits are developed, timing requirements become more and more critical. Trying to sort out the timing relationships for two or more components on paper (or in your head) becomes more and more difficult. To meet the need for a better way, a couple of companies have come up with software that helps circuit designers investigate and analyze timing relationships as they develop a design.

Chronology's *Timing Designer* for *Windows* ($995) and engineerium's *dV/dt* for MS-DOS ($725 and $825) and the MacIntosh, ($695) are similar



SIGNAL	PARAMETER	8 MHZ EXTERNAL OSC MIN	MAX	VARIABLE OSC MIN	MAX	UNITS
t_{cyc}	Cycle time	500				nanosec.
PW_{EH}	Pulse Width, E High	222		1/2tcyc-28		nanosec.
PW_{EL}	Pulse Width, E Low	227		1/2tcyc-23		nanosec.
tr	E and AS rise and fall time		20			nanosec.
t_{AH}	Address hold time	33		1/8tcyc-23		nanosec.
t_{AV}	Non-Muxed Addr valid to E rise	94		PWEL-(tASD+80)		nanosec.
t_{DSR}	Read Data Setup Time	30				nanosec.
t_{DHR}	Read Data Hold Time	10	83			nanosec.
t_{AVM}	Muxed Addr valid to E rise	84		PWEL-(tASD+90)		nanosec.
t_{ASL}	Muxed Addr valid to AS fall	26		PWASH-70		nanosec.
t_{AHL}	Muxed Address Hold Time	33		1/8tcyc-29.5		nanosec.
t_{ASD}	Delay Time, E to AS rise	53		1/8tcyc-9.5		nanosec.
PW_{ASH}	Pulse Width, AS High	96		1/4tcyc-29		nanosec.
t_{ACCA}	MPU Address Access Time	296		tAVM+tr+PWEH-tDSR		nanosec.

Fig. 7. A timing diagram for the read operation (or expansion-bus timing) of Motorola's 68HC11.

products that allow you to draw timing waveforms on-screen and specify the timing relationships between signals. The software then analyzes the waveforms and their requirements and lets you know if there are timing violations. You can experiment with different clock signals and access times, and the software tells you what will work and what won't. The key to successful analysis is to describe the signals completely and accurately as you enter them into the diagrams.

Both companies offer free demo disks that allow you to try out the software on simple circuits. They're worth a look if you're interested in learning more about timing diagrams.

Sources

Chronology Corp.
2721 152 Ave. N.E.
Redmond, WA 98052-5516
Tel.: 1-800-800-6494
Fax: 206-869-4229

engineerium
8950-1200 Vila La Jolla Dr.
La Jolla, CA 92037
Tel.: 619-292-1900
Fax: 619-292-6236

Project Pro
1710 Enterprise Pkwy.
Twinsburg, OH 44087
Tel. :1-800-800-3321
Fax: 216-425-1228

Moving On

If you're in the market for good-looking enclosures for your projects, send for Project Pro's free catalog. It lists a wide assortment of metal and plastic enclosures, along with knobs, fixtures, brackets, LED bezels, panels, hardware and tools. There's no minimum order, but there's a $5 handling charge on orders less than $25.

Next time, I'll discuss how to use keypads and other devices to allow you to interact with your circuits.

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

Jan Axelson

 By Joseph O'Connell

Build an Ultrasonic Ranger

This multi-purpose computer add-on device can be used to measure distances, dimensions, height of liquids and much more

The Ultrasonic Ranger described here is a complete distance-measuring device that connects to virtually any computer via an RS-232 serial port. With only a few lines of program code, it lets you measure room dimensions, liquid levels and particles in a tank; detect intruders in a home and visitors in front of a display; and measure the height of people standing under it, to name just a few of its many possible applications.

When a visitor stands under the Ultrasonic Ranger, it measures the distance from the ceiling to the top of his head. It then subtracts this distance from the distance between ceiling and floor and displays the result on the screen of the computer being used with it. The prototype of the Ultrasonic Ranger is being used at a science exhibit in Canada, running on an Apple Macintosh with Hypercard, though it can just as easily run on any other computer equipped with a standard RS-232 serial port and a BASIC language interpreter.

The Ultrasonic Ranger requires an RS-232 port with selectable baud rates between 300 and 4,800 bps, eight data bits, even parity bit, one start bit and one stop bit. As many as 127 Rangers, each individually addressable, can be connected to the same computer.

The Ranger emits 16 pulses at a time, at a frequency of 49.4 kHz. Its automatic digitally-controlled gain and variable-bandwidth amplifier minimizes false triggering that can be caused by noise and side-lobe detection. Sensitivity to objects is highly directional.

The Polaroid ultrasonic module around which the Ultrasonic Ranger is built has a range of 16 inches to 35 feet. Its resolution is limited to 0.15 inch by the wavelength of the ultrasonic pulses. Typically better than 11% in normal use, accuracy is limited only by the module's resolution, provided air temperature hasn't changed since last calibration.

About the Circuit

The Ultrasonic Ranger doesn't directly measure the distance to an object.

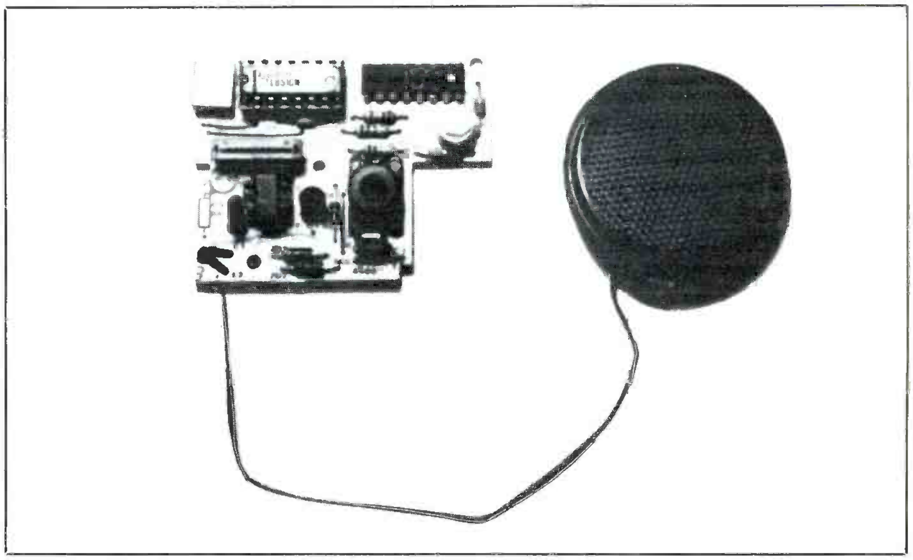
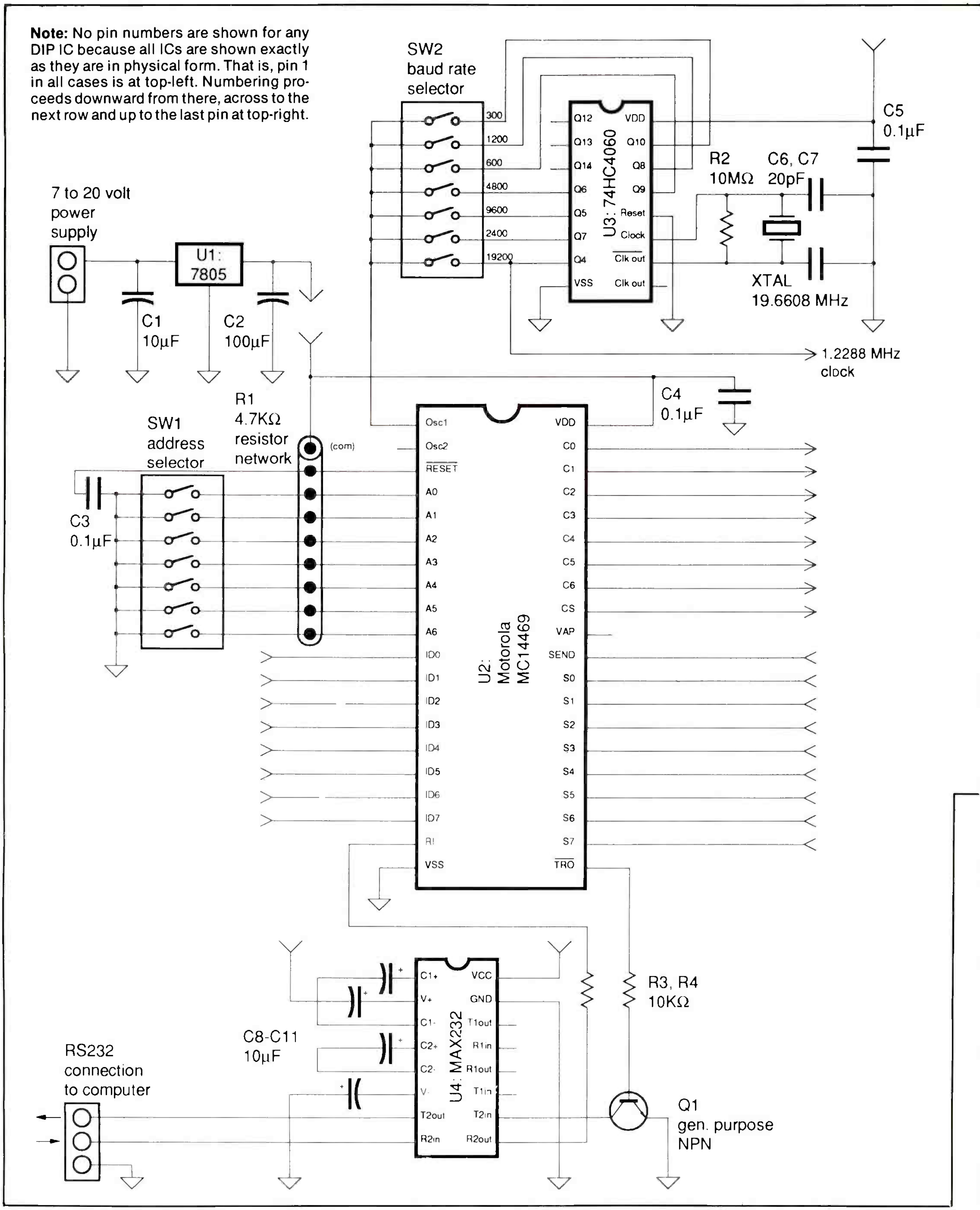


Fig. 1. Polaroid's factory-assembled ultrasonic ranging module and transducer greatly simplify building this project.

Note: No pin numbers are shown for any DIP IC because all ICs are shown exactly as they are in physical form. That is, pin 1 in all cases is at top-left. Numbering proceeds downward from there, across to the next row and up to the last pin at top-right.



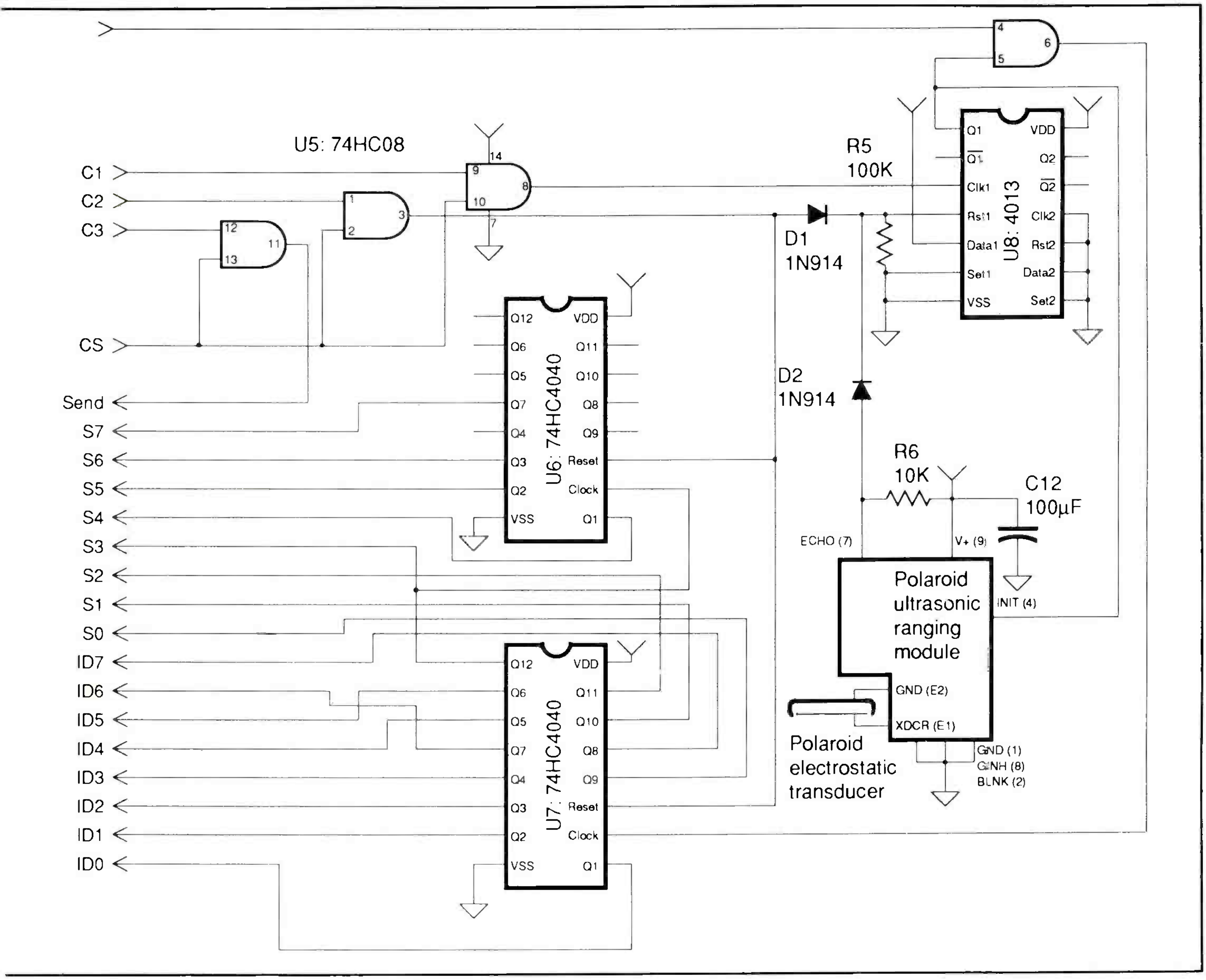


Fig. 2. Complete schematic diagram of the circuitry used in the Ultrasonic Ranger.

It measures the time it takes for sound waves to make the round-trip circuit from its transducer to an object and back again. It can obtain quite accurate measurements using sound waves because the speed of sound in air is relatively constant, except for its dependence on temperature.

Speed is calculated using the formula 331.4 $\sqrt{T/273}$ meters/second, where *T* is ambient temperature in °K. Within the 0° to 40° C range over which the Ranger will most likely be used, the speed of sound varies by approximately 14%.

The best way to deal with this variation is to measure temperature every time you wish to measure distance and make an appropriate compensation or measure the temperature once and recalibrate the Ranger only when the air temperature has changed appreciably.

The program that controls the prototype Ranger at the science exhibit mentioned above is set up to automatically calibrate at start-up in the morning and then calibrate later in the day when a button is pressed. The Ranger is typically re-calibrated once or twice later in the day to accommodate the slight temperature rise that occurs in the building.

It would be difficult to design and build an ultrasonic transmitter and receiver from scratch. Fortunately, Polaroid Corp. has a nifty module (Fig. 1) that obviates the need for this. This ultrasonic transmitter/receiver ranging module requires only a 5-volt dc power supply. It accepts a logic-level pulse to initiate transmission and responds with its open-collector output when an echo is received. External circuitry need concern itself only with triggering the module, detecting the module's response and timing the interval between these two events.

Shown in Fig. 2 is the complete

schematic diagram of the Ultrasonic Ranger's circuitry. Regulator *U1* is the heart of a simple 5-volt dc power supply, which accepts 7 to 20 volts dc as its input. Most of the current drawn by this circuit goes to the Polaroid ranging module, which draws less than 100 milliamperes continuously and has a peak current requirement of 2.5 amperes when it transmits. Even though *U1* is rated to deliver only 1 ampere continuously, it can easily power this circuit because most of the 2.5 amperes drawn by the ranging module is supplied by *C12*.

The most sophisticated chip in the system is addressable asynchronous receiver/transmitter *U2*. On power-up, *U2* is reset by the momentary low that *C3* impresses on its RESET pin. It's then ready to accept serial data applied to pin RI.

Chip *U2* expects to receive one or two 11-bit words from the host computer. The first word should contain the address. If the address matches the binary number applied to pins A0 through A6, *U2* transmits back to the computer the information it reads from pins ID0 through ID7 and S0 through S7 in two 11-bit word data streams. Each 11-bit word contains eight data, even parity, one start and one stop bits.

If the first 11-bit word received by *U2* doesn't contain the address programmed onto pins A0 through A6, *U2* does nothing. This would occur if two MC14469s were connected to the same data line and the other chip was being addressed. The second 11-bit word received by *U2* contains a seven-bit word that's latched onto pins C0 through C6 for controlling external devices, provided *U2* has received a valid address.

Rather than go through every possible way of communicating with the MC14469, a subject covered in detail by the application note mentioned at the end of the Parts List, we'll discuss only what you must know to use the MC14469 with the Ultrasonic Ranger or similar circuit.

You must first initialize the serial port of your computer with the correct baud rate, eight data bits, even parity, one stop bit and one start bit. This done, a typical send/receive cycle, as seen from the point of view of the computer controlling *U2* is as follows:

PARTS LIST

Semiconductors
D1,D2—1N914 diode
Q1—General-purpose silicon npn transistor (2N2222, 2N3904 or similar)
U1—7805 fixed +5-volt regulator
U2—MC14469 addressable asynchronous receiver/transmitter (Motorola; see Note 2 below)
U3—74HC4060 CMOS oscillator/divider
U4—MAX232 single-supply RS-232 transceiver (Maxim or Intersil)
U5—74HC08 CMOS quad AND gate
U6,U7—74HC4040 CMOS divider
U8—CD4013 CMOS dual-D flip-flop
Capacitors
C1,C8 thru C11—10-μF, 16-volt electrolytic
C2,C12—100-μF, 16-volt electrolytic
C3,C4,C5—0.15-μF ceramic or Mylar
C6,C7—20-pF ceramic disk
Resistors (¼-watt, 5% tolerance)
R1—Eight-element SIP 4,700-ohm resistor network (see Note 3.)
R2—1 megohm
R3,R4,R6—10,000 ohms
R5—100,000 ohms
Miscellaneous
SW1,SW2—Seven-position DIP switch (see Note 3)
XTAL—19.6608-MHz crystal
Polaroid ultrasonic ranging module and instrument-grade electrostatic transducer (see Note 4); power supply; cables and connectors to attach to RS-232 port; experimenter boards (see text); sockets for all IC chips; suitable enclosure; machine hardware; hook wire; solder; etc.

Notes 1. Some programming languages have trouble handling the number 0 and can't send it over serial ports. To get around this problem that occurs when you want to toggle low control pins, send a command word that toggles high an unused control pin, rather than sending 0.
2. The MC14469 isn't commonly used; so it may help to contact Motorola and obtain Application Note 806: "Operation of the MC14469" (Motorola Semiconductor Products, 5005 E. McDowell Rd., Phoenix, AZ 85008).
3. If you don't think you'll frequently have to change the address of a particular node, you can tie high or low pins 4 thru 10 of U2, to permanently set an address, and eliminate R1 and SW1. Likewise, if you don't anticipate changing baud rates, connect the appropriate output of U3 to pin 1 of U2 and eliminate SW2.
4. The Polaroid ultrasonic ranging module and electrostatic transducer are available from Polaroid Corp., Ultrasonic Components Group, 119 Windsor St., Cambridge, MA 02139 (Tel.: 617-577-4681). Parts used in this device are the 6500 Series module (No. 615077) and instrument-grade transducer (No. 604142). Polaroid's $99 OEM Kit contains two of each of these.

(1) Send the first number over the serial port: first number = 128 + A6*64 + A5*32 + A4*16 + A3*8 + A2*4 + A1*2 + A0, where *A6, A5, A4, A3, A2, A1* and *A0* are either 1 or 0, corresponding to the logical status of those pins on the MC14469 to be addressed.

(2) Send the second number over the serial port: second number = C6*64 + C5*32 + C4*16 + C3*8 + C2*4 + C1*2 + C0, where *C6, C5, C4, C3, C2, C1* and *C0* are either 1 or 0, corresponding to the logical status you want latched onto those pins of the MC14469. At this point, *U2* will briefly take its CS (Command Strobe) pin to a logic high.

If you want to receive data from *U2*, you must arrange the circuit so that the pulse on CS brings high SEND. This can be accomplished with a hard-wired connection, a switch or an AND gate in this circuit. If a valid address has been received by *U2* and its SEND pin is brought high within seven bit times of CS, it returns two numbers to the host computer. The task of the computer will be to:

(3) Receive an eight-bit number over the serial port. This number corresponds to the number present on ID0 through ID7, where *ID0* and *ID7* represent the least- and most-significant bits, respectively.

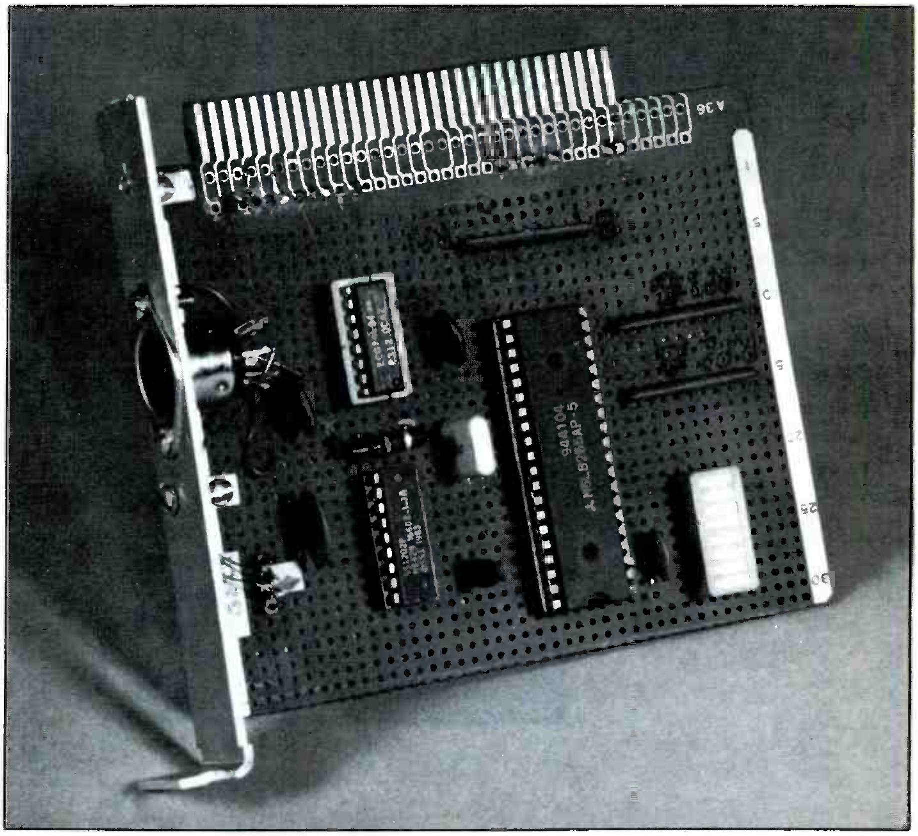
(4) Receive a second eight-bit number over the serial port. This number corresponds to the number present on S0 through S7, where *S0* and *S7* represent the least- and most-significant bits, respectively.

For the above to work, the baud rate to which your computer's serial port is initialized must match that at

(Continued on page 81)

The Super Sleuth

Computer phone-call monitor deciphers scanner and mobile radio numbers . . . and also tracks long-distance phone use



Your PC can decipher the tones received by a scanner, mobile telephone, shortwave radio and telephone instrument when dialed. The DTMF (Dual-Tone Multi-Frequency) tones being transmitted contain coded numbers and information you might like to decode and log. To do this with a PC, you need a decoder circuit like the one described here.

Several uses could be made of the Super Sleuth decoder, including the phone-line monitor application to be described, which uses the circuit to record dialed numbers, register times the calls came in and list the duration of each. Keeping a log like this has a number of benefits, among them tracking long-distance phone usage. Other logs could be made of numbers from your scanner and mobile phone for the same purposes.

About the Circuit

The decoder circuit is built around the SSI-202 DTMF decoder and Intel's versatile 8255A peripheral interface adapter chips. The 8255A provides port control for the decoder. Though the circuit configuration shown in Fig. 1 is designed for PC/XT and compatible computers, you can easily adapt it for use in AT and faster machines.

Chip *IC2* is basically a port controller that provides three separate parallel I/O ports to and from the PC with which the project is used. These ports can be made either input or output, depending on the control signals sent to the controller through three-to-eight-line decoder/multiplexer *IC3*. If the decoder is enabled using AEN (Address Enable), A8 and A9 from the bus, the decoder decodes the inputs connected to address lines A5, A6 and A7.

The decoder sends a chip-select (CS) pulse from one of its eight outputs to *IC2* when various combinations of address lines A5, A6 and A7 are active and AEN is low. This means the decoder will decode eight separate chunks of memory between decimal 512 and 736. DIP switch *S1* lets you select the address that best suits your needs and doesn't interfere with other I/O addresses connected to your system.

The DIP switch is connected to the decimal 576 port address, which makes this the base address. The various addresses that can be selected are shown next to the appropriate pin on *S1*. If address 576 is already in use in your computer, select another pin connection via *S1* simply by setting the 576 line to OFF and the chosen one to ON. Make sure you set only one DIP-switch position to ON. If more than one position is active at a time, strange results will occur as your PC tries to read two port addresses simultaneously.

Decoded data is supplied by *IC1*, which converts standard DTMF tones to binary values between 1 and 16. The circuitry to perform all required filtering, band splitting and analog converting is contained inside *IC1*, which requires only a single 5-volt source of dc power to operate. The decoder uses an inexpensive 3.579-MHz crystal and has very high noise rejection. Special provisions have been made on the filters to reject the dial tone.

The tone input at pin 9 can be coupled through a ceramic capacitor to the signal source. All standard DTMF tones are recognized and converted to unique binary values on data output pins D1 through D4. This gives the IC

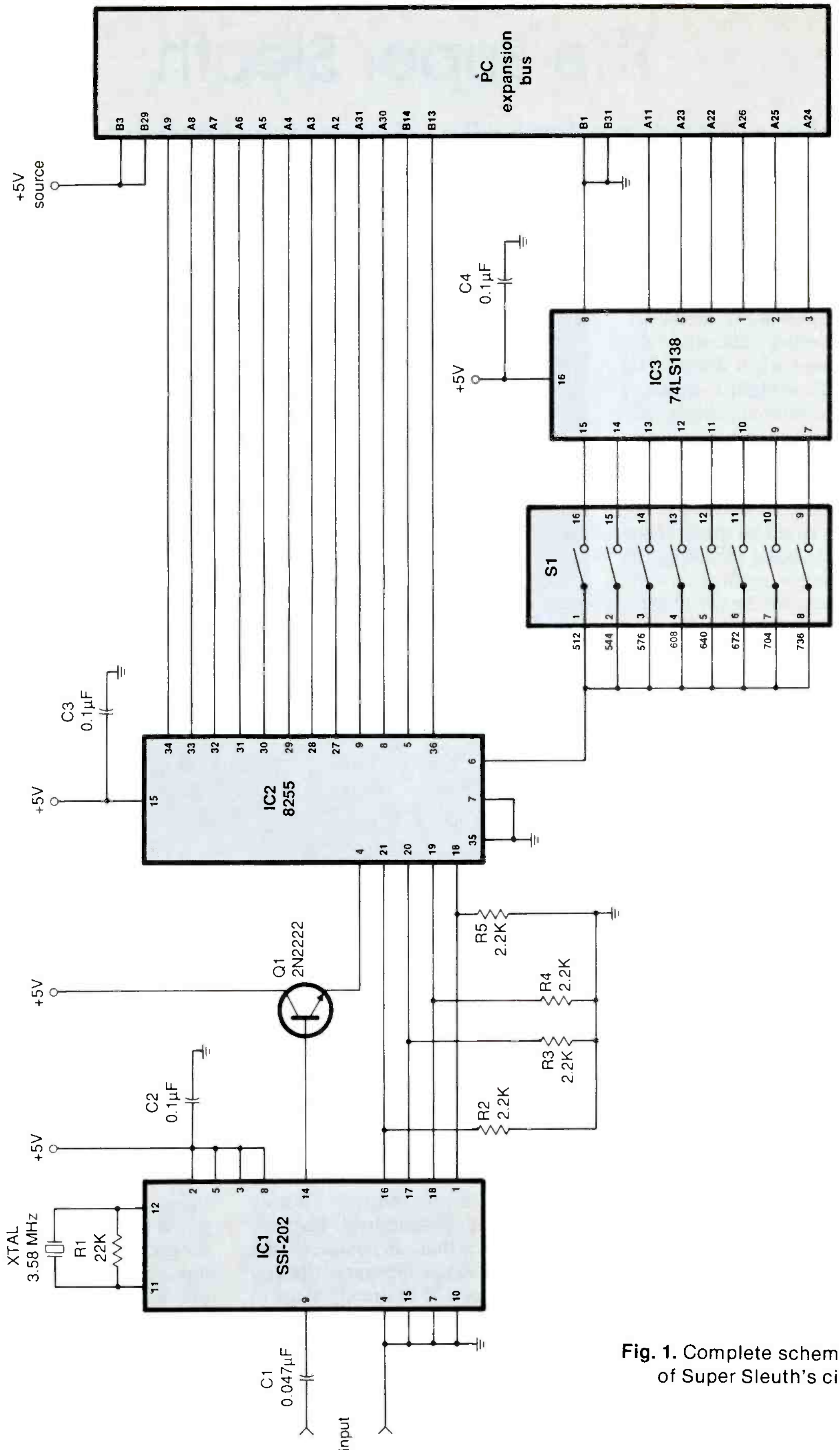


Fig. 1. Complete schematic diagram of Super Sleuth's circuitry.

PARTS LIST

Semiconductors
IC1—SSI-202 DTMF tone decoder (see Note below)
IC2—8255 peripheral interface adapter
IC3—74LS138 decoder multiplexer
Q1—2N2222 npn transistor
Capacitors
C1—0.047-μF ceramic disc
C2,C3,C4—0.1-μF ceramic disc
Resistors (¼-watt, 5% tolerance)
R1—22,000 ohms
R2 thru R5—2,200 ohms
Miscellaneous
S1—Eight-position DIP switch
XTAL1-3.579-MHz colorburst crystal Radio Shack Cat. No. 272-1310 or similar)
Perforated board with holes on 0.1″ centers (Radio Shack Cat. No. 276-192 72-position Plugboard or similar; see text); sockets for all ICs; hookup wire; solder; etc.

Note: The following items can be obtained from Syntronics, 2143 Guaranty Dr. Nashville, TN 37214: SSI-202 DTMF tone decoder, $14 and enhanced compiled Telephone Call Log program, $15.

a decoding capability of 15 separate tones. A value of 0 on its output pins indicates no decoded tones.

Pin 14 is the DAV line that goes high when a valid tone has been decoded successfully. This line can be used to provide handshaking between the IC and output device. Once a pause between tones is detected, the DAV line returns to low and doesn't activate again until the next tone is decoded.

The DAV line is used in the small decoder test program given elsewhere in this article to permit decoding of a single tone and avoid repeating if the tone key is held for a longer-than-normal time. Because the DAV line doesn't have high drive capability, *Q1* is used to present a clean, reliable signal level to the 8255.

The analog input of static-sensitive *IC1* must be protected against high current and voltage spikes. Power-supply leads to each IC must be suitably bypassed with capacitors to avoid noise and voltage spikes from getting to the IC. If the analog input isn't protected with specific blocking capacitors and pull-up resistors when connected to power sources that deliver greater than +5 volts, damage can occur. This would be especially true of the ring-signal voltage found in standard telephone lines.

Figure 2 is the schematic diagram of a demonstration interface circuit you can build for the phone line. This is *not* part of the decoder project. It's given here for for discussion purposes only since it hasn't been certified by the FCC. A suitable interface circuit could be built using certified transformers that meet with phone-company approval.

The Fig. 2 circuit shows that some means of recognizing the off-hook condition of the handset is needed and provides a means of receiving DTMF tones generated by a caller. When the handset of a telephone instrument is lifted off-hook, the potential on the phone line drops from about 48 to 5 volts. High-voltage transistor *Q1* is clamped to read 5 volts and 0 volt, respectively. The actual +5-volt signal is fed through *Q2*, which conducts when the handset is lifted off-hook. This signal can then be routed to Port C of the 8255 in the decoder circuit to provide the program with a means for detecting an outgoing call.

Analog tones can be detected via the green-insulated telephone conductor. These tones are effectively blocked from the ring voltage swings by *C1*, which is held high by pull-up resistor *R5*. The voltage drops below ground potential when an incoming call is completed. Resistor *R5* prevents this negative voltage from occurring and protects the analog input to the SSI-202. The signal is double protected by being routed through *C1* on the decoder circuitry.

Construction

You should have no difficulty finding the components needed for this project locally. If you do encounter a problem with the SSI-202, you can obtain it from the source given in the Note at the end of the Parts List.

As you can see from Fig. 1, this project contains very few components. Mount the components on a prototyping board designed specifically for IBM PC-type expansion slots, and use sockets for all ICs.

Figure 3 shows all 62 contacts and their functions for the PC expansion bus. You build the project on a 62-contact experimenter's card that fits into the expansion connector in your computer.

Although you can buy expansion cards made for the PC case and con-

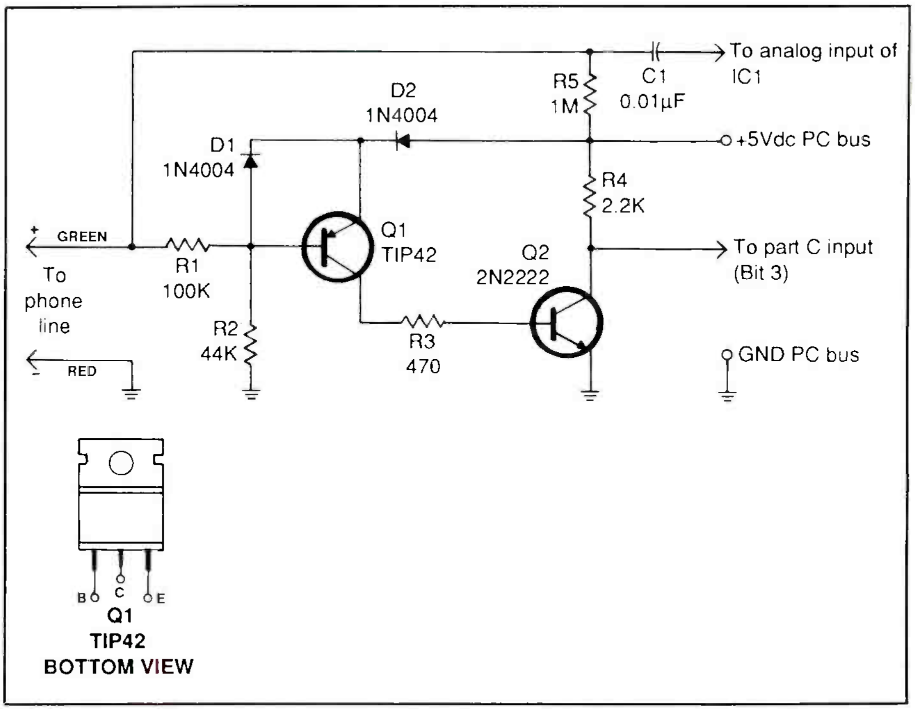


Fig. 2. Example of an experimental telephone interface for project

nector, a much less expensive method is to purchase the Radio Shack experimenter's card specified in the Parts List and trim it to fit. The connectors must be cut down to 62 pins by trimming five double fingers from the end of the board. The + 5-volt and ground buses for the decoder circuit are taken directly from the expansion bus on pins B3, B29, B1 and B31 of the expansion connector.

Make sure you beef up the traces to the power supply fingers on the card with solder to provide greater current-handling capability.

Wire the crystal and *R1* close to pins 11 and 12 of the decoder chip.

Programming the I/O Ports

The data lines from the parallel interface adapter are accessed only when the CS signal is active. One of the three ports can be read as an input or used as output, depending on your programming.

The control register that configures the ports as either input or output is located at base address 576 + 3. Therefore, the control register for your configuration is 579. Port A of the 8255 is read at the base address, Port B is accessed at the base address + 1, or 577, and Port C is accessed at the base address + 2, or 578. Table 1 shows the combinations that can be sent to the control register to configure Ports A, B and C as all input, all output or any combination in between.

Listing 1 is a simple BASIC program that configures all three ports as input and reads the data from the 8255 on Ports B and A. Only bit A0 is read on Port A as a status bit. This line is connected to DAV and is used as a data-ready signal that shows that the data is available. The actual data is read from Port B on data lines B0 through B7. This program waits until line A0 goes high and reads the data from Port B. The program prints the decimal value to the screen and waits until another valid tone is generated.

Lines 70 and 80 convert binary values 11 and 12 to the asterisk (*) and number (#) signs, respectively, as found on the standard telephone keypad. If more than the standard set of tones are to be decoded, line 50 must be changed to permit all 16 numbers to be recorded. After decoding a tone, lines 100 and 110 sample the DAV line to see if the tone is still active. If so, it waits until a pause has occurred and returns to again sample the data line. This keeps the program from repeating the same digit if the key is held down for longer than a "normal" period of time.

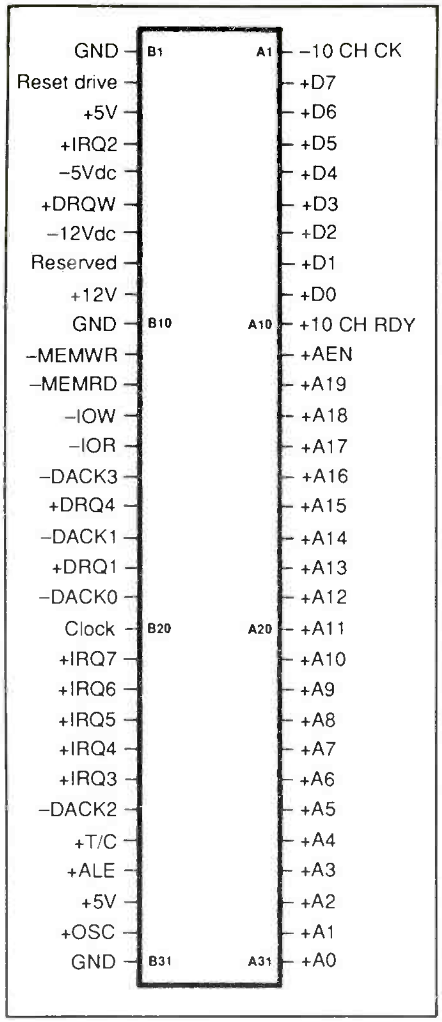


Fig. 3. Pinout configuration and contact assignments for the standard IBM PC (and compatible) expansion-bus connector.

A more elaborate machine-code program can be written around this sample listing to store numbers in memory, format them and any area codes included, record time and date and send a formatted listing to the printer for hard-copy printout. Since regular BASIC isn't fast, this formatting might have to be done after numbers are acquired. Placing the numbers in formatted strings and storing them is too much for regular BASIC to do quickly. This program could easily be written in compiled BASIC or assembly code, which would yield extremely fast operation.

Table 1. Port Configuration Words For Base Address + 3

Decimal Word	Port A	Port B	Port C
128	Out	Out	Out
130	Out	In	Out
133	Out	Out	In
135	Out	In	In
136	In	Out	Out
138	In	In	Out
130	In	Out	In
143	In	In	In

Often, tones are entered as fast as three per second. Regular BASIC must watch the data bus almost constantly to avoid missed tones at such speed. The enhanced machine-code telepone-log program can be obtained from the source given in the Note at the end of the Parts List. For simple decoding, however, the sample test program in Listing 1 works extremely well for this.

Operation & Troubleshooting

After assembly and before plugging the ICs into their respective sockets, check all power-supply connections to each chip. This is particularly necessary for *IC1*, since a reversed connection here could destroy this chip. This test can be done with an ohmmeter without having to insert the board into your PC expansion bus. Note that four pins of the decoder are brought to ground and four others connect to the positive rail. Check each of these pins to make sure they're electrically and mechanically solid because, if not, a bad connection will inhibit proper operation if the connection is reversed.

When the board checks out okay, install the ICs and plug the board into an available expansion slot in your PC. Power up your computer and run the BASIC program shown. Nothing should appear on-screen until a tone is received. If a number does occur or keeps repeating, the DAV line may be remaining high or there's an error in program entry.

For simple tone decoding, tones can be tape recorded from the phone or scanner and played back to check the operation of the circuit and program. Input can be provided from the ear-

Listing 1. Sample BASIC Program

```
1 REM SAMPLE PROGRA - SUPER SLEUTH
2 REM BY JIM STEPHENS
3 REM DECEMBER 1990
10 OUT 579,143
20 C=INP(577)
30 IF C>0 THEN GO TO 50
40 GOTO 10
50 IF C>14 THEN GOTO 10
60 IF C=10 THEN C=C-10
70 IF C=11 THEN PRINT "*";:GOTO 100
80 IF C=12 THEN PRINT "*";:GOTO 100
90 PRINT C;
100 D=INP (576)
110 IF D>0 THEN GOTO 100
120 GOTO 10
```

plug jack of the recorder. If proper operation fails to occur, reverse the connections to the earplug, since many recorders interchange ground connections. If the decoder still fails to operate properly, vary the setting of the VOLUME control of the recorder either up or down or change the value of input capacitor *C1* to greater or lesser value than that specified.

If the project consistently gives decoded numbers that are incorrect by a factor of 1, 2, 4 or 8, one or more data lines are being held higher than allowed. The data line at pull-down resistors *R2* through *R5* should all be reading zero when no decoding is being done. A logic probe can be of help in checking the data lines from *IC1* back to the PC expansion bus.

If no data is getting through *IC2*, use the logic probe to check for a pulse at the CS pin of *IC2* each time a port is accessed by the program, and check for the DAV pulse each time a tone is sent. If the DAV pulse is absent, try increasing the level of the tone, either with the recorder's VOLUME control or a change in the capacitor's value. Also, verify that address selector switch *S1* is set to decode Port 576. Otherwise, the program must be changed to reflect the new address.

Once you have the project up and running, you'll find it fascinating to watch your computer interpret numbers that you once couldn't fathom. Many decoded numbers that fill the screen of your computer still won't be recognizable. An acquaintance of mine who is familiar with tone transmissions tells me that many of these numbers are probably access codes, account numbers and even credit card numbers. This is really no concern to me since my main interest is to connect the decoder to the phone (through an approved interface) and tabulate the numbers, times, duration and dates of outgoing calls. ■

VGA To The Max

Part 2

A brief but comprehensive Computer Graphics Glossary of Terms

Last month, in Part 1 of this article, we discussed in detail the latest trends in computer graphics technology as it pertains to the VGA standard and beyond. In this concluding part, we present a brief but fairly comprehensive Glossary of Terms commonly used in this area of computer technology.

Aliasing—See Jaggies.
Analog Video—A method used to generate the signals delivered to the video monitor. Digital picture information is passed to the graphics card, on which a video DAC (see RAMDAC and DAC) converts the binary data into continuously variable analog voltages that drive the CRT's electron guns. Accelerated electrons from the guns excite the RGB (red, green and blue) phosphors from which each viewed pixel is constructed.
Anti-Aliasing—A technique used to alleviate the jaggies often observed along the edges of on-screen curved and angular objects (text and graphics). Performed either by software or in hardware, these algorithms appear to smooth such anomalies by slightly blending (blurring) the colors of pixels immediately adjacent to an edge.
Area Fill—Sometimes referred to as "flooding," area fills are the complete painting of any enclosed area, regardless of its shape, with a solid color.
Artifacts—Unwanted portions of an image usually resulting from an incomplete or incorrect conversion process. In color space conversions, artifacts can appear as patches of color within the converted image that don't approach those in the original. This can also occur when attempting to drastically alter the scale of a bitmapped image.
Aspect Ratio—The perceived proportional relationship in pixels between an image's horizontal X and vertical Y axes viewed on-screen. A brief breakdown of these ratios versus common computer resolutions is as follows:

Mode	Resolution	Aspect Ratio	Percent
CGA	640 × 200	2:1	200
EGA	640 × 350	1.33:1	133
VGA	640 × 480	1:1	100
SVGA	800 × 600	1:1	100
8514/A	1,024 × 768	1:1	100

As the Percent column reveals, images displayed at VGA resolutions and better are reproduced at a balanced 100% of their original proportions (1:1 aspect ratio). Simply put, this means that a given image, like one captured from PAL or NTSC video, will appear "proportionally correct" (though at different scales) across these modes. The same image, however, will appear distorted (elongated or squeezed) at modes less than VGA, where the percentages become exaggerated.

Attribute—A single defined color element of a computer graphic. Also referred to as on-screen colors, the combined attributes are the maximum number of simultaneous colors a graphics adapter can generate at one time.
Banding—The visual anomaly that occurs when a graphics adapter lacks the necessary pixel depth to smoothly gradate a color from light to dark shades. This effect appears on-screen as coarse strips or "bands" of color.
BitBlt—(Bit-Block-transfer). The moving of visually rectangular groups of pixels (display memory) from one on-screen location to another. Microsoft *Windows* is an excellent example of a BitBlt-intensive application.
Bitmapped Image—Also known as a raster image, this is the simplest method of manipulating and storing computer graphics. Citing VGA as an example, each pixel of the display corresponds to a byte value stored in video RAM's frame buffer (it's no coincidence that the order in which these bytes are arranged is similar to the way each video scan line is displayed). Usually, the first address location of image data within the file corresponds to the upper-left-most corner of the screen, the final address to the lower-right-most corner of the screen. Variations of image bitmaps are employed by the majority of graphics file formats, including TGA, GIF, TIFF, PCX, PIC and *Windows* BMP.
BPP—(Bits-Per-Pixel). The number of data bits that determine the color of each displayed pixel. The maximum number of displayable colors a pixel can assume (color depth) is determined by the weighted sum of these bits. A 15-bit value, for example, yields a weighted sum of 32,768 colors, while an eight-bit value yields only 256 colors.
Example. Sierra 32K HiCOLOR BPP
RGB = red, green and blue primary colors of each pixel
R + G + B = final color
25 = 32K possible combinations of R, G or B
25 × 25 × 25 = 32,768 possible colors = 32K HiCOLOR

The BPP in 32K HiCOLOR would then be the sum of the three powers of 5 (to which the RGB values are raised), yielding a BPP of 15.

The amount of video RAM required for an 800 × 600 × 32K display would then be (800 × 600 × 15)/8 = 900K bytes.

64K HiCOLOR (XGA color) is obtained by raising the green bits to the power of 6. The BPP in 64K HiCOLOR would then be the sum of two powers of 5 plus one power of 6, for a BPP of 16.
CGA—(Color Graphics Adapter). A false-color, low resolution TTL-based digital graphics standard developed by IBM. CGA has a maximum of 16 displayable and available colors.
CMYK—(Cyan Magenta Yellow blacK). The color primaries used by the printing industry to create four-color separations. The CMYK color model has been proposed for PCs as an option to the more-familiar RGB format currently in use. The reasoning behind this proposal is the increasing use of PCs to generate color artwork destined to be typeset. Errors in color selection (a common problem when estimating CMYK results on an RGB plat-

form) would be eliminated by working in a single, defined color space, from layout to final printing. Although emulated in some graphics software, CMYK has yet to become an adopted hardware platform for computer graphics.

Color Depth—See BPP.

Color Space Conversion—Also known as color enhancement, these are algorithms performed in hardware and/or software to convert colors in one graphics format to those in another. Conversion is required when a source like broadcast TV has far more colors available or fewer, as in CMYK, than the target, which might be 256-color VGA. If the source color space is greater than the color space of the target format, a distillation must be performed to more closely match the limitations imposed on the destination. Depending on the algorithm used, the conversion can assume a very close approximation of the original, with only minor anomalies and artifacts remaining.

CRT—(cathode-ray tube). The vacuum tube that makes up the bulk of the video monitor on which computer data (text and graphics) is displayed.

DAC—(digital-to-analog converter). A device that converts digital computer data into a variable analog output voltage directly proportional to the numeric value of the input data. For example, if data received by a DAC is in eight-bit bytes (2^8), the input range can be said to vary from 0 to 255 (256 contiguous steps). Additionally, if the DAC's reference is 2.5 volts, the range of the analog output would be 0 to 2.5 volts in 255 steps of 9.8 mV. Values of the voltage steps are approximated by dividing the reference (in this case, 2.5 volts) by the input range (256).

Dithering—Sometimes (often not accurately) referred to as halftones, this is a method of emulating gradient shades of colors (or grays) by varying the density of the "dots" within an area of the image, using tightly spaced groups of dots to reflect deeper tones and moving to more loosely grouped dots to reflect lighter tones.

Deep Color—Color graphics with a BPP of 15-bits or greater are collectively called deep color and produce a minimum of 32,768 simultaneous colors. Although this approaches the visual effects of true color, there's a distinction. Deep color is capable of reproducing photographic-quality imagery in some cases, but in others it yields unwanted anomalies, like banding. Only 24-bit true color can reproduce images with the accuracies demanded by the publishing and broadcast video industries.

Display Driver—A program-specific software file written to support proprietary features of an installed graphics adapter. These files contain such information about the graphics card as display resolutions available and how to enable them, methodology for performing BitBlts, color programming, cursor overlays, etc.

Dot Pitch—The physical distance (in millimeters) between adjacent phosphors that make up each pixel on a CRT's screen. As this value decreases, perceived sharpness of the displayed image increases. Current CRT technology permits dot pitches of 0.26 and smaller, with 0.28 mm being the most economically popular. Values greater than 0.28 mm render images that can appear fuzzy and lacking in detail, even at higher resolutions. Though a difference of only 0.03 mm may seem slight, the resulting fuzziness is a cumulative effect across the full display area and is easily seen in side-by-side monitor comparisons.

DRAM—(dynamic random-access memory). Commonly used as PC main memory. Use of DRAMs is the most cost-effective means of implementing a frame buffer (video memory) on a graphics adapter. Although slower than VRAMs, these chips can be used in non-interlaced display modes, providing the video controller can access its frame buffer in 0 wait states. "Dynamic" refers to the need to periodically send a refresh pulse to the device to recharge the individual capacitive memory elements.

Dumb Frame Buffer (DFB)—Applies to the vast majority of currently installed PC display adapters, including VGA. A DFB isn't capable of processing display data beyond simply accepting instructions from the host CPU and effecting traffic control of its display memory and video output circuitry. Calculations required for line draws, circles, BitBlts and other display algorithms are all performed by the host CPU. To draw a line, the host must first calculate the X-Y coordinates of each pixel within the line and then pass the results to the DFB for display.

EGA—(Enhanced Graphics Adapter). A medium resolution, false-color analog graphics standard developed by IBM. A predecessor to VGA, EGA can display a maximum of 16 simultaneous colors from an available palette of 64 colors.

False Color—A method of displaying computer graphics with a pixel depth of less than eight (usually four or two) bits. Independent of the actual stored image BPP, "false" refers to the fact that displayed colors are essentially a "best guess" by virtue of this shallow BPP limitation. CGA and EGA graphics standards fall into this category.

Gradient Fill—Similar to an area fill, except that the colors used to paint the area gradate from light to dark shades, often lending the illusion of three-dimensional "shadows" to an object.

Graphics Accelerator (GA)—The next step up from the dumb frame buffer. Inclusive of the functions found in the DFB, the typical GA also contains engines to perform BitBlts and generate graphics primitives (lines, polygons, circles, etc.). More-recent single-chip GAs, are essentially standard VGA cores with an embedded processor that relieves the host CPU of computing most graphics tasks to greatly accelerate display throughput and overall system performance. To draw a line, the host need only tell the GA the beginning and ending coordinates (vectors) of the line. The GA calculates the positions of the pixels along the path between these points and displays the line. XGA and 8514/A graphics adapters fall into this category.

Grid—Virtually the electronic equivalent of graph paper, a grid within a drawing program assists the video artist in placing items on-screen with greater accuracy. Grids are usually visible as a framework of faintly colored (so as not to detract from any artwork in progress) and uniformly spaced dots across the drawing field. Popularized by CAD programs, grids have become *au rigeur* of even the simplest of paint software.

GUI—The graphical user interface, or GUI, was first conceptualized at Xerox PARC (Xerox's Palo Alto Research Center) and later adopted and popularized by Apple with the Macintosh. It has matured and proliferated across numerous system platforms, including X-Windows for UNIX, OS/2 for IBM, *Windows* and *Desqview* for DOS, etc. Each with its own unique look and feel, a GUI presents a collection of small graphical objects (icons) that represent different applications or tasks. Ideally, this method of user/computer interaction eases the burden of navigation in what would otherwise be a complex and time-consuming series of text-based queries.

Horizontal Sync—Also referred to as the horizontal scanning frequency, this signal determines how often a video monitor draws a single, horizontal line of the display. Measured in kilohertz (kHz), the standard VGA horizontal frequency is 31.5 kHz, while SVGA can range from 35 kHz to 50 kHz, depending on the vertical refresh rate of the display adapter.

Icon—Familiar to GUIs, an icon is a small graphic image that represents a function or software application. An icon of a pencil, for example, might indicate a tool for drawing lines.

Image Buffer—Also page buffer, frame buffer or video memory. It's the RAM used by a graphics adapter to hold screen data. The size of the image buffer determines maximum displayable resolution. Example: The amount of RAM in bytes required for a resolution of 1,024 × 768 × 256 (1,024 horizontal pixels by 768 vertical pixels with 256 color attributes) is determined by multiplying 1,024 × 768 × BPP, and then dividing by 8. Since 256 color graphics have a BPP of 8, the RAM requirement for a full screen using the above formula would be 786,432 (786K) bytes. In contrast, the image buffer size required for CGA graphics is only 16K bytes. This collection of bytes comprises a bitmap of the display

area, or one page of video memory.
Interlacing—If a computer display is conceptualized as a stack of horizontal lines, "interlacing" refers to the graphics adapter generating an image by first displaying only the odd-numbered lines of an image, then returning to display the even-numbered lines. Half the image data is displayed first, and then a second pass is made to display the other half. Each group (odd and even lines) is called a field. Combining, or interlacing, the two fields produces the complete image, or a frame. This method has been employed in broadcast TV since its inception and is the least-taxing on a computer graphics system. An inherent drawback to interlacing is the slow scanning frequency (56 or 60 Hz) that can generate annoying flicker that's exacerbated at SVGA resolutions of 800 × 600 and better.
Jaggies—Also referred to as aliasing, is the "stair-step" effect apparent along the edges of curved and angular lines viewed on-screen. Exacerbated at low resolutions, jaggies result from the "building-block" nature of pixels to display images.
Mosaic—The blurring of an image area by greatly increasing perceived pixel size and blending adjacent colors. Sometimes referred to as low-pass filtering, mosaics are often used by TV news media to mask a person's identity.
Non-interlacing—The most ergonomic method of generating a computer display. Horizontal lines in each frame of video are drawn continuously from top to bottom in a single pass. The obvious advantage is that screen flicker is significantly reduced by virtue of the higher scanning frequencies (70 Hz or faster) employed in non-interlaced video.
Panning—This is movement (shifting) of the displayed images in any direction without changing its current magnification. It's useful if the image boundaries extend beyond the limits of the screen's viewing area.
Picture Element (PEL)—Archaic form of pixel.
Pixel—Smallest viewable element of a computer image. On color monitors, a single pixel is inclusive of the three RGB phosphors (grouped in triads) that determine the pixel's color. Different colors are determined by varying the intensity of each RGB phosphor independently within the pixel. Conversely, gray shades are determined by varying these intensities equally. The following helps to illustrate the relationship in dots-per-inch (dpi) between pixels and common graphics resolutions.

Mode	Resolution	Horizontal*	Vertical*
CGA	640 × 200	96	48
EGA	640 × 350	96	72
VGA	640 × 480	96	96
8514/A	1,024 × 768	120	300
Laser Printer	N.A.	120	300

*Figures in these columns are in dots per inch (dpi).

Pixel Depth—See BPP.
Primitives—The most basic graphics elements (lines, polygons, curves, etc.) that can be combined to create more-complex images. It's desirable to have the ability to generate these in hardware (a feature common to some graphics accelerators) because of their math-intensive nature.
Pseudo Color—A method of displaying computer graphics with a pixel depth of eight bits. "Pseudo" refers to the fact that displayed colors are only an approximation by virtue of the 8-BPP limitation. Each pure primary color value (R, G and B values) is limited to only 64 possible shades. This is far below even the upper limits of how many shades of a given color the eye can perceive. This category includes 256-color VGA graphics.
RAMDAC—Also hardware color palette, a device inclusive of a 256-byte RAM color lookup table (attribute buffer) and three video DACs (one each to generate the R, G and B primary colors used by analog color computer monitors).
Raster—The action of producing a horizontal line of pixels on a computer screen; one horizontal line of a displayed image (text or graphics).
Ray-Tracing—A method of creating computer images based on perceived reflective and refractive qualities of virtual "rays" of light striking various surfaces. Its usage in animation still largely limited to super-computers, a much scaled-down version of ray-tracing software (capable of generating static images) has been ported to PCs in the form of Pixar's *Renderman* (an add-in tool for *AutoCAD*). To give some idea of the complexity of ray-tracing, consider that employees at Apollo Computer created a very impressive, 5-minute animated short, using only Apollo workstations (based on Motorola's 68000 microprocessor) titled "A Long Rays Journey Into Light" (the final cut being filmed directly from the screen of a high-resolution video monitor using an antique motion picture camera to avoid synchronizing with the monitor's refresh rate). Total computation time was 50,000-plus CPU hours!
Refresh Rate—Also scanning frequency or vertical retrace frequency, expressed in hertz (Hz) or events-per-second. It's how often a display adapter updates the complete on-screen image.
RGB (Red/Green/Blue)—The three primary colors used by analog computer graphics hardware to create various color combinations. Unique colors are established by varying the intensities of each primary color and then combining them to achieve the desired shade. The breadth of possible color combinations is determined by the range of variations available to each R, G and B value. See also True Color and BPP.
Rubber-Banding—Essentially a graphics previewing tool for placement of objects on-screen. Connecting the cursor (mouse pointer, etc.) to a fixed point along a line or other object that stretches or contracts like a "rubber band" as the cursor is moved.
Sprite—A group of programmable rectangular pixels, usually 32 × 32 or greater, used in computer animation. Requiring dedicated hardware (common to arcade games and some small computers), sprites appear to travel smoothly about the screen and can pass over or behind other on-screen objects without disturbing them.
SVGA (Super VGA)—Sometimes referred to as EVGA (Extended VGA), SVGA graphics modes are proprietary controller-specific methods of boosting the 320 × 200 resolution of standard 256-color VGA to 1,024 × 768.
Tiling—Similar to both area fills and gradient fills, tiling paints an area with a repetitive pattern of defined graphical sub-entities or "tiles."
True Color—A method of displaying computer graphics with a pixel depth of 24 bits or greater. "True color" refers to the displayed colors being the most accurate and natural reproductions possible, provided the original image file was captured on equipment capable of not less than 24 BPP. This studio-quality graphics standard is derived from the fact that the human eye can't distinguish the subtle differences between more than 256 adjacent shades of any color. Essentially, the individual R, G and B primary colors have a minimum depth of 256 shades each, for a possible 16.7-million colors. First popularized on PCs by Truevision's Targa boards, 24-bit color has quickly become the *de-facto* standard for high-end computer graphics, where photo-realistic image processing is required.
TTL Video—An all-digital method of communicating image data between display adapter and monitor, TTL (transistor-transistor logic) video was among the earliest forms of computer displays but now has all but disappeared from the marketplace due to the huge success of analog graphics formats. The major drawback of TTL video is its restricted image-data bandwidth that severely limits both pixel depth and graphics resolution.
Vectored Graphics—A format common to CAD software that defines an image as a collection of absolute physical coordinates
(Continued on page 80)

DR DOS Version 6.0: Is it a Better O/S Than MS-DOS 6.0?

A computer's operating system can be likened to the neural centers of the brain. After all, it's the operating system that endows the computer with a set of instructions that enable it to do useful work and interact with its user.

Back in the early days of "personal" computing, the pre-eminent operating system was CP/M, created by a chap named Gary Kildall. Kildall is the founder and CEO of Digital Research, Inc., a multinational organization that develops and markets a range of general-purpose operating systems for microcomputers, family of real-time operating systems and line of graphics systems and applications software products. The advent of the 16-bit IBM PC with its PC-DOS operating system (developed by a fledgling company named Microsoft) marked the beginning of the end for the eight-bit CP/M.

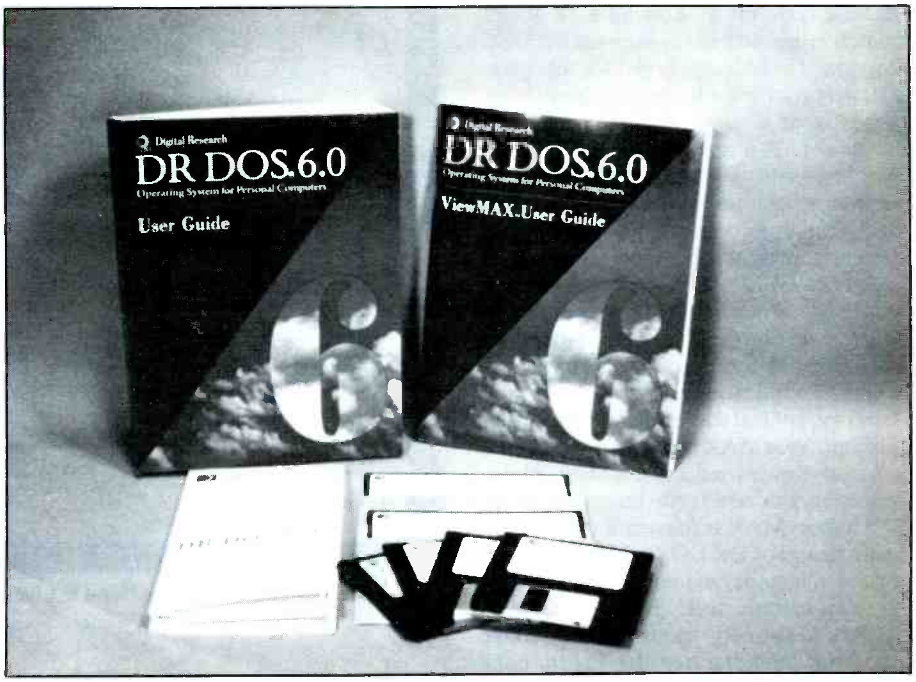
Digital Research, however, developed a competitive product to Microsoft and continued to wage a quiet operating-system war with Microsoft for years. DR released DR DOS 5.0 a couple of years ago for IBM-compatible PCs, and it produced quite a stir as a greatly-enhanced alternative to the then-popular Microsoft MS-DOS 3.3 and new DOS 4.01 versions.

DR DOS overcame many of the deficiencies of the Microsoft operating systems, including better support for high-capacity hard disks. Also, a full-screen text editor and more-efficient memory management made it a better product than either of the Microsoft versions against which it was positioned to compete. But, alas, it wasn't a stellar success in the marketplace, compared to Microsoft DOS.

Several OEMs (Asian makers of laptop and notebook computers) selected DR DOS 5.0 as the standard operating system for their machines. The DOS was commonly put into ROM, which made it convenient for the user and saved disk space that DOS would normally take up. Microsoft's DOS, in contrast, couldn't be easily put into ROM because of the way its code was written at the time.

It seems that Microsoft did pick up a pointer or two along the way, as evidenced by the release of MS DOS 5.0 last year, which was hailed as the "DOS you've been waiting for." Hot on Microsoft's heels, Digital Research released DR DOS 6.0. The operating-system competition was back again in full swing.

In an effort to make DR DOS more useful and more attractive and to overcome the inbred preference for Microsoft's DOS that many users feel, Digital Research has packed its new operating system with loads of "extra" goodies—features like a built-in dynamic disk compression and expansion utility that effectively doubles the capacity of a hard disk, a full version of *PC-Kwik* disk-cache software, excellent system security options and more.



I always approach a major system configuration change with some trepidation, and shifting operating systems is certainly a major change. Upgrading to MS-DOS 5.0 within the last year was relatively painless; the improvements of this new version over earlier ones are significant. One of the nice "comfort" features of the MS-DOS 5.0 upgrade was the uninstall option if you felt "antsy" about it and wanted to revert back to your original configuration.

I had the same anxieties about installing DR DOS 6.0, although finding that Digital Research also included a complete uninstall utility with DR DOS 6.0 bolstered my confidence.

Installing DR DOS 6.0 is about as painless as it can get, since the install program analyzes system resources and automatically selects installation and configuration options to optimize your system. You're also given the choice of manual override. In truth, the automatic mode does a pretty good job of it, but manual adjustment of several parameters will improve overall performance in many instances.

DR DOS 6.0 has the same look and feel of MS-DOS, and virtually all of the same utilities and commands of MS-DOS have equivalents (usually with the same name) in DR DOS. To applications, DR DOS "looks" like MS-DOS 3.31. So any application that runs satisfactorily under MS-DOS 3.3 should, in theory, run without a hitch under DR DOS 6.0.

The SETVER.EXE program in MS-DOS 5.0, used to establish compatibility with some programs, is conspicuously absent in DR DOS 6.0. That's not to say that compatibility problems aren't an issue with the DR product, however. While Digital Research guarantees that any program that runs on a true IBM-compatible PC will run under DR DOS 6.0, some conditions are imposed. Some features of the operating system may have to be disabled, system configuration may require alteration and loading order of device drivers and TSRs may have to be modified. In comparison, Microsoft's SETVER.EXE is a remarkably effective and simple-to-use compatibility "band-aid." (Configuring DR DOS to work with *Windows* proved to be a trial-by-fire ordeal that I'll get into later.)

Documentation supplied with DR DOS 6.0 is excellent, surpassing Microsoft's 5.0 user's manual. Digital Research provides a 666-page user's guide, in addition to a 94-page ViewMAX user's manual. Within weeks of receiving the initial DR DOS package, I received an additional 52-page manual, titled "Optimization and Configuration Tips," along with a software update disk. Moreover, excellent context-sensitive help is always available for any DR DOS command or function with the DOSBOOK command. Adding a /? or /H switch to any internal or external DR DOS command produces help text for that item. DR gets four stars in the documentation department.

ViewMAX is a graphical shell that has windows and is largely icon-driven. It bears a strong resemblance to the GEM graphical environment, another Digital Research product, but this is no surprise since the GEM "desktop" was around while *Windows* was just a gleam in Bill Gates' eye. The shell uses a point-and-click interface for accessing DOS functions, data and applications. If you like working from a graphical shell rather than a system prompt, ViewMAX is easy to learn and use (if you've ever used any GEM-based application you're already an expert).

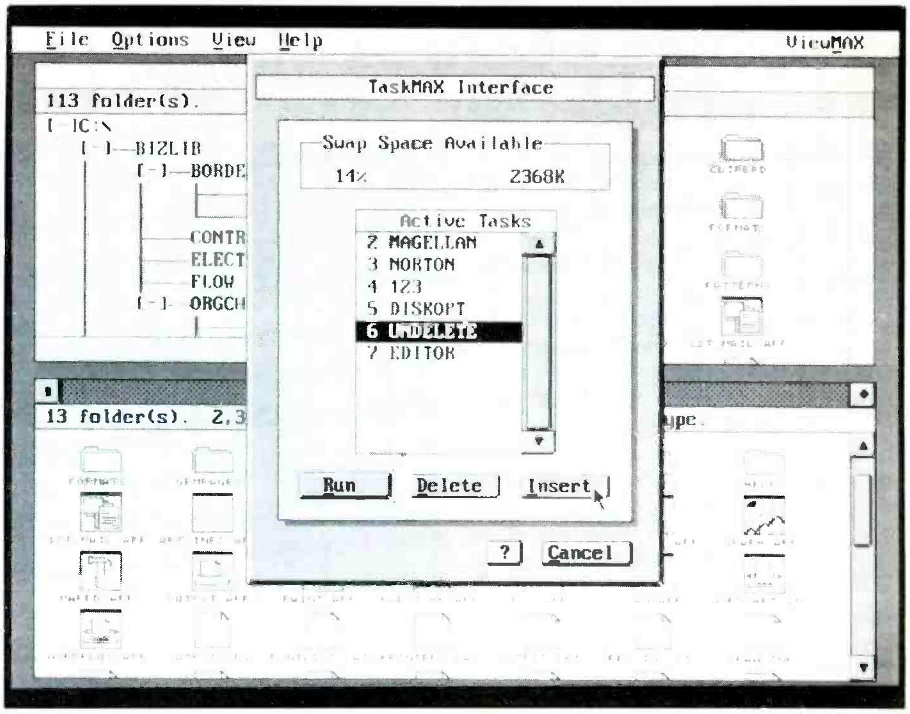
MemoryMAX is the memory-management center of DR DOS 6.0. This system-oriented memory manager moves the operating system itself, buffers, drivers, TSRs and any networking software above the 640K memory area, freeing up huge amounts of RAM (625K or more free RAM isn't unusual) for use by applications. There's a section in the manual that goes into great detail about memory allocation, configuration and optimization. This is very helpful, although many users will find it to be too technical.

The newly-supplied Optimization and Configuration Tips manual goes a long way in clearing up some of the techno mumbo-jumbo in the manual and is invaluable in setting up your system to get the most out of it. Table 1 shows the MemoryMAX features available with various hardware/device driver combinations.

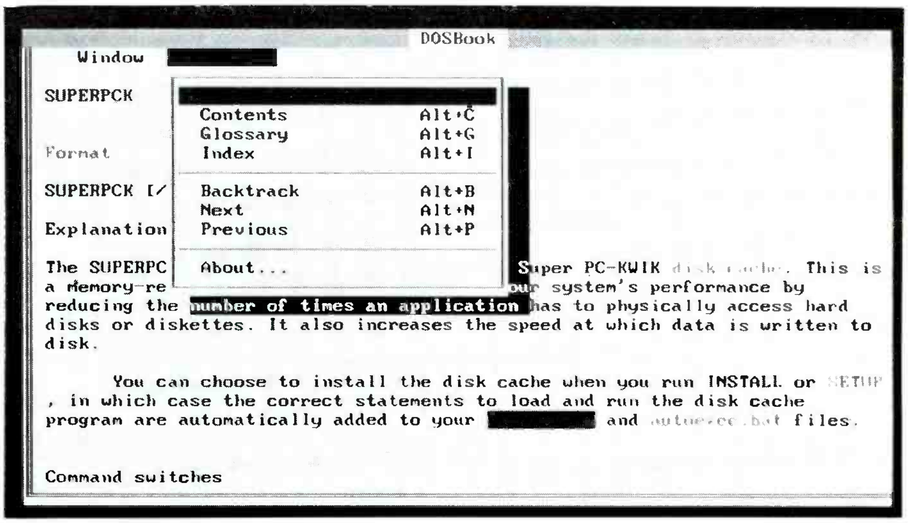
DiskMAX is the on-board file compression and expansion utility that can double hard-disk space. Dynamic compression and expansion, in conjunction with a very fast disk caching program (*PC-Kwik*), significantly speeds up accessing and using applications. Two drivers, SUPERSTOR.SYS and DEVSWAP.SYS, are loaded to activate compression and caching capabilities.

It's interesting to observe that SUPERSTOR by itself slows disk performance because files have to be compressed when writing and expanded when reading. The *PC-Kwik* disk cache counteracts this effect and, in so doing, actually improves data and application access time.

TaskMAX is the Digital Research task-switching utility that permits loading up to 20 programs into memory simultaneously and hot-keying from one to another. This is particularly handy for cutting-and-pasting from one application to another via the system's clipboard, just as is possible in Microsoft's *Windows*. Keeping a "bookmark" of each active application for quick switching uses memory, however. So TaskMAX isn't a panacea for having several heavy-duty programs all running at once.



DR DOS 6.0's TaskMAX Interface is shown superimposed on main program screen.



Inset on this DR DOS 6.0 DOSBook screen shows keyboard commands that are to be used for executing various options.

If you've ever had occasion to transfer files between one computer and another, say from a laptop to a desktop machine, the FileLINK serial file-transfer utility will be a very appealing feature. Using a standard serial cable to interconnect the two machines, files can be transferred back and forth directly (as with *Laplink* and *Brooklyn Bridge*) without using a modem.

Digital Research had the first really useful full-screen text editor in DR DOS 5.0, simply named "EDITOR." This utility used common *Wordstar* commands (the control key in concert with one or two alpha keys) and allowed you to work with a full screen of text, rather than a single line at a time, as with MS-DOS's EDLIN and COPY CON commands. EDITOR is again

Table 1. DR DOS 6.0 MemoryMAX features Configurations

Applicable Hardware	Driver	LIM	DR DOS Kernel	XMS	DR DOS Upper Memory
386SX,386,486	EMM386.SYS	*	*	*	*
386SX,386,486	HIDOS.SYS, Third-Party XMS Memory Manager	?	*	*	—
IBM PS/2 80286	EMMXMA.SYS, IBM XMA Card	*	—	—	—
80286 With Extended Memory	HIDOS.SYS	—	*	*	—
80286 With Mappable Shadow, Extended Memory	HIDOS.SYS	—	*	*	*
80286, Mappable Shadow, No Extended Memory	HIDOS.SYS	—	*	*	*
80286 with NeAT, LeAP or SCAT Chip Set	HIDOS.SYS	—	*	*	*
80286, LIM 4.0 Driver, Extended Extended Memory	HIDOS.SYS, Third-Party LIM 4.0 Driver	*	*	*	*
8088/8086/80286, LIM 4.0 EMS Card, No External Memory	HIDOS.SYS, Third-Party LIM 4.0 Driver	*	*	*	—

* = supported feature; — = unsupported feature; ? = dependent on features offered by 3rd-party memory manager.

included in DR DOS 6.0, with all of the same features and functionality it had in the earlier version but without mouse support. On a personal level, I prefer the new EDIT.COM in Microsoft's MS-DOS 5.0 as a friendlier text editor with its drop-down menus and full mouse support.

Undelete and unformat commands are also included in DR DOS 6.0. They're powerful medicine, on a par with or surpassing dedicated-purpose products that perform equivalent functions from third-party developers like Norton, Mace and Multisoft.

I frequently have to change my system configuration to accommodate new devices and/or software for specific projects on which I'm working, and my root directory usually has at least a half-dozen versions of AUTOEXEC.BA? and CONFIG.SY? files which reflect various customizations (the ? is replaced by a number for each version and I keep a log of what each contains).

One of the really handy features of DR DOS 6.0 is the ability to keep multiple CONFIG.SYS and AUTOEXEC.BAT selection options available at boot time to select the configuration "flavor" that's best for the current work session. The real strength of this feature is appreciated only when you get into advanced configuration and optimization of the system to squeeze the most out of each individual application you're running.

At boot-up, you select the optimized configuration that maximizes your resources for the selected application. This is certainly much easier than my MS-DOS method of renaming CONFIG.SYS to CONFIG.TMP and renaming CONFIG.SY1 to CONFIG.SYS and then rebooting. This doubles the effort if you have to modify the AUTOEXEC.BAT.

Passwords can be assigned to files and directories to prevent unauthorized access via the PASSWORD command. The keyboard can be locked with a command, and disk partitions can be security-protected to make them inviolable.

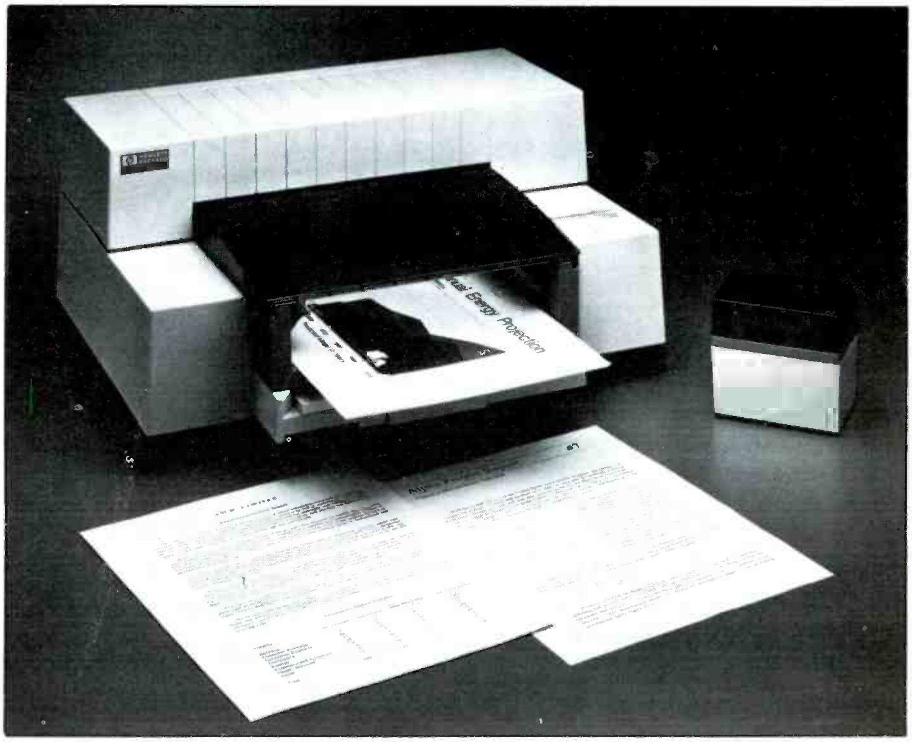
Disk and file management is excellent in DR DOS 6.0, which has the ability to display files in multiple subdirectories using the XDIR command. Using the TREE command, you can search for a file or multiple occurrences of a file and display the file's location on your disk. This gives the operating system functionality like some of the independent shell programs exhibit, such as *X-Tree* and Still River Shell.

There are scores of other useful features

(Continued on page 74)

Ted Needleman

Add Some Color to Your Output



Back in the earliest days of microcomputing, we were all so excited by the power and potential of the desktop PC, few of us paid much attention to the form the output took. Though my original Apple II offered color output with a composite monitor, for the first few years, I was glad to have its standard 40-column monochrome screen. Over the years, as my applications (and budget) grew, I added an 80-column adapter, letter-quality daisywheel printer and, finally, an RGB composite monitor. It didn't provide anywhere near the quality display of even an ordinary color TV receiver, but it was color! At the time, it was almost as much of a kick as my first color TV.

That was then, this is now. All the PCs I use, other than my old 512K Mac, have VGA color adapters and monitors capable of 256 colors at 640 × 400 resolution. And I'm in the process of testing a Super VGA card/monitor combo that promises 32,000 colors at standard VGA resolution and crisp 256-color display at 1,024 × 768 resolution.

The one thing that hasn't changed much in the last 14 years of PC use is my output. With 300-dpi laser resolution, it looks good, but it's predominantly black and white. I say "predominantly" because for the last few months I've been using the new Hewlett Packard Deskjet 500C color ink-jet printer.

Color printers have been available for quite some time, of course. However, in the past, there have been enough negatives in using them that few of these printers have become popular. In fact, until recently, much of the color output generated from PCs has been created on plotters, which are hardly more than motor-driven pens.

Most color printers in use today are either dot-matrix or thermal-transfer units. Apple's ImageWriter II was one of the first popular printers to offer color output capability, using a special four-color (red, blue, yellow and black) ribbon. Other printer vendors—Epson, Panasonic, Citizen and Star Micronics—also offer color kits for some of their dot-matrix printers.

Printing color with a dot-matrix printer so equipped isn't difficult, but it requires that the ribbon carriage be able to be moved up and down so that a particular color band can be positioned in front of the printhead. Colors other than the four bands on the ribbon are produced by overprinting. For example, overprinting red and blue produces purple. For an inexpensive way of adding color, this method works—with a few serious limitations.

There are two inherent limitations of this process that explain why color dot-matrix printing hasn't become more popular. One is color quality. It isn't too bad when printing a pure color that's contained on the ribbon band. However, colors created by overprinting two or more primaries are often very "muddy" looking, a result of the type of wax-based ink used in these ribbons (it doesn't mix very well). The other inherent limitation is registration and resolution.

Registration and resolution both relate to the placement of the dots on the page. Modern dot-matrix printers are capable of resolutions of up to 360 dpi, which is somewhat better than the standard laser's 300 dpi. In reality, though, this resolution is difficult to achieve with any consistency across a page because of the mechanical limitations imposed by the movement of the print carriage and paper-handling mechanism. When you try to place single dots of different colors right over each other, which is necessary to produce a mixed color, these mechanical limitations make it difficult to obtain proper registration at any kind of decent resolution.

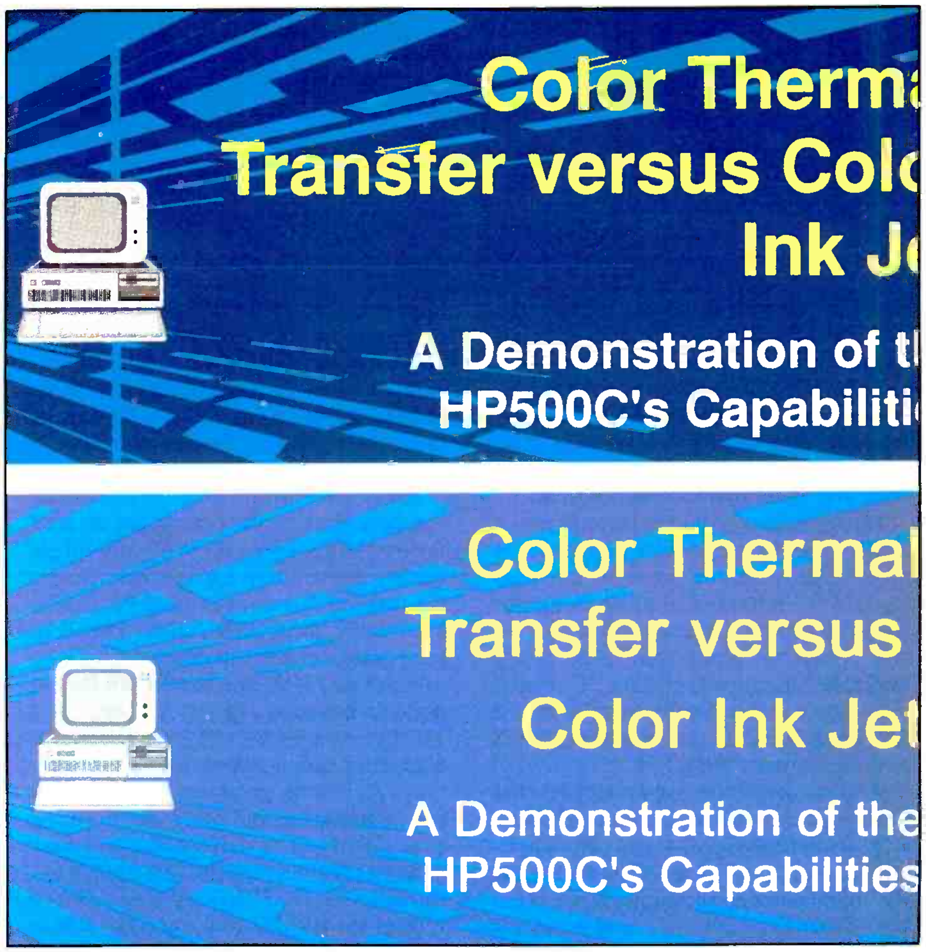
The most commonly used color printers nowadays are thermal-transfer printers, which also use a wax-based ink in the form of sheets or a long roll. An image is created on paper by a thermal printhead that melts tiny dots of the desired color onto the paper. Multiple passes of the paper under each color panel of the ribbon produce colors other than the primaries. Because wax-based ink is melted onto the paper, different colors overlaid on each other blend much better, yielding brighter and more consistent colors.

Resolutions of thermal-transfer printers, at a laser quality 300 dpi, are much higher than with the dot-matrix method. Also, because the paper-handling mechanism is more precise, registration is far superior. Most thermal-transfer printers are PostScript-based and contain several megabytes of memory. They even offer hard disks for storage of fonts.

There are two downsides that preclude the use of color thermal-transfer printers for casual use. Both relate to cost. The first is acquisition cost. Color PostScript printers are expensive. The NEC PS Mate printer used to print the sample in the exhibit, for example, has a list price about $6,000. The per-copy cost of using such a printer is also high. With replacement ribbons costing close to $100 and special paper necessary for best results, it can cost between 70 cents to a $1 per page to generate color output. If you need to run out two or three copies of each page to get the color balance right, your final cost can be in excess of $2 per usable page.

The newest color printers, which use a dye-sublimation process, are a refinement of thermal-transfer technology. These use a similar wax-based ribbon, but they vaporize the ink before depositing it on the paper. By controlling vaporization temperature, the printer can vary the size of the dot produced. This technology produces an almost continuous-tone quality output, but it's several times more expensive than the already pricey thermal-transfer printer.

A third alternative, color ink jet printers, has also been around for a while. Until recently, these printers, like the HP PaintJet, have offered moderately poor resolution (in the range of 170 dpi). The most workable way of adding color to a high-resolution page was to use a color-transfer system like LetraSet's Color Tag, reviewed in this column a while back. These systems use a heat process to melt a color into laser printer toner. You can get a Color Tag starter set for less than $100 at many graphic supply houses, but it's a very labor-intensive process and is most appropriate for adding limited spot color to laser-printed documents.



Outputs from NEC PS Mate (upper) and Hewlett Packard DeskJet 500c color printers. The latter sacrifices some color density, but at only a sixth of the price of the former, it's a real bargain.

I've run across a color output device that lets me do high-resolution color output at a reasonable price. The Hewlett Packard DeskJet 500C is a color printer that's both affordable to buy and inexpensive enough to use. It's an extended version of HP's popular DeskJet 500 inkjet printer introduced in 1990. The original DeskJet Plus, and the DeskJet 500, introduced laser quality 300 dpi output at a price that was, at the time, about a third of what a laser printer sold for. The 500 added more RAM (to hold downloaded softfonts), and the 500C model extends the line-up by offering full-color output. The price for the DeskJet is a very reasonable $1,105 at retail, which translates to about $700 to $750 "street" price.

Physically, the only way to tell the DJ500C from any other DeskJet is to look at the identification plate. It has the same compact dimensions 17.3″W × 8″H × 14.8″D and light 14-pound weight. Like other members of the DeskJet family, it also has an external power supply and serial and parallel ports. The ports are accessible from the bottom of the printer, but the unit is light enough to make turning it over to plug in the interface cable an easy task.

While offering similar choices in resolution (75, 150 and 300 dpi) the DJ500C differs from the rest of its family in another way. To install the ink cartridge, you must hit a button on the control panel marked "Print Cartridge." This moves the print carriage into the middle of its travel, where the cartridge can be easily accessed.

The 500C can use one of two different ink cartridges. One is the standard black ink cartridge used by all DeskJet series printers. This obviously yields black-and-white output. At about $20, the black ink cartridge is much less expensive for day-to-day printing than the other choice—the color cartridge. The color cartridge is slightly larger than the standard cartridge and costs about twice as much at $39.95. It produces somewhat fewer pages than the black cartridge, depending on how dense you've set the color print.

The printer automatically senses which cartridge is installed. The 500C comes complete with one of each cartridge, as well as a handy hinged box to store whichever cartridge isn't currently being used. It's a good idea to keep this storage box right on top of the printer so that, when you're not printing a color document, you can quickly pop in the standard cartridge. You'll want to use the black ink cartridge that's both less expensive to use when printing black-and-white documents and produces much "blacker" black than the somewhat muddy black produced by mixing colors.

Unfortunately, you can't just plug the DeskJet 500C in and start printing everything in color (other than the printer test pattern, that is). Most DOS-based software won't know how to make use of the color capabilities of the 500C. Hewlett Packard provides a number of printer drivers that enable selected DOS applications to print in color.

Applications for which there are drivers to take advantage of the color capabilities of the DeskJet 500C include Ashton-Tate's *Applause II*, SPC's *Harvard Graphics*, *The HP Gallery Collection*, several versions of Lotus' *1-2-3* and Borland's *Quat-*

(Continued on page 86)

Getting to the Next Frontier

If you work with Windows because the "G" in GUI stands for graphics, I've got an incredible new product for you—two, actually. When it comes to making graphics files small, they're more potent than the chemistry Lewis Carroll's Alice used. And while you won't have to go down a rabbit hole, you'll get there faster if you do.

This technology could be the engine that drives us to the next frontier of video on the PC. The need for fast eight-bit video has largely been satisfied by the technologies used in the forthcoming glut of *Windows* video-accelerator cards. Even truly low-cost full color is coming. Genoa is planning to ship a 16-million-color board for *Windows* by the end of March. It will sell for less than $300!

What we need now are developers that support image compression to speed up the monstrous files of real-world color applications—not just for real-time video, but for all full-color applications. While video has both the storage and speed problems that compression addresses, work requiring a high level of image quality can benefit from compression, too—if the quality is preserved.

Right now, we're at the stage where the inexpensive commodity computer can do acceptable color work for a limited number of applications. *Ventura Publisher* 4.0, with its color extensions, and *Quark* 4.0 for *Windows*, are going to bring many color professionals down from higher-cost solutions. But they're going to pay a penalty in productivity when they switch from their high-performance workstations. Putting support for fast compression into applications like those cited above could go a long way to bringing high-end color performance down toward the desktop's irresistibly attractive prices.

Most artists and designers have probably solved their storage problems by buying a huge hard drive and a Bernoulli or Syquest removable mass-storage-media drive. They know from experience that a lossless algorithm like LZW (the one used in products like *PKzip*) may only compress those natural-image TGA and TIFF files down about 6% to 10%.

But solving the storage problem, even with one of the new super-fast Bernoulli 90s, doesn't reduce the delay when huge files move into memory. JPEG's lossy 20:1 ratio helps, but it doesn't seem like much on an 11″ × 14″, full-color bleed that takes around 100M. And if that doesn't give you gas, consider that an uncompressed, 600 × 600-dpi, 32-bit tabloid page can consume an enormous quarter of a gigabyte. Feeling queasy yet?

Alka-Seltzer won't help. JPEG's lossy compression can get rid of that bloated feeling, but you lose some of your image quality. Fortunately, LEAD Technologies has two new *Windows* products that offer extended compression ratios. The company claims either will digest a file down as much as 255:1, and they'll produce as good an image as JPEG's 20:1 ratio at a 180:1 crunch. There's no question that, at equivalent compressions, LEAD's proprietary algorithm produces far less color loss, contouring and other deterioration than JPEG. The differences are easy enough for the untrained eye to pick out immediately. "JPEG isn't bad, but a typical 1M file that looks good at 60K in JPEG will look at least as good with LEAD's compression at 6K," according to vice president of engineering Mohammad Daher.

LEADVIEW works on-line to display on the fly its compressed files directly to the screen. It's the feature that makes a hardware version of the product worth its price. Decompressing to the screen is typically a lot faster than the I/O time that's normally required to view the original uncompressed file.

Incredibly, LEADVIEW also has a *lossless* compression that can produce size reductions comparable to JPEG—without changing your files. Compression is done at 24 or 32 bits (lower resolutions are converted automatically), and, depending on the image, it can range from a 10:1 to 20:1 ratio. The number of colors won't change. The number of pixels won't change, either. While there's no loss involved, you may sometimes find that DOS COMP.COM will find discrepancies.

Daher explains that decompression can select a different output format without changing the image, but it does change the file slightly in other ways. These may be due to header information or format type. For example, there are 12 varieties of TGA, he says, and a potentially unlimited number of TIFF formats (the header describes each uniquely). For significant storage savings in the most demanding color applications, this is a viable solution.

LEADVIEW supports compression and decompression of the following standard image modes: RGB 4:4:4:; YUV 4:2:2: or 4:4:4:; eight-bit grayscale; and CMYK 4:4:4:4:. This allows you to work with compressed files produced from other products, if they're in any of these formats, and even to further compress them. And LEADVIEW supports many file formats: TGA (8- to 32-bit), TIFF (8- to 24-bit), BMP (4-, 8- and 24-bit), GIF, PCX. It also provides the JFIF and JTIF interchange compression formats, in addition to LEAD's own Extended Compression.

Software-only and combination hardware-and-software products are available. Both support Targa cards (up to full color) and eight-bit (256-color) VGA or SuperVGA cards, with resolutions up to 1,024 × 768. It takes from 1 to 2 seconds to go from 1M down to 5K with the hardware. The software takes from 8 to 25 seconds. A *Windows*-specific version of LEADVIEW is in beta and ships sometime in the second quarter of this year.

This program has built-in drivers for many video cards, including those with the Sierra RAM-DAC, Tseng 3000 and 4000, Video 7, Paradise, VESA, Targa and other compatibilities. In addition to compressing a file, LEAD's technology produces a color palette that accompanies each. This palette is ignored in 16- or 24-bit true-color environments, but it contains an optimum selection of 256 colors that provide appropriate color conversions for use on eight-bit cards. A single file, thus, provides images that are suitable for either hardware platform.

However, conversion to an eight-bit mode is very time-consuming. So, Targa or other 16-bit, or higher, cards are recommended for applications where the card's fast display capability is required. Under *Windows*, LEADVIEW will support any driver up to 32 bits, which, of course, is the *Windows* advantage.

It isn't magic. The LEADVIEW 255 uses C-Cube's CL550 B chip as its main processor. (It's a single-chip JPEG engine, which means that standard JPEG files are also available for interchange when necessary.) It's lossy, but it can do 30 frames

A Quick Tour In Color-Image Compression

After compression, images were decompressed to a TGA 32-bit file, which was then output to a 4,000-line matrix film recorder. The recorder produced the film and the slides were generated.

The original was scanned by Terry Wessling of Coyne & Wessling (704-332-1990). The slides were digitized and created by Dave Crook of Vargo Color Lab (704-529-1555). Both are located in Charlotte, North Carolina.

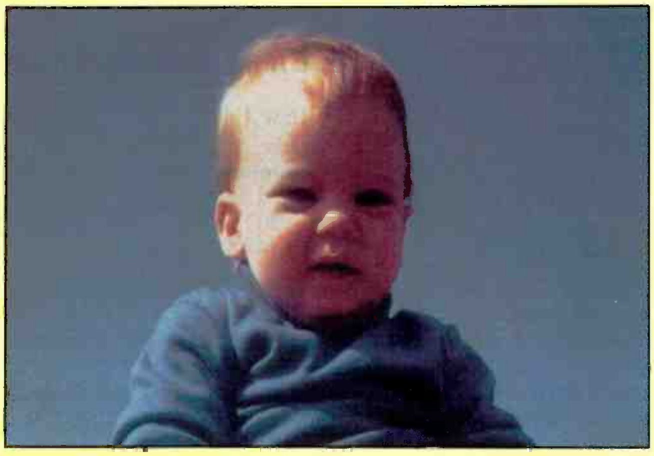
Notice the quality of the PFQ shot. You shouldn't be able to tell the difference between this and the original. Also notice that the Maxcomp image scanner, which is 17.7% smaller than the JPEG maximum. Look at the difference in quality between this and the original.

Lead delivers a smaller size and better image quality.

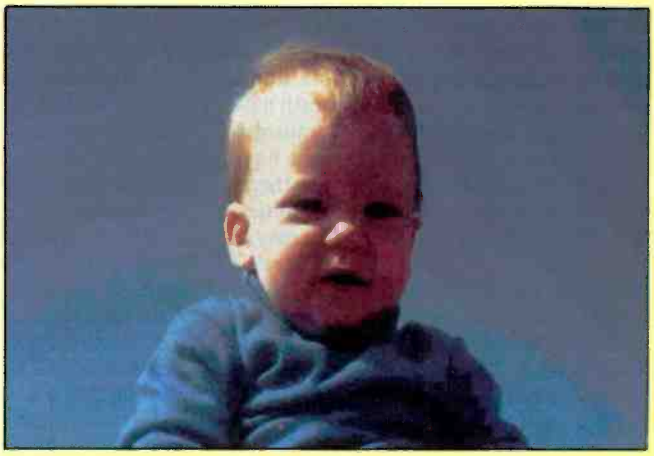
—Rich Little

This original was shot with a Canon EDS Rebel 35-mm camera with Fuji Velvia 50 ISO slide film. It was then scanned on a Nikon AF3500 to a 32-bit TGA file (6,358,840 bytes).

This PFQ shot was compressed at Lead perfect quality to a size of 482,058 bytes, for a ratio of 15.26:1. The RGB haven't changed.



This Maxcomp shot was compressed at lead size now more important than quality to a size of 35,623 bytes, for a ratio of 206.57:1.



This shot was compressed at maximum JPEG compression to a size of 43,282 bytes, for a ratio of 170:1.

All photos courtesy of Rich Little, Lead Technologies, Inc.

per second (full-motion video). Lossless compression is done in software.

LEAD Technologies bundles a utility that converts, scales and re-sizes TGA (8- to 32-bit), TIFF (8- and 24-bit), BMP (4-, 8- and 24-bit), GIF and PCX file formats. And it captures frames of live or still video from the buffers of targa-compatible cards like the Viga-16. Unfortunately, the hardware version doesn't include software to select addresses for its own configuration on the AT bus. This must be done with jumper blocks.

A Second Alternative

Video & Image Compression Corp. offers an example of straight JPEG in both hardware and software-only products. The hardware version costs less than half as much as the LEADVIEW 255, but VIC doesn't have LEAD's enhancements. Picture Packer's 30:1 compression limit is necessary, VIC claims, to limit information loss to an unnoticeable level. "Our Q factor is around 10, and that produces very little loss," maintains executive vice president Alan Shen. Picture Packer compresses a 1M file to roughly 33K in about 3 seconds (it's machine dependent). The software takes about 20 seconds to accomplish the same task.

Packer has a second advantage, beyond low-cost JPEG compression, that can make it the preferred choice in some environments: interoperability. Versions are available for both DOS and *Windows* on the PC, and for the Mac. "I think that nobody else has a product on both platforms," Shen says. On the PC, the hardware uses a TI TMS320C25 DSP (digital signal processor), on the Mac an SGS Thomson IMSA121 DCT (discrete cosine transform) chip.

Supported file formats include TIFF (8-bit gray and 24-bit color), TGA (16-bit), PCX, GIF (but not BMP) for the PC. It supports PICT and TIFF on the MAC. Packer doesn't have LEADVIEW's wide range of image-modes. Only a few are supported: RGB 4:2:2: or 2:1:1:; YUV 4:2:2:; and 8-bit grayscale. Packer's display compatibility isn't provided by drivers but by a TSR on the PC or a CDEV or an init on the Mac. It's compatible with a wide array of PC video cards: VGA, SuperVGA, Targa cards and any card that works with its supported file formats.

One last word before I change topics. Although *PKzip* isn't well-suited for some types of graphic files, I don't mean to disparage it. It's a good product that's available as shareware, and it's worth having for other files, especially for transmission between modems that don't have compatible compression built into them. PKware offers a number of other utilities, too. *PKfind* and *PKzmenu* make it easy to work with the compressed files. There's a version of *PKzip* for OS/2. Another utility, *PKlite*, produces compressed executables that spontaneously expand when you run them. If you need disk space, these products can provide it cheaply, and they're well worth supporting with a paid registration if you use them.

Everything Plus the Fax

The propellers at Xerox PARC have been busy whirring like a wind farm in a hurricane. If you're not familiar with the Palo Alto Research Center's earlier work, it manifests itself in products like the Mac interface and the laser printer. This time, they've whipped up a radical new way to use the ubiquitous facsimile machine. When PC fax boards were first introduced, several vendors used a paraphrase of Sgt. Joe Friday's line, "Just the fax." One product, JT Fax, was named after it. But the idea behind PaperWorks is to provide everything through the fax.

Due to ship by the end of March, *PaperWorks* lets you send and receive data from files on your PC through an ordinary fax machine, using nothing more than a pen and blank piece of paper. "If you think of the PC as your docubank, we're turning fax machines into ATMs," quips project leader Z Smith. Not only can you download files by using a type of fax polling, you can direct the system to broadcast them to a distribution list. Send a text file to one recipient, a technical drawing to another, a handwritten memo to a third. The only equipment they need is a conventional fax.

The back-end that drives everything is a program that runs on any PC with a supported fax-modem. You control the program remotely from any standard fax machine with a "paper user interface" on which you check your requests. And if you don't have a form handy, you can request one by sending a blank page. Generic forms come with the product, and the software includes an "object-oriented" custom-form generator.

There's more. You can also enter and store data from the field. In fact, *PaperWorks* is a complete system designed to organize documents around the work or a particular job. So an architect, for example, can organize communication with his customers, contracts, sketches, CAD files and cost spreadsheets, around each project. Multiple instances of a document (those related to a subassembly used in multiple projects, for instance) are represented by an icon, not an actual file. (From what I know so far, it sounds like Saros' *Mezzanine*.)

PaperWorks sells for $249 and has support for four fax boards: Intel's SatisFAXtion, Complete PC's Complete FAX or Complete Communicator and Singapore Technologies' CEI proFAX. (Note: A representative of Singapore Technologies indicated that it's no longer actively marketing its fax-modem.) About the only thing they seem to have overlooked was a catchy high-tech spelling like Xerox "PaperWorX." You can order from Xerox by calling 800-4FAXFAX (800-432- 9329).

Incidentally, there's an interesting story behind *PaperWorks*. It's fairly common knowledge that Xerox is almost as infamous in marketing circles as it's renowned in the research community. This time, though, the company plans to actually make money from its research. To forestall another of its historic technology turnovers, PARC brought company researchers, developers and marketers into the same facility, where they worked together to make sure a product was developed. The staff even included anthropologists who chipped in with a study of the way people use their faxes and data.

Mutant Ninja Morons

Did you survive the Michaelangelo Virus? That's what everybody, including Bill, the guy from UPS, has been asking me. I spent most of last night organizing and archiving several year's worth of data. I suppose I should be grateful to the fan of comic culture who wrote this virus for the motivation to do something I've been putting off for a long time. But these virus writers aren't exactly virtuous. I wouldn't be sitting here now creating files with tomorrow's date on them if they were. In fact, it occurs to me that what motivates them is a need to control and terrorize people. In other words, they're a new breed of rapist: the mass rapist. And just like physical rape isn't about sex, electronic rape isn't about intellectual challenges. ■

In Brief

Genoa Systems
75 E. Trimble Rd.
San Jose, CA 95131
Tel.: 408-432-9090

CIRCLE NO. 101 ON FREE INFORMATION CARD

LEADVIEW, $129,
LEADVIEW 255, $1,495
Lead Technologies, Inc.
8701 Mallard Creek Rd.
Charlotte, NC 28262
Tel.: 704-549-5532

CIRCLE NO. 102 ON FREE INFORMATION CARD

Picture Packer Accelerator Card, $595 (PC); $695 (Mac)
Video & Image Compression Corp.
2221 Rosecrans Ave., Ste. 203
El Segundo, CA 90245
Tel.: 310-643-7571

CIRCLE NO. 10 ON FREE INFORMATION CARD

PKzip, $47 (DOS or OS/2); *PKlite*, $46; *PKfind* $25; *PKzmenu*, $36
Developer products: *PKlite Professional*, $146 (enhanced version); *PKware Data Compression Library*, $295
PKware
9025 N. Deerwood Dr.
Brown Deer, WI 53223
Tel.: (414) 354-8699

CIRCLE NO. 104 ON FREE INFORMATION CARD

Joseph Desposito

An Adapter Card That Makes PCs I^2C Bus Compatible and a Quad Eight-bit Serial DAC With Data Readback

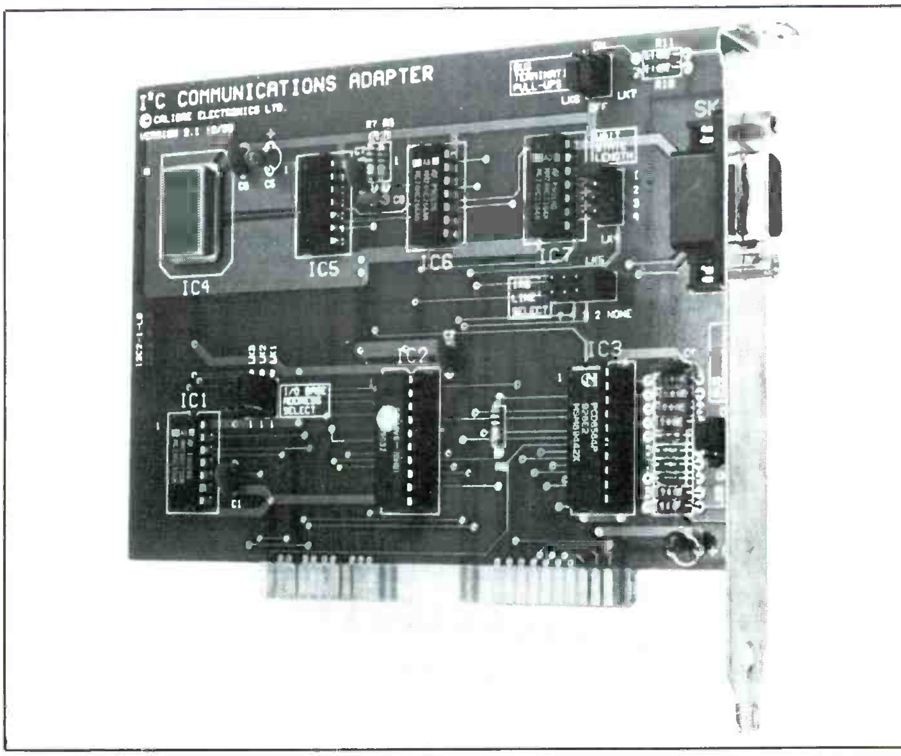
The first IBM-PC compatible I^2C serial communications adapter, the Calibre Electronics ICA-90, already popular in Europe, is now available from The Saelig Co. (1193 Moseley Rd., Victor, NY 14564). This half-length card supports the full two-wire I^2C (inter-I.C.) protocol and is based on the Philips PCD8584 I^2C bus controller. It works with any IBM compatible PC or AT.

With link-selectable PC I/O addresses, bus termination/protection and hardware interrupts, the ICA-90 makes all I^2C functions software controllable via a library of supplied routines, including data transmission mode and clock speed. The ICA-90 can work as an I^2C master or a slave in receiver and transmitter operations. Both polled and interrupt-driven modes can be supported, making programming in popular languages easy.

Provided software library routines allow a user to start system communication with minimum software. All the intricacies of driving devices "clipped" onto the I^2C bus are made easy with the ready-made library provided, including a bus-monitoring capability. Convenient external +5-volt power for devices is also available on the nine-way D-socket that carries the I^2C bidirectional serial data (SDA) and serial clock (SCL) lines.

The ICA-90 adds inexpensive PC computing power to any I^2C system and offers an attractive alternative to using a microcontroller. The ICA-90 is already in use for setup and control of I^2C systems, automatic computer monitor setup, frequency control of radio-based telecom links, development systems, data collection, instrumentation and chemical plant control, production line test of I^2C-based equipment, etc.

The ICA-90 package includes software in C and TurboBASIC, an instruction manual and the I^2C adapter card. It's priced at $299.



I^2C Communications' plug-in adapter board for PC/compatibles.

An I^2C Bus Primer

A system bus handles communication between components (usually integrated circuits) in electronic products like printers, computers, disk drives, calculators, TV receivers and telephone instruments. The main functions of a system bus are to allow all of the system's parts to communicate with each other, ensure that the parts communicate accurately and decide which part can communicate first when two or more parts of the system want to communicate at the same time. Deciding which part can communicate first is called arbitration.

Most microprocessor (MPU) based systems have, as a main bus, a set of parallel wires that are traces on a printed-circuit board. These are grouped in bundles of eight or more (one for each bit) that interconnect the circuits. An entire unit of data, such as a byte, is transmitted in its component parts (bits) across all wires at the same time.

Most microcontroller (MCU) based systems, found in a wide range of products that include subsystems of MPU-based products, usually don't require the high speed of today's MPUs. Hence, there's no need for a fast parallel bus. Microcontroller buses like the I^2C bus are generally serial buses. Individual bits of data follow each other sequentially over a wire in a serial bus.

I^2C is a serial bus standard developed by Phillips/Signetics that allows all circuits within a system to communicate with each other bi-directionally. Two conductors are used, one to carry data and the other to carry timing information.

Because I^2C communicates serially, the number of physical connections required between parts is reduced from eight or more to just two. This reduces the number of traces on the pc board and the number of pins required on the circuits used. I^2C also eliminates the extra logic circuits required to manage parallel buses.

These savings cut the complexity, size and cost of the design. So the cost of microcontroller-based products that use I^2C is cut considerably.

An I^2C bus interface is incorporated on-chip in every I^2C integrated circuit. This means no external components are required to tie the I^2C circuits to the bus. Only two pull-up resistors are required for the entire bus, one for the data line (SDA), and one for the clock (SCL) line (Fig. 1). It's also possible to interface non-I^2C circuits to an I^2C bus with external logic.

Circuits that currently incorporate the I^2C bus interface include a 68000-based CMOS microprocessor; an extensive selection of microcontrollers, including a large family based on the popular 80C51 archi-

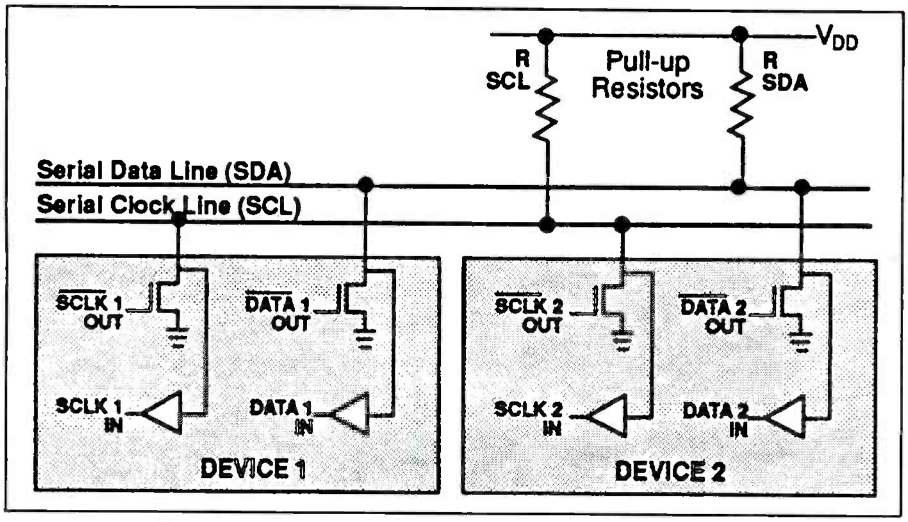


Fig. 1. Schematic details for interfacing the I²C bus to other circuitry.

tecture; general-purpose ICs, including I/O drivers, data converters, memory and clock calendars; and application-oriented ICs for video, radio, audio and telecom products.

Examples of application-oriented ICs include: voice synthesizers, picture-in-picture controllers, tuning circuits, stereo components, car radio components, tone generators for telephony and a frequency synthesizer for mobile telephones.

Some of the features of the I^2C bus are as follows:

- Only two bus lines are required to carry serial data (SDA) and serial clock (SCL) signals.
- No external parts needed to connect I^2C circuits to the bus.
- Data transfer rates ranging up to 100K bits per second.
- Communication that's independent of speed (fast and slow circuits can communicate over the same bus because I^2C features automatic synchronization).
- Non-I^2C components can be used on the bus with extra interface circuitry.
- Full multi-master capabilities so that more than one master can attempt to control the bus without corrupting data.
- On-chip collision detection and arbitration.
- On-chip addressing and data-transfer protocols.
- On-chip filters on peripheral devices preserve data integrity.
- Any or all circuits on the bus can be addressed with a single address.
- Addressing is automatic so that microcontrollers don't have to be slowed or stopped by interrupts to process addresses that aren't theirs.
- Up to 40 components or so can be connected to a single I^2C bus.
- Bus length can be up to 4 meters (more than 13 feet) in length to permit connection to external devices.
- I^2C-bus circuits offer special features for portable equipment and battery-backed systems. These include low-power options on some chips (such as an idle or "sleep" mode that retains data integrity), high noise immunity, different voltage supply ranges, and wide operating temperature ranges.

Some of the benefits of the I^2C bus are reduction in system size and cost and a simplified design process. Designing with the I^2C bus is relatively easy. Hence, time-to-market is cut significantly, and modifications can be made quickly. Also, the I^2C bus simplifies diagnostic testing, as well as testing during manufacture.

I^2C simplifies the design process in several ways. One is that bus interfaces are already on-chip and don't have to be designed in. Another is that functional blocks on a block diagram actually represent the layout of the board (Fig. 2). Also, an I^2C-based system can be completely software defined. Additionally, ICs can be added to or removed from the system without affecting other circuits on the bus, making it easy to change or enhance system features. Finally, malfunctions can be easily traced to their sources.

How does the I^2C bus work? Each circuit has its own bus address. The master generates clock signals and initiates and terminates data transfer. Data packets start with a seven-bit address and a single-bit that defines a request for read or write, followed by an acknowledge bit that allows the master (initiator) to know if anyone on the bus is receiving its message.

The data packet itself can contain an unlimited number of eight-bit bytes, each byte followed by an acknowledge bit. If a device on the bus can't deal with the next oncoming bit until it performs some other function (handles an interrupt, for example), it can force the master into a wait state using the clock (SCL) line.

Data transfer continues after the SCL is released. Arbitration is handled by on-chip wired AND logic (see Fig. 1). An I^2C bus committee is available to coordinate the allocation of I^2C component addresses.

Several types of circuits currently use the I^2C bus. Each type has different internal requirements. So various on-chip I^2C interfaces are different from each other. All I^2C interfaces include latches to trap data and logic for arbitration as well as other I^2C control circuitry. ICs that have internal parallel buses—some microprocessors, for example—also include serial-to-parallel and parallel-to-serial converters to convert the data to the format used by the non-I^2C part of the circuit. Also, peripheral circuits include filters that ensure the integrity of the data.

What are the alternatives to I^2C? This technology is rapidly emerging as a worldwide standard for microcontroller buses. An alternative to it is the designer-defined bus that uses port pins and interrupt lines of circuits, but this is very design-intensive and may not offer the flexibility of the I^2C bus. These designs may also slow down the speed of the bus.

Some designers opt to use a microcontroller's UART to perform some inter-IC communication functions. This alternative not only uses a UART but can present design problems and limitations of its own. Other designers find it more convenient to work with parallel bus structures. When the speed of a parallel bus is not required, this alternative adds unnecessary circuitry and traces to the board, which increase its cost and complexity. National Semiconductor, Motorola and Intel offer alternative serial buses to I^2C.

National Semiconductor and Motorola buses require more lines than are required by I^2C, increasing design complexity and cost. Intel's nine-bit bus doesn't permit clock synchronization. All circuits on the nine-bit bus must operate at the same speed. This is an unlikely occurrence in many designs and reduces design flexibility. In addition, some versions of the Intel bus do not offer the automatic addressing features of I^2C.

Design-Simplifying DAC

National Semiconductor's (2900 Semiconductor Dr., P.O. Box 58090, M/S 16.300, Santa Clara, CA 95052) DAC0854 is a quad eight-bit serial digital-to-analog converter with readback that simplifies test system design. It minimizes system design complexity by integrating a 2.65-volt reference, four output amplifiers, and four eight-bit DACs on a single chip. This com-

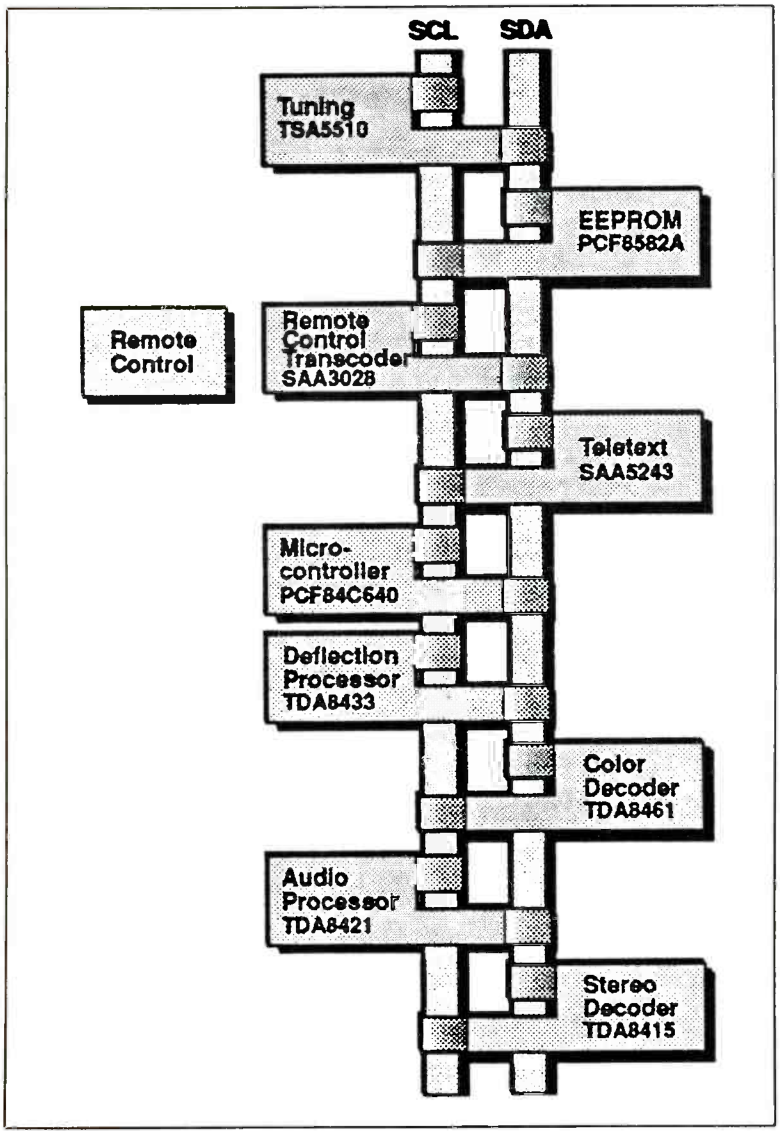


Fig. 2. I²C bus products are easy to design and manufacture, as this model of a computer-controlled TV receiver illustrates.

plete 5-volt quad DAC also features a data readback function that adds diagnostic capability at the chip level in such applications as automatic test equipment, processor-controlled instrumentation and industrial monitoring equipment.

Data readback permits a user to verify the digital data path between the host processor and DAC0854 and performs a distributed memory function. By writing a data word to the DAC0854 and having it read back to the processor, a designer can verify that the correct digital code has been received by the converter.

The DAC0854's serial data I/O conforms to National Semiconductor's Microwire serial data exchange standard for easy interface to the COPs family of controllers. It can easily interface with standard shift registers and microprocessors. In addition, the input is double-buffered to permit all four DAC outputs to be updated simultaneously.

Four DAC supplied reference inputs provide maximum design flexibility, allowing independent range selection for each DAC. The output of each DAC can range between 0.3 and 2.8 volts. The DAC0854 has a guaranteed voltage output settling time over temperature of 2.7 μs and maximum power dissipation of 95 mW. A "power-fail" feature enables the DAC0854 to flag the host processor in the event of a power failure on the system.

Housed in 20-pin plastic DIP, ceramic DIP and surface-mount packages, the DAC0854 is available in industrial and military temperature ranges for the ceramic DIP package. It's available from authorized National Semiconductor distributors at a suggested price ranging from $7.50 to $22.50 each in 100-piece quantities. ■

and enhancements to DR DOS 6.0, most of which have compatible counterparts in MS-DOS 5.0, such as command-line history and command-line editing. They all contribute to making DR DOS a rich and robust operating system. But the real acid test, at least for me, is whether it could handle *Windows* 3.0 with Microsoft's Multimedia Extensions.

My system configuration has several device drivers and several environment "set" variables in it to provide adequate buffering for its multimedia capabilities and hardware devices installed. Using MS-DOS 5.0's HIMEM.SYS and 386-EMM.SYS drivers, coupled with DEVICEHIGH and LOADHIGH designations for drivers and TSRs, everything works fine with *Windows* 3.0. Conversely, using the DR DOS install program's choices, I couldn't get *Windows* to operate properly. It would bomb and return me to a system prompt for no apparent reason from within an application.

After reading the sections on memory management a couple of times and experimenting with different configurations, I was able to get *Windows* to run stably in standard and real modes but not in enhanced mode. It still went to lunch for no discernible reason.

Digital Research provides free lifetime user support for the product, and the tech support team is courteous and knowledgeable. A phone call to tech support for some advice resulted in more experimentation with the HIDEVICE loading order and some other tweaking, which finally worked. By the time I received the upgrade disk and Optimization and Configuration Tips booklet from Digital Research, I had already found most of the right combinations through trial and error, although *Windows* would still occasionally "bomb" for no apparent reason. These upgrade materials specifically addressed problems with *Windows* under DR DOS, and it did make things better . . . temporarily.

The following week, I received my editorial beta copy of *Windows* 3.1 and all hell broke loose when I installed it over *Windows* 3.0 with DR DOS as the primary operating system. Mysterious "insufficient conventional memory" messages required more shuffling of the drivers in CONFIG.SYS, and assorted error messaging in *Windows* 3.1 made life with DR DOS rather testy. When I finally got *Windows* 3.1 to run, several of the multimedia capabilities either wouldn't execute or the system or would frequently lock up, necessitating a total reboot.

It didn't take long for me to realize that I couldn't live like this, so I initiated the "uninstall" program, bidding farewell to DR DOS 6.0 and saying hello once again to MS-DOS 5.0. With the Microsoft operating system in place, I reinstalled the Beta version of *Windows* 3.1 on my machine and rebooted. All was at peace once again. There are still some multimedia functionality issues of which Microsoft is aware and promises to resolve in the release version of *Windows* 3.1, but I experienced none of the memory or bombing problems like those I'd encountered while DR DOS 6.0 was in control.

Conclusion

DR DOS 6.0 is an excellent operating system that has lots of features that will appeal to many but not all users. The disk-caching feature was no big deal to me, since my i486 system has built-in caching. Moreover, I don't feel comfortable with dynamic data compression and expansion schemes (I don't trust them, to be honest), I wasn't enticed by the SUPERSTOR feature of DR DOS, either. The enhanced memory management held the biggest promise for me, but tweaking the system to find the optimal configuration for all the applications and devices I run could prove to be a life's work. And since I don't use the MS-DOS shell, I didn't find DR DOS's TaskMAX shell to be alluring, either.

DR has better documentation and terrific on-line help, but MS-DOS 5.0 has a friendlier text editor and better mouse support. All the way down the line, there are strong points and weak points for each operating system. But in the end, the element that tipped the scales in Microsoft's favor was MS-DOS 5.0's ability to run *Windows* 3.1 beta version with Multimedia Extensions without making me feel like I was walking through a mine field.

While Digital Research's DR DOS 6.0 is a strong contender that will likely be a good choice for many users, especially those who want its excellent extra features that I personally don't need, Microsoft's MS-DOS 5.0, for me, is a clear winner by a technical knockout. Others, however, may feel that it's well worthwhile waiting a short time for an upgrade disk that enables DR DOS to work with a new program version, such as the anticipated release of *Windows* 3.1. ■

DR DOS 6.0
Digital Research Corp.
Box DRI
70 Garden Ct.
Monterey, CA 93942
Tel.: 408-647-6675

CIRCLE NO. 117 ON FREE INFORMATION CARD

Low-Cost/High-Speed Modems Update & Combatting Computer Viruses

In past columns, I discussed the new, low-cost, high-speed modems that were appearing on the market, operating at speeds of 9,600 and 14,400 bps. Now I have more information on how and why these super-speedsters are available and what you can expect from them in the near future.

Back in the old days (15 years ago), it was common knowledge that the fastest one could communicate over the dial-up telephone network was 300 baud! The average modem back then used analog frequency-generating devices composed of coils and capacitors in an LC circuit or crystal oscillators in more-expensive units. Neither the coils nor capacitors had long-term stability; so the modems that used them weren't very reliable. Moreover, the crystal-controlled ones were very expensive.

Following the first flush, modems and every other type of frequency-sensitive device went digital, and modem operating speeds increased to 1,200 baud. With the development of large-scale integrated (LSI) modem chips, speed took another jump to 2,400 bps and then to 9,600 bps. We're now about to go to 14,400 bps. How and why did this come about?

The International Telegraph and Telephone Consultative Committee (which we know by its French initials as CCITT) established the V.32 specification for 9,600-bps modem transmission in 1984. Since then, however, data-traffic and data-using applications grew exponentially.

Manufacturers like U.S. Robotics and others recognized the need for a higher-speed standard. At first, they sought to develop an asymmetrical modem standard that would allow fax transmission to exceed 9,600 bps by using a slower back channel for error control. The push for this type of standard died out, but modulation schemes developed for it eventually became part of two CCITT standards: V.32bis for high-speed symmetrical duplex modems and V.17 for high-speed fax transmission.

The modulation scheme for the new V.32 bis standard uses the same trellis-encoded, quadrature amplitude modulation (QAM) used in the V.32 standard (9,600 bps). At 14,400 bps, however, a more complex scheme that allows 50% more information to be transmitted is used. This requires sending four times as much information per time division (baud). The result is the ability to transmit more information in the same telephone channel bandwidth.

While the V.32bis standard (14,400 bps) is an extension of the V.32 standard (9,600 bps), there are several key differences. V.32bis adds the new speeds of 7,200, 12,000 and 14,400 bps. It also includes a new speed-changing procedure called "rate re-negotiation," or on-line speed switching. This allows modems to change transmission speed quickly without having to re-synchronize the two modems.

Under V.32bis, speed changes can be accomplished in a few hundred milliseconds, rather than the 8 to 20 seconds it took using older V.32 modems. Under V.32, the time penalty was so great it didn't pay to change speed. Rate re-negotiation makes it practical to change speed to precisely match line conditions.

U.S. Robotics augmented the V.32bis standard with additional enhancements called Adaptive Speed Leveling (ASL). The standard defines a procedure for speed switching, but not a strategy. ASL permits even faster on-line speed switching without interruption in data transmission. It's claimed that modems that employ ASL are more efficient and result in lower telephone line charges.

According to a study in *Business Communications* magazine, time charges in sending a 100K file via AT&T long distance from New York to Los Angeles during a business day, can be reduced by 50% using 14,400 bps instead of 9,600 bps. Using V.32bis modems instead of 2,400 bps results in an 85% reduction in line charges. Using data compression, U.S. Robotics' V.32bis modems can operate at an effective speed of up to 38,400 bps. However, according to Dave Walsh of USR, "You can't always depend on just data compression to achieve higher speeds. Many of the files that people transfer aren't compressible or are already compressed. So in those cases, you have a real need for the higher transmission speeds specified under V.32bis, both for convenience and to decrease line charges."

The CCITT has begun work on a 19,200-bps standard called V.fast. However this standard isn't expected until 1993 because it's a much more difficult task. It may be a very long time before modem transmission speeds are pushed above V.32bis' 14,400 bps. The remarkable thing is the speed at which the cost of high-speed modems are being made available to PC users.

Beware the Ides of March!

By the time this is published, the threatening month of March will be long past and the virus threats that were timed to occur in then will be over. We can't even begin to add up the costs of the multiple virus threats to the computer industry and to all the clients it serves. However, the computer industry responded to the threats with a remarkable demonstration of cooperation and unselfish free distribution of anti-virus software and public-service advertising to ward off the problem. The Michelangelo strain was the most-talked-about virus. Most viruses are easily detected by such programs as McAffee's *Scan*, *Norton Anti-Virus* and similar programs.

Because I'm writing this in February, I don't know what happened on March 6, 1992, but I do know this. A friend's computer tested positive for the Michelangelo virus. So he decided to test it. He set the computer clock to March 5 at 11:59 pm and waited. Within a few minutes he said, "It's still working! That virus is the bunk." Then he switched off his computer.

When my friend tried to turn it on again he found the boot tracks on his hard drive were gone! *Norton Utilities* couldn't help him, nothing could. He had to wipe everything, start with a low-level format and rebuild his system from original disks. Even his backup disks were infected! If you had problems on March 6, please drop me a line about them.

You aren't defenseless in the face of this massive assault by viruses. You can take precautions to avoid being infected. First *never* download directly to your hard disk. Route downloaded programs to floppy disks. Then have a write-protected anti-virus-programmed floppy on hand and use it to scan your newly downloaded software for virus infection. If an infection is found, run a "Clean" program.

Many anti-virus cleaning computer programs are available both as Shareware and as commercial software packages. There are also anti-virus programs for networks. McAfee Associates' *Netscan* can be used over most networks from Novell, Banyan, Microsoft, IBM, 3-Com and Artisoft. The company also has *Winscan for Windows* 3.x systems.

No anti-virus program will help you if the one you buy isn't kept up-to-date with current viruses.

 (from page 10)

Corel SCSI Interface

Corel Systems, publisher of *CorelDRAW*, has entered the hardware peripherals market with CorelSCSI, a series of SCSI adapters for eight-bit ISA, 16-bit ISA and MCA machines. Corel has made a commitment with this product to support every SCSI device currently available and to continue to add support for new devices as they're introduced. SCSI permits up to seven devices to be daisy-chained to a single adapter card. Slight differences in SCSI implementation among various manufacturers result in incompatibilities that have hampered the growth of the SCSI market. The 16-bit Corel card provides a feature called "auto-sense termination" that automatically unterminates the SCSI card when it's no longer the last device on the SCSI chain. This eliminates the need for users to open their computers to either terminate or un-terminate their SCSI cards. Improper termination, according to Corel, is the most common compatibility problem with SCSI devices. Back-up software is included with each interface card. $150, eight-bit; $325, 16-bit; $195, MCA. *Corel Systems Corp., The Corel Building, 1600 Carling Ave., Ottawa, ONT, Canada K1Z 8R7; tel.: 613-728-8200; fax: 613-728-9790.*

CIRCLE NO. 47 ON FREE CARD

Novell Batch Enhancer

Horizon Consulting's *NOVBAT* is a Novell Batch Enhancer designed to assist the Netware LAN manager in developing network-intelligent batch files. With *NOVBAT*, one can interrogate the network for information that previously required using several separate utilities. The program contains more than 30 netware-oriented commands that help the system administrator/installer develop powerful log-in scripts and batch files quickly and easily. It requires DOS 3.0 or later. $129. *Horizons Consulting, 1432 E. Commercial St., Springfield, MO 65803; tel.: 417-839-2174; fax: 417-831-1329.*

CIRCLE NO. 48 ON FREE CARD

High-Performance Serial Interface

Twincom ACI/550 from Image Communications is an advanced communications interface board that incorporates two 16550 UARTs for dual RS-232 communication ports. Each UART supports 64 channels and six interrupts, making it virtually impossible for external high-speed modems to have conflicts with existing bus devices. Transmission includes all standard speeds up to 112,000 bps, and the unit is compatible with all normal software. It's a direct replacement for older serial boards built around 8250 and 16450 UARTs. An on-board buffer offers 16 bytes FIFO transmit and receiver buffering, which results in greater throughput between CPU an UART when engaged.

The 16550 reduces data loss and increases overall system performance in high-speed communications, multitasking environments, CPU-intensive application and multi-port systems. A further benefit is that the 16550 decreases the actual time the CPU interacts with the UART. Fewer interrupts need to be presented to the CPU. Additionally, the 16550 requires up to 75% less servicing time from the CPU than the standard 16450.

Twincom features one 9- and one 25-pin serial connectors on an eight-bit half-size card. $99. Image Communications, 6 Caesar Pl., Moonachie, NJ 07074; tel.: 800-666-2496; fax: 201-935-6548.

CIRCLE NO. 49 ON FREE CARD

Menu Software

FOXMenu from Alamo City Computer is said to be an easy-to-install general-purpose menu system that runs on multi-user or single-user systems. Using no memory when executing applications, *FOXMenu* includes a small executable file size for fast loading on networks; full mouse and keyboard support; screen saver logic; and password security on all functions. Available are 20 menu options on each level of the *FOXMenu* system.

FOXMenu automatically configures first-time users on network systems according to defaults established by the network administrator. The new menu can then be tailored to the needs of the new user. $49. *Alamo City Computer, 16601 Blanco, Ste. 206, San Antonio, TX 78232; tel.: 512-492-2225; fax: 512-492-2827.*

CIRCLE NO. 50 ON FREE CARD

VGA *(from page 58)*

(or vectors) between each picture element. It differs greatly from simple bitmap graphics because the bulk of a vector file points to dimensional information throughout an image, rather than the memory locations of its pixel values. Although highly math-intensive to generate, the advantage of vectored formats is that image proportions can be infinitely scaled without loss of image integrity.

VESA (Video Electronics Standards Association)—Established in 1988, VESA's goal was to eliminate incompatibilities among proprietary SVGA modes. Before adoption of VESA guidelines by all display adapter and most monitor manufacturers, entering an 800 × 600 SVGA mode often meant performing manual adjustments to a monitor's horizontal and vertical positioning to re-center an on-screen image. Image misalignment was caused by conflicts in video signal timing between display adapter and monitor. At the time, SVGA graphics adapter manufacturers defined their own timing signals arbitrarily, with different timing resulting in different on-screen positioning. By bringing together the graphics hardware industry, VESA goes a long way toward eliminating such inconveniences by cementing standards across different SVGA graphics platforms.

VGA (Video Graphics Array)—A pseudo-color graphics standard developed by IBM for its line of PS/2 personal computers, VGA is a true analog method of generating color images on a computer. Maximum displayable colors are 256, from a palette of 262,144 possible colors.

Video Bandwidth—Expressed in megahertz (MHz), this refers to the highest frequency at which a given video monitor can accept image information and, thus, determines the maximum displayable resolution of the monitor.

Video BIOS (Basic Input/Output System)—Routines (firmware encoding) contained within the ROM chip(s) located on a display adapter board that contain such information as how to decode instructions from the host CPU, alphanumeric character sets, self-tests, etc.

VRAM—This is dual-port video random-access memory permits simultaneous access by the host CPU and video controller to let the host write new instructions to the frame buffer, while the video controller reads previous data. Providing greater throughput than conventional DRAM frame buffers, VRAM is usually the only way a video controller can access its memory fast enough to generate a non-interlaced display.

YCrCb—Luminance and chrominance (intensity and color-difference). The composite picture signals extracted from broadcast TV, color video cameras and VCRs. To capture and digitize an image from YCrCb requires its color space and format to be converted to RGB before it can be processed by a computer.

Zooming—The visible magnification of an area within an image.

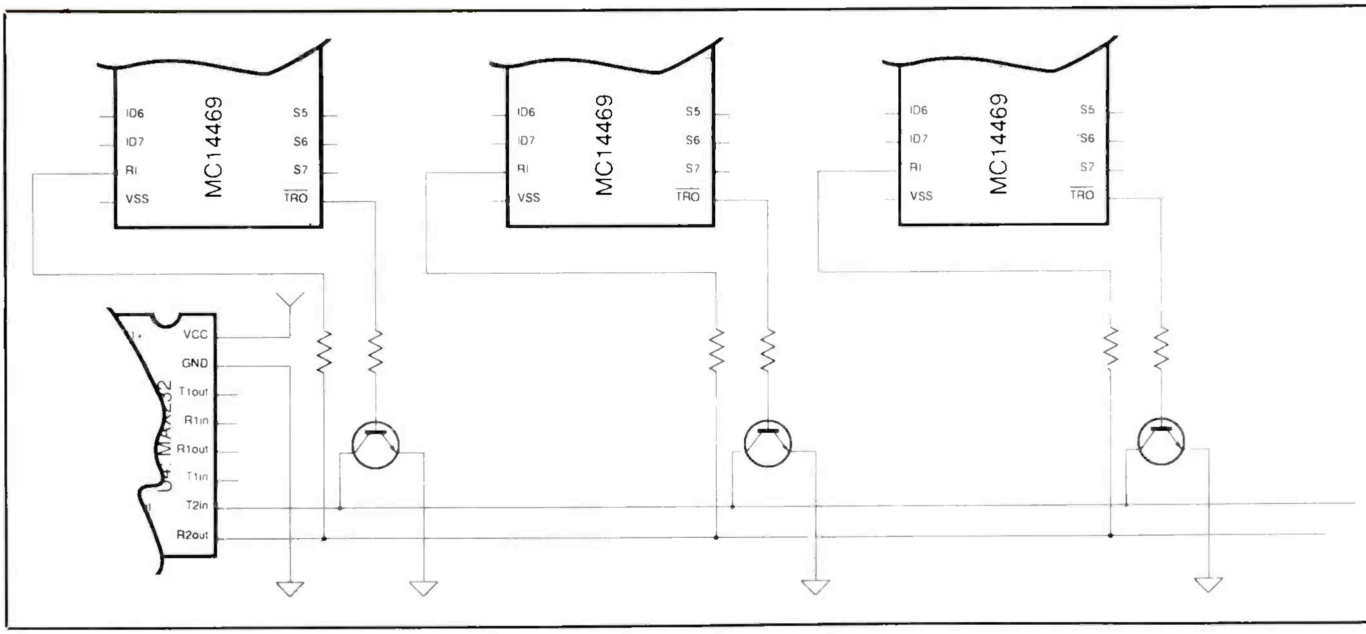


Fig. 2. Complete schematic diagram of the circuitry used in the Ultrasonic Ranger.

which *U2* is running. This equals the frequency present at OSC1 divided by 64. For example, to operate at 1,200 baud, you'd initialize your computer's serial port to 1,200 baud and drive OSC1 with a 76.8-kHz signal. The easiest way to obtain 76.8 kHz is to divide a higher frequency by a multiple of 2. In conjunction with a readily available 19.6608-MHz crystal, oscillator/divider *U3* provides the proper frequencies for 1,200 baud and other commonly used rates.

Figure 2 shows DIP switch *SW2* connecting OSC1 to one of the outputs of *U3*. If you don't anticipate frequently changing the baud rate of your system, you might prefer to hard-wire OSC1 directly to one of *U3*'s outputs and save on the cost of a DIP switch. Besides generating the correct baud rate, *U3* also produces a 1.2288-MHz clock signal for use by another part of the circuit.

Chip *U4* contains two transmitters and two receivers that translate between RS-232 levels and the logic levels used by *U2*. There are many different transceiver chips that could be used instead, but the MAX232 specified was chosen because it's readily available and operates from a single 5-volt supply. Transistor *Q1* and a pull-up resistor inside *U4* form an inverter between transmit output TRO of *U2* and the T2IN input of *U4*.

Additional MC14469 chips can be added to *U4*, as shown in Fig. 3. Up to 127 Ultrasonic Ranger circuits can be connected to a single computer, provided each has a different address. To all of the Rangers, the computer will send an address and command word, but only the chip that receives its own personal address will respond.

You can best understand the functions of *U5* through *U8* by stepping through the sequence of events that occurs each time the computer requests the Ranger to take a measurement. First, you must initialize the serial port and establish the address of the Ranger with which you wish to communicate. In BASIC, this could be accomplished by keying in:

```
ADDRESS = 255 'This corresponds
   to A0-A7 held high
OPEN "COM1:1200,E,8,1" AS #1
```

To initiate a measurement, it's best to start by resetting *U6*, *U7* and *U8*. This is done by toggling high C2, ensuring that a CS pulse is generated by *U2*, and then toggling low C2. In BASIC, a subroutine to perform this sequence of actions might be as follows:

```
PRINT #1, CHR$(ADDRESS)
PRINT #1, CHR$(4) 'Toggle C2
   high and send CS
PRINT #1, CHR$(ADDRESS)
PRINT #1, CHR$(16) 'Toggle C2 low
   by toggling C4 high (see Note 1)
```

Having reset the flip-flop and counters, you want to tell the ultrasonic ranging module to initiate a measurement. This is accomplished by bringing high the INIT pin of the module. At the same time, you want to begin timing how long it takes until the ultrasonic signal bounces back from its target. You can do this by toggling high C1, ensuring that a CS pulse is generated by *U2* and then toggling low C1. The code for this is:

```
PRINT #1, CHR$(ADDRESS)
PRINT #1, CHR$(2) 'Toggle C1 high
   and send CS
PRINT #1, CHR$(ADDRESS)
PRINT #1, CHR$(16) 'Toggle C1 low
   by toggling C4 high
```

When C1 is toggled high and the CS pulse that follows reception of the second word by *U2* is ANDed with C1, a pulse is generated at the CLOCK input of D-type flip-flop *U8*. This causes the flip-flop's output to latch high, causing the ranging module to emit an ultrasonic signal because its INIT pin was taken high and the output of the flip-flop opens an AND gate to allow the 1.2288-MHz clock pulses from *U3* to start incrementing *U7* and *U8* (*U7* and *U8* form a 16-bit binary counter).

When the ultrasonic signal is received by the ranging module a few milliseconds after it was emitted, the module allows its ECHO pin to be pulled high by *R6* (it has an open-collector output). This resets the flip-flop, forcing low its output and stopping the 16-bit counter.

At this point, *U6* and *U7* have on their output pins a 16-bit number that corresponds to the number of clock cycles that have elapsed while the ultrasonic signal traveled from the transducer to the target and back. This number is directly proportional to the distance to the target.

All that remains is to read the number off *U6* and *U7*. To do this, you issue another command to *U2*. This time, you toggle high *U3* to allow the CS pulse that follows to briefly take high the SEND pin. This tells *U2* to read the 16-bit number on pins ID0 through ID7 and S0 through S7 and send them to the computer. This is accomplished as follows:

```
WHILE B$ <> " "
B$ = INPUT$(1,#1)
WEND 'This loop clears the serial
   port buffer

PRINT #1, CHR$(ADDRESS)
PRINT #1, CHR$(8) 'Toggle C3 high
   and send CS
```

The numbers have been sent from the Ranger to the computer, but you must still read them from the computer's serial port buffer using a subroutine like:

```
BYTE1$ = INPUT$(1,#1)
BYTE2$ = INPUT$(1,#1)
COUNT = ASC(BYTE1$) + ASC
   (BYTE1$)*256
```

At this point, the variable "count" holds the number (0 through 65,535) of clock cycles that elapsed while the ultrasonic signal traveled to the target and back. "Count" is directly proportional to the distance to the target. From here on, the program code should be dictated by your application. In the prototype, what follows is computing the distance from the total count, subtracting the measured distance from 2.400 meters to find the visitor's height and various procedures to display and vocalize that height.

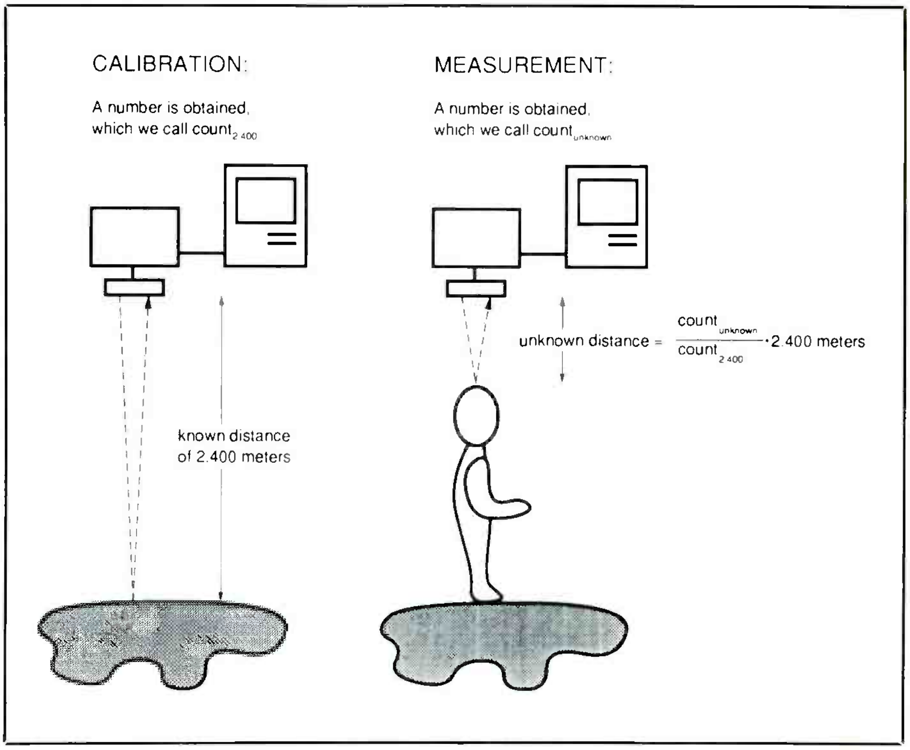


Fig. 4. Illustrated here is the ratiometric approach to calibrating and measuring distance in the application for which author's prototype is used.

Construction

The ultrasonic transducer is supplied by Polaroid with a short two-conductor cable for connecting it to the ranging board. If you wish to extend this wire very much, use shielded cable.

The ranging module has a connector for a supplied nine-conductor foil ribbon cable. If you can't locate a matching connector (Burndy No. SLP9s-2) for the other end of the special cable, you have two options. The simpler is to unsolder the Burndy connector from the module and replace it with your own ribbon cable soldered into the holes left by the connector.

If you don't want to tamper with the Polaroid module, you can use the Burndy connector and foil ribbon cable by modifying the end of the ribbon cable. To do this, separate the foil ribbon into its separate conductors and carefully insert the conductors into a DIP socket. This method seems to work best with AMP DIP sockets.

Decide now whether to include *SW1, SW2* and *R1* (for convenience when connecting multiple Rangers to the same computer) or omit them and hard-wire baud rate and address. Eliminating these components simplifies assembly and is something you can probably get away with in most applications. If you eliminate *R1* and *SW1*, be sure that pins A0 through A7 are either grounded or connected to V_{DD}, rather than leaving them floating.

The circuit is simple enough that it can be built on a few experimenter boards. No pin numbers are shown in Fig. 2 because the ICs are drawn exactly according to their physical packaging. Hence, pin 1 is at the top-left and the last pin number is at the top-right of each DIP IC. This makes it relatively easy to work between schematic and board layout.

You may want to build the left and right halves of this circuit on separate boards because the circuit half centered around the *U2* has considerable utility apart from the Ultrasonic Ranger and might at some point be used elsewhere.

There's nothing critical about component layout. Just make sure to locate bypass capacitors *C4* and *C5* physically close to pin 40 of *U2* and pin 16 of *U3*, respectively. Connect *C12* close to the ranging module because its function is to supply the brief pulses of current needed by the module.

You can use any type of enclosure into which all elements fit to house your Ultrasonic Ranger. Machine the selected enclosure as needed to mount the circuit-board assemblies, using ½" spacers and suitable machine hardware. Mount the transducer that comes with the Polaroid ranging module outside the enclosure.

Using It

There are two ways to convert the number returned by the Ultrasonic Ranger into a usable distance measurement. One is to measure the temperature of the air, calculate the speed of sound at that temperature and then calculate distance based on the speed of sound and the clock frequency, using the equation: distance = [counts/frequency (Hz)] $\times 331.4\sqrt{(T/273)}$ = meters/second. Here, T is temperature in °K and clock frequency is 1.2288 MHz.

A far easier method to compute distance is to forget about directly measuring the temperature and calibrate the Ultrasonic Ranger in such a way that temperature is taken into account. Do this by having the project measure a known distance and then use the number obtained to calculate unknown distances, utilizing the linear relationship that exists between counts and distance.

At the science exhibit in Canada, for example, the Ultrasonic Ranger starts each day by counting the number of clock pulses it takes the ultrasonic signal to travel the distance from transducer to floor (2.400 meters). Actually the average of three successive measurements, this number is stored as a variable the computer uses throughout the day to make measurements of unknown distances per the formula given in Fig. 4.

If you anticipate a relatively constant temperature in your environment, and if it's feasible to calibrate the Ranger by measuring a known distance, you can do as we did. On the other hand, if you expect the temperature to vary over a wider range, or if you can't calibrate by measuring a known distance, you can add a temperature sensor to your computer to mathematically compensate for temperature changes.

You may encounter situations in which the Ultrasonic Ranger is slightly late in giving an echo pulse when directed at such acoustically "soft" targets as carpeting and heads of hair. In our science-exhibit setup, we determined that the echo pulse was 0.32 to 0.38 milliseconds late, making our distance measurements a few centimeters too large.

It appears that only the last of the 16 pulses emitted by the ultrasonic transducer are reflected from our targets with enough strength to register with the Ranger as an echo. (The Polaroid ranging module increases its gain with time to compensate for sonic attenuation with distance to give later pulses a better chance of being detected.) Subtracting 0.38 ms from every measurement corrected the problem.

Joseph O'Connell

adventure as "a true Multimedia Experience" and "the first interactive cinema product" for the home market. These claims are debatable, depending much on the unclear definitions of "multimedia" and "interactive cinema." Multimedia is, in part, the intertwining of video, speech and music to produce an integrated product. Interactive means that the user in some sense takes part in the play or operation of the product, other than just running the program.

The video portion of this game is enhanced by digitized images of people and distinctive places in San Francisco. Heightened visuals greet users, thanks to the use of background coloration and brief scenes of animation. Sound enters in the form of music that varies from scene to scene, playing along with digitized voices of people Tex meets. The overall effect is very impressive when added to a detective story.

As I mentioned, this technique was skillfully used in *Mean Streets*, which premiered long before *Martian Memorandum*. Yet there appears little change in general game presentation. *Mean Streets* and other Access games witnessed a digitized speech technique called RealSound. That was before all the fancy add-on sound cards hit the market. *Martian Memorandum* supports some sound cards, but its speech reproduction isn't as clear as what's being heard in other games.

Enjoyment of a graphic adventure can be greatly affected by its interactive system. This makes sense because character and story interaction is the nature of adventure games, no matter how graphic they may become. *Mean Streets'* interactive system was somewhat clumsy because players often had to make unnecessary keystrokes (or mouse clicks) to obtain or examine a game object. Clumsiness in this instance was easy to overlook because *Mean Streets* offered a fairly new look to the graphic adventure, especially with the use of RealSound. Gladly, interaction improves for *Martian Memorandum*. Talking with game characters is more efficient. So is the ability to interact with game objects, although the interface isn't quite as smooth as in other game programs I've used.

Talking with game characters highlights *Martian Memorandum*'s interesting procedure for interaction. When Tex meets a game character, players can choose to converse. The character says something and waits for Tex to respond. Players select from a list of responses that may be radically different.

Response tones can be polite and witty or rude and threatening. Furthermore, the proper response must be selected in correct sequence. Anything else, and the encounter is unsuccessful, yielding little useful information. This method presents a double-edged effect for game playing. To its credit, it's a different and always-welcome approach in computer games, but it's also quite rigid. Discovering the correct response sequence for any one character is a matter of methodical trial and error that, at times, becomes fatiguing.

Martian Memorandum is an overall good-quality game. It evidences much work and forethought, especially on the part of visual presentation. Its music is adequate but not very diverse. The story is involved and lengthy, which is just what's needed for an adventure game. *Martian Memorandum* is interactive, as adventure games have to be, and it has the key components of multimedia. If you like graphic adventures, this one won't displease you. You'll really like it if you're a fan of Tex Murphy, the tough private eye from *Mean Streets*.

Monkeys . . .

Does the name Guybrush Threepwood ring a bell? It should if you've played *The Secret of Monkey Island*, LucasFilm's offbeat pirate adventure game. In case you're an adventurer who missed this one, let me refresh your memory.

Threepwood is a young man with the great ambition of becoming a pirate. In the original *Monkey Island*, he faced three challenges that, if he solved them, saw him to that glorious social status. He fights voodoo, used-ship salesmen, cannibals and puns that are so bad they'll knock your socks off. Eventually he has to defeat ghost pirate LeChuck, who's so mean he sometimes even scares himself. Well, enough history. If you want more, you can read my review of original *Monkey Island* game in the August 1991 issue.

As you might have guessed by now, Guybrush Threepwood is back. He's a full-fledged pirate with a daring story to tell. Now he sits around camp fires on the shores of Scabb Island recounting the chilling details of how he beat ol' LeChuck and evaporated away the ornery apparition. It's a good story when you hear it the first time. But after hearing it several hundred times, all of Scabb Island is sick of it. So begins the tale of *Monkey Island 2: LeChuck's Revenge*.

Like the original *Monkey Island*, unabashed humor is the impetus for this computer game. When Threepwood tells his pirate friends that he's aiming for big adventure, they think he wants go grow a mustache. "No, bigger!" Threepwood responds. Then they think he wants to grow a beard. But no, Threepwood wants to find . . . Big Whoop! That's right, Big Whoop. Nobody seems to know what it is exactly. But it's something either so wonderful or so horrible that its original discoverers took great pains to keep it hidden.

Big Whoop is a quest that's sure to yield a good story, and a pirate needs a good story as much as he needs his humor. There's a darker reason, though, that impels Threepwood to find Big Whoop. It turns out that ghost pirate LeChuck isn't really dead. He's just plain miffed, and he's looking for a certain fresh-faced pirate. Legend has it that Big Whoop holds the key to unimaginable power.

The only way to finish off LeChuck for good (and save a young pirate's life) is to find Big Whoop. What a plan! But a minor obstacle stands in the way. Threepwood has to get a ship and leave Scabb Island. Preventing any departure is ruthless Largo Legrande, the island bully who has forced an embargo so that no ships can leave. He also shakes down everyone he meets and swills grog like a pig. Of course, every pirate swills grog like a pig, so that's okay. Legrande is hated and feared by every inhabitant of Scabb Island. First task as game player is to bust the Largo Embargo.

The playing stage is set for cemeteries, tombs, voodoo dolls and ancient maps. *Monkey Island 2* picks up where the first game leaves off in both plot and game design. Player interface is still as seamless as ever, allowing full concentration on plot and puzzles. Music sets the right mood from foreboding and spooky to shamelessly jovial, with a score that fits so well as to be transparent. The intricate artwork is consistently sharp and colorful from scene to scene. And the humor is again second to none. *Monkey Island 2* is a perfect continuation of the series and an excellent graphic adventure in general.

And Magic . . .

Fantasy adventures abound in the world of computer gaming. It remains a favorite vehicle for gaming, whether role playing with computers or real people. Interestingly, fantasy adventure has lagged other graphic adventures' quality of user interface and player interaction. The typical fantasy adventure is basically a text-based numbers game traditional for the genre.

Fantasy adventure games are all alike in the same manner flight simulators are all alike. Differences between competing items in any category are in execution of the game concept. If a game doesn't play well, it ends up just another game. This was the case with the first two installments of *Might And Magic*. They were simply two more titles in the wash of adventure games, appealing mostly to gamers. The third installment, however, made many changes toward a more playable interface, better graphics and sophisticated sound. These changes make the game accessible to gamers who don't do much with fantasy but would like to try it sometime. Traditional role-play methods tend to frighten away the curious or occasional gamer, due to almost mandatory tedium.

The quest of *Might And Magic 3* is to defeat Sheltem, the returning evil Guardian of the Isles of Terra. Ostensibly, the evil antagonist was killed in *Might And Magic 2*, but bad guys have a way of coming back. Before players battle Sheltem, they must solve a host of smaller but necessary mini-quests that comprise the meat of the game. They have to search the land for clues, speaking with inhabitants, dealing with magic and fighting monsters along the way. This, too, is a typical but strong feature for fantasy adventure.

The biggest change to the *Might And Magic* series is its three-dimensional view. Formerly, as in other fantasy adventures, the action was represented by a checkerboard matrix of squares. Little icons, picturing game characters, moved from one square to another. Results were reported in the form of text. This method of play relies much on player imagination for its success, which is what games do anyway. But improved game execution heightens imagination.

In *Might And Magic 3*, game players see all of the action instead of just reading the textual results. Even though numbers like hit points and spell points represent the core of fantasy role play, games are more enjoyable if players aren't inundated with such as this.

This version of *Might And Magic* is one of several fantasy adventure games that are moving toward more-elegant play. Still, it and other fantasy adventures have some milestones to pass before running pace with the smooth style of other adventure games on the market.

Might And Magic 3 is interesting to play, strictly from an adventure game point of view. It's full of puzzles and unusual characters taken from the myth and lore of legend and fantasy. Experienced fantasy players will like its new look and better handling. Gamers who are new to fantasy will find it a playable introduction into the alluring realm of good and evil in which might and magic reign supreme. ■

Bird's Eye View

Monkey Island 2: LeChuck's Revenge, $59.95
LucasFilm Games
P.O. Box 10307
San Rafael, CA 94912
Tel.: 415-721-3300

Requirements

Memory	640K (Hard drive required)
Graphics	VGA, MCGA
Sound	Roland, AdLib, SoundBlaster, SoundMaster
Controllers	Keyboard, Mouse, Joystick

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Short
Complexity	Easy
Playability	Excellent

In Brief: Well-executed graphic adventure where humor and silliness are as important as any other game aspect.

CIRCLE NO. 121 ON FREE INFORMATION CARD

Bird's Eye View

Martian Memorandum, $59.95
Access Software
4910 Amelia Earhart Dr.
Salt Lake City, Utah 84116
Tel.: 800-800-4880

Requirements

Memory	640K (Hard drive required)
Graphics	VGA, MCGA
Sound	Roland, AdLib, SoundBlaster, RealSound
Controllers	Keyboard, Mouse, Joystick

Evaluation

Documentation	Fair
Graphics	Excellent
Learning Curve	Short
Complexity	Easy
Playability	Good

In Brief: Interesting science-fiction graphic adventure with complex plot and intricate story.

CIRCLE NO. 118 ON FREE INFORMATION CARD

Bird's Eye View

Might and Magic 3, The Isles of Terra, $59.95
New World Computing
20301 Ventura Blvd., Ste. 200
Woodland Hills, CA 91364
Tel.: 800-325-8898

Requirements

Memory	640K
Graphics	VGA, MCGA, EGA, Tandy
Sound	Roland, AdLib, SoundBlaster, Tandy
Controllers	Keyboard, Mouse, Joystick

Evaluation

Documentation	Good
Graphics	Good
Learning Curve	Medium
Complexity	Medium
Playability	Good

In Brief: A quest of monsters, magic, and difficult puzzles. A little more playable than most fantasy adventures.

CIRCLE NO. 120 ON FREE INFORMATION CARD

tro Pro 3.0. Installing these drivers (as well as the drivers for MS *Windows*) is amply detailed in the very well written *Software Information Guide* that accompanies the printer. In addition to this excellent manual, the printer comes with an equally well done hardware manual and a guide to using color effectively.

Color printing is much easier to accomplish with *Windows* applications. You just install the new DeskJet Family driver under the *Windows* printer driver Control Panel. When you install this driver, you can specify the color density you wish to use (from light to dark). The samples reproduced here, which were generated using the fabulous new *Freelance Graphics for Windows* from Lotus, were printed using the highest available print density. I'm not sure the difference will be highly visible when the printouts are reproduced in the magazine, but the color quality and brightness of the 500C does suffer somewhat in these areas when compared to the six times more expensive thermal-transfer printer. The output, though, especially on the special inkjet paper that HP recommends (which reduces ink "wicking" into the paper), is very usable for even important business presentations.

Keep in mind two things when considering the DeskJet 500C. This printer is very slow when compared to a laser printer. A full page of black-and-white bit-mapped graphics can take a minute or more to print out, and a color page takes about 7 minutes. It's also more expensive than black-and-white printing. Depending on how much white space my pages contain, I'm not getting more than about 500 pages out of a color cartridge. Though for the quality of the output, 8 cents per page seems like an outright bargain.

I've liked HP's DeskJet printer since I first used it, though the standard version has become somewhat obsolete by the inexpensive 4-ppm laser printers that have recently become available. The DeskJet 500C should breathe a lot of vitality back into the DeskJet product line. HP has developed the reputation of setting the standards for non-impact printing. HP did it with the original LaserJet and original DeskJet. The newest member of the family is sure to again set a standard in low-cost, high-quality color printing. ■

Product Tested

DeskJet 500C, $1,095
Hewlett-Packard Corp.
18110 S.E. 34 St.
Camas, WA 98607
Tel.: 800-752-0900

CIRCLE NO. 105 ON FREE INFORMATION CARD

Of Mars, Monkeys and Magic

Question: What do Magic, Monkeys and Mars have in common? *Answer:* They all begin with the letter "M." After wracking my brain, this is about all I could come up with to tie together the three unrelated computer games in this review.

Of Mars . . .

Get set for the thrilling return of Tex Murphy. If you've never met him before, you're missing an interesting experience in graphics adventure. Tex is a hard-boiled private investigator who muscled his way into computer games a couple of years ago. He drove a Lotus Speeder, lived in scenic San Francisco, and got his job done by breaking the rules.

Tex's first graphic adventure was a murder case. A local university professor hired him to find the truth about his daughter's murder. VGA graphics, digitized video, voice, music and animation saw Tex question witnesses, sweet-talk dolls and threaten thugs. An ace secretary kept him informed and in line via Com Link, a Dick Tracy-esque wrist radio. *Mean Streets* was a push ahead for Access Software, which pioneered RealSound, a technique of reproducing understandable human voice on a computer without requiring additional hardware. That was the computer game year 2033.

It's now 2039, and Tex is on the beat again in *Martian Memorandum*. Marshall Alexander, the powerful and mysterious president of Terra Form Corp., wants Tex to find his missing daughter. It may well be kidnaping, but what's the truth? Alexander is reticent, providing naked facts without insight. However, his stunningly beautiful executive assistant, Rhonda Foxworth, is bound to have an inside track on important information. What will it take to loosen her tongue?

Elsewhere, the missing daughter's home is thoroughly searched by police. But they might have missed something. Unsavory characters of all sorts pop up, and Tex has to learn something from everyone. The plot skids forward with a grisly ritual killing, Central American smugglers and onward to the Red Planet itself, Mars.

Access Software hails its latest graphic

(Continued on page 84)

Young Threepwood gets tough.

The quest for Big Whoop.

Spying is a dirty business, but Tex doesn't mind.

A new interface for Might & Magic.

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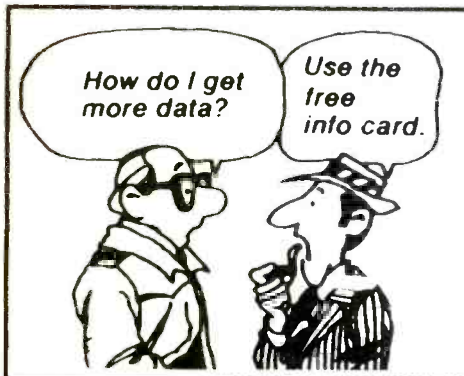

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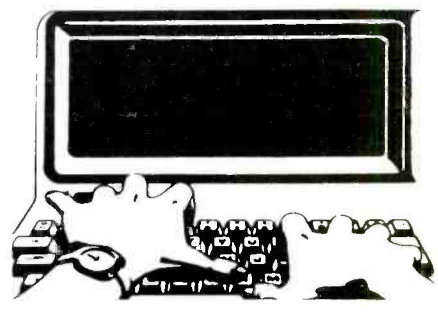

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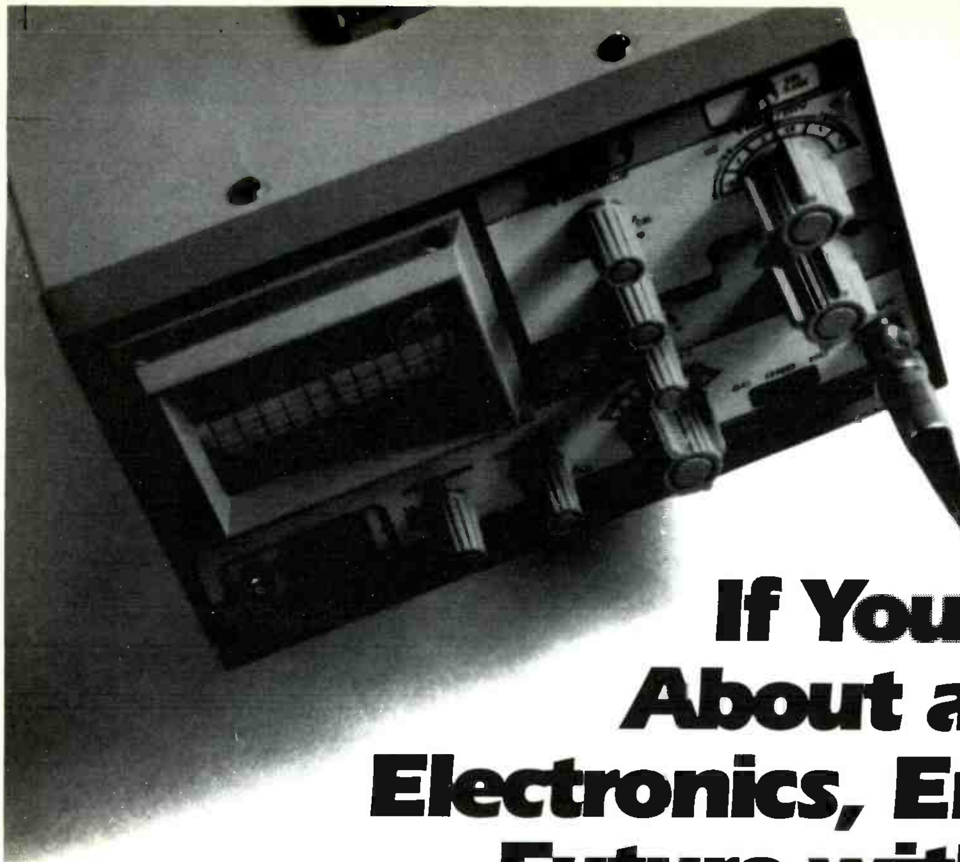

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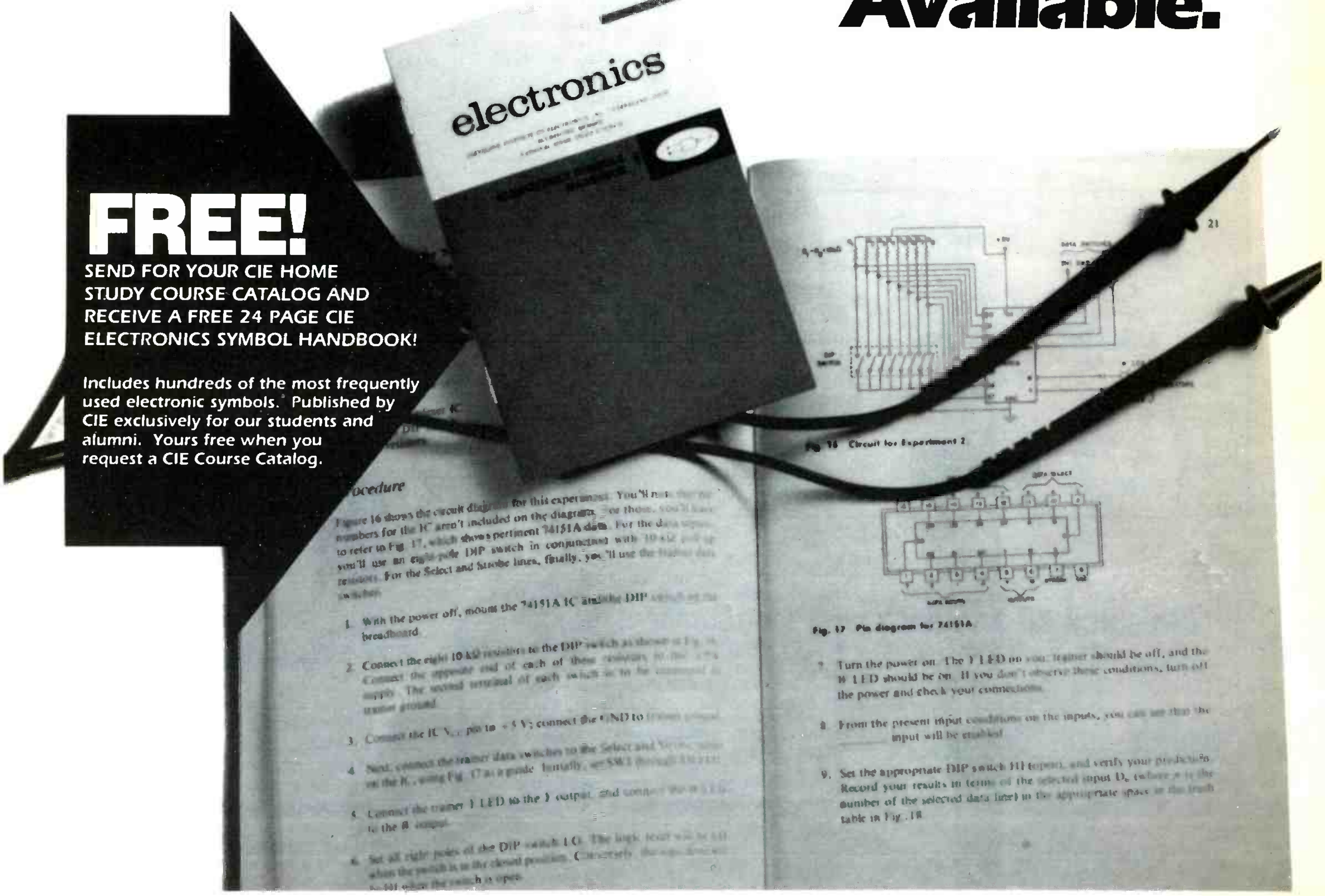

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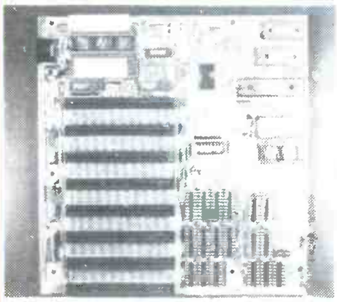

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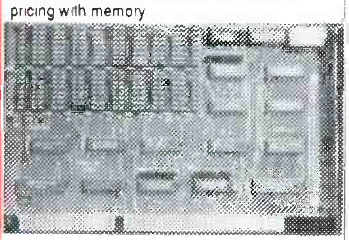

Part#	Description	Each
IFC-47A	BOCA 128K AT Memory Board	$79
IFC-60	AT Plus - Up to 8 MEG RAM	$119
IFC-60A	AT Memory Board 8 MEG Using SIMMS	$119
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IFC-62	PS-2 MOD 50 60 EMS up to 2 MEG	$119
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IFC-27X	XT 2/IDE Controller	$69
IFC-28	XT MFM Hard Drive Controller Board	$47
ST-01	8 Bit SCSI Controller	$29
ST-02	8 Bit SCSI/Floppy Controller Board	$47
IN-2000	16 Bit SCSI Hard/Floppy	$189

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Part#	Description	Each
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IFC-12A	Second Serial Port Kit for IFC-12	$6
IFC-25	2 Serial Parallel Game Board XT/AT	$16
IFC-13	Parallel Board XT/AT	$9
IFC-19	Clock Board PC/XT	$10
IFC-19B	Chipchip for PC/XT	$24
IFC-20	Game Board XT/AT 2 Ports	$9
IFC-70	BOCA 2 Serial 2 Parallel I/O Board	$49
IFC-73	BOCA 2 Serial 1 Parallel & Clock Board	$49
IFC-75	BOCA 2 Serial 1 Parallel MCA I/O Board	$99
IFC-76	BOCA Parallel Port MCA I/O Board	$55

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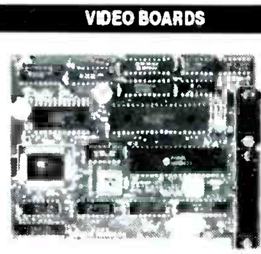
Part#	Description	Each
MS-400A	Multi-Serial Board for PC/AT	$89
MS-422A	Dual RS-232/422 Serial Card for PC/AT	$69
MU-440	Multi-User Board	$139
LCS-8880	4-Port Multi-Terminal Card	$75

VIDEO BOARDS



IFC-32	Mono Board w/printer port XT/AT	$16
IFC-33	Color Graphics w/printer port XT/AT	$25
IFC-42	640x480 VGA Card	$59
IFC-42C	BOCA Super VGA Card	$139
VG-7000	Super VGA w/512K	$85

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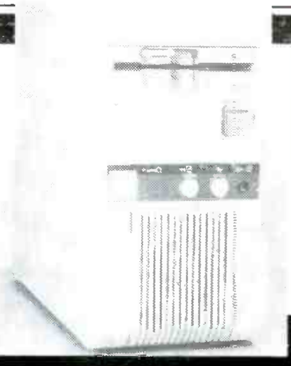
STC-10	Regular AT Case w/230 Power Supply	$95
STC-08	Medium Vertical Case w/230 Watt Power Supply	$119
STC-18	Regular Vertical w/250 Watt Power Supply	$133
STC-16	Regular Vertical w/250 Watt Power Supply	$136



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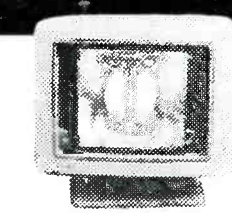
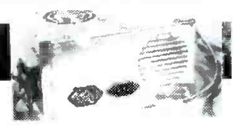


RM9502	Monochrome VGA (800 x 350, 400, 480)	$139
RE1420	Super VGA (1024 x 768) Unlimited Colors	$359
RE1520	15" Super VGA Monitor (Noninterlaced up to 1024x768)	$469

POWER SUPPLIES



PS-150	150 watt XT Power Supply	$32
PS-150UL	Same as PS-150 - UL Listed	$69
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PS-200MUL	Same as PS-200M - UL Listed	$89
PS-200	200 watt AT Power Supply	$42
PS-200UL	Same as PS-200 - UL Listed	$89
PS-220	220 watt Vertical Case Power Supply	$79
PS-230UL	230 watt Vertical Case Power Supply - UL Listed	$99
PS-200MINI	200 watt Baby Vertical Case Power Supply	$59

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DDD-04	5 1/4 inch DSDD 360K black faceplate	$59
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DDH-09	3 1/2 inch 720K beige w/brkt	$59
DDH-10	3 1/2 inch 1.44MB beige w/brkt	$59
DDH-11	Same as DDH-10 without 5-1/4" mounting bracket Fits in 3-1/2" bay	$55
RAIL01	AT Drive Rail Kit	$1.99
FP-BLK	1/2 Height Black Faceplate	$2.49

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MON-05	Monochrome TTL Amber 12"	$89
MON-06	Paper White TTL 14"	$112
MON-10	CGA/RGB (640 x 240) 14"	$219
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Part#	Description	Each
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K-158-1	Small Footprint Spanish Language	$47

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