XTree For Windows Debuts

ComputerCraft

January 1993 $2.95
THE PRACTICAL MAGAZINE FOR PERSONAL COMPUTERS & MICROCONTROLLERS (Canada $3.95)

- A PC-Sound Hardware Buyer's Guide
- Experiment With Parallel Processing
- Shells Can Make Your Computer Friendlier

0 74820 08559 01

BASIC-52 Options For 8051 Microcontrollers

Recycle That Old PC You Aren't Using

SBC Digital Thermometer With Binary Display

LIMITED TIME SPECIALS! ORDER TODAY!

Items stamped with this seal are compatible with X-10 Powerhouse, Leviton Decora Electronic Controls, Radio Shack Plug-n'Power, Sears Home Control, Stanley Lightmaker, GE Homeminder, and most powerline carrier remote control systems.

HOME CONTROL CONCEPTS

Buy with confidence from HCC!
- *LOWEST PRICES GUARANTEED!*
- *DOUBLE MANUFACTURER'S WARRANTY*
- *TECHNICAL SUPPORT SECOND TO NONE*
- *IMMEDIATE SHIPPING*

New! *HomeBase*

Intelligent Controller Integrates X-10 and Infrared Technology!

Introducing HomeBase, the most powerful mid-end (under $10,000) home automation system on the market!

"Suprisingly easy to use yet extremely powerful" -Robert B. Dunham, Consultant to McDonnell Douglas and Pacific Bell

- Intelligent Home Control System
- At last, a user interface that's really EASY to use!
- Monitors your powerline and allows IF-THEN control. Complete 2-way X-10 system!
- Uses PC to set your home's schedule... once programmed your PC may be powered down or used for other things
- User-friendly windows-like interface
- Can even be used with a mouse
- Real-time clock/calendar keeps track of sunrise/sunset
- Battery backup
- Mega-Controller allows on-line control... It's an on-screen X-10 controller and a status display of your home
- Advanced Scheduling features: IF-THEN-ELSE, AND/OR, Macros, Timers, Counters, Flags, etc.
- Super Sequence Feature: A series of X-10 commands within a settable time window can trigger an event. For example, pressing A1, A2, A1 within 2 seconds can dim the lights
- Log Feature: Your schedule can log (with time/date) any event you specify
- Security Mode: Have your front porchlight come on at "approximately" the time you specify... gives the house a real lived-in look
- No language to learn
- Add complete Infrared capability with addition of IR Interface (see below)
- Expansion port for future add-on products
- Requires IBM PC or compatible w/Serial Port

HCC-3001 HomeBase ..... ONLY $299

FREE REMOTE COMMUNICATIONS UPGRADE KIT

Remotely control your home from any computer anywhere in the world! Dealer/Installers, change your client's schedule or debug their system from your office! Allows you to offer a service contract with your home automation package!

$99 Value! Yours FREE if your order HomeBase by Dec. 15th!

HomeBase's expansion port allows easy integration with add-on products to expand and enhance your home automation system!

Infrared Interface

The Infrared Interface integrates HomeBase with your home's infrared-controlled devices! Allows HomeBase to control IR functions such as TV volume & channel, CD player track & song select, stereo system speakers on/off, VCR play or record & much more! Avail. December 1992. HCC-3005

I/O Interface

The I/O Interface integrates HomeBase (above) with security systems, moisture sensors, temperature input, motion detectors, motors, virtually anything that X-10 can't! Opto-isolated inputs, relay outputs. Available 1st Quarter 1993. HCC-3008

Lamp Module Mania!

Plug-in lamp module controls incandescent lights up to 350 Watt max. Off-white color. Module is labeled "Emergency HouseLighter Lamp Module." HCC-2474. By Schlage. **ONLY $6.90**

Wall Switch Module

Replaces existing wall switch. Controls incandescent lights up to 500 Watt max. Ivory color button. Only 830 modules reserved for this promo, so order now! By Stanley. Limit 24. HCC-2475. **ONLY $9.99**

HCC-2476 3-Way Switch Set (pair) ONLY $12.99

X-10 Development Kit

Use to develop your own PC-based "smart" home automation system! Monitor status of home's lights & appliances and make intelligent decisions based on their on/off status. Develop a home control system with IF-THEN logic, even 1-button macros! Add Stanley motion detectors to give system input of room presence. Development software is interrupt based (does not use polling!) and includes compiled library routines and sample C-language source code.

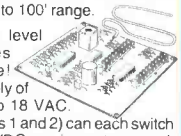
Use with *PC to Infrared Interface* (below) to develop a system which combines home automation and IR control; any X-10 controller can control infrared! With addition of *Voice Master Key*, voice control of the home becomes possible. Use X-10's *Sundowner* to give dusk/dawn input to your system. Add voice PC voice mail card for remote call-in control of X-10!

Requires IBM PC or compatible computer with parallel port. Includes TW523 module, adapter, interface cable, development software, demo program & technical info/data. HCC-523K **ONLY $69!**

Keychain control of anything!

Manufactured by Linear, this low cost RF link is ideal for wireless control of your own projects, your home and car alarm, car doorlocks, and even X-10 modules (with addition of HCC-284 Powerflash Module)! Set security code on transmitter and receiver, apply power to receiver board, and you're ready for wireless control!

TRANSMITTER: Tiny keychain transmitter is approx. half the height of a matchbox! Transmitter has two buttons corresponding to channels 1 and 2. Includes two Lithium batteries. Up to 100' range.



RECEIVER: Board level receiver measures approx 3" square! Requires power supply of 8 to 24 VDC or 12 to 18 VAC. Two outputs (channels 1 and 2) can each switch up to 300 mA @ 18 VDC maximum to ground. Directly activate relays, drive bulbs, more.

HCC-RF1 RF Link set includes transmitter, receiver, documentation. **ONLY $39.90!**
HCC-RFX Extra transmitter **ONLY $19.95!**
HCC-PA12V 12VDC 500mA plug-in adaptor **$4.99**

"Understanding & Installing Home Systems: How to Automate Your Home" by David Gaddis

Home Automation Book

New Edition, expanded and improved! *Electronic House* magazine says "...really works. ...Gaddis has done a great job..." Also reviews in *Popular Science*, *Radio Electronics*, and *Circuit Cellar INK*. Excellent! Topics include Security, Lights, Appliances, Entertainment, Communications, Energy Management, Heat & Air, Pools & Spas, Home Theatre, and more! 150 pages and over 125 illustrations. Recommended! **ONLY $26.95** Reg. $29.95

Home Automation Video

Lights, camera, automation! See home automation in action. Learn about equipment, systems, what's available, how to install, professional troubleshooting techniques, never before seen tips and secrets and lots more. **ONLY $29.95**

Professional Quality Designer Components

Wall Switch Use to control fluorescent or incandescent lighting, appliances, motors, etc. Rated 20A. Neutral required. HCC-8001 White; HCC-8000 Ivory

Ceiling Fan / Low Voltage Dimming Switch Module Dims low voltage lighting & controls motor speed (e.g. ceiling fans) using X10 DIM/BRIGHT! Rated 500W incandescent, 500VA inductive. HCC-8041 White; HCC-8040 Ivory

YOUR CHOICE **ONLY $39.90 EA.**

X-10 Keychain & Base

New! 2-button keychain remote can be set to unit codes 1&2 or 5&6. Plug-in base transceiver receives 16 unit codes from any X-10 transmitter (incl. HCC-2554 below) HCCC-6500 **ONLY $29.95**

Mobile Control

Stanley 8-button hand-held remote done in sleek 1990's styling. Transmits RF signal up to 100' to plug-in base transceiver (below). Off-white color. HCC-2554 **ONLY $16.95**

Base Transceiver

Here's a great chance to expand your X10 or Stanley wireless remote control system to an entire housecode or several house-codes. Set to any house-code; receives unit numbers 1-8 or 9-16.

BUILT-IN APPLIANCE MODULE! Also features a built-in appliance module preset to unit number 1 (may be used as A1, B1, etc). This appliance module contains X10's future 2-way technology... It an answers "status query" command from TW523! (see *X-10 Development Kit* this pg) Off-white. By Stanley. HCC-501X Reg. $29.90 **ONLY $16.99** *50% OFF!*

PC to Infrared Interface

Great for development of your own infrared home control system! Allows your PC to "push buttons" on remote control! Combine PC based home automation with infrared control of your TV (volume, channel, etc), stereo, VCR, and more! Add whole-house IR repeater such as X-10's *Powermid*. Use with Covox *Voice Master Key* (HCC-VMK1 $169) for voice control of your entertainment system! Combine with *X-10 Development Kit* (above right) to allow any X-10 controller to control your infrared devices! Use with voice mail system for remote control of IR from any telephone. Possibilities are limitless!

Requires *One-For-All* remote control (see right). Remote has special port which connects to your PC's serial port (using our cable and hardware interface). Use the SendIR program to transmit infrared signalss by "pushing buttons" on the remote control. For example type the dos command **SendIR TV MUTE** to mute the tv; or SendIR VCR REC to start your VCR recording! Call SendIR from DOS batch files, your existing software program, or develop a program from scratch using sample source code.

Complete with cable and hardware interface, development software, sample C-language source code, technical info/data and documentation. Requires *One-For-All* remote control and IBM PC or compatible computer with serial port. HCC-PCIR **ONLY $69!**

PowerFlash Interface

Plug-in module is activated by a 6-24V low voltage input or a dry contact switch. Output mode can be set to several types; use to turn on any X-10 module, turn on all lights for an entire house-code, or send ALL LIGHTS FLASHING (will also activate PowerHorn Siren, HCC-508x $29.95).

Wire to output of your existing home security system to flash your X10 lights. Use with external switch (e.g. doorbell switch, motion detector, etc) to activate an X-10 chime (HCC-CH1 $19.95) or beeper (HCC-506 $19.95). Your interface between X10 and the out-side world. By Schlage. **ONLY $16.99**

X10 Computer Interface

White box connects to PC's serial port; once programmed PC may be shut off or used for other purposes. Schedule up to 256 devices (IBM & Mac versions), 72 devices on Apple IIe/IIc, Commodore. Battery backup. Console, software, cable, manual. HCC-290P (IBM version) **ONLY $59.95**

Brand New! One-For-All 12

Lets You Control X10 and Infrared from one remote!

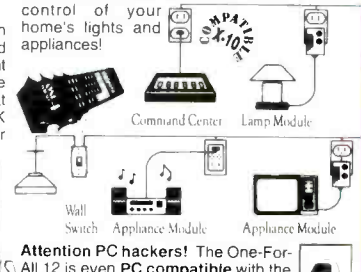
Universal Electronics has just unleashed their newest model remote control, the One-For-All 12. Billed as the most powerful universal remote in the world, the One-For-All 12 replaces 12 of your existing remotes for TVs, VCRs, Cable Boxes, CDs, Audio Products, Satellite Receivers and more! It can even control X10 modules!

The One-For-All 12 has a 32K memory which contains the world's largest library of infrared codes! In fact, the manufacturer is so confident that your component's infrared codes are contained in the One-For-All 12's memory that they're offering a DOUBLE YOUR MONEY BACK GUARANTEE! (call HCC Customer Service or Universal Electronics for further details)

Check out these great features: Provides any device with a Sleep Timer function * Simple set-up * One Button System Control * Perfect replacement for lost or broken remotes * Toll-Free Consumer Help Line * Upgradable (by manufacturer, no charge!) to match the latest advancements in IR remote control technology... won't become obsolete!

Built-in macros mean you can turn on a number of IR devices with the touch of one button! Complex audio or video systems can be powered up with the touch of a single key! Saves time & convenience!

X10 Compatible! Combine with the HCC-3000 One-For-All Command Center for control of your home entertainment devices AND X10 devices! Just aim the remote at the HCC-3000 for instant control of your home's lights and appliances!



Attention PC hackers! The One-For-All 12 is even **PC compatible** with the addition of the *HCC-PCIR PC to Infrared Interface!* (see description upper left)

One-For-All 12 Universal Remote Control HCC-RC5 **ONLY $79.95!**

One-For-All Infrared Command Center HCC-3000 **ONLY $29.95!**

INFO, PRICING & CUSTOMER SERVICE

1-619-693-8887

TOLL-FREE ORDER LINE (ORDERS ONLY)

1-800-CONTROL

VISA MasterCard DISCOVER

WHOLESALE PRICES. IMMEDIATE SHIPPING.

TERMS: Most in-stock orders ship within 24 hours. Tax applies to Calif. orders for non-resale. Shipping & Handling charge will be added to order. COD orders add $6.50 to shipping charge. Our standard shipping method in the Continental U.S. is by UPS ground service. Additional charge for UPS second day air, UPS Next Day Air, Federal Express or Airborne Express. Alaska and Hawaii orders are shipped by air service. International orders must be paid in U.S. funds by money order, cashiers check, or credit card. Returned merchandise subject to 15% restocking fee; before returning call for required RMA number. Certain merchandise (test equipment, software, books, etc) may not be returned for credit. Defective prodcuts will be repaired or replaced at our option. Double manufacturer's warranty on most items. We will match or beat any competitor's price. Not responsible for typographical errors. Limited time specials. Quantities may be limited. Phone our Customer Service Department between 8 a.m. and 5 p.m. Pacific Time for complete details.

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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

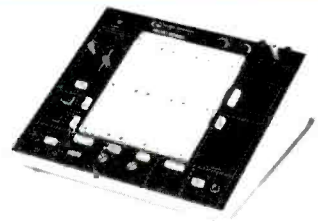
WAO II PROGRAMMABLE ROBOTIC KIT

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

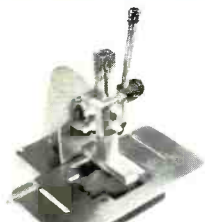
PROTOBOARD DESIGN STATION



- The total design workstation - including expanded instrumentation, breadboard and power supply.
- Ideal for analog, digital and microprocessor 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 breadboard 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 6-½" 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-Ne 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 5⅛" 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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CIRCLE NO. 140 ON FREE INFORMATION CARD

ComputerCraft

Volume 2, No. 1
January 1993

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UPGRADING & ENHANCING

APPLICATIONS

SPECIAL REPORT

COLUMNS

DEPARTMENTS

ON THE COVER: Sound is rapidly moving to the forefront as the next step in fleshing out the PC platform for multimedia operation and adding sound to presentations, applications, educational software and entertainment. Pictured is a Covox, Inc. internal sound board.

Cover Photo Courtesy of Covox, Inc.

ComputerCraft on MCI Mail

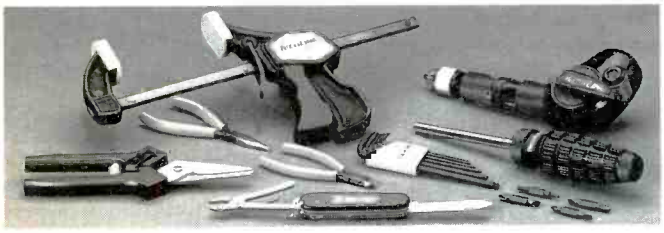
You can contact *ComputerCraft* on MCI Mail directly or through an on-line service, such as CompuServe. Any questions, article proposals, comments, etc. are welcome on this electronic mail box (MCI ID No. 456-3433).

THE PARTS PLACE SM.

NEW! Autoranging LCD Digital Multimeter

Convenient autoranging and auto-polarity at a low price. Select the function—meter does the rest. Diode-check mode. Measures to 1000VDC, 750VAC, 200mA DC current, 20 megohms resistance. Fuse protected, UL 1244 listed.
#22-166 . . . . . **36.99**

TECHLINE™ Tools—The new standard in strength and precision!



- **Precision-crafted with top-quality materials**
- **Designed for long life and ease of use**
- **Backed by Radio Shack's 1-Year Limited Warranty**

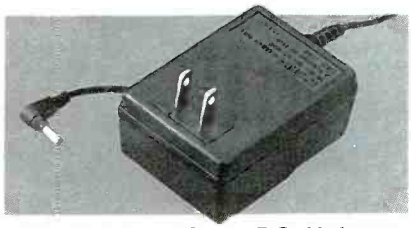
New TECHLINE tools represent Radio Shack's uncompromising dedication to quality. Each is precision-crafted of long-lasting, hard-working materials and employs the latest design innovations for comfort and ease of use. And, each is backed by our full 1-year limited warranty.

Speedy service and low prices on thousands of parts and accessories!

- **FREE delivery to Radio Shack on orders $5 and up**
- **Semiconductors and ICs ■ Hard-to-find batteries**
- **CB and scanner crystals ■ Long-life vacuum tubes**
- **Phono cartridges/styli ■ SAMS® service books**

Why pay more for mail-order? Your Radio Shack stocks 1000 electronic components, and another 15,000 are available *fast* from our special-order warehouse. Ordering is easy! Bring in the exact part number (or old part). We'll check availability and order by phone. Delivery time to your nearby Radio Shack for most items is a week.

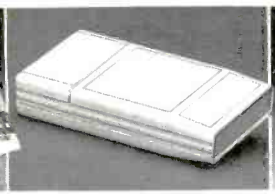
TECHLINE Rechargeable Soldering Gun. Great for autos, boats and campers—solder up to 250 joints on one charge. Trigger-activated light. UL listed AC charger, case.
#64-2194 . . . . . **39.95**



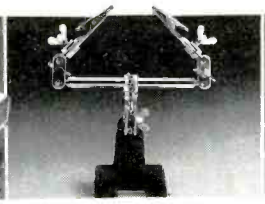
CD Player AC-to-DC Voltage Adapter. Saves batteries! Connect to your portable CD player's DC jack and plug into wall outlet to play from 120VAC. 3VDC regulated output. UL listed. #273-1659 . . . . . **16.95**

AC Voltage Sensor. Detects broken connections, blown fuses, defective grounds, open breakers, more. Indicates presence of AC voltages from 70 to 440VAC. Replaceable battery.
#22-103 . . . . . **11.99**

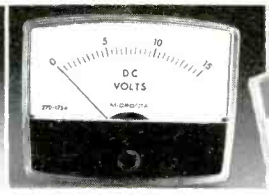
TECHLINE 18-Piece Hex Key Set. Ideal for engine and machinery work. Heavy-duty steel alloy. Standard sizes.
#64-1816 . . . . . **4.99**



IR Transmitter Project Case. For beeper or remote. 9V battery compartment. Molded 7/8 × 2 3/8 × 4 1/4" enclosure.
#270-294 . . . . . **4.49**



Project Holder. Alligator-type clamps adjust to hold work in any position. Solid cast-iron base prevents tipping.
#64-2093 . . . . . **8.49**



DC Voltmeter. Measure vehicle or power-supply voltage. Jeweled movement. Mounts in 1 7/8"-diameter round hole.
#270-1754 . . . . . **7.95**

Infrared Sensor Card. Detects normally invisible infrared to confirm output from remotes, IR LEDs or lasers.
#276-099 . . . . . **5.95**

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CIRCLE NO. 150 ON FREE INFORMATION CARD

Multimedia

Multimedia, which integrates text, graphics, animation and audio CD, continues to advance on the personal-computing scene. To do justice to it all, you need a bare minimum of a 386SX machine. Combined with other peripherals, such as a CD-ROM player, makes for a rather costly system. But for those who can afford it, multimedia makes for the possibility of tapping great resources for information, education and entertainment.

The latest move in the multimedia direction has been made by Sony's introduction of its new Multimedia CD-ROM Player. The portable (7″W × 2″H × 6″L and weighing 2 pounds) Model PIX-100 combines a CD-ROM drive that supports the CD-ROM XA standard, a PC-compatible microprocessor, an LCD display panel, a speaker, a keyboard and a cursor pad. It's got an audio jack for stereo speakers or headphones, a video-output port for color TV and a serial port for outputting to a printer, uploading information to a PC or connecting to a modem.

A bevy of software makers have announced support discs for the Sony player, including IBM with five $49.95 titles. Interestingly, it's reported that Northern Telecom, a leading suppler of digital telecommunications switching systems, is using Sony's Multimedia CD-ROM portable to provide its field technicians with electronic documentation, storing 20,000 pages of tech info to support its Meridian 1 PBX on a CD-ROM disc.

Developed by Sony, Philips and Microsoft in 1989, CD-ROM XA (extended architecture) compresses audio, which allows it to be interleaved with text, still images and motion video. As a result, up to 16 times as much audio play time can be accommodated on a single disc. Moreover, it's claimed that interleaving delivers more-accurate synchronization with graphics, video and text, whereas a traditional CD-ROM drive would have to perform a double search to play such information together, besides requiring 4M to 8M more RAM and possibly a more-powerful microprocessor as well.

The PIX-100 uses a V-20 CPU running at 9.55 MHz, with ROM-DOS 3.22 and 1M of RAM. It incorporates a 4½″-diagonal monochrome LCD back lit screen that can display seven shades of gray with 320 × 200-pixel graphics or 25 lines × 40 characters. It has a 26-key QWERTY keyboard, Yes and No keys, a numeric keypad and multiple-function keys, and a built-in speaker. Power is provided by a small rechargeable nickel-cadmium battery pack that provides up to 2 hours of continuous play time or an ac adapter that also charges the battery pack.

Each 5″ Multimedia CD-ROM disc has 600M for storage 9,000 graphic images or 16 hours of audio. The machine also plays conventional audio CDs.

The new PIX-100's suggested list price is $999.95. It evidently competes with Tandy's new VIS (Video Information System) discussed here last month, which lists for $700. Looks like we've got a VHS-versus-Beta type of battle looming. Or should I say an IBM-versus-Apple contest, where each can come up a winner.

Art Salsberg

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Letters

Ranger Hits Home

•Congratulations on your excellent article on the application of the Ultrasonic Ranger in your June 1992 issue. I am an electronics technology educator and an avid analog and digital experimenter. Because of articles like this, I have subscribed to *ComputerCraft* for the next three years.

Chin Leong Wong
Norman, OK

Stick to Niche

•Enclosed is my subscription renewal to *ComputerCraft* magazine. I enjoy each edition, but I want to encourage you to concentrate on areas of computer hardware and microcontroller articles. These are the areas that are handled well in your magazine and unique to it. They are your publishing niche and are ignored in other magazines.

There are numerous other magazines that I turn to when I want to see evaluations of business or games software. It really seems a shame to waste space to an evaluation of a word processor when it has been covered in great detail by several other magazines.

K. Lehman
Ontario, Canada

FotoMan Camera Update

•After reading your October review of Logitech's FotoMan digital camera and the accompanying FotoMan software, I felt compelled to stand up in Logitech's defense. I use the FotoMan on my 386DX through *Windows* 3.1 and have had unqualified success in saving images to my hard drive in both TIF and TIF Uncompressed (required for use in *CorelDRAW* and *Ventura Publisher* formats), which the author was unable to accomplish without incurring a General Protection Fault.

Also, Mr. Benford found that he could not print any images from *FotoTouch* under *Windows* 3.1. Again, I have printed all kinds of images from *FotoTouch* to my HP LaserJet printer without encountering even one small problem.

Either I have a more-recent version of *FotoTouch* (purchased in late June) or Mr. Benford is doing something wrong.

Ryan J. Hansen
Everett, WA

The author's FotoMan software was so early it didn't even have a serial number. Benford has since received updates from Logitech, and the shortcomings he cited have, indeed, been taken care of, per your comments. He found the operations painfully slow, however.—Ed.

Coming Next Month

Special Reports Revisited

Supplementing Earlier Reports (November 1992 and January 1993), February's ComputerCraft Will Present:

- Software to Make PC's "Sing" When Coupled With Sound Cards and Alternatives to Hardware
- Evaluating Eight-Bit Microcontroller Models on the Market

Acquisitions. Colorado Memory Systems, Inc., popular PC tape back-up system maker, will be acquired by Hewlett-Packard. With CMS's quarter-inch cartridge (QIC) tape systems for entry-level and midrange stand-alone personal computers and HP's 4-mm digital audio tape (DAT) back-up products for high-end PCs, workstations and mid to high-end network servers, the new teaming gives HP one of the broadest tape back-up lines in the industry.... Kalok Corp. recently sold its KL3000 line of hard-disk drives to Xebec America (no affiliation with Xebec Corp.) They're 105- and 120-M AT/IDE drives, complementing the company's lower-capacity drive line. Most large drive makers have moved to higher-capacity drives, leaving a vacuum for smaller drives. It's predicated that in 1993, there'll be worldwide shipments of more than 8.5-million drives in the 30M-to-60M range and more than 4-million in the 60M-to-100M range.

Intel's Neural-Network Chip. Intel's 80170X electrically trainable analog neural network (ETANN) chip has a high-density parallel architecture that provides a new way to solve pattern-recognition problems such as robotic motion and process optimizing.... To assist PC programmers in creating in implementing neural networks, DynaMind Developer software from NeuroDynamX (800-747-3531) guides designers with little or no neural network experience through step-by-step creating, training and embedding of neural networks. It runs on 286, 386 and 486 PCs. The program costs $145, while the Developer package is priced $495.

Tandy Unveils Factory-Direct Delivery with support of its nearly 7,000 Radio Shack stores. Buyers can choose a variety of hardware-specific options from one of the local stores and, within two days of placing the order, the computer system is shipped directly to the customer by second-day air. The program, which is said to maintain aggressively low prices, comes with a 30-day money-back satisfaction guarantee and a custom nameplate reading "Custom Made For (Name)." The program is limited to the Tandy Omni Profile 486 series of PCs.

Stolen Computer Registry. A stolen computer registry, created in late 1990 by NACOMEX, is designed to intercept the sale of stolen computers through legitimate secondary sales channels. It's designed for use by insurance companies, brokers, resellers and law-enforcement agencies. For example, bulletin-board operators who list used equipment for their shoppers can protect themselves and customers by subscribing to the Registry. For more information, call 212-777-1291. For this and any potential insurance claims for stolen computers, be sure to keep a record of the make, model and serial numbers of computers in your possession.

Notebook Has Removable Hard Drive

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

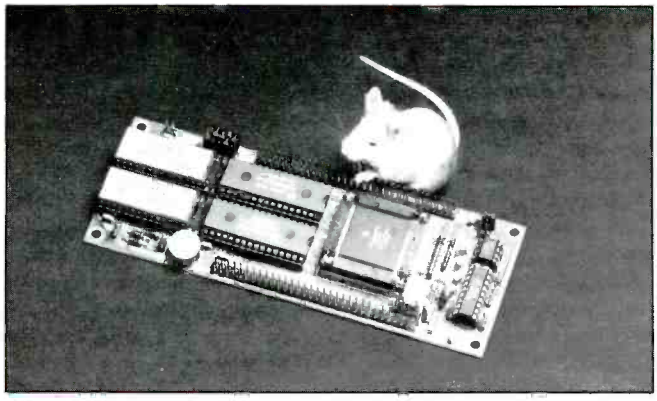
External ports are provided for a full 101-key keyboard, external VGA monitor, a parallel and two serial ports and a proprietary 100-pin port for an external AT bus-expansion station. The standard configuration includes an external power pack, DOS 5.0, *Windows* 3.1 and carrying case. $1,995. *Aurum Computer Corp., 5 Pond Park Rd., Hingham, MA 02043; tel.: 617-749-5092; fax: 617-749-5188.*

CIRCLE NO. 1 ON FREE CARD

Hard-Drive Installation Utility

Micro House's *Drivepro* permits installation of any hard drive in any computer, whether or not the BIOS supports that particular drive type. *Drivepro* stores custom parameters on the drive itself, instead of in CMOS. It finds and executes the controller's on-board firmware, creates and edits partition tables, views and edits BIOS drive-type table, formats the hard drive with operating system transfer, low-level formats most drive types, including IDEs, and saves all important parameters to a backup file. *Drivepro* requires a 286 or later processor. *Micro House, 4900 Pearl East Cir., Ste. 101, Boulder, CO 80301; tel.: 800-926-8299.*

CIRCLE NO. 2 ON FREE CARD



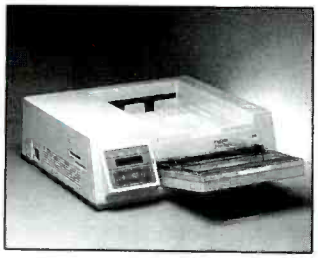
Single-Board Computer

Vesta Technology's SBC332 is based on Motorola's MC68020 processor and has a 32-bit internal data path and internal 32-bit address bus, while externally it has a 16-bit data bus and 24-bit address bus. This facility, coupled to a 16.78-MHz clock 28- and 32-pin DIP external memory, makes for design and user convenience. Low-power operation is supported with minimal power consumption during normal operation (110 mA), the ability to reduce clock speed as the application permits and a standby mode.

The SBC332 measures 2.3" × 6.25" and is BCC-compatible for direct employment without porting of software systems designed around Motorola's popular evaluation platform. $249 per board in 25-piece quantity. *Vesta Technology, Inc., 7100 W. 44 Ave., Ste. 101, Wheat Ridge, CO 80033; tel.: 303-422-8088; fax: 303-422-9800.*

CIRCLE NO. 3 ON FREE CARD

LED Printer



Okidata's OL810 eight-page-per-minute LED-based page printer has built in OKI Smoothing Technology for enhanced resolution and superior print quality. Smoothing Technology is able to create four different dot sizes at 100%, 80%, 65% and 25%. Different-size dots are grouped in varying combinations along the scan and sub-scan lines to create noticeably smoother lines on both axes. The OL810 offers PCL5 compatibility; 1M of memory, expandable to 5M; 13 resident AGFA Compugraphic Intellifont scalable outline fonts; and 42 resident bitmap fonts. The OL810 printer is HP III-compatible and has two font-card slots. $1,699. *Okidata, 532 Fellowship Rd., Mt. Laurel, NJ 08054; tel.: 609-235-2600.*

CIRCLE NO. 4 ON FREE CARD

Cleaning Products

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

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

CIRCLE NO. 5 ON FREE CARD

Radio Scanner Computer Control

The HB-232 Scanner/Computer Interface from Commtronics Engineering is a retrofit kit for the Radio Shack PRO-2004, PRO-2005 and PRO-2006 series vhf/uhf radio scanners. The modification offers complete two-way communication and control of the scanner by an IBM/compatible computer through a serial port. Up to 400 memory channels can be programmed by downloading information to the scanner from a computer database.

Autologger appends a comma-delimited line of data to a DOS text file for every event or transmission detected by the scanner. Each plain-text data line in the file shows memory channel, frequency, mode, delay and lockout status, operating function, search increment, date, start time and duration of the event. A built-in feature prevents the scanner from locking up on birdies and other undesired signals. Partial kit, $170. *Commtronics Engineering, PO Box 262478, San Diego, CA 92196; tel.: 619-578-9247; fax: 619-578-2947.*

CIRCLE NO. 6 ON FREE CARD

Your Calendar Is Watching You

Powercore has two new "calendaring" packages for networks and the individual user. *Network Scheduler III (NS3)* is a multi-user calendar that operates on most popular communications environments to enable a group of users to make scheduling decisions quickly and automatically. *NS3* schedules persons, work groups and such key resources as rooms and equipment. It provides a shared calendar for use by the group, with personal reminders for private events. Any user can request a meeting by selecting the desired day and time period.

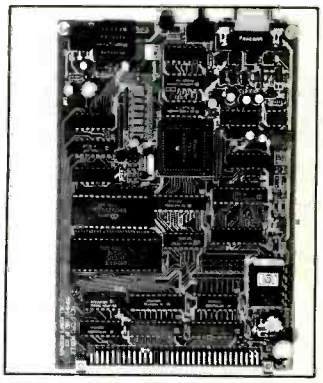
NS3 informs the user immediately if there are any individual conflicts with the proposed place and times. Once a meeting is selected, *NS3* broadcasts new requests to each member of the group. The new meeting appears on the individual calendars, informing the users about the details of the meeting.

Time Vision, available for *Windows*, DOS and Macintosh, has many of the most useful functions of *NS3* redesigned and repackaged for the individual user. It can be used to plan daily calendars, prioritize "to-do" lists, make appointments or schedule other people and resources. $119 (*Time Vision*). *PowerCore Inc., One Diversatech Dr., Manteno, IL 60950-0756.*

CIRCLE NO. 7 ON FREE CARD

CPU Module

The HC11 CPU module from ACS provides expandable control in a low-cost format that includes all necessary features for most embedded control applications. Additional expansion is provided by the ACS-BUSS via either 64-conductor ribbon cable or ACS motherboards for larger applications. Flash EPROM and EEPROM



technology permit remote in-system updates. Hardware includes MC68HC811E2 eight-bit microcontroller, 2K EEPROM with block protection, 256-byte RAM, 16-bit timer, eight-bit pulse accumulator, real-time interrupt, COP watchdog timer, eight-channel eight-bit A/D converter and serial port (RS-232 or RS-485). Software includes HC11 IPL in EEPROM, POST diagnostics and IBM programming utilities. $287. *Ackerman Computer Sciences, 4276 Lago Way, Sarasota, FL 34241-5815; tel.: 813-377-5775; fax: 813-378-4226.*

CIRCLE NO. 8 ON FREE CARD

Data-Acquisition Packages

Texmate has three new integrated data-acquisition packages for laboratory and field applications. *VIS/2000* is virtual instrumentation software that employs a mouse and GUI. It supports four 16-channel ac/dc voltage input boards on an AT. The program displays 16 channels simultaneously an panel meters, chart recorders or oscilloscope traces.

The *Acquisitor* is a menu-driven real-time graphic display of multi-channel strip chart, bargraph and spreadsheet data with process monitoring functions. Hardware is available in four versions that plug into a PC's parallel port.

DASH300 is a *Windows* 3.x application program that supports most popular eight- and 16-channel data-acquisition boards. Menu driven, it acquires and displays up to 16 channels.

Texmate Inc., 995 Park Center Dr., Vista, CA 92083-8397; tel.: 619-598-9899; fax, 619-598-9828.

CIRCLE NO. 9 ON FREE CARD

No other training shows you how to troubleshoot and service computers like NRI!

NEW! 386sx/20 MHz MINI TOWER COMPUTER!
Features 32-bit 80386sx CPU, 1 meg RAM, 64K ROM, 1.2 meg high-density floppy disk drive

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High-resolution, nonglare, 12" TTL monochrome monitor with tilt and swivel base

NEW! 40 MEG HARD DISK DRIVE!
You install this 40 meg IDE hard disk drive internally, for greater data storage capacity

DIAGNOSTIC HARDWARE AND SOFTWARE
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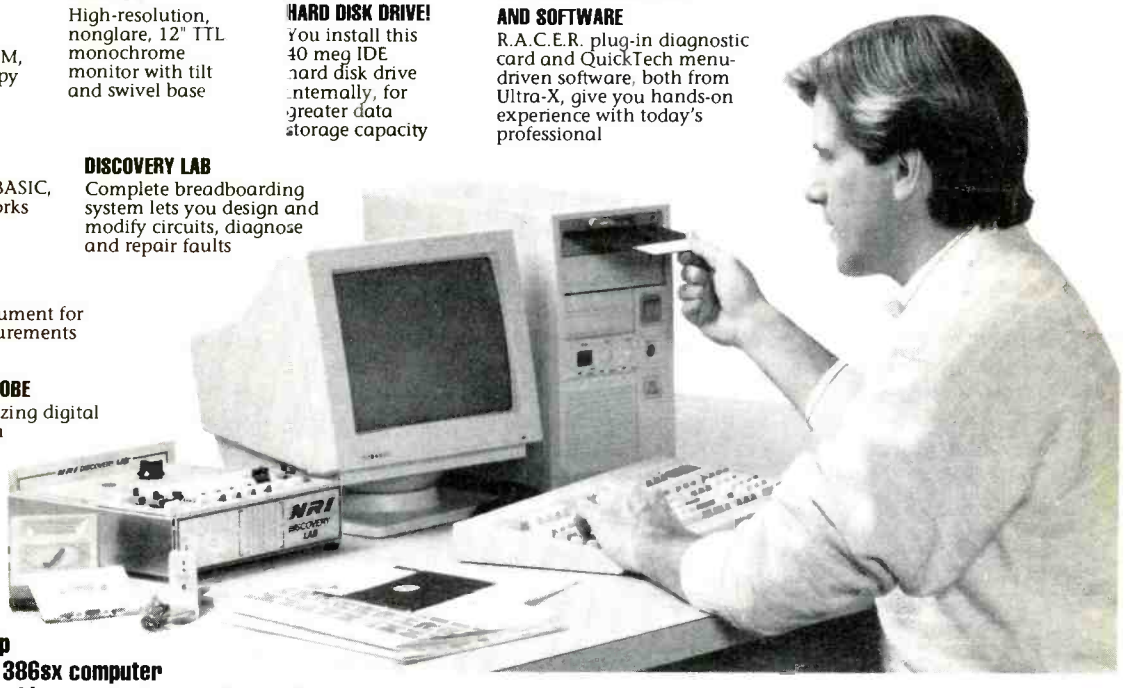
Train with MS-DOS, GW-BASIC, and popular Microsoft Works applications software

DISCOVERY LAB
Complete breadboarding system lets you design and modify circuits, diagnose and repair faults

DIGITAL MULTIMETER
Professional test instrument for quick and easy measurements

DIGITAL LOGIC PROBE
Simplifies analyzing digital circuit operation

LESSONS
Clear, illustrated texts build your understanding of computers step by step



Only NRI walks you through the step-by-step assembly of a powerful 386sx computer system you train with and keep — giving you the hands-on experience you need to work with, troubleshoot, and service today's most widely used computer systems. Only NRI gives you everything you need to start a money-making career, even a business of your own, in computer service.

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Get inside the West Coast 386sx computer system ... and experience all the power and speed of today's computer technology!

With NRI's exclusive hands-on training, you actually build and keep the powerful new West Coast 386sx/20 MHz mini tower computer system.

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What's more, you now go on to install and test a powerful 40 meg IDE hard disk drive — today's most-wanted computer peripheral — included in your course to dramatically increase your computer's data storage capacity while giving you lightning-quick data access. But that's not all!

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Your NRI training now includes a remarkable diagnostic package that allows you to quickly locate and correct defects in IBM XT, AT 80286/80386, and compatible computers.

You'll use your Ultra-X QuickTech diagnostic software to test the system RAM and such peripheral adapters as parallel printer ports, video adapters, and floppy and hard disk drives. You'll go on to use your R.A.C.E.R. diagnostic card, also from Ultra-X, to identify individual defective RAM chips, locate interfacing problems, and pinpoint defective support chips.

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Memory Management and Multitasking Beyond 640K

By Lenny Bailes & John Mueller
(Windcrest/McGraw-Hill. Soft cover. 434 pages. $29.95)
The popularity of multitasking environments *Windows* and *DESQview* and growing interest in networks, no matter how small, means that more and more PC users are being forced to deal effectively with memory management or suffer the consequences. This book is dedicated to those users who find themselves thrown into the middle of this fray.

Chapter 1 is an introduction to PC hardware with emphasis on the features and limitations of the x86 family of processors. Chapter 2 is devoted to taking stock of your base system. How DOS uses the first megabyte of memory is detailed in Chapter 3. Then Chapter 4 defines and discusses memory beyond the first megabyte. Three of the more common software tools to access this memory are discussed: *QEMM*, Rational Systems DOS extender, and Microsoft's XMS.

Chapter 5 surveys hardware requirements for different PC productivity situations and features alternative upgrade options. Strategies for improving performance by minimizing the overhead of your current applications are covered in Chapter 6. Coverage of the basics of memory management is handled in Chapter 7, which uses examples based on the utilities bundled with DOS 5.0. In Chapter 8, the authors provide a similar treatment of DR DOS and show how to perform more advanced memory-management tasks with third-party packages.

Chapter 9 moves on to memory management in the context of *Windows* 3.x, with emphasis on the differences in performance and capability between 286- and 386/486-based systems. Quarterdeck's *DESQview* as an alternative to *Windows* is the topic of Chapter 10. Chapter 11 discusses memory management tasks under OS/2.

Appendices cover troubleshooting tips, network considerations and other sources of information, as well as a brief description of the freeware and shareware utilities contained on an accompanying 1.2M disk. Programs range from an IRQ display utility to a basic 386 memory manager.

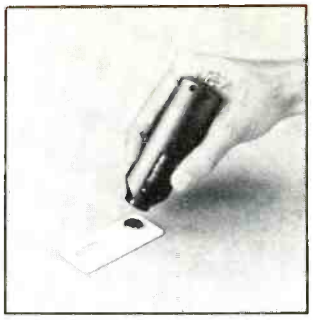
The writing is clear and concise, and the depth of coverage is more than adequate for the intermediate user.

Parallel-To-SCSI Adapter

Trantor Systems' T348 Mini-SCSI Plus provides simple, quick connection of many different types of SCSI devices through a computer's parallel printer port without losing use of a printer connected to the port. It features an integral 3-foot cable, built-in SCSI termination and a physical design that improves on the original T338 adapter by moving the portion of the product containing the active circuitry adjacent to the SCSI device. This new design makes connection to a computer port much smaller than the T338 and eliminates the need for a separate SCSI cable. Also, the new T348 makes full use of bidirectional parallel ports, which can improve the performance of CD-ROMs and similar devices. $229. *Trantor Systems, Ltd., 5415 Randall Pl., Fremont, CA 94538-3151; tel.: 510-770-1400; fax: 510-770-9910.*

CIRCLE NO. 10 ON FREE CARD

Button Reader



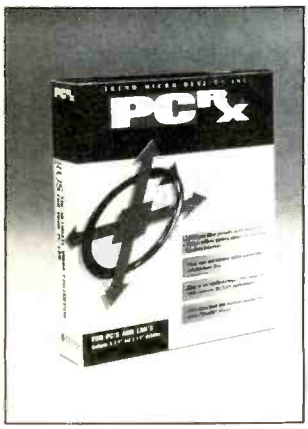
The TouchProbe portable touch reader from Videx is about the size of a small pocket flashlight and reads information to and from "touch buttons," which are memory chips housed in small water-resistant stainless-steel cases. Touch buttons work like electronic labels that the TouchProbe can access for the purpose of reading information or storing data. This is done by a simple contact of the TouchProbe to the button.

The standard TouchProbe model features a cast metal case, real-time internal clock and 128K of RAM. Its lithium battery requires no recharging and lasts more than five years (about 350,000 reads). More than 5,000 reads can be stored in internal memory before downloading to a computer. Communications software is available for IBM/compatible and Macintosh computers. $395. *Videx, 1105 NE Circle Blvd., Corvallis, OR 97330-4285; tel.: 503-758-0521; fax: 503-752-5285.*

CIRCLE NO. 11 ON FREE CARD

Broad-Spectrum Anti-Virus Programs

Trend Micro Devices's *PC Rx Antivirus* 2.0 is a rule-based program that both scans and removes 1,650 viruses in DOS and *Windows* and monitors suspicious programs for up to nine virus-like activities. This pattern-independent method of filtering for both old and new viruses doesn't require frequent updates. Detecting even the newest Mutation Engine viruses, the filter monitors suspicious programs for such activities as redirection of DOS interrupts. In *Windows*, the *PC Rx* scanning meter runs minimized (reduced to an icon) while you continue working. Once a virus is detected, the program gives you several options for handling the situation. $69. *Trend Micro Devices, 2421 W. 205 St., Ste. D-100 Torrance, CA 90501; tel.: 310-782-8190; fax: 310-328-5892.*



CIRCLE NO. 12 ON FREE CARD

NOVI 1.1, a similar program from Certus, provides invisible virus protection for DOS and *Windows* applications. It operates continuously in the background and neither requires frequent updates, nor flashes false alarms when new software is loaded onto a system or when program files change. *NOVI* uses several advanced virus-protection technologies driven by artificial intelligence to either prevent files from becoming infected or perfectly repair any files that become infected. The repair facility operates much like "unerase" DOS utilities. Improvements over Version 1 include speed (about 30 seconds for an 80M drive), updated scanning information and more-efficient support of *Windows*. $129. *Certus, 6896 W. Snowville Rd., Brecksville, OH 44141; tel.: 216-546-1500; fax: 216-546-1450.*

CIRCLE NO. 13 ON FREE CARD

(Continued on page 80)

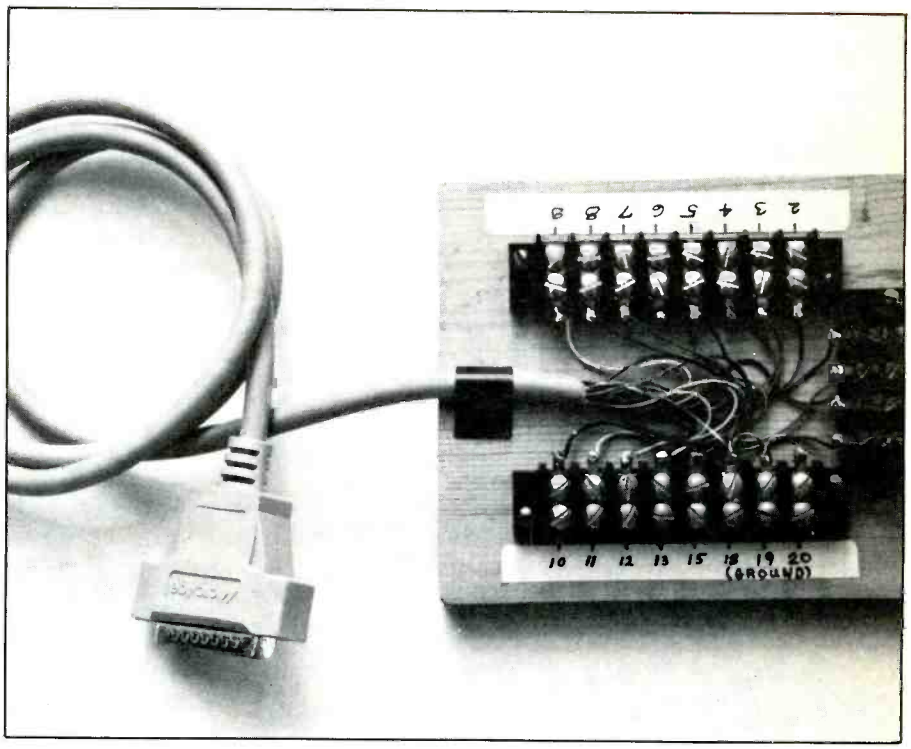
Recycling Old Computers

Let an old computer you no longer use control your home environment

Do you have an old IBM PC or compatible collecting dust because it's outlived its usefulness for running today's sophisticated software? If so, this article describes an easy and fun way to restore it to service for controlling lights, motors, coffee makers, burglar alarms, fire alarms or anything else you have that operates electrically.

My old PC was still serviceable. So I decided to put it to use controlling my everyday electrical appliances, rather than mothballing it. You, too, can recycle your old PC to perform the same or similar service. I came up with a simple, elegant solution that could be executed in short order.

What makes the system described here easy to implement was that I used existing appliance modules, available from Radio Shack, Sears and other outlets, that can be connected to a PC. Without having to make internal connections. All control circuits connect to the parallel printer port.



The Hardware

If you don't already have a computer you can dedicate to appliance control, you can buy an XT/compatible with monochrome display and one or two floppy drives for as little as $250. A hard drive isn't required, and 64K of RAM is sufficient.

My control method is easy and effective because I use the computer's parallel port to operate all external circuits I've incorporated into the system. This port can monitor up to nine input circuits and switch up to eight output circuits simultaneously.

The best way to connect to a parallel port is via a standard parallel printer cable that has a 25-pin male DB-25 connector on the computer end and 36-pin male connector on the printer end. Alternately, you can use any serial cable that has a 25-pin male connector on one end with wires connected to all 25 pins and no connector at the other end.

If you're starting with a standard printer cable, cut off the connector at the printer end and fan out the conductors at this end. After you fabricate a barrier-block assembly, you'll connect these conductors to positions on the barrier blocks, as detailed in Fig. 1. Make the cable about 3 to 4 feet long. Though a longer cable won't hurt, you really don't need it.

For this project, you need the items listed in the Bill of Materials. Start construction by fabricating the barrier-block Interface assembly. For this, you need the first six items listed in the Bill of Materials.

Construction is simple. Begin with

BILL OF MATERIALS

1—6″ × 4¾″ × ¾″ block of wood
2—Eight-position dual-row barrier blocks (Radio Shack Cat. No. 274-670 or similar)
1—Four-position dual-row barrier block
1—25 conductor cable with male DB-25 connector on one end (see text)
1—Plastic cable clamp
20—Spade lugs
7—Woodscrews
3—Plug 'n Power universal interface modules (Radio Shack Cat. No. 61-2687 or similar)
2—Universal appliance modules (Radio Shack Cat. No. 61-2684 or similar)
1—Wall-switch module (Radio Shack Cat. No. 61-2683 or similar)
1—Cadmium-sulfide photocell (Radio Shack Cat. No. 276-116 or similar)

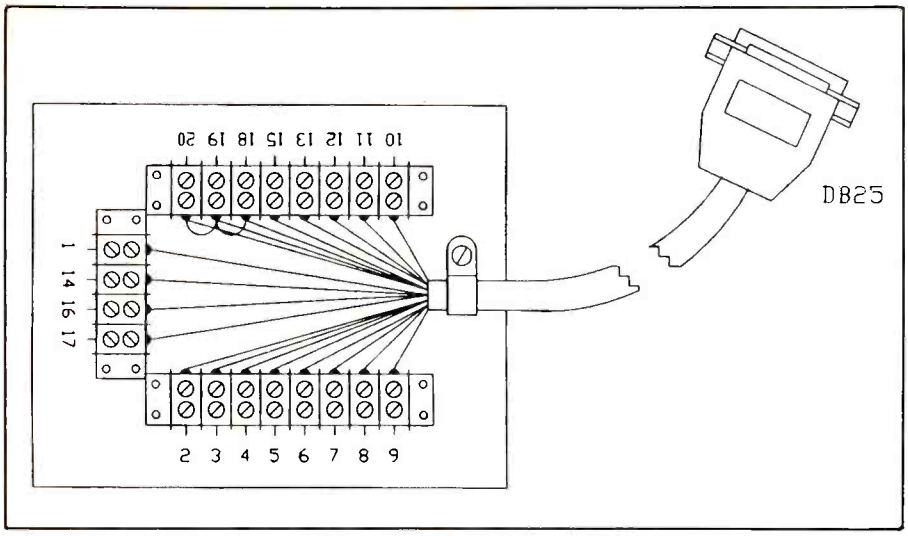


Fig. 1. Fabrication details for the Parallel Interface Board.

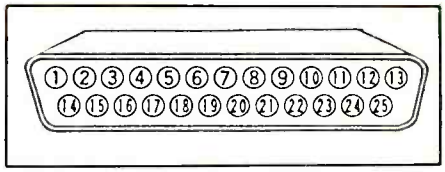


Fig. 2. Pin location, pin view, on male parallel printer cable connector.

the block of wood specified in the Bill of Materials, using any type of lumber you have handy. When you're finished trimming the block to size, sand it smooth and give it a coat or two of clear urethane and allow it to dry. Then, referring to Fig. 1, mount two eight- and one four-position barrier blocks on it as shown. Label the parallel-port pin numbers on the block of wood near the positions on the barrier blocks exactly as shown.

Carefully remove about 4″ of outer plastic jacket from the end of the printer cable that has no connector. Strip ¼″ of insulation from the ends of all conductors in the cable.

Now determine which cable conductor connects to which pin on the remaining cable connector. With some cables, you can remove the hood from the connector and simply record the insulation color(s) of the conductors that connect to each pin of the connector. If you're able to remove the hood from the connector, you'll find the pin numbers molded into the plastic by each pin on the DB-25 connector. If you're unable to remove the hood from the connector, use an ohmmeter or continuity checker to determine which conductor connects to which pin on the connector. Refer to Fig. 2 for the pin-numbering scheme.

Make a chart of the connector's pin number and the color of insulation on cable conductor to which each connects. An example of what your table should look like is shown in Table 1. Some parallel printer cables use the insulation color code shown. If the color scheme is different for the cable you're using make suitable entries for each pin.

Next, connect the cable to the barrier blocks. To assure good electrical and mechanical connections, it's a good idea to solder a spade lug to each conductor end in the cable.

Position the cable on the Interface Board as shown in Fig. 1 so that all its conductors can reach their respective barrier-block positions. Fasten the cable to the board with a cable clamp. Then connect the conductors to their respective positions on the barrier blocks, matching the numbers on the barrier-block positions with the same numbers you determined for the connector on the cable, until you've wired conductors 1 through 17.

Interconnect positions 18, 19 and 20 on the upper barrier block with a solid bare jumper wire. Then slip the spade lugs on conductors 18 through 25 of the cable under the heads of the screws at positions 18, 19 and 20, distributing them evenly. Be aware that some cables have a jumper wire inside the connector that interconnects pins 18 through 25 and have only a single conductor in them that serves as a common conductor. Also, if your cable has a shield wire, connect this to position 20 of the upper barrier block.

Finding LPT1 Port Address

To use the Interface Board, you must know its address. Older computers with monochrome monitors that have the printer port on the video card most often use address 956. Later models that have a separate printer card usually use address 888. Any address is okay, as long as it's the correct one.

If you use BASIC, you can use your computer to locate it's port address quite simply. With DOS 5.0 or later, you need GWBASIC from an earlier DOS version. Put this in your DOS subdirectory. (Earlier versions of DOS come with GWBASIC.) Boot up your computer, call up BASIC, type DEF SEG = 0 and hit Enter. Your computer should respond with "Ok." Type PRINT PEEK(1032) + 256 * PEEK(1033) and hit Enter.

At this point, the screen should display port address 956 or 888 or, on rare occasions, 632. Make a note of this address for future reference, and exit BASIC. To keep things simple, I'll use 956 as the port address in this article. If the port address in your particular computer is different, substitute its number whenever you read address 956 here.

Table 1. Wiring Scheme For Parallel Printer Cable

Pin	Insulation Color
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Purple
8	Gray
9	White
10	Black
11	Pink
12	Light Green
13	Light Blue
14	Brown/White Stripe
15	Red/White Stripe
16	Orange/White Stripe
17	Yellow/Brown Stripe
18-25	Green/White stripe

Typical example of insulation color scheme used for pins on the DB-25 connector on a parallel printer cable.

If you have a second parallel port (LPT2), the address will be the next lower number. For example, if the address of LPT1 is 888, use address 632 for LPT2.

Now test your Interface Board as follows. You need an analog or digital voltmeter or a multimeter with a minimum dc sensitivity of 20,000 ohms per volt. All measurements you make will be less than 10 volts dc.

Turn on your computer, and bring up BASIC. Set your meter to a range on which you can measure 10 volts dc. Connecting the meter's "hot" and common test leads to positions 2 and 18 on the barrier blocks, respectively, should yield a meter reading of about +0.1 volt.

Now type OUT 956,1 and hit Enter (don't forget to substitute the appropriate number if you have a different port address from 956 in the OUT statement). With its leads connected to the Interface Board as above, your meter should read +3 to +5 volts (typically about +3.5 volts).

Next, type OUT 956,0 and hit Enter. Your meter should read about +0.1 volt once again. When you type OUT 956,128 the potential on position 9 should be about +3.5 volts. Typing OUT 956,0 should yield a meter reading of about +0.1 volt on position 9 again. If you obtain the proper results, you've correctly wired the Interface Board.

The OUT statement in the above test routines and the program listings in this article directs an action to a specific address. This statement controls pins 2 through 9, which connect to bits 0 through 7 on your parallel I/O card. For example, OUT 956,1 directs bit 0 at pin 2 to go high (+3.5 volts), OUT 956,128 directs bit 7 at pin 9 to go high, etc. OUT 956,0 directs all eight bits on pins 2 through 9 to go low (+0.1 volt).

Applications

Now let's look at a few applications to which you can put this simple Interface Board and your PC, using simple control programs written in BASIC.

• *Computer-Controlled Light Switch.* Begin by connecting a wire from position 2 of the terminal block to the + screw terminal on the Plug 'n Power Universal Interface Module, as in Fig. 3. Connect another wire (ground) from position 20 to the – terminal on the Interface Module. Set both switches on the Interface Module to position 1 and plug this module into an ac outlet.

Plug a Universal Appliance Module into another ac outlet within sight of your PC. Turn on a table lamp, unplug it from the ac outlet and plug it into the socket on the Universal Appliance Module. Make sure the unit and house codes read the same on both modules. Power up your PC and bring up BASIC. Turn on the lamp by typing OUT 956,1 and hitting Enter. To turn off the lamp, type OUT 956,0 and hit Enter.

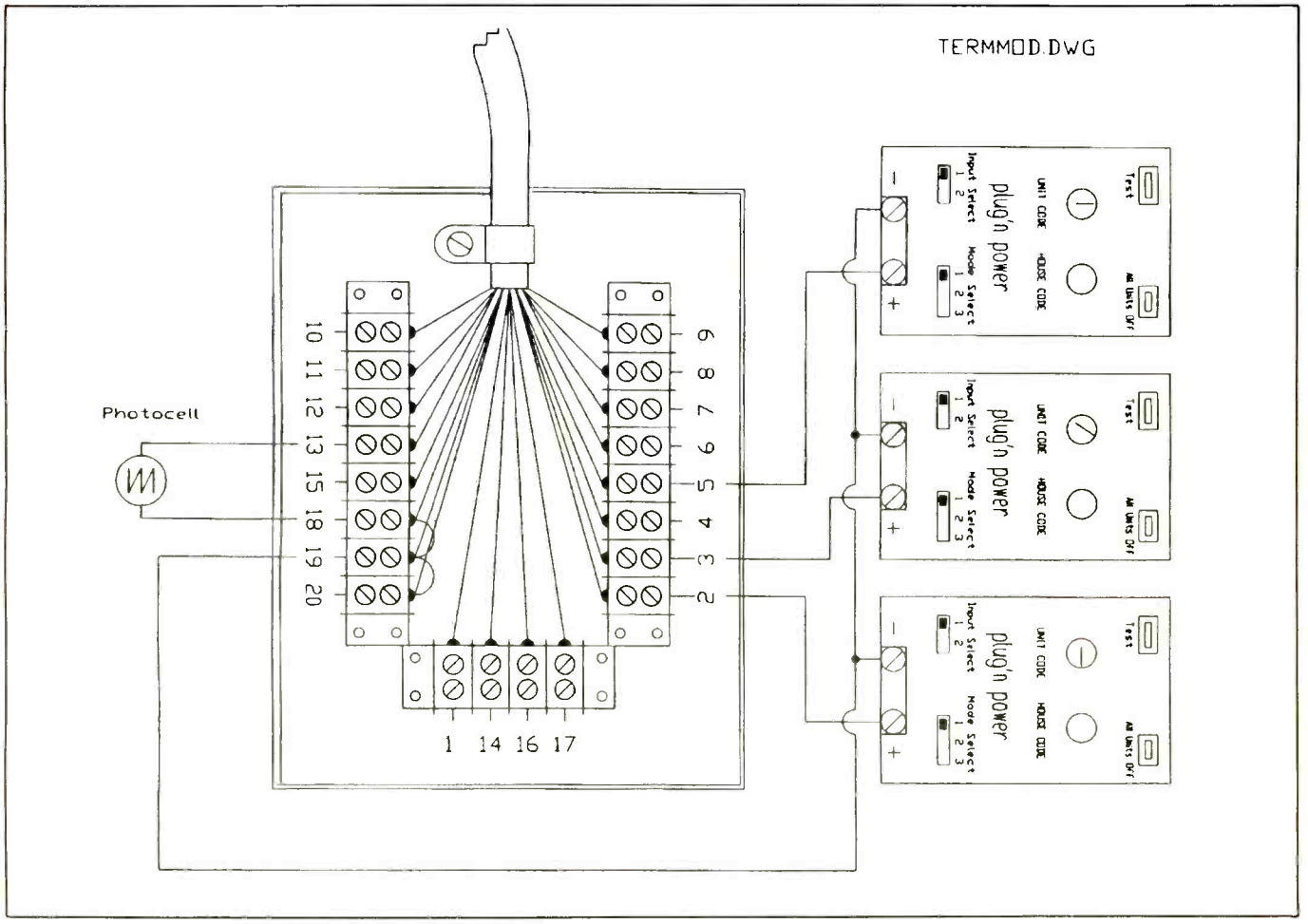


Fig. 3. A computer-controlled light-switch arrangement.

Listing 1. Computer-Controlled Lamp BASIC Program

```
10 CLS
20 PRINT "Light control program, 'LIGHTEST.BAS'."
30 LOCATE 6,1 : PRINT "The time is ";TIME$
40 IF TIME$ > "18:00:00" AND TIME$ < "22:00:00" then PIN2=1 ELSE
PIN2=0
50 OUT 956,PIN2 : REM  Output 'Hi' on Pin 2 when PIN2 = 1
60 IF PIN2 = 1 THEN LIGHT$ = " ON" ELSE LIGHT$ = "OFF"
70 LOCATE 8,1 : PRINT "The light is ";LIGHT$
80 GOTO 30
```

Listing 2. Dusk-to-Dawn Light-Control Program

```
10 KEY OFF : CLS
20 PRINT "Dusk to dawn light control, 'PHOTOCEL.BAS'."
30 LOCATE 6,1 : PRINT "The time is ";TIME$
40 REM Photocell connected to parallel Input, pins 13 and 18
50 IN13 =-((INP(957) AND 16)=16) : REM Read Input on pin 13
60 IF IN13 = 1 THEN PIN5 = 8 ELSE PIN5 = 0
70 OUT 956,PIN5 : REM Output 'Hi' on Pin 5 when PIN5 = 8
80 IF PIN5 = 8 THEN LIGHT$ = " ON" ELSE LIGHT$ = "OFF"
90 LOCATE 8,1 : PRINT "The light is ";LIGHT$
100 GOTO 30
```

With the Interface still connected to your computer, you'll now put the computers' clock to work to control the lamp. Key in Listing 1 and save it to disk with the filename LIGHTEST,A (the ",A" saves the program in ASCII format for compiling or/and viewing it under DOS).

Line 50 shows 956 as the port address. If your port address is different, substitute the appropriate number. When entering the program, make sure you punctuate it exactly as shown. Note in line 60 the space after the quote in " ON." Once you've entered and saved the program, run it. When the program starts, the following message should appear on-screen:

```
Light control program, 'LIGHTEST.BAS'.

The time is 17:43:38
The light is OFF

Stop the program with a Ctrl + Break.
```

Line 10 clears the screen.

Line 20 prints a statement.

Line 30 positions the time statement on the screen and prints it.

Line 40 sets the lights to turn on at 18:00 (6:00 P.M.) and off at 22:00 (10:00 P.M.). You can easily change the on and off times by changing the numbers in this line.

Line 50 tells the computer to OUT 956,PIN2. When PIN2 = 1, pin 2 goes high. The variable name "PIN2" helps to keep the pin numbers straight.

Line 60 selects the string value of LIGHT$ to be either "ON" or "OFF."

Line 70 positions and prints the statement "The light is," followed by the string value of LIGHT$.

Line 80 causes the program to loop back to line 30 and run through the whole program again.

You might want the lights to go on at 2:30 P.M. and off at 2:35 P.M., for example. You do this by changing the times in line 40 as follows:

```
40 IF TIME$ > "14:30:00" AND TIME$ <
"14:35:00" THEN PIN2 = 1 ELSE PIN2 = 0
```

Make the change by typing the new time over the old and pressing Enter. To make the time change permanent, use the SAVE command again and give the program a new filename like SAVE "LIGHTON,A."

Now let's look at some practical applications for this simple project:

• *Dusk-to-Dawn Light Control.* This application uses an input port. In addition to sending out high and low levels, the parallel port can monitor input levels. This project monitors the resistance of a photocell connected to one of the inputs. When darkness falls, the lights turn on.

With a cadmium-sulfide photocell connected between positions 13 and 18 of the terminal blocks on the Interface Board, as the light intensity increases, the cell's resistance decreases, to less than 2,000 ohms with sufficient light intensity. At this point, the control port input switches from high to low.

Though you can connect the photocell to any control port input, it seems to be the most sensitive and works best when connected from input pins 12, 13 and 15 to ground. These pins have a lower positive voltage on them than the others and require less current to switch. If you choose a different input from that in the program, modify the program to read the pin you use.

Some photocells are more sensitive than others. A small paper tube can help control light if the cell doesn't

Listing 3. Control Your Home Program

```
10 KEY OFF : CLS
20 LOCATE 2,18 : PRINT "Control your Home Program,
'HOMECON.BAS'."
30 LOCATE 3,18 : PRINT "-------- ---- ---- -------- -------------
"
40 LOCATE 5,5 : PRINT "The time is ";TIME$; TAB(60); DATE$
50 IF TIME$ > "18:00:00" AND TIME$ < "22:00:00" THEN PIN2=1 ELSE
   PIN2=0
60 IF TIME$ > "06:30:00" AND TIME$ < "08:30:00" THEN PIN3=2 ELSE
   PIN3=0
70 REM Photocell connected to parallel Input, pins 13 and 18
80 IN13 = -((INP(957) AND 16)=16) : REM Read Input on pin 13
90 IF IN13 = 1 THEN PIN5 = 8 ELSE PIN5 = 0
100 OUT 956,PIN2+PIN3+PIN5 : REM Output control on pins 2, 3 and 5
110 IF PIN2 = 1 THEN L$ = " ON" ELSE L$ = "OFF"
120 LOCATE 8,5 : PRINT "Timer control for Lights.  Lights are ";L$
130 IF PIN3 = 2 THEN C$ = " ON" ELSE C$ = "OFF"
140 LOCATE 10,5 : PRINT "Timer control for Coffee Pot.  Coffee is
   ";C$
150 IF PIN5 = 8 THEN P$ = " ON" ELSE P$ = "OFF"
160 LOCATE 12,5 : PRINT "Control for Photocell.  Lights are ";P$
170 GOTO 40
```

Table 2. Parallel Port Details for LPT1

Hexadecimal Address	Decimal Address	Register Type	Port Designation
03BC	956	Eight-Bit Output	LPT1
03BD	957	Five-Bit Input	LPT1
03BE	958	Four-Bit I/O	LPT1

Table 3. Details for Separate Parallel Printer Card

Hexadecimal Address	Decimal Address	Register Type	Port Designation
0378	888	Eight-Bit Output	LPT1 or LPT2
0379	889	Five-Bit Input	LPT1 or LPT2
037A	890	Four-Bit I/O	LPT1 or LPT2
0278	632	Eight-Bit Output	LPT2 or LPT3
0279	633	Five-Bit Input	LPT2 or LPT3
027A	634	Four-Bit I/O	LPT2 or LPT3

switch off under low light conditions. Very bright light can drop the resistance of some cells to as low as 100 ohms. In complete darkness, a photocell typically has a resistance of several megohms.

Input addresses are different from output addresses. In Listing 2, note that line 50 shows INP(957) as the input address. If your output address is 888 or 632, use INP(889) or INP(633), respectively. Enter and save to disk Listing 2 and then test it. This program is similar to LIGHTEST.BAS above.

To test the program, connect your Universal Interface Module between positions 5 and 18 on the Interface Board, run the program and cover the photocell with your hand. The Appliance Module should switch on when the photocell is in darkness.

•*Home Control.* The program given in Listing 3 illustrates a very good way to control devices around your home with three separate switching circuits, for which you need three Universal Interface Modules. One module connects between positions 2 and 18, a second between positions 3 and 18 and the last between positions 5 and 18 on the Interface Board.

Make sure each Interface Module is set to a different unit code number. Also, switch the Appliance Modules to the same unit code numbers as the Interface Modules that control them.

One thing you can do with this arrangement is turn on and off an electric coffee maker. The first circuit (lines 50 and 100 in Listing 3) controls lights, using the PC's clock. To control switched lights, replace the switches will Wall Switch Modules.

The second circuit (lines 60 and 100) controls a coffee maker or other electrical appliance, again using the computer clock.

The third circuit (lines 80, 90 and 100) is controlled by a photocell and switches dusk-to-dawn lights.

To use the program, plug correct output address (956, 888 or 632) into line 100. Line 80 shows INP(957) as the input address. If your output address is 888, use INP(889). If your output address is 632, use INP(633).

Table 4. Pin Connections to Main Output Port

DB-25 Pin	Binary Code	Port Bit	Address Command
2	0000 0001	0	OUT 956,1
3	0000 0010	1	OUT 956,2
4	0000 0100	2	OUT 956,4
5	0000 1000	3	OUT 956,8
6	0001 0000	4	OUT 956,16
7	0010 0000	5	OUT 956,32
8	0100 0000	6	OUT 956,64
9	1000 0000	7	OUT 956,128

More-Complex Control

For more complex programs, you need to know more about the parallel port and how to control it. The parallel port is capable of reading up to nine input ports and switching up to 12 output ports. As you can see, this permits control of many things simultaneously.

If you wish to keep your printer output separate, you can install a second parallel card as LPT2 for these projects. There are three port registers on each card, including an eight-bit output port, five-bit input-only port and four-bit input/output port. If you're using a monochrome display card with built-in parallel printer adapter, its address will probably be set at decimal 956, 957 and 958 (03BC, 03BD and 03BE hex), which your computer designates as LPT1, as in Table 2.

If you have a separate parallel printer card, its address will probably be decimal 888, 889 and 890 or decimal 632, 633 and 634, as in Table 3.

Table 4 details pin connections to the main output port (used to send characters to the printer) and the BASIC OUT command required to send a high to this pin.

Line 100 of HOMECON.BAS in Listing 3 illustrates how to do this. Simply add the values that represent the desired switch selection. For example, OUT 956,8 + 66 + 128 switches high pins 5, 6 and 9. In a program, this could be stated as OUT 956,PIN5 + PIN6 + PIN9. If PIN5 = 0 and PIN6 = 0 and PIN9 = 128, only pin 9 would switch high.

When connecting to the main output of the parallel port, keep its current limitation in mind. Limit load current to 1 mA when drawing current from a high and to 10 mA when using a port as a sink bit in the low condition. Absolute maximum ratings for the parallel output port are 2.6 mA sourcing and 24 mA sinking.

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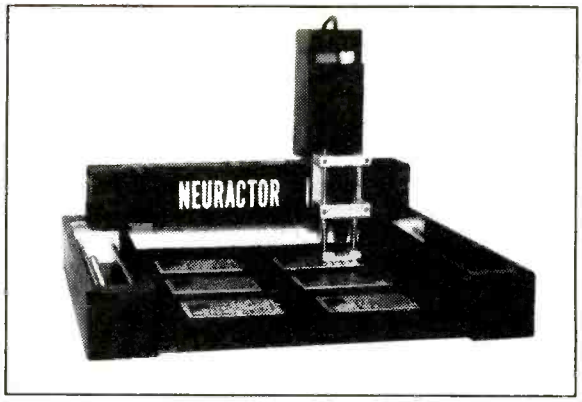

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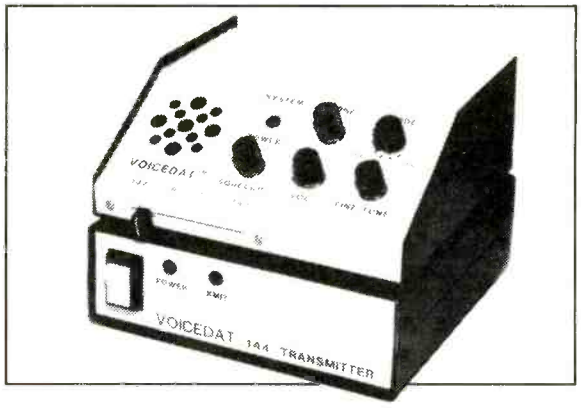

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Instead of Universal Interface Modules, an output can drive a 500-ohm, 5-volt relay, provided the other side of the relay is connected to + 5 volts. The relay will close when a bit is low and open when a bit is high. A 500-ohm relay draws less then 10 mA. Connecting it between an output pin and ground would probably damage the parallel port because it would draw more than the 2.6 mA limit. You can exceed these load limitations by buffering the output circuit with a 74LS240 or 74LS244.

When using the four-bit input/output port for output, you can't use it for input as well. This limits your inputs to five. If you plan to drive a greater-than-1-mA load, connect it between the pin and + 5 volts so that it draws current when the pin is switched low. Sinking load current mustn't exceed 7 mA, unless you use a buffer. The address for this port is 958. Alternate addresses are 890 and 634.

Table 5 shows the OUT commands required to individually switch low each four-bit I/O port bits, while the balance switch high. Most external loads using this I/O port should return to + 5 volts so that they operate when the bit is low or sinking current. Table 6 shows the OUT command required to individually switch high each of the four-bit I/O bits, while the balance switch low. The unusual address commands in Tables 5 and 6 are the result of interaction between pins 16 and 17 and the fact that pin 16 is low when the computer is turned on.

Until now, I've shown you how to address the four-bit input/output port for output. Now I'll show you how to use this same port addressed for input. Table 7 shows the port register connections and the BASIC command to use to read this register.

Pin 17 can't normally be used as an input because it comes up low when your PC is turned on. The solution is to insert OUT 958,4 in your program prior to the above address commands to cause the open state of pins 16 and 17 to be high. When high, inputs to this port switch low after the input pin is grounded. This port can read five different inputs.

Connections to the five-bit input-only port and the BASIC command required to read a given bit are detailed in Table 8. All read high but switch to low if the pin is grounded. Bit 7 on pin 11 can take several seconds to return high after being grounded; so don't use it if you want fast off response.

Table 5. Commands Required to Switch Low Four-Bit I/O Ports

DB-25 Pin	Binary Code	Port Bit	Address Command
1	1110	0	OUT 958,5
14	1101	1	OUT 958,6
16	1011	2	OUT 958,0
17	0111	3	OUT 958,12

Table 6. Commands Required to Switch High Four-Bit I/O Ports

DB-25 Pin	Binary Code	Port Bit	Address Command
1	0001	0	OUT 958,10
14	0010	1	OUT 958,9
16	0100	2	OUT 958,15
17	1000	3	OUT 958,3

Each bit is normally high. Grounding an input pin to pin 18, forces low the input bit. The programs here use the format in the above INP statements to check the high/low status of the input bit you select.

Many control applications require information from the outside world to respond, including but not limited to measuring temperature, controlling a heating system, connecting an electric eye, sensing rain, measuring moisture in your soil for watering your garden, reading humidity or wind speed and monitoring a burglar/fire alarm. The simplest monitoring application is to see if the condition of an external switch is open or closed.

To make a burglar alarm, put normally-open switches on windows and doors and connect them in parallel. Connect one side of the switches to an input pin, the other to the ground pin, and have the computer sound an alarm if a switch closes.

The Input Test Program given in Listing 4 illustrates how to read all nine inputs and print on-screen the status of each. It serves as the basis for

Table 7. Using the Four-Bit I/O Port for Input

DB-25 Pin	Port Bit	Address Command	Open State
1	0	IN1 = −((INP(958) AND 1) = 0)	High
14	1	IN14 = ±((INP(958) AND 2) = 0)	High
16	2	IN16 = −((INP(958) AND 4) = 4)	High
17	3	IN17 = −((INP(958) AND 8) = 0)	High

Table 8. Using the Five-Bit Input-Only Port

DB-25 Pin	Port Bit	Address Command	State
15	Bit 3	IN15 = −((INP(957) AND 8) = 8)	High
13	Bit 4	IN13 = −((INP(957) AND 16) = 16)	High
12	Bit 5	IN12 = −((INP(957) AND 32) = 32)	High
10	Bit 6	IN10 = −((INP(957) AND 64) = 64)	High
11	Bit 7	IN11 = −((INP(957) AND 128) = 0)	High

Listing 4. Input Test Program

```
10 CLS : KEY OFF
20 PRINT "Test all Inputs port test program. 'INPTEST.BAS'"
30 PRINT "Test program used to check input status."
40 PRINT
50 PRINT "As this program runs, touch a wire between ground"
60 PRINT "and each of the following pins respectively."
70 PRINT
80 PRINT "Notice each input goes to '0' (Lo), when it is grounded."
90 PRINT : PRINT "Use Ctrl-Break to stop program."
100 OUT 958,4 : REM Required to raise bit 3 high.
110 REM     Read the input port registers
120 REM IN numbers are the same as the pin numbers
130 IN1 = -((INP(958) AND 1)=0) : REM Address 958, Bit 0
140 IN14 = -((INP(958) AND 2)=0) : REM Address 958, Bit 1
150 IN16 = -((INP(958) AND 4)=4) : REM Address 958, Bit 2
160 IN17 = -((INP(958) AND 8)=0) : REM Address 958, Bit 3
170 IN15 = -((INP(957) AND 8)=8) : REM Address 957, Bit 3
180 IN13 = -((INP(957) AND 16)=16) : REM Address 957, Bit 4
190 IN12 = -((INP(957) AND 32)=32) : REM Address 957, Bit 5
200 IN10 = -((INP(957) AND 64)=64) : REM Address 957, Bit 6
210 IN11 = -((INP(957) AND 128)=0) : REM Address 957, Bit 7
220 LOCATE 11,1
230 PRINT "Pin #1  Address 958 (Bit 0) = ";IN1
240 PRINT "Pin #14 Address 958 (Bit 1) = ";IN14
250 PRINT "Pin #16 Address 958 (Bit 2) = ";IN16
260 PRINT "Pin #17 Address 958 (Bit 3) = ";IN17
270 PRINT "Pin #15 Address 957 (Bit 3) = ";IN15
280 PRINT "Pin #13 Address 957 (Bit 4) = ";IN13
290 PRINT "Pin #12 Address 957 (Bit 5) = ";IN12
300 PRINT "Pin #10 Address 957 (Bit 6) = ";IN10
310 PRINT "Pin #11 Address 957 (Bit 7) = ";IN11
320 GOTO 110
```

further experiments you may wish to make. Switch to BASIC, type in Listing 4 and save this program under the file name "INPTEST,A." Alternate addresses are 890 or 634 in place of 958 and 889 or 633 in place of 957.

Line 10 clears the screen.

Line 100's OUT 958,4 statement sets high bit 3.

Lines 120 through 200 read the input ports.

Line 210 sets the next print position on the screen.

Lines 220 through 300 print the results on the screen.

Line 310 puts the program in a continuous loop, reading the inputs.

Notice that the pin number is assigned to the IN number for easy reference. For example, IN14 means input on pin 14. When you run this program, the on-screen display should be as shown in Fig. 4. In this example, pin 13 shows 0 because it's grounded.

```
 Input port test program. 'INPTEST.BAS'
Test program  used to check input status.

As this program runs, touch a wire between ground
and each of the following pins respectively.

Notice each input goes to '0' (Lo), when it is grounded.

Use Ctrl-Break to stop program

Pin #1  Address 958 (Bit 0) = 1
Pin #14 Address 958 (Bit 1) = 1
Pin #16 Address 958 (Bit 2) = 1
Pin #17 Address 958 (Bit 3) = 1
Pin #15 Address 958 (Bit 3) = 1
Pin #13 Address 958 (Bit 4) = 0
Pin #12 Address 958 (Bit 5) = 1
Pin #10 Address 958 (Bit 6) = 1
Pin #11 Address 958 (Bit 7) = 1
```

Fig. 4. Screen display obtained when the program in Listing 4 is run.

Table 9. Parallel-Port Measurements

Pin	Voltage	Current*
1	5.0	1 mA
14	5.0	1 mA
16	5.0	1 mA
17	5.0	1 mA
10	1.5	0.5 mA
11	1.7	0.03 mA
12	1.5	0.3 mA
13	1.5	0.3 mA
15	1.1	0.3 mA

*When pin is grounded

Measure and record the voltage and current between each input pin and ground pin 18. I made measurements on my computer with the input pins high (nothing connected). Depending on the particular computer you're using, your results may be different from those given for one parallel port on my computer shown in Table 9.

Grounding an input pin causes current to flow. If you're going to be monitoring inputs on a permanent basis and an input current exceeds 0.5 mA, place a 470- or 1,000- ohm resistor in series with the input pin.

Dedicating a computer for the sole purpose of home control is worthwhile, especially if you have an old computer you haven't used for a while or can get one at very low cost. Leaving a computer that lacks a hard drive operating around the clock is economical, too. Just keep the video monitor turned off until you need to read a screen display.

The projects described here and others you dream up can be great fun in addition to providing state-of-the-art control of the electrical devices in your home. ■

Raymond H. Green

BASIC-52 Options for 8051 Microcontrollers

Options available to BASIC-52 users and a circuit that places the BASIC-52 interpreter in battery-backed nonvolatile RAM, EEPROM or EPROM to permit use of a low-cost 8032 chip

Intel's 8052-BASIC microcontroller has long been popular because its full-featured, embedded BASIC-52 programming language makes it easy to get a project up and running quickly. With the 8052-BASIC chip, you don't need a large investment in development tools or a lot of programming experience because BASIC is easy to learn and use.

Since the 8052-BASIC was introduced in the mid-1980s, development of products relating to BASIC-52 has become a small industry in itself. Several variants of the original chip have appeared, including a low-power CMOS version and low-cost and enhanced BASICs in external EPROMs. Also available are BASIC-52-compatible compilers and other development software.

In this article, I'll take you on a tour of the options available to BASIC-52 users, including a BASIC 31 EPROM that executes on low-cost 8031 microcontrollers, and provide you with a circuit and instructions for placing the BASIC-52 interpreter in a battery-backed or nonvolatile (NV) RAM, EEPROM or EPROM that you can then use with a low-cost 8032 chip.

BASIC-52 History

It all started with Intel's 8052AH-BASIC chip. This is an 8052 microcontroller with a BASIC interpreter mask-programmed into its 8K on-chip ROM. The chip costs $25 to $35 in single quantity and is available from many mail-order sources. The 8052AH-BASIC chip, a static RAM chip, personal computer, serial interface and a few other components form a complete development system for 8052-based microcontroller projects.

Using a PC's keyboard and video screen, you can write, run and debug BASIC-52 programs. By adding an EPROM, a programming voltage and related components, you can even save your BASIC programs in EPROM and configure the system to run the BASIC program automatically on power-up. You then can disconnect the serial link to the PC and use the 8052-BASIC circuit as a stand-alone system.

The BASIC-52 interpreter has more capabilities than you might expect would fit into 8K. Its floating-point math capabilities let you calculate with decimal fractions, rather than being limited to whole numbers as other ROM-based BASICs require. BASIC-52 also permits string variables and includes real-time clock instructions, a pulse-width-modulated output and many other functions useful for controller projects.

The main drawback of BASIC-52 is its slow execution speed. When a BASIC-52 program runs, the BASIC interpreter must read each line of BASIC code and translate it into assembly language for execution on the 8052. Toggling a port bit takes microseconds in assembly language but milliseconds in BASIC-52. If necessary, you can write high-speed routines in assembly language and call them from a BASIC-52 program.

Two BASIC-52 manuals are available, Intel's original *MCS BASIC-52 User's Manual* (No. 270010-003) and a re-write of this from Systronix titled *BASIC-52 Programming*. Each costs $15 and covers much of the same material. The Systronix manual contains more example code, while the Intel manual includes circuit schematics.

If you're interested in seeing the source code for the BASIC-52 interpreter, you can download it from Intel's BBS (it's number was scheduled to change in October 1992 to 916-356-3605). The source code is in the public domain, and you're free to use or adapt it as you wish in your own projects. To modify the code, you'll also need an Intel ASM51 or compatible assembler.

For experimenting with BASIC-52, you can buy a ready-made printed-circuit board with an 8052-BASIC chip or you can build your own circuit. The buyers guide in the November 1992 *ComputerCraft* described several BASIC-52 boards, both assembled and in kit form. If you'd rather build your own from scratch, sources for schematics include Q-Line Productions, Pure Unobtainium (schematic included in parts kit) and the Intel BASIC-52 manual.

As an alternative to the 8052AH-BASIC, Micromint offers its 80C52-BASIC for $25, which is a low-power CMOS 80C52 chip with a BASIC interpreter in ROM, just like the original. Maximum power-supply current for the 80C52 is just 30 mA, compared to the 8052AH's 175 mA. The 80C52 also has power-saving idle and power-down modes.

BASIC-52 in External Memory

The ROM-based BASIC-52 is convenient, but it can get expensive, since you have to buy the special, higher-

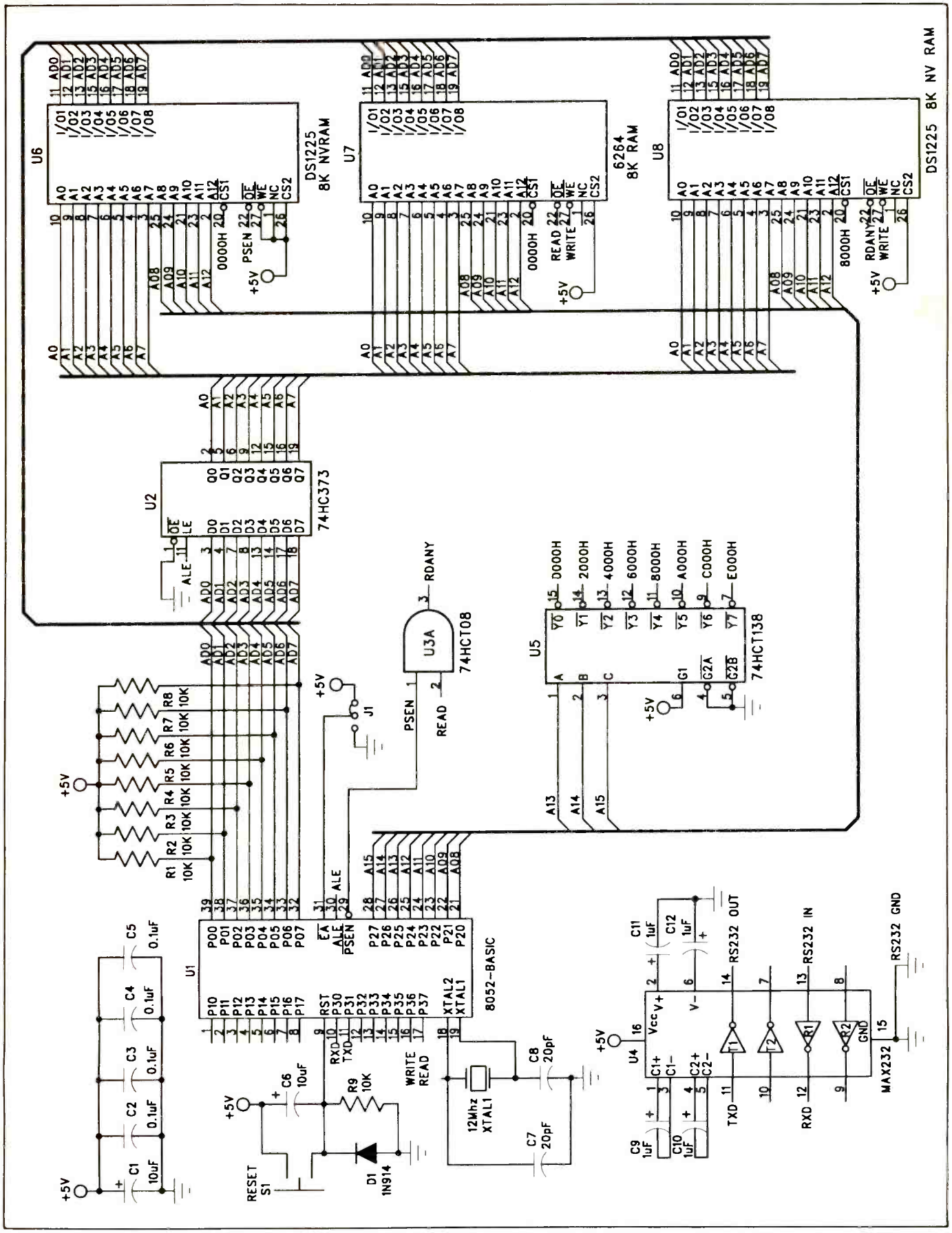

Fig. 1. With this circuit, you can copy the BASIC-52 interpreter from ROM to external nonvolatile RAM.

PARTS LIST

Semiconductors
D1—1N914 or similar silicon signal diode
U1—8052AH-BASIC or 80C52-BASIC (can be replaced by 80(C)32 or 80(C)52 after copying BASIC-52; see text)
U2—74HC373, 74HCT373 or 74LS373 octal latch
U3—74HCT08 or 74LS08 quad AND gate
U4—MAX232 RS232 interface
U5—74HCT138 or 74LS138 3-to-8-line decoder
U6,U8—DS1225 64K (8K) battery-backed static RAM, DS1213 or DS1216 28-pin SmartSocket with 6264 8K static RAM installed or 2864 or 2865 8K EEPROM (access time 250 ns or less)
U7—6264 8K static RAM
Capacitors (16-volt)
C1—10-μF aluminum or tantalum electrolytic
C2 thru C6—0.1-μF ceramic disc
C7,C8—20-pF ceramic disc
C9 thru C12—1-μF aluminum or tantalum electrolytic
Resistors (¼-watt, 5% tolerance)
R1 thru R9—10,000 ohms
Miscellaneous
J1—Three-position jumper
S1—Spst momentary-action pushbutton switch
XTAL1—12-MHz crystal (see text)
Printed-circuit board or perforated board and Wire Wrap or soldering hardware (see text); DIP sockets (required for U6 and U8 and recommended for other ICs); DB-25 or other RS-232 connector

priced 8052-BASIC chip for each system you build. To get around this, you can place the BASIC-52 interpreter in an external EPROM and then use the EPROM with a lower-cost 8032, which is identical to the 8052, except that it has no internal ROM. Of course, with this approach you have the added expense of the EPROM and its socket and wiring, but you can still come out ahead, since the 8032 sells for as low as $3.

Iota Systems offers two EPROMS for use with its EC-series boards: BASIC-52 for $15 and BASIC-52 PLUS for $25. BASIC-52 PLUS adds monitor-type commands for displaying, filling and changing internal and external memory and uploading and downloading Intel hex files. The PROG and FPROG commands in these BASICs save a program to NV RAM or EEPROM but not to EPROM. Source code is also available.

For those who would rather do it themselves, the schematic diagram shown in Fig. 1 illustrates a circuit you can use to copy the BASIC-52 code from an 8052-BASIC chip into a NV RAM. You then can use the NV RAM as the BASIC interpreter in projects that contain an 8032. This circuit is similar to many other 8052-BASIC designs. Chip *U1* is an 8052-BASIC, which you can replace with an 8032 after you copy the BASIC interpreter.

Like all 8052s, the 8052-BASIC accesses separate data and code memory areas, with PSEN accessing the read-only code memory, and READ and WRITE accessing data memory. An AND gate combines PSEN and READ to create a RDANY signal that's active when data or code memory is read.

The circuit has three memory sites, each of which holds an 8K device. Chip *U6* is an 8K NV RAM that occupies code memory from 0 to 1FFFh. When an NV RAM containing the BASIC-52 interpreter is placed at *U6* and pin 31 of *U1* is jumpered to GND, BASIC-52 runs automatically on power-up. Chip *U7* is an 8K static RAM that occupies data memory from 0 to 1FFFh. This is included because BASIC-52 requires at least 1K of RAM beginning at 0 in data memory.

Chip *U8* holds another NV RAM, at 8000h in combined data/code memory. This site is used for permanent storage of BASIC programs, duplicating the function of the EPROM in a regular 8052-BASIC system.

Other circuit components include 74HCT138 3-to-8-line *U5* decoder that divides the 64K memory area into eight 8K blocks, each of which has its own chip-enable signal, although only 0 and 8000h are used in this circuit. 74HC373 octal latch *U2* latches the low address byte (A0 through A7) on the multiplexed data/address bus. MAX232 *U4* provides a serial interface to a PC. You'll also need a regulated +5 volts at 0.5 ampere to power the project.

I built the Fig. 1 circuit on perforated board using Wire Wrap hardware and techniques. You could also use point-to-point wiring and solder components and leads or design and make a printed-circuit board.

Here are a few tips to keep in mind when assembling the Fig. 1 circuit:

- You *must* use sockets for *U6* and *U8* because you'll move the NV RAM from the *U8* to the *U6* socket after programming. Use a socket for *U1* as well to permit replacing the 8052AH-BASIC chip with an 8032.
- Wire a jumper or switch to pin 31 of *U1* to permit tying this pin to +5V or GND. This allows you to select booting from internal or external memory.
- Except for *U4*, V+ power-supply and ground pins for ICs aren't indicated in Fig. 1. These are in their traditional locations, with the highest-numbered pin connecting to +5 volts and the diagonally opposite pin connecting to ground.
- Space decoupling capacitors *C2* through *C5* evenly across the board.
- Wire *U4* exactly as shown. Connect the positive (+) terminal of *C12* to ground because pin 6 of *U4* is at −10 volts. Also note the non-standard ground location at pin 15 on *U4*. Wire RS232 OUT, RS232 IN and RS232 GND to a connector that mates with your PC's serial cable.
- To connect to a typical male 25-pin DB-25 serial connector, use a female DB-25 connector and wire pin 13 of *U4* to pin 2 on the DB-25, pin 14 of *U4* to pin 3 and pin 15 of *U4* to pin 7. Check your serial port's documentation, since pinouts can vary.
- The crystal frequency isn't critical. Any value from 3.5 MHz to 12 MHz should work.
- For NV RAM, you can use Dallas Semiconductor's DS1225 or the DS1213 or DS1216 SmartSocket with a 6264 static RAM installed. A SmartSocket contains a battery-backup circuit in a socket into which you plug a 6264 or similar 8K static RAM. Use separate NV RAMs to store the BASIC-52 interpreter at *U6* and BASIC-52 programs at *U8*. NV RAMs and SmartSockets are available from parts distributors, or order parts and a data book directly from Dallas Semiconductor, with no minimum order.

Copying & Using BASIC-52

Now I'll describe how to use the Fig. 1 circuit to copy the BASIC-52 interpreter to NV RAM and then detail how to use your new BASIC-52 in external memory. These instructions assume that you have some experience using the 8052-BASIC chip.

Listing 1. BASIC-52 Program for Copying from Internal ROM to External RAM

```
10     PRINT "copying BASIC-52 from ROM to RAM at 8000h..."
20     FOR I=0 TO 1FFFH
30    XBY(I+8000H)=CBY(I)
40     NEXT I
50     PRINT "verifying..."
60     X=0
70     FOR I=0 TO 1FFFH
80     IF XBY(I+8000H)<>CBY(I) THEN  GOSUB 120
90     NEXT I
100    IF X=0 THEN  PRINT "Copy successful"
110    END
120    PH0. "Error at location ",I
130   X=1
140    RETURN
```

Begin by configuring and running the circuit as a normal BASIC-52 system. Install an 8052AH-BASIC or 80C52-BASIC chip in the *U1* socket and a DS1225 or equivalent in the *U8* socket. Leave the *U6* socket vacant for now, but install the other components as labeled. Jumper pin 31 of *U1* to +5 volts so that this chip will boot to its internal ROM.

As with other BASIC-52 circuits, plug the 8052-BASIC circuit's serial connector into a serial port on your PC and run your communications software or terminal emulator with eight data bits, one stop bit and one parity bit. BASIC-52 automatically detects the baud rate. Power up the 8052 circuit and, as usual, press the space bar on your PC's keyboard to see the BASIC-52 sign-on message.

Listing 1 is a BASIC-52 program that copies the BASIC-52 interpreter from the 8052-BASIC's internal program memory (0 to 1FFFh) into *U8*. Enter the program and run it as you would any BASIC-52 program. You should now have the BASIC-52 interpreter stored in the NV RAM at *U8*.

To test your new component, power down the circuit and disconnect the serial link. Remove the DS1225 from the *U8* socket and install it in the *U6* socket. If you use a SmartSocket, be sure to remove it along with the RAM installed in it, to preserve the battery back-up.

Jumper pin 31 of U1 to ground to force the 8052 to boot to external memory at *U6*. If you wish, you can now replace the 8052-BASIC chip with a ROM-less 8032 or 80C32, since you no longer need BASIC-52 in ROM. You can also use any 8052 or 80C52 microcontroller.

Reconnect the serial link, power up the circuit and press the space bar, as before. You should see the same sign-on message, and BASIC-52 should function exactly as before, with one main exception. BASIC-52's PROG and FPROG commands, which store programs in EPROM, will no longer work because BASIC-52 uses the address and data lines as I/O ports with these commands. When BASIC-52 executes from external memory, these lines are needed to access *U6*.

In-circuit EPROM programming isn't possible. But there's another way to store programs, which I've adapted from one of Micromint's application notes for its RTC52 board. Install a second NV RAM in the *U8* socket. Write and test your BASIC programs as usual. When you want to store a program permanently, append the code in Listing 2 to your program. The code is shown beginning at line 9000, but it can begin at any line number after the END statement in the program you want to save.

Let's take a quick run-through of Listing 2 to familiarize you with what's going on as it runs:

Line 8990 indicates the end of the program you want to save.

Lines 9000 through **9040** have the user press "P" to copy the current BASIC-52 program to NV RAM at *U8* or "Q" to quit without copying.

Line 9050 has 55h indicate to the interpreter that a BASIC program follows.

Lines 9060 through **9080** copy the current BASIC-52 program, which is stored beginning at 200h in external data memory *U7*, to NV RAM *U8*, beginning at 8011h. These lines (beginning at 8990) are also copied as part of the current program.

Lines 9090 through **9130** have the user press a number from 1 to 6 to simulate a BASIC-52 PROG1 through PROG6 command or press "Q" to quit without executing a PROG-.

Lines 9140 through **9190** have the PROG- simulation store the PROG- value, RCAP2 upper and lower bytes (for saving the baud rate) and MTOP upper and lower bytes, as requested. (See

Listing 2. BASIC-52 Program Simulates PROG and PROG- Commands

```
8990    END
9000    PRINT "Press 'P' to copy the current BASIC program to
RAM at 8000h."
9010    PRINT "Press 'Q' to quit."
9020   G=GET
9030   G=GET :  IF G=0 THEN 9030
9040    IF (G<>80.AND.G<>112) THEN  END
9050   XBY(8010H)=55H
9060    FOR X=200H TO (200H+LEN)
9070   XBY(X+7E11H)=XBY(X)
9080    NEXT X
9090    PRINT "Press a number from 1 to 6 to do PROG1-PROG6."
9100    PRINT "Press 'Q' to quit."
9110   G=GET
9120   G=GET :  IF G=0 THEN 9120
9130    IF (G<49.OR.G>54) THEN END
9140   XBY(8000H)=G
9150   XBY(8001H)=INT(RCAP2/256)
9160   XBY(8002H)=RCAP2-(XBY(8001H)*256)
9170    IF G<50 THEN  END
9180   XBY(8003H)=INT(MTOP/256)
9190   XBY(8004H)=MTOP-(XBY(8003H)*256)
9200    END
```

the BASIC-52 manuals for more on the PROG- commands).

To store a program in *U8*, type GOTO 9000, where 9000 is the line number at which Listing 2 begins, and follow the on-screen instructions. The code can simulate all of the PROG functions, including automatic execution on power-up, setting baud rate and saving MTOP.

This technique stores only the current program, not multiple programs like the original PROG command. But you can store a new program whenever you wish by writing over the previously stored program. And you don't have to worry about removing and erasing an EPROM when it has been filled.

You now have a BASIC-52 system without the 8052AH-BASIC chip. If you want to store BASIC-52 or your BASIC-52 programs in EPROM, you can do so with many EPROM programmers. Configure the EPROM programmer to read a DS1225 RAM or, if this option isn't available, a 2764 EPROM, since the pinouts for reading these two devices are equivalent. Place the DS1225 or SmartSocket and RAM in the programmer's socket and read the contents into the programmer's buffer.

Remove the DS1225 or SmartSocket from the programmer. Be sure not to subject the DS1225 to any EPROM programming voltages, which would be lethal to it. Plug a 2764 EPROM into the programmer's socket, and program the EPROM with the buffer's contents. You now have an EPROM with the same contents as your NV RAM and can use it just like the NV RAM at *U6* or *U8*, except that *U8* is now write-protected.

You can also use 8K EEPROMs at *U6* and *U8*. Many modern EEPROMs operate entirely from a single +5-volt supply and function much like NV RAMs. That is, you can read from and write to them, and they retain their contents when power is removed. The main thing to be careful about with EEPROMs is their write cycle time (minimum time between write cycles). Typical values are 2 and 10 ms. For an EEPROM with a 10-ms write cycle time, writing to 8192 (1FFFh) locations should take at least 82 seconds.

To slow down Listings 1 and 2 to give a longer delay between writes, after each XBY statement, call a subroutine that contains the "do-nothing" loop "FOR J = 1 to 2:NEXT J" or something similar.

If you design your own circuits using BASIC-52 in external EPROM, remember that each circuit must have the following:

- Any 8052, 8032, 80C52 or 80C32 microcontroller chip.
- BASIC-52 stored in non-volatile memory (NV RAM, EEPROM or EPROM), beginning at 0 in code memory.
- At least 1K of read/write memory (RAM), beginning at 0 in data memory.
- For permanent storage of BASIC-52 programs, non-volatile memory beginning at 8000h in data or data/code memory.

One other thing to be aware of is that, on power-up, BASIC-52 examines and clears contiguous data memory beginning at 0. In Fig. 1, BASIC-52 clears only *U7* and ignores *U8*, since no data memory exists from 2000h to 7FFFh. This enables you to save BASIC-52 programs in *U8* without loss on powering down.

If you design a circuit with a 32K RAM at 0 on power-up, BASIC-52 clears an NV RAM at 8000h unless you do one of the following: in BASIC-52, set MTOP to 32767 (7FFFh) and use Listing 2 to do a PROG3, -4, -5 or -6 to instruct BASIC-52 not to clear memory beyond 7FFFh; install a jumper that ties pin 27 of *U8 to* +5 volts, preventing writes to *U8*; or use an EPROM at *U8* when your program is debugged and requires no more changes.

BASIC 31

Figure 1 requires an 8032 or 8052 chip—not an 8031 or 8051—mainly because the BASIC-52 interpreter uses TIMER 2, which the 8031/51 doesn't have. But the 8031 and 80C31 are more widely available than the 80(C)32 and often cost less. If you want to use 8031s, there's a solution. Reader Ronald Papasso has developed a version of BASIC-52, which he calls BASIC 31, that runs from an external EPROM using an 8031 or 80C31. He created the code by modifying and reassembling the original BASIC-52 source code.

Projects Ronald has created using BASIC 31 include a loop-back tester for data and voice telephone carrier lines, special effects controller for radio-controlled aircraft, phase-locked-loop tester and battery cycler. He offers two versions, BASIC 31 and VBASIC 31 at $25 each, as programmed EPROMs. User's manuals ($6) summarize in 20 pages hardware requirements, BASIC 31's differences from BASIC-52 and BASIC 31 commands and statements and include a sample schematic.

Also available is a kit that contains a bare BASIC 31 printed-circuit board and assembly manual for $41. Write for a complete price list (see Sources box at end of article).

VBASIC 31 differs from BASIC 31 mainly in that the interrupt vectors are relocated from 4003h through 4023h to 8010h through 801Ch. Thus, you don't have to add program memory at 4000h if you write your own assembly-language interrupt routines. BASIC 31 retains the original BASIC-52 interrupt-vector locations. VBASIC also replaces BASIC-52's > prompt with } to prevent the problems some communications programs have in distinguishing when the > symbol is meant as a greater-than operator and when it's used as the prompt.

Creating BASIC 31 from BASIC-52 involved several challenges:

As in Fig. 1, the original PROG and FPROG commands won't work when the BASIC interpreter is in external memory. So PROG and FPROG were revised to use ordinary write instructions that copy a program to an NV RAM or EEPROM. You can use PROG and FPROG without having to add EPROM-programming components or voltages to your circuits. FPROG waits 1 ms between write cycles, and PROG waits 50 ms to accommodate EEPROMs that require longer delays.

Another challenge in creating BASIC 31 was that BASIC-52 uses TIMER 2 in its baud-rate generator for the serial port. TIMER 2 is a 16-bit timer, and the 8031 has only two eight-bit timers, TIMER 0 and TIMER 1. In BASIC 31, the baud-rate generator and associated code were rewritten to use TIMER 1.

Because TIMER 1 is just eight bits wide, BASIC 31's automatic baud detection isn't as capable at adjusting to different baud rates, but it's adequate for most purposes. The BASIC 31

Sources

Binary Technology
P.O. Box 541
Carlisle, MA 01741
Tel.: 508-369-9556
CIRCLE NO. 102 ON FREE INFORMATION CARD

Dallas Semiconductor
4350 S. Beltwood Pkwy.
Dallas, TX 75244-3292
Tel.: 214-450-0400
Orders: 1-800-336-6933
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MDL Labs
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Columbus, OH 43235
Tel./fax: 614-431-2675
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Q-Line Productions
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Sharon, WI 53585
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Systronix
754 E. Roosevelt Ave.
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Salt Lake City, UT 84152-6398
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manual lists ranges of allowable crystals at different baud rates. At higher baud rates, the ranges are more restricted. You can use the popular 11.059-MHz crystal at all common baud rates from 300 to 19,200.

Moving the baud-rate generator to TIMER 1 creates new problems because BASIC-52's PWM, LIST-, PRINT-, PROG and FPROG all use TIMER 1. In BASIC 31, these now use TIMER 0, as does the real-time clock; so only one of these functions can be used at a time.

Other BASIC-52 Options

To complete this roundup of BASIC-52 tools and options, you should be aware that compilers and development systems are also available. BASIC-52-compatible compilers include Binary Technology's BXC51 ($295) and Systronix's BCI51 ($299). Compiled programs execute faster than interpreted programs and eliminate the need to store the BASIC interpreter in-circuit.

If you like the convenience of the BASIC-52 interpreter but long for a more-elegant development environment than BASIC-52 offers, several alternatives are available. Micro Future's BDT52 ($199) and MDL Labs' BASIKIT ($150) include features like block editing, structured modules, elimination of line numbers, stripping of comments, on-line help, debugging tools, communications software and conversion of BASIC-52 programs to hex files for EPROM programming. BASIKIT also has versions that are compatible with Blue Earth's Micro-440 and Iota Systems' EC-series boards, since the BASIC-52 on these boards differs slightly from the original.

A final possibility is Micromint's ROM A and B ($100), which add an assembler, monitor commands, line renumbering and other utilities to BASIC-52 systems.

Moving On

Next time, I plan to answer a variety of questions submitted by readers over the past several months.

If you have comments, suggestions or questions relating to designing, building and programming microcontrollers or other small, dedicated computers, contact me on Compuserve at 71163,3555 or by writing to me at ComputerCraft, *76 North Broadway, Hicksville, NY 11801. Questions of interest to all may be published and answered in this space. For a personal reply by mail, please include a self-addressed stamped envelope.* ■

Jan Axelson

The World of PC Sound

By Tom Benford

When designers of the original IBM PC made a list of essential features to build into the machine, sound was apparently at the bottom of it. The PC contained only a wimpish 2" speaker that's capable of producing little more than a "beep" sound. This shortcoming was filled by the Apple Macintosh, Atari and Commodore Amiga models, which took the sonic route. In time, however, things changed.

With a sound board, you can immediately enter the world of multimedia, for example, whether you're a staunch DOS user or you run everything under *Windows*. Digitized voice narration, sound effects and music can all be added and blended with graphics, text and even animated sequences to make presentations, applications and programs come alive with sound as well as sight.

The ability to digitally sample your own voice, sounds and music gives computing a whole new perspective. Once sound is digitized, it can be manipulated, processed, cut and pasted, reversed and more with almost the same ease as using the editing functions of a word processor.

What can't be sampled can probably be synthesized with an on-board 11- or 20-voice synthesizer chip, depending on sound card and model. Virtually any musical instrument sound and sound effect can be created (or recreated) by controlling the chip's registers. "Patches" of sounds are also provided with the software that comes bundled with many sound boards. Patches—preprogrammed libraries of sound settings ready to load and use—can change the sound of the synthesizer from laser zaps to "ah-ooga" horns, for example. Many of the sound utility programs provided with sound boards permit you to create and store your own patch libraries as well.

Music files can also be edited into new versions or variations on the original that were never possible before. With a sound board and the right software, complex variations, like changing the entire key of a song, can easily be accomplished with a couple of mouse clicks. Dedicated sequencer, compositing/arranging and score-printing software packages can all be utilized with the sound card's on-board synthesizer, too. So you don't have to spend a bundle on purchasing additional hardware to tap into the world of MIDI.

If you want to explore or work with MIDI beyond what the sound card itself can provide in the way of audio, external MIDI devices, such as keyboards, synthesizers, drum boxes, lighting and more, can also be accessed and controlled. Most sound cards provide MIDI support, either as a standard feature of the card or with an optional MIDI cable kit. Virtually all sound cards that support MIDI are Roland MPU-401-compatible (in UART mode) and are capable of sending, receiving and passing-through MIDI control signals. This makes linking together several MIDI devices under computer control and further expands creative possibilities.

Today, the PC audio card is one of the most popular peripherals you can add to your system, opening up a whole new dimension in computing.

Sound Source

PC sound devices come in numerous varieties and flavors. Some are internal boards that require an expansion slot. Some are self-contained units that connect externally. Others utilize synthesizer chips to produce music and sound effects, and still others rely on actual digitized samples as the sound source. There are other differences as well. So it might be a good idea to define the basic required capabilities and componentry that comprise a sound board.

A sound-generation source is a prerequisite for any sound board. Most boards use a multi-timbral FM (frequency-modulated) synthesizer chip or chips for the sound source, although devices that utilize actual digitized sound samples (though quite pricey) are beginning to make their appearance in the marketplace.

Using digitized sound samples is another way of providing a sound source for the board. There are advantages and disadvantages with this method. Major advantages are that digitized sample sounds are absolutely pristine renditions of the instruments (or other sources) that created them since they're digital recordings of the actual sounds. Moreover, sounds can be changed by replacing the EPROMs on the board with a different "library" of samples. Major disadvantages are high cost of the board and forfeiture of the ability to produce satisfactory audio effects with some software, especially games, that make extensive use of synthesized sound effects.

For satisfactory playback of these programs, each waveform variation of the most commonly-used sounds would have to be recorded (since there's no on-board synthesizer). In a practical sense, the sonic variations used in game and recreational software products are almost limitless. So covering all bases with a library of sampled sounds would be impossible.

This month, I'll deal the hardware means of implementing high-quality sound on the PC by looking at exter-

nal and internal devices from a variety of manufacturers. Next month, I'll conclude with an overview and capsule evaluations of a range of software alternatives to implementing sound on the PC.

MIDI and More

The MIDI (Musical Instrument Digital Interface) standard is included as an integral part of *Windows* 3.1 and as part of the Multimedia Extensions 1.0 for *Windows* 3.0. Many of the sound boards and devices to be examined here contain a multiple-voice FM synthesizer chip that can be accessed through MIDI to create and play back music files. The *Windows* Media Player accessory makes it possible to play back MIDI files through an installed sound card without the need for an externally-connected MIDI device.

A synthesizer chip artificially creates facsimiles of sounds. These sounds can be simulations of musical instruments, common everyday noises, sonic special effects and more by changing values of the synthesizer registers via software. This approach is the most common means of generating sound on an audio board and is the method used by most manufacturers.

Synthesizer chips most frequently employed are from Yamaha. The two leading ones are the YM3812 and the YMF262, more commonly referred to as the OPL2 and the OPL3, respectively. The OPL2 is a monophonic synthesizer, while the OPL3 is a stereo chip with some additional capabilities (see Table 1 for feature comparisons of both chips).

Some sound boards use a pair of OPL2s to provide stereo (discrete left- and right-channel) capability. Newer board designs are utilizing the OPL3, which produces cleaner-sounding audio and requires less support circuitry. This results in a smaller physical board size.

TABLE 1
SYNTHESIZER CHIP COMPARISON

	YM3812 OPL-II	YMF262 OPL-III
Sound Generation System	FM	FM
Type	monophonic	sterephonic
Number of Operators/Modes	2	4
Total # of Sounds Possible	11 (9 sounds or 6 melody sounds with 5 rhythm sounds)	20 (18 simultaneous melody or 15 melody sounds with 5 rhythm sounds, other sound/ operator variations possible; 8 selectable waveforms)
Effects	built-in vibrato oscillator & amplitude modulation oscillator (AM)	LFO for vibrato and tremolo effects
Other Features	input/output TTL compatible Si-gate CMOS-LSI 5V single power supply	two programmable timers 5V single supply silicon gate CMOS process shorter register access time than YM3812 24-pin DIP or 24-pin SOP package
Recommended D/A converter	YM3014	YM3015 (stereo)

Other Key Components

Regardless of whether the sound source is synthesized or sampled, other components are essential to make a sound board a functional peripheral. These include:

•An amplifier to boost the raw signal to an easily audible level. This can be a one-channel amplifier for monophonic boards, with two single-channel amplifiers or a dual-channel amplifier for stereo boards.

•A digital-to-analog converter (DAC) to translate stored digital sound data to an analog format that's capable of being heard through speakers or headphones.

•A physical means of outputting sound. Headphone and/or line-out jacks are usually provided, along with an output connector for MIDI signals if the board supports MIDI.

•A means of transferring sound information from PC to sound card. This can be byte-by-byte transferral, as with Covox's SpeechThing, or in DMA (direct memory access) blocks, which is the method used in most sound-card designs. In addition to providing a faster transfer rate, the DMA method also works in the background; so other events, like animation, can take place in the foreground simultaneously.

•A physical means of inputting sound if the board is capable of sampling. Inputs are usually provided for microphone and line sources.

•An analog-to-digital converter (ADC) for converting analog sound source information into digital format. A preamplifier is also required to boost microphone gain, as are some filters to remove any alias distortion. DMA support of input is also desirable, rather than the byte-by-byte transfer method.

The sound boards and devices covered here contain all or most of the listed components to one degree or another. But the ways they are put together and the resulting capabilities vary quite a bit from one product to another.

As with just about any other computer peripheral, how deep your pockets are determines how lavish a sound setup will be right for you. Included here are sound boards from the lowest to highest price ranges, as well as software to produce sound through the PC's own speaker.

Let's take a look at the products themselves.

Products Evaluated

External Sound Devices

Covox "SpeechThing" ($100)

The smallest and least-expensive external audio hardware device covered here,

Covox's SpeechThing was one of the first products released for sound on the PC. While it has remained basically unchanged over the last few years, Covox's driver and utility software has undergone constant improvement and finessing, with the latest release providing support for the playback of .WAV files through SpeechThing in *Windows*.

Measuring only about 2⅛" square and weighing well under an ounce, SpeechThing plugs directly into a PC's parallel port. Unlike the other parallel devices covered here, which monopolize this port, SpeechThing is a transparent device that fits between printer cable and parallel port. Since it doesn't interfere with normal printer operation, SpeechThing can be left permanently installed at the parallel port, adding to its convenience of use and overall appeal.

SpeechThing uses FIFO (first-in, first-out) data streaming instead of the DMA (direct memory access) schemes used with other external-connected devices. Although this doesn't affect sound quality, it does cause other operations to come to a standstill as sound is being output through it. FIFO streaming hogs all I/O operations while sound is being accessed, but DMA permits other events (like video refreshing, mouse control, keyboard input, etc.) to continue while sound is playing.

Covox provides an amplified speaker that mates with a miniature phone jack on SpeechThing's cable. A second cable fitted with a subminiature jack is used to deliver an additional +5 volts of dc power to the speaker from the parallel port. The documentation states that on some computers SpeechThing sounds better without the +5-volt source plugged in. I found this to be true of my CAF 386SL notebook computer, which generated static sounds during floppy or hard-drive accesses. Unplugging the +5-volt connector silenced the noise without compromising quality of the sound.

A 9-volt dc power adapter is supplied, and the speaker can also be powered via a 9-volt battery that fits into a compartment inside the enclosure. The wedge-shaped speaker cabinet (4" tall by 3" wide and deep) has a red LED power indicator and a thumbwheel volume control with power on/off switch built in. The speaker delivers surprisingly good sound for its size.

SpeechThing is a D/A-converter playback-only device. You can't sample sounds or digitally record your own voice with it. To do so, you need one of Covox's other products (SoundMaster II or VoiceMaster Key System in either the internal or external configuration).

Plenty of software is supplied with SpeechThing, including a *CVSD* playback utility for CD-ROM and IBM talking programs, *SmoothTalker* text-to-speech software, a music synthesizer utility that modulates sampled sound, utility software for playback of digitized speech and sounds and speech/sound editing software.

Also included in current packages is a driver for *Windows* to playback .WAV sound files via SpeechThing. (Covox has the latest versions of all its drivers for *Windows* on its BBS. They're available for downloading free of charge. Call 503-342-4135. Set up your modem for 1,200, 2,400 or 9,600 baud and 8-N-1 terminal settings).

Because no FM sound synthesizer is used in SpeechThing, MIDI playback and encoding aren't possible. Notwithstanding its drawbacks, the SpeechThing, ounce-for-ounce and dollar-for-dollar, is truly a bargain for the hardware, software and audio playback capabilities it delivers.

Covox Voice Master System II ($240 External)

Voice Master System II is the external counterpart of Covox's internal PC-card Voice Master Key System covered elsewhere in this article. It shares all of the same capabilities as the internal version, but it connects to a parallel port, rather than requiring an internal expansion slot. This makes it compatible for use with laptops and notebooks as well as desktop PCs (even Micro Channel machines). Since it attaches to this port, no conflict exists with I/O addresses, IRQs or DMA request/acknowledge settings.

Other features of the external model include separate tone and volume controls located on the front of the unit, where ⅛" miniature phone jacks for microphone input and speaker output also reside. On the front panel are also a built-in speaker, high/low microphone impedance selector switch, red power LED and nearby green LED that turns on when VoiceMaster's (recognition) mode is active.

A pass-through printer port and a parallel-input port (a 3-foot cable is provided for connecting to the PC) are on the rear of the enclosure. The pass-through port keeps System II and printer connected simultaneously. A three-position switch on the front panel establishes priority for System II, printer or automatic selection of either device.

A power jack is on the rear panel of the cabinet, along with dual miniature phone jacks for external input and output. A dc power adapter is also supplied with the unit, along with a Covox microphone/headset, for hands-free recording, playback and speech recognition.

Voice Master System II doesn't contain an FM synthesizer. Therefore, it isn't capable of playing back digital sound files or MIDI files. It can record and play back digital speech and sampled sounds in either native Covox .VOX format or, under *Windows*, .WAV file types.

Aside from providing an excellent monophonic means of digitally recording and playing back sampled sounds, Voice Master System II's strongest card is its ability to provide speech recognition for voice control of the PC and application software. A *Voice Master Key* software utility lets you add voice commands to existing programs. These commands activate a predefined series of macros that enable you to perform tedious tasks, repetitive keystrokes or multiple mouse movements by uttering a spoken command. Version 3.1 of *Voice Master Key* software supports up to 1,023 commands, while memory requirement has been reduced to under 20K, when using EMS.

The voice-recognition software uses a pull-down menu system and features context-sensitive help and mouse support. This software is currently available for DOS. A *Windows* version is nearing completion and should be available by the time you read this. Recording and playing back of .WAV files, however, is currently supported with the Covox *Windows* driver.

Covox's user manual is thorough to the

point of almost containing too much information. You'll surely like this manual if you have more than a casual interest in learning about sound and voice recognition or in writing your own programs in BASIC or C that utilize the Voice Master Key System. The manual, along with the additional software and utilities provided with System II, is identical to that provided with the internal model. It's covered in more detail in that section.

MediaVision "AudioPort" ($349)

A self-contained external device measuring a petite 4¾″ long × 2¼″ wide × ⅞″ thick, the AudioPort plugs into the 25-pin parallel printer port of any PC. This little device fits conveniently into a pocket and provides a host of features, including digital recording and playback of sounds.

Power for the AudioPort can be from four internal AAA cells that install inside a snap-open compartment or from a supplied supply that delivers 6 volts dc. Average battery life expectancy is rated at about four hours, a realistic figure.

For sound generation, a Yamaha YM3812 FM synthesizer chip produces 11 voices. The AudioPort can sample eight-bit monophonic sound at rates ranging from 2 kHz to 22.1 kHz. Frequency response is 100 Hz to 12 kHz, with a signal-to-noise ratio of −50 and −80 dB at maximum and minimum gain, respectively.

A ⅛″ miniature microphone jack is provided for audio input. Input level is 10 mV, and input impedance is 10,000 ohms. Automatic gain control (agc) is built into the device and yields 20-dB minimum and 100-dB maximum boost.

Mounted on the side of the unit, next to the input jack, is a ⅛″ miniature microphone jack for connecting Walkman-type headphones or speakers. A built-in 1½″ internal speaker provides audio playback without connecting other external devices. Sound quality is surprisingly good. A thumbwheel volume control is mounted on the opposite side of the unit.

AudioPort comes with an assortment of software for using the product under *Windows* 3.1 or 3.0 with MultiMedia Extensions 1.0. The main software program is Lotus *Sound*, a *Windows* application that permits recording and playing back digitized sound. The program can be used independently or with any other *Windows* application that supports OLE, such as Lotus *Ami Pro*, Microsoft *Excel* or Microsoft *Word*.

Pocket Recorder permits you to record and play back eight-bit digital audio at sample rates up to 22 kHz. The main strength of this application is extensive editing capability of digital sound files, including splicing and blending files and adding special effects like echo, reverberation, pitch adjustments and directional reversing of sound files.

The user interface for both Lotus *Sound* and *Pocket Recorder* is a graphical analogy to the controls on a standard cassette recorder. It has "pushbuttons" for rewind, stop, play, fast forward and record. Scrollbars are also available for moving to a desired point in the recording for editing, and views at different magnifications are provided for easy editing of even the smallest audio file sections.

AudioPort doesn't support DOS-based applications directly from the system prompt. However, games and other programs that utilize sound can be run in a DOS window from within *Windows* with the SB2AP utility program, a virtual *Windows* driver that's also part of the supplied software (*Windows* 3.1 must be running in enhanced mode to use SB2AP).

An animated talking calendar program, *At Your Service*, is supplied with AudioPort. This is a personal reminder that runs as a background task in *Windows* and features "Jeeves," the talking butler. Based on data entered into the calendar's database, Jeeves reminds you of appointments, phone calls, meetings and other events that require action or attention at the appropriate times. This program has some practical merit, but it's more "cutesy" than I care for in my software. So I'll stick to *ACT for Windows* for my scheduling tasks and reminders.

MIDI file playback is supported via the Media Player accessory in *Windows*, although the device doesn't allow MIDI input through it.

Overall, AudioPort is an ideal device for notebook users and users who are slot-poor when it comes to adding internal peripherals. It's unfortunate that AudioPort isn't a transparent device that permits a printer to be attached at the same time as it is. Since there's no through port, you must disconnect your printer to attach the sound device. Aside from this limitation, AudioPort is a very good way to easily add AdLib- and SoundBlaster-compatible sound to your system, particularly if you're a *Windows* user.

MicroKey "AudioPort" ($195 to $295)

Both MicroKey and MediaVision have licensed the name "AudioPort" for their respective products, but the two are different and distinct devices and don't share a commonalty of engineering or design. To avoid confusion, I'll use the full brand name from here on.

Another external device that connects via the PC's parallel port, the MicroKey AudioPort from Video Associates Labs is slightly shorter than the MediaVision described above. The MicroKey AudioPort measures 2.18″ wide × 3.42″ long. It's housed in metal, rather than plastic, adding considerably to its weight.

As with the MediaVision unit, the MicroKey AudioPort doesn't provide a parallel pass-through port. Thus, a parallel printer can't be connected simultaneously while the device is in place. Since power for the unit is provided by an included 9-volt dc adapter, you'll need an ac outlet any time you intend to use this unit. This is a limiting factor for notebook users on the go who like to fly solely on battery power, but it shouldn't pose a hindrance for desktop PC users.

Two miniature phone jacks are located on the MicroKey AudioPort between two thumbscrews for fastening it to a parallel port. One is for input from a microphone or, with an included −40-dB attenuating adapter, from a line source. The other is for output. There's no built-in speaker, but supplied headphones make the output audible. A 500-ohm ball-type microphone is also provided, along with a microphone-stand adapter and a stereo miniature phone-to-standard phone plug adapter.

Sonic capabilities for the MicroKey AudioPort are up to most tasks since the unit supports monophonic 12-bit sampl-

ing at eight user-selectable sampling rates from 4 kHz to 44.1 kHz. Built-in agc controls input signal strength. No volume control is provided; so no manual override is possible. Dynamic recording range is greater than 55 dB for both recording and playback, and frequency response is 20 Hz to 20 kHz ±3 dB).

ADPCM 3:1 compression is supported to let you store up to 11 minutes of audio in a 1M file. MPC (.WAV) files are directly supported, and uncompressed Sound-Blaster-format .VOC files are converted for compatible playback using an included utility.

DOS-based software supplied with the unit is straightforward and easy to use, thanks to a drop-down menu scheme you use for recording, editing and assembling presentations. The device is compatible with numerous presentation graphics, multimedia and authoring packages, including Autodesk *Animator/Animator Pro, Ask*Me 2000, Freelance Plus/Graphics, GRASP, Harvard Graphics, Show Partner FX, Asymetrix Toolbook* and some others.

Several stand-alone utility programs are also provided for recording and assembling sound files. And a rich assortment of samples and example programs give food for thought as well as showcase the device's capabilities.

In addition to required *Windows* drivers, Voyetra's *WinDAT* digital-audio editing software comes with the unit. The "DAT" in the software's name stands for "digital audio transport," an appropriate moniker because it uses the familiar tape-deck interface that features mouse-activated pushbuttons for play, record, rewind, fast forward and pause, in addition to range-selection controls. Drop-down menus further simplify using the program that allows you to play, record and edit sound files with the MicroKey AudioPort.

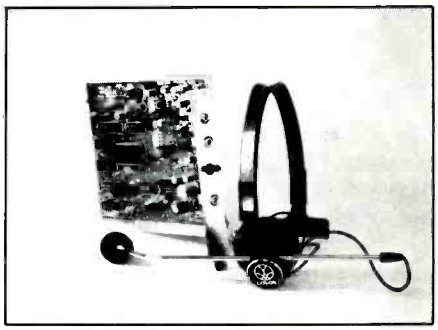
Documentation consists of a 43-page user manual for AudioPort itself and a 24-page manual for *WinDAT* software. Between the two, everything you need or want to know about the device and using it from either DOS or *Windows* is covered in depth.

No support is provided for input or playback of MIDI files through the unit, which doesn't contain an FM synthesizer chip. This is an important point to consider if you wish to incorporate MIDI music with presentations and digitized samples.

Though lacking an on-board synthesizer and a few other features, the device does provide a functional means of inputting and outputting sound to and from the PC's parallel port, without having to open the system unit. Its greatest appeal will be to users who want a good device for extensive voice annotation (or even dictation over a network) and don't want or need the musical/sound-effects capabilities of a synthesizer chip and MIDI support.

Eight-Bit Internal Sound Boards

Covox Voice Master Key ($200 Internal)



The internal counterpart to Covox Voice Master System II reviewed earlier, the Voice Master Key is a half-length card that fits into any eight- or 16-bit expansion slot. This model has DMA circuitry that permits recording and playback of a single audio file up to the maximum capacity of available hard disk space. A side benefit of DMA access is that audio files can play in the background while you're accessing other applications in the foreground.

Voice Master Key's default port configuration is jumpered for 22Fh. Because changing the jumper to any of the adjacent three pin pairs changes port address to 24Fh, 28Fh or 2CFh, resolving any I/O conflicts with other devices is easily accomplished.

A cable lets you bypass the PC's internal speaker and route the sound through the Voice Master Key card to get enhanced audio. The board features an eight-bit PCM digitizer that supports software-defined sample rates that range up to 25K bytes/second.

Recording and playback are both under software control, although volume can be controlled via software or a bracket-mounted knob. Separate high- and low-impedance miniature microphone jacks are mounted on the card's bracket, as is a miniature phone jack for connecting an earphone or extension speaker.

As with the external System II, the bus version of the Voice Master Key system can record and play back sampled sounds and is capable of voice recognition. Two record and edit programs are provided as part of the standard software complement. One is a very sophisticated graphics-based editing program that displays sound waveforms and supports cut-and-paste, raises/lowers sound levels and provides high- and low-pass filtering, inversions, duplications and more.

Sampling rate is user-variable between 1K and 25K bytes per second. An included data-compression utility can compress the sound file in the buffer by removing silence periods, sections of sound or compressing to four-, three- or one-bit samples.

Though this editing program is DOS-based, it relies on a graphical user interface to make working with sound files almost as easy as using a word processor. Using the same procedures as in a word processor, you can highlight a section of sound, cut or copy it, modify it and paste it wherever you want. You can also cut and clip sections of sound files to create altered versions. You can save to disk and link to form digital sound files for use in software programs or even external EPROMs.

The other utility is much easier to use but bare-bones in capabilities. But it's enough to meet the needs of most users. *Record* and *Say* utilities are executable programs you run from the DOS prompt to record and play back, respectively. Command-line arguments permit you to select record/playback rates, format coding (eight-, four-, three- and two-bit PCM/ADPCM) and port addressing (internal, external Voice Master or internal PC speaker). These utilities are normally used for creating sound files (verbal responses) for the Voice Master Key recognition program, rather than elaborate sampled files with lots of special effects as a result of heavy editing.

Another program, *Convert*, lets you convert custom sound files created with the graphics-based editor to *Say*-executable format. In addition, Covox provides several sound samples, a talking blackjack game and an oscilloscope program. Needless to say, plenty of value and utility are packaged with the hardware.

Covox SoundMaster II ($230)

SoundMaster II is a three-quarter-length card that plugs into any eight- or 16-bit slot on a PC bus. It incorporates all of the recording, playback and voice-recognition capabilities of the Voice Master Key board reviewed earlier and adds FM sound synthesis and MIDI (UART mode) capabilities.

The board makes extensive use of CMOS logic for high noise immunity and

low power consumption. SoundMaster was the quietest of all the boards covered here in terms of residual background noise through Labtec Model CS-150 amplified speakers.

Every function of SoundMaster II has alternate addresses so that two boards can be installed in a PC at the same time for stereo output or extended instrument voicing using the FM synthesizer(s). Three jumper banks let you avoid any device conflicts with other installed peripherals. One bank selects address 330 (default) or 338 for the MIDI port. Another jumper set governs selection of DMA acknowledge channel 1 (default) or 3, while shunting a second set of pins selects DMA request channel 1 (default) or 3. A three-cap row of jumper pairs select DMA interrupt 3, 4, 5, 6 or 7 (default), MIDI IRQ 2 (default), 3, 5 or 7 and port 220 (default), 240, 280 or 2C0.

On the card's mounting bracket are two miniature microphone jacks, designated M1 and M2 for high- and low-impedance, respectively; a rotary volume control; an earphone/external speaker jack; and a nine-pin D connector for attaching the included combination MIDI input/output cable. An included jumper wire lets you route the PC's speaker sounds through SoundMaster II.

A headset/microphone comes as part of the standard complement of accessories. The headset is outfitted with dual ⅛" miniature plugs, one from the high-impedance hands-free microphone and the other from the earphone built into the headset.

A Yamaha YM3812 FM synthesizer chip provides the audio source for creating music and sound effects, with a 1-watt audio amplifier. A pair of stereo Walkman-type speakers and a stereo-to-mono miniature phone adapter are provided. Because SoundMaster's output is monophonic, the adapter is needed to route the signal to both speakers.

The user manual tells you everything you could want to know about SoundMaster II and the software provided with it and how to program for it. In addition to the Voice Master Key software supplied with Voice Master systems, SoundMaster includes Covox's *DSP-FX* digital signal-processing utility. This facilitates real-time pitch changing, harmonizing, flanging, chorusing, echoes, reverberation, distortion and numerous other special effects. The Covox graphic waveform editor is also included, as are dozens of MIDI song files, sound samples and other interesting tidbits.

The real bonus is the inclusion of *PC-Lyra*, a graphics-based music-composition program that permits musical input using a mouse or computer keyboard or directly from a MIDI instrument connected to the PC via SoundMaster's cables. All of these software programs run from DOS.

Microsoft Introduces Sound System

Just as I was finishing this report, Microsoft announced its new Windows Sound System. This is a set of software applications and an internal sound board.

According to Microsoft, the Windows Sound System was designed specifically for the business environment, with applications that include voice annotation, proofreading and voice recognition figuring heavily into product design. In keeping with the "business" intent of the system, there's no joystick port on the Sound System's board.

The Windows Sound System has a suggested retail price of $289, or $349 when bundled with *Windows* 3.1.

The half-slot Sound System card is a 16-bit board that supports selectable sampling rates up to 48 kHz and includes a CODEC chip, Yamaha YMF262 (OPL3) FM music synthesizer and five connectors (inputs and outputs). The board will ship with headphones and a microphone.

The unique feature of the Sound System board is that it includes Analog Device's AD1848 SoundPort CODEC IC, a chip that supports audio from a variety of difference sources, including CD-quality (16-bit, 44-kHz) and telephone-quality (eight-bit, 11-kHz) sampling. The board also comes with a load of software utilities, among which are *VoicePilot*, which provides a limited number of voice-recognition commands, and *QuickRecord*, which adds vocal and other sounds to documents.

On the heels of this, Microsoft also announced release of *SoundBits*, a new software series that consists of a number of audio software collections. Aimed at making using sound in the *Windows* environment more enjoyable and fun, *SoundBits* includes digitized sound samples of one-liners, fun sound effects and a variety of musical sounds.

Three *SoundBits* collections will be available by the time you read this. *Classic Cartoons from Hanna-Barbera* brings back the childhood fun and nostalgia of The Flintstones, The Jetsons, Yogi Bear and Scooby-Doo. *Classic Hollywood Movies* features memorable dialog clips from Groucho Marx, Humphrey Bogart, Cary Grant and some of the characters from The Wizard of Oz, among others. *Musical Sounds from Around the World* provides rare cuts of international music ranging from harmonicas to violins to African drums and Andean pan pipes. Each *SoundBits* collection has a suggested retail price of $39.95.

Windows Sound System, $289; $349.00 Bundled With *Windows* 3.1
SoundBits Collections, $39.95 Each Collection
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
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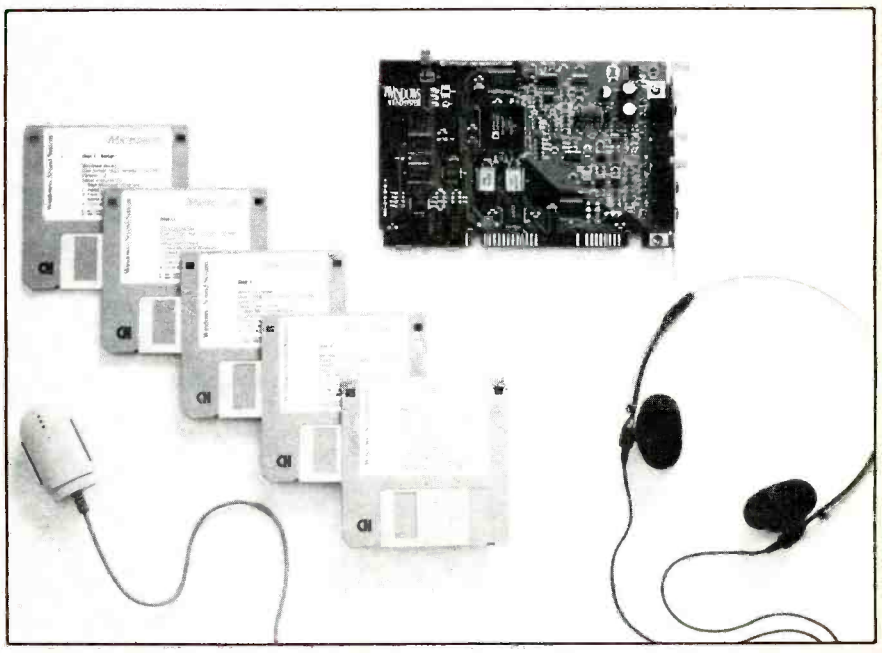
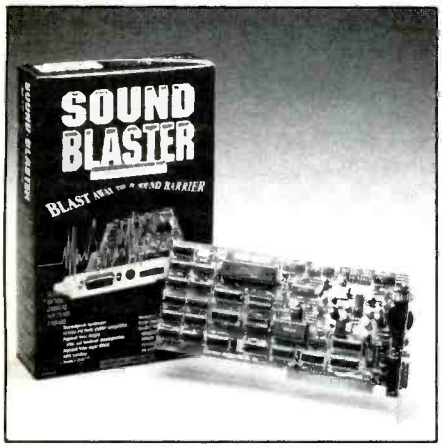


As of this writing, Covox's *Windows* drivers are shipping and can be downloaded from the company's BBS (503-342-4135). Covox is converting its other software and utilities to run under *Windows* as well. These should be ready by the time you read this. Contact Covox directly to check availability.

Creative Labs SoundBlaster ($230)



One of the original sound cards to make its way onto the PC scene, the three-quarter-length SoundBlaster, has become the *de-facto* standard for PC audio in the DOS environment, and it was the only sound card directly supported by Multimedia Extensions 1.0 for *Windows* 3.0.

Longevity for hardware peripherals in the microcomputer industry depends largely on support for the device by software developers. SoundBlaster is unquestionably the most-supported audio card, as evidenced by the thousands of applications and recreational titles that access its audio capabilities.

SoundBlaster plugs into an eight- or 16-bit slot. The heart of the board is Yamaha's 3182 synthesizer chip, which delivers 11-voice FM sound. Older versions of SoundBlaster are about 2" longer than the current version and sport only one audio input jack, as opposed to the two microphone and line-input jacks on the newer model. The older model uses more discrete components, which requires more surface area than the tight integration used on the newer model. Both models, however, have a sticker that bears the legend "FM1312" covering the top of the 3812 chip.

Jumpers are provided for selecting port address of either 220 (default) or 240. Likewise, shunting pairs of pins with a jumper cap changes the IRQ setting from the default 7 to 2, 3 or 5, if needed.

In addition to the input already mentioned, the card's mounting bracket provides access to a thumbwheel volume control, the subminiature audio output jack and a 15-pin D-type connector for attaching an analog joystick or optional MIDI connector box (circuitry for an MPU-401 MIDI interface in UART mode is built into the board itself).

SoundBlaster comes with *FM Intelligent Organ*, a program that's very easy to use and lets you compose and play compositions directly from a PC keyboard or an attached MIDI device. Included is *Talking Parrot*, a program that displays on-screen a gaudily-colored parrot that mimics speech, talks back and makes wisecracks to passersby (an AT-class or better machine is required for proper program execution). The parrot's digitized voice has a markedly "pigeon English" accent, which is good for evoking a laugh or two with some of its erroneous pronunciations and misplaced emphasis.

Voxkit is also included in the basic package and wraps up a well-rounded assortment of sound- and voice-development tools that permit recording, compressing, editing and playback of digitized sounds. Since SoundBlaster supports DMA transfer, sound files of any length up to available capacity of the hard or floppy disk being used.

Required *Windows* drivers and DLLs are also provided. Hence, you can take advantage of the board's sonic capabilities from the DOS prompt or within *Windows* 3.1 or 3.0 with Multimedia Extensions 1.0.

SoundBlaster is the sound card that started it all for lots of PC users. It continues to be a strong seller and a good choice for adding sound for both DOS and *Windows* applications.

Media Vision ThunderBoard ($179 for *Windows*; $169 for DOS)

Media Vision's half-length Thunderboard comes in two flavors: DOS and *Windows*. These are separate entities, each in its own distinctive packaging. The ThunderBoard card is physically the same in both versions, but accompanying software and drivers are different.

ThunderBoard requires only an eight-bit slot for installation. A six DIP-switch bank is utilized for setting DMA channels, and a four-pair jumper block is used to select IRQ 2, 3, 5 or 7. On the card's mounting bracket are a thumbwheel volume control, miniature phone jacks for audio input and output and a 15-pin joystick-port connector.

Both DOS and *Windows* versions support eight-bit digital-audio recording and playback from 2 kHz to 22 kHz and feature dynamic filtering to reduce noise. The sound source for ThunderBoard is a Yamaha 3812 (OPL2) synthesizer chip that produces 11 frequency-modulated voices. In addition to a manual volume control, agc is built in to further improve recording quality by reducing overload distortion.

ThunderBoard is capable of realtime hardware compression at a 2:1 ratio and realtime hardware decompression at ratios of 2:1, 3:1 and 4:1. Software compression/decompression at 2:1, 3:1 and 4:1 is also supported so that large sound files can be compressed and expanded on the fly to conserve disk space. As with any compression algorithm, the greater the compression factor, the greater the sound-quality deterioration, although the 2:1 compression ratio yields very acceptable sound with either ThunderBoard version.

The real difference between the DOS and *Windows* versions is the software that accompanies the hardware. The DOS version comes with *Thunder Master*, a utility program for recording, editing and playing sound files. The program is straightforward to use, and on-line help is available if needed.

With *Thunder Master*, you can record and play back sound files of any length since DMA transfer is supported. Sound file length is limited only by available disk space. The Sound Editor feature of the program lets you edit and enhance recordings, and quite a bit of control is afforded by it. Available modifications include adding echo, reversing a sample or section thereof, increasing/decreasing playback speed, changing sample rates in 1-kHz increments from 4 kHz to 22 kHz, changing volume and mixing prerecorded sound files.

For DOS-based software, *Thunder Master* does a lot and does it well. A games sampler software assortment is included to get you started using ThunderBoard right out of the box. This includes special versions of *Nova 9, Lemmings, Lexi-Cross, Rex Nebular* and *Goblins* and, on specially marked boxes, *F-15 Strike Eagle*.

ThunderBoard for *Windows* comes with drivers and DLLs need for *Windows*, Lotus *Sound* (OLE-enabled sound recorder utility), *Sound Forge* (fairly sophisticated waveform sound editor), *At Your Service* (talking *Windows* calendar and scheduler), *Monologue* (*Windows* text-to-speech converter) and *Pocket Recorder* (simplified "down-and-dirty" recorder/playback utility for quickie sound bytes). MIDI music files can also be played through ThunderBoard's FM synthesizer via the *Windows* Media Player accessory.

Since ThunderBoard for *Windows* also supports all PC games for DOS and *Windows*, this is the versions to go for if you think you'll be upgrading to *Windows* in the near future. You can also use the DOS version under *Windows*, but you have to obtain the drivers and other *Windows* sound utilities yourself. In either version, ThunderBoard is a good, moderately priced means of adding sound and music to your PC.

Internal 16-Bit Sound Cards

Creative Labs SoundBlaster Pro ($300)

Using the original SoundBlaster as a starting point, SoundBlaster Pro takes a good thing and makes it better by expanding the capabilities of the board and adding some additional features. This three-quarter-length board, like the original monophonic version that used only a single chip, utilizes a pair of Yamaha 3812 FM synthesizer chips to produce 22 voices of synthesized sound (11 voices per stereo channel). Like the mono version, both of these chips wear the "FM1322" sticker that mask their true identity.

SoundBlaster Pro mounts in a 16-bit slot. It has several features that aren't found on the monophonic model. For example, a 40-pin CD-ROM interface header accommodates an internal or external CD-ROM drive from Creative Labs, Panasonic, Matsushita or any other drive that complies with the SBCD or Panasonic interfacing standards. (Note: this is not a standard SCSI interface.)

A four-pin connector on the card is used to route a CD-ROM drive's audio output through SoundBlaster Pro for mixing or processing. A pin header is provided for connecting the PC's speaker signals to SB Pro, as well for enhanced audio.

On SB Pro's mounting bracket are subminiature phone jacks for microphone and line input, a thumbwheel volume control and a stereo subminiature jack for audio output. A 15-pin D-type connector allows you to attach single or dual joysticks, as well as the included MIDI cable kit.

With the exception of the Covox SoundMaster II, SoundBlaster Pro is the only other product covered here that includes all required MIDI cabling and software as part of the basic package. MIDI kits are extra-cost options with all other products reviewed here that support MIDI.

All standard configuration features are selectable by changing jumper settings. Jumpers are used to select IRQ address 2, 5 (default), 7 or 10; DMA channel 0, 1 or 3 for acknowledge/request (1 is default for both functions); and I/O address 220 (default) or 240.

The software assortment is good and includes the *FM Intelligent Organ* that came with the original SoundBlaster. Additional software include: an advanced *SB Voice Editor II* recording, editing, processing and playback utility; memory-resident *SB Talker* to convert text to speech (it isn't as good as *Monologue* that comes with the MediaVision products); *CD Music Player* to bring all the features of a home audio CD player to a PC so that you can play audio CDs on a CD-ROM drive; and a complement of *Windows* drivers, DLLs and utilities. The last includes a Mixer that lets you mix all attached audio sources (stereo DAC, stereo FM synthesis, microphone input, stereo line input, stereo CD audio and PC speaker signal).

Voyetra's *Sequencer Plus Pro* MIDI software is also provided to let you utilize the 22-voice capability of the on-board synthesizers. Though this is a "bundled" software product, it's comprehensive enough to satisfy the demands of even the more-than-casual computer musician and it's easy to use and well-documented. An *MMPlay Presentation* utility is also integrates graphic animations with the sound capabilities of the board for creating synchronized presentations.

SoundBlaster Pro represents a good value for the standard in PC sound.

MediaVision ProAudio Spectrum Plus ($199)

MediaVision's ProAudio Spectrum Plus is a three-quarter-length high-performance stereo sound card that offers plenty of flexibility and an excellent assortment of standard features. It requires a 16-bit slot and has the circuitry required to support a built-in MIDI interface, joystick port and SCSI interface.

The joystick port is ready to use right out of the box, but you need an optional MIDI Mate kit to take advantage of the MIDI interface. This break-out box "kit" connects to the card and provides a full-duplex (play and record simultaneously) MIDI port.

To utilize the card's on-board SCSI adapter, you also need an optional SCSI cable kit. Internally-mounted SCSI devices, like a CD-ROM drive, can be accommodated via the 40-pin header, which accepts a standard SCSI ribbon cable. Any external SCSI devices you use requires an external SCSI cable that attaches via the joystick port.

The 16-bit PC bus interface enhances card performance while extending the choices for interrupt and DMA settings. This is something to consider if you have lots of peripherals installed in your system. Jumpers are provided for selecting port 220 (default), 230 or 240. Another trio of jumper pins lets you select DMA sharing (the default) or non-sharing for some PCs (like the Dell 310, HD 386/33, Swan 386SX/16, PD 386/25, Microlabs 386/33 and others) that cause the board to have problems with the default setting.

Software-selectable DMA and IRQ settings make installation quick and easy. Available IRQ settings are 2 through 7 and 10 through 15. DMA choices are 0, 1, 2, 3, 5, 6 and 7.

On the card's mounting bracket are separate miniature phone jacks for microphone input, line input and audio output.

PRODUCT	Covox SpeechThing	Covox VoiceMaster Key II	MediaVision AudioPort	MicroKey AudioPort	Covox SoundMaster II
Sample/digitize sounds	No	Yes	Yes	Yes^	Yes
Playback digitized sounds	Yes	Yes	Yes	Yes	Yes
Can be used from DOS	Yes	Yes	Yes	Yes	Yes
Can be used from Windows	Yes	Yes	Yes	Yes	Yes
Attachment to PC	External (parallel port)	External (parallel port)	External (parallel port)	External (parallel port)	Internal card 3/4-length
Slot required	None	None	None	None	8-bit
Microphone input	No	Yes	Yes	Yes	Yes
Microphone included	No	Yes*	No	Yes	Yes*
Line input	No	Yes	Yes (Mic. port)	Yes (Mic. port) (attenuating adapter included)	Yes
Built-in Speaker	No	Yes	Yes	No	No
External speaker included	Yes	No	No	No	Yes
Patch cables included	No	No	No	No	No
Ear/headphones included	No	Yes*	No	Yes	Yes*
Audio Output Jack	Yes	Yes	Yes	Yes	Yes
Manual Volume Control	Yes (on speaker)	Yes	Yes	No	Yes
Power	Batt./DC adapter	DC Adapter	Batt./DC adapter	DC adapter	PC exp. slot
Power Adapter included	Yes	Yes	Yes	Yes	N/A
Built-in FM Synthesizer	No	No	Yes	No	Yes
Synthesizer Chip	None	None	Yamaha 3812 (OPL2)	None	Yamaha 3812 (OPL2)
AdLib compatible synthesize	No	No	Yes	No	Yes
Mono/Stereo Output	Mono	Mono	Mono	Mono	Mono
# of Synth voices	0	0	11	0	11
MIDI Capable	No	No	No	No	Yes
MIDI connectors included	N/A	N/A	N/A	N/A	Yes
Joystick port	No	No	No	No	No
Sample sizes	8-bit	8-bit	8-bit	12-bit	8-bit
Playback sample rates (DAC)	4-44	4-44	2-22kHz	3.5-44.1	4-44kHz
Record sample rates (ADC)	N/A	4-25kHz	2-22kHz	3.5-44	4-22kHz
Output Power	1 Watt	1 Watt	1/2-Watt	1/2-Watt	1 Watt
Mfg. Sugg. Retail	$99.95	$239.95	$199.00	$295.00	$229.95

^a playback-only version (no recording capability) of the MicroKey Audioport is also available for $195 list

Covox Voice Master Key	Creative Labs SoundBlaster	MediaVision ThunderBoard (DOS & Windows)	Creative Labs SoundBlaster Pro	MediaVision ProAudio Spectrum Plus	MediaVision ProAudio Spectrum 16	MediaVision Thunder & Lightning (Sound + Super VGA)
Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	DOS version	Yes	Yes	Yes	Yes
Yes	Yes	Windows version	Yes	Yes	Yes	Yes
Internal card 1/2-length	Internal card 3/4-length	Internal card 1/2-length	Internal card 3/4-length	Internal card 3/4-length	Internal card 3/4-length	Internal card 3/4-length
8-bit	8-bit	8-bit	16-bit	16-bit	16-bit	16-bit
Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes*	No	No	No	No	No	No
Yes	Yes	Yes (Mic. port)	Yes	Yes	Yes	Yes (Mic. port)
No	No	No	No	No	No	No
Yes	No	No	No	No	No	No
No	Yes	No	Yes	No	No	No
Yes*	No	No	No	No	No	No
Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	No	No	Yes
PC exp. slot	PC exp. slot	PC exp. slot	PC exp. slot	PC exp. slot	PC exp. slot	PC exp. slot
N/A	N/A	N/A	N/A	N/A	N/A	N/A
No	Yes	Yes	Yes	Yes	Yes	Yes
None	Yamaha 3812 (OPL2)	Yamaha 3812 (OPL2)	2 - 3812 (OPL2)	YMF262 (OPL3)	YMF262 (OPL3)	Yamaha 3812 (OPL2)
No	Yes	Yes	Yes	Yes	Yes	Yes
Mono	Mono	Mono	Stereo	Stereo	Stereo	Mono
0	11	11	22	20	20	11
No	Yes	No	Yes	Yes	Yes	Yes
N/A	No (optional extra)	N/A	Yes	No (optional extra)	No (optional extra)	No (optional extra)
No	Yes	Yes	Yes	Yes	Yes	Yes
8-bit	8-bit	8-bit	8-bit	8-bit	8, 12, 16-bit	8-bit
4-44	4-44kHz	2-22kHz	4-44kHz	4-44kHz	2-44kHz	2-22kHz
4-25kHz	5-12kHz	2-22kHz	4-44kHz	4-44kHz	2-44kHz	2-22kHz
1Watt	4 Watts/channel	2 Watts	4 Watts/channel	4 Watts/channel	4 Watts/channel	4 Watts
$199.95	$229.95	DOS = $169.00 Windows = $179.00	$299.95	$199.00	$299.00	$349.00

No manual volume control is provided, since this is a software-controlled function. A 15-pin D-type connector on the bracket lets you attach an analog joystick or an optional MIDI Mate kit to the card. This port also provides for connection of external CD-ROMs, as mentioned earlier.

The sound source for ProAudio Spectrum Plus is a Yamaha YMF262 (OPL3) FM synthesizer chip that provides 20 voices for synthesizing music and sound effects. MIDI files can also be channeled through the synthesizer for playback without the need for an external MIDI device.

Also provided is a four-pin connector for channeling audio output from a CD-ROM drive through the board for additional processing and mixing. This is a very convenient feature because it allows all of the PC's audio to emanate from one pair of speakers, rather than requiring a separate pair for sound board output and another pair for CD-audio.

MediaVision packs a rich assortment of software utilities that enable you to exploit the card's potential from DOS as well as *Windows*. The *Stereo Studio F/X* waveform sound editor features easy access to all record, playback, edit, cut and paste functions through a GUI. You can record sounds directly from a microphone, CD or another source and add such effects as echo, reverberation and envelope shaping to alter the original file.

Included *SP Spectrum* software provides a reasonably powerful MIDI sequencing program that lets you compose and play back music using the card's synthesizer. Though it also works well with external MIDI devices, if you have serious MIDI musical requirements you'll want a more-powerful dedicated program, such as the Passport Designs software that I'll review next month. A mixer utility lets you set volume levels for CD-audio, digital audio (sampled sound), FM synthesized audio, external line input, microphone input and PC speaker input.

A jumper on the board lets you route PC speaker sound through this speaker as well. The mixer uses familiar slide-type controls for adjusting individual left- and right-channel volume for each device, as well as a master volume control.

TrakBlaster Pro is a music utility that provides a four-track scope, spectrum analyzer and left and right VU meters.

Pro Speech is a text-to-speech synthesizer that works surprisingly well, once your ear becomes accustomed to its synthesized pronunciations.

Audio Mate is a DOS-based multimedia application that lets you add CD-audio, digital sound effects, stereo synthesized audio and MIDI to existing DOS files. Autodesk *Animator/Pro*, *Harvard Graphics* and other popular applications are supported, and you can even add sounds to your .BAT and .EXE files with this utility.

A rich assortment of MIDI songs, digital sound effects and four-track music files are included, as are all drivers and DLLs for *Windows* 3.1 and 3.0 with Multimedia extensions.

MediaVision ProAudio Spectrum 16 ($299)

The only device covered here that features a true 16-bit linear DAC, the ProAudio Spectrum 16, is designed to meet the demands of high-end users who want superior PC audio.

Physically, the Spectrum 16 is very similar to its sister, the Spectrum Plus. On its metal mounting bracket are miniature phone jacks for microphone and line inputs and a stereo output. On the bracket is also a 15-pin joystick/expansion connector. The board sports a 40-pin SCSI connector for attaching a ribbon cable to mate an internal SCSI device and four-pin connectors for CD-audio, routing PC-speaker sound and auxiliary audio input (the latter isn't present on the Spectrum Plus).

The principal distinction of the Spectrum 16 is its 16-bit 44-kHz stereo sound that yields incredibly pure and clean audio. MediaVision devoted lots of attention to shielding the circuitry and adding dynamic filtering to eliminate noise.

Sixteen-bit stereo sampling (linear ADC) as well as 16-bit stereo playback (linear DAC) are supported, and MediaVision touts the board as being capable of recording CD-quality (16-bit, 44-kHz) recordings. I'll attest that digitized music I recorded directly from an audio CD through the mixer utility was virtually indistinguishable from the original CD music on playback. Without doubt, the Pro Audio Spectrum 16 does, indeed, have the best sound of all the products covered here.

Eight-, 12- and 16-bit PCM sampling from 2 kHz to 44 kHz in stereo is possible, along with user-programmable dynamic filtering in the 4-Hz-to-20-kHz range. No manual volume control is provided. Software permits master volume adjustment from 0 to −62 dB in 1-dB increments. The input mixer also provides volume control from +1 to −60 dB in 2-dB increments.

Dynamic range and signal-to-noise ratings are 90 dB for synthesized and mixed audio, sampled audio and PCM. Total harmonic distortion is only 0.05% for a frequency response of 30 Hz to 20kHz at ±3 dB. If a better-sounding audio card exists, I've yet to hear it!

As with Spectrum Plus, to take advantage of the MIDI or SCSI features supported by Spectrum 16 you'll have to purchase an optional MIDI Mate for $69.95 or SCSI cable kits for less than $50. The SCSI interface built into the board is capable of 690K-bytes-per-second transfer rates. Hence, it's capable of driving virtually any multimedia-capable CD-ROM drive and related applications, including those with full-motion video, without a problem.

The user manual is very well-written and extraordinarily comprehensive in coverage. Excellent organization makes finding help on a particular topic a painless procedure. The troubleshooting section is especially helpful in resolving DMA and IRQ conflicts, too.

The same rich assortment of software programs, utilities and sound/music files that come with Spectrum Plus is also included with Spectrum 16. However, some of the applications and utilities (like *Windows* drivers) are tweaked to take advantage of this board's 16-bit recording and playback capabilities.

If you want really superb sound along with the optional MIDI and SCSI capabilities this board supports, the ProAudio Spectrum 16 is the way to go.

Media Vision Thunder & Lightning ($349 Combination Audio/Video Board)

The three-quarter-length, 16-bit Thunder & Lightning board is a new product that was released by MediaVision in time to be

included in this guide. The product is noteworthy because it combines both audio and video on a single card for use under *Windows* 3.1.

This multi-function card combines super-VGA graphics with high-quality audio. It's capable of displaying 24-bit color up to 640 × 480 resolution from a palette of up to 16.8-million colors. Additional standard and enhanced VGA modes up to 1,024 × 768 in 256 colors are also supported, as are 15- and 16-bit color (800 × 600 is the maximum resolution, but the 16.8-million color palette is active in these modes). A comprehensive set of drivers for *Windows* and popular application packages like *AutoCAD*, GEM, *Ventura Publisher* and others are included with the hardware.

The board is very densely populated, with a Yamaha 3812 (OPL2) 11-voice FM synthesizer as its sound center. On its mounting bracket are a thumbwheel volume control, miniature phone jacks for audio input and output and a 15-pin video connector. A 10-position DIP switch lets you enable/disable various audio features and select I/O addresses. A four-pin header routes the PC's speaker audio through the Thunder & Lightning board.

A 15-pin header mates to an included ribbon cable that terminates with a standard IBM joystick port on a second mounting bracket. This port also doubles as the MIDI connector for attaching MediaVision's optional $69.95 MIDI Mate breakout box (the T&L board has MIDI MPU-401/UART mode circuitry built in). If slots are at a premium in your machine and you don't intend to use a joystick or an external MIDI device, you don't have to install the ribbon connector and second mounting bracket.

A 26-pin VGA feature connector mounted on the board accommodates another video card for special applications that support tandem video processing.

Jumper-pin headers are also used to select IRQ, DMA request/acknowledge channels and MIDI interrupts. Available audio interrupts are 2, 3, 5, 7, 10, 11, 12 and 15. Available audio DMA channels are 0, 1 or 3. MIDI interrupt can be 2, 3, 5, 7, 10, 11, 12 or 15. With so many choices available, there should be no problem finding a setting that's compatible with any other installed peripherals.

The board's audio amplifier outputs 4 watts into a 4-ohm load. Frequency response is 35 Hz to 10 kHz. The audio section has all of the same features and functionality of ThunderBoard for *Windows*. It's guaranteed to be fully SoundBlaster-, ThunderBoard- and AdLib-compatible. (Though AdLib is no longer in business, the popularity of its sound boards has made it one of two standards, along with the SoundBlaster, for manufacturers to make their sound boards and other products to be compatible with.)

The included software bundle consists of Lotus *Sound, Sound Forge for Windows, At Your Service, Pocket Recorder*

and *Monologue for Windows* (see the ThunderBoard review for more detail on this software). As a special bonus, a working sample demo of Passport Designs *Master Tracks Pro MIDI Sequencer for Windows* and an assortment of MIDI song samples are included.

Thunder & Lightning does, indeed, provide a viable single-slot solution for adding both audio and high-end video capabilities to a PC system.

In Closing

Be with us next month, when I'll tell you about no-hardware alternatives to implementing sound on your PC. I'll discuss a range of software you can use to inexpensively achieve this aim and give summary reviews of some really interesting software packages I've used for this purpose and to expand upon the abilities of sound boards. As sound becomes as standard a feature on the PC as a mouse now it, prices for sound boards will probably drop and their capabilities increase. Getting started now means that you'll be a step ahead when sound finally—and inevitably—does become a routine part of daily computing.■

Tom Benford

Names & Addresses

SpeechThing, $99.95
Voice Master Key, $199.95 Bus Model
Voice Master Key System II, $239.95 Parallel Model
SoundMaster II, $229.95
Covox Inc.
675 Conger St.
Eugene, OR 97402
Tel.: 1-503-342-1271
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SoundBlaster, $229.95
SoundBlaster Pro, $299.95
Creative Labs, Inc.
2050 Duane Ave.
Santa Clara, CA 95054
Tel.: 1-408-986-1461
CIRCLE NO. 120 ON FREE INFORMATION CARD

MediaVision AudioPort, $199
ThunderBoard, $169 (DOS Version)
ThunderBoard, $179 (*Windows* Version)
ProAudio Spectrum Plus, $199
ProAudio Spectrum 16, $299
Thunder & Lightning (Sound & Super-VGA), $349
MediaVision Inc.
47221 Fremont Blvd.
Fremont, CA 94538
Tel.: 1-800-348-7116
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MicroKey AudioPort, $295 Record/Play, $195 Play-Only
Video Associates Labs, Inc.
4926 Spicewood Springs Rd.
Austin, TX 78759
Tel.: 1-800-331-0547
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SBC Applications
Conclusion

Using input capture to turn the MAG-11 SBC into an accurate digital thermometer with binary display

Last month in Part 1 of this article, I introduced you to MAG-11's binary output and how to use its D/A converter to produce a digital voltmeter with binary display and a photometer with bargraph display. This time out, I introduce you to MAG-11's input-capture feature and detail how to use it to make an accurate binary-display thermometer.

Using Input Capture

In the past, when data like voltage, temperature, pressure, etc., was input into an MPU-based circuit, one instinctively reached for a data book on A/D converters. With the HC11's advanced timer, it's often easier to input information using its input-capture capabilities at pins 6, 7 and 8 (MC68HC11A1P) than using an external or even internal A/D converter. The built-in binary-display thermometer, contained in MAG-11DIAG firmware, makes use of this feature. Now let's look at the concept of input capture and how it can be used to measure temperature.

Both input-capture and output-compare features make use of the HC11's timer. The concept of this timer is almost trivial, but it's a complex device. One look at its block diagrams in Fig. 10-1 and Fig. 10-3 in the *M68HC11 Reference Manual* will convince you of this. Figure 5 here illustrates the Main Timer System Block Diagram.

In essence, the timer is a free-running 16-bit counter with a four-stage programmable prescaler and an overflow function that allows software to extend the timer's range. The basic clock is the MCU's E clock. With a 4-MHz crystal, the E clock is 1 MHz. The programmable prescaler divides this E clock by 1, 4, 8 or 16; 1 is the default value, chosen automatically after a system reset.

From the prescaler, this clock then goes to the 16-bit free-running counter, which starts from a count of $0000 after reset and then counts up continuously. Nothing, except perhaps if someone steps on the board or hits the RESET switch, stops it while the MCU is in normal mode. You can read this counter at any time.

The contents of the timer counter are in the TCNT register at $100E and $100F. It's important to read this register with only a double-byte read instruction like LDD or LDX. If you try to read this register with a single-byte read instruction, you'll likely get errors associated with the data. When the register reaches its maximum count of $FFFF, the counter rolls over to $0000, sets an overflow flag (bit 7 of TFLG2 at $1025) and continues counting.

The basic concept of input capture is simple. All it does is use the timer to measure the length of a portion of an input waveform. The input-capture function includes edge-detection logic; so the the time between successive rising edges, successive falling edges or any edge can be determined. Since f = 1/T, you determine instantaneous frequency at the same time.

You can configure the MC68HC11A1P's three input-only pins for input capture. They're on Port A and are PA0/*IC3* pin 8 (bit 0 of Port A or Input Capture 3), PA1/*IC2* pin 7 and PA2/*IC1* pin 6. We'll concentrate on PA2/*IC1* pin 6, since it's used by MAG-11's built-in binary thermometer. The other input-capture pins perform identically.

Three registers are used by MAG-11's binary thermometer:

TIC1. Input Capture 1 Register stores the value of the 16-bit free-running counter at the time an input-capture occurs. It isn't affected by reset and can't be written by software. It isn't shown here because it can be viewed as two read-only registers located at $1010 and $1011. Normally, TIC1 is read with an LDD or other double-byte instruction.

TCTL2. Timer Control Register 2 ($1021) enables the capture input and determines whether capture occurs on a falling or rising edge or both (see Fig. B). Table 4 details the significance of the various bits.

The other register used by the Binary Thermometer is TFLG1 (Timer Interrupt Flag Register 1; Fig. C), which indicates the occurrence of timer system events and by both the input-capture and the output-compare systems. The Binary Thermometer makes use of bit 2, Input Capture 1 flag.

0CxF. This Output Compare x Flag bit is set each time the timer counter matches the output-compare Register x value. This bit is cleared by a write of 1; a 0 write has no effect.

ICxF. This Input Capture x Flag is set each time the selected active edge is detected on the ICx input line. As in the OCxF, this bit can be cleared only by a write of 1.

The sensor circuit is a simple inverter astable multivibrator. With R_{TH} in the circuit, the period decreases as the temperature rises. It's approximately 2.2RC, where C is 0.1 μF and R is the combination of the *R5* and R_{TH} parallel and *R6* and *R19* serial networks. (Exact frequency depends on the type of inverter and IC technology used.) The length of the oscillation period is

	7	6	5	4	3	2	1	0	
	0	0	EDG1B	EDG1A	EDG2B	EFG2A	EDG3B	EDG3A	TFLG2 $1021
Reset	0	0	0	0	0	0	0	0	

Fig. B. Timer Control Register 2 ($1021).

	7	6	5	4	3	2	1	0	
	OC1F	OC2F	OC3F	OC4F	OC5F	IC1F	IC2F	IC3F	TFLG1 $1023
Reset	0	0	0	0	0	0	0	0	

Fig. C. Timer Interrupt Flag Register 1.

made more linearly related to the temperature with *R5*.

After adjustment, the multivibrator's output period at 0F is 2,503 μs, or 2,307 cycles with a 921-kHz clock. (With a 1-MHz clock, exact figures are slightly different, but the basic theory is identical.) Each cycle corresponds to 1 ° F, and each decrease (in cycles) of period length corresponds to an increase of 1 ° F.

If the data was used directly by the display, it would appear nonsensical because as temperature increases, the displayed value would decrease. This problem is simply corrected by complementing the data and then subtracting 63,228 (65,535 − 2,307) from the complement. The partial program in Listing 5 was taken directly from the assembly-language listing for MAG-11DIAG. Its only difference is that a few more comments (preceded by *) have been added for more clarity.

Listing 5 is included here for instructional purposes only and doesn't show subroutines. Subroutine names are descriptive of their function: JSR CLRLED, simply turns off all LEDs, and JSR DLY500 causes a delay of about 500 ms. MAG-11DIAG software automatically executes this program when positions 1 through 4 and 6 through 8 of *S1* set to OFF and position 5 is set to ON.

Listing 5 should be meaningful if you're familiar with 6800-series MPUs. We'll briefly look at the BRCLR 0,X -$04 * instruction, which is new to the 68HC11. BRCLR is BRanch if bit(s) CLeaR. Lets see what BRCLR 0,X -$04 * does.

Here, 0,X means index addressing is being set with a 0 offset (the address is contained in the index register). In our example, this is the address of the TFLG1 register, since we previously stored this address in the index register.

Next, -$04 is the mask (in binary it's 0000 0100). This instruction causes a branch if the mask bit at the address of interest is clear; otherwise, the program continues.

The * in this instruction is interpreted by the assembler to branch to the current value of the program counter. The program continues looping until bit 2 of the TFLG1 register is set, indicating a capture has occurred.

Table 4. Significance of Various Bits for TCTL2

EDG1B	EDG1A	Configuration
0	0	Input Capture 1 disabled
0	1	Capture on rising edges only
1	0	Capture on falling edges only
1	1	Capture on either rising or falling edge

The 1 in EDG1B and EDG1A refers to Input Capture 1; 2 and 3 have similar meanings.

Practical Aspects Of the Thermometer

To run the binary thermometer, you must have an EPROM with MAG-11DIAG firmware in the EPROM plugged into the *U7* socket. To operate the thermometer, set position 5 of *S1* to ON and all other positions to OFF. (Of course, if position 9 is also OFF, MAG-11 is in its low-power invisible mode and all but *LED11* are always off.) Press the RESET switch.

After a few seconds, the binary thermometer starts running. Because 3.6864-MHz crystal was originally used, the E clock ran at about 921.6 kHz and a 74HC14 Schmitt-trigger hex inverter was used, values chosen for *R5, R6* and *R19* are acceptable. However, using a 4-MHz crystal and a 74HC14 prevents calibration of the thermometer with the values shown. (If you change the value of *R19* to 6,040 ohms, you can then calibrate the thermometer.)

If you use a 74HCT04 as *U14*, you can calibrate the thermometer with the resistor values shown, but only if you use a 4-MHz crystal. The reason for this is that the 74HCT04 provides a slightly shorter period waveform. For calibration, set *R6* so that the display shows the temperature of T_{TH} in binary notation. For instance, if the temperature is 72 ° F, adjust *R6* for a display of 0100 1000 (64 + 8 = 72).

More Input Capture

A simple application is use of the input-capture pins as a general-purpose input, even if the input-capture function is enabled. To do this, simply read Port A ($1000). Read bit 0 for logic-level data at pin 8, read bit 1 for data at pin 7 and bit 2 for pin 6.

One possible application for the input-capture pins is to use them in a robot, where pin 6, 7 or 8 connects to a front "bump" sensor that causes the MCU to issue a "back-up" command to the main drive motor if the robot bumps into something. Another possibility is in an HC11 used in an agricultural weather-monitoring instrument, where an input-capture pin could be connected to a sensing circuit so that

it can be used to record the start and end of a critical wetting period.

A somewhat more sophisticated use for the input-capture pins is as a flexible interrupt input. To enable masked interrupt structure, you must clear the I bit in the CCR (Condition Code Register). It's automatically set after reset. Additionally, you must set the appropriate control bit in the TMSK1 ($1022) register to generate a hardware interrupt request whenever the corresponding ICxF bit is set to 1 (see Fig. D). Before leaving the interrupt service routine, clear the ICxF bit by writing to the TFLG1 register.

For an interrupt request to occur at pin 6 of *IC1* (PA2), bit 2 (IC1I) of the TMSK1 register must be set. Interrupt requests for the other pins are similarly enabled. You can individually configure pins 6, 7 and 8 as an edge-triggered interrupt with its own interrupt vector. You can also specify the type of edge that causes an interrupt.

Referring back to Table 4 and register TCTL2, for an interrupt occurring at pin 8 (IC3), the interrupt vector is $FFEA and $FFEB; for pin 7 (IC2), it's $FFEC and $FFED; and for pin 6 (IC1), it's $FFEE and $FFEF. Recall that the interrupt vector is the address that loads into the program counter when the respective interrupt occurs.

Normally, a programmer places the starting address of the interrupt service routine at the address of the interrupt vector. For example, let's suppose you're designing a cuckoo clock that pops out a bird from its house and cries "cuckoo" every hour and vocally tells you the weather outside and how you should dress. If you use an HC11, you connect pin 8 to a simple rain sensor that alerts the clock when it starts to rain outside.

Having detected a rain condition, you might program the clock's bird to vocalize something like: "Close that window! I don't want soggy feathers! Its raining outside!" Assuming the software for the cuckoo clock's rain routine starts at address $D000, you'd make sure $D0 is stored at address $FFEA, with $00 at address $FFEB.

Output-Compare Function

By now, you should have a glimmer of the enormous versatility of the HC11's design. For instance, the programmable timer is just one of the chip's several subsystems. The input-capture function is just one of the several peripherals that make use of the programmable timer. Moreover, there are many different ways of using the input-capture pins, considerably more than have been discussed here.

The concept of output-compare is almost trivial. As in the input-compare function, output-compare makes use of the free-running timer. However, here you set up a 16-bit "number" (up to 65,535 decimal). When a match occurs between this number and the free-running timer, a status flag is set (OCxF), an interrupt can be generated (if enabled), and timer output pins are automatically changed per software-accessible control bits.

As a simple but practical example, let's use the output-compare function to generate an accurate 1-kHz square wave. To hear this signal, breadboard the Fig. 6 circuit, which uses an optically-isolated input and an LM386 IC audio power amplifier to drive a small speaker. Connect a wire from pin 4 of *J3* to the circuit's input. Use an oscilloscope to view the signal.

Use BUFFALO's ASM line assembler to enter the program in Listing 6. Run it with the GO B650 command.

Listing 5. Thermometer With Binary Display *

```
. . . . . .
. . . . . .
*CONFIGUR TCTL2 FOR FALLING EDGE CAPTURE MODE
                LDAA            #00100000B
                STAA            TCTL2
*DELAY 1 SECOND
                JSR             DLY1S
*CLEAR ANY IC1F FLAG GOTEMP
                LDAA            #$04
                STAA            TFLG1
*BE READY TO DETECT FIRST FALLING EDGE
                LDX             #TFLG1
*LOOP HERE UNTIL EDGE WAS DETECTED
                BRCLR       *   0,X $04
*WHEN FIRST EDGE DETECTED CONTINUE
*FIRST READ TIME OF FIRST EDGE
                LDD             T1C1
*SAVE TIME OF FIRST EDGE AT FIRSTE
                STD             FIRSTE
*CLEAR IC1F FLAG
                LDAA            #$04
                STAA            TFLG1
*WAIT FOR SECOND EDGE
                BRCLR       *   0,X $04
*WHEN SECOND EDGE DETECTED CONTINUE
*FIRST READ TIME OF SECOND EDGE
                LDD             T1C1
*SUBTRACT FIRST TIME FROM SECOND TIME WITH
*DIFFERENCE IN DOUBLE ACCUMULATOR. THIS
*DIFFERENCE IS PULSE LENGTH IN CYCLES OF CLOCK 'E'
                SUBD            FIRSTE
*IF TEMPERATURE IS ABOVE 255 F BRANCH TO TOOHI
                CPD             -2050
                BLO             TOOHI
*IF TEMPERATURE IS BELOW 0 F BRANCH TO TOOLOW
                CPD             #2307
                BHI             TOOLOW
```

	7	6	5	4	3	2	1	0	**TMSK1** $1022
	OC1I	OC2I	OC3I	OC4I	OC5I	IC1I	IC2I	IC3I	
Reset	0	0	0	0	0	0	0		

Fig. D. TMSK1 Register.

```
*NOW COMPLEMENT DOUBLE ACCUMULATOR AND SUBTRACT 63,228
                COMA
                COMB
                SUBD            #63228
*ACCUMULATOR B NOW HAS TEMPERATURE IN DEGREES F FROM 0 TO 255 F
*NOW WE MAKE LED1 - LED8 INDICATE TEMPERATURE IN BINARY
                STAB            TEMPF
                LDX             #LED1
*ACTIVATE LED POINTED TO BY 'X' NXTLED
                STAB            0,X
                LSRB
*LAST LED YET?
                CPX             #LED8
*IF DONE BRANCH TO GOTEMP FOR NEXT READING
                BEQ             GOTEMP
*OTHERWISE SET UP INDEX REGISTER FOR NEXT LED
                INX
                BRA             NXTLED
*THE FOLLOWING ROUTINE SIMPLY MAKES LED8 FLASH ON AND OFF
TOOHI   JSR             CLRLED
                LDAA            #$01
                STAA            LED8
                JSR             DLY500
                CLR             LED8
                JSR             DLY500
DOAGIN          JMP             GOTEMP
*THE FOLLOWING ROUTINE SIMPLY MAKES LED1 FLASH ON AND OFF
TOOLOW  JSR             CLRLED
                LDAA            #$01
                STAA            LED1
                JSR             DLY500
                CLR             LED1
                JSR             DLY500
                BRA             DOAGIN
.....
.....
*Binary display drivers are contained in MAG-11DIAG firmware.
```

(With a Data Precision 5740 Digital Frequency meter, the output frequency measured 1,000.1 Hz when E was 1.000087 MHz.)

Two registers I haven't discussed yet are used by this example. TOC2 is a 16-bit output-compare register that simply holds the "number" you wish to compare the free-running timer with. It isn't shown here pictorially since there's no need for it. Its address is $1,018 and $1,019. Timer control register 1 (TCTL1; Fig. E) has several important control bits. Table 5 lists how the bits control Output Compare 2.

Line 1 loads the stack pointer with $50, which is a good habit to get into.

Line 2 loads the index register with $1000 so that reads and writes to HC11's registers can use index addressing when desired.

Lines 3 and 4 configure TCTL1 so that pin 2 of the HC11 toggles when a successful compare is made.

Lines 5 and 6 clear double-byte register TOC2.

Lines 7 and 8 clear the Output Compare 2 Flag in the Timer Interrupt Flag Register 1.

Line 9 loads the double accumulator with 500 decimal ($1F4).

Assuming you're using a 4-MHz crystal, the free-running timer's clock has a period of 1 μs. So if you want a 1,000-Hz output signal (1-ms or 1,000-μs period), you must toggle pin 2 every 500 ms. To do this, simply load D with decimal 500.

Line 10 adds the data in the TOC2 register to D.

Line 11 stores the result back in the TOC2 register. Line 12, the program waits until the TCNT timer register matches TOC2. When the compare is successful, the program branches back to line 7 and clears the Output Compare 2 flag and continues to run through again.

Listing 6 polls the TFLG1 register. All you have to do is change line 9 by loading D with a different number.

There are limits to how high a frequency you can generate. Unless you change bits 0 and 1 of the TMSK2 register ($1024), the longest wavelength signal that can be generated (assuming E = 1 MHz) is 2 × 65,535 μs or 0.13107 second, or 7.6295 Hz. You do this by loading D in line 9 with 65,535 decimal (FFFF hex or 1111 1111 1111 1111 binary).

What if you load D with 1 in Line 9? Is a 500-kHz signal generated? Try this and note your result. If you keep in mind that the shortest instructions (for example, NOP) take at least two cycles (2 μs) to complete, it's obvious that it isn't possible to generate a 500-kHz signal. (The instruction on line 12 alone takes 7 μs to complete.)

Practically speaking, don't try to create a signal shorter than 70 μs (f × 14,286 Hz) using a 4-MHz crystal. If you want a wavelength with a longer period, first change the TMSK2 register. If you set both bits 0 and 1 of this

Listing 6. Square-Wave Generator Using Polling

```
Line    Address
   1    B650    LDS     #0050
   2    B653    LDX     #1000
   3    B656    LDAA    #40     *OC2 PIN TOGGLES ON
                                SUCCESSFUL COMPARES
   4    B658    STAA    1020
   5    B65B    CLR     1018
   6    B65E    CLR     1019    *CLEAR TOC2
   7    B661    LDAA    #40
   8    B663    STAA    23,X    *CLEAR ANY OC2 FLAG
   9    B665    LDD     #01F4   *LOAD D WITH 500
  10    B668    ADDD    1018
  11    B66B    STD     1018
  12    B66E    BRCLR   23,X 40 B66E *LOOP HERE TIL OC2F = 1
  13    B672    BRA B661
```

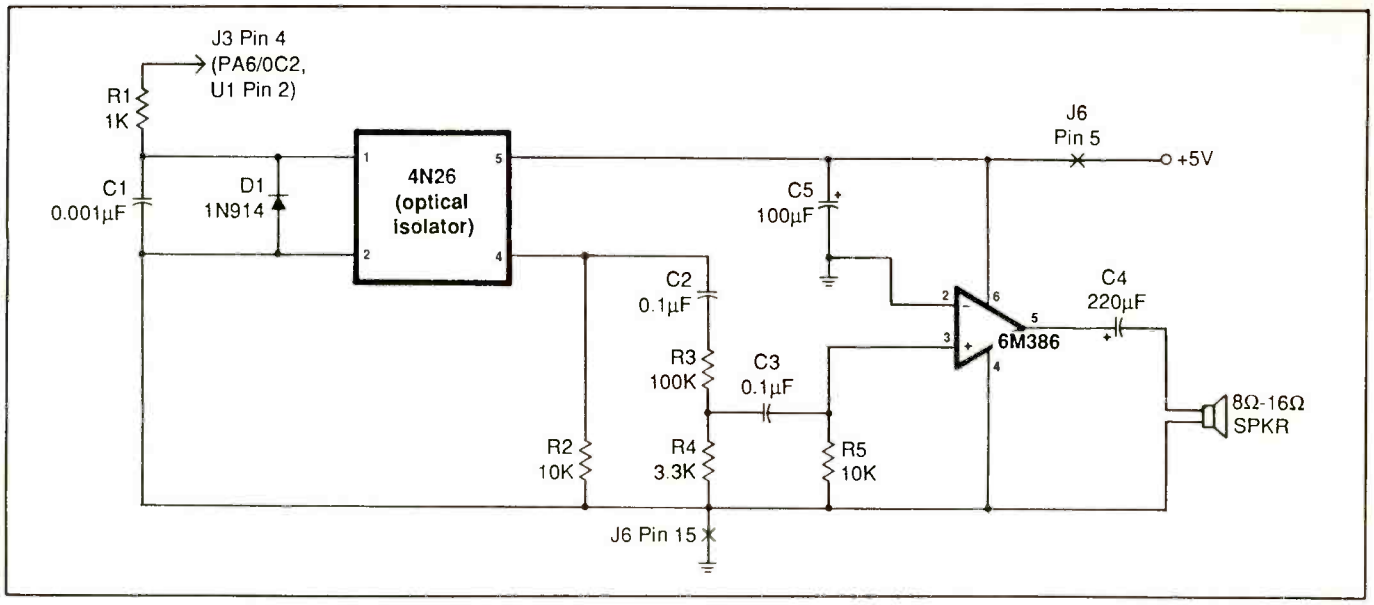


Fig. 6. MAG-11 can be programmed to generate accurate square waves. If you wish to listen to the output signal, wire this circuit and connect it to the SBC.

Table 5. How Bits Control Output Compare 2

OM2	OL2	Action Taken
0	0	OC2 Does Not Affect Pin (OC1 still may)
0	1	Toggle pin 2 of 68HC11A1P on successful compare
1	0	Clear pin 2 of 68HC11A1P on successful compare
1	1	Set pin 2 of 68HC11A1P on successful compare

	7	6	5	4	3	2	1	0	
	OM2	OL2	OM3	OL3	OM4	OL4	OM5	OL5	TCTL1 $1020
Reset	0	0	0	0	0	0	0	0	

Fig. E. The TCTL1 Timer Control Register.

register, you can produce a wavelength that's slightly longer than 2 seconds (16 × 0.13107) in duration.

Generating Square Waves

Because polled-driven software wastes CPU time, the designers of the HC11 (who must hate the thought of wasting CPU time) included a myriad of interrupts. We'll look at only the Timer Output Compare 2 interrupt here (I discussed several others in previous Installments).

The HC11's Interrupt vector assignments are shown in the left column of Table 6. However, if you use the BUFFALO monitor, these assignments aren't very useful because they're occupied by BUFFALO. Fortunately, BUFFALO provides pseudo-vectors, located in internal RAM space. (They're identical to the pseudo-vectors used by the HC11's bootstrap ROM. The only difference is that at reset, the bootstrap ROM jumps to $BF40, while the BUFFALO monitor jumps to $E000).

Refer to the right column in Table 6 for the starting address of these pseudo-vectors. These differ slightly from normal vector assignments in that they require a JMP op code (7E) to be placed before the address of your interrupt service routine.

The first step in using the OC2 interrupt is to bring it to life by clearing the I bit in the CCR register, using op code CLI and setting the OC2I bit (bit 6) in the TMSK1 register.

Listing 7 provides a 1,000-Hz signal, as did Listing 6. However, this time, instead of polling, the interrupt method is used. As before, it's shown here in a form that allows direct entry using BUFFALO's ASM line assembler, and the program resides in the HC11's EEPROM. To run this short program, enter GO B6B0. If you have the circuit connected as shown in Fig. 6, you should hear a loud, moderate-pitched sound from the speaker.

Lines 2 and 3 load the JMP op code at location $00DC, which is the pseudo-vector for Output Compare 2.

Lines 3 and 4 load the starting address ($B6A0) at address $00DD and $00DE. Thus, after an OC2 interrupt is detected, the program jumps to $B6A0, which is the starting address of the interrupt service routine.

Line 7 sets OC2 for a toggle of pin 2 on a compare match.

Line 8 clears the OC2 flag bit in the TFLG1 register.

Line 9 enables the OC2 interrupts and the CLI.

Line 10 enables the interrupts.

Lines 11 through 14 make up a pro-

Table 6. HC11's Interrupt Vector Assignments

On-Chip Normal Vector Address	Interrupt	Source Pseudo-Vector* Source Pseudo-Vector*
FFD6,D7	SCI	00C4
FFD8,D9	SPI	00C7
FFDA,DB	Pulse Accumulator (Input Edge)	00CA
FFDC,DD (Overflow)	Pulse Accumulator	00CD
FFDE,DF	Timer Overflow	00D0
FFE0,E1	Timer Output Compare 5	00D3
FFE2,E3	Timer Output Compare 4	00D6
FFE4,E5	Timer Output Compare 3	00D9
FFE6,E7	Timer Output Compare 2	00DC
FFE8,E9	Timer Output Compare 1	00DF
FFEA,EB	Timer Input Compare 3	00E2
FFEC,ED	Timer Input Compare 2	00E5
FFEE,EF	Timer Input Capture 1	00E8
FFF0,F1	Real Time Interrupt	00EB
FFF2,F3	IRQ	00EE
FFF4,F5	XIRQ	00F1
FFF6,F7	SWI	00F4
FFF8,F9	Illegal Opcode Trap	00F7
FFFA,FB	COP Fail	00FA
FFFC,FD	Clock Monitor	00FD
FFFE,FF	Reset	E000(IN ROM)

Note: All addresses are in hexadecimal.

*Starting address of pseudo-Vector used by BUFFALO monitor.

Listing 7. Square-Wave Generator Using Output-Compare Interrupter

```
Line  Instruction
 1    B680   LDS   #50
 2    B683   LDAA  #7E
 3    B685   STAA  DC
 4    B687   LDX   #B6A0
 5    B68A   STX   DD
 6    B68C   LDAA  #40
 7    B68E   STAA  1020
 8    B691   STAA  1023
 9    B69A   STAA  1022
10    B697   CLI
11    B698   NOP
12    B699   NOP
13    B69A   NOP
```

Note: After entering line 13, press LINE FEED or + —not ENTER.

```
14    B69B   BRA   B698
```

The next line starts the interrupt service routine. Press LINE FEED or + until address B6A0 shows up.

```
15    B6A0   LDD   60
16    B6A2   ADDD  1018
17    B6A5   STD   1018
18    B6A8   LDAA  #40
19    B6AA   STAA  1023
20    B6AE   RTI
```

Press LINE FEED or + instead of ENTER until address B6B0 shows up.
The next program segment places the frequency/period data at addresses 60 and 61 and then jumps to the start of the main program.

```
21    B6B0   LDX   #1F4
22    B6B3   STX   60
23    B6B5   JMP   B680
```

gram that serves as a place to wait for interrupts. (A JMP xxxx instruction can substitute for the three NOPs. You can use this instruction to lead into a more-meaningful program.)

Line 15 starts the Interrupt Service routine. It loads the double accumulator with the data (pre-stored in internal RAM at $60) for the delay time for ½ cycle.

Lines 16 and 17 add this value to the last compare value and store it back in the OC2 compare register.

Lines 18 and 19 clear the OC2 flag in the TFLG1 register before returning from the interrupt (Line 20).

Line 21 starts a short program that stores 500 decimal, or $1F4 hex (for a 1,000 μs period) at location $60. The program them jumps to $B680, where the square-wave program starts.

Interesting Programs

Listing 8 automatically sweeps the scale from about 93 Hz to nearly 9 kHz. The rate of frequency climb is determined in the third line (the LDY -300 instruction). Change the data here if you want to experiment. If you want to try this program, change line 11 of Listing 7 to jump to the start of Listing 8 as follows:

```
Line  New   Instruction
11    B698  JMP B6C0
```

Enter GO B680 to run this program from the BUFFALO monitor.

Lines 1, 2 and 3 load D with a pseudo-random number. (The original number comes from free-running timer register TCNT.)

Lines 4 through 7 reject this number if it's less than 56 decimal ($38) or greater than 4,608 decimal ($1200).

Line 8 stores this number at $0060 and $0061 if its number passes the test in lines 4 through 7. This number determines the frequency produced by the listing.

Lines 9, 10 and 11 cause a ⅓-second delay for the "note" to be heard.

Line 12 causes the program to get another number.

MAG-11 Plays Music

After loading Listing 9, running the program and listening to the "alien" sound produced for a few minutes, it becomes obvious that it isn't difficult to have MAG-11 produce computer music. Keep in mind that the length of time a note is held is determined by line 9. If you load D with $B000, the length of a note will be about ⅓ second.

The basic program to produce music is given in Listing 10. The data required to play *Old MacDonald* is given in Listing 11. Key in MEM 1100, followed by ENTER to enter this data. Use the space bar—*not* ENTER—to step the address for loading the data.

Listing 8. Square-Wave Sweep Generator

Line	Instruction		
1	B6C0	LDX	#1500
2	B6C3	STX	60
3	B6C5	LDY	#300
4	B6C9	DEY	
5	B6CB	BNE	B6C9
6	B6CD	DEX	
7	B6CE	DEX	
8	B6CF	CPX	#38
9	B6D2	BLO	B6C0
10	B6D4	BRA	B6C3

Listing 9. Produces Music

Line	Instruction		
1	B6D8	LDD	100E
2	B6DB	MUL	
3	B6DC	MUL	
4	B6DD	CPD	#38
5	B6E1	BLO	B6D8
6	B6E3	CPD	#1200
7	B6E7	BHI	B6D8
8	B6E9	STD	60
9	B6EB	LDY	#B000
10	B6EF	DEY	
11	B6F1	BNE	B6EF
12	B6F3	BRA	B6D8

This program is fun to listen to. Line 11 of Listing 7 must be altered to actually use this listing as follows: JMP B6D8. Use GO B680 to run this program.

Data FF causes a delay (lines 6, 7 and 19 through 24), and data 00 causes the program to halt (lines 5, 16, 17 and 18). The larger the number in data, the lower the pitch of the note. Note pitch is also determined by lines 3 and 9 of Listing 10.

The length of the note is determined by line 11, and the relative length of pause is determined by line 20. If you're using the MAG-11BAT battery-backup board, it would be wise to install it before entering the data in Listing 11. Because this data is stored in CMOS static RAM, it will be lost shortly after power is removed when MAG-11BAT isn't used.

If you run the program in Listing 10, you must first change line 11 of Listing 7 to JMP B7C7. Again, run the program with GO B680.

If you'd like to experiment with voice synthesis, load D in Line 11 of Listing 10 with $150 or even $100 instead of $B000. Doing this allows the program to take several hundred of these short notes to voice a word. I've briefly experimented with MAG-11 in voice synthesis, but generating speech with it seems possible.

If you do experiment with voice synthesis, vary the notes sharply. For instance, a fairly accurate "s" sound can be made with the data: F0 01 E0 05 F0 01 D0 80 01 F0 01 E0 . . . . With 100 to 300 distinct notes a second, the human ear interprets such a combination of notes as the "pink noise" of the "s" sound. Rapid alteration of frequencies is required to obtain the sound of the human voice. Some sounds, like a long "e," don't require as abrupt changes in frequency as does "s."

Its obvious considerable memory is needed for MAG-11 to vocalize a single word, with no guarantees on speech quality. However, experimenting with computerized speech is a fascinating pursuit all by itself.

Advanced I/O Pin Control

Our examples of output-compare control of pin 2 is labeled "Normal I/O Pin Control" in the *M68HC11 Reference manual*. "Advanced" methods of using OC1 are also covered. OC1 permits one output compare to control up to five pins or two output compares to control one pin. Details of using OC1 in this manner are beyond the scope of this article.

A simpler feature in the HC11's output-compare system is Forced Output Compare (Fig. F), used in some

Listing 10. Electronic Organ/Vocal Chord

Line	Instruction		
1	B7C7	LDX	#1100
2	B7CA	CLI	
3	B7CB	LDAB5	#6
4	B7CD	LDAA	0,X
5	B7CF	BEQ	B7F0
6	B7D1	CMPA	#FF
7	B7D3	BEQ	B7F4
8	B7D5	MUL	
9	B7D6	ADDD	#A7
10	B7D9	STD	60
11	B7DB	LDY	#B000
12	B7DF	DEY	
13	B7E1	BNE	B7DF
14	B7E3	INX	
15	B7E4	BRA	B7CA
press 'LINE FEED' or '$' key			
16	B7F0	SEI	
17	B7F1	NOP	
18	B7F2	WAI	
press 'LINE FEED' or '$' key			
19	B7F4	SEI	
20	B7F5	LDY	#3000
21	B7F9	DEY	
22	B7FB	BNE	B7F9
23	B7FD	INX	
24	B7FE	BRA	B7CA

Listing 11. Data for "Old MacDonald"

```
77 FF 77 FF 77 FF 90 FF 87 FF 87 FF 90 90 FF FF FF FF FF FF 65 FF 65 FF 70 FF 70 FF
77 77 FF FF FF FF FF FF 77 FF 77 FF 77 FF 90 FF 87 FF 87 FF 90 90 FF FF FF FF FF FF
65 FF 65 FF 70 FF 70 FF 77 77 FF FF FF 77 FF 77 FF 77 FF FF FF FF 77 FF 77 FF 77 FF
FF FF FF 77 FF 77 FF 77 FF 77 FF 77 77 FF FF FF FF FF FF FF FF FF FF 77 FF 77 FF 77 FF 90
FF 87 FF 87 FF 90 90 FF FF FF FF FF FF 65 FF 65 FF 70 FF 70 FF 77 77 00 00
```

Starting address is at $1100.
Note: Data reads across; press space bar for next address.

	7	6	5	4	3	2	1	0	
	FOC1	FOC2	FOC3	FOC4	FOC5	0	0	0	CFORC $100B
Reset	0	0	0	0	0	0	0	0	

Fig. F. Forced Output Compare Register.

automotive spark timing systems. Forced Output Compare enables a program to "force" a compare before a compare can occur in the "normal" way. This "force" mechanism uses the CFORC register ($100B).

To force one or more output-compare channels, write to this register with 1s in the bit positions that correspond to the channels to be forced. Thus, storing $40 at $100B "forces" a compare of OC2 at the next timer counter clock cycle. (In our examples, this would occur at the next E clock cycle, since the prescale factor for the timer system is the default value of 1. If the prescale factor was set to 16, forced compare would require 16 E clock cycles to occur.)

We've looked at, sometimes with significant myopia, most of the 68HC11's features and peripherals so far. Two peripherals I didn't mention are the Synchronous Serial Peripheral Interface (SPI) and Pulse Accumulator (PA). SPI permits communication with peripheral devices like an LCD display driver and a multi-channel D/A converter. The Pulse Accumulator can be used to count things like pieces on an assembly line or count time like the width of a pulse.

It should be obvious that the 68HC11 is "loaded." The only things you need to fully use this MCU are desire and a little skill. The HC11's design is a two-edged sword, though. Its numerous features permit you to design simplified and economical systems, but its complexity can unnerve some designers. If you persevere, you'll soon find yourself deeply enmeshed in the fascinating world of mocrocontrol. ■

Parts Availability

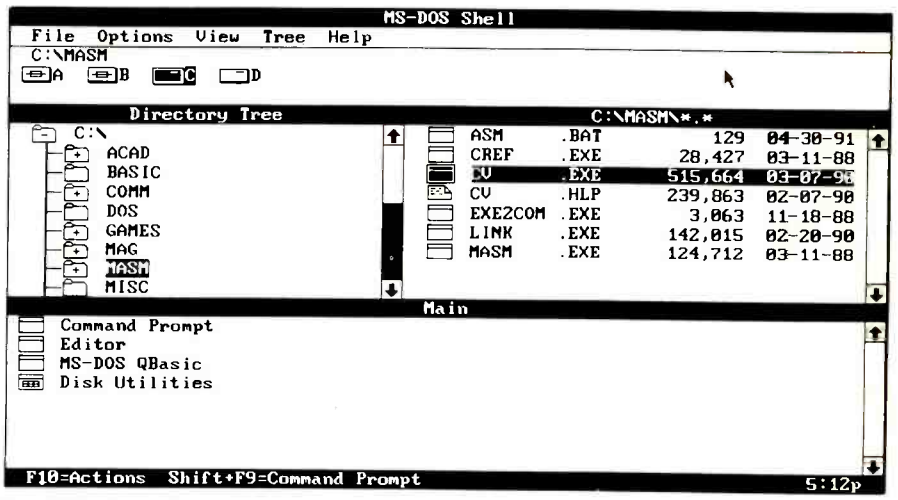
The following items are available from Magicland, 4380 S. Gordon Ave., Fremont, MI 49412: ready-to-wire double-sided MAG-11 pc board with plated-through holes, component-placement silkscreen and complete Parts List (No. MAG-11BD), $25; semi-kit with pc board and all ICs that aren't optional, including a 27C256 programmed with your choice of MAG-11DIAG or BUFFALO firmware, IC sockets, thermistor, 7.32K and 6.04K 1% tolerance resistors, loaded PC-compatible software disks with all software mentioned thus far and pc fabrication guides for MAG-11 revision c and MAG-11BAT, and a utility for printing the exposure mask using a HP LaserJet II-compatible laser printer or 100% compatible IBM dot-matrix printer (specify your choice of 3½" or 5¼") manual; and three-ring binder (No. MAG-11PKT/c), $69. Also available are: MC68HC11A1P CPU, $25; 27C256 programmed with either MAG-11DIAG or BUFFALO firmware, $12; loaded pc-compatible disk (see above), $10.

All prices include postpaid shipping in the US. Add $5 for shipments to Canada, $10 for shipments to all other countries. Deduct 15% on orders that exceed $100. Michigan residents, please add 4% sales tax.

The Shell Game

Using shells can make your computer a lot friendlier and much more likely to help you get work done instead of hindering you

Lurking in your CONFIG.SYS file is probably an innocuous-looking line that says something like: SHELL = C: \ COMMAND.COM /P /E:512. You may know that this line reserves 512 bytes for the master environment (the text you see if you type SET at the DOS prompt). Otherwise, you probably ignore this line completely. However, this line says a lot about how DOS and other operating systems work. Before it sets aside environment space, it specifies that you want to use a program called COMMAND.COM as your DOS shell. Without really thinking about it, you've defined the program you'll probably use most often while your computer is turned on.



The DOS 5.0 shell's main screen.

A shell is an unusual program. Very often, its design is crucial to the success of an operating system. In fact, in most people's minds, the shell *is* the operating system. But if you're an assembly-language programmer, you probably have a more-realistic view of DOS and what it really is.

At its heart, an operating system is a collection of services that are available to application programs. These services take care of the disk file system and other computer resources, including the keyboard and time-of-day clock. The services an operating system makes available strongly influence the applications written for it. For example, DOS's eight-character filenames give it a completely different feel from the operating systems that permit much longer filenames.

To request a DOS function, a program puts specific values into the CPU's registers, including a function-selection number. The program then transfers control to DOS, usually by invoking software Interrupt 21 hex. DOS performs the requested function, puts data and status information back into the CPU registers and returns to the application program that called it.

DOS provides a large number of services, but it's severely lacking in one area. It has absolutely no user interface. DOS itself doesn't know how to display a C > prompt. It doesn't know how to interpret or react to simple commands like DIR and TYPE, and it doesn't know how to run a program when you type its name at your keyboard. These aren't properly DOS activities at all. Instead, they're the job of the user interface shell.

When you turn on your computer, it goes through its self-tests (the POST routine), loads a bootstrap program from disk, loads and initializes the operating system and, finally, starts a user shell. The shell is then responsible for all interactions between you and the operating system. If you want to see a directory of files, for example, the shell is responsible for interpreting your request, making the necessary DOS calls to generate a list of files and putting the filenames on the screen. The only thing DOS does during this operation is pass filenames to the shell, one at a time.

Almost any program can be used as a DOS shell. If you like to experiment, format a bootable floppy disk and copy any small program onto this disk. Then create a CONFIG.SYS file on the floppy that has only a SHELL = line that defines the program as your shell. Now boot up from this floppy disk, and you'll see your chosen program instead of the DOS prompt. The program should run in the normal manner, but if you try to exit from it, you'll see a "Bad or missing command interpreter" error, and the computer will lock up.

Remove the floppy disk and re-boot from your hard drive to restore your computer to normal operation. This

little test demonstrates a shell's first responsibility: it can't end. If it does, you're left without a method of interacting with your computer.

If you try this experiment, you'll also see that COMMAND.COM, not DOS, runs your AUTOEXEC.BAT file (and all other batch files). COMMAND.COM is also responsible for maintaining the environment, including the PATH, displaying the C> prompt, reacting to your typed commands and launching other programs. Commands listed as "internal" in your DOS manual are those built into COMMAND.COM. "External" commands are any other programs available on your system, including several utilities, like XCOPY, that are shipped with DOS.

You probably know how to change the name of an external command by changing the file name. For example, many users change the name of FORMAT.COM to something else and then write a batch file called FORMAT.BAT that keeps them from accidentally formatting their hard disks. And you may have read that you can't write a program or batch file with the same name as an internal command, because such a program will never run. The point of this warning is that COMMAND.COM reads through its internal list of commands before it searches for a .COM, .EXE or .BAT file to execute.

If you really want to alter the way COMMAND.COM works and use your own DIR.BAT or DIR.EXE program, you can. All you have to do is disable the DIR command inside COMMAND.COM. If you examine COMMAND.COM with a sector editor like the one in *Norton Utilities* or *PC Tools*, you'll find a list of commands in upper-case letters. Between each command, you'll see a few nonsense characters, which you can ignore but not change. COMMAND.COM shifts any command you type to upper-case and then tries to match your command with a word in its command list. If you want to disable one of these internal commands, use your sector editor to change one or more characters in the command to lowercase. You can re-enable the command at any time by changing it back to uppercase.

You may not have a reason to alter COMMAND.COM on your personal computer, but doing so might make an office computer a lot more secure. You could, for example, disable DEL and ERASE or the COPY command. A sophisticated user will find ways of performing the same operations with various application programs, but you may keep relatively inexperienced users from accidentally destroying important files. Of course, you should make sure that you have a good backup of the original COMMAND.COM to use in case your patches cause unexpected problems.

Just because COMMAND.COM is shipped with DOS and installed as the default command interpreter, it isn't the only user shell available. Starting with MS-DOS4, MS-DOS itself incorporates the option of using its own shell to work with the OS in a visual way. The most popular replacement for COMMAND.COM is a shareware product called *4DOS* from J.P. Software (the NDOS program included with the *Norton Utilities* is an earlier version of *4DOS*).

4DOS is fully compatible with MS-DOS' and PC-DOS' COMMAND.COM and adds many new features that are absent in both of these DOSs. It includes an improved command history that lets you re-issue commands without retyping them, faster and much

more powerful batch files, many new and vastly improved commands, more-powerful aliases or macros than those available in DOS 5 and many other new features. I use *4DOS* constantly on my computer. Though I may be biased in its favor since I helped write the manual for the current version, I can honestly say that if you enjoy using a command-line interface, you might want to try *4DOS* and see whether its powerful enhancements help you get your work done.

Secondary Shells

The program defined on the SHELL = line in CONFIG.SYS is known as the primary shell because it's the first link between DOS and the user. However, it's certainly possible to start a secondary shell to install a new user interface, either temporarily or until you reboot your computer.

Both COMMAND.COM and its substitutes can be used as a secondary shell. At the DOS prompt, type COMMAND and you'll start another copy of COMMAND.COM. To prove that this really is a second copy of COMMAND.COM, redefine the DOS prompt. Then, once the new prompt is displayed, type EXIT. You'll be returned to your original copy of COMMAND.COM and its normal prompt.

You probably won't have much reason to start a second copy of the primary shell like this, but before DOS 3.3's CALL instruction, doing so was the only way to run one batch file as a subroutine of another batch program. Also, every time you "shell to DOS" from an application program, you're essentially, starting a secondary copy of COMMAND.COM.

Dozens of commercial and shareware programs call themselves DOS shells. Almost all are meant to be run as a secondary shell instead of the primary shell. They leave the work of maintaining the environment, responding to direct commands and executing AUTOEXEC.BAT to COMMAND.COM. These programs then take over the computer to provide an improved user interface.

Secondary-shell programs usually fall into two categories. One group includes programs that normally display a file list and/or directory tree and let you move a light bar or mouse cursor around the screen to select programs you want to execute. These point-and-shoot programs are often aimed at new computer users and experienced users who simply want a faster method of finding and launching programs. Probably the best-known program in this category is *XTree* in its many versions.

The other group is composed of menu programs. These shells usually let you set up a series of menus that launch favorite applications or run a subset of DOS commands, often with the help of a secondary copy of COMMAND.COM. These menu programs are excellent if you want to set up a computer for someone who has no experience with DOS. They're also good if you want to create a standard user interface for all computers in an office. And because many menu programs include password protection for some menus and many DOS operations, they can help improve the safety of data on an office LAN. One of the most-thorough menu programs I've seen is *MenuWorks Advanced*, but there are hundreds of other such programs from which to choose.

If you're thinking of trying either a point-and-shoot or menu-based secondary shell, you may want to try a shareware program before paying for a full commercial program. There are dozens, if not hundreds, of shells from which to choose on information services and bulletin boards and in the catalogs of disk resellers. Try two or three that sound interesting, and you may find one you like as well as any commercial product.

Your choice of a secondary shell will be determined largely by your tastes and the way you want to use your computer. Therefore, don't feel limited to programs suggested by others. Their tastes and requirements will probably be different from yours and even from each others'.

Shells Around Windows

If you use *Windows* 3.0 or 3.1, you use another shell. Like DOS, *Windows* is an operating environment. Also like DOS, it has no built-in way to collect and react to user commands. To use *Windows*, you need a shell program that translates whatever requests you make into *Windows* commands.

The *Windows* shell is defined in the file SYSTEM.INI in the *Windows* subdirectory. If you look at this file with a text editor or *Windows* Notepad, you'll see a line that probably states: shell = progman.exe. This line tells *Windows* to run PROGMAN.EXE (the *Windows* Program Manager) during initialization. It also tells *Windows* that when the user exits from PROGMAN.EXE, it's time to shut down *Windows* and return to DOS.

Like DOS, *Windows* can run any program as its shell. Unless you use *Windows* to run a single application, you'll want to make sure to choose a shell that can launch other programs. Those who dislike the Program Manager often choose to install the *Windows* File Manager as their shell. If you want to make the change, edit the "shell = " line in SYSTEM.INI to read: shell = winfile.exe. Then save SYSTEM.INI and restart *Windows*. If you want to use the Program Manager also, you can start it (and any other application) from the File Manager.

Of course, not everyone will want to use either the Program Manager or the File Manager as their *Windows* shell, and several developers believe they've come up with a better way to use *Windows*. Some of these programs are meant to be a primary shell, while others are intended to be used as a secondary shell, running beside the *Windows* Program Manager or File Manager.

If you want to look for a new *Windows* shell, you have a few shareware programs and many commercial programs from which to choose. Probably the most popular is the *Norton Desktop for Windows*, which integrates several utility programs with features borrowed from both the Program Manager and the File Manager. Some programs, like *New Wave* 4.0, create a completely different kind of desktop and organize your applications and files according to projects and activities, instead of directories and application groups.

Some replacement *Windows* shells, like *Windows Express*, are meant to provide a common user interface throughout an office and give the system administrator the ability to add password protection to files and applications. Others, like *WinTools*, seem aimed more at individual users and try to make *Windows* more intuitive environment to use.

Instead of calling their products *Windows* shells, distributors of these programs often call them *Windows* desktops. Some have macro commands and even agents, which are simply powerful macros that can be triggered automatically based on the time of day, particular windows appearing on the screen or specific keystrokes or mouse activity. If you're interested in these programs, make sure that the package you pick can support both universal, or system-wide, agents and local agents that appear only when you're using a specific application.

Like their DOS-shell cousins, *Windows* shells or desktops are designed to fit particular tastes, ways of working and computer expertise. Because *Windows* is much more flexible than DOS, you'll find a greater variety of programs from which to choose. However, being that few shareware *Windows* desktops are available at the present time, you probably won't have the luxury of trying several approaches before you find the one that's right for you. Instead, ask around at user-group meetings and on bulletin boards and read as many desktop reviews as possible until you find a program that seems geared to your tastes.

You may understand intellectually that DOS and *Windows* are collections of services for application programs and COMMAND.COM and Program Manager are simply the default user interfaces. But these interfaces have a lot to do with the way you feel about these two operating systems. A new shell or desktop will alter your feelings, perhaps dramatically. When you've found the right shells for your way of working, you'll enjoy these operating systems much more and won't be willing to return to the built-in defaults.

Part of the power of DOS and *Windows* is that they permit and even encourage development of new shells. When you take advantage of this power, you'll probably find that your computer is a lot friendlier and much more likely to help you get your work done instead of hindering you. ■

CYDAT Goes Parallel

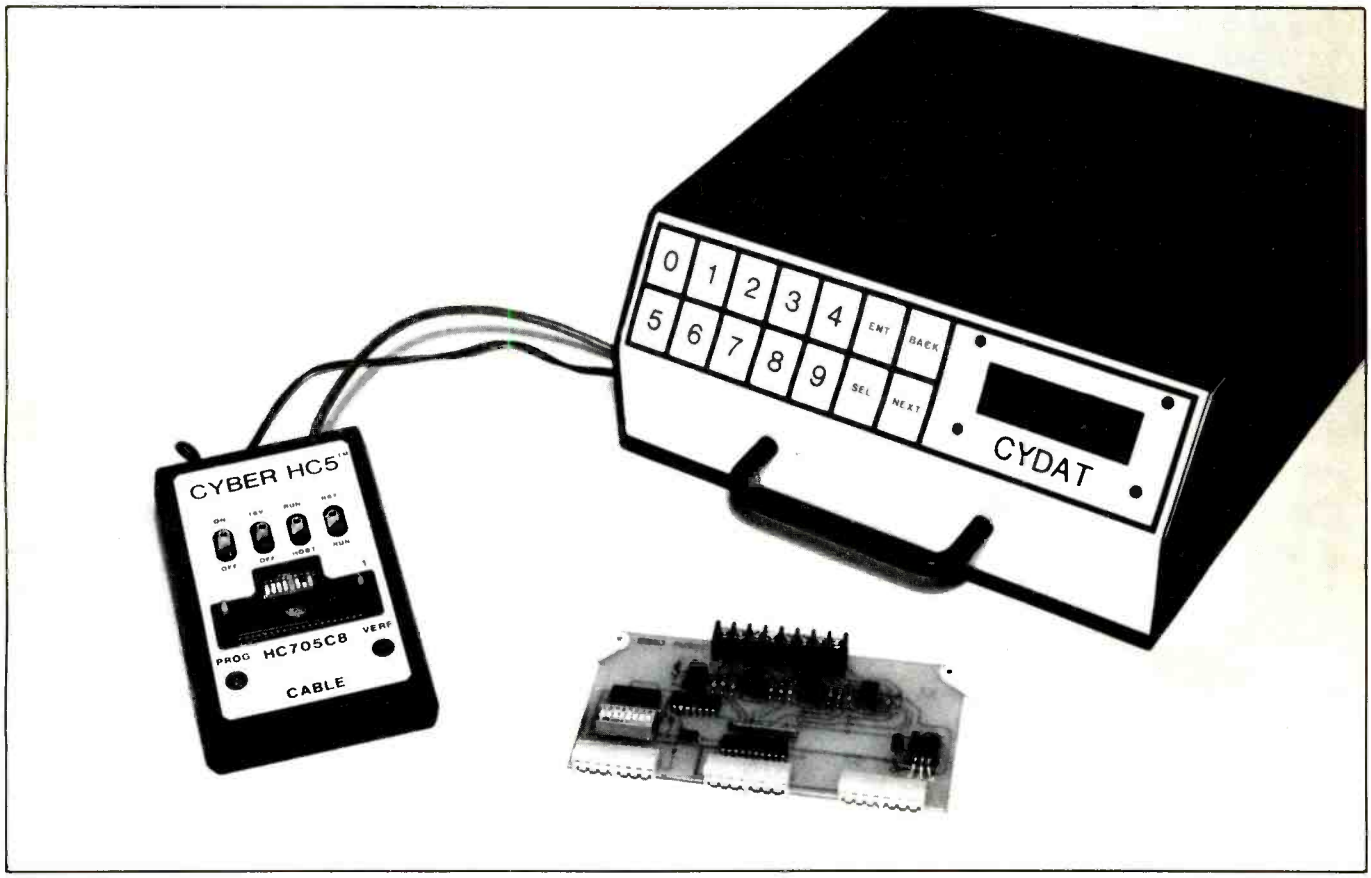
Using the CYDAT Data Collector/Controller to experiment with parallel processing

In the November and December issues of *ComputerCraft*, I detailed how to build a CYDAT Data-Collector/Controller system that lets you use just about any microcontroller you prefer as an "engine." Now I'll show you how to include a parallel-processor arrangement that greatly increases the power and flexibility of the basic system. When you do this, you can use CYDAT as a processing platform by adding modems, nonvolatile memory, real-time clocks, speech processors, digital signal processors, math coprocessors and more.

Traditionally, one simply added these devices to the parallel data and control buses in small processor systems. Though this approach serves well in many cases, in other cases, the single-processor approach can sometimes overwork the processor, resulting in processor latency and poor overall system performance. CYDAT breaks with traditional controller architecture by heavily utilizing what has become known as "parallelism."

Using a high-speed "global" serial bus, CYDAT can share data with and control seven on up to 255 Parallel Peripheral Processors (PPPs). Thus, CYDAT is capable of amazing performance with its Peripheral Processors managing individual tasks concurrently!

If you've ever wanted to experiment with parallel processing, CYDAT gives you an excellent opportunity to build a simple and easy-to-understand system with which to do so. Some of the things you can do with such a system include performing several processor-intensive tasks simultaneously; experimenting with distributed intelligence; and developing an array processor. Only your imagination and technical proficiency limit how you can expand CYDAT to achieve an al-



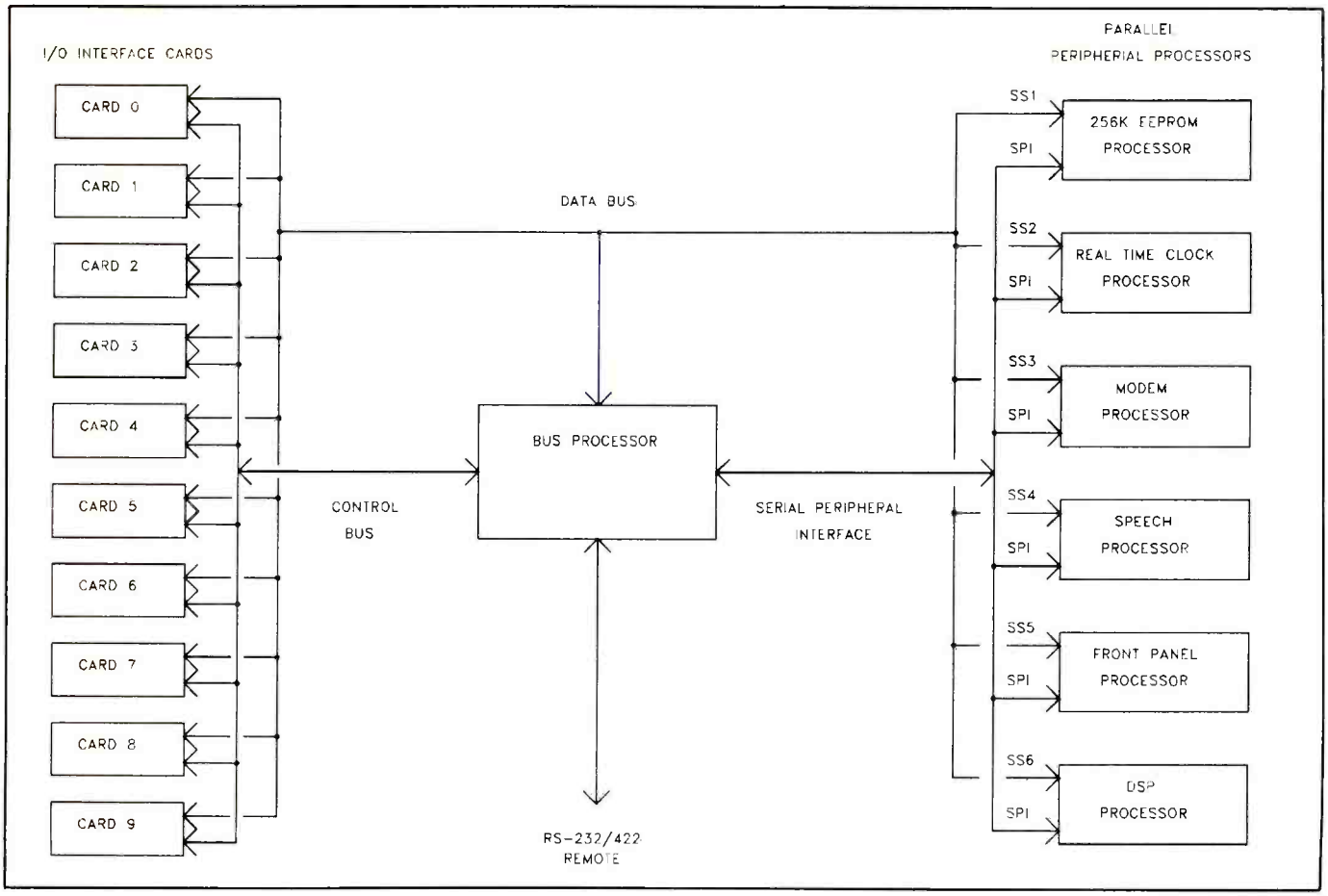


Fig. 1. Block diagram of CYDAT system architecture.

most bewildering variety of sophisticated tasks.

Parallel Processing

Parallel processing isn't new. However, though the theory behind it is very simple, the hardware needed to implement it has traditionally been too costly to be practical in most applications. Too, parallel processing presents special challenges in terms of inter-processor communication.

Many communication schemes have evolved over the years, each optimized for the particular problem the parallel processor was designed to solve. For various topologies, unique software also had to be evolved.

The CYDAT system has a very simple and efficient high-speed serial bus with which to communicate with its peripheral processors. Its SPI (Serial Peripheral Interface) scheme is easy to understand and use. It isn't difficult to imagine how powerful a CYDAT system can be when using separate peripheral processors to manage a variety of real-world tasks in parallel. In addition to the power of parallel processing, CYDAT opens the door to customized processing.

I chose the Motorola 68HC705C8 as an inexpensive microcontroller to implement the CYDAT Parallel Peripheral Processors. Last month, I detailed how to use the '705 as the Bus Processor for the CYDAT system. Now let's look at it as a Peripheral Processor that can be used for expansion purposes.

Notice in Fig. 1 that the '705 Bus Processor connects directly to the I/O interface cards via the parallel data and control buses. This arrangement remains the same during the expansion process. However, by selecting (enabling) individual peripheral processors with the data bus, you can use the SPI as an inter-processor communication system. With the SPI, you can communicate between individual peripheral processors, between a specific peripheral processor and the Bus Processor or globally across all processors.

Figure 2 shows that individual peripheral processors can take on specific functions through a special-function module (SFM). These inexpensive function blocks are "personality modules" that add required hardware to the basic Peripheral Processor Card to perform predetermined tasks.

As an example of the above, if you need to configure a peripheral processor to function as a modem, you simply attach a Modem SFM to the card via the 40-pin module socket. You can then download the appropriate modem software directly to a given '705C8 peripheral processor. If you wish to change the card's "personality" later, just change the SFM and controller software.

In addition to standard SFMs, you can build modules of your own design. These might contain specialized hardware for data encryption, fiber-optic

interfaces, math coprocessors, etc. Keep in mind that CYDAT is flexible and is designed to serve as a platform for personal experimentation and development.

In Fig. 2, *U1* is a standard Motorola MC68HC705C8 microcontroller that mounts in a 40-pin IC socket for easy removal and reinstallation during programming. The frequency control crystal connected to pins 38 and 39 of *U1* mounts in the SFM IC and operates at 4 MHz.

Power for *U1* is supplied by fixed + 5-volt regulator *U3*. Capacitors *C2* and *C3* bypass the power supply lines, and resistor *R1* and capacitor *C1* provide a power-on reset timing function.

Ports A, B and C of *U1* go to the associated pins on SFM chip *U2*. These lines handle control and transfer of data to and from the SFM and are configured in software according to the needs of the specific SFM IC. Pins 31 through 37 of *U2* route signals between the SFM and the outside world.

Individual Peripheral Processor Cards mount on a small motherboard, called the Parallel Peripheral Processor Bus Card. In Fig. 3, you can see how PPP Bus Card connectors are arranged.

Ribbon cables that attach at connectors *P3* and *P4* connect to the PPP Bus Card. Each card slot contains *P1* and *P2* connectors that correspond with the *P1* and *P2* connectors on each PPC. The *P2* connectors use pins 7 and 8 to supply + 12 volts to the PPCs. Power from the external power-supply module attaches via *P6*, as shown in Fig. 3.

Each card slot position along the PPP Bus Card receives a different SS Enable line from the Bus Processor Data Bus at pin 4 of *P2*. These individual lines signal the appropriate Peripheral Processor Card when a data exchange is made to or from that card. With this simple enable technique, the Bus Processor is able to establish and coordinate the SPI communication protocol.

Pins 1, 2 and 3 of *P2* are the backbone of the SPI bus. They correspond to the MISO (Master In/Slave Out), MOSI (Master Out/Slave In) and SCK (Serial Clock) pins on the '705C8. The auxiliary bus formed by the *P1* and *P3* connectors aren't defined, which leaves them free for you to customize as card-to-card interconnects or card-

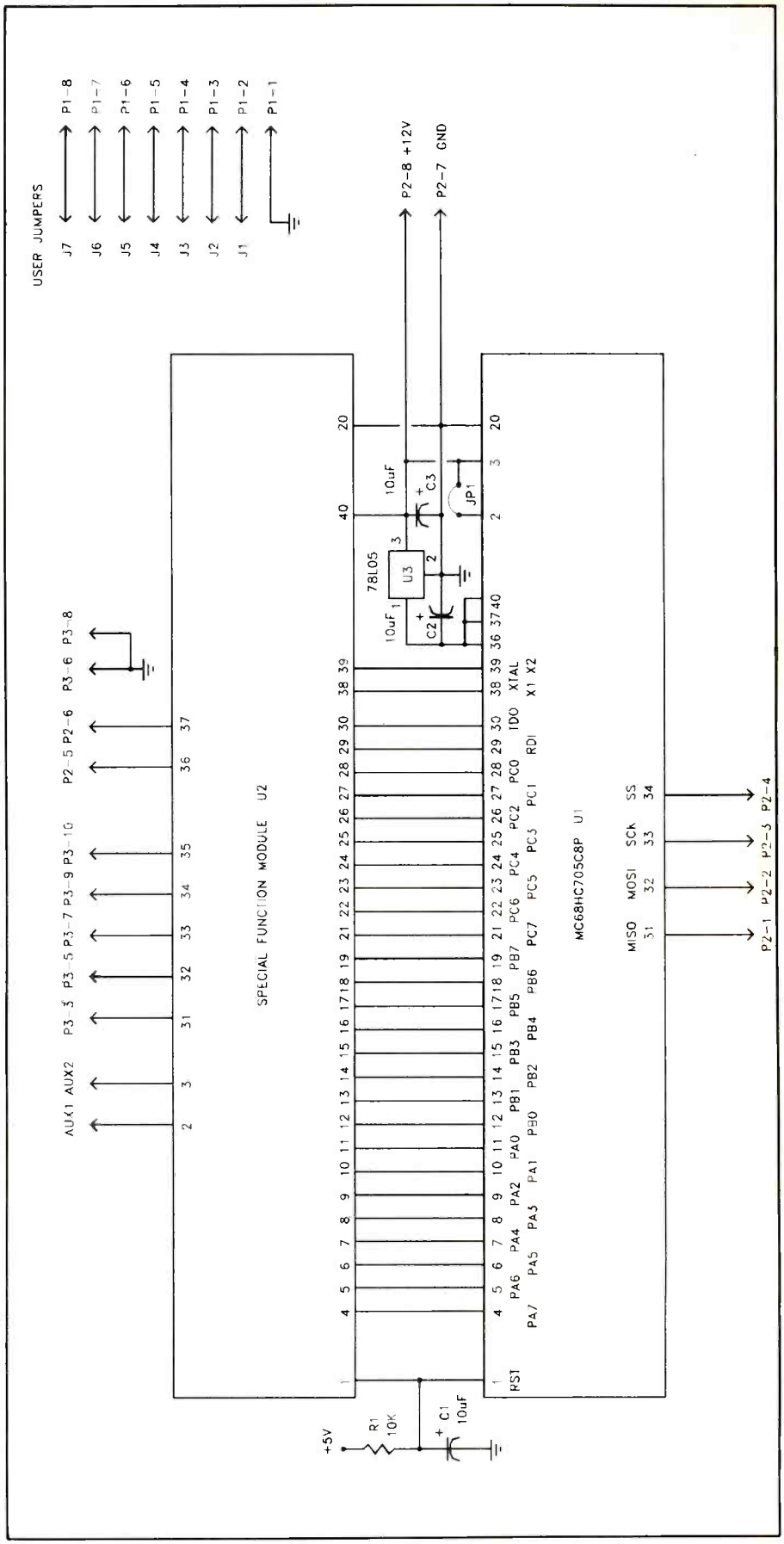


Fig. 2. Schematic diagram of Peripheral Processor Card circuitry.

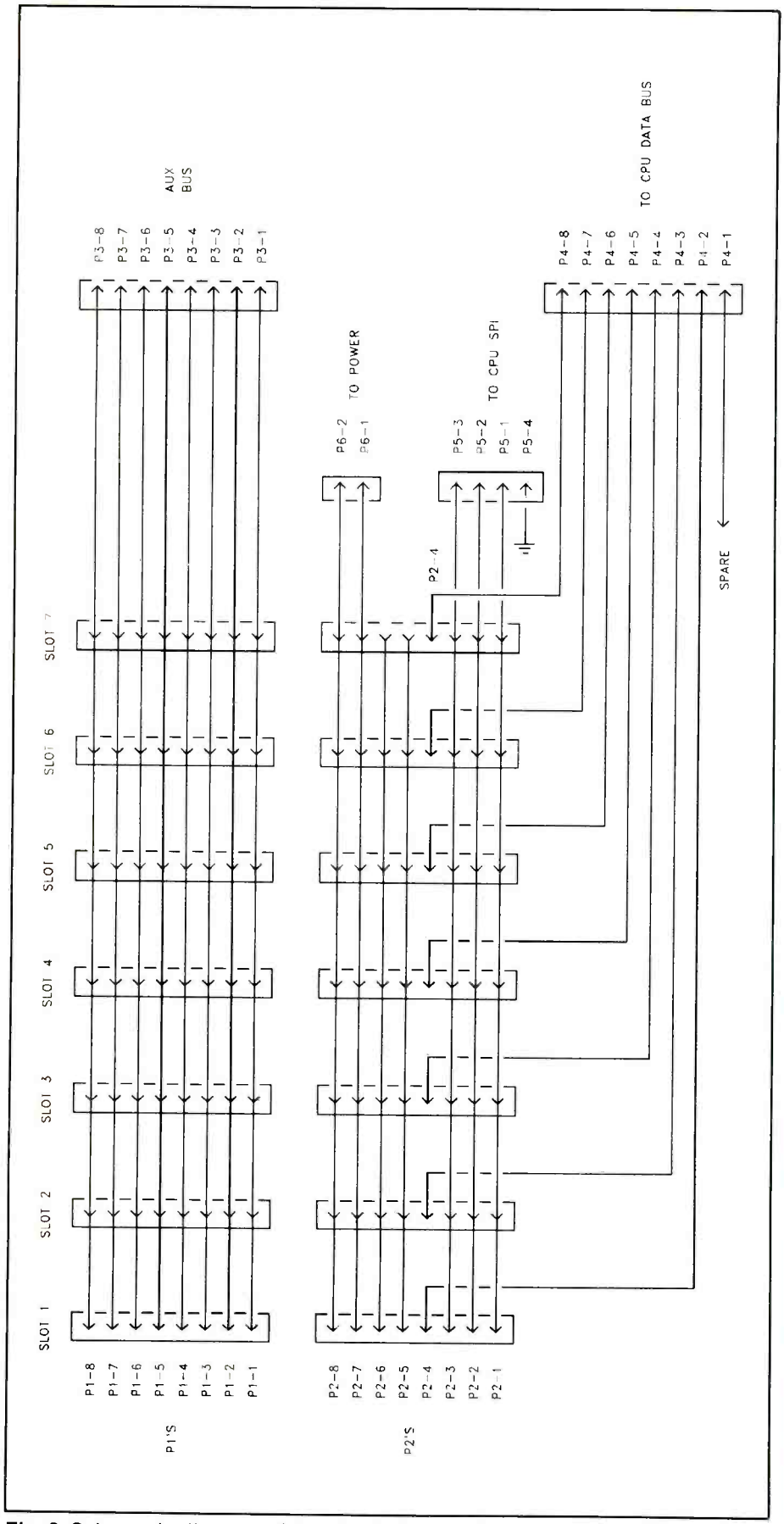


Fig. 3. Schematic diagram of Parallel Peripheral Processor Bus Card circuitry.

to-outside world terminals.

Parallel Peripheral Processors communicate with each other over the SPI bus. If you think a serial bus is slow, consider that the SPI transfers data at 1- and 2-MHz bit rates. This is both fast and efficient for a simple eight-bit serial bus.

The Bus Processor discussed last month functions as the master SPI processor, and each Parallel Processor

PARTS LIST

PPP Bus Card

16—Eight-position Molex male KK connectors
1—Two-position Molex male KK connector
1—Six-position Molex male KK connector
8—4-40-⅜" Phillips-head screws
4—4-40-⅜" threaded spacers
Misc.—Printed-circuit board (see Note below); machine hardware; etc.

Peripheral Processor Card

Semiconductors

U1—MC68HC705C8P microcontroller
U2—ASIC special-function module
U3—78L05 fixed +5-volt regulator

Capacitors

C1,C2,C3—10-μF, 16-volt electrolytic

Resistors (¼-watt, 5% tolerance)

R1—10,000 ohms

Miscellaneous

P1,P2—Eight-position Molex female KK connector
P3—10-pin C-grid male connector
Printed-circuit board (see Note below); plastic card extractor clip (plastic); two 40-pin DIP IC sockets; 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: Ready-to-wire PPP Bus Card pc board, $19.95; PPC card, $9.95; CYDAT enclosure chassis with 10 slot card rack, $39.95; MC68HC705C8 Bus Processor kit, $69.95; EPROM version of MC68HC705-C8S, $22.95. Other available items include: Cyber HC5 Development System, $89.95; membrane front-panel keypad, $24.95; and Optrex two-line by 16-character LCD unit, $24.95. A complete Modem SFM kit with pre-programmed '705, pc board and all parts is available for $99.95. A 256K EEPROM SFM kit with pre-programmed '705, PC board and all parts costs $79.95. A Real-Time Clock SFM kit with pre-programmed '705, pc board and all parts costs $69.95. Call for free full-line catalog and specifications sheets on DSP, Speech and Neural Net SFMs (sold individually or as kits). Arkansas residents, please add 5% sales tax. MasterCard and Visa welcome.

Card functions as a slave. Pin 34 of the '705 Controller presented last month ties to + 5 volts to configure the processor's SPI as a master device. The 68HC7805C8 Bus Processor uses its data bus to directly select the individual SS (Slave Select) lines at pin 34 of each PPC.

The MOSI signal at pin 32 is the Master Output/Slave Input line that outputs data from the master device (Bus Processor) and receives data at the slave device (Peripheral Processor Card). This line transfers data from the master to the slave, with the most-significant bit sent first.

The MISO signal at pin 31 is the Master Input/Slave Output line that receives data at the master device (Bus Processor) and outputs data from the slave device (Peripheral Processor Card). This line transfers data from slaves to the master, with the most-significant bit sent first.

The SCK signal at pin 33 is the serial clock that synchronizes data transfer in and out of the master and slave devices. Master and slave processors can exchange a byte of information during a sequence of eight serial clock cycles. The Bus Processor (master) genrates the serial clock. Software in the master and slaves select the data-transfer rate by controlling the SCK clock stream.

When the Bus Processor wishes to transfer data to one or more Peripheral Processor Cards, it parallel-loads a byte of data into a special on-board hardware shift register. Using the SCK signal, the master device shifts the data out to the slave devices. As data is received at the slave, it's loaded one bit at a time into an on-board hardware shift register. After all eight bits are transferred, the data byte can be parallel-loaded into the slave accumulator with a software command.

To simplify use of the SPI, other on-board control registers set options like serial peripheral interrupts, clock polarity, clock phase, write collision protection, etc., all from software. As you can see, the SPI is an efficient and fast communications technique.

Construction

Begin building the CYDAT Parallel Peripheral Processor by fabricating the PPP Bus Card, using the actual-size artwork shown in Fig. 4. If you prefer not to fabricate your own pc board, you can purchase a ready-to-wire one from the source given in the Note at the end of the Parts List. If you fabricate your own board, drill the PPP Bus Card connector holes with a No. 52 drill to allow for plenty of clearance on the Molex pins.

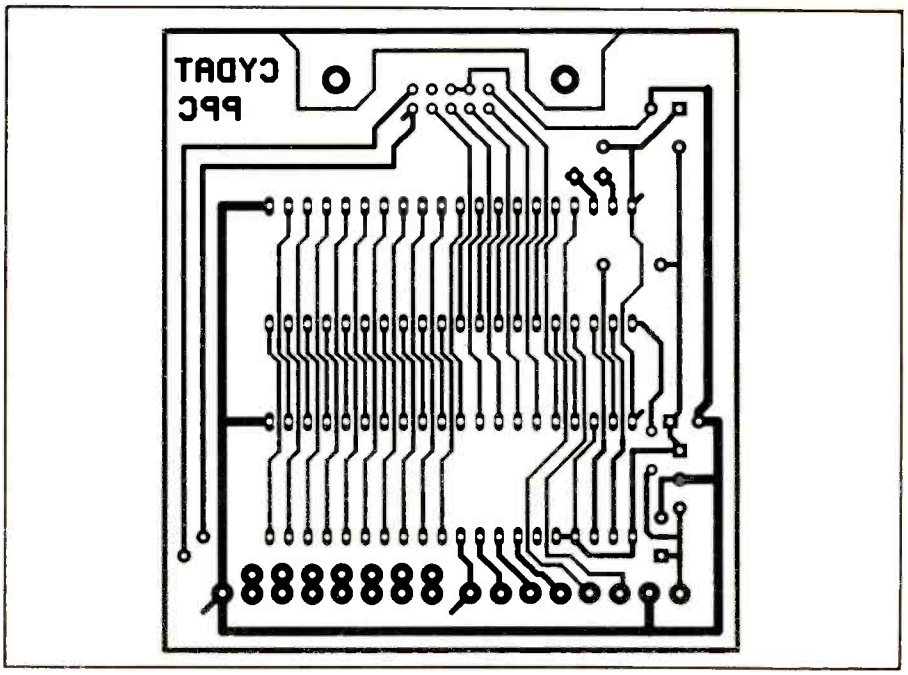


Fig. 4. Actual-size artwork for Peripheral Processor Card printed-circuit board.

Referring to Fig. 5, populate the board. The male connector pins are easy to solder into place, but make sure that the connectors are perpendicular to the board's surface before soldering. I like to tack-solder a pin or two, check vertical alignment and then, when everything appears to be okay, finish soldering all pins. Make mounting holes with a No. 28 or No. 30 bit so that they're large enough to clear the 4-40 screws that will secure the spacers against the bottom of the CYDAT chassis.

I use the CYDAT chassis for mounting the PPP Bus Card. While you can certainly leave the card out on your bench as you experiment, the chassis provides support for the PPC card guides and makes a professional-looking system package.

When connecting the various ribbon cables to the PPP Bus Card, route them neatly out of the way of the PPC card guides.

Construction of the Peripheral Processor Card is straight forward. Again, fabricate a pc board or purchase one from the source noted. Fig. 6 shows the full-size artwork to use if you fabricate your own board. Drill all holes with a No. 68 bit, except for the large Molex connector pad and extractor-handle holes, which should be made with a No. 52 bit.

Referring to Fig. 7, solder the Molex connectors into place on the component side of the PC card. Mount high-quality 40-pin IC sockets in the U1 and U2 locations. Snap the extractor handle into place along the top of the card. Then mount and solder into place voltage regulator *U3* (make sure it's properly oriented). Finally, mount the other passive components and 10-pin C-grid male connector below the extractor handle.

Configuring It

Install whatever special-function modules you plan to include in your system. The source listed in the Note at the end of the Parts List can provide several different types of SFMs. For example, if you wish to add a modem to your CYDAT, simply plug a Modem SFM into any one or more of your PPCs. The modem SFM is provided with pinout information for connecting it to the telephone line and a software disk or pre-programmed '705C8 controller.

In addition to the Modem SFM, nonvolatile memory modules (EE-

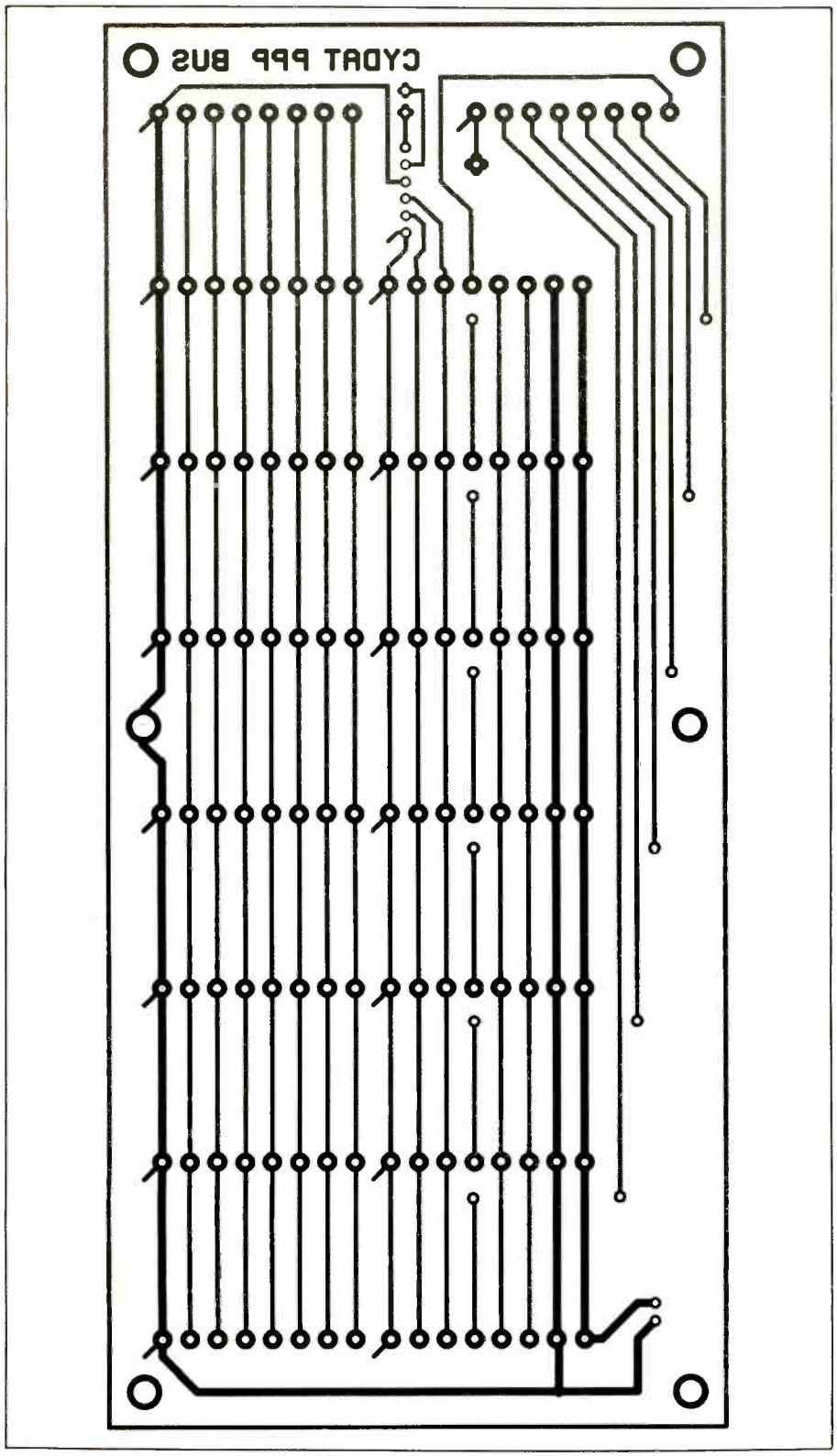


Fig. 5. Actual-size artwork for Parallel Peripheral Processor Bus card pc board.

PROM) and real-time-clock modules are also available. Digital signal processing, speech synthesizer/recognition, fuzzy-logic and neural-network SFMs are on the way and should be available in the near future.

Keep in mind that PPCs use open-architecture design and, thus, are ready for you to experiment as you wish. Try your hand at developing

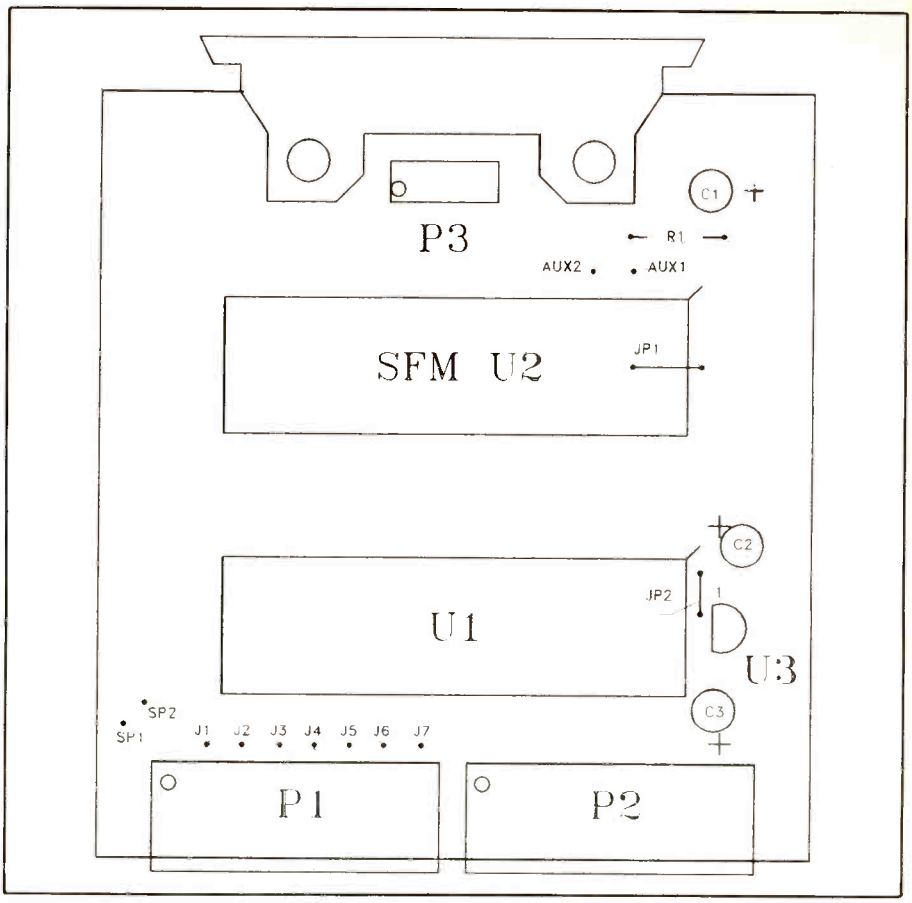


Fig. 6. Wiring guide for Parallel Peripheral Processor Card.

SFMs that satisfy specific CYDAT applications.

Using the PPCs as building blocks lets you rapidly restructure your CYDAT into many useful configurations. Note, too, that you can use PPCs as input/output modules. For example, you can use a PPC to operate the front panel user interface system in the CYDAT.

Front-Panel Interface

Referring to the User Interface diagram shown in Fig. 8, note that the Optrex display and membrane keyboard connect to a PPC via a standard 40-pin ribbon cable. Software in *U1* controls the data displayed at the Optrex alphanumeric LCD display. User input can also be collected by directly scanning the membrane keypad on CYDAT's front panel.

When information is entered at the keypad, the data is stored in the PPC for further processing or directly routed via the SPI to the Bus Processor or other PPC card. Likewise, data to be displayed is transferred from the Bus Processor or other PPC card to the User Interface PPC. Using this type of distributed-processing architecture, CYDAT can handle many different time-domain-sensitive functions in parallel, without interrupting sensitive timing loops and communication routines.

Feel free to experiment with your own front panel designs. Many different keyboards and LCD displays exist. Take advantage of your newfound front-panel freedom!

The Software

To utilize a computer system's full processing power, software development tools are required. CYDAT is well-supported when you use MC-68HC705C8 microcontrollers. Using your PC as a host, software generation is straightforward with the Cyber HC5 development system (see the June 1992 issue of *ComputerCraft* for details). This device lets you develop code and program the '705C8s used in the bus processor and PPCs. Several

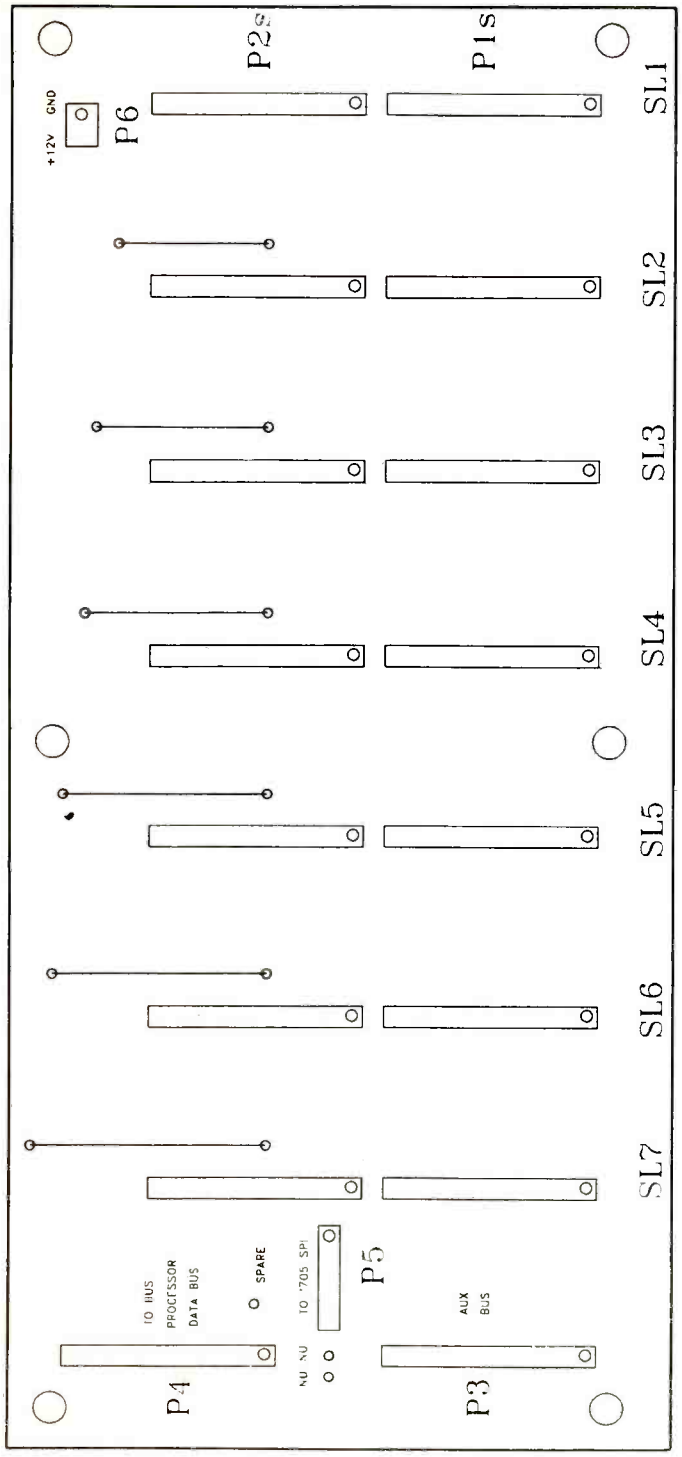


Fig. 7. Wiring guide for Peripheral Processor Card.

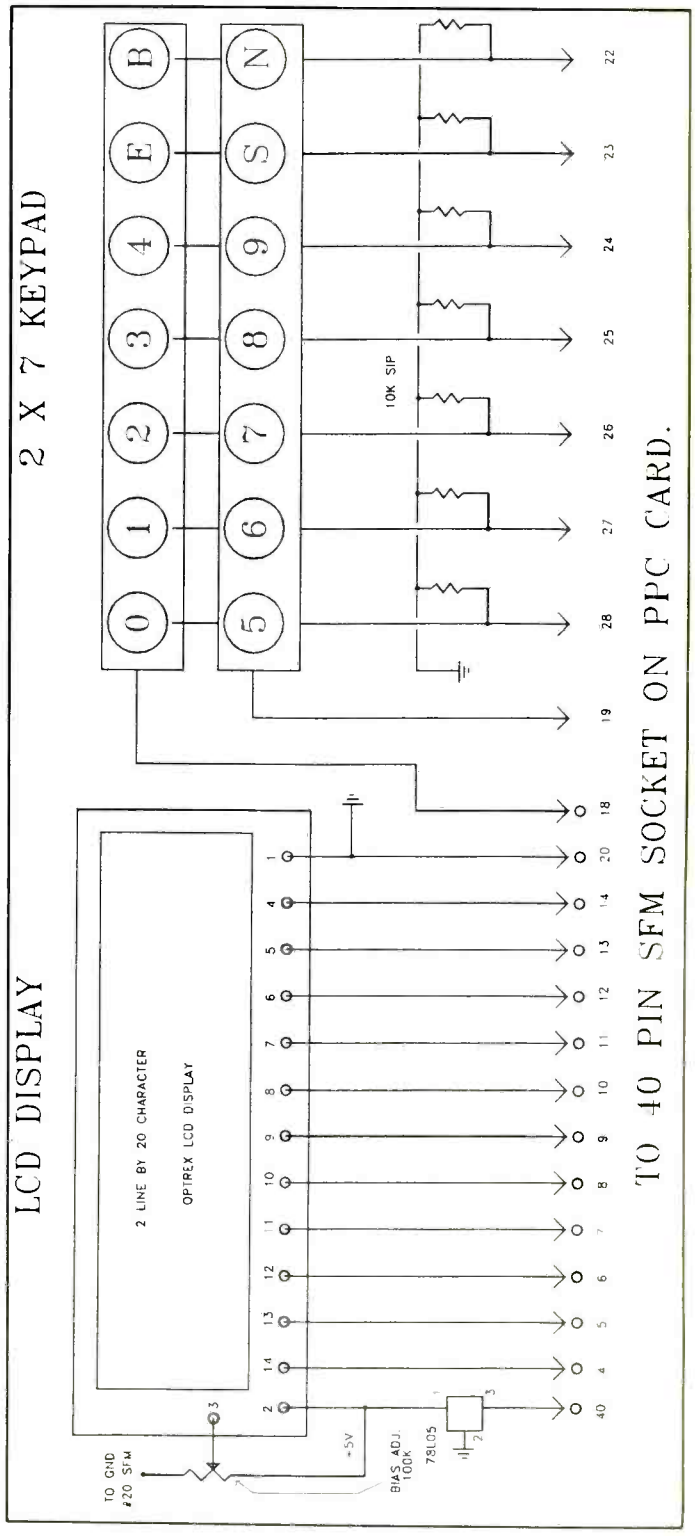


Fig. 8. Schematic of front-panel user-interface circuitry.

excellent C compilers available for the '705 will work in conjunction with the Cyber HC5.

Developing your own parallel-processor operating system can be fun and challenging. By expanding the code in your bus processor a little at a time, you can grow a PPOS at whatever rate suits you. Individual special-function modules used on the PPCs come with their own software drivers, making it easy to interface them with your bus-processor software. Free membership on Motorola's '705 BBS and CYDAT BBS can be helpful to you when developing your software. ■

Nick Goss

Ted Needleman

Making Your Point With Style

It's no big surprise to me that presentation software has become a very popular force in the marketplace. In my experience, both in business and in the increasing amount of public speaking I do, the better the presentation tool, the easier it becomes to get a point across.

Today's tools are very good, indeed. Of course, the particular software tool you select to create a presentation will vary according to what you need to accomplish, the time and effort you're willing to put into creating visuals, what's available in your arsenal and your budget. Low-cost graphics packages, like the Micrografx *Windows DRAW!* and Computer Support Corp.'s *Picture Wizard*, reviewed a while back in this column, are an excellent place to start.

Inexpensive desktop-publishing software like Microsoft's *Publish* and PowerUp Software's *Express Publisher* are also rich enough in features for you to create an impressive presentation, as are high-end word processors, like *Word for Windows*, that provide a large amount of typographic control and inclusion of clipart and graphics. Even a feature-rich typography package, like *MakeUp* from Bitstream (reviewed here in the November 1992 issue) can let you create eye-catching slides, handouts and overhead transparencies.

To create a really impressive presentation, you must have two things. One is an understanding of some of the basic principles involved in making any presentation. Then, regardless of which tools you use, you must have a game plan. You must know exactly what information you want to impart and how to present it in a way that facilitates, rather than obscures, its meaning. A planned approach, coupled with a clear understanding of the points to be presented and the proper presentation tools, go a long way in helping you make points that buttress your conclusions.

Enough is Enough

The first thing I'd suggest for anyone contemplating doing a lot of public speaking is to take one of the many courses given in this art at numerous colleges and adult education centers. One of these days, if I can ever find the time, I'd like to do this myself. In the interim, I'll share a few of the more obvious principals gleaned from years of trial and error.

Here are five important principles that are germane to any presentation, whether it's an explanation to your boss of why you deserve a raise or a presentation on an esoteric subject to a group of 500.

1. *Make sure the time you have is appropriate for the information presented.* One of the worst mistakes people who are creating a presentation make is trying to conform to a time constraint. Therefore, one of the first things you learn as you start making presentations is that the length of the presentation depends on how much information you're trying to impart and how much explanation of the information is necessary.

There's really no point in trying to stretch 15 minutes of information into an hour's presentation. Though it can be done, doing so means you'll either have to spend a lot of time telling your audience things they already know or going over the same points several times. Either way, you'll quickly lose your audience's attention and interest.

The same caveat applies to trying to impart huge amounts of information in a very short time. Glossing over important data your audience really needs to gain an understanding of the rest of your presentation serves little purpose. You can finish your presentation in the allotted time, but you won't have presented a firm enough foundation to support the conclusions you want your audience to reach.

No pat solution exists to either of the above situations, though too much time is somewhat easier to deal with than too little. With a presentation that doesn't take up the allotted time, you can always throw the floor open to questions, move on to another subject or just end early. With too much information for a given time period, the best thing you can do in many circumstances is to reduce the scope of what you're trying to accomplish. While your presentation may not cover as much ground as you may have wanted it to, the ground that you do manage to cover will be presented in an effective and persuasive manner.

2. *Be Prepared.* Having sat through my share of presentations, as well as having given them, I've noticed that there are two extremes of presentation styles, neither of which is particularly ideal. On one end is the ad-lib presenter, who obviously hasn't given a moment's thought to what he'll actually say once he's in front of his audience. We've all come across this type of presentation (I've even given a few myself), and they're usually boring enough to put us to sleep.

If I'm listening to a presentation on, for example, where pen-based computing will be in the next two years, I don't want to hear about the difficulty the presenter had learning script in third-grade, even though he may use the anecdote to underscore the problems that exist with handwriting recognition.

On the other side of the coin are presenters who have taken the time and effort to create a truly impressive and extensive lecture and then reading it to their audiences word-for-word. If this is all I'm going to get out of a presentation, the speaker can mail it to me so I can read it myself.

Obviously, the ideal is somewhere in between these two extremes. A well-thought-out presentation uses visuals to explain and underscore the points one is trying to make, while the verbal part of the presentation fills in the gaps and rough spots.

3. *Focus Attention.* To accomplish the above "ideal" takes a fair amount of forethought and orchestration. For a presentation to accomplish its goal, you must capture and keep your audience's attention. Part of this process consists of manipulating your audience's focus. You want it directed at you most of the time and, when you need to make a point, transferred to your visual. If your audience is focused on either for too long, their attention tends to drift.

The secret is movement. When you want the attention on you, look up and *talk* to your audience. Make eye contact with as many of your audience as you can. Smile and, if at all possible, move around a little. Don't hide behind a podium, reading from your notes. Instead, try to use notes that touch upon your most-important points in the order in which you want to present them. Make a note of the next important point or two, then look up at your audience and talk to them.

When you want to focus your audience's attention on a visual, use a transitional sentence like: "This next slide shows the difference between my approach and the more conservative method of approaching this problem." *Never, ever*, use the phrase:

"As you can see . . . "! Your audience *can* see, and they don't need you pointing out what's patently obvious. What they want is for you to tell them the significance of what they're seeing!

4. *Emphasize important points, but do so sparingly.* The great thing about today's graphic tools is that it's easy to create a stunning piece of visual art. It's also easy to go completely overboard. There's a fine line between a stunning and effective graphic and one that's so busy it detracts from the information contained in it. Using a package optimized for presentations, like the *Freelance Graphics for Windows* software package discussed later is one way to deal with this problem.

With software specifically meant to create a presentation, odds are good that the design of the visual has already been done for you. But when you're using a more-general graphics package, keep in mind the old cliche that "less is more." If you're not sure whether your graphic overshadows the data you're trying to present, go for less rather than more graphics.

The main point is that the graphics you use in your presentation should enhance the information you're presenting, not detract from it. Sometimes, this means using appropriate symbols. For example, a bargraph depicting cash revenues over a period of time might benefit from using the dollar sign ($) symbol rather than just run-of-the-mill color bars.

You might even be more effective using a ghosted graphic of a pile of coins as background to this particular visual. But stay away from graphics used in a slide or overhead that are so complex and detailed that your audience's attention is focused on deciphering and analyzing the graphic instead of the information presented.

The same principle holds for the number of graphics you use in a presentation. It may be very impressive to have 120 slides or overheads in an hour-long presentation. But what tends to happen in this situation is that individual slides quickly lose their impact. A good rule of thumb is to use one graphic for each important point. If time permits, and the subject of your presentation supports it, you can sometimes double this figure. But if a graphic contains a fair amount of information or explanation, it could be displayed for five minutes or longer.

Using the foregoing rule of thumb, most one-hour presentations should consist of somewhere between 20 and 40 slides. The one thing you want to avoid if at all possible is having such a complex visual presentation that you're spending more of your attention keeping up with the mechanics of your visuals than on actually thinking about what you're saying.

5. *Come to an end.* One last word of advice. When you're first putting together your presentation, spend a little time thinking about how you'll conclude it. As with almost every kind of expository writing, a presentation has a beginning that lays out the reason for your presentation, a middle that presents the information and supports your premise and an end. Many presenters spend a tremendous amount of time on the first two, then just stop. This is extremely jarring to an audience and can undo all of the careful preparation and effort that went into the presentation demonstrated.

A good way to wind up a presentation is to provide a quick summary of the important points you've made. Don't go overboard—three or four of the most important of these is enough. If your presentation is intended to answer a question, your wind-up should re-state the question, give the important points you've made and state the answer you feel your presentation.

Finally, there's one slide I always show last in every presentation I make, whether it's to my management or a large group. It has two simple words on it: "Thank You." Never forget to thank your audience for sitting through your presentation.

Now that you have an idea of what goes into making a good presentation, let's see how you can put all this theory into practice. To do this, I'll give you a critical look at a software package, Lotus *Freelance Graphics for Windows*, that can help you make it all happen.

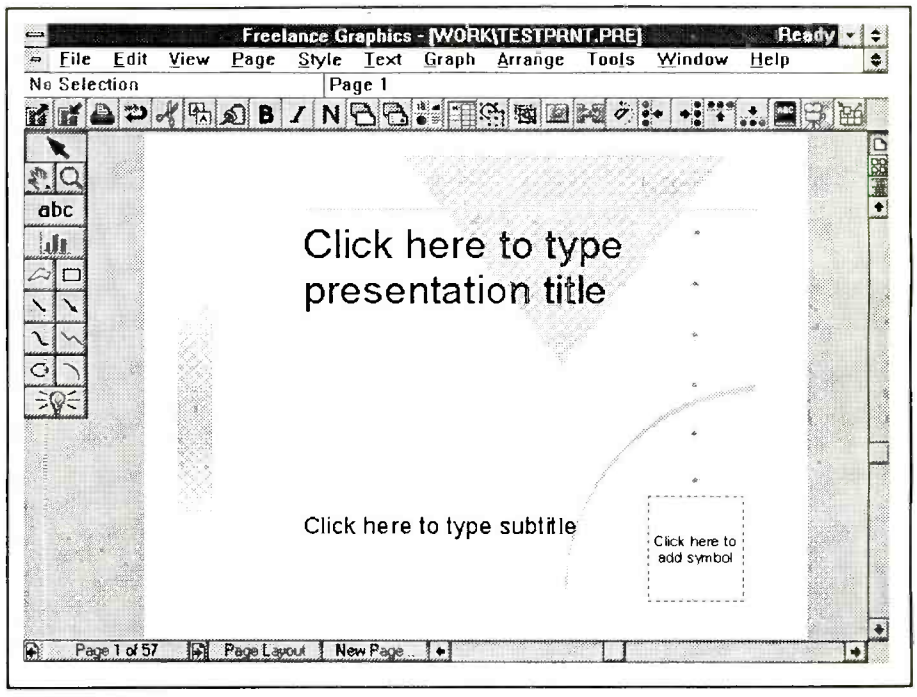
Freelance Graphics For Windows

I've spent such a large amount of this column talking about the theory and principles behind giving an effective presentation for a good reason. It provides a foundation for what a good presentation software package must provide.

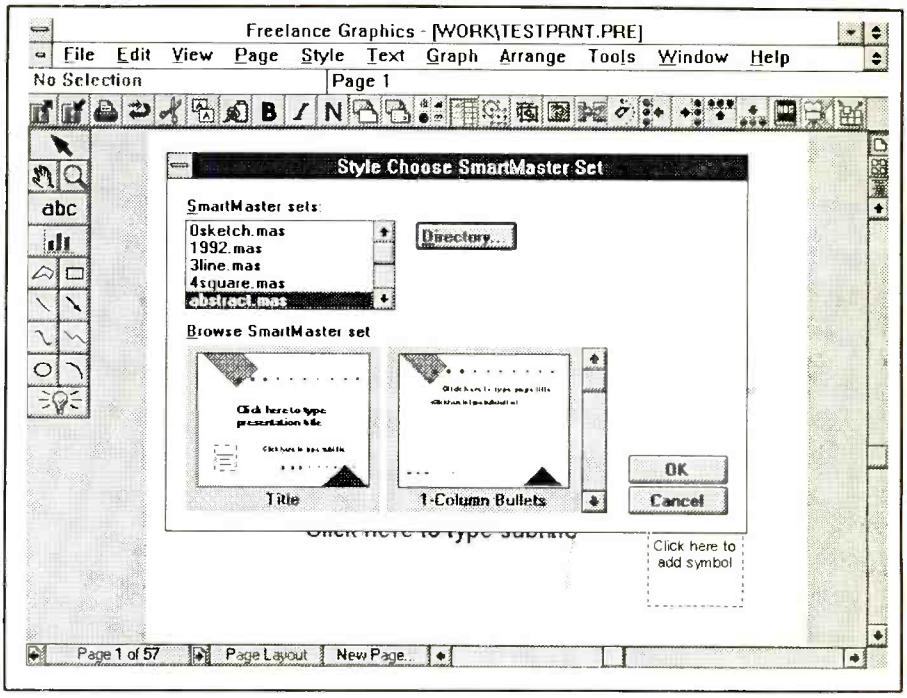
While almost any decent graphics package will let you prepare overheads and slides, a presentation package goes beyond this with features that make it easier to not only mechanically prepare and give a presentation, but also follows the principles that govern an effective one.

There are lots of presentation graphics packages around, of course. Microsoft's *PowerPoint*, Computer Associates' *CA-Cricket Presents* and Aldus' *Persuasion* are just a few of the better-known ones. During the last year, though, I've standardized on Lotus' terrific *Freelance Graphics for Windows* (*FGW*). It was my first experience with this software that largely sold me on it.

On the day I received and installed *FGW*, my boss walked into my office with the department's sales manager, who had an important presentation to give early the next day. My boss wanted to know if I could do "something" on the computer to



Freelance Graphics' title page offers three areas in which you can click to add text or a symbol of your choice.



Freelance Graphics' title page with window overlay for choosing a style from a SmartMaster Set built into the program.

turn eight pages of handwritten notes into something a bit more presentable to give to a potential client. It was late in the day, but I said I'd give it a shot.

Curious about the *Freelance Graphics* package, I spent about 10 minutes running through the tutorial. An hour and ten minutes later, the last of a 20-page color presentation rolled off the Seiko color thermal-transfer printer I had connected to my computer. The sales manager was delighted, and I was sold on *Freelance Graphics*!

Freelance Graphics for Windows provides two major benefits. Given my first and every subsequent experiences with it, it's obviously easy to learn to use. Granted, after 25 years using computers, I'm obviously no longer a novice, but because of the way the software provides guidance, I'd predict that anyone who spends 10 minutes with the tutorial will be able to turn out a credible presentation the first time through—within an hour! Also, because *FGW* provides all the tools needed to conform to the principles of good presentations, your presentations in general will show an improvement as you become more familiar with the software.

As with most *Windows*-based software, *FGW* uses an icon bar above the working space for quickly choosing and performing the operations most frequently needed. In addition to these "SmartIcons," as Lotus calls them (you can redefine what they mean and add or delete icons as you wish from the icon bar), there are the more-familiar *Windows*-style pull-down menus at the top of the screen, a Toolbar along the left side of the screen and a Viewbar on the right side, directly over the vertical scroll bar.

The Toolbar provides a simple but robust set of drawing tools that include ellipse, rectangle, line and fill tools, among others. The Viewbar allows you to change from outliner view to page view with just a mouse click on the appropriate icon.

Although the manual doesn't discuss the Outliner until Chapter 4, well after it has already covered the basics of using *FGW*, the most-efficient way to use the software is to start with this feature. Having stated this, I also have to admit that I'm not especially enamored of outlining software in general. So I rarely use *Freelance*'s Outliner, preferring the good old pencil and paper approach for my outlines.

Lotus' Outliner is a pretty good one, though. It uses a yellow-pad emulation and allows you to easily create a complex multilevel outline, complete with bulleted lists. When the outline is finished, you transfer it directly into your presentation pages, where you can polish it up a bit. Changes made in the outline are reflected directly in the presentation, and vice-versa.

The one limitation in using the Outliner is that you can't directly print it. It must first be "dumped" it into a presentation and then you print the presentation. If you

feel comfortable working from only the computer screen, this won't be a problem. A built-in spelling checker that works in both outline and presentation view lets you minimize embarrassing goofs in your finished presentation.

Once you've laid out your presentation, either in the Outliner or on paper, creating it is quick and easy. *Freelance Graphics for Windows* features something that Lotus calls "SmartMasters." These are pre-defined sets of presentation pages that contain a border or design and a variety of page-layout templates.

There are 60 different SmartMaster sets, some optimized for color presentations and others for black and white. Each contains a page layout for a Title Page, One or Two-Column Bulleted Text, Text with one or more graphics, Bullets and Symbol, Bullets and Graph and a Basic Layout that's pretty much a clean page, except for the page design graphic.

Once you've chosen your SmartMaster set (you can change this even after your presentation is completed), creating your presentation is just a matter of going page by page selecting the type of page you want and plugging in the elements on it. *FGW* automatically brings up the Title Page layout for the first page, but you can easily change to another page layout by clicking on the Page Layout button at the bottom of the page.

Each page layout contains instructions on what elements you can add to the page. For example, the Title page has three element boxes that instruct you to "Click here to type presentation title," "Click here to type subtitle" and "Click here to add symbol." Clicking on either of the first two opens a text box in which you type in the appropriate text.

As with most *Windows* applications, typeface and size can be selected from those installed on your system. You can even change text color, though *FGW* will automatically use an appropriate color, depending on the SmartMaster set you've chosen. Provided is a large selection of symbols you can include on every page of your presentation, or you can import your own graphic from a wide variety of formats and even add to the symbol-set library.

Alternatively, you can create your own graphics with the draw tools. There's a very complete graphing facility built into *Freelance Graphics*. Click on the Graph icon, and you're brought into a spreadsheet screen, where you construct the data table for your graph. When you've finished entering labels and data, another mouse click lets you select the type of graph you want the software to generate. If you don't like what you see, simply click again to change the type of graph.

When you're finished creating a presentation, there's a "slide sorted" function that lets you change page order. You can automate the presentation, if you're going to present it on computer, adding fades and other special-effects transitions. These are rather limited, compared to some other presentation packages, but they provide a nice effect nonetheless.

When you're ready to print, you can create a file that can be sent to one of the many graphics companies that generate slides or color overheads, print a full-page per presentation page on your printer or make speaker's notes that have the presentation page on the top of the page and lines to add your own notes on the bottom. You can also print "Handout," which contains two, four or six presentation pages on each handout page.

I haven't discussed many of the features available in *Freelance Graphics for Windows*, a goodly number of which I've never used. You have almost infinite control over the creation of your presentation. Most of the time, though, if you just follow what's on-screen, your presentation will turn out terrific!

The manual set that comes with the product is excellent, but most of the time, the on-line help has been sufficient to answer questions I've had. Perhaps, with the next release of *FGW*, Lotus will add the great multimedia SmartHelp provided with the CD-ROM version of *1-2-3 for Windows*.

At a list price of $495, which is widely discounted down to as little as $149 with one of the many mail-order competitive upgrade plans, *Freelance Graphics for Windows* isn't only a great way to create a presentation, it's also an excellent education on the elements that make up a good presentation. I consider it one of the most effective and efficient software tools in my arsenal. ■

Product Mentioned

Freelance Graphics for Windows, $495
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
Tel.: 617-577-8500

CIRCLE NO. 101 ON FREE INFORMATION CARD

Joseph Desposito

New Kind of PROM, Software for NEC Microcontrollers, Switchable SCSI Terminator and Comparator with Digital Threshold Control

Programmable read-only memory, or PROM, has been a staple of microcomputer systems since their inception. With this in mind, I lead off this month's column with a device that adds a new twist to this old technology.

Processor-Intelligent PROM

Cypress Semiconductor (3901 N. First St., San Jose, CA 95134) has a PROM that integrates on-chip user-configurable burst counters, registers and latches. The device reduces chip count, lowers cost, improves performance and simplifies design when interfacing PROM to a wide range of popular processors used in embedded control.

By incorporating this logic on-chip with the PROM array, the Cypress CY7C270 Processor-Intelligent PROM permits system designers to interface PROM directly with processors, including:

SPARC	68030	R3000
486	80960KB	R2000
386	80960CA	88000
68040	29000	

Featuring a high amount of programmable on-chip logic, the CY7C270 saves the design complexity and performance penalties of going off-chip to discrete logic devices. Designers can eliminate one or a pair of 22V10s generally used to implement burst counters, latches (for CISC processors) and registers (for RISC processors).

Access times of 14 ns for burst reads and 28 ns for single reads let the 16K × 16 CY7C270 deliver zero-wait-state memory accesses for 33-MHz CISC processors and 25-MHz RISC processors. The CY7C270's high degree of integration also lets it run with better in-system performance than a solution that employs faster PROM and external logic for the memory interface. This is because solutions using the CY7C270 do not suffer from delays associated with implementing the memory interface using external logic.

The CY7C270's × 16 architecture means designers need only two chips to support the 32-bit buses of many processors, further reducing chip count. Trimming the need for still more external devices, the CY7C270's three programmable chip selects eliminate the need for off-chip decoding logic.

To accommodate various processor burst sequences, the CY7C270 can be configured by the user to provide a two-, four- or eight-bit linear burst counter; a two-bit non-linear burst counter (for the 486 CPU); or no burst counter (for use with RISC processors).

The CY7C270 is re-programmable for low-cost prototyping. It's priced at $56.05 each in 100-piece quantity in PLCC packages.

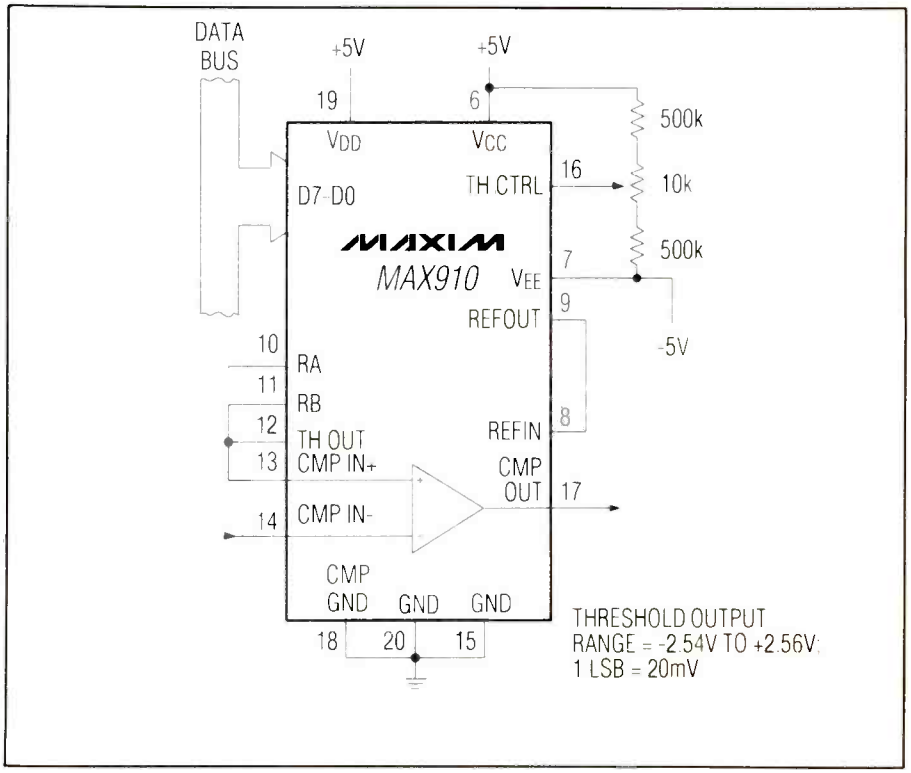


Fig. 1. Schematic diagram of a programmable level detector built around Maxim's MAX910.

Software for NEC K Series

Avocet Systems, Inc. and NEC Electronics Inc. (401 Ellis St., P.O. Box 7241, Mountain View, CA 94039) have the first in a series of Avocet software support solutions for the NEC K-Series family of microcontrollers. Two new design tool packages, Avocet C 78K2 and AVICE, allow for optimizing and high-level debugging of both C and assembly-language source code with NEC K2 in-circuit emulators.

Avocet Systems, one of the leading U.S. microcontroller design software vendors, has created a robust set of software tools that fully utilizes the features of NEC's K2 microcontrollers.

K2 is an eight-bit family of CMOS microcontrollers designed for real-time embedded control applications. These devices are particularly rich in on-board peripherals. Most chips include synchronous and asynchronous serial I/O; multiple counter/timers with compare and capture registers that support high-resolution timing; pulse-width-modulated (PWM) outputs; real-time output ports; and multichannel A/D converters and D/A converters.

A macro service data-transfer facility, unique to the K-Series, is also included with all K2 devices. Macro service greatly reduces the interrupt load on the CPU by

handling many repetitive service requests normally addressed by the CPU.

In addition, the K2 CPU features high-speed data execution, permitting the devices, operating at 12 MHz, to support a minimum instruction cycle of 333 ns. NEC's K2 family also offers large memory capacity, including products with up to 32K of ROM and 1K of RAM. On-chip data memory includes 512 bytes each of RAM and EEPROM. K2 microcontrollers can address 64K of program memory and 1M of external data memory.

The Avocet C 78K2 package contains an ANSI C compiler with complete K2 family feature support and the AVMAC 78K2 macro assembler. The C compiler uses a compiled stack technique that produces optimized K2 code. It additionally supports interrupt service routines written in C, generates ROM-able code and copies initialized variables from ROM to RAM at run time.

The AVMAC 78K2 assembler includes a macro pre-processor, linker/locator, object librarian, cross-reference utility, HEX file utility and cross-reference report generator. Created to write assembly language, it contains assembly and structured programming directives.

AVICE 78K2 is a new high-level debugger front-end that supports all of the features of the NEC K2 IE-78230-R and IE-78240-R in-circuit emulators. The package contains a window-style user interface that supports high-level debugging of C and assembly-language source code. A watch window allows the debugger to inspect variables within their execution scope and proper format. Based on a sophisticated command language, a user can create new commands, configure windows, bind key strokes to commands, and attach them to breakpoints.

Additional AVICE 78K2 features include real-time trace; multiple source and memory dump windows; hardware and software breakpoints; single and multiple stepping; and on-line help.

To run the Avocet C 78K2 and AVICE 78K2 packages, an IBM PC/AT or compatible computer with a minimum 640K of RAM, and MS-DOS 3.1 or later are required. A 386 or 486 machine is recommended for running this software.

NEC's IE-78230-R and IE-78240 in-circuit emulators with one probe are available for $9,490. The IE-78240-R supports NEC's PD2821XA line of microcontrollers, while the IE-78230-R supports the μPD7823X products.

A complete package containing both Avocet C 78K2 and AVICE 78K2 sells for $1,496. The packages are also sold separately, with the Avocet C 78K2 package priced at $1,195, the AVICE 78K2 high-level debugger at $300, and the AVMAC macro assembler at $495.

Switchable SCSI Bus Terminator

Motorola (2200 W. Broadway, Mesa, AZ 85202) has a new family of switchable precision SCSI bus-terminator solutions that eliminate the need to physically remove termination. These SCSI Bus Terminators are available in reliable, easy-to-implement surface-mount packages that reduce board-area requirements.

These devices improve manufacturing flow and reliability and are easy to expand to 27-bit-wide SCSI bus applications. One SCSI terminator replaces all termination resistor packs and sockets, which simplifies printed-circuit board layout and reducing inventory and carrying costs.

The new circuitry gives designers a simple way to enable or disable termination with either software or hardware. When enabled, these circuits provide passive or active-style SCSI termination. When their switches are disabled according to their truth tables, these devices are in a high-impedance state on nine or all 18 bits.

Motorola's family of SCSI Bus Terminator solutions currently include five devices. The MCCS142233 is a nine-bit passive terminator. The MCCS142234 and MCCS142235 are nine- and 18-bit active terminators that can be used with Motorola's MC34268 voltage regulator. The MCCS142236 and MCCS142237 are nine- and 18-bit active terminators with integrated 2.85-volt regulators.

All these SCSI terminators contain a Local V_{cc} (LV_{cc}) low voltage sense circuit to latch the enable state, which provides the ability to latch the current output state when power is removed from the LV_{cc} pin. As long as the terminator power or voltage regulator remains, no interruption to the SCSI bus occurs when powering down are SCSI peripheral.

Motorola's family of SCSI Terminators can be used in computer equipment applications that include all SCSI, SCSI-2 and SCSI-3 computer platforms (PCs, workstations, mini-computers) and their associated peripherals that utilize single-ended SCSI buses. Examples include rigid-disk drives, printers, barcode readers, CD ROMs, tape drives, plotters, image scanners and laser-disk drives.

Pricing for the SCSI Terminators in 10,000-piece quantity ranges from 99 cents for the MCCS142234 nine-bit active to $2 for the MCCS142235 18-bit active device.

Digital Threshold Comparator

Maxim Integrated Products' (120 San Gabriel Dr., Sunnyvale, CA 94086) new MAX910 and MAX911 ultra-high-speed comparators are the first to include a high-speed eight-bit DAC and voltage reference to rapidly set the input threshold voltage of the comparator (Fig. 1). The MAX910 is TTL-compatible with an 8-ns propagation delay, while the MAX911 is ECL-compatible with a 4-ns propagation delay.

The comparator's threshold level, set by the DAC, has a 10-mV resolution and is digitally updated through its full-scale range in only 50 ns. By combining a comparator, voltage reference and an eight-bit DAC in a single IC, the MAX910 and MAX911 reduce board space requirements by a factor of 10 and power consumption by a factor of five.

For high-speed comparator applications in which the threshold voltage must be updated rapidly, such as automatic test equipment (ATE) or process-control applications, the MAX910 and MAX911 provide a complete single-IC solution that reduces stray capacitance, design time and cost over multi-chip discrete solutions.

The MAX910 and MAX911 come in 24-pin DIP and SO packages. The price for the MAX910CNG or MAX911CNG is $5.20 in 1,000 piece quantity. ■

On-Line Population; Getting the Fax; Closing the GUI Gap; Pre-Loaded CompuServe; Beware The Tax on Modems!; Setting Up Your Own BBS

We have no idea how many people are on-line these days. No census is taken of the population of cyberspace, nor do the major public networks like CompuServe release numbers we can rely upon. Thus, we have no concept of the number of people on the internet. When you add the number of people who are on private corporate nets and others who sign onto only local BBS services, you have a population numbering in the millions.

However many people may be on-line, though, the fact that on-line services exist has already affected the way we live and communicate with each other. I recently read a report that 1.5-million people were on-line in Japan, this in a country where there are nowhere near as many personal computers as there are in the U.S.

Getting the Fax

Now fax is rapidly becoming the preferred method of sending written messages, so much so that this past year has seen an explosion in low-cost fax modems. You can get 2,400/9,600-baud modem/fax boards for less than $100 and 1,400-baud modems are going for about $300. So now you can use the board as a regular modem at 2,400 baud and as a fax modem at 9,600 baud (or 1,400 baud). Fax communications software is bundled with these modems at no extra cost.

Brands offered by direct-market vendors and discount retail stores include Twincomm, Cardinal, Practical Peripherals, The Complete PC, BSR and Ultimate, to name just a few. Higher-priced boards or external modems, like those from Hayes, cost about twice as much as the economy brands. With these boards, you can write a message using any of the popular word-processing programs and transmit it to any Group 1, 2 and 3 fax machine, or to another computer equipped with a fax board.

When a fax message is received by a computer, it can be printed on any dot-matrix or laser printer that can print graphics. The printer must be able to print graphics to churn out fax copy that started out as an ASCII text file because the fax software you use in your transmitting computer converts ASCII text into a bit map that's a picture of the printed page.

Until now, one important thing you couldn't do with a received fax was receive the fax message with a fax modem board, save it into your word processor and modify it. Another problem was that the received fax took a lot of memory to store it. Now there are several programs from character-recognition software publishers that eliminate these limitations.

FaxMaster from Caere Corp. allows you to launch a fax from within a *Windows* application. You can even select a time for the fax to be transmitted. When a fax is received, the software converts it back to ASCII within the *Windows* application so that you can export it into a word processor or DTP program. You can even click on a *Windows* box and look at the cover sheets of up to six faxes.

So far so good. However, this program does even more. It can compress a bit-mapped fax into 1/3 of its received size and store it on you hard disk. In addition, a Viewer function enables you to look at all the thumbnail-sized faxes you've stored. The only problem with this wonderful program is its $249 cost. When you add this to the cost of the modem, the price is about as much as for a stand-alone fax machine. You have to add up pros and cons to decide the best deal for you.

Another fax-conversion program is Calera's *Faxgrabber*, also a *Windows* application. It receives incoming faxes and converts them to ASCII or any of the popular word-processor formats.

Both of the fax converters cited are available from most software retailers.

Pre-Loaded CompuServe

CompuAdd Computer Corp. is now preloading the CompuServe Information Manager onto the hard disks of all computers it sells. Included are a month of free use of CompuServe's Basic Services and a $15 credit for use of other extended services that are optional at additional charges. The CIM front-end program makes it much easier to sign onto and access specific areas of the service. This front end greatly speeds up use of the service and reduces the amount of on-line time needed to access specific services.

Closing the GUI Gap

Now with the two dominant GUI's, Macintosh and *Windows*, coming closer and closer to each other in functionality, the time of the graphics network has arrived. Prodigy is part of the proof, but it's America On Line that's blazing the trail. It keeps growing and looking better and better, with more graphics features and new innovative services.

AOL is the model for the future. The former specifications for graphic-based networks, such as those used by Prestel in England, didn't offer clear-cut advantage and, therefore, were a failure in this country. But the current crop of graphic networks based on *Windows* or *Motif* are something else again.

The whole concept of personal computers on-line and connected in LANs is expected to take another leap forward from the original idea of one person, one computer. Now the buzzword is "workgroups," the idea being that people in business aren't isolated or grouped in vertical LANs. They work in groups, and work done is the product of many minds. Microsoft recognized this with the new *Windows for Work Groups* and included the workgroup concept in the forthcoming *Windows NT*.

Beware The Tax on Modems!

They never stop trying, only this time it isn't the states or even Congress that are after modem users for more money. It's the IRS, which is making its own rules by interpreting laws passed by Congress for totally different purposes.

The Information Technology Association of America has issued a warning that the IRS may be seeking to extend a 3% communications tax to users of on-line services. A similar tax is already being collected on all telephone service and has been since 1965. After Congress made the tax permanent, the IRS began making rules to implement it. The IRS may now be seeking to extend it to use of modems.

The ITAA is calling this a foul because it would impose an unfair burden on the growth of a highly competitive and expanding sector of the economy. Users are already paying a tax on their use of the phone service. An additional tax on on-line services they use would be double taxation.

The greatest fear is that IRS could decide to tax services like CompuServe and GEnie directly. Moreover, the extension of the tax

to new technologies may come as the result of an IRS ruling not caused by an action of the President or Congress and is, therefore, harder to protest or influence by voters.

It's much harder to get Congress and the administration to legislate on specific reductions in bad tax law. However, one hope is that it will take about a year for the IRS to implement such a ruling and that there may be a different administration and Congress by the time this column appears in print.

Setting Up a BBS

Have you ever considered running your own BBS for your business or club or just for the fun of it? It's not that hard to do. If you have an 80286 or better computer you don't use all the time, you can run your own board. You need about 2M of RAM, a floppy drive, a hard-disk drive of at least 40M capacity, a 2,400-baud modem and a telephone line for a minimum installation.

You also need bulletin-board software and the time to look in on your system once in a while. Most of the time, your BBS can run unattended. There are many kinds of BBS software systems. I'll examine one here and others over the next few months and explain their operation.

One of the most successful BBS systems is *The Major BBS* from Glacticomm, now released in Version 6. Minimum configuration is a complete bulletin-board software system for two simultaneous users on a single PC. *The Major BBS* includes five prepared BBS models from which to choose:

The Public Model grants anyone who calls full access immediately.

The Sign-Up Model allows new users to call and sign up. You approve them later.

The Private Model allows you to specify exactly who can sign onto your net.

Customer Service Model supports your customers and gets their feedback.

For Profit Model has users pay for using your service.

The software enables users to send messages and write electronic mail with a full-screen editor. They can attach a binary or ASCII file via the file-transfer protocol of their choice, with XMODEM, YMODEM, ZMODEM, Y-MODEM-G, KERMIT, Super KERMIT and ASCII supported. They can request return receipts and send "carbon copies" to other users.

You can have up to 3,500 public message forums with keyword searching, file attaching, message threading, message quoting, and "quick-scan" capabilities. And you can assign users read-only, read/write or co-management access to each forum. Each forum can have its own teleconference for real-time discussions.

Each forum can also have a file library, with as many sub-libraries as you want. Users can do key-word search or tag a group of files to be downloaded. *Major BBS* has propriety Locks and Keys security, which allows you to place locks on features or areas of the board. You can give a "Key" to each user you authorize to use the features of the board. A common group of keys can be combined into a key ring that can be set up for sharing by many users.

You can also conduct polls about members, and each member can have a personal resume on the board that describes his or her interests.

The Major BBS also has a full accounting system with as many types of users as you wish. You can assign time limits per call and exempt any user you wish. The pay-for-use system can calculate a user's on-line time by the minute and generate accounts for billing purposes.

In short, *The Major BBS* can do just about anything the commercial networks do in a local mode.

For each modem you use, you must have an available COM (COM 1, 2, 3 and 4 are supported) port and a Hayes-compatible modem. Speeds can range from 300 to 3,800 bps.

The standard package costs $259 and supports up to two simultaneous users. For more users, you need only a "User Six Pack" to support up to six additional users, at $249 per "Pack." Advanced LAN options and X.25 Packet Switching options to offer long-distance callers easy access to your BBS are also available.

The Major BBS also has all kinds of games and other options that can be added as the BBS grows. This includes multi-user applications and on-line order entry.

Running a BBS is a hobby in itself and can really hook you. There are networks of BBS sysops who provide world-wide communication via relay systems, and there are board-busters against whom you must protect your system.

If you're going to run a board as a free hobby, you'll be exempt from most regulation and taxes. However, once you start to charge fees to use your board, you're considered to be running a business. In such a case, there are sales taxes to be paid on the fees you charge. Be aware, too, that there's also a tendency in some states to try to tax any software that is downloaded from your board.

You can also be held responsible for illegal information placed on your board by members. There have been cases where BBS sysops have had their equipment seized because a user placed credit-card numbers on their boards without their knowledge. Being that you'll be held responsible for what's posted on your board, pay attention to the goings-on. Play safe by controlling access to users you can trust.

For information about *The Major BBS*, call 1-800-328-1128. To sign onto *The Major BBS*, call 1-305-583-7808.

If you're interested in the legalities of being a BBS sysop, get a copy of *Syslaw—The Legal Guide for On Line Service* by Lance Rose, Esq. and Jonathan Wallace, Esq. Now in its second edition, this book spells out to BBS sysops their basic rights and responsibilities. It has been written so that non-lawyers can understand it. Subjects covered include the First Amendment, copyrights, trademarks, the user agreement, privacy, criminal law, searches and seizures, viruses and adult materials.

Syslaw not only explains the law, it gives advice that can enable sysops to protect their boards from risk of legal actions. It's available for $34.95 plus $3 S&H (and any applicable sales tax) from PC Information Group, 1125 E. Broadway, Winona, MN 55987; tel.: 800-321-8285 or 507-452-2824.

XTree for Windows Debuts

My favorite file-management program for DOS, *Xtree*, has finally made it to *Windows*. Despite the fact that I've been eagerly anticipating *XTree for Windows*, I was somehow less than satisfied with what I got. It wasn't the program. *XTree for Windows* has even more features than the DOS version. It includes a large array of viewers that let you see files from popular word processors, databases and spreadsheets with some of their formatting intact. Many common graphic-file formats are also supported.

The program has several functions for handling compressed files and a file-transfer utility. And *XTree for Windows* effectively uses *Windows*' GUI conventions to provide easy access to its features, as well as to display different file groups. There are a feature toolbar, buttons to quickly change the number of levels displayed in the tree view, a window for the automatic file viewer, and so on. Moves and copies can be accomplished using drag-and-drop, and files can be launched by dropping them on any executable or batch file.

Nevertheless, *XTree for Windows* didn't give me the same thrill *XTree* for DOS first did. I think the reason is that *Windows* is so much more self-sufficient than DOS. DOS originally lacked sophisticated file-management tools. *XTree* was an order of magnitude or two beyond it. But although File Manager pales in comparison to *XTree for Windows*, it lets you do the basics.

You can tag groups of files and then copy, move or delete them. There's a global search, and you can select from a number of display options. *Windows* leaves a file-management utility with a relatively smaller incremental advantage than DOS did. This may not be enough to justify extra expense or extra training.

Utility vendors must be careful about how they enter the *Windows* marketplace or they may find too much of their target market preferring free functions over extra-cost enhancements they offer. For example, take the experience of Flambeaux Software's *DOS Help*, which is a nearly perfect utility and one that has held up well over quite a few years. Nothing beats it for providing help with DOS commands. In fact, the help systems in both *Windows* and OS/2 have more than a passing resemblance to its method of threading through topics, something *DOS Help* has been doing since well before hypertext became fashionable and widespread.

A few years ago, Dan Rollins, *DOS Help*'s author and a Flambeaux partner, revealed to me that users wouldn't buy a good program if a free alternative was available. He was talking about the on-line references included with later versions of DOS and their effect on sales of *DOS Help*. Despite *DOS Help*'s excellence, the majority of DOS users apparently prefer the free built-in product to paying for an additional utility. These free references are hollow substitutes for *DOS Help*, of course, but Rollins maintained that they still kept down his sales.

Flambeaux's marketing hasn't always impressed me as the industry's strongest, but I suspect Rollins's argument has merit—and relevance—for *Windows* utilities. The company's experience makes me wonder how much room there's going to be for third-party ISVs as *Windows* continues to grow and add functions.

Windows for Workgroups

The next challenge will be to network utilities, peer-to-peer networks themselves and several groupware categories. By the time this appears in print, *Windows for Workgroups* 3.1 should be shipping.

Additions in *Windows for Workgroups* include special toolbars for both the Print Manager and File Manager. There are also several utilities. A Chat Accessory enables point-to-point, real-time communication. Net Watcher lets you see who's connected to your machine. And Win Meter shows the percentage of resources going to local and remote applications.

The Control Panel in *Windows for Workgroups* includes a slide bar to adjust performance between local and remote requests. You can also use it to configure cards and the network transport layer, perform a drag-and-drop Netware installation, change machine names and workgroup names, etc.

Windows for Workgroups users will be able to share printers, access files on servers and share files on their local machines with others. The program runs on *LanManager, LanServer, Netware, DEC PathWorks, PowerLAN* (from Performance Technologies) or any other network that supports the SMB (Server Message Block) protocol. It also has its own peer-to-peer network capabilities. *Windows for Workgroups* can even connect to an SMB network and other *Windows for Workgroups* machines over its built-in peer-to-peer network simultaneously.

Windows for Workgroups should be a powerful competitor for the small peer-to-peer installation. Installation is eased by detection of known network cards and automatic configuration of the appropriate drivers. However, Microsoft says that beta sites are also using the product for networks with hundreds of nodes.

The program's network support is based on the NDIS (Network Device Interface Specification) standard for card-to-transport layer communications (between the network and physical layer). Out of the box, there are expected to be at least 29 drivers and support for 112 Arcnet, Token Ring and Ethernet cards. An additional 35 drivers and 65 cards are on the *Windows* Supplemental Driver Library.

Moreover, *Windows for Workgroups* includes a Microsoft *Mail* 3.0 work-alike with capabilities of both the client and sever. You'll be able to send mail directly from the File Manager toolbar or by dragging a file and dropping it on the minimized email icon. Almost everything is in there except the message-transfer agent that allows you to send mail between Microsoft *Mail* post offices.

Also included in *Windows for Workgroups* is the *Schedule+* application, which is an email-enabled calendar and group meeting scheduler. Its Network DDE feature extends DDE across the network. A Clipbook View Accessory provides a network-wide clipboard. Workstations that want to share data simply copy it to the Clipbook, and any node with access privileges can paste from it.

Microsoft says all of this will break down the barriers to networking. It may also break down a few competitors in the network and groupware markets and keep many others from entering.

The above is just the beginning. The Mac's remaining advantage over cheap commodity computers is already being eroded by *Windows*. For instance, SuperMac has launched a *Windows* business

group, and insiders have informed me that the company's *Video Spigot* will soon be available for the PC.

When the *Windows*-compatible *NT* operating system rolls out in a few months, we may finally see the beginning of the end—if not of the Macintosh itself, at least the end of the absolute need for one. It will certainly be much more difficult to justify getting into Apple's high-cost closed technology once a popular 32-bit operating system is on the PC.

Developers are flocking to *NT* now, and it's just a matter of time before the innovations that have traditionally kept the Mac out in front for designers and artists are developed for both computer platforms at the same time.

Disk Technician Gold

Some utilities still seem like safe bets. Neither *Windows* nor DOS has yet approached the issue of hard-disk reliability. So, you're definitely going to want to consider the new Disk *Technician Gold* (*DTG*) from Disk Technician Corp. It's the first hard-disk maintenance-and-restoration utility to run in the background under *Windows* 3.1.

On Columbus Day, Disk Technician president Norm Ivans touched his Aerostar 601/700P down in Burbank, CA just long enough to show me a pre-release version of the product before continuing enroute to Minneapolis for a meeting with Seagate the following day. He also told me about a ground-breaking joint announcement the two companies were planning. It was an exciting demonstration—and surprising news.

But then, Disk Technician has been breaking new ground for years. I've been a fan of the program for a long time because of its soft-error tracking. From its beginning, *Disk Technician* has built a database of soft errors over time that allows it to move data before hard errors occur. The last version, released about a year ago, added another innovation by making repairs in the background.

Now, the current revision extends this capability to *Windows*. Just install the 14K *Disk Technician* device driver, and it moves your data away from failing areas of the drive. It does this while you work.

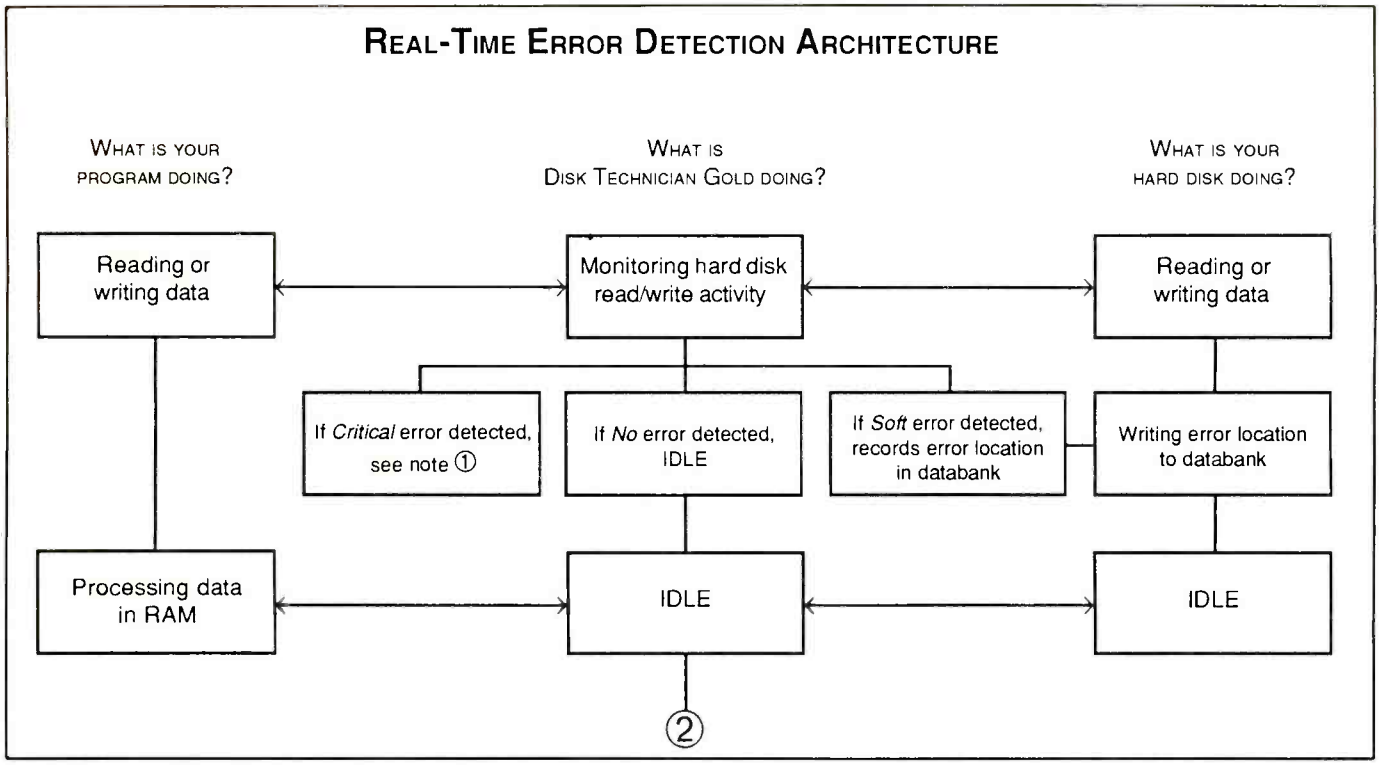
Another new feature allows *Disk Technician* to protect data from power failures. Though there's an overhead penalty, with this option enabled, you can pull the plug in the middle of a disk write operation without losing a single bit. If this seems unlikely, think about using it with your laptop. You can forget about the habit Ni-Cd batteries have of draining almost without warning and outright battery failures.

Disk Technician has also answered a thorny question it shares with virus software. How do you know if it's going to work when you really need it? It isn't easy to test the efficacy of either type of program, and *Disk Technician* claims to be the only drive utility that can detect soft errors. Fortunately, according to Ivans, Seagate has made the definitive determination using its own *Intelligent Disc Tester* (*IDT*).

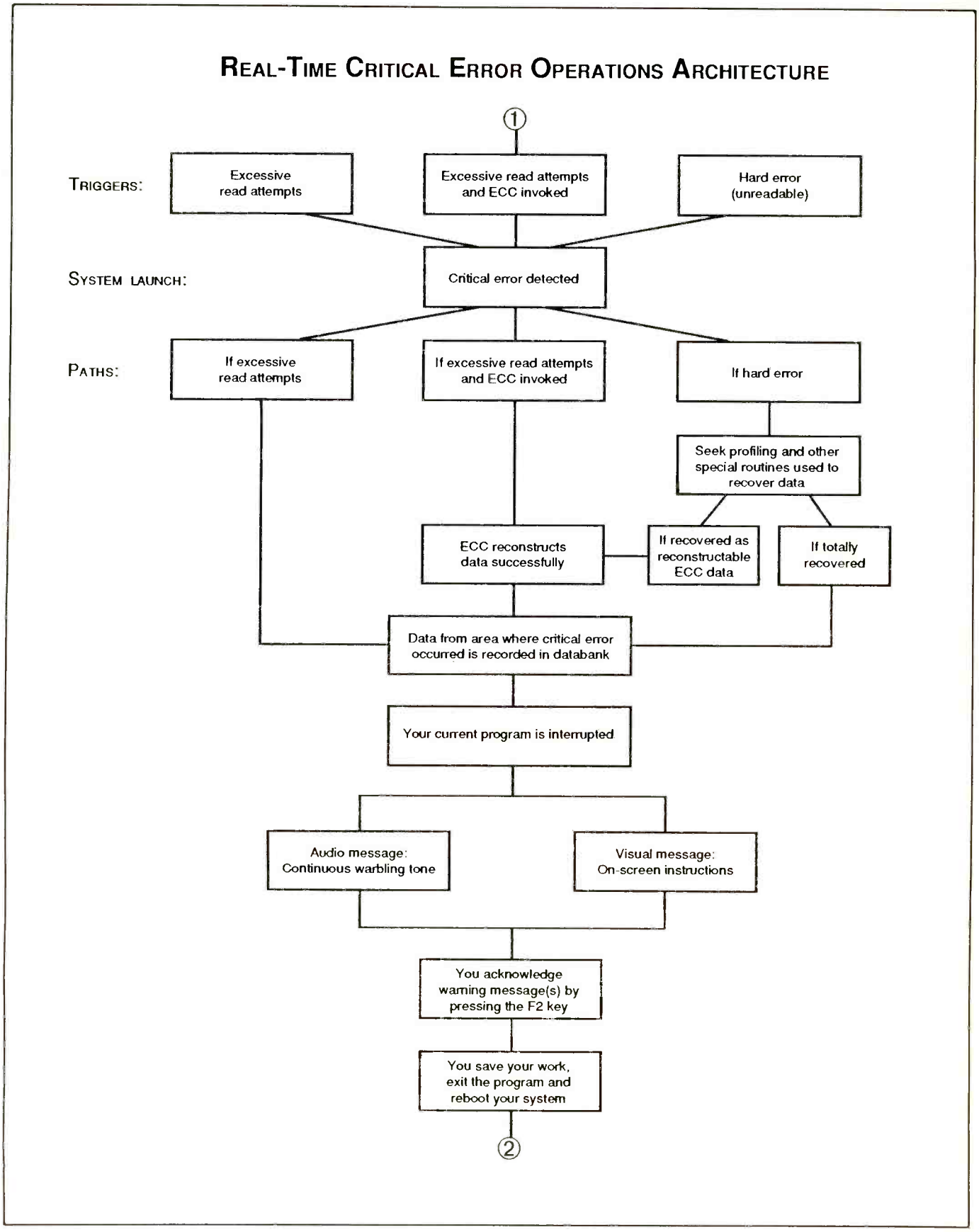
Ivans says that Seagate became a convert when *Disk Technician* found 100% of the known errors in 120 drives that had been tested with its expensive hardware devices. Not only did *Disk Technician* find all the errors, it did so 20 to 30 times faster than *IDT* did. A 40M drive takes roughly 3 minutes to test with the software. A more-comprehensive hard-disk media certification takes *Disk Technician* about 40 minutes for a slow MFM drive of the same 40M capacity.

As a result of its tests, Seagate is expected to recommend *Disk Technician Gold* with an endorsement that will include the use of a Seagate medallion on the software's packaging. The drive vendor will also use the software to replace some of the testing presently done by its *IDT*s. *Disk Technician* will allow VARs and other resellers to test drives without having to send them back to the manufacturer. Savings in time and money should be significant.

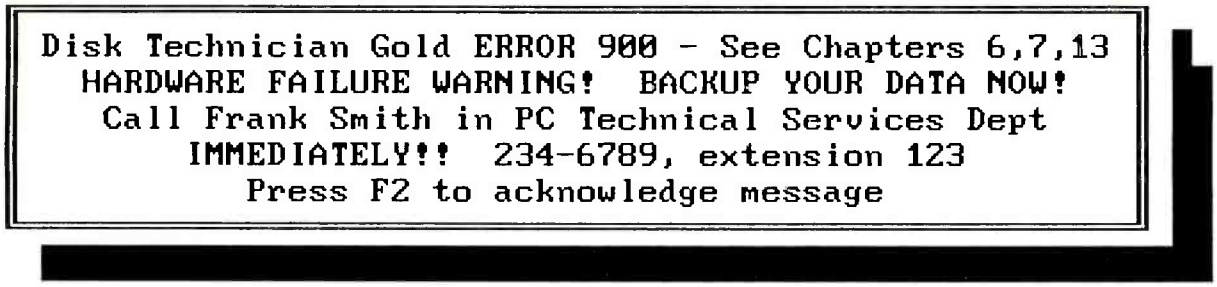
Disk Technician claims to find soft errors not only on MFM drives but on IDE and almost all SCSI drives (except fast-wide) as well. This is possible because the



Block diagram of Disk Technician Gold's real-time error-correction architecture.



Flow chart of DTG's real-time critical error operations architecture.



When DTG detects a hard-disk problem, it generates an on-screen warning, like the one shown here, that tells you exactly what to do.

program doesn't rely on ECC status. Instead, *Disk Technician* relies on methods of measuring the time a drive requires to complete reads. A long interval can indicate read failures that are requiring retries.

Soft errors are recorded in a database that's used to find intermittent errors and to detect patterns. An expert system evaluates the patterns for incipient hardware failures. For example, a predominance of errors on inside tracks may indicate that heads, amplifiers or (rarely) data-separator circuits are going bad. Bearing wobble is likely to cause more soft errors out at the edge of the disk, where deflection is greatest.

DTA also claims to be able to recover data from almost all hard errors, given enough time. Ivans says testers have yet to find an error from which the program was unable to recover the data.

Two other functions are included with the product. A built-in defragmenter operates on full drives (save a single sector) and handles unlimited partition sizes and an unlimited number of files. The method used moves data only once. Every time the system boots, a system-integrity test runs to prevent virus infections of user-specified file types. Other tests automatically check for bad FATs, lost clusters, cross-linked chains, allocation errors and errors in subdirectories.

Correction

Last month, I mentioned a couple of humorous calendar programs, and stated that the product from Amaze is "more flexible about how and when you consume its cartoons." What I meant to say was that *Cartoon-A-Day* from Individual Software is more flexible, but I didn't notice my careless error until after it went to press. Actually, Individual allows you to choose when you change its cartoons and to print them in a variety of ways (as correctly stated). The cartoons in the *Far Side Calendar* from Amaze are more rigidly programmed for their consumption to coincide with the passage of time. ■

Blue Multimedia

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

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

CIRCLE NO. 14 ON FREE CARD

Super Super-VGA

Video Seven's 1024i PLUS graphics card is configured with 512K DRAM and is capable of producing 16 colors at 1,024 × 768 resolution, or 256 colors at 800 × 600 resolution in either interlaced or noninterlaced modes. It supports high-resolution text and graphics on both fixed- and variable-frequency monitors. The card offers high-resolution drivers for most major software programs $129.

CIRCLE NO. 15 ON FREE CARD

The Win.VGA Super VGA card, also from Video Seven, is optimized for fast *Windows* graphics performance. It offers built-in hardware-assisted icon (BitBlt) transfers and line draws for dramatic improvement over standard VGA. The card supports *Windows* 3.1 and is packaged with drivers for most major software packages. $199. *Video Seven, 46221 Landing Pkwy., Fremont, CA 94538; tel.: 510-623-7857; fax: 510-656-0397.*

CIRCLE NO. 16 ON FREE CARD

New Windows Spreadsheet

Borland's *Quattro Pro For Windows* is a powerful new spreadsheet designed for the *Windows* environment from ground up. Two unique technologies that provide a significant departure from traditional spreadsheet models are an integral part of the product's design. Object Inspector menus let a user "right-click" on an object to display a list of all options that can be changed for that object. All changes can be made at once, saving the time of wading through several different menus. Spreadsheet Notebooks, based on the familiar tabbed paper notebook, organize spreadsheet data and dramatically improve the way a user builds and manages spreadsheets.

SpeedBar controls are collections of conveniently placed buttons that provide point-and-click access to the most-frequently-used features, such as cut, copy, paste, instant summing, automatic data entry, formatting, graphing and others. SpeedFill determines what information should be placed into a range of cells, based on information the user provides (adding the remaining month labels to a row once "JAN" is entered, for example). Drag And Drop lets a user select a block of cells, drag it, and drop it to move or copy to another location. Speed Buttons are user-created push buttons that run macros.

Several other significant areas of functionality include point-and-click feature accessibility, comprehensive presentation graphics, easy access to external *dBASE* and *Paradox* database files, and visual applications building tools. *Quattro Pro For Windows* is compatible with Lotus *1-2-3* and *Excel* at the file level and even at the macro level, simplifying upgrading existing applications. Upgrades and DOS/*Windows* bundles available. $495. *Borland, PO Box 660001, Scotts Valley, CA 95067-0001; tel.: 800-331-0877.*

CIRCLE NO. 17 ON FREE CARD

Microcontroller Technology: The 68HC11

By Peter Spasov
(Regents/Prentice Hall. Hard cover. 622 pages)

This is an engineering text book suitable for theory and some hands-on experience with a production microcontroller. It consists of 15 chapters organized and divided into five parts. Part 1, consisting only of Chapter 1, provides an introduction to computers, covering such topics as the technology, terminology, and essential memory concepts.

Programming concepts are covered in Part 2, which is made up of Chapters 2, 3 and 4. This section also includes information on the language used to instruct the microcontroller, how to use the registers and memory and how to produce, use and document programs.

Part 3 (Chapters 5, 6 and 7) is devoted to operation of the chip itself. Topics include the system bus, operating modes, clocked operation and memory technology.

Chapters 8 through 12, which make up Part 4, deal with subsystems for parallel, serial, programmable timer and analog interfacing. This section covers basic software techniques to use these systems and introduces some common hardware designs used to connect the microcontroller to sensors and actuators.

In the concluding Part 5, three chapters cover control methods, the microcontroller industry, a survey of typical applications, choices in selecting microcontrollers and characteristics of other microcontrollers.

The book ends with four appendices that cover the 68HC11 instruction set, a quick-reference section, a glossary of terms and sources of further information.

This book isn't a "light" read. It will be of most interest to someone who needs to learn the ins and outs of designing with the 68HC11.

Windows Accelerator Card

Add-On America's Renoir NT Windows Accelerator provides graphics-intensive environments, like *Windows* and *X-Windows*, with increased video speed and high-resolution display support. It supports up to 1,280 × 1,024 for both interlaced and noninterlaced monitors with eight-bit mode for 256 colors and 15-bit direct mode for a maximum of 32,000 colors. The card also supplies a hardware-supported cursor that provides perfect, smooth cursor and icon movement.

At the heart of the card is the S3 chip set that provides such on-board graphic primitives as circles, squares and rectangles, freeing the CPU of the necessity of generating them each time they're used on-screen. Renoir NT has 1M RAM. Bundled software drivers are included for *Windows, WordPerfect,* Lotus, *Ventura Publisher, AutoCAD* and most other CAD programs. $300. *Add-On America, 433 N. Mathild Ave., Sunnyvale, CA 94086; tel.: 800-292-7771.*

CIRCLE NO. 18 ON FREE CARD

Print Utility

Version 3.1 of *TreeSaver* from Discoversoft adds the ability to make saddle-bound pamphlets and manuals to its utilities for laser printing "tiled" pages onto a single sheet. *Treesaver* is a PCL interpreter. As such, it can handle graphics, soft fonts and even LaserJet macros. It also handles ASCII and PCL files. Because not all programs have the ability to print LaserJet-formatted output to a file (a PCL file), Version 3.1 has a utility that enables the user to capture LaserJet output into a file from any DOS application. $90. *Discoversoft Inc., 1516 Oak St., Alameda, CA 94501; tel.: 510-769-2902; fax: 510-769-0149.*

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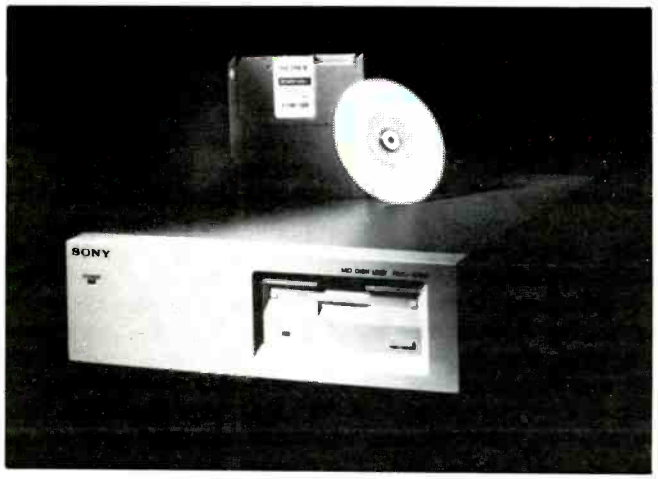

Rewritable Optical Drive

Sony's RMO-S350 is a rewritable optical system for IBM/compatible and Apple Macintosh computers. It stores up to 128M of fully rewritable information on a 3½" magneto optical disk. Using a SCSI-2 interface for high throughput, it has an average seek time of less than 40 ms with a 4M/s burst transfer rate. Sony's RMOS driver supports full removability by enabling users to import files from several rewritable optical disks without exiting the program and booting the computer every time the disk is changed. $2,295. *Sony Computer Peripheral Products Co., Optical Products Div., 655 River Oaks Pkwy., San Jose, CA 95134; tel.: 800-352-7669; fax: 408-432-0253.*

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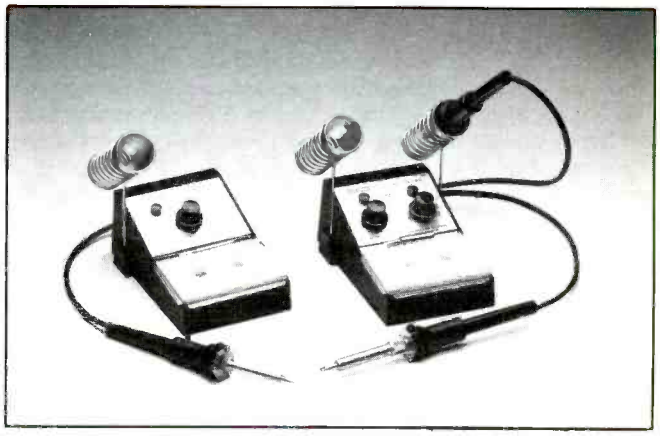


Soldering Stations

Hexacon's HTC series soldering stations feature heating elements located inside the tip for rapid recovery and an innovative sponge holder design with removable dross tray that eliminates operator contact and collects potentially hazardous solder dross. The sponge holder makes tip cleaning more effective by using a double-sponge concept with four wiping surfaces that total 32 sq. in.

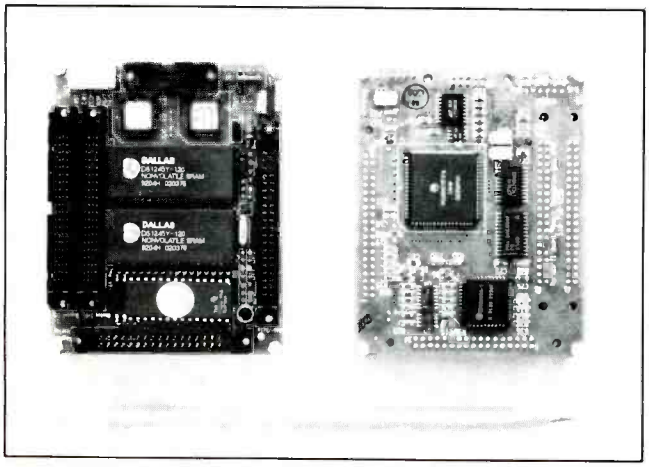
Solid-state circuitry regulates temperature with ± 10° F from 550° to 850° F. A positive grounded tip, together with static dissipative handle and case, ensures that the unit is ESD safe. The station has spike-free performance and exceeds requirements of all military soldering specifications. *Hexacon Electric Co., PO Box 36, Roselle Park, NJ 07204-1946; tel.: 908-245-6200; fax: 908-245- 6176.*

CIRCLE NO. 21 ON FREE CARD

Board & Design Kit

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

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



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

CIRCLE NO. 22 ON FREE CARD

Windows Printing Booster

WINSPRINT from Myriad is a low-cost printer controller that accelerates *Windows* 3.x printing on LaserJet II and III printers. It consists of a small interface board that fits into the optional input/output slot at the back of the LaserJet, a 16-bit ISA interface board that installs in the computer, a cable that connects the two interface boards and a printer driver. The controller requires an 80386 or 80486 computer with one open 16-bit slot and at least 4M of system memory and uses 2M of available memory. It supports 64 shades of gray and device-independent bitmaps and such advanced desktop-publishing features as negative justification, inter-character spacing, full kerning pairs and extended text metric information. $399. *Myriad Enterprises, Inc., 3149 Bonn Dr., Laguna Beach, CA 92651; tel.: 714-494-8165; fax: 714-497-9398.*

CIRCLE NO. 23 ON FREE CARD

Dvorak's Inside Track to DOS & PC Performance

By John C. Dvorak & Nick Anis
(Osborne McGraw-Hill. Soft cover. 879 pages. $39.95)

At best, DOS is often confusing to even people who have used it for years. To the newcomer, DOS can be overwhelming. This book addresses the needs of both the long-time user and the newcomer, and it succeeds in being useful to both groups amazingly well. In large part, this is due to the clear, straightforward writing style employed by the authors. A few evenings spent with the book and the 70 or so utilities included on the 720K floppy could move the casual DOS user up to the "power-user" category.

DOS basics and commonly used commands are covered in the first three chapters. Chapter 4 is devoted to menu programs and DOS shells. AUTOEXEC.BAT and CONFIG.SYS are covered in Chapter 5. Chapters 6 and 7 are devoted to multitasking, task switching, background processing and PC memory management. Data protection and recovery, back-up software, back-up hardware, security and viruses are covered in Chapters 8 through 11. Then operating environments—such as *Windows*, OS/2, Unix, *Desqview*, VMS, DR-DOS and networks—are covered in Chapters 12 through 18. Chapters 19 through 23 discuss diagnostic utilities, benchmarks, disk caching, disk defragmenters and other performance-enhancing software. Edit and other line editors are addressed in Chapter 24. The most important section in this book may be Chapter 25, which is an extremely clear presentation on DEBUG. Batch files and macros are the main topics in Chapter 26, while device drivers are covered in Chapter 27.

Major utilities (commercial, shareware and freeware) are described and evaluated in each chapter to provide the newcomer with a basis for judging the suitability of a particular program. The utilities range from freeware to shareware to portions of commercial programs. This volume would be a solid addition to almost any PC user's library. To quote John C. Dvorak, "Highly recommended."

C-Size Inkjet Plotter

Pacific Data Products' new ProTracer personal CAD printer produces both large drawings (C-size, 17″ × 22″) and standard text documents. It combines an Intel i960 RISC-based controller and high-performance Canon engine to provide quality C-size drawings in less than 5 minutes. By adding HP-GL and/or PostScript emulation cards, you can customize the printer to match your software applications. For check plots, ProTracer also supports a higher-speed mode that prints at 180 dpi instead of the standard 360 dpi.

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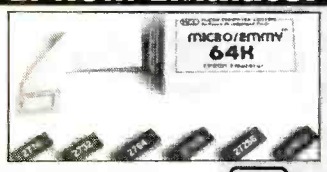

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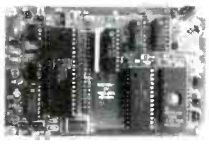

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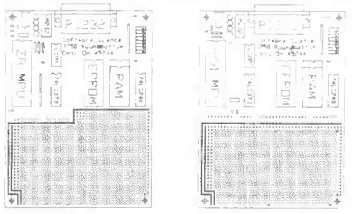

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U.S. Department of Defense cut a deal with the government of Japan for Mitsubishi Heavy Industries and General Dynamics to join mind and machine to make a new fighter jet. If the dual project isn't blown apart by politics and cost overruns, the Japanese F-16 FSX may see its first test flight in 1996. The FSX will incorporate larger and stronger wings, a more-powerful engine and a longer fuselage and larger fuel tanks.

Whatever the eventual fate of the FSX, fighter jocks who can handle a "hot" joystick are able to lift off from a computer-generated tarmac and fly missions in *Operation: Fighting Tiger*, which is more than a new addition to *Falcon* 3.0. It's another significant upgrade (3.0 to 3.01), with game improvements and new theaters of conflict.

As with *Falcon* 3.0, players of *Fighting Tiger* get to fly with a squadron and even plan an entire engagement. New digitized messages are used, with radio chatter, new wingman commands, more weather conditions and better landing aids. Although three new theaters beckon for action—Korea, Kashmir and the Kurile Islands—only the Kurile Islands campaign flies the FSX. Another change to game play is that more emphasis is placed on mission planning and execution, as opposed to the use of brute force.

Like *Falcon* 3.0, *Fighting Tiger* is complex and requires a large investment of time. The game manual is comprehensive and tedious. Graphics are excellent. Air-combat enthusiasts who like the play of *Falcon* 3.0 will undoubtedly like *Fighting Tiger* even more.

And now. . . **Falcon: The Book**. As detailed as the *Falcon* 3.0 manual (and the *Fighting Tiger* manual) is, its complexity welcomes additional instruction. One such aid to increased *Falcon* understanding is the book *Falcon 3.0 Air Combat* by F-16 pilot Pet Bonnani and writer Bernard Yee. This in-depth treatise launches itself with a historical perspective of air combat and F-16 development.

The meat of fighter pilot tutelage doesn't get going until Chapter 3. Still, plenty of room is left in the more-than-300-page book to over all aspects of *Falcon* 3.0, this from the perspective of an experienced pilot.

The advantage of owning this book is that it can help you through the rough parts of *Falcon* 3.0, like landing, ground-bombing and SAM avoidance. Mercifully, the book includes a keyboard template, a useful tool that has become all but extinct in this age of multifarious simulations.

John Madden Football

Some years elapsed between the time John Madden retired from coaching professional football and release of the initial version of the football game that bears his name. Madden's football game was well-received in the computer-game market, at least well enough for Electronic Arts to have a second version ready for the 1992/93 NFL season.

Both versions of the *John Madden Football* game reflect Madden's concepts of individual player match-ups, coupled with the kind of rough-and-tumble play that characterized his coaching tenure and current sports announcing. *Madden Football* lets computer coaches take full control, selecting plays, substituting players and looking for the most advantageous one-on-one match-up.

Perhaps the game's most useful feature is its Chalkboard, where you can diagram, edit and examine formations and plays in great detail. Computer coaches can even design original plays and execute them in slow motion to see what occurs. Furthermore, one can isolate a particular player position to look for ways to make minute adjustments.

Player positions can be assigned to run block, pass block or trap in either direction. Potential pass receivers can be told to block and go, execute a comeback or run a curl pattern. The Chalkboard can help novice coaches learn the basics of football and serves as a refinement aid for armchair veterans.

John Madden Football II is undoubtedly the football game that offers the most tools and the most control over game play. From a coach's view, it lacks nearly nothing. However, computer football fans who like a lot of graphics will be disappointed with this game in this area. *Madden Football* comes up short of a first down. Players appear on a low-resolution football field that lacks visual detail. Players themselves are little more than blocky figures that lumber across the computer screen.

The visuals of *Madden Football* suffer from poor depth of field, making it difficult to gain precise control of key players like pass receiver or running back. Even the menus can become fatiguing to the eyes after a few minutes of play. The game design team might want to work on improving the graphics for any future version of *John Madden Football* or eliminate the 3D look and go completely to Xs and Os, with everything text-based.

The weight of *John Madden Football* clearly rests in its coaching aspect, which is what one might expect from an ex-coach of professional football. It's a fun game, once you understand how it works. The game is easy to control via computer mouse, and it offers an interesting view of football.

World Atlas

Most computer users have probably seen a computerized atlas of one kind or another. One of the original proponents of this kind of software is The Software Toolworks. Honoring its own efforts, The Software Toolworks has released Version 3.0 of *World Atlas*.

The geopolitical world saw rapid changes in the last few years. *World Atlas* reflects some of these changes by including maps of the Republics, formerly known as the Soviet Union. An advantage of any map is that it lets you oversee a large section of geography at a glance but still dispense supportive and informative details. If the map package is large, it might have several smaller maps or fold-out sections that contain other kinds of factual data. Map-browsing in this manner can easily demand the entire area of a large tabletop.

Another way to enjoy maps and their characteristic information is to use a software map like *World Atlas*. Not only does this reduce the physical work space, but voluminous amounts of data can go right along with it. *World Atlas* provides more than 240 maps of varying kinds, including index, topographical and statistical maps and even maps of the ocean floor. All maps are detailed and colorful, which makes them easy on the eyes.

No map is much good without supporting information like coordinate markings and indications of land elevations. This information and lots more is waiting for owners of *World Atlas*. A keyboard combination or click of a mouse button produces detailed intelligence about geography, people, education, health, government, crime, economy, agriculture, communications or travel.

World Atlas handles its own virtual river of data by displaying it in logical groupings. Thus, you can witness a listing of agricultural exports by country and have it sorted in alphabetical order. In case simple textual lists aren't enough, *World Atlas* can make a graph of the same data.

World Atlas needs about 6M of hard-drive space, which is a significant investment for many computer users. But the disk space is well used by this program, considering the wealth of material and generous number of maps.

At one's whim, information displays abound. Some displays concern climate, religion, language, health care, legal systems, crime, energy, inflation, transportation. . . . You get the idea. *World Atlas* is the kind of tool one wishes had been available years ago, during certain testy classes in junior high school. What a world of difference it might have made.

Looking Ahead

LucasArts Games, maker of fine simulations and graphic adventures, plans the release of what may be an exciting new simulation. It is called *X-Wing*, based on the famed *Star Wars* series by George Lucas. Rebel Alliance fighters will execute a continuing battle with the Empire. X-Wing, Y-Wing and A-Wing fighters will escort transports, dogfight against TIE fighters and attack the Death Star.

If you're wondering what took LucasArts so long to do the foregoing, designer Lawrence Holland remarks that the technology to accomplish LucasArts goals wasn't available until recently. *X-Wing* will for the first time integrate polygon and bit-mapped graphics, complete with shading and lighting effects. Keep a watch out for this one. ■

Bird's Eye View

Operation: Fighting Tiger, $39.95
Spectrum Holobyte, Inc.
2490 Mariner Square Loop
Alameda, CA 94501
Tel.: 800-695-GAME

Requirements

Memory	1M, DOS 5.0
Graphics	VGA only
Sound	All sound cards
Controllers	Joystick, Mouse, Thrustmaster

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Long
Complexity	Difficult
Playability	Good

In Brief: This is the best F-16 simulator yet. Recommend '386 computer, joystick, expanded memory and sound card for best results.

CIRCLE NO. 113 ON FREE INFORMATION CARD

Bird's Eye View

Falcon 3.0 Air Combat, $19.95
Osborne McGraw-Hill
2600 Tenth St.
Berkeley, CA 94710
Tel.: 510-549-6600
In Brief: This book is an in-depth tutorial of air combat and F-16 technique as it applies to *Falcon* 3.0.

CIRCLE NO. 114 ON FREE INFORMATION CARD

Bird's Eye View

John Madden Football II, $49.95
Electronic Arts Sports Network
1450 Fashion Island Blvd.
San Mateo, CA 94404
Tel.: 415-571-7171

Requirements

Memory	640K
Graphics	VGA, EGA
Sound	Tandy, Sound Blaster, Roland, Covox
Controllers	Joystick, Mouse

Evaluation

Documentation	Good
Graphics	Poor
Learning Curve	Medium
Complexity	Medium
Playability	Fair

In Brief: This software incorporates John Madden's own coaching philosophy into a computer game. Recommend hardware include '386 and mouse for best results.

CIRCLE NO. 115 ON FREE INFORMATION CARD

Bird's Eye View

World Atlas, $69.95
The Software Toolworks, Inc.
60 Leveroni Ct.
Novato, CA 94949
Tel.: 800-234-3088

Requirements

Memory	640K, Hard Drive
Graphics	VGA
Sound	AdLib, Sound Blaster, Pro Audio Spectrum
Controllers	Joystick, Mouse

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Short
Complexity	Easy
Playability	N.A.

In Brief: This package provides detailed software map and collection of data and facts about the world. Recommend hardware include a mouse and extended memory for best results.

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Microcontroller applications plans/software catalog. Temperature datalogger plans, $9.95 US. TENSOR, 342 Roberta St., Thunder Bay, Ontario, Canada P7A 1A3.

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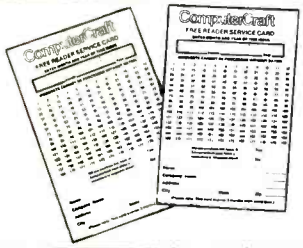

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Game Potpourri

One definition for *potpourri*, taken from *Webster's Third New International Dictionary*, is "a general mixture of often disparate or unrelated materials or subject matter." As you'll soon see, this definition readily describes the contents of this month's column.

Operation: Fighting Tiger

The date is May 1992; the magazine is *ComputerCraft*; and the subject is *Falcon* 3.0. After a long absence from the airspace of military flight simulation, Spectrum Holobyte yanked open the doors of its marketing hangar and rolled out a completely restructured version of its combat simulator of the F-16 Fighting Falcon. As reported in this column in May 1992, *Falcon* 3.0 was newer and brighter than its predecessors. It was complex, thrilling and, unfortunately, "buggy."

Initial consumer reaction to *Falcon* 3.0 ranged from disappointment to outrage. With no time to waste, Spectrum Holobyte launched software upgrades like radar-guided missiles. It took at least three pinpoint "kills," but the bugs were shaken. Falcon subsequently kicked in afterburners and went ballistic.

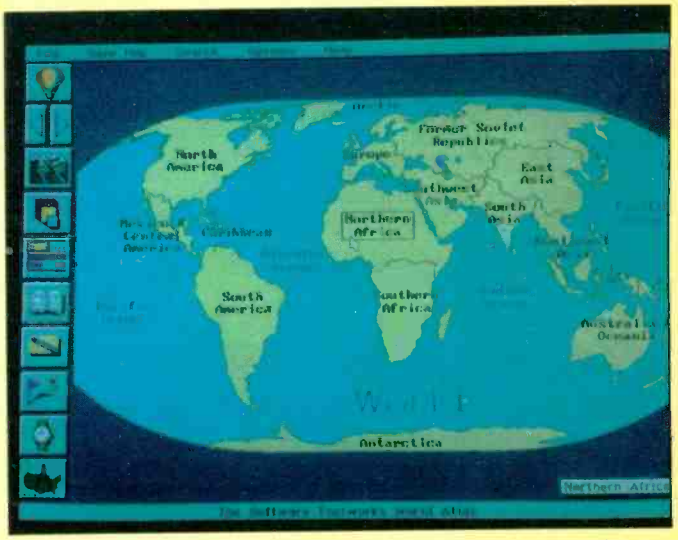
Now there's a new bird in the air—or soon will be. Its appearance is like that of the esteemed F-16, but the newer model will fly with marked improvements. The

(Continued on page 86)

Falcon's title screen.

Planning the FSX mission in Falcon.

Screen shot of an All Madden Team line-up.



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