On The Road With A Color Notebook Computer

ComputerCraft

November 1992 $2.95
THE PRACTICAL MAGAZINE FOR PERSONAL COMPUTERS & MICROCONTROLLERS (Canada $3.95)

- Special Report On 8-Bit Microcontrollers
- Build A Miniature Scrolling Marquee
- How To Remotely Reset Microcontrollers

A Preview Of Microsoft's Windows NT

Build A Universal Data Collector/Controller

Annual Shareware Industry Awards

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*

Brand New! One-For-All 12

Lets You Control X10 and Infrared from one remote!

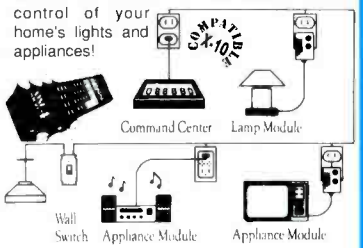
Universal Electronics has just unleashed their newest model remote control, the One-For-All 12. Billed as the most powerful universal remote in the world, the One-For-All 12 replaces 12 of your existing remotes for TVs, VCRs, Cable Boxes, CDs, Audio Products, Satellite Receivers and more! It can even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

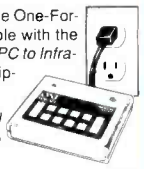
Check out these great features: Provides any device with a Sleep Timer function * Simple set-up * One Button System Control * Perfect replacement for lost or broken remotes * Toll-Free Consumer Help Line * Upgradable (by manufacturer, no charge!) to match the latest advancements in IR remote control 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 lower right)

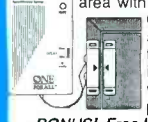


One-For-All 12 Universal Remote Control HCC-RC5 **ONLY $79.95!**

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

New! Supervised Wireless Security System

Installs in minutes - with no tools - and no wiring! URC8000 Console keeps track of 16 zones and displays status of each using LEDs. Because it's supervised you'll know if any door/window sensor is not working or has low battery. Add wireless door/window sensors to protect up to 16 different groups of doors and/or windows. Add a motion detector to protect an area with more than one entry point. Console sounds loud 85 dB alarm and sends X-10 signals to flash all X-10 lights! Scares intruder and makes home visible to others (neighbors, police enroute, etc).



Built-in infrared command center (see HCC-3000, above) for use with *One-For-All* remote! Console is also a receiver for the Stanley hand-held Mobile Control and the X-10 hand-held remote for controlling 16 X-10 devices!

Expand your system anytime by adding door/window sensors, motion detectors, or a plug-in Powerhorn siren!

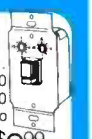
HCC-8000 Security Console (Reg. $99) ONLY $49!
HCC-574 Keychain arm/disarm ONLY $19.95
HCC-534 Door/window Sensor ONLY $14.95
HCC-508 Powerhorn 110 DB Siren ONLY $29.95
HCC-554 Wireless Motion Detector ONLY $49.95

BONUS! Free HCC-574! When you order an HCC-8000 and One-For-All remote control!

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 16. HCC-2475. ONLY $9.99

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

New Edition! Automation Book

"How to Automate Your Home" by David Gaddis. Excellent! Reviews in Popular Science & Radio Electronics, Circuit Cellar INK, & Electronic House. This superb book is now in it's 2nd edition, expanded and improved! 150 pages and over 125 illustrations. Recommended. Reg. $29.95 ONLY $26.95

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.

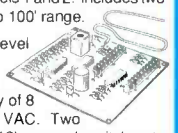
Use with *PC to Infrared Interface* to develop a system which combines home automation and IR control; any X-10 controller can control infrared! With addition of *Voice Master Key*, voice control of the home becomes possible. Use X-10's *Sundowner* to give dusk/dawn input to your system. Add voice PC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

HACKER'S BONUS: Get an HCC-RFX extra transmitter for ONLY $9.99 with HCC-RF1 & total HCC purchase over $249! Order HCC-711R

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.

Motion Detector

Stanley Indoor/outdoor wireless motion detector mounts virtually anywhere. Set to any X-10 housecode and unitcode. Transmits ON signal to base transceiver (see lower left) up to 66 ft. away. Operates 24 hrs. or only after dusk. Sensitivity adjustment and variable OFF delay. Detects 40 ft. at 110° arc. HCC-2652 ONLY $29.99

PowerHorn Remote 110 DB Siren

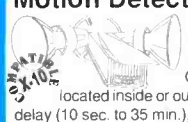
For use with Supervised Security System (above). Can also be triggered by the PowerFlash module (right) or any X-10 "On-Off-On" sequence. White. By Schlage. Reg. $49. HCC-508X ONLY $29.90

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 housecode, or send ALL LIGHTS FLASHING (this will also activate PowerHorn Siren, left).

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 outside world. By Schlage. ONLY $16.99

Motion Detector & Floods



Detects motion, turns on floodlights, and sends up to four X-10 ON signals to modules located inside or outside the house. OFF delay (10 sec. to 35 min.), dusk/dawn and sensitivity adjustments. Detects 40 ft. at 110° arc. Weatherproof. By Stanley. HCC-2651 ONLY $39.99

Stanley Premier Home Control

Controls 16 devices. Handsome simulated woodgrain design with smoked flip-up keyboard dust cover. HCC-2549. ONLY $17.49

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 housecode; receives unit numbers 1-8 or 9-16. Off-white. By Stanley. Reg. $29.90 HCC-501X ONLY $14.99

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 (left). Off-white color. HCC-2553. ONLY $16.95

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 $149) for voice control of your entertainment system! Combine with *X-10 Development Kit* (above) 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 upper left). Remote has special port which connects to your PC's serial port (using our cable and wardware 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!**

Enerlogic ES1400e

Step up to Intelligent Home Control!

New ES1400e puts out 50% stronger X10 signal strength than original ES1400! Version 2 software & expansion port for future integrated products.

This intelligent X10 scheduler with 2-way interface monitors your powerline and allows IF-THEN control. Combine with Stanley motion detectors and have music and mood lighting follow you from room to room! Use X10 Sundowner to give your system dusk/dawn input. Great for setting up one-button macros! Once you've set up your home program, the on-line simulator allows you to test it completely! Once the ES1400e is set up, your PC may be powered down or used for other purposes!

The ES1400 is packed with features, including a battery back-up, Hayes Chronograph clock and calendar functions, programming samples, on-line help, complete documentation, 1 yr. warranty. HCC-1400 ONLY $369

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1-800-CONTROL

WHOLESALE PRICES. $100 MIN. PER ORDER.

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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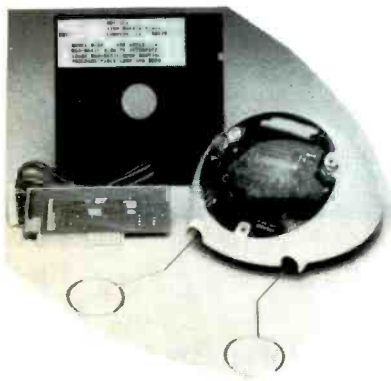
LASER DIODES

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

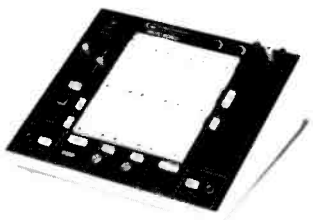


The pen mechanism included with the robot allows it to draw. In addition to drawing straight lines, it can also accurately draw circles, and even draw out words and short phrases. WAO II comes with 128 x 4 bits RAM and 2K ROM, and is programmed directly via the keypad attached to it. With its built-in 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

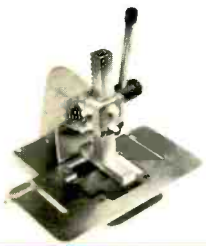
PROTOBOARD DESIGN STATION



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

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

He-Ne TUBES

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

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

POWER SUPPLY

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

STOCK #	PRICE
PS1003	$19.99

ROBOTIC ARM KIT

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

STOCK #	PRICE
YO1	$43.99

AVOIDER ROBOT KIT

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

STOCK #	PRICE
MV912	$43.99

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ComputerCraft

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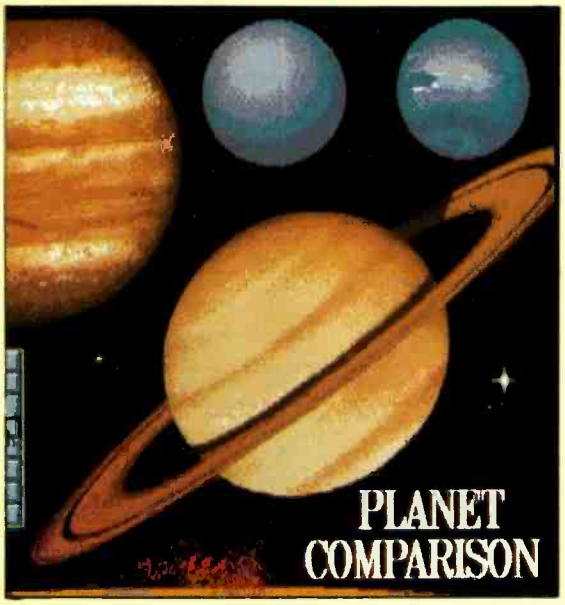

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90

Cover Photo by William DeVore

ON THE COVER: Microcontrollers and SBCs have come into their own as almost universal solutions for implementing a host of real-world applications. Beginning on page 37, Jan Axelson focuses on eight-bit microcontroller boards.

THE PARTS PLACE℠

Come in for Your FREE Radio Shack Catalog!

The most important part of your next project is the all-new, 172-page 1993 Radio Shack catalog. It's yours for the asking at our store or dealer near you. Hurry in today—supplies are limited!

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

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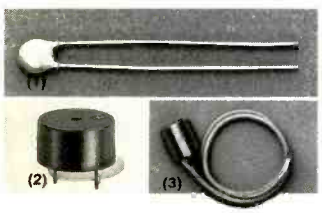
- **CB and scanner crystals ■ Long-life vacuum tubes**
- **Phono cartridges/styli ■ SAMS® service books**

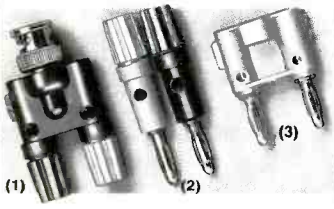
Why pay more for mail-order? Your Radio Shack stocks 1000 electronic components, and another 15,000 are available *fast* from our special-order warehouse. Ordering is easy! Bring in the exact part number (or old part). We'll check availability and order by phone. Delivery time to your nearby Radio Shack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



(1) Picofarad 50-Pack. Delight for tweakers. 50 ceramic capacitors, assorted 1 to 33 pF values. 50 WVDC. #272-806 ..... **2.99**

(2) Efficient PC-Mount Piezo Buzzer. Tiny yet has 70 dB output and requires only 7 mA at 12VDC. #273-074 ..... **2.99**

(3) Omnidirectional Electret-Type Mike Element. 30-15,000 Hz. 4 to 10 VDC. #270-092, **2.99**

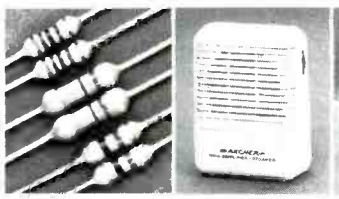


Test-Equipment Adapters. Great for use with scopes, frequency counters and multimeters. Hook up with the best.

(1) Binding Posts to BNC Plug. 50 ohms impedance. #274-715 ..... **8.95**

(2) Binding Post to Banana Plug. #274-716 ..... **Set of 2/4.95**

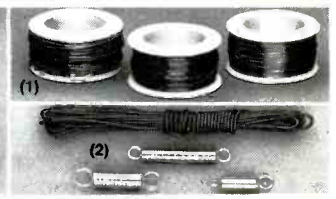
(3) Stackable Dual-Inline Banana Plug. #274-717 ..... **2.99**



Resistor Assortments. Popular values—stock up and save.

Description	Cat. No.	Set of	Price
Metal-Film 1/8W	271-309	50	2.29
Carbon 1/4W	271-308	100	2.99
Carbon-Film 1/4W	271-312	500	7.95
Carbon 1/2W	271-306	100	3.49

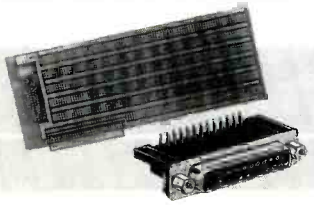
Mini Audio Amp With a Built-in Speaker. Many uses! Tough 3⅜"-high case. Low Radio Shack price. #277-1008 ..... **11.95**



(1) Magnet Wire Assortment. For custom coil winding. Includes 40 feet of 22-gauge, 75 feet of 26-gauge and 200 feet of 30-gauge on spools. #278-1345 ..... **4.99**

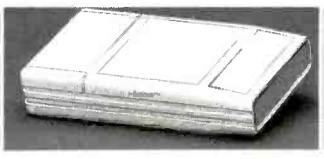
(2) Dial Cord Fix-It Kit. Our exclusive! Includes six feet of high-strength cord and three tension springs. Put a radio back into action! #274-435 ..... **99¢**

High-Speed 12VDC Mini-Motor. Produces an amazing 15,200 RPM at no load. Ideal for projects, robotics, fun! About 2" long (with shaft). #273-255 ..... **2.99**



PC/XT Circuit Card. Epoxy. Fits computer expansion bus. 10 1/16" long. #276-1598 ..... **29.95**

Right-Angle D-Sub 25 Female Connector for Above. #276-1504 ... **2.69**



Infrared Project Box. Ideal for a remote. Has removable infrared-transparent end panel and space for 9V battery. 7/8 × 2 3/8 × 4 1/4". #270-294 ..... **4.49**

100-Watt Soldering Gun. For big jobs! Reaches full temperature in seconds. Built-in work light. Replacement tips in stock. UL listed. #64-2193 ..... **11.95**

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CIRCLE NO. 78 ON FREE INFORMATION CARD

Over the Horizon

PC hardware and software changes are never-ending. Looming on the horizon are some shifts that will affect all of us in one way or another as we continually scamper to take advantage of new technology.

Some movements augur well for those of us who don't wish to make an immediate change. For example, if you have a fast machine, you don't have to dump it soon whenever a new development speeds things up a bit. However, you'll likely take advantage of this advance when you're in the market for a new computer, driven by some need or when the money to buy one becomes available. Other design deviations call for swift action if you want to gain productivity in a major way. This might mean giving up an XT or AT for a 386 machine to be able to use *Windows* programs.

There are always a number of developments churning that will turn up in next year's models or, perhaps, in a few years that will change your computing life. For some people, this might be a moderately priced pen-based computer that works with handwriting recognition software.

Sophisticated voice-recognition software and hardware will undoubtedly come into its own in time, though the moment isn't close at hand for it at an acceptable price. The Cumberland Microcomputer Users Group's August club paper had an interesting write-up about a demonstration of a software/hardware system called Dragon Dictate that turns a PC into a voice-driven typewriter.

This $9,000 system has a 25,000-word base vocabulary, with another 5,000 user-customized words. An additional 80,000-word vocabulary is said to be available from the *Random House Unabridged Dictionary*. According to the writer, Jo-Ann Edinburg, a Dragon representative spoke into a microphone and the PC typed a memo, a letter, captured an address for an envelope from *WordPerfect* and created a spreadsheet from a loaded Lotus program. Utterances can be words up to 5 seconds in length, which can be command phrases to link to a program's macros. The system is reported to adapt to the speaker's way of talking, creating a speech pattern model for an individual.

The representative said that most users become productive with the system in a few hours. Experienced users can reportedly create 30 to 40 words per minute typing speed with the voice-driven system. Words appear on-screen, where they may be proof-read. When two words sound alike, the voice program makes its choice and gives the speaker a chance to select the proper word from a list or spell out the word if none are correct.

Then there's a new computer development from Ricoh called a "neurocomputer" that's reported to work without software, using neuron chips instead. It's claimed that it has a processing speed of 128 Mcps (million neuron connections per second), which is about 500 times faster than a typical engineering workstation. The system "learns" tasks, storing information in the company's LSI RN-100 chips. The first commercial neurocomputers are expected to reach the marketplace within five years, and possibly as early as next year.

Not everything that's around the corner realizes its anticipated potential, of course. Just take a look at the Unix operating system, for example. As far back as ten years ago, industry pundits were touting it as an OS that's just about to start taking over from MS-DOS. It hasn't and probably won't, unless there's a sudden rapid expansion of very-powerful computers bought by many millions of people.

There are some 60- to 70-million computers in use that aren't as powerful as a 386 model, which itself isn't suited for the bloated code used in Unix. Furthermore, Microsoft will be pushing its *Windows NT* operating system, while IBM pushes its OS/2 development. Unix is out in the cold insofar as dominance is concerned, and its unlikely that it will ever make it to this point in our lifetime. Nevertheless, it promises to remain a very important, vital OS because it's relatively machine-independent, has a solid base of users and continues to develop UNIX-trained people in universities.

Look, instead, to major advances that don't break with the past, such as exciting wireless telecommunications, which will surely emerge in a big way. There's a crying need for it, whether for networking in offices or for transferring data from and to CompuServe, MCI Mail, fax machines, and so forth.

Art Salsberg

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Letters

Outstanding!

•Nick Goss' article "Build a Controller/Actuator" to turn stepper motors into neural servos in the July issue of *ComputerCraft* was outstanding! It attracted my attention since I was in the development stages of a system that will allow me to make prototype circuit boards straight from my PCB design program.

Pablo Santa
Vallejo, CA

Avid Fan

• I've been an avid reader of Jan Axelson's articles for many months now. I like the variety of topics she covers. I've been working with microprocessors for years and have just lately become interested in microcontrollers. Jan's articles have been a great source of information for me.

Several times in the past, Jan and other writers in *ComputerCraft* have mentioned Intel's *Embedded Microcontroller Handbook* as a source of information on the 8051 family of microcontrollers. I called Intel and ordered the books. They cost me $25 plus shipping. They are, indeed, informative. I also called Advanced Micro Devices (1-800-538-8450) and requested the eight-bit 80C51 *Embedded Processor Data Book*, which was free (as are all the company's data books; AMD even pays shipping). I thought your readers might like to know of this additional source of information.

Charles R. Goulding
Black Canyon City, AZ

It's a Must!

• As a college student majoring in computer engineering, I find that almost everything I read in *ComputerCraft* is "upgrading" my knowledge in the computer world. As an example, "Memory Management" (May and June) was really interesting. Yacco presented this topic in a very comprehensive manner. What makes me certain about this is that this is the type of material we learn about in school.

I subscribe to a lot of computer magazines and I personally think *ComputerCraft* is the best. I do have a wish list, though. I'd like to see a more in-depth article on the I/O bus cycle and its circuitry, internal architecture of ix36 bus controller and the microprocessor interface.

Last but not least, I would like to say that *ComputerCraft* is a must for every electronics engineering major. Keep publishing this good stuff!

Zuliak Maibin
Fresno, CA

Coming Next Month

Special Report on Upgrading Microprocessors

December's Special Feature Will Provide Valuable Information On:

- How to Choose a Better CPU
- Benefits to 286, 386 and 486 Performance
- Evaluating CPUs for Substitution Purposes

Radio Shack's Software Kiosk. Radio Shack replaced its Express Order Software Program with an in-store, freestanding, interactive multimedia kiosk system. Allying with distributor Ingram Micro, it makes available a huge software selection (more than 1,000 titles) for shipment within 72 hours directly to the customer. The system provides a photo and description of each software package on a video screen, and products are indexed for viewing and data-sheet printing by using TandyVision's touch-sensitive screen.

New Anti-Radiation Shield Add-On. NoRad Corp. (Santa Monica, CA) introduced "UltraGlass," an anti-radiation and glare shield for video displays that is said to exceed Swedish standards (MPRII) for electric field attenuation. It also eliminates static electricity with a grounding cable. Universal models are top-mounted with a hinge, while "Form Fit" models are available to match Macintosh displays. They're priced at $149 and $139, respectively. Call 800-262-3260 for test documentation and NoRad's White Paper on "VDTs as a Source of Electromagnetic Radiation."

A Quote-A-Day Software. Wisdom of the Ages Version 5.1 adds Quote-A-Day to this electronic book of quotations, sayings and ideas. It offers more than 6,500 selected thoughts from over 1,000 of history's great minds, both Eastern and Western. Material is grouped into 81 major subjects, each having seven subdivisions that include Positive, Negative and Advice. Every time the computer is turned on, an inspirational quote automatically appears on-screen; quotes can be customized, too. A word search finds all quotes containing a target word. A hard drive with 1.8M free disk space is needed. $99. Call MCR Agency, Oakland, CA at 1-800-767-6797.

Battery-Powered Portable Hard Drives. Vision Logic (San Jose, CA) has introduced very-small, battery operated hard-disk drives for IBM PC compatibles. The portable IDE drives, in 60M and 80M storage sizes, feature 19-ms access time. Priced at $499 and $599, respectively, including dc set, they connect to a parallel port and have printer feed-through. Powered by a rechargeable Ni-Cd battery, measuring only 1" x 3" x 6", plus cable length, and weighing just 1 lb., plus cable, makes carrying around programs and files easier than ever. They can also work as internal drives. Computer pioneer Adam Osborne is the company's president.

Device Speed Leader. Cypress Semiconductor announced a new process technology, BiFAMOS, that's moved PROM speed onto the RAM track. The first products in the family are 25-nanosecond erasable reprogrammable 1M-bit PROMs, said to beat rival devices by 20 ns. This breakthrough will eliminate the penalties of transferring code from slow PROMs to fast "shadow" RAM to keep pace with fast processors.

68HC11 BASIC Interpreter

Allen Systems' CB-11 full-featured BASIC interpreter for the 68HC11 microcontroller supports most standard BASIC constructs, including floating-point operations, trigonometric functions, string handling and versatile output formatting. Process control constructs are also available and include a real-time clock, PWM output and access to HC11 on-chip resources. User programs can be burned into EPROM or saved to disk on a host computer. $100. *Allen Systems, 2346 Brandon Rd., Columbus, OH 43221; tel.: 614-488-7122.*

CIRCLE NO. 13 ON FREE CARD

Color Hand Scanner

Logitech's ScanMan Color 24-bit color hand-held scanner for the *Windows* environment captures up to 16.8-million colors and features a proprietary white fluorescent light that permits consistent scanning brightness without a warm-up period. With its 24-bit capacity, ScanMan Color can capture true 256-level gray-scale data on-the-fly, without need to convert color information to gray scale.

The scanner is bundled with *FotoTouch Color*, a significantly expanded version of gray-scale software. *FotoTouch Color* has a variety of editing tools located in a "toolbox & drawer" structure that can be customized. An interactive context-sensitive graphical help system lets a user browse through a series of graphics screens and icons to locate specific help. *ScanMan Color* adheres to the TWAIN protocol and functions as a *Windows* OLE server. Minimum hardware requirements are a 386SX computer, *Windows* 3.x, 4M of RAM, 5M free hard-disk space, open 16-bit expansion slot, VGA card and monitor and a mouse. $699. *Logitech Inc., 6505 Kaiser Dr., Fremont, CA 94555; tel.: 510-795-8500; fax: 510-792-8901.*

CIRCLE NO. 14 ON FREE CARD

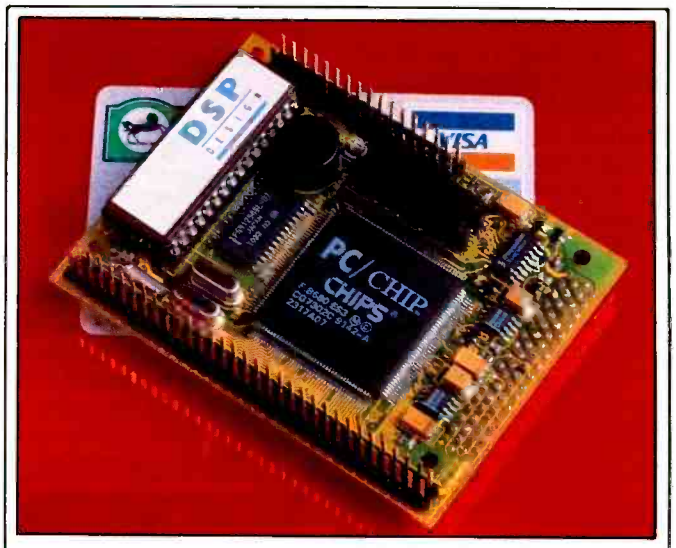
Engineer's Complete Guide to PC-Based Workstations 80386/80486

By Gary A. Shade
(Prentice Hall. Hard cover. 286 pages.)

This book seems to be for an engineer who knows virtually nothing about IBM/compatible computers specifically (and computers in general) but is about to venture into the PC world. Perhaps there is such a reader.

Chapter 1 is devoted to an overview of how PCs are used in engineering. Subtopics include component design, software tools, hardware emulators, CAD systems, data acquisition and more. Chapter 2 covers the Altera Corp. erasable programmable logic devices (EPLDs) in detail. Chapter 3 moves into hardware selection, with a discussion of single-user versus networked systems. Consisting of only 10 pages, Chapter 4 covers PC graphics from fundamentals to high-resolution subsystems. The fifth chapter is a discussion of various types of hard disks and other forms of mass storage, including MFM, ESDI, SCSI, DAT, optical drives. Chapter 6 is a guide to making hardware selections such as Unix systems, networking options, site planning, output devices, and input devices.

Technical publishing is covered in the seventh chapter, with attention given to word processors, elements of text, editing graphics, training and installation. In Chapter 8, the author provides a glimpse of what he sees in store for graphics, mass-storage systems, tape systems, optical disks, instrumentation, networking, operating systems and output devices. Finally, there is a listing of sources for systems products, software, and networking products.



Miniature PC

The GCAT miniature PC built by DSP Design and imported by The Saelig Co. measures only 3.4″ × 2.6″ and has a Chips & Technologies 14-MHz F8680 CPU. Graphics is built in, and the board drives a CGA LCD screen or CRT without using additional boards. The serial port is COM1 hardware compatible (can be configured for RS-485). On the board are 1M of RAM and a 512K ROM-disk capability. With DOS and BIOS installed, about 400K of application space is left for diskless operation.

Power consumption of the GCAT is about 73 mA from a single 5-volt supply, dropping to less than 600 μA in Suspend mode. Because expansion to any I/O is via the regular PC bus, off-the-shelf I/O boards can be used. A development system is available with everything needed for programming. An optional peripheral board contains a floppy controller, IDE controller, bi-directional parallel port, second COM port and a six-channel 12-bit-plus-sign A/D converter. $799. *The Saelig Co., 1193 Moseley Rd., Victor, NY 14564; tel.: 716-425-3753; fax: 716-425-3835.*

CIRCLE NO. 15 ON FREE CARD

Caching Controller

GTEK's PCDC-14 new hard disk caching controller allows up to 14M of hard disk caching in non-volatile static RAM. Back-up battery life is reportedly ten years minimum. It can be used with all types and sizes of hard disks. A background auto-flushing option provides a typical 100% write hit rate.

The PCDC-14 has its own on-board BIOS, requires no drivers or TSRs and doesn't use any of the computer's RAM. It works in both ISA and EISA machines and comes with 0K of RAM. $399. *GTEK, 399 Hwy. 90, Bay St. Louis, MS 39521-2310; tel.: 601-467-8048; fax: 601-467-0935.*

CIRCLE NO. 16 ON FREE CARD

PC-Board Layout Program

Version 4.0 of *PCRoute+* from PCBoards uses two routing algorithms for typically 95% completion ratios. The program features new graphics support, including super VGA, and has an almost seamless interface with its companion program, *SuperCAD Schematic*. Also included is via optimization. The *PC Route +* program has a completely new look, with all new screens that include a pop-up window user interface to make it easier to use. $149. *PCBoards, 2110 14 Ave. S., Birmingham, AL 35205; tel.: 800-473-PCBS; fax: 205-933- 2954.*

CIRCLE NO. 17 ON FREE CARD

Notebook Computer

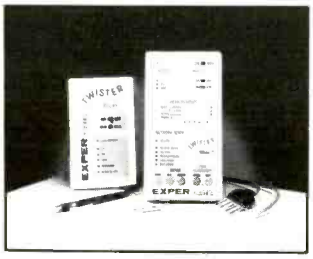
Everex's new Carrier SL/25 Notebook computer has a removable 80M hard drive and built-in trackball. The 5.8-pound computer, based on the Intel 25-MHz 386SL processor, features 64K of internal cache and supports Advanced Power Management (APM), which defines the power-management relationship between hardware and software in several ways to provide maximum power efficiency while ensuring compatibility. The removable hard drive provides added data security; or several users could use the same computer at various times and always keep their applications and data with them on their own drive.

Other features include optional desktop drive adapter, the ability to "hot swap" batteries without stopping or suspending an application, battery recharge in 50 minutes, built-in virus detection, simultaneous display on LCD and external monitor, flash BIOS for simple upgrade, instant power-on capability and 4M of RAM. $2699. *Everex Systems, Inc., 48431 Milmont Drive, Fremont, CA 94538; tel.: 510-498-1111.*

CIRCLE NO. 1 ON FREE CARD

Network Tester

Twister from Experdata is a tester for 10 Base-T Ethernet BO2.3 networks. To test network wiring, the Twister generates a 5-to-10-MHz signal to check compliance with the 10 Base-T standard in terms of attenuation and near-end crosstalk. A dynamic test with Ethernet frame transmission (operating at 100% traffic capacity) detects excessive jitter caused by physical wiring defects. For the concentrator test, the Twister verifies that all network hubs are functioning properly by transmitting and receiving Ethernet frames as well as testing link status and jabber.

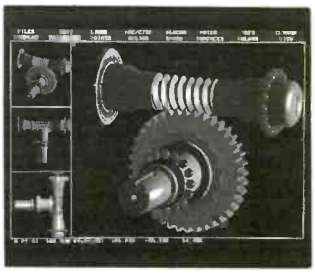


To validate connections once the network has been wired and equipment hooked up, an echo test is carried out over each connection between the twister and its relay. The device is portable and battery powered and can be operated by a single individual. *Experdata Inc., 10301 Toledo Ave. S., Bloomington, MN 55437; tel.: 612-831-2122; fax: 612-835-0700.*

CIRCLE NO. 2 ON FREE CARD

New DesignCAD 3D

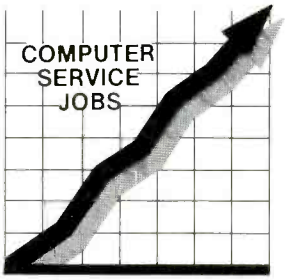
Version 4.0 of *DesignCAD 3D* from ASBC adds realistic shading, greater speed, a new *Windows* CUA-like interface, on-line manual, keyframe animation, texturing, complete color control and new DCFILES utility. DCFILES transfers files to and from most popular graphics file formats, like DXF, HPGL, IGES, PCX, PostScript, RIB, and *WordPerfect* WPG. Minimum requirements are an IBM/compatible computer with 2M RAM and a hard drive. $499 ($50 upgrade). *American Small Business Computers, One American Way, Pryor, OK 74361; tel.: 918-825-4844; fax: 918-825-6359.*



CIRCLE NO. 3 ON FREE CARD

5 sure steps to a fast start as a high-paid computer service technician

1. Choose training that's right for today's good jobs



Jobs for computer service technicians will almost double in the next 10 years, according to the latest Department of Labor projections. For you, that means unlimited opportunities for advancement, a new career, or even a computer service business of your own.

But to succeed in computer service today, you need training—complete, practical training that gives you the confidence to service any brand of computer. You need NRI training.

Only NRI—the leader in career-building, at-home electronics training for more than 75 years—gives you practical knowledge, hands-on skill, and real-world experience with a powerful 386sx/20 MHz computer you keep. Only NRI gives you everything you need for a fast start as a high-paid computer service technician.

2. Go beyond "book learning" to get true hands-on experience

NRI knows you learn better by doing. So NRI training works overtime to give you that invaluable practical experience. You first read about the subject, studying diagrams, schematics, and photos that make the subject even clearer. Then you do. You build, examine, remove, test, repair, replace. You discover for yourself the feel of the real thing, the confidence gained only with experience.

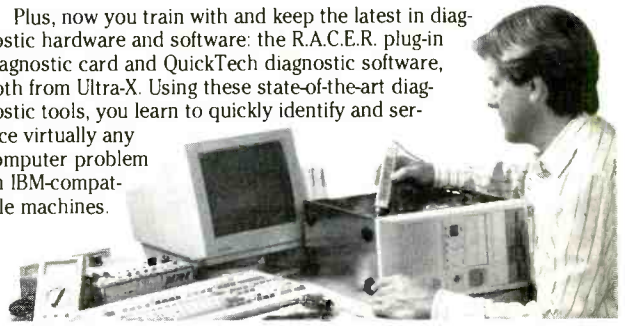
3. Get inside a powerful computer system

If you really want to get ahead in computer service, you have to get inside a state-of-the-art computer system. That's why NRI now includes the powerful new West Coast 386sx/20 MHz mini tower computer as the centerpiece of your hands-on training.

As you build this 1 meg RAM, 32-bit CPU computer from the keyboard up, you actually see for yourself how each section of your computer works. You assemble and test your computer's "intelligent" keyboard, install the power supply and high-density floppy disk drive, then interface the high-resolution monitor. But that's not all.

You go on to install a powerful new 40 meg IDE hard disk drive—today's most-wanted computer peripheral—included in your course to dramatically increase the data storage capacity of your computer while giving you lightning-quick data access.

Plus, now you train with and keep the latest in diagnostic hardware and software: the R.A.C.E.R. plug-in diagnostic card and QuickTech diagnostic software, both from Ultra-X. Using these state-of-the-art diagnostic tools, you learn to quickly identify and service virtually any computer problem on IBM-compatible machines.



4. Make sure you've always got someone to turn to for help

Throughout your NRI training, you've got the full support of your personal NRI instructor and the entire NRI technical staff. Always ready to answer your questions and help you if you should hit a snag, your instructors will make you feel as if you're in a classroom of one, giving you as much time and personal attention as you need.

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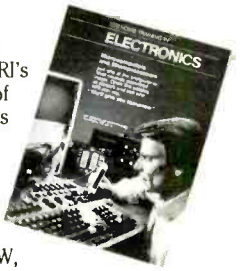

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Pocket Computer

Sharp's PC-E500 pocket computer features built-in engineering software, equation reference library, graphics capabilities, high-speed performance and expanded storage capacity for custom equations and BASIC programs. The PC-E500 boasts a 40-character × four-Line screen, a 240 × 32-dot full graphics display and 32K RAM, the last expandable to 92K with plug-in RAM cards. A RAM file function enables 64K RAM cards to be

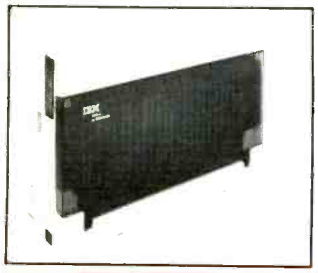
used as floppy-disk storage for data and additional programs. An optional pocket disk drive is also available for added data storage.

A QWERTY keyboard and separate keys for scientific functions combine to make the PC-E500 extremely easy to use. An algebraic expression reserve function stores up to 99 individualized expressions or constants, and scientific calculation capabilities provide 124 constants, 744 formulas and data and 233 scientific calculation functions. Weighing on ½ pound and measuring a mere 7″ × 3″, the PC-E500 offers computing power in a highly mobile package. $250. *Personal Home Office Electronics, Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430; tel.: 800-237-4277.*

CIRCLE NO. 4 ON FREE CARD

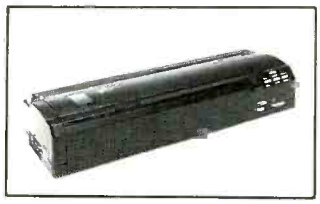
Two IBM Printers

The IBM Portable Printer from Lexmark uses thermal-transfer printing technology on plain paper and is designed for use with notebook personal computers. Weighing in at only 2.5 pounds, it's ideal for business travelers. The printer produces 360 × 360-dpi resolution. $549.



CIRCLE NO. 5 ON FREE CARD

Also from Lexmark is the IBM 4070 IJ ink-jet personal printer for use in the home and a small office. It features 360 × 360-dpi resolution, a small working space, quiet operating levels and battery pack. A carrying case is optional. $599 with sheet feeder; $499 without sheet feeder. *Lexmark International, Inc., 740 New Circle Rd. NW, Lexington, KY 40511-1876.*



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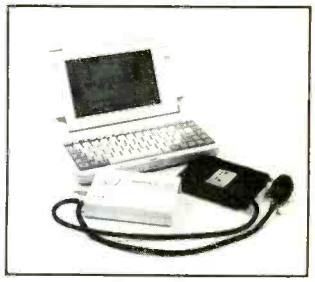
Health Product

Pulse Metric's DynaPulse 200M Home Version is a PC-based blood pressure and heart rate monitoring system said to provide clinically accurate blood pressure (systolic, diastolic and mean arterial) and heart-rate measurements. It also records and displays the complete heartbeat pressure waveform during each measurement. DynaPulse Home version provides unlimited trending and charting capabilities for all users (up to six) of the system. $179. *Pulse Metric, Inc., 10225 Barnes Canyon Rd., Ste. A100, San Diego, CA 92121; tel.: 800-927-8573; fax: 619-546-9470.*



CIRCLE NO. 7 ON FREE CARD

Working With Windows 3.1

By Marshall L Moseley & R. Andrew Rathbone

(Windcrest/McGraw-Hill. Soft cover. 331 pages. $19.95)

This is a beginner's book that steps the newcomer to *Windows* through the basics of this popular GUI. The first two chapters are devoted to an overview of *Windows*. Chapter 3 walks the reader through his first *Windows* session, covering such basics as using a mouse, the components of a window, the Control menu, selecting menu items, dialog boxes and exiting *Windows*. Using the Program Manager is the topic covered in Chapter 4, which devotes particular attention to group windows and icons, as well as individual program items. The Help system is covered in Chapter 5. *Window*'s anemic File Manager is covered in detail in Chapter 6. With the instructions included, the reader ought to be able to stretch File Manager to its limits.

Write, Paint and Terminal are each given a chapter of their own. Although none of these applications match up to the competition, the reader should be able to perform all the basic operations afforded by these built-in applications. Another chapter is devoted to the desktop accessories that ship with *Windows*, including Solitaire and Minesweeper.

Running DOS applications under *Windows* is the topic of a separate chapter. Particular attention is paid to creating custom PIFs for DOS applications.

Once the reader has the basic *Windows* operation down pat, he's ready for more-advanced topics, such as using the clipboard and Print Manager, which are covered in Chapter 12. This is followed with a chapter devoted to configuring *Windows* via the Control Panel. Closing the book is a chapter devoted to using *Windows* for Multimedia.

Fuzzy Estimation Design Tool

Manifold Editor from Fuzzy Systems Engineering provides an intuitive interface for capturing the expert judgments needed to build fuzzy systems. It provides a two-dimensional matrix display of the fuzzy system rules for viewing and editing rules and permits up to five input dimensions and two output dimensions in the fuzzy estimation surface design. Output selection in each rule is by mouse pointing and button clicking.

Manifold Editor provides piece-wise editing of fuzzy sets for simplicity and freeform fuzzy set editing for generality. A Manifold Walker testing tool in the Manifold Editor permits static testing of the fuzzy-estimation surface at any time in the design cycle. Manifold Editor outputs the expert information in an include file for use in your application code. The program requires a '286 or better computer with mouse, VGA and *Windows* 3.x. $250. *Fuzzy Systems Engineering, 12223 Wilsey Way, Poway, CA 92064; tel./fax: 619-748-7384.*

CIRCLE NO. 8 ON FREE CARD

Remote Console

Version 3.0 of Wheeler's *Remote Console*, a remote control program, requires only 22K of RAM to run and can be stored on a single 360K floppy disk. The new version adds remote printing, "call back," "auto-call" and a new diagnostic tool, as well as high-speed remote screen updates (up to 115,200 bps when connected directly). It's a remote-access communications and control system designed to link two IBM/compatible or terminal and computer systems via modem or direct cable connection. The program provides support for all popular LANs. $99. *Louis E. Wheeler, PO Box 888, Oceano, CA 93445; tel.: 805-481-5687.*

CIRCLE NO. 9 ON FREE CARD

(Continued on page 80)

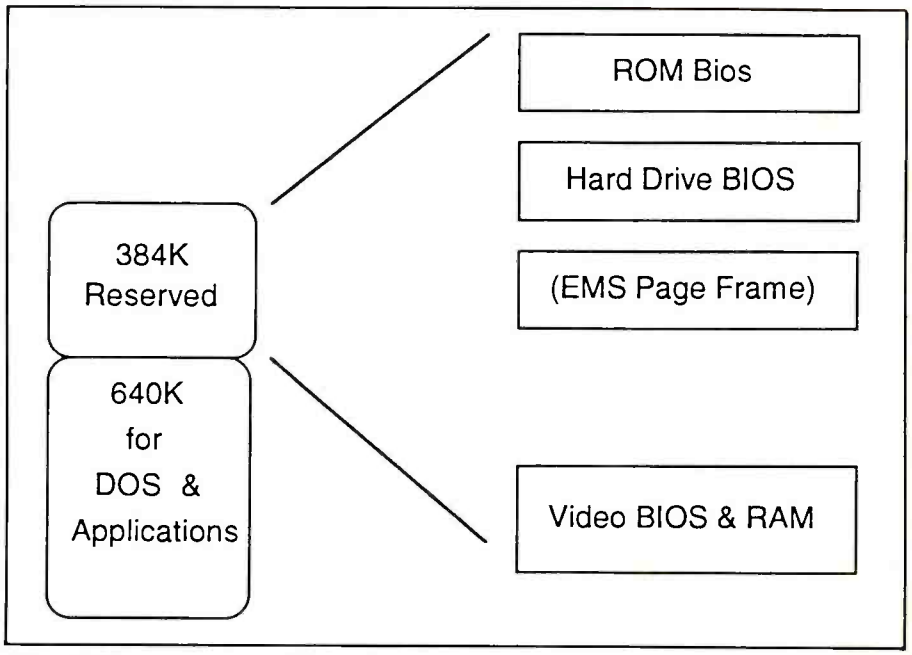
Breaking the 1M/640K Barrier

Accessing and using extended memory for DOS applications

I was standing at the service counter at a local computer supermarket, when the customer in front of me exploded. "What do you mean, I can't use this memory from DOS? Why," he asked, "did you sell me these extra memory chips if I can't use them? What can I do to get another megabyte of memory?"

His anger and confusion are typical. Users buy computers with a megabyte or more of memory or pay up to $100 per megabyte to add memory to their computers, only then to find out that the memory doesn't seem to do anything more than warm insides of their computers.

There are good reasons for adding more memory to your computer, of course, and ways to use all the memory you install. But you have to understand the nature of your computer's CPU and of common memory managers before you can take advantage of this extra memory.



The 8086's real-mode memory map.

Background

Up to and including Version 5.0, DOS is written to be compatible with the 8086 and 8088 CPUs Intel released in 1978 and which IBM included in the original PC and PC/XT. (The 8086 and 8088 are identical, except in the way they use the external bus.) The 8086 runs in a single mode, now called "real mode," and can address a maximum of 1M (1,024K) of memory. IBM reserved 384K of this memory space for hardware devices and its ROMs; the remaining 640K was devoted to DOS and applications. However, only the lowest 64K of RAM was actually present on the first PCs and compatibles.

Since those early days, Intel has released numerous versions of three new CPUs that are compatible with the 8086: the 80286, 386 and 486. By the time you read this, Intel will probably have announced the first 586 CPUs. But DOS continues as an 8086 operating system, with a few tidbits of support for advanced CPUs and general blindness to anything past the 1 M/640K limits that have always existed in PCs and compatibles.

Most application programs are still written to be compatible with the original 8086. But more and more programs are breaking those shackles and using much more than DOS memory. However, many of them can use the extra memory only if you know how to make it available to them.

All of the advanced Intel CPUs, from the 80286 to the 486 and beyond, can run in an 8086-compatible mode, called "real mode," that can address the same 1M as an 8086 CPU. But all of the advanced CPUs can also shift into "protected" mode and suddenly use up to 4 gigabytes (4,048 M) of RAM. It's important that you understand that, with one exception, extended memory—everything outside the 1 M/640K limit—is accessible only if the CPU is in protected mode.

In addition to the installed memory chips, the advanced chips support virtual memory. This means that, with a sophisticated operating system, programs can use more memory than is physically available in the computer. The CPU and operating system can team up to shift data to and from disk to supply a program's memory needs.

Our new user in the complaint line would probably cheer at this news until he understood that DOS isn't the required sophisticated operating system needed to take advantage of the extra memory. Except for its HIMEM.SYS and EMM386.SYS memory managers, DOS won't run in protected mode, and it doesn't know anything

about protected mode. Programs that use protected mode, either to store data in extended memory or to get the most performance possible from the CPU, have to shift back to real mode for DOS and BIOS services like reading and writing files and changing video modes.

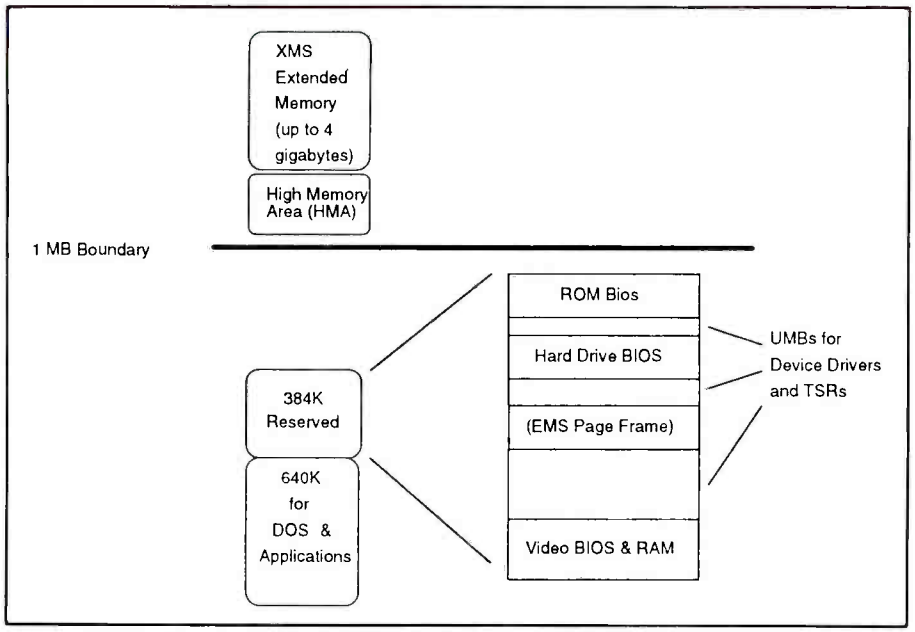
Shifting into protected mode takes a fair amount of preparation. If a program simply sets the protected-mode bit in the CPU's status flags, the computer will crash. Instead, a program has to set up several data structures, load registers that most real-mode programs have never heard of, and then change CPU modes. If this weren't inconvenient enough, the 80286 chip can't shift from protected mode back into real mode. When it was designed, Intel couldn't have guessed that any program would want to go from the far superior protected mode back to the confines imposed by real mode.

However, an 80286 computer can shift from protected to real mode by employing a special trick. A program can store a special magic number in memory, save all the machine registers at a special location, send a code to the keyboard controller and then put the CPU to sleep with a HALT instruction. Eventually (a millisecond or more later), the keyboard controller generates an interrupt that forces the CPU to reboot. The CPU always boots up in real mode, to maintain compatibility with the 8086.

During the reboot operation, the ROM BIOS sees the magic number and skips its self-test and other power-up routines. Instead, it loads the registers with the saved values and lets operation continue in real mode. This is neither an elegant nor a fast way to change modes, but it does work.

Reaching Extended Memory

It's easier to shift a 386 or 486 CPU from protected to real mode. But there are other problems that face all programs that want to use protected mode and extended memory. In real mode, an application can access any memory in the computer by putting a memory segment address in the DS or ES register and using an offset from that address. In protected mode, programs no longer have such complete control of the computer. The values in the segment registers are no longer specific memory segments but are instead pointers to a memory selector table that's controlled by a protected-mode operating system.



Virtual 86 mode memory map (386 or 486 plus XMS server).

Normally, a protected-mode application can't write directly to video memory, for example, because it can't know what selector points to the video buffer. And even if it does know or guesses the correct selector, it still may not have access rights to video memory. Also, since protected-mode applications aren't permitted direct access to I/O ports, they can't directly control such things as the video mode or a serial port.

The 80286 and later chips are designed to be run by a protected-mode operating system that controls memory allocation and access rights. Only the operating system has access to I/O ports and other system resources. One way to use all of the memory in your computer is to install a protected-mode operating system, like OS/2 or UNIX. But, despite the hurdles, some DOS programs can also make use of protected mode and extended memory.

Using Extended Memory

Memory can be used for either data or program code, of course. Generally, it's much easier for DOS programs to use extended memory to store data in much the same way that programs can use EMS expanded memory as a data store. Programs can access extended memory for data storage by employing a number of schemes, some of which have industry sanction and approval and some of them don't and are inherently dangerous (but still in use).

When the PC/AT was first released, it included a pair of documented BIOS calls that programs could use to find extended memory and use it for storage. The same BIOS services have been available on every compatible 80286, 386 and 486 since the release of the PC/AT, except on the PS/2 Models 25 and 30.

The extended memory BIOS calls are available to programs as Interrupt 15 hex, services 87 hex and 88 hex. Service 88 hex returns the size (in kilobytes) of extended memory. Service 87 hex switches the computer into protected mode, copies up to 128K – 2 bytes of data from any location in the computer to any other location and then switches back into real mode and returns control to the calling program.

One problem with service 88 hex is that it disables interrupts for the entire time that the computer is in protected mode. Therefore, it may interfere with programs that rely on the timer chip, serial interrupts and network drivers.

Temporarily disabling interrupts is

bad enough, but most software can work around this problem. The near-fatal flaw in these two BIOS services is that they allow access to extended memory, but they do nothing to control that access. For example, suppose you install a RAM disk in extended memory during boot-up. Later, you run an application that decides to use extended memory as a data storage area. Both programs can write to the same block of extended memory, thereby wiping out each other's data, without any warning from the computer at all.

Early Solutions

The real problem with the extended memory services in Int 15h is that they assume that one and only one program will want to use extended memory at any one time. However, there's no reason why a RAM disk, a TSR or two and an application (or many applications using a task-switching environment) shouldn't be able to use extended memory at the same time.

After the PC/AT was released, programmers searched for a way to share extended memory among competing programs. One idea, used by several early programs, was to substitute a new Int 15h, Service 88h routine that would lie about the amount of extended memory available. Under this scheme, each program would use whatever extended memory it wanted, taking its block from the top of available memory and working down, and then install its own Int 15h/88h handler. Later programs that looked for extended memory would be told only how much was left, not how much was truly installed in the system.

A second scheme was based on VDISK.SYS, a RAM disk that's included (along with source code) in every copy of PC-DOS. VDISK can use extended memory for a RAM disk, and it reserves this memory with a pair of special "signatures." One signatures was held in conventional memory, the other in extended memory in the boot sector of the RAM disk.

The signatures were important if a user wanted to install VDISK twice to create two different RAM-disk volumes. The second copy of VDISK read and altered both signatures in order to show that it was using more of the available extended memory.

Extended Memory Access Methods

- **Int 15H/Top Down**
  - Requires "lying" to other applications
  - Can be difficult to release memory
  - No enforcement/protection from other programs
- **VDISK/Bottom Up**
  - Requires two "signatures"
  - Can be difficult to release memory
  - No enforcement/protection from other programs
- **XMS**
  - Full enforcement/protection from other programs
  - Control of UMBs, HMA and extended memory from one memory manager
  - DOS programs must run in Virtual 86 mode
- **VCPI**
  - Used to let XMS and protected-mode applications coexist
  - No system protection from protected-mode bugs
  - Only one protected-mode application can run at any time
- **DPMI**
  - Used to let XMS and protected-mode applications coexist
  - Programs are protected from bugs in other applications
  - Multiple DOS/virtual-mode and protected-mode applications can run simultaneously

Developers who studied the VDISK source code concluded that this method of allocating extended memory had IBM's blessing and they adopted it in their own programs.

Unfortunately, some of these developers were lazy and updated only one of the two signatures. So new software that wanted to use extended memory had to do some major checking:

(1) Use Int 15h to see if any memory is available.

(2) Look for the VDISK signatures in both conventional and extended memory.

(3) If the signatures are found and they seem to be reserving different amounts of memory, be conservative and believe the highest number.

(4) Either update the signatures (if they're found) or install a new Int 15h/88h handler to lie to future programs.

(5) At the end of the program, undo (if possible) the signature or Int 15h handler.

As more and more programs used (and misused) extended memory, the lack of a standard allocation method made things worse and worse. In 1988, four years after the appearance of the PC/AT, Lotus, Intel, Microsoft and AST Research released the extended memory specification, or XMS. XMS requires an expanded memory manager (XMM) that takes control of all expanded memory and hands it out to programs as they make requests for it. XMM also controls two other areas of memory known as high memory and upper memory.

Other Memory

In real mode, the CPUs in the Intel family form a memory address by taking a 16-bit segment address, shifting it left four bits and adding a 16-bit offset address. If you've done any assembly-language programming, this segment:offset addressing scheme should seem familiar if somewhat clumsy. It lets the processor reach any address in its 1M memory space through 20 address lines, labeled A0 through A19, even though its registers are only 16 bits wide.

If the shifted segment plus offset add up to an address greater than 1M, the overflow is normally simply discarded. However, if the A20 address line on an 80286, 386 or 486 CPU is enabled, suddenly the CPU can reach an extra 64K – 15 bytes of memory in real mode. The overflow isn't discarded; the memory addresses don't wrap around. This extra memory has been dubbed the "high" memory area or HMA. Logically, it shouldn't be available from real mode, but it is. When you load DOS 5 high, it stores itself into this HMA.

In addition to real and protected modes, the 386 and 486 can also run in "virtual 86," or V86, mode. In this

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mode, an operating system can run one or more real-mode applications at the same time. Each application thinks it has a full computer to itself, including free access to BIOS and DOS memory areas, the video RAM buffers and I/O ports (with a few exceptions). In both protected and V86 modes, an operating system can re-map any physical 4K page of RAM to any RAM address.

One advantage of paging RAM is that empty areas above 640K but below 1M can be filled with RAM. Then, with appropriate help, device drivers and TSRs can move into these areas, leaving more memory below the 640K ceiling for application programs. Pages moved into empty memory areas are called Upper Memory Blocks, or UMBs. They're pieces of extended memory that are re-mapped, through paging, to appear below the 1M ceiling. However, they can be re-mapped for DOS use only when the CPU is in V86 mode. (Memory paging is also used by LIM EMS emulators that run on 386 and 486 PCs.)

XMS provides a specified method of allocating extended memory, the HMA and UMBs. With an XMM running, programs no longer have to worry about whether to use a VDISK or Int 15h approach to extended memory. They simply call XMM and request the necessary memory.

When a program requests extended memory through an XMM, it's given a handle or arbitrary number to use when it needs access to the memory. The memory manager is free to move memory around, either through paging or by copying data, to create unfragmented memory blocks for various requests. The application never needs to know what physical addresses hold its data, merely the handle that it and the memory manager are using to represent the data. Also, the memory manager guarantees that programs can release handles in any order without causing problems.

Up and Running

XMS lets programs use extended memory for data storage in a consistent manner, but it does little to help programs run in extended memory (and protected mode), other than allocating memory. The problem with operating in extended memory and protected mode is that all BIOS and DOS services are available from only real mode. Whenever a program needs a DOS service and a hardware interrupt (like a keystroke or timer tick) occurs, the computer must switch back to real mode to handle the interrupts.

Designing a program to run in protected mode from DOS is anything but trivial. Most developers who want to use protected mode use a DOS extender, a commercial product that links into their program code. The DOS extender provides services like controlling protected mode memory allocation, switching modes as necessary to handle interrupts and cleaning up and returning to real mode when a program ends.

In many ways, a DOS extender is a mini operating system that becomes part of a program. Like most operating systems, it wants complete control of the computer. However, XMS memory managers (and the EMS emulators that are often part of the same program) also need complete control of the computer. In fact, a memory manager usually runs in protected mode and lets DOS run in V86 mode on a 386 or 486 computer. A DOS extender needs to start in real mode, not V86 mode, which means that early DOS extenders can't run at all if a memory manager is installed.

To overcome this conflict, Phar Lap Software, a leading vendor of DOS extenders, and Quarterdeck Office Systems, the vendor of memory managers like *QRAM* and *QEMM*, developed the Virtual Control Program Interface (VCPI) in late 1987. The standard was improved at a large developers conference in 1989. VCPI lets DOS extenders and the programs that use them switch from protected mode to V86 mode and back under control of the memory manager. The manager also gives the extended program memory. However, the extended program also has many duties to perform. In essence, the VCPI server and DOS extender share responsibility for the total computer, although the DOS extender is ultimately subservient to the VCPI server.

VCPI servers (which almost always include EMS emulators and XMS servers) run only on 386 and 486 computers or specially equipped 80286 machines. Since VCPI servers include EMS emulators, VCPI services are an extension of EMS 4.0 and, like EMS, are available through Interrupt 33 hex.

If your own programs need extended memory only for data storage, they don't have to be concerned about VCPI but can stick to XMS calls. If they do need to run in protected mode, you'll want to invest in a DOS extender and let it handle the details of negotiating with the VCPI server. Very few programmers ever have to worry about VCPI directly.

The one major shortcoming of VCPI is that it doesn't provide support for multiple DOS-extended programs running simultaneously. A less-important drawback of VCPI is that it draws heavily on the memory paging of 386 and 486 CPUs, so that it generally can't be implemented on 80286 computers.

Microsoft's Answer

By 1990, the VCPI standard had been adopted by virtually all DOS-based programs that were specific to 386 and 486 CPUs—except programs from Microsoft. The VCPI committee was working on an upgrade to VCPI that would have been called XVCPI (X for Extended) when Microsoft released beta copies of *Windows* 3.0.

Included in *Windows* 3 is the DPMI, or DOS Protected Mode Interface, a more general solution to running protected-mode, DOS-extended and real-mode applications simultaneously. At first, DPMI seemed like a competitor to XVCPI, and there were threats of lawsuits and chaos in the DOS-extender field. When Microsoft turned over control of DPMI to an industry committee with open membership, XVCPI supporters joined the committee, making DPMI a *de-facto* industry standard.

DPMI version 0.9 appeared in *Windows* 3.0; Version 1.0 was released as part of *Windows* 3.1. Other DPMI servers are just beginning to appear on the market. DPMI enforces memory and resource protection when it runs DOS-extended programs, which means that it can protect each program against bugs in other programs that are running simultaneously. It also has provisions for protected-mode TSRs and inter-program communication. It can be implemented on an 80286 computer, as well as on 386s and 486s.

Wise Consumer

As memory-management standards become stable, more and more applications and TSRs will be written to take advantage of them. Several programs already insist on XMS memory; others insist on a VCPI or DPMI server in memory. Fewer new programs are appearing that use extended memory directly if no memory manager is running.

If you have a computer with more than the base 640K of memory, you need a memory manager. If you're using DOS 5, HIMEM.SYS, DOS 5's EMM386.SYS, will provide emulated EMS memory if you have a 386 or 486 computer. DOS 5 programs generally work well, but some third-party memory managers may give you more memory and speed.

HIMEM.SYS provides XMS support for extended memory, for the high memory area and, with DOS's help, for upper memory blocks on 386 and 486 computers. And *Windows* 3.x will provide DPMI support for newer versions of protected-mode DOS programs. However, if you stick only with DOS 5, you won't have a VCPI server in memory for protected-mode applications that need one, nor will you be able to squeeze out every last byte of conventional memory for large applications.

If you really want to get as much use of memory as possible, you'll want either a 386/486 computer or an 80286 computer built around a "shadow-RAM" chipset like NEAT, SCAT or LEAP. On an 80286 computer, you may also want to add an EEMS or EMS 4.0 expanded-memory board. On a 386/486 computer, forget the expanded-memory board and simply add as much extended memory as possible.

Next, purchase an appropriate memory manager for your computer. The ones from Qualitas and Quarterdeck Office Systems are excellent, as are managers from other suppliers. If you have an 80286, you might want *QRAM* from Quarterdeck or *386 MAX* from Qualitas. If you have a 386/486, pick *QEMM* or *386 MAX*. Qualitas also offers *BLUE MAX* for PS/2 Models 50 and 60.

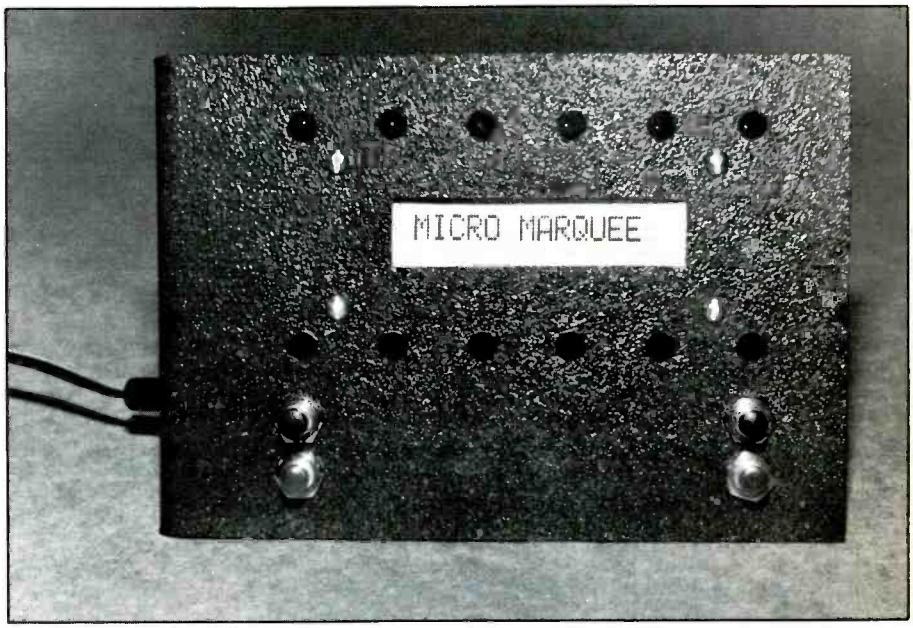
As I write this, the latest versions of the Qualitas products can act as DPMI servers but the Quarterdeck products can't. Both act as VCPI and XMS servers, both let DOS 5 (or any other program) load itself into HMA, and both can load programs into UMBs. Both include utilities that simplify setting up your system efficiently and viewing memory allocations. The one advantage of *QEMM* is that it can draw from the same memory pool for both expanded and extended memory as programs make requests. Most other products make you decide how you want to partition memory resources.

Be prepared to spend some time learning about and tweaking your memory manager. Some of the tweaks increase performance noticeably because programs will be able to spend more time computing and less time shuffling data between memory and hard disk. In the end, you'll probably find that the time is worth the rewards as your applications have more room, your computer runs faster and your hard disk doesn't clatter as much while you're working. Your computer will also be able to run the newest applications that take full advantage of advanced CPUs and run circles around programs written only a few years ago.

Build a Miniature Scrolling Marquee

An inexpensive microcontroller project displays scrolling messages of your choice

A $5 CMOS microcontroller, ready-to-use LCD module and a handful of discrete components let you build a novel scrolling message board like those used to display stock-market quotes. You can program it with up to a 72-character message, perhaps leaving it on your desk to continuously "broadcast" opinions, convey greetings, etc.



About the Circuit

For the Micro Marquee, I wanted to use the smallest available PIC. To this end, I settled on the circuit shown schematically in Fig. 1. It consists of four very simple subsystems: clock, switch inputs, LED outputs and LCD output. The simplest is the clock. Because timing isn't critical for this project, I selected an inexpensive RC PIC.

Clock speed is set by *R5* and *C1* to a leisurely 500 kHz, or 125,000 instructions per second. Running the PIC any faster wouldn't have made a better design, and it would have made larger delay loops necessary in the programming. It also would have increased the PIC's power consumption.

OSC2 pin 15 of PIC *IC1* isn't connected. When the circuit is powered, the clock frequency divided by four appears on this pin. When a PIC circuit seems to be totally dead, usually because of a programming error, the first thing to do is check this pin for the presence of the clock/4 signal. If it's present, the PIC is getting power and the clock is running.

The switch-input subsystem consists of *S1* through *S4* and *R6* through *R9*. These pull-down resistors keep low I/O pins rb.0 through rb.3 until the corresponding switch is closed.

Switching transistors *Q1* and *Q2* in the LED output system handle the 30-mA or so of current drawn by the LEDs. I/O bits ra.0 and ra.1 drive the transistors through *R1* and *R3*. Current through the LEDs is limited by *R2* and *R4*. The PIC itself can source up to 20 mA and sink up to 25 mA through an output pin, provided no port has more than two pins operating at full current (40 or 50 mA total). If the design had used fewer LEDs, the PIC could have powered them directly through its I/O port, without the need for the switching transistors.

The LCD output subsystem is simply a direct connection between the upper four bits of port rb and the upper four bits of the LCD data bus. Output bits ra.2 and ra.3 drive the LCD's enable (E) and register-select (RS) inputs. The lower four bits of the LCD's data bus and its read/write pin are grounded because the Micro Marquee uses a four-bit interface to communicate with the LCD module and doesn't read data back from the LCD. A thick data package on the LCD is available from the source given in the Note at the end of the Parts List at no additional cost.

A few final points: Pins 3 and 4 of *U1*, the real-time clock/counter and master clear (RTCC and MCLR), are wired to the + 5-volt rail because they aren't used. RTCC is a Schmitt-trigger input to a counter built into the PIC, which helps clean up slow and noisy signals the device might be required to count. MCLR forces a reset of the PIC when a low pulse is applied to it. This pin could be connected to a pull-up resistor and pushbutton switch to add a warm-start function to a project or

PIC Details

PICs are 5-volt, eight-bit microcontrollers made by Microchip Technology and marketed, along with special development tools, by Parallax Inc. Low-cost PICs have a number of features that make them attractive candidates for control projects.

Input/output (I/O) options are noteworthy. Depending on the model selected, a PIC has 12 or 20 I/O pins you can configure as any combination of inputs and outputs. When their I/O pins are in input mode, they exhibit high impedance, which allows them to share or even monitor a bus. PICs also have an additional input-only pin connected to an internal eight-bit counter.

You can buy practice PICs and permanent PICS. Much of the cost of microcontrollers with built-in EPROM apparently comes from manufacturing them with a window on top to permit erasure with ultraviolet energy. However, when a controller program is finished, there's no need for the window. With PICs, you don't pay for what you don't need, because you can buy one that's non-erasable for $3.50 to $5 instead of an erasable PIC with window that you don't need for $20 to $29.

Parallax also offers a PIC emulator that allows you to eliminate the 5-minute erasure step by downloading code to a board that mimics a working PIC in your circuit.

PICs have on-chip ROM and RAM and are available with 512 to 2,048 words of program ROM and 25 to 72 bytes of general-purpose RAM. (A word of ROM corresponds to a single instruction. Size is given in words because PIC instructions are 12 bits long.)

PICs use a Harvard architecture in which program memory and data memory are completely separate. With a PIC, a number stored at address 10 of program memory is different from one at address 10 of data memory. Basically transparent to the programmer, this is the key to the PIC's high speed.

During a single instruction cycle (four clock cycles), a PIC executes one instruction while fetching the next. Another advantage is that an out-of-control program can't try to execute data, nor can data be written over the program.

PICs also have a simplified instruction set. The native PIC instruction set consists of only 33 instructions, putting the PIC in the category of a reduced instruction set computer (RISC) chip, although Microchip Technology conservatively calls it "RISC-like" because it doesn't employ some of the fancier tricks associated with RISC processors.

Parallax's assembler extends the PIC instruction set to 63 instructions, primarily by combining common decision and branching operations into a single operation. For instance, the Parallax instruction set includes the instruction compare and jump if above (cja), which is equivalent to the BASIC code IF x > y THEN GOTO.... When the Parallax software assembles a cja, it generates four native PIC instructions. Since programmers use these structures repeatedly, Parallax's approach trades a little extra complexity for compact, clear source code.

Low power consumption and/or high-speed operation are hallmarks of the PIC. Like other CMOS devices, PIC power consumption depends on speed. With a 15-kHz clock, it consumes just 15 microamperes (μA). At full 20-MHz speed (one instruction every four clock cycles, for a respectable 5-million instructions per second), PICs need a maximum of 20 milliamperes (9 mA typical).

PICs are available in a variety of package options: 18- and 28-pin DIP and 18- and 28-pin SOIC packages.

A watchdog circuit in the PIC can be configured to automatically reset the chip if it fails to periodically reset a timer. This is the electronic equivalent of a dead-man switch. A built-in circuit takes care of power-on reset, saving additional components and real estate.

A two-level stack makes it easy to program and use subroutines.

A sleep mode lets the PIC remain dormant (using only 3 μA of current) until a reset wakes it up.

A security bit that can be set during programming to protect code from inquisitive eyes.

Table A summarizes the features of the four basic PIC families. Each family is available as both erasable and non-erasable devices. Non-erasable types are further divided into resistor/capacitor (RC), crystal-controlled (XT), high-speed (HS) and low-power (LP) clock types. Erasable PICs can use any of the timing circuits supported by non-erasable types, once they're told through programming which oscillator to use. All PICs, except the RC type, can accept timing from an external clock. Table B summarizes the speeds of the clock types.

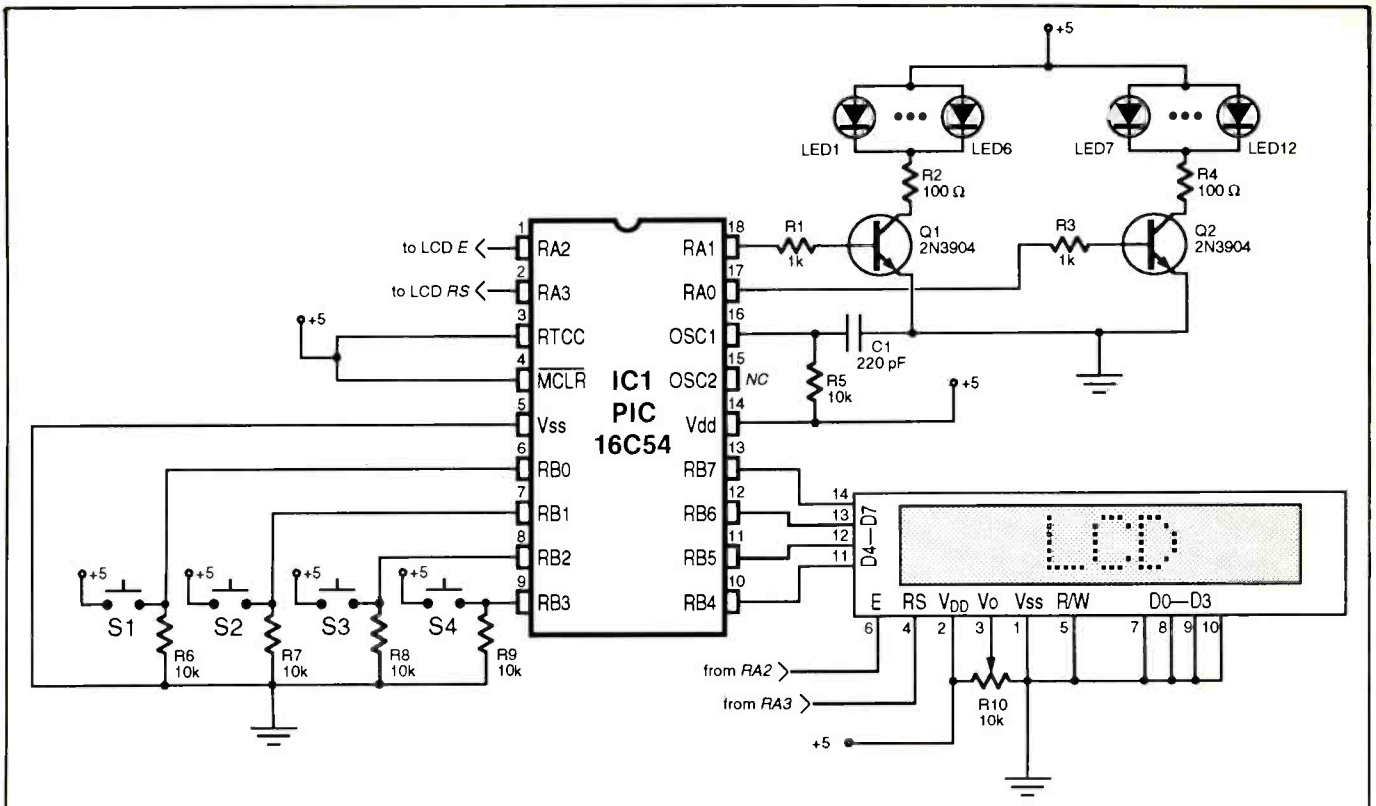
Table A. Features of PIC Devices

	PIC Type			
	16C54	16C55	16C56	16C57
Number of Pins	18	28	18	28
I/O Bits	12	20	12	20
General-Purpose RAM (Bytes)	25	24	25	72
Program EPROM (Words)	512	512	1,024	2,048

Table B. Built-In Clock Options

PIC Type	Part Number Suffix	Frequency Range	External Clock
Resistor/Capacitor	-RC/P	dc to 4 MHz	No
Crystal	-XT/P	*0.4 to 4 MHz	Yes
High Speed	-HS/P	4 to 20 MHz*	Yes
Low Power	-LP/P	dc to 40 kHz	Yes
EPROM	/JW	dc to 20 MHz	Yes

*XT and HS devices operate down to dc when an external clock is used. Operation at dc means that the PIC can be halted completely (to conserve power, for instance) and then resume the program at the same point when the clock is restarted.



PARTS LIST

Semiconductors
IC1—Programmed PIC16C54-RC
IC2—LM78L05 fixed + 5-volt regulator
LED1 thru LED12—T-1¾ red LED
Q1,Q2—2N3904 or equivalent npn switching transistor

Capacitors
C1—220-pF ceramic disc
C2—0.33-μF tantalum
C3—10-μF tantalum

Resistors (5% tolerance)
R1, R3—1,000 ohms, ¼-watt
R2,R4—100 ohms, ½-watt
R5 thru R9—10,000 ohms, ¼-watt
R10—10,000-ohm subminiature horizontal pc-mount potentiometer (Radio Shack Cat. No. 271-282 or equivalent)
S1 thru S4—Normally open, momentary-contact pushbutton switch (Radio Shack Cat. No. 275-1547 or equivalent)

Miscellaneous
J1—14-pin, dual-row male header
Printed-circuit board (see text); Hitachi 16-character-by-1-line LCD module; regulated 5-volt dc power source (see text); suitable enclosure (see text); machine hardware; hookup wire; solder; etc.

Note: Blank PICs and tools to program them are available from Parallax, Inc., 6200 Desimone Lane No. 69A, Citrus Heights, CA 95621; tel.: 916-721-8217: assembler and programmer, $199; emulator, $299; assembler, programmer and emulator, $449.

The LCD module is available for $8.33 from Timeline Inc., 1490 W. Artesia Blvd., Gardena, CA 90247; tel.: 800-872-8878.

PICs programmed with the software described in this article are available for $10 (check or money order) each, postpaid from Scott Edwards, 964 Cactus Wren Lane, Sierra Vista, AZ 85635. For an unabridged program listing, send a self-addressed stamped envelope to the same address. Send comments or questions via E-mail to CompuServe mailbox 72037,2612.

Fig. 1. Complete schematic diagram of the Micro Marquee's circuitry.

to circuitry designed to wake the PIC from its sleep mode.

Programming

If you've worked with EPROM-based controllers before, the programming cycle will be familiar. It's as follows:

(1) Write or edit the source code.
(2) Compile the object code.
(3) Download the object code to the PIC device.
(4) Test the chip in-circuit.
(5) If the circuit performs correctly, you're done; if not, erase the chip and return to step (1).

Listing 1 is the program for the Micro Marquee. If you're familiar with assembly language for Intel's 80xx-series micros, you'll recognize many of the instructions. However, be aware that some Parallax instructions have the same mnemonics as Intel's but with different meanings. For instance, jb means "jump if below" for the 8088. For the PIC, it means "jump if bit set." Newcomers to assembly language should be able to follow the program's overall logic by referring to the PIC glossary in Table 1, which lists only those PIC instructions used in this program.

Since the the program in Listing 1 doesn't have line numbers, I've added comments in the form "; NOTE x" to the code. Interpret these Notes as follows:

Note 1. At the beginning of the program are the equates. Giving important memory locations significant la-

Listing 1. Micro Marquee Assembly-Language Program

```
RS              =       ra.3            ; NOTE 1
E               =       ra.2
LED1            =       ra.0
LED2            =       ra.1
S1              =       rb.0
S2              =       rb.1
S3              =       rb.2
S4              =       rb.3

                org     8               ; NOTE 2
a_low           ds      1
a_high          ds      1
loop_index      ds      1
temp            ds      1
char_in         ds      1
char_out        ds      1
position        ds      1

                org     0               ; NOTE 3
                device  pic16c56,rc_osc,wdt_off,protect_off
                reset   start

; Begin by setting the I/O ports, then initialize the LCD for a four-bit interface.
start           mov     !ra,#0h         ; NOTE 4
                mov     !rb,#00001111b
                mov     rb,#00100000b
                setb    E
                clrb    E
                call    wait
                mov     temp,#00100100b
                call    blip_E
                mov     temp,#00001100b
                call    blip_E
                mov     temp,#00000110b
                call    blip_E
:restart        mov     char_in,#'A'    ; NOTE 5
                mov     char_out,#'A'
                mov     position,#10000111b
                mov     temp,#00000110b
                call    blip_E
                call    display

; Wait for a switch to be pressed, then jump to appropriate routine.
:switches       jb      S1, abcde
                jb      S2, edcba
                jb      S3, forward
                jb      S4,back
                goto    :switches

; Send four bits of data to LCD, bring enable pin high briefly.
; Swap nibbles, send next four bits and blip enable again.
blip_E          mov     rb,temp
                setb    E
                clrb    E
                swap    temp
                mov     rb,temp
                setb    E
                clrb    E
                ret

; Delay subroutine. Other versions 'medwait' and 'longwait' are omitted for brevity.
; They are identical, except that the initial values of 'loop_index' are #11 and #32, respectively.

wait            mov     loop_index,#2
:loop           djnz    a_low,:loop     ; NOTE 6
                djnz    loop_index,:loop
                ret

; Increase character code by one and display new character. If both switches are
; down, output a space. After a short delay, auto-repeat if switch is held down.
; Routine 'edcba' omittedfor brevity. It is identical to 'abcde' except that it
; decrements character code.

abcde           mov     char_out,#32
                call    medwait
                jb      S2, :display
                inc     char_in
                call    exceptions
:display        call    display
                mov     temp,#200
                call    longwait
:switch         sb      S1
                goto    start:switches  ; NOTE 7
                djnz    temp, :switch
:still_down     inc     char_in
                call    exceptions
                call    display
                sb      S1
                goto    start:switches
                goto    :still_down

; Increment display position when S3 is pressed. If the end of the
; message is reached, scroll the message and blink the LEDs.
; Routine 'back; omitted for brevity. It is identical, except
; that it decrements position and does not auto-repeat.
forward         inc     position
                cjae    position, #208, run_msg
                clrb    RS
                mov     temp,#00011000b
                call    blip_E
                call    display
                call    longwait
:switch         sb      S3
                goto    start:switches
:still_down     inc     position
                cjae    position, #208, run_msg
                clrb    RS
                mov     temp,#00011000b
                call    blip_E
                call    display
                sb      S3
                goto    start:switches
                goto    :still_down

; Output a character to the LCD.
display         clrb    RS
                mov     temp,position
                call    blip_E
                setb    RS
                mov     temp,char_out
                call    blip_E
                call    medwait
                ret

; Use full-height versions of letters g, j, p, q, and y.
exceptions      cje     char_in, #'g',tails
                cje     char_in, #'j',tails
                cje     char_in, #'p',tails
                cje     char_in, #'q',tails
                cje     char_in, #'y',tails
                mov     char_out, char_in
:return         ret

; Versions of g, j, p, q, y with tails are offset by F0h from regular versions.
tails           mov     char_out, char_in
                or      char_out,#F0h
                goto    exceptions:return

; Start scrolling message.
run_msg         clrb    RS
                mov     temp,#00001100b
                call    blip_E
                setb    LED1
                setb    LED2
                call    longwait
:loop           mov     temp,#00011000b
                call    blip_E
                setb    LED1
                clrb    LED2
                call    longwait
                mov     temp,#00011000b
                call    blip_E
                clrb    LED1
                setb    LED2
                call    longwait
                jb      S4, restart
                goto    :loop

; Get set to return to entry mode. Not necessary to reinitialize LCD.
restart         clrb    RS
                mov     temp, #00000001b
                call    blip_E
                clrb    LED1
                clrb    LED2
                call    longwait
                goto    start:restart
```

bels is a good and common way to make your code more self-explanatory. What's interesting here is that the PIC supports many operations on individual bits. Therefore, these equates give memorable names to particular I/O bits. For example, the first one gives the label "RS" to bit 3 of port ra (ra.3). Referring back to Fig. 1, you see that ra.3 is connected to the RS bit of the LCD, which makes it easy to implement the LCD manufacturer's instructions. Whenever "set bit RS" is used, the program reads setb RS.

Note 2. The directive org sets the origin or starting point for the code that follows. In this case, I reserved space for assigned names to variables in RAM. Since RAM locations 0 through 7 are special PIC registers, the first variable is at location 8.

Note 3. Remember that PICs use separate memory for data and instructions. This org sets the origin of the program to 0 in program in EPROM. The next two instructions, device and reset, are for the benefit of the compiler. Device tells the compiler to set up the program for a 16C54 PIC with an RC oscillator and leave off the watchdog timer and security functions. Reset instructs it to place the code address represented by start in the location reserved for instructions to be executed when the chip resets.

Note 4. Any of the PIC's I/O pins can be configured as input or output at any time during program execution. This line of code shows how it's done. A control register, named !ra (for port ra), is loaded with 1s for inputs and 0s for outputs. The PIC initially wakes up with all I/O pins configured as inputs. The assembler permits you to mix and match number types. Hexadecimal 0 (#0h) is loaded into !ra, while binary number #00001111b is loaded into !rb. This allows you to use the most-expressive number for a particular job. The mov !rb,#15 instruction would have exactly the same effect as mov !rb, #00001111b, but the latter case makes it clearer that you want four inputs and four outputs on port rb.

Note 5. The assembler also supports the standard ASCII character set as a data type. Here, #'A' means the number corresponding to a capital letter A in ASCII (65 decimal). This makes constructing strings easy.

Table 1. Glossary of PIC Commands Used in Program

Note: PIC documentation uses the term 'file register' to mean a location in RAM; throughout this glossary the more familiar term 'byte' is used. When an argument (information that a command acts upon) can be either a byte in RAM or a literal number, the term 'data' is used. A location in program memory is referred to as an 'address.'

Instruction	Meaning
call *address*	Call. Used to implement subroutines (e.g., BASIC GOSUB). Stores the location of the next instruction in the two-level hardware stack and jumps to *address*. When the instruction ret (return) is later encountered, gets (pops) the address off the stack and jumps to that address (the instruction immediately following call). A two-level stack means that the first subroutine called may call only one other subroutine. If a third subroutine is called, the return address for the original call is lost.
cjae *byte, data, address*	Compare and jump if above or equal. Compares *byte* to *data*, which may be a variable (memory location containing a value) or a literal number. Literal numbers are stored in program ROM along with the instruction and can only be altered through reprogramming. If *byte* is greater than or equal to the value of *data*, jumps to *address*.
cjbe *byte, data, address*	Compare and jump if below or equal. Same as cjae, but jumps if *byte* is less than or equal to *data*.
clrb *bit*	Clear bit. Stores a 0 in *bit*.
dec *byte*	Decrement. Subtract one from *byte*.
djnz *byte, address*	Decrement and jump if not zero. Subtracts 1 from *byte* and compares the result to zero. If the result is not zero, jumps to *address*. Used to create loops.
goto *address*	Go to address. Synonymous with jump (jmp).
inc *byte*	Increment. Add one to *byte*.
jb *bit, address*	Jump if bit set. If *bit* contains a 1, jumps to *address*.
mov *byte, data*	Move the value *data* into the location of *byte*. Data may be either a variable (memory location containing a value) or a literal number. Literal numbers are stored in program ROM along with the instruction and can only be altered through reprogramming.
ret	Return. See call.
setb *bit*	Set bit. Stores a 1 in *bit*.
swap *byte*	Swap. Exchanges high and low nibbles of *byte*. If *byte* is 11110000 before swap, it will be 00001111 after.

Note 6. The Parallax assembler supports local labels, which begin with a colon (:). These are called "local" because you can use the same name in different subroutines without fear of conflict. Notice that the delay subroutine, wait, uses the local label :loop. The assembler knows that when you request a jump to :loop within the subroutine wait, you don't want to end up at any of the other locations labeled :loop (that is, in the other delay subroutines medwait or longwait).

Note 7. If you do want to jump to another subroutine's local label, just use the subroutine name followed by the name of the local label (in this case, start:switches).

If you decide to program a PIC for the Micro Marquee, keep in mind that the Listing 1 program is written in the Parallax dialect of PIC assembly language. Other assemblers won't work. The Parallax assembler will accept standard PIC code, however.

Construction

To begin building the Micro Marquee, you need a programmed PIC16C54, which you can obtain from the source given in the Note at the end of the Parts List or by programming one yourself using the supplies mentioned in the Note at the end of the Parts List. Once you have a programmed PIC, fabricate a printed-circuit board using the actual-size etching-and-drilling guide shown at the top of Fig. 2.

When the pc board is ready, refer to the wiring guide shown at the bottom of Fig. 2. As you wire the board, note

that the following components and connections go on the solder side of the board: *R10*, the jumper that brings +5 volts to *R5* and pin 14 of *IC1*, and *S1* through *S4*. You can connect power to any convenient points on the +5-volt and ground traces.

As Fig. 3 shows, you must wire all components on the pc board *before* mounting the LCD module because the latter covers most of the component side of the board. Also note that there's no room for a socket for *IC1*. Solder the PIC directly to the board, using a grounded iron and appropriate antistatic measures. If you feel must use a socket for *IC1*, connect the board to the LCD module via a short length of 14-conductor ribbon cable instead of mounting it as shown.

The circuit requires a source of well-regulated 5 volts dc, but it doesn't have an on-board regulator. If you have a power cube that supplies regulated 5 volts dc, you're ready to go. If you plan to use a battery or unregulated supply, use the simple arrangement shown in Fig. 4 between power source and circuit to assure good regulation. I glued the transistor-sized regulator and capacitor to the side of the on/off switch and used their leads as terminals for the battery connections.

If you use a battery, be aware that the Micro Marquee's LEDs make it a current-hungry device. A 9-volt alkaline battery lasts only about 12 hours of semi-continuous use (3 hours at a time). If you use AA or even C cells, keep in mind that the regulator wants at least a 1.7-volt difference between input and output voltages. To provide 5 volts, it needs at least 6.7 volts. In practice, the circuit seems to tolerate the 6-volt input provided by four cells, but five cells would probably significantly improve battery life by preventing the regulator from shutting down before the battery is used up.

Choice of an enclosure in which you house the project is up to you. Since the four holes in the circuit-board assembly are positioned to line up with the mounting holes in the LCD module, the easiest method is to use four 2-56 machine screws to mount the assembled device to a faceplate. Use insulating washers to make sure the nuts are isolated from nearby circuit traces.

Checkout & Use

Before turning on the Micro Marquee

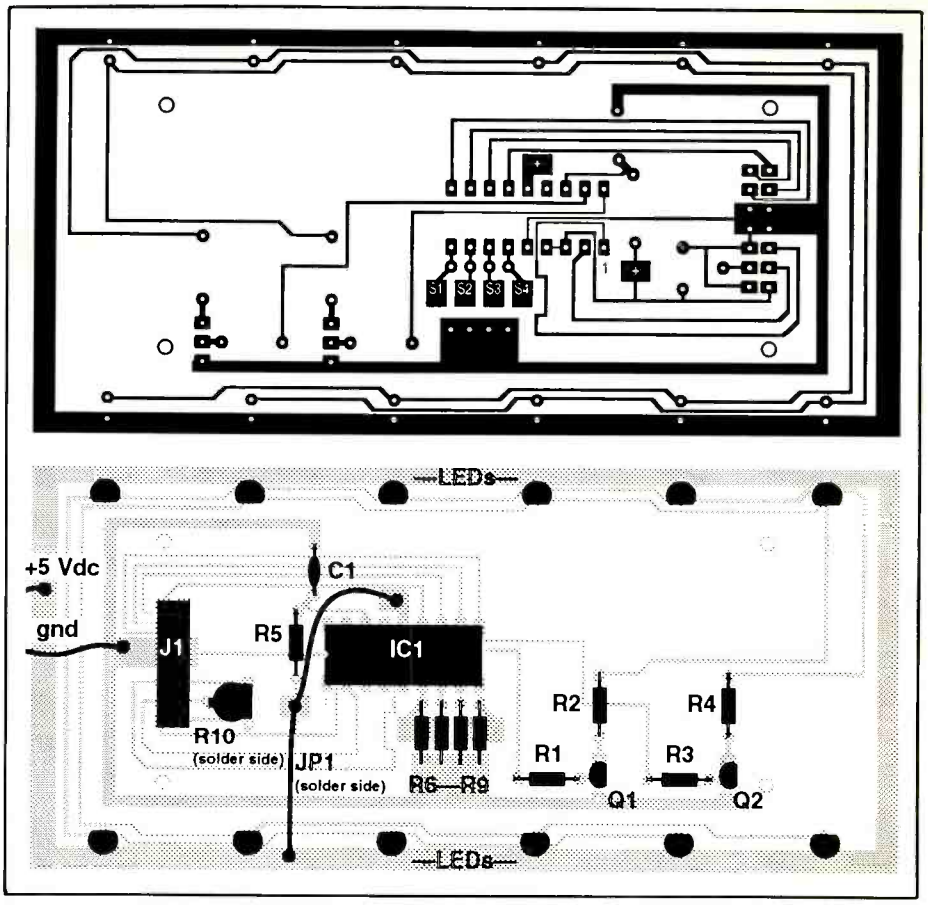
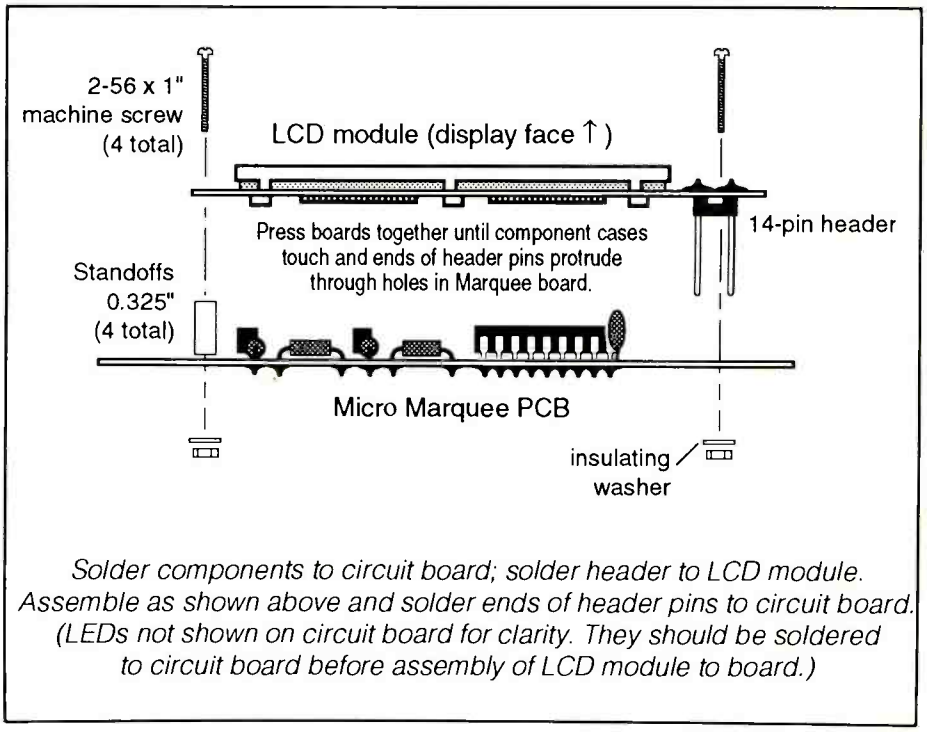


Fig. 2. Actual-size etching-and-drilling guide (upper) and wiring diagram (lower) for project's printed-circuit board.



Solder components to circuit board; solder header to LCD module. Assemble as shown above and solder ends of header pins to circuit board. (LEDs not shown on circuit board for clarity. They should be soldered to circuit board before assembly of LCD module to board.)

Fig. 3. The LCD module is fitted with a male header and plugs into holes in the pc board.

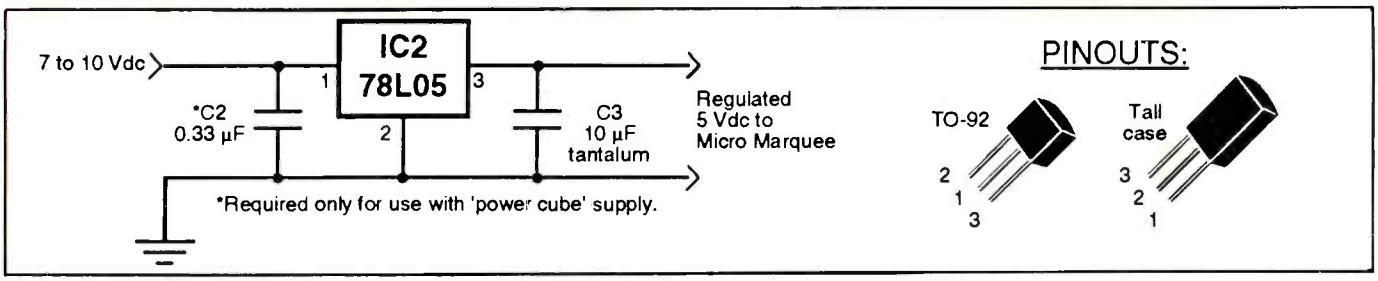


Fig. 4. Use this simple regulator arrangement to stabilize the power source used with the project.

for the first time, double-check your work to make sure you made no wiring or soldering errors. If you use the Fig. 2 artwork to make a pc board, be sure to check for shorts between the +5-volt and LED traces. Inspect the closely spaced traces at the base of *J1*.

When you're satisfied that all is well, turn *R10* fully counterclockwise and apply power. You should see a capital letter "A" in the middle of the LCD screen. If you see dark squares filling the screen instead, try adjusting the setting of *R10*, which controls the contrast of the display. If things still aren't right, power down and inspect your work more closely. If you have an oscilloscope, apply power and check for a 125-kHz clock signal on pin 15 of *U1*. If no signal is present, the PIC isn't functioning at all and may be installed incorrectly.

Once you have the Marquee working and an A displayed on-screen, press *S1* for a moment, and a B will replace the A. Hold down *S1*, and the display will race forward through the alphabet (actually an extended version of the ASCII character set, including Japanese kana characters and Greek symbols). Now try *S2*, which works the same as *S1* but takes you backward through the alphabet. This is how you choose the letters that will make up your message.

For spaces, I included a routine to instantly put a space on the screen. Briefly press *S1* and *S2* simultaneously. When you have the character you want on-screen, press *S3*. The display will advance. If you need to back up a space to correct an error, press *S4*. You can enter up to 72-character messages. If you try to enter yet another character, the Marquee will automatically begin scrolling your message and flashing the LEDs. To end a message containing less than 72 characters, enter a blank and hold down *S3*.

My Micro Marquee has seen plenty of service, warning co-workers not to disturb batch jobs in progress on my computer, broadcasting silly sayings and provoking discussions of its PIC processor. You'll undoubtedly find lots of uses for your Micro Marquee that I haven't thought of as well. ■

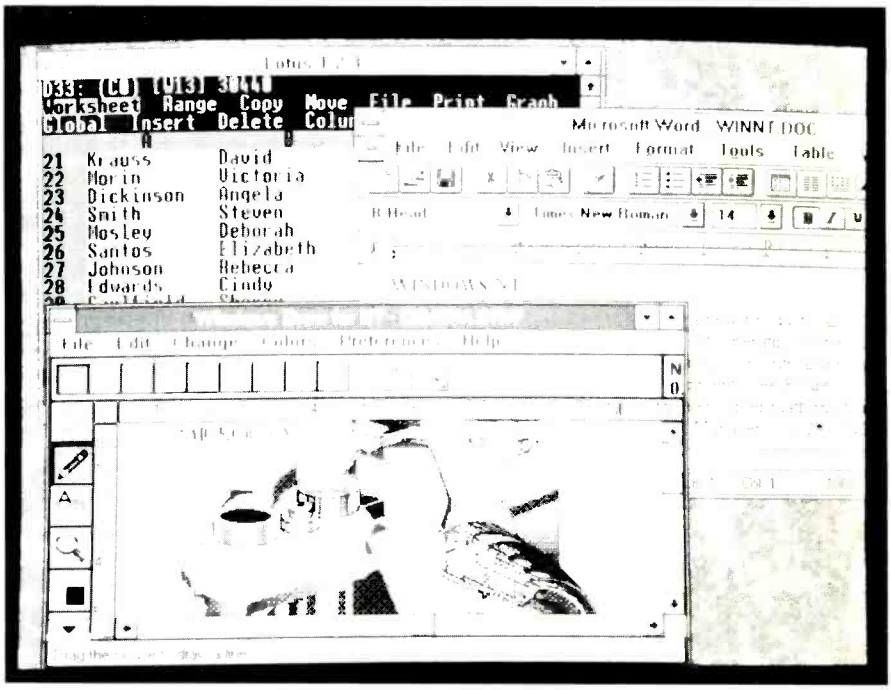
Windows NT is Top Carnivore

How Microsoft is providing the benefits of a common interface with a cross-platform mobility of Windows applications

The Microsoft family of *Windows* operating systems, with *Windows NT* (New Technology) at the top of the chain, is like a zoological family. It consists of four species composed of two genera that, in turn, constitute the *Windows* family. These systems will become an integral part of the diverse desktop ecosystem.

No ecosystem is permanent, of course. Somewhat like nature's ecosystem, in a stable economic climate undergoing major changes in a technological environment, we expect a primary succession of computing communities: pioneer stage, followed by gradual change, leading to a relatively stable climax phase. The desktop climax community may never exist, but *Windows* operating systems are likely to be some of the most important pioneers in the desktop ecosystem of this century.

What's so important? Simply put, *Windows* is an operating system based on a scalable architecture that permits *Windows* applications to run on a range of hardware platforms, including notebook, pen and desktop computers; RISC workstations and servers; and multi-processor systems. The end result is that it will fill niches from the mobile to the masterful, each searching for optimal solutions in a particular environment, yet maintaining the benefits of a common interface with a cross-platform mobility of *Windows* applications.



Windows NT offers a familiar Windows interface but will run on Intel and RISC-based processors, as well as a range of hardware platforms.

Nomenclature and Classification

The *Windows* family consists of two genera and four species, which include: the *Windows NT* genus that contains *LAN Manager for Windows NT* 3.1 and *Windows NT* 3.1, while the *Windows* genus contains *Windows* 3.1 and *Windows for Workgroups* 3.1 (Fig. 1). This sounds like *NT* offers industrial strength solutions, while *Windows* has a more-domestic future.

Windows for Workgroups 3.1, a new 16-bit networking product, will provide peer-to-peer capabilities. These will include print and file sharing, electronic mail and calendaring services. *Windows NT* 3.1 targets power users and such server applications as SQL Server, Oracle, Informix, Microsoft Mail Server and Lotus Notes, and will run on leading networks like NetWare, LAN Manager, Vines, PATHWORKS, 3COM and LAN Server. *Windows NT for LAN Manager* 3.1 will offer high-end management and administration capabilities.

You might well ask, "Is DOS related to *Windows NT*?" While simple-minded DOS-based *Windows* 3.1 fits into ROM and is optimized for x86 computers, *Windows NT* sheds its MS-DOS genes and has a completely new kernel. *Windows NT* is *not* a mutation of MS-DOS, nor does it replace *Win* 3.1. *Windows* 3.1 will remain a 16-bit DOS environment. And most 16-bit *Windows*, DOS and OS/2 applications software should run under *Windows NT*. While *NT* opens completely new areas in desktop computing for the personal computer, DOS is not dead.

What about DOS? DOS certainly

needs a little more intelligence. After all, *Windows* can't do it all on its own. MS-DOS 6.0, expected to include *Stacker*, a popular compression program for disks, is just around the corner. A new and separate version of DOS may support 32-bit multitasking applications and work with applications generated from an enhanced version of Microsoft *Win32s* API, an *NT* subset programming interface.

This assertive new *NT* genus is a full 32-bit, symmetric multiprocessing system finding comfort in either x86 or RISC processors. Furthermore, *NT* is a social animal. *LAN Manager for Windows NT* provides distributed client/server networking services, file and print sharing, fault tolerance and network administration facilities. What an appetite!

Minimum desktop requirements (MDR) make for an appetite that's truly Olympian. *Windows* 3.1 and *Windows for Workgroups* require a minimum of a 386SX processor and 4M of RAM. *Windows NT* demands a minimum configuration of a 386DX, 486 or RISC processor and not less than 8M of RAM. *LAN Manager for Windows NT* accepts nothing less than a 486 processor and 16M of RAM.

The appetite continues. Regarding mass storage, the operative word is "mass." You'll need about 80M of hard-disk space for *NT*'s cover charge. If you believe applications will be small, think again. The first time I opened my MDR machine to *Windows* 3.1, I ran rapidly from a 286 machine with 2M of RAM to a 386 machine with 8M of RAM and as quickly headed straight for a 33-MHz 486 with 16M of RAM, video accelerator card, cache controller and a 17″ video monitor. With this setup, I'm okay to begin working with *NT*.

With its Olympian appetite, what can we expect to get from *Windows NT*? Topping the list is performance, 32-bit performance, that is, the result of using the 32-bit 486 microprocessor brain. You also get increased memory space combined with 32-bit intelligence. Remember that at the foundation of these binary beasts are 1s and 0s. This means that a 16-bit segmented memory address system (DOS) confronts programmers with a 64K barrier (2^{16}).

NT's 32-bit linear model, also called flat memory model, results in more than 4-billion (4,294,967,296) bytes of memory space. That's a 65,000× increase in memory space, with expected increases in speed performance of three to five times. In other words, a

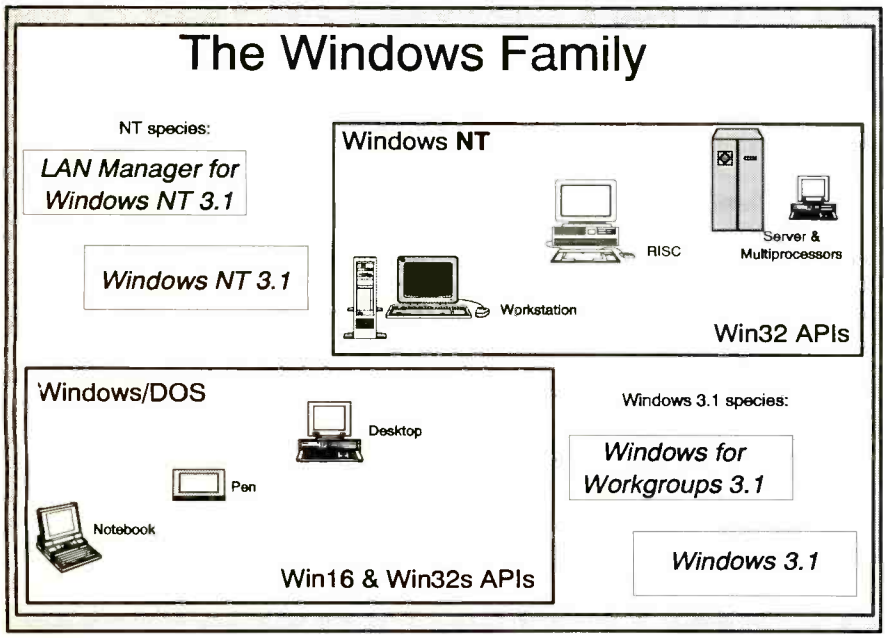


Fig. 1. Windows operating systems will have two generations (Windows NT and Windows/DOS) with two species in each. In turn, each species will find suitable silicon habitats.

50-MHz 486 will be equivalent to a 150- to 250-MHz machine!

In conjunction with programming languages like C++, developers use a software interface referred to as the *Windows* 32-bit Application Programming Interface, or API. APIs are standardized programming services like functions, messages, data structures and file formats, to name a few. They permit external-device control, sound, DDE transactions, messaging, macros and much more—the *Windows* environment, *per se*.

With a *Win32* and *Win32s* API, developers will be able to write 32-bit programs that run on both platforms: *Win32* running only on *NT* and *Win32s* working with either *NT* or DOS-based 16-bit *Windows* 3.1. So *Win32s* applications running as a virtual device driver (VxD) and dynamic link library (DLL) under *Windows* 3.1 will incur a slight translation overhead (less than 10%) to execute as a 16-bit program. As a compromise to this 32-bit emulation, *Win32s* may not support pen-based and multimedia applications. *Windows* is getting meaner but not leaner. Is there any doubt in your mind that you'll need industrial-strength hardware?.

With developers able to write programs as described above, only one application in 32-bit code is needed to run on both platforms. But single users may have to pay for what developers will save, perhaps part of some trickle-down theory yielding upward mobility. Furthermore, we should expect to see upgrades for *Windows* 3.1 to improve the GUI interface to make it more competitive with Apple, NeXT and Hewlett Packard.

A wide array of developers tools add strength to *NT*'s potential. Borland recently demonstrated a 32-bit version of its C++ for *Win32s* on *NT* and Symantec offers *Zortech C++ for Windows NT*. The list of vendors providing development tools includes ASK/Ingres Corp., Congruent Corp., Digital Equipment Corp., Digitalk, Easel Corp., Gupta Technologies Inc., Oracle Corp. and some 100 others.

Furthering this development process, Microsoft is working on a cross-compiler, based around its C/C++ 7.0 product, which will take *Windows* source code and generate Motorola 680x0 machine code, thus opening the

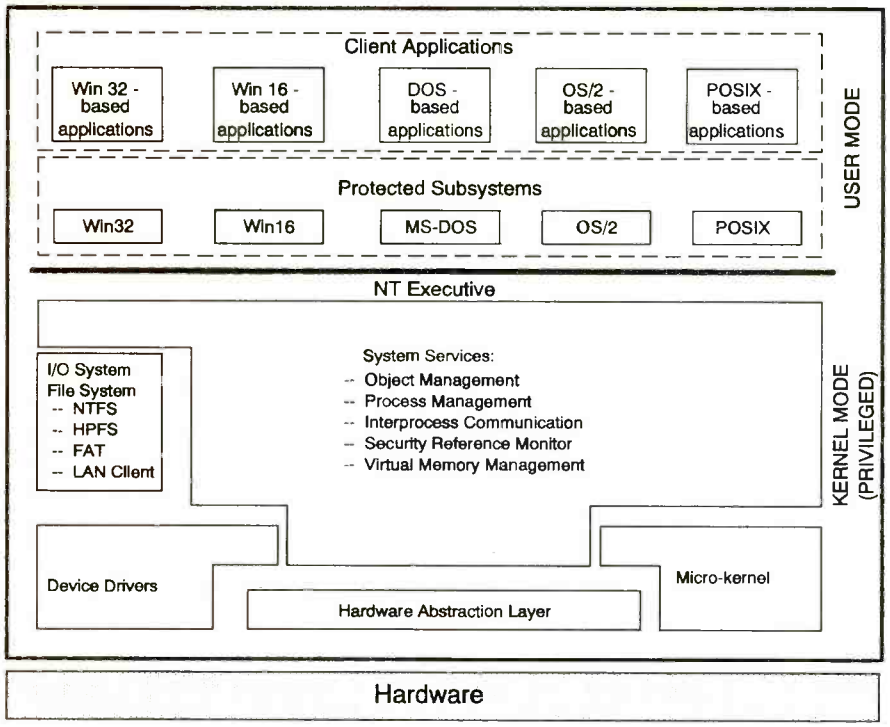


Fig. 2. Windows consists of a user mode running client applications and protected subsystems, and a privileged mode or kernel mode offering system services and interfaces to a variety of hardware platforms.

Macintosh platform to *Windows* developers. Are there no boundaries for *Windows*? Is the Mac-versus-PC controversy rapidly becoming moot, or will the functionality and performance of the PC clearly surpass those of the Mac?

If you're considering developing for *Windows NT*, you can access a great deal of pre-release support from Microsoft. The company have a Developer Services Team you can reach by dialing 800-227-4679, extension 11771, that can provide you with a Microsoft Win32 Preliminary SDK (System Development Kit) and subscriptions to the Microsoft Developer Network CD program and Developer Network News. Many software vendors are committed to delivering more than 140 products for core development, utilities/libraries and general tools. Already, more than 50 32-bit applications are running under *Windows NT*.

It's the social imperative that's the most compelling rationale for *NT*. With 4G bytes of memory space, symmetric multi-processing, client/server model, object model, distributed computing, U.S. Defense Department Class C2-level security, POSIX (Portable Operating System Interface for UNIX) compliance, fault tolerance, memory protection, structured exception handling, OLE, multi-threading and pre-emptive multitasking, it's very clear which desktop habitats will be colonized. *NT* is top carnivore going after big game.

The game in question is the biggest. For internetworking, *Windows NT* supports DECNet from Digital Equipment, IBM's SNA, Novell Inc.'s IPX/SPX, TCP/IP and X.400. There are more to come.

Anatomy of a Carnivore

Windows NT's structure can be divided into two parts: user mode and kernel mode. It's designed internally around a client/server model with several protected subsystems acting as application servers (Fig. 2). Acting as a client/server, *NT* provides multiple operating-system environments for DOS, *Windows*, OS/2 and POSIX.

Running on top of the Executive, user-mode functions include protected subsystems (so-called servers) that provide APIs for programs to call. Each message or call from a user application is screened by the Executive that, in turn, communicates with the server (for example, a file or display server). Results from the

server are returned to the application program or caller. This message-passing mechanism is called Local Procedure Call (LPC), *NT*'s version of Remote Procedure Call (RPC), which is an industry-standard for client and server processes across a network.

The heart of *Windows NT* is NT Executive. It comprises several independent modules that handle such system tasks as I/O, memory management and process control. The Executive handles all hardware calls, providing the interface with device drivers and the hardware abstraction layer. Hence, Executive components remain independent of hardware-dependent information, making *NT* flexible for upgrading to changing technologies.

While most of the things users want to do are performed by Executive components, the kernel handles interrupts, exceptions and schedules threads for execution and synchronizes multiple processing, as examples. The kernel is where much of processor-specific code (Intel or MIPS R4000) is located. This removes differences between processors from the rest of the operating system.

Glossary

Client/Server Model—System software structured into several processes, each offering a service. Examples are file, print, mail, display and network servers. Part of the operating code is moved up to higher layers, leaving a minimal kernel. The client is either another operating system component or an application program.

Distributed Operating System—Appears to its user like an ordinary centralized operating system but runs on multiple independent CPUs.

Fault Tolerance—A system fails because it contain design faults. Fault-removal techniques are used to find and remove faults. This involves error detection, damage assessment, error recovery and fault treatment with continued service. *NT* is expected to include such fault-tolerant features as disk mirroring, duplexing and RAID-5 striping.

Memory Protection—This is protection of memory used by one process from unauthorized access by another.

Multitasking—Execution of more than one program apparently at the same time on a single CPU.

Multithreading—This is an application's ability to run many sub-programs simultaneously. For example, while an application performs a long database sort in the background, you continue to retrieve database information for specific queries.

Preemptive Multitasking—This is an operating system's ability to run several programs simultaneously yet reserve controls of processor allocation should a more-important application require computing. For example, printing from one application won't halt all other applications. *Windows NT* and OS/2 2.0 are preemptive multitasking while *Windows* 3.1 is a cooperative multitasking system.

Privileged Mode—Provides direct access to hardware resources and operating-system functions.

Symmetrical Multiprocessing—This is the ability of an operating system to run on any free processor or several processors simultaneously while sharing memory. Unlike OS/2 2.0, UNIX supports symmetrical multiprocessing, as will *Windows NT*.

User Mode—This provides access to system data structures or hardware.

Virtual Memory—This is a memory-management scheme that provides a large, protected address space for each process. When memory usage exceeds available RAM, selected portions of memory are transferred to disk and later reloaded to RAM when needed. Virtual memory refers to the operating system's ability to let applications use more memory than actually exists by treating disk space as extra RAM, also called paging.

Endangered Species

The age of the dinosaurs is passing. If *Windows NT* colonizes the corporate environment, it will be diehard mainframe vendors who will be at risk of losing the most.

The question of whether *Windows NT* or OS/2 2.0 will reign supreme can be answered by considering two significant factors. One is the installed base of *Windows*, which may be too overwhelming for OS/2 to ever overcome. The other is the ability of an organization to rapidly develop and deliver new technologies, which, by itself, is likely to determine the ultimate winner. As an anecdote for the latter, I recently heard a former IBM executive, now an entrepreneur creating his third successful company, say, "We can design, engineer and deliver a new product in four to six months, while it takes that long in IBM to just find out who can work on such a product."

If the people at Microsoft can continue to avoid those kinds of inefficiencies, then combined with the *Windows* installed base, the *Windows* family of operating systems may very well become not only dominant but ubiquitous.

Pundits may be correct about Microsoft having to delay delivery until 1993, and some of the planned functionality may be missing for several months thereafter. But unless Microsoft falls asleep, the *Windows* family of operating systems is likely to dominate the desktop landscape by the end of this decade. ■

In Brief

Win32 Preliminary SDK, $69 on CD-ROM; $399 on CD-ROM with printed documentation
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052-6399
Tel.: 800-227-4679 or 206-882-8080;
800-563-9048 in Canada
CIRCLE NO. 110 ON FREE INFORMATION CARD

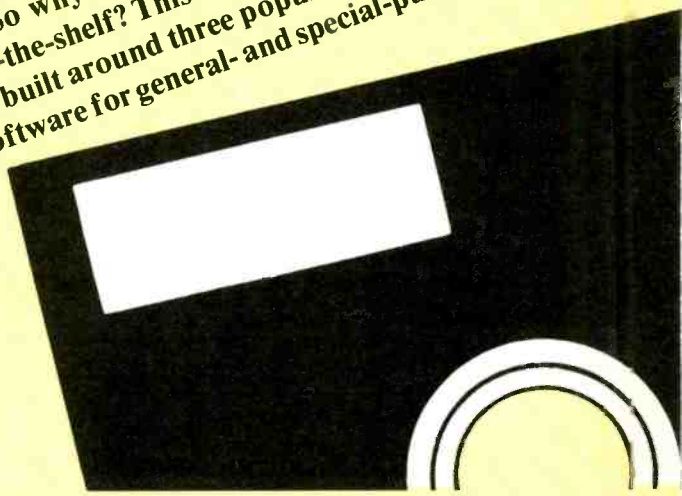
Special Report on Microcontroller Boards

By Jan Axelson

Microcontrollers have become popular because you can do so much with them, at relatively low cost. Designing with them is also fun, partly because their small size keeps designs and programming more manageable than with larger, more complex devices. Furthermore, you don't tie up your general-purpose PC.

One of the most useful products relating to microcontrollers is a microcontroller board, which is a printed-circuit assembly that contains the basic elements of a generic microcontroller circuit. When you use one of these boards, much of your circuit design, board fabrication and testing have been done for you. All you need add are the components your specific application requires and programming to control the circuits.

Compared to other methods of circuit design and construction, microcontroller boards can save both time and money. So why spend time re-inventing and building circuits that are readily available off-the-shelf? This focus examines a wide variety of eight-bit microcontroller boards built around three popular microcontroller families, add-ons, accessories and software for general- and special-purpose applications.



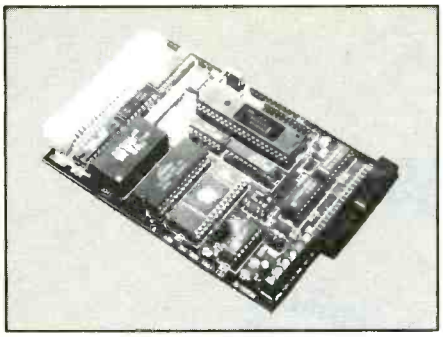
Over the past few years, a profusion of new boards has appeared in the marketplace from a variety of vendors. This is good news for buyers, since the selection is wide and pricing is competitive. For limited budgets, kits and bare boards are available, but even assembled boards are a good deal because high-volume purchasing means savings for the vendor.

In the Buyer's Guide presented here, I'll introduce you to eight-bit-microcontroller boards in the 8051, 68HC11 and Z8 families. Included are basic information about the boards, their uses, additional hardware and software needed to use a board and how to choose the right board for your needs. To help you decide on a board when you're ready to buy, I've also included tables that compare the basic features of each family of microcontroller and product summaries for more than 60 microcontroller boards.

Board Uses

Most uses for microcontroller boards fall into one of three main categories: learning, prototyping and production. If you like to plunge in and explore things on your own, rather than follow a step-by-step course, you can learn a lot from a microcontroller board, its documentation and manufacturers' data books. The board enables you to begin programming and interfacing quickly, without having to learn every detail about the circuits first.

To simplify testing and debugging, some boards include a monitor program or a BASIC or FORTH interpreter. These programs enable you to easily examine and change data in memory locations, upload and down-



Advanced Design Solutions MCU-32

load programs from and to a personal computer, run programs and set breakpoints to stop program execution at certain locations or under certain conditions. Features like these are very helpful for learning about how the microcontroller works.

Documentation included with a board can also help a lot in learning about a device. Typically, you get complete schematic diagrams, a description of the circuits and how to configure the board for different hardware options. Some vendors offer more-extensive tutorials or free or minimal-cost example schematics and programs to get you started quickly.

If you use a microcontroller board for prototyping, you can try out circuit ideas before committing yourself to a final design for a project. After drawing an initial schematic, you'll want to test your circuit and programming ideas. To do so, you could hand-wire the circuit using Wire Wrap or point-to-point soldering or design and make a printed-circuit board.

Another option is to buy a microcontroller board containing the basic features you'll need and add only the additional components your particular application requires. There are two advantages to this approach. One is that you save the time you'd otherwise spend wiring or designing and making a board that will almost certainly require changes before the design is finalized. The other is that if the board includes a monitor program or other debugging firmware, you can more easily run and test your program code as you develop it.

Once the basic circuit is up and running, you can design and fabricate a pc board with confidence that the pretested circuits and program will work. Some board vendors will even design a custom board for you, using their original board layout as a base. This

Comparison Chart for 8051 Microcontroller Boards

Vendor[1]	Advanced Design Solutions	Allen Systems	Allen Systems	Allen Systems	Applied Logic Engineering	Basicon	Basicon	Basicon
Model	MCU32	CP-31	DP31/535	CP-526	RS-232 SBC	AD1/S	MC-2i	MC-1i
Price	$299	$250	$250	$350	$110	$70	$178	$198
Microcontroller	80C32	80C31	8051 or 80535	80C535	80C32	8031	80C31	80C52-BASIC
Power Supply (Volts)	+5	+5	+5, +12, −12	+5	+9	+5	+5	+5
Current Consumption[2]	30	50	150	50	100	10	40	140
Clock Frequency (MHz)	11.0592	11.0592	12	11.0592	7.3	4	11.0592	11.0592
Board Size (Inches)	3.5 × 5	3 × 6	4.5 × 6.5	4 × 5.5	4.5 × 6	2 × 3	3 × 4	3 × 4
Total Socketed Memory Space[3]	96	64	120	64	64	8	64	24
Included Memory								
EPROM (UV-Erasable)	-	32	8	32	32	8	-	-
RAM (Volatile)	32	-	8	32	-	-	8	8
RAM (Nonvolatile)	-	32	-	-	-	-	-	-
FLASH EPROM	-	-	-	-	-	-	-	-
EEPROM	-	-	-	-	-	-	-	-
Digital I/O Bits	12	32	48	40	None	12	36	24
Serial Ports	1	1	2	1	1	1	2	2
A/D Converter	Yes	-	Yes	-	-	Yes	-	No
Firmware (A = Available; I = Included)								
Monitor Program	-	A	A	A	I	-	A	A
BASIC	-	A	-	-	-	-	A	I
FORTH	-	-	-	-	-	-	-	-
Prototyping Area	-	-	-	-	-	-	No	-
Expansion Board	Yes	Yes	-	-	-	Yes	Yes	Yes
Kit or Bare Board	-	Yes	Yes	Yes	Yes	-	No	No
Sample Applications	Yes	-	-	-	Yes	Yes	Yes	Yes

[1]See Sources box at end of article for addresses and telephone/fax numbers. [2]At +5 volts, in milliamperes. [3]All memory listed is in kilobytes.

is usually easily done, since most vendors have their layouts available on a CAD system.

Prototyping can have more uses than you might think at first. Even single-chip designs that don't access external memory can benefit from using a microcontroller board with a monitor program or other debugging tools. You can use the resources of the microcontroller board to test your basic ideas for the circuit and programming. Even if you later have to revise the code to fit the target device, you can save time and trouble in the long run by first testing the code on a more-flexible and interactive system.

Finally, if a project involves building just one, a few or even dozens of a circuit, the microcontroller boards can be a part of the final product. Many boards have a prototyping area or an optional expansion board for adding your own circuits or at least a connector that enables you to design and fabricate your own add-on circuits. Most vendors offer discounts for multiple boards, which helps in making this approach cost-effective.

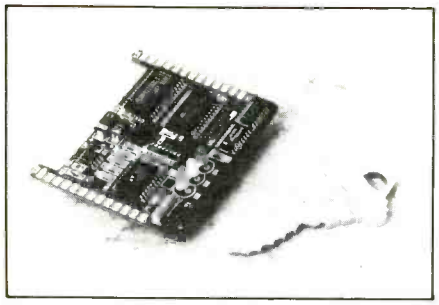
To give you an idea of the possibilities, here are just a few examples of applications that users have found for microcontroller boards:

- Operating outdoor advertising and scoreboard.
- Sewing machine controller.
- Quality-control testing
- Liquid metering control.
- Controlling CO_2 valves used in food processing.
- Controlling a knife on sheeter machine in paper mill.
- Controlling tape machines and other remote or portable devices in TV a broadcasting station.
- Building automation systems for HVAC manufacturers.
- Vending machine controller.
- Reading and writing information on magnetic-card systems.
- Semiconductor-memory testing.
- Sonar detection.
- Satellite uploading.
- Stacker for newspaper plant.

Microcontroller Board Basics

Microcontroller boards are useful because most microcontroller circuits needn't be designed from scratch. Many designs are built around a base of similar elements. A typical circuit contains the microcontroller chip, a crystal or other timing reference,

Basicon	Binary Technology	Binary Technology	Blue Earth Research	Cottage Resources	Cottage Resources	HiTech Equipment Corp.	HiTech Equipment Corp.	Iota Systems
SBC-64A	SIBEC-II	SIBEC-II	Micro-440	Control-R I	Control-R II	80031SBC-10	552SBC	EC-25
$729	$150	$228	$199	$50	$80	$199	$349	$100
80C52	80C31	8052-BASIC	83C51FB	8031	8031	8031	80C552	80C32
18-40 dc or 14-28 ac	+5	+5, +12.5	6 to 16 dc	+5	+5	+5 or 7-9 dc	7-9 dc	5-15 dc
200	100	350	40	200	250	150	100	38
11.0592	11.0592	11.0592	12	11.0592	11.0592	11.0529	11.0529	11.0529
7 × 9	3.5 × 4.5	5.4 × 7.75	1.9 × 2.25	3 × 4	3.5 × 4.5	6 × 3.5	6.1 × 5.3	3.5 × 6.5
128	128	128	128	8	16	64	128	120
8	-	16	-	8	8	16	64	-
8	-	8	24	-	-	8	32	-
-	-	-	8	-	-	-	-	-
-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
64	36	36	14	12	12	12	40	12
1	1	2	2	1	1	1	3	2
No	-	-	Yes	-	-	-	Yes	-
A	A	A	I	-	-	I	I	A
I	A	I	I	-	-	A	-	A
A	-	-	-	-	-	-	-	-
No	-	Yes	-	-	-	-	-	Yes
Yes	-	Yes	Yes	-	-	-	-	Yes
No	-	-	Yes	Yes	Yes	-	-	-
Yes	-	-	Yes	Yes	Yes	-	Yes	Yes



Blue Earth Research MICRO-440

memory chips and parallel I/O (input/output) ports.

In addition to these basic elements, two things customize the circuit for its intended use: the program the microcontroller executes and the components that connect to the generic circuit. Even here, many elements are usable in a variety of circuits. For example, an RS-232 serial port, keypad interface or analog-to-digital converter and program code to control these might be used in a variety of devices.

Microcontrollers covered in this guide each have 16 address lines that let the chip access 65,536 (2^{16}, or 64K) memory locations. Special circuits and programming permit some boards to access more memory. Eight data lines hold bytes the microcontroller reads or writes to the memory locations.

Typical components that are read and written to using the address and data lines include EPROMs, RAMs and interfaces to a variety of other circuit components, including liquid-crystal displays, keypads, linear and stepping motors, ac power and more.

In addition to data and address buses, a microcontroller can read and write to special I/O port pins. Compared to using the data and addresses buses, port pins have several appealing advantages.

On most devices, special instructions for reading and writing to individual port pins make it easy to control or monitor a simple on/off condition or high/low logic level. Also, many port pins have optional special functions that are supported by the chip's internal hardware, which makes the functions easy to implement. Common functions include serial interfaces, counter inputs and external interrupts. And where speed is essential, reading and writing to a port pin is usually faster than accessing external memory.

Once you have the basic circuit ele-

Comparison Chart for 8051 Controller Boards

Vendor[1]	L.S. Electronic Systems Design	L.S. Electronic Systems Design	L.S. Electronic Systems Design	L.S. Electronic Systems Design	Micromint	Micromint
Model	EMC32	EMC32F	DG31	DG32F	RTC31	BCC52
Price	$80	$89	$129	$155	$119	$189
Microcontroller	8031AH	8031AH	8031AH	8031AH	80031	80C52-BASIC
Power Supply (Volts)	+5	+5, +12	+5	+5, +12	+5	+5, +12, −12
Current Consumption[2]	150	150	195	230	150	350
Clock Frequency (MHz)	11.0592	11.0592	11.0592	11.0592	11.0592	11.0592
Board Size (Inches)	4 × 3	4.24 × 3	5.5 × 4.5	6 × 4.8	3.5 × 3.5	4.5 × 6
Total Socketed Memory Space[3]	40	136	24	56	64	48
Included Memory						
EPROM (UV Erasable)	16	-	16	16	-	-
RAM (Volatile)	8	8	8	8	8	8
RAM (Nonvolatile)	-	-	-	-	-	-
Flash EPROM	-	128	-	32	-	-
EEPROM	-	-	-	-	-	-
Digital I/O Bits	12	12	40	40	12	32
Serial Ports	1	-	1	1	1	2
A/D Converter	-	-	-	-	No	No
Firmware (A = Available; I = Included)						
Monitor Program	Yes	Yes	Yes	Yes	A	A
BASIC	-	-	-	-	A	I
FORTH	-	-	-	-	-	-
Prototyping Area	-	-	-	-	No	No
Expansion Board	-	-	-	-	Yes	Yes
Kit or Bare Board	Yes	Yes	Yes	Yes	Yes	No
Sample Applications	Yes	Yes	Yes	Yes	Yes	Yes

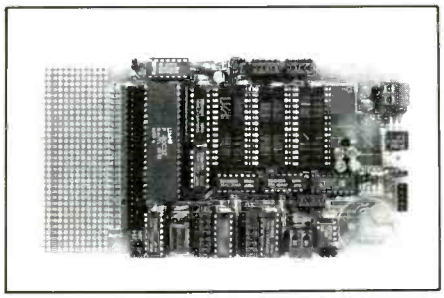
[1]See Sources box at end of article for addresses and telephone numbers. [2]At +5 volts, in milliamperes. [3]All memory listed is in kilobytes.

ments, you're ready to customize the hardware for your application. For example, you can add displays, keypads, motors, switches, sensors and other components, as well as the interfaces they require.

Typical Board

Most of the microcontroller boards reviewed in this report include microcontroller, crystal and memory or memory sockets. Microcontrollers are from one of three major families: Intel's 8051, Motorola's 68HC11 and Zilog's Z8. Each family includes the original chip and derivative chips from the original source or a licensed manufacturer. Derivative chips may have additional features, enhanced operation, smaller size and price or other benefits, while remaining compatible with the basic chip.

On most boards, the microcontroller and memory chips are socketed for easy replacement. You can often configure memory sockets to suit your application, populating them with EPROM, FLASH EPROM, EEPROM or RAM as desired.



Iota Systems EC-25

Many boards have additional circuits or offer them as options. Sometimes, additional components are installed on the main circuit board. At other times, they use separate expansion boards that connect to the main board.

Below are some of the popular items you'll find included on microcontroller boards. The individual product summaries mention other, less-common items that are available with specific boards.

A *serial port* is included on most boards, since it's commonly used during program development for uploading, downloading and debugging programs using a personal computer as a host system.

An *analog-to-digital* (A/D) *converter* enables you to measure analog

Micromint	MJS Designs	Modular Micro Controls	Modular Micro Controls	Modular Micro Controls	Modular Micro Controls	Modular Micro Controls	Modular Micro Controls	New Micros	Prologic Designs
BRUTE-52	EV80C51FX	MC51C	MC51H	MC51S	MC51E	MC51D	MC51T	NMIS-0016	BASCOM1
$459	$2600	$129	$149	$199	$199	$299	$399	$99	$120
80C52-BASIC	80C51FC	80C51FA	80C51FA	80C51FA	87C51FA or DS5000	80C51FA	80C537	80535	80C52-BASIC
+5	+5, +12, −12	+5	+5	8-18 dc	8-18 dc	8-18 dc	8-18 dc	+5	+5, +12.5
600	225	80	40	60	40	80	80	50	60
11.0592	16	11.0592	11.0592	11.0592	11.0592	11.0592	11.0592	7.63	11.0592
3.5 × 5.3	6.5 × 4	3.9 × 6.3	3.0 × 3.15	3.9 × 6.3	3.9 × 3.15	3.9 × 8.6	11 × 8.5	2 × 4	3.1 × 4.8
56	64	128	0	96	0	128	64	64	48
-	32	-	-	-	4	-	-	8	8
8	32	-	-	-	-	-	-	8	32
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
28	14	14	32	14	32	14	48	28	9
1	2	1	1	1	1	1	2	1	2
Yes	-	-	-	-	-	-	Yes	Yes	-
A	I	I	I	I	I	I	I	A	-
I	-	-	-	-	-	A	-	-	Yes
-	-	-	-	-	-	-	-	I	-
No	-	-	-	-	-	-	-	-	-
No	-	-	Yes	Yes	-	Yes	Yes	Yes	-
No	Yes	-	-	-	-	-	-	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

voltages generated by a variety of sensors and other electronic devices.

A *digital-to-analog* (D/A) *converter*, the reverse of an A/D converter, converts digital signals, such as a byte placed on a data bus, into an analog voltage for interfacing with components that require analog inputs.

A *liquid-crystal display* (LCD) and interface provides a simple, low-power way to display information. Small one-to-four-line programmable displays are versatile enough for many applications and are available at reasonable cost.

A *keyboard* or *keypad* interface permits easy interfacing with these devices.

For controlling ac line voltages or other high-voltage or high-current loads, you can use *optically-isolated I/O, relays* or an X-10 *power-line interface*.

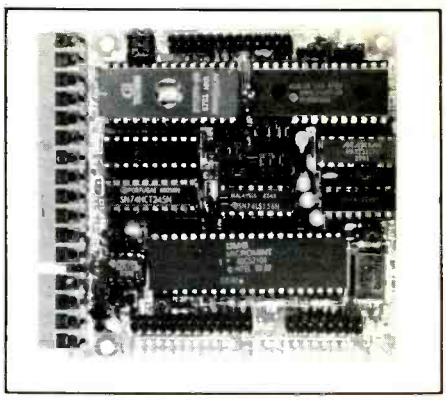
Port expansion adds I/O ports to those available on-chip, usually by adding a special chip dedicated to this purpose.

Memory expansion increases the amount of memory you can access.

Battery back-up can preserve the contents of memory or even keep the entire system running when the main power supply fails.

A *real-time clock and calendar* provides a simple, usually battery-backed, way of keeping track of time and date.

To connect your own circuits or a vendor's expansion boards, most boards provide *expansion connectors*. These are a series of contacts that connect to power, signal or control lines on the main board. Several types of expansion connectors are used. Many boards use headers or IDC connectors for use with ribbon cables. An edge connector has fingers that plug into a



Micromint RTC52

Comparison Chart for 8051 Microcontroller Boards

Vendor[1]	Rigel Corp.	Rigel Corp.	Rigel Corp.	Software Science	STD-Micro Controls	STD-Micro Controls	Suncoast Technologies	Tri-L Data Systems
Model	R-31J	R-31	RMB-S	ProtoQuick 8051	TCU-2R	RTU-17	70691C	GPC11
Price	$130	$190	$495	$99	$125	$275	$38	$275
Microcontroller	8031	8031	80535	8031/51	80C552	80C552	8051AH	80C535
Power Supply (Volts)	+5	+5 or 9 ac	9 ac	+5	24 ac or 24 dc	24 ac or 24 dc	+5	8-14 dc
Current Consumption[2]	100	100	500	200	250	250	100	66
Clock Frequency (MHz)	11.0592	11.0592	12	11.0592	11.0592	11.0592	11.0592	12 or 16
Board Size (Inches)	3.5 × 4.5	4 × 6	7.75 × 10.5	4.5 × 6	5 × 7	7 × 9	4 × 4.5	5 × 3
Total Socketed Memory Space[3]	64	64	128	64	64	96	8	72
Included Memory								
Eprom (UV-Erasable)	32	32	32	8	32	32/64	8	32
RAM (Volatile)	32	-	32	-	-	-	-	8
RAM (Nonvolatile)	-	32	-	-	32	32	-	-
FLASH EPROM	-	-	-	-	-	-	-	-
EEPROM	-	-	-	-	0.256	0.256	-	-
Digital I/O Bits	12	12	28	12	16	16	14	40
Serial Ports	1	2	1	1	1	1	1	3
A/D Converter	-	Yes	Yes	-	Yes	Yes	-	Yes
Firmware (A = Available; I = Included)								
Monitor Program	I	I	I	Yes	-	-	-	A
BASIC	-	-	-	A	I	I	A	-
FORTH	-	-	-	-	-	-	-	-
Prototyping Area	No	-	Yes	Yes	-	-	Yes	-
Expansion Board	-	-	-	-	Yes	Yes	-	Yes
Kit or Bare Board	Yes	Yes	Yes	-	-	-	Yes	-
Sample Applications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1]See Sources box at end of article for addresses and telephone/fax numbers. [2]At +5 volts, in milliamperes. [3]All memory listed is in kilobytes.

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backplane. A typical vertical stacking connector is a pair of headers on the component side of a board that plug into matching sockets on the solder side of a mating board. Screw terminals permit easy hook-ups to individual wires. Other options include DB-25 and phone-jack connectors.

Essential Tools

To use a microcontroller board, you need a development system that, at minimum, consists of the board, a programming language and a way of transferring programs into on-board memory. Most systems use a personal computer and communications software as a host system for communicating with the microcontroller board.

Some boards include an on-board, or firmware, BASIC or FORTH interpreter. To use the interpreter, you connect your microcontroller board via an RS-232 serial link to a PC running any generic communications program, such as one you'd use to communicate with on-line BBSes. You then can write, run and store programs using your personal computer's keyboard and video display to type in and view the program code.

Interpreters are easy to use because you can run programs immediately after writing them, without the intermediate step of assembling or compiling and downloading from a PC to the microcontroller board. Interpreters are ideal for quickly writing and testing simple programs.

Another option for development systems is to use a firmware monitor, along with a PC-based assembler or compiler. With this option, as with the previous one, the microcontroller board connects to a PC via a serial link and communications software. You write your program on the personal computer, using a standard text editor, and then use an assembler or compiler to generate an executable version of the program. The communications software and monitor program enable you to download the executable file to the microcontroller board's memory.

This approach allows you to program in assembly language, BASIC, C or any language for which you have an assembler or compiler that generates executable files for your microcontroller. Assembled and compiled programs execute faster than interpreted programs. Also, since the assemblers and compilers are on-disk, only the program code has to be stored on-board.

Comparison Chart for HC11 Microcontroller Boards

Vendor[1]	Allen Systems	Micromint	Microsystems Development Technology	Minotaur Systems	Minotaur Systems	Modular Micro Controls
Model	CP-11	RTCHC11	ispHC11	E2-KIT	F1-KIT	MCHC11
Price	$250	$239	$199	$79 (kit only)	$106 (kit only)	$149
Microcontroller	68HC11	MC68HC11A1	MC68HC11A1FN	MC68HC11E2FN	MC68HC11F1FN	68HC11A8
Power Supply (Volts)	+5	+5	+5	+5	+5, +12	+5
Current Consumption[2]	50	75	100	30	40	50
Clock Frequency (MHz)	8	8	8	8	8	8
Board Size (Inches)	3.5 × 5.5	3.5 × 4.5	4.6 × 4.2	4 × 5	5 × 5	3.9 × 3.15
Total Socketed Memory Space[3]	60	64	192	0	64	0
Included Memory						
EPROM (UV-Erasable)	32	-	8	-	-	-
RAM (Volatile)	28	8	8	0.256	32	-
RAM (Nonvolatile)	-	-	-	-	-	-
FLASH EPROM	-	-	-	-	32	-
EEPROM	0.512	0.512	0.512	2	0.512	0.512
Digital I/O Bits	24	21	38	38	38	14
Serial Ports	3	2	1	2	2	2
A/D Converter	Yes	Yes	Yes	Yes	Yes	Yes
Firmware (A = Available; I = Included)						
Monitor Program	-	I	I	-	-	-
BASIC	A	A	A	-	-	-
FORTH	-	-	A	-	-	A
Prototyping Area	-	No	-	Yes	Yes	-
Expansion Board	-	Yes	-	No	No	Yes
Kit or Bare Board	Yes	No	Yes	Yes	Yes	-
Sample Applications	-	Yes	Yes	Yes	Yes	Yes

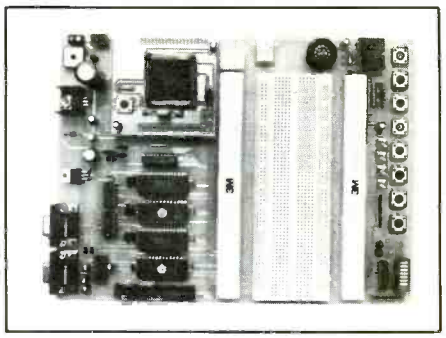
[1]See Sources box at end of article for addresses and telephone/fax numbers. [2]At +5 volts, in milliamperes. [3]All memory listed is in kilobytes.

Microcontrollers can't use compilers like QuickBASIC or Turbo C, which generate files for MS-DOS computers. You must use a cross-compiler or assembler that generates executable files for the 8051, HC11, Z8 or whatever microcontroller family you're using. Most board vendors can help you find suitable software, and some include it free.

If you don't have communications software, a final option is to assemble or compile your code and then program or "burn" an EPROM or other memory chip with the code, install the chip in your system and run the program. This approach isn't recommended because it dooms you to repeating cycles of "burn and crash" as you program an EPROM, try it out, look for program bugs and re-program, without the convenience and debugging tools available with a monitor program or interpreted programming language.

Many board vendors offer interpreters, assemblers and compilers for microcontrollers. Some also stock communications software, cables, power supplies, project enclosures and other products to help you get running.

In addition to the above items, there are some others that are helpful or essential when developing a project. If you intend to place your final program in an EPROM (including FLASH EPROMs), you'll need a programmer to write the executable file into the EPROM. A few boards have on-board EPROM programmers. If your board doesn't, you need a programmer that can program your EPROM with the file your assembler or compiler creates. Ultraviolet-erasable EPROMs require an EPROM eraser as well.



Rigel Corp. RMB-S

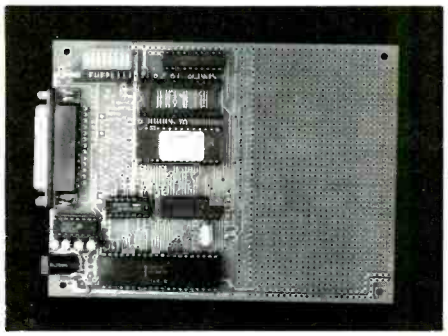
Alternatives to EPROMs include battery-backed RAM and EEPROMs that may not require special programmers. Often, you can download files directly into these devices on the microcontroller board.

Troubleshooting your hardware and firmware (programs stored on-chip) is easier if you have suitable test equipment. At minimum, you should have a digital voltmeter and logic probe for monitoring voltages. An oscilloscope can save you a lot of time and energy by allowing you to monitor signals that are too fast to capture with a voltmeter or logic probe. You can also set up an oscilloscope to trigger on specific events or monitor more than one signal at a time.

Logic analyzers, EPROM emulators and other test equipment are also available, but not essential. You may also find uses for test software, such as simulators for microcontrollers and other circuits.

If you're going to add circuits to the basic board, you need materials for circuit construction. The options include solderless breadboarding, a Wire Wrap tool, a soldering iron and materials for designing and making a

Mosaic Industries	New Micros	New Micros	New Micros	Wheatstone Microsystems
QED Board	NMIN-0021	NMIS-0021	NMIX-0022	WMS1
$495	$67	$85	$300	$159
68HC11F1	68HC11FN	MC68HC11E9	MC68HC11A8	68HC11A1
6-12 dc	+5	+5 7-18 ac	+5 or	8-24 dc
100	10	30	150	60
8 or 16	8	8	8	9.8304
3.2 × 4	2 × 4	2 × 4	4 × 6	7.5 × 4
384	0.75	64	64	64
-	-	-	-	32
32	0.256	8	-	-
-	-	-	8	32
-	-	-	-	-
0.512	0.512	0.512	0.512	0.512
44	38	22	38	24
3	2	2	2	2
-	Yes	Yes	Yes	Yes
I	-	-	-	Yes
-	-	A	A	Yes
I	I	I	I	-
-	-	-	-	-
Yes	-	Yes	Yes	Yes
Yes	-	-	Yes	-
Yes	Yes	Yes	Yes	Yes



Software Science ProtoQuick 8051

pc board. Materials and equipment for these are available from many mail-order sources. Of course, you need a power supply to power your board. Voltage and current requirements vary, depending on particular board.

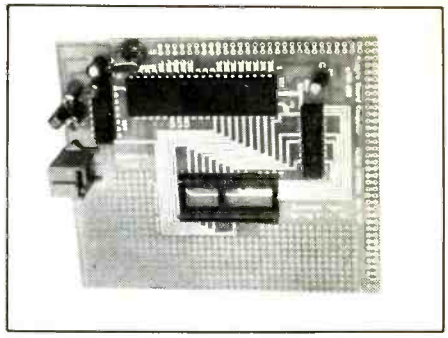
About the boards

The following product summaries and chart describe and compare over 60 boards from 24 vendors. The lists are limited to boards containing eight-bit microcontrollers in the 8051, 68HC11 and Z8 families—by far the most popular for microcontroller boards.

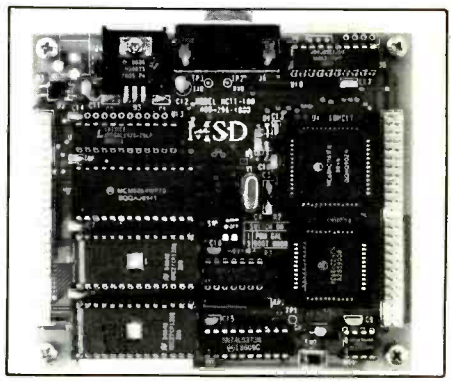
To keep the guide to a reasonable size, I didn't include boards that contain such general-purpose microprocessors as the Z80 and HD64180. Nor will you find microcontroller boards offered by Motorola, Intel and other chip vendors. You can find out more about these by contacting the manufacturers or distributors. For more-elaborate design needs, there are boards that use 16- and 32-bit microcontrollers and microprocessors, but you won't find these described here, either.

The table listings compare the boards in the following areas:

- The *microcontroller chip* is the standard chip installed on the board. If the chip is socketed, you may be able to install a replacement, for example, exchanging an NMOS device for a CMOS equivalent to lower power consumption. Some vendors offer alternate microcontrollers.
- *Price* is the cost of a single assembled and tested board. When comparing prices, be sure to also compare installed components and features. Because boards are available in several configurations, you need pay for only those options you want. Quantity discounts are common.
- *Power-supply voltage* or voltages describes the potentials you must provide to operate the board. Many boards require a single +5-volt supply. Some have on-board voltage regulators and can be powered by a battery or other supply within a specified range. A few boards require additional power supplies, such as ±12 volts, usually for a serial port or EPROM programming. Other boards can generate these voltages from the +5-volt supply, if needed. Listed voltages are dc, unless otherwise indicated. Some vendors sell or include power supplies for their boards, or you can use your own.
- *Current consumption* should be taken as a rough estimate, since it will vary according to the components you install or add to the basic circuits. The chart lists the +5-volt current only.
- *Clock frequency* describes the frequency of the on-board crystal or other timing reference that clocks the microcontroller.
- *Total socketed memory space* is the amount of EPROM, RAM or other



Suncoast Technologies 60791C

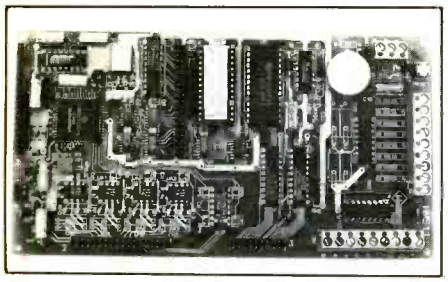


Microsystems Development Technologies ispHC11

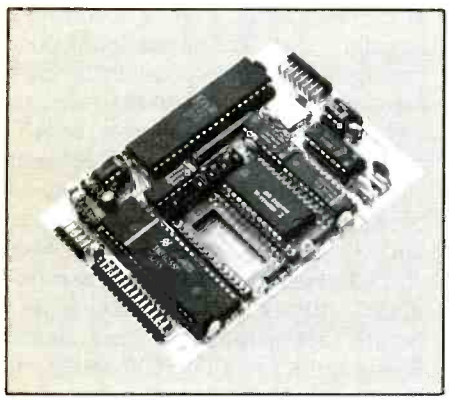
Comparison Chart for Z8 Microcontroller Boards

Vendor[1]	Basicon	Micromint	MJS Designs	Software Science
Model	MC-1z	BCC11	Z8PM	ProtoQuick Z8
Price	$185	$139	$335	$99
Microcontroller	Z8671	Z8671	Z086C9320	Z8681PS
Power Supply (Volts)	+5	+5, +12, −12	+5 or 6.5-12 dc	+5
Current Consumption[2]	250	250	35	200
Clock Frequency (MHz)	7.3728	7.3728	20	7.3728
Board Size (Inches)	3 × 4	4 × 4.5	4 × 6	4.5 × 6
Total Socketed Memory Space[3]	8	6	56	64
Included Memory				
EPROM (UV-Erasable)	-	-	32	8
RAM (Volatile)	-	-	16	-
RAM (Nonvolatile)	-	-	-	-
FLASH EPROM	-	-	-	-
EEPROM	-	-	-	-
Digital I/O Bits	38	16	16	14
Serial Ports	1	1	1	1
A/D Converter	No	No	-	-
Firmware (A = Available; I = Included)				
Monitor Program	A	-	I	I
BASIC	I	I	-	A
FORTH	-	-	-	-
Prototyping Area	No	No	-	Yes
Expansion Board	Yes	Yes	-	-
Kit or Bare Board	No	No	-	-
Sample Applications	Yes	Yes	Yes	Yes

[1]See Sources box at end of article for addresses and telephone/fax numbers.
[2]At +5 volts, in milliamperes. [3]All memory listed is in kilobytes.



Wheatstone Technologies WMS11



Basicon MC-1Z

memory you can install on the board. Off-board memory expansion may be available as well.

- *Installed memory* describes the memory chips installed on the standard board, including EPROM, RAM and EEPROM.
- *Digital I/O* describes the number of I/O port bits available on the standard board. The exact amount available will vary, depending on what functions you use on the board.
- *Serial ports* include RS-232 ports for communication with a host system or other uses, as well as RS-422 or RS-485 ports that are better suited for networking and synchronous serial ports for fast communication over short distances.
- An *A/D converter* is a common addition to microcontroller boards. Some devices have an on-chip converter, and a board containing one of these chips automatically includes this function.
- *Firmware* includes installed or available programming languages or monitor programs stored in EPROM or other on-board memory.
- *Sample programs* or applications are available from many vendors, including programs and schematics for implementing common functions.

Sources

Advanced Design Solutions
1920 Moore's Mill Rd.
Atlanta, GA 30318
Tel.: 404-352-4788; fax: 404-355-1763

Allen Systems
2346 Brandon Rd.
Columbus, OH 43221
Tel.: 614-488-7122

Applied Logic Engineering
13008 93 Pl. N.
Maple Grove, MN 55369
Tel./fax: 612-494-3704

Basicon, Inc.
14273 NW Science Park Dr.
Portland, OR 97229
Tel.: 503-626-1012; fax: 503-643-4686

Binary Technology, Inc.
P.O. Box 541
Carlisle, MA 01741
Tel.: 508-369-9556; fax: 508-369-9549

Blue Earth Research
310 Belle Ave.
Mankato, MN 56001
Tel.: 507-387-4001; fax: 507-387-4008

Cottage Resources Corp.
10271 S. 1300 E., Ste. 151
Sandy, UT 84094
Tel.: 801-268-2875

HiTech Equipment Corp.
9400 Activity Rd.
San Diego, CA 92126
Tel.: 619-566-1892; fax: 619-530-1458

Iota Systems, Inc.
POB 8987
Incline Village, NV 89450
Tel.: 702-831-6302; fax: 702-831-4629

L.S. Electronic Systems Design
2280 Camilla Rd.
Mississauga, Ontario L5A 2J8 Canada
Tel.:/fax: 416-277-4893

Micromint
4 Park St.
Vernon, CT 06066
Tel.: 203-871-6170 or 1-800-635-3355;
fax: 203-872-2204

Microsystems Development Technologies
4100 Moorpark Ave. #104
San Jose, CA 95117
Tel.: 408-296-4000; fax: 408-296-5877

Minotaur Systems
4241B Valley Rd.
Drexel Hill, PA 19026

MJS Designs
1438 W. Broadway Rd., Ste. B185
Tempe, AZ 85282
Tel.: 602-966-8618

Modular Micro Controls, Inc.
109 S. Water St.
Northfield, MN 55057
Tel.: 507-645-8315 or 1-800-832-7731;
fax: 507-645-4342

Mosaic Industries Inc.
5437 Central Ave., Ste. 1
Newark, CA 94560
Tel.: 510-790-1255

New Micros, Inc.
1601 Chalk Hill Rd.
Dallas, TX 75212
Tel.: 214-339-2204; fax: 214-339-1585

Prologic Designs
P.O. Box 19026
Baltimore, MD 21204

Rigel Corp.
P.O. Box 90040
Gainesville, FL 32607
Tel.: 904-373-4629

Software Science
3750 Roundbottom Rd.
Cincinnati, OH 45244
Tel.: 513-561-2060; fax: 513-271-3181

Sierra Controls
(formerly STD-Micro Controls)
6406 NW High Dr.
Kansas City, MO 64152
Tel: 816-587-2762

Suncoast Technologies
P.O. Box 5835
Spring Hill, FL 34606
Tel.: 904-596-7599

Tri-L Data Systems, Inc.
94-871 Farrington Hwy., 2nd Fl.
Waipahu, HI 96797-3146
Tel.: 808-671-5133 or 1-800-245-8745;
fax: 808-671-8543

Wheatstone MicroSystems, Inc.
105-14 Elm St., Ste. 418
Old Saybrook, CT 06475
Tel.: 203-669-0401

• Several boards include a *prototyping area*, usually an area of perforated board for wiring circuits to the components on the main board. Other boards have optional add-on protoboards.
• *Expansion boards* are available for many boards, to add functions to the basic board. The product summaries give more details about the specific boards available.
• *Kits or bare boards* are available for some boards, if you'd rather build and test your own.

Product Tables

Our product tables are grouped by family (8051, 68HC11, Z8) and arranged alphabetically by company name within each family. Vendors range from small one-person operations to larger companies with a variety of products and services. Of necessity, the tables are brief and point out only a few of the features of each board. Many boards are available in a variety of configurations, not all of which can be described here.

If you find yourself overwhelmed by the selection, don't despair. Decide on the features you consider important. whether low current consumption, a large number of I/O ports, expandability, low cost or whatever. Use the comparison charts to narrow your choices. For more specific detailed information, contact the vendors. They'll be happy to provide more complete specifications and answer questions.

Note that some companies offer boards in more than one family. A Sources list elsewhere in this article gives addresses and phone numbers for ordering or/and requesting additional information.

The 8051 is by far the most popular family for microcontroller boards, with more than 100 derivatives, in addition to the basic 8051, ROM-less 8031 and the equivalent CMOS 80C31 and 80C51.

Some popular enhanced 8051s include: the 8032 and 8052 add a second timer and additional RAM; the 80C51FA adds a programmable counter array, enhanced serial port and up/down timer/counter; the Siemens 80535 adds two parallel ports, an eight-channel A/D converter, watchdog timer, 12 interrupt sources and flexible timer reload, capture and compare capabilities. Signetics' 80C552 adds an eight-channel, 10-bit A/D converter, two pulse-width modulator outputs, capture and compare registers and a watchdog timer. Dallas Semiconductor's DS5000 series includes on-chip battery-backed program and data memory and an optional clock/calendar.

Also very popular is the 80(C)52-BASIC chip, which has a BASIC interpreter in ROM. Some vendors offer 8051-family boards with a BASIC-52 interpreter in external EPROM.

The 68HC11 is a full-featured chip from Motorola, with several derivatives available. Most HC11s include an eight-channel, eight-bit A/D converter and at least 512 bytes of EEPROM. The -F1 version has a non-multiplexed data bus that provides speedier operation.

Zilog's Z8 family is the smallest of the three listed in the tables, but it has dedicated fans. A popular Z8 chip among its adherents is the Z8671, which includes a BASIC/DEBUG interpreter in ROM.

Jan Axelson

A Universal Data Collector/Controller

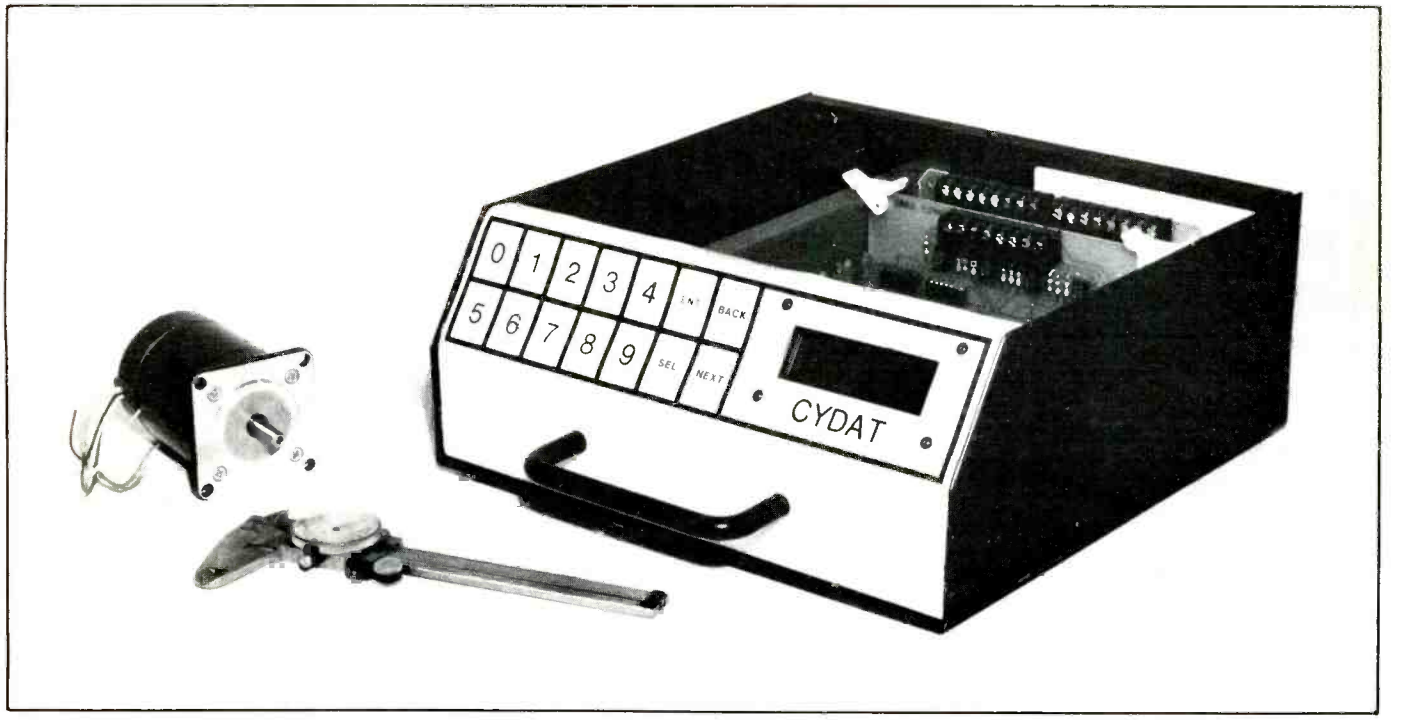
Part 1

Extremely flexible project lets you quickly add inputs and outputs to just about any microcontroller "engine" to easily implement virtually any application you may have in mind

Don't reinvent the wheel by designing and building a microcontroller every time you need a device for collecting data or controlling an external physical device. With the CYDAT Universal Data Collector/Controller described here and virtually any existing microcontroller "engine," you concentrate on the inputs and outputs needed to satisfy the data-collection and/or control requirements to implement your applications. CYDAT's unique multiplexing scheme accommodates just about any microcontroller or microprocessor engine in existence and even lets you use the bus of a PC/compatible computer.

CYDAT supports up to 80 each digital inputs and digital outputs. It gives you the ability to select up to 80 channels of eight-bit A/D and control up to 80 relay outputs. It can also sense up to 40 5-to-220-volt ac or dc inputs and control up to 40 24-to-220-volt ac triac outputs. Additionally, it accommodates a wide range of microcontrolers and microprocessor "engines" (MC68HC05, HC16, Z8, 84C015, 8085, 8051, to name a few)

Adding to its versatility, the CYDAT system's I/O bus directly interfaces with the PC bus to create the ultimate lab bench or industrial controller. It has provisions for an auto-dial/auto-answer modem and a serial port for remote terminal or host com-



puter interconnection. The system accepts nonvolatile program and data memory modules and an LCD display. Its menu cursor-control buttons make field operation easy and fast.

A high degree of versatility gives the build-it-yourself CYDAT Universal Data Collector/Controller the ability to adapt itself to a virtually limitless range of applications. So, whether your application is lab bench data collection and analysis, process control, automation or whatever, CYDAT provides a simple and cost-effective system solution.

System Overview

Data-collection/control systems have traditionally been developed specifically for a particular type of microcontroller or microprocessor chip. Breaking with tradition, CYDAT allows you to create your own processor "engine" module.

In this article, we start with a simple engine module based on the Motorola MC68HC705C8 microcontroller. Then we move on to more sophisticated devices that utilize recent advances in architecture and methodology. If you already have a favorite microprocessor or microcontroller IC, complete with a development system, you'll see how easily the CYDAT I/O bus can be adapted to it. Alternatively, you can use a personal computer and bus to collect data and control real-world events.

CYDAT was originally designed to extend the input and output capabilities of popular microcontrollers, most of which have eight to 20 or more digital input or output lines. Some microcontrollers also have internal A/D and D/A converters.

When selecting a microcontroller for a particular application, most designers consider the tradeoffs associated with performance features, cost, ease of programming, etc. Inevitably, external "glue" chips and devices must be added to the chip to interface it with the real world. Optical isolators, transistors, FETs, relays, A/D and D/A converters, etc., are usually needed to complete a design.

CYDAT is an eight-bit system. If you you need a 16- or 32-bit data path, you can scale the CYDAT system up to your needs. As an eight-bit system, CYDAT inputs and outputs (reads

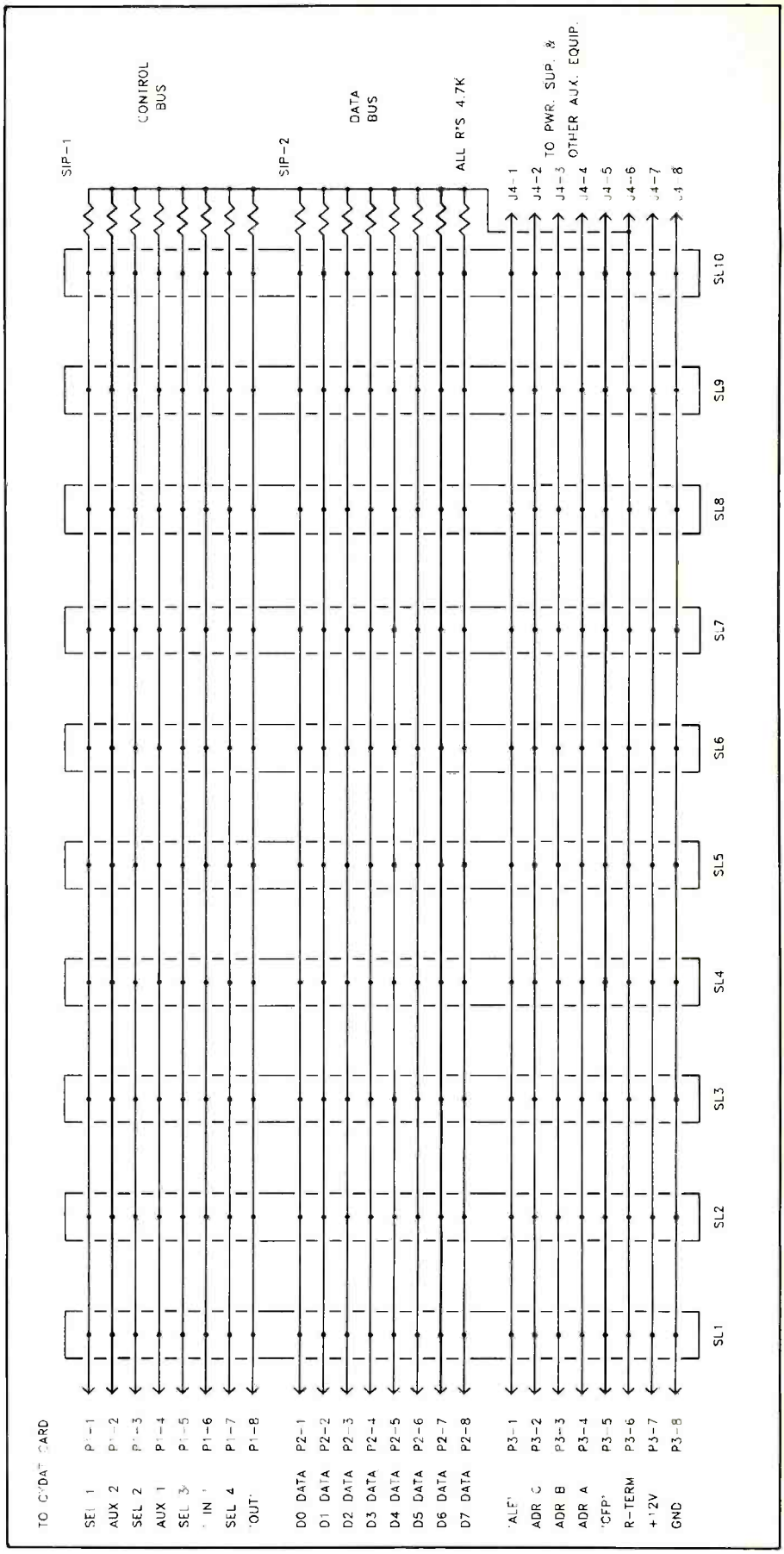


Fig. 1. Schematic details of the I/O Bus Card.

and writes) a single eight-bit byte value at its data bus. This buffered data bus attaches directly to any eight I/O lines of your microcontroller. If you're using a microprocessor, the eight-bit bus connects directly to the data bus buffer IC chip

Each of CYDAT's 10 I/O card slots can be fitted with a Digital Input Card, Digital Output Card, Optically-Isolated ac/dc Sensor Card, Relay Output Card, Triac Output Card, A/D Converter Card or any other I/O card you can imagine. As you can see from CYDAT I/O Bus Card schematic Fig. 1, each of the eight bits on the data bus connects to the corresponding pin of each of the 10 I/O cards. To avoid confusion, the data bus connector on each I/O card is designated *P2*.

Connector *P1* on each I/O card is called the Control Bus. Also, an eight-bit Control Bus uses four Select and two Enable lines to determine which I/O card is to respond to data on the Data Bus. The Control Bus also connects directly to any eight I/O bits available on the microcontroller, except those already used for the CYDAT Data Bus.

This simple architecture allows you to select any or all of eight data bits on 16 input or 16 output cards. However, because CYDAT's I/O Bus has only 10 slots, you're limited to 10 input or 10 output cards.

Connector *P3* on each I/O card is the Power Supply and Auxiliary Equipment connector that distributes unregulated dc power, auxiliary address lines and a CFP (Computer Functioning Properly) signal. Power for each I/O card is supplied by an external unregulated dc power supply. The power delivered to each board is regulated on each individual card. This distributed-power approach simplifies construction and adds to the overall design flexibility of the project.

Inexpensive Molex I/O Bus Card connectors are used for two reasons. One is that these low-density connectors are rugged and not easily misaligned. The other is that they're inexpensive.

In addition to the I/O Bus Card connectors, each card has one or more barrier-type wire terminal strips with contacts on 0.250" centers. These connectors make it easy to physically interface CYDAT to the real world. Individual card guides and ejectors make

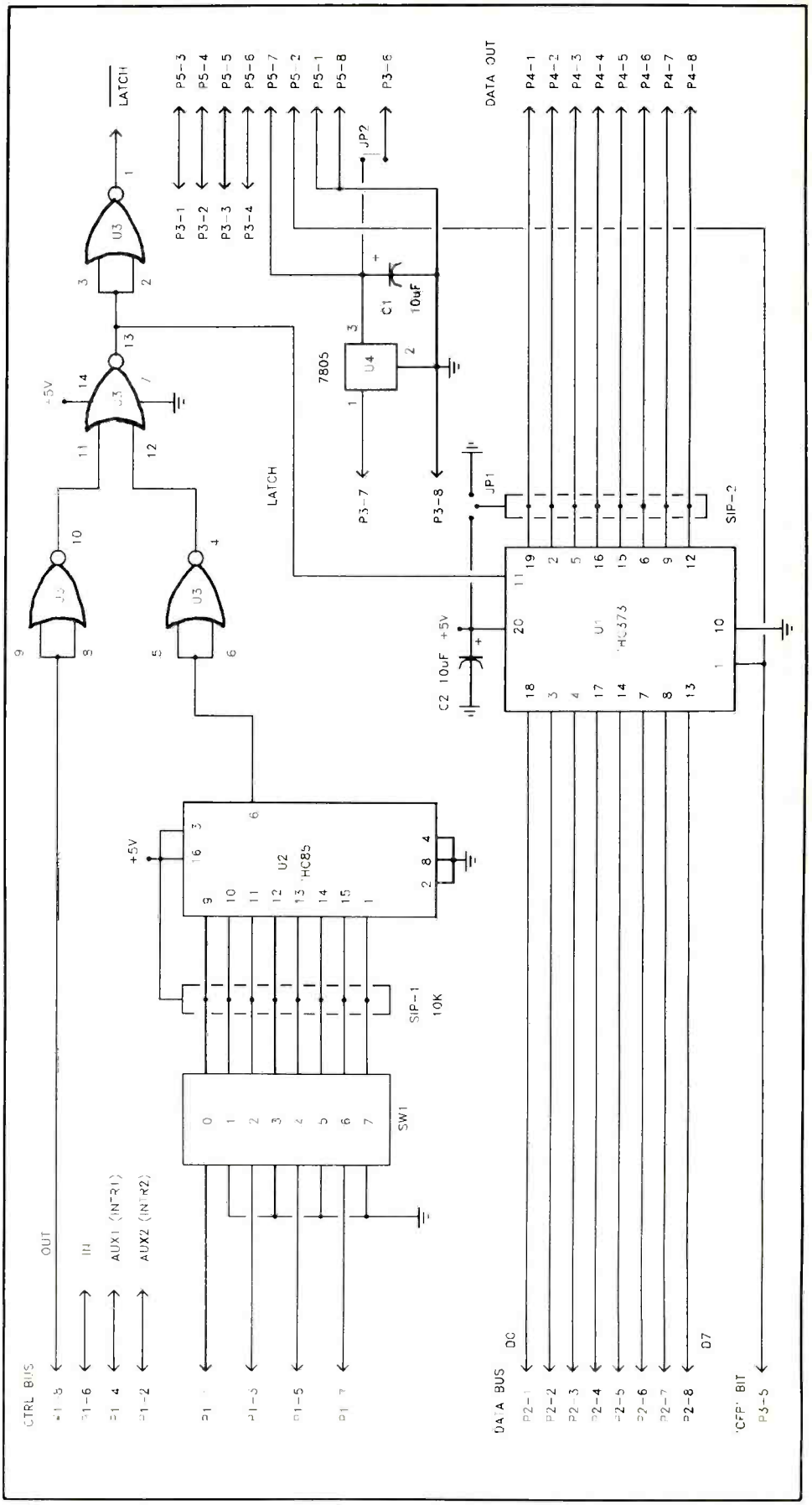


Fig. 2. Circuit details for the Digital Output Card.

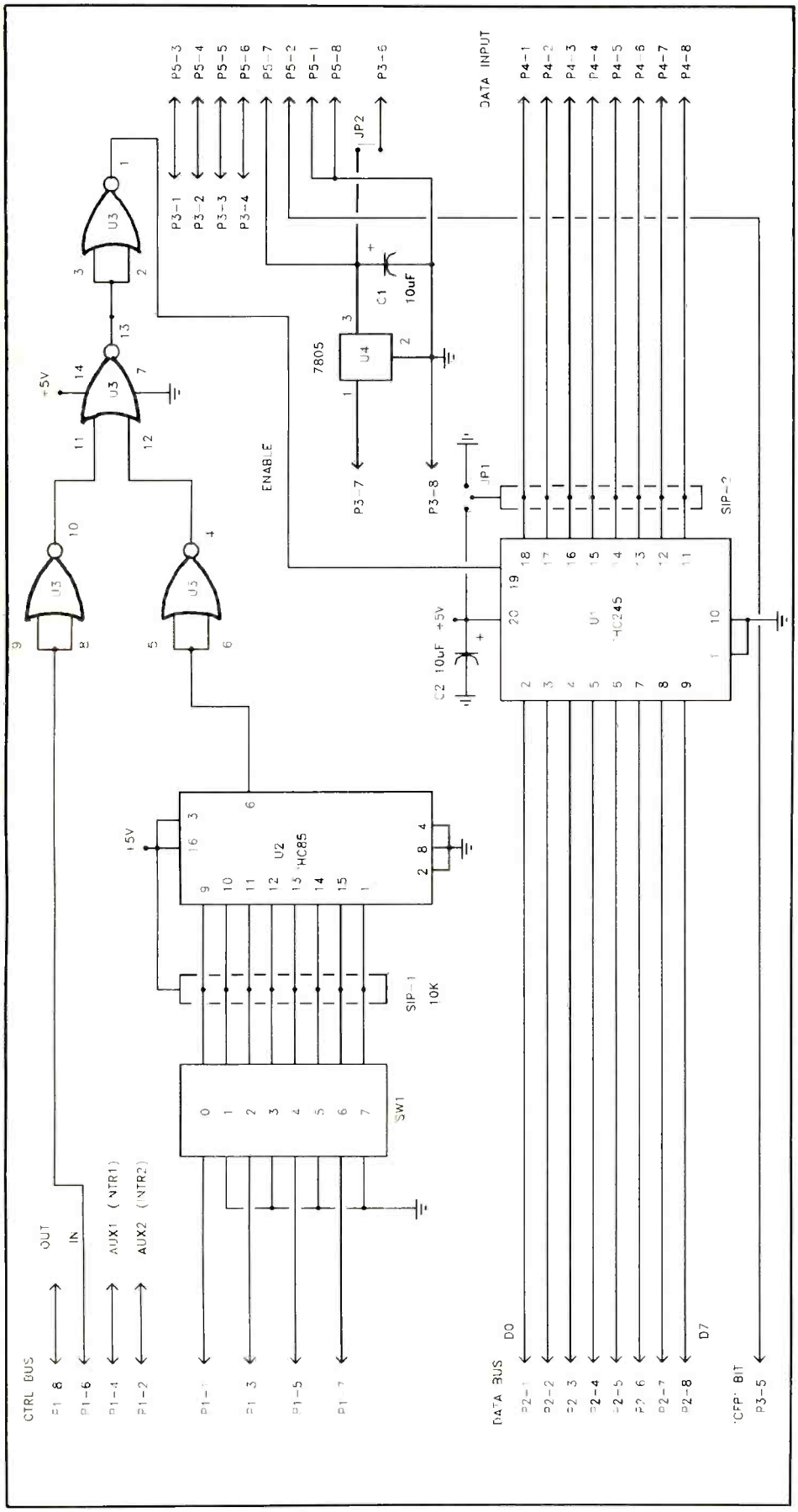


Fig. 3. Circuit details for the Digital Input Card.

the bus mechanically reliable. Housing the system inside an aluminum enclosure assures a stable mounting platform.

About the Circuit

In Fig. 2, you can see how simple the Digital Output Card is. Notice that the input pins on the left side of 74HC373 latch *U1* connect directly to the Data Bus at connector *P2*. As data is output by the controller or processor module, it's presented to *U1*. With data latched in the controller, and subsequently stable on the CYDAT data bus, the controller sets up and latches the Card Select lines at positions 1, 3, 5 and 7 of *P1*.

Each Select line routes through card ID switch *SW1* into four inputs on 74HC85 four-bit magnitude comparator *U2*. Pull-up action created by *SIP1* sources current into the second four inputs of *U2*. As determined by the settings of DIP switch *SW1*, data is compared by *U2*, and an "equal-to" signal is generated if the Select line data matches the card ID. This high-going enable signal is inverted by one section of *U3* and subsequently combined with the inverted OUT signal at position 8 of *P1*.

If the Digital Output Card being considered has been properly identified by the controller, and the controller wishes to output data, a high-going pulse is applied at pin 13 of *U3* and the latch input of *U1*. Data on the Data Bus is then latched into *U1* and applied to pins 1 through 8 of *P4*. Ground return for real-world circuits is provided by pins 1 and 8 of *P5*.

The CFP bit at position 5 of connector *P3* controls the output-enable status of *U1* by its action on pin 1 of this IC. If the Computer Functioning Properly bit is set low by the "watchdog" circuitry in the controller/processor-engine module, latched output data from *U1* is enabled. However, if the watchdog circuit deems the controller to be "incompetent," pull-up/down *SIP2* acts directly on Data Output pins 1 through 8 of *P4*. Jumper *JP1* permits you to decide whether or not the outputs at connector *P4* are to be low or high.

You can configure card ID switch *SW1* to ignore some Select lines in small system configurations. Digital outputs from the 74HC373 latch are

specified by the manufacturer of the device and are usually sufficient to drive several external HCMOS devices.

The Digital Input Card circuitry shown in Fig. 3 is very similar to that of the Output Card in that the card ID decoder made up of *SW1*, *U2* and *U3* is configured almost identically. In the Digital Input Card design, however, the IN signal is used to control *U1*, rather than the OUT line.

Figure 3 details how *U1* connects to the CYDAT Data Bus via positions 1 through 8 of *P2* and Data Input positions 1 through 8 of *P4*. As card ID Select lines at positions 1, 3, 5 and 7 of *P1* are latched in the controller, a high output is generated at pin 6 of 74HC85 four-bit magnitude comparator *U2*.

When coupled with the IN signal at position 6 of *P1*, a low-going pulse is created at pin 1 of *U3*, which subsequently strobes pin 19 of *U1* to sample the data input byte at *P4*.

Inputs at *P4* are pulled up or down, depending on the orientation of jumper *JP1*. The inputs are HCMOS-compatible.

With card ID decode and Latch circuitry identical to that of the Digital Output Card, the Relay Output Card (circuitry shown in Fig. 4) utilizes eight FET transistors to drive output relays *K1* through *K8*. Resistor pack *SIP2* provides pull-up or pull-down, depending on how jumper *JP1* is configured. When the CFP bit goes high, the output lines of *U1* go into high-impedance mode to allow pull-up or pull-down action of *SIP2* to be applied to the gates of FETs *Q1* through *Q8*. This arrangement has the effect of "jamming" full-on or full-off data into the relays.

Relay specifications can be selected, depending on the manufacturer, to include either 5- or 12-volt options, as set by the power jumper. There's no need for steering diodes because an internal diode is in each FET. Relay outputs are available individually along connectors *P4* and *P5*.

The Triac Output Card (circuitry shown in Fig. 5) is virtually identical to that of the Digital Output Card, except for the added triac output circuitry. Digital output signals from *U1* route through optical isolators *U5* through *U8*.

By toggling low and high adjacent output pins of *U1*, the internal LEDs

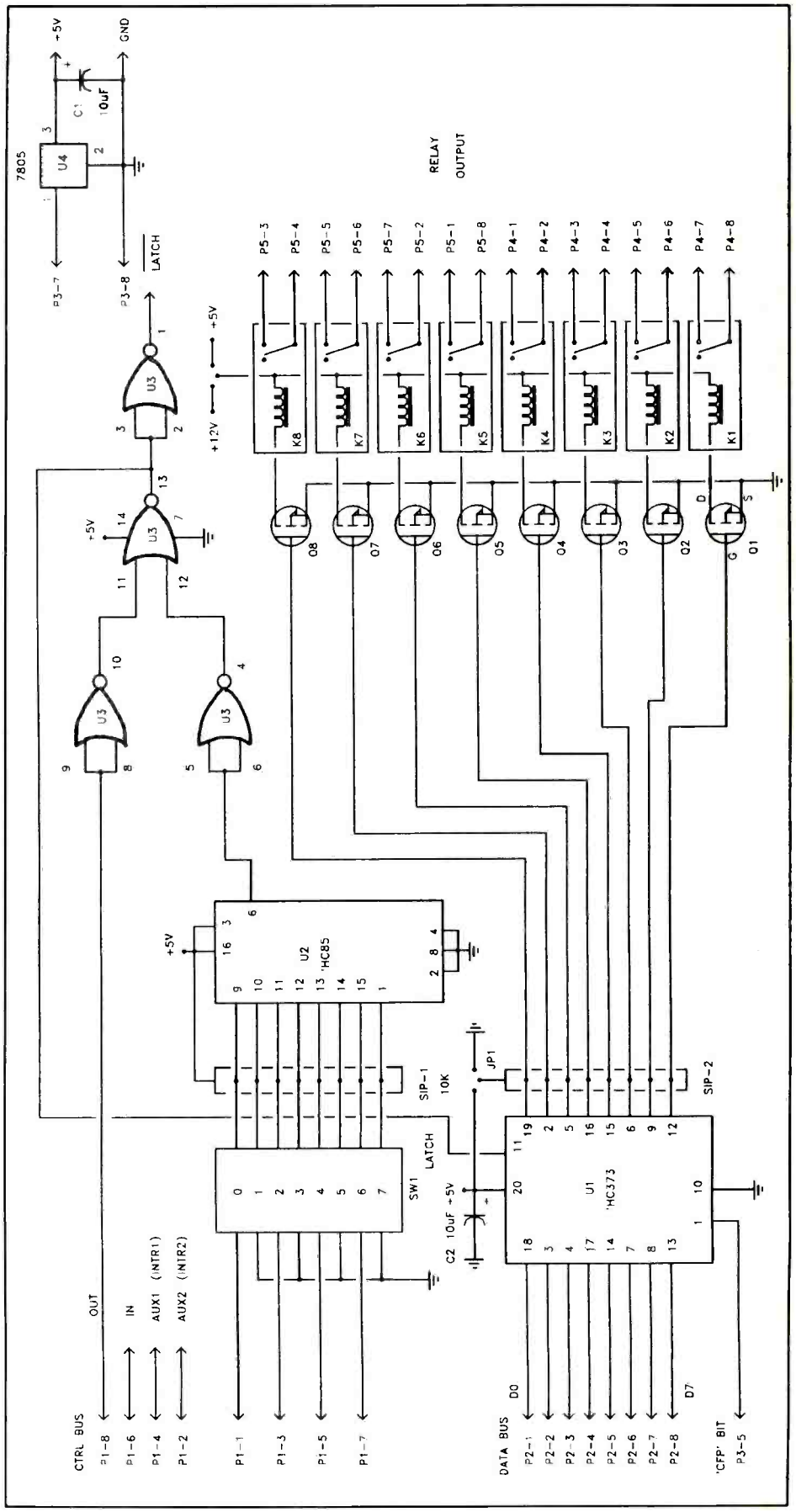


Fig. 4. Circuit details for the Relay Output Card.

PARTS LIST

Digital Output Card

Semiconductors

U1—74HC373 octal latch
U2—74HC85 four-bit comparator
U3—74HC02 quad two-input NOR gate
U4—7805 fixed +5-volt regulator

Capacitors

C1,C2—10-μF, 16-volt electrolytic

Resistors

SIP1,SIP2—Eight-element 10,000-ohm SIP resistor pack

Miscellaneous

P1,P2,P3—0.156″ Molex pc-mount female connector
P4,P5—0.250″ mini-barrier terminal block
SW1—Eight-position DIP switch
Printed-circuit board; pcb extractor clips (2); 4-40 × ⅜″ machine screw; 4-40 Keps nut; solder; etc.

Digital Input Card

Semiconductors

U1—74HC245 octal bus transceiver
U2—74HC85 four-bit comparator
U3—74HC02 quad two-input NOR gate
U4—7805 fixed +5-volt regulator

Capacitors

C1,C2—10-μF, 16-volt electrolytic

Resistors

SIP1,SIP2—Eight-element 10,000-ohm SIP resistor pack

Miscellaneous

P1,P2,P3—0.156″ Molex pc-mount female connector
P4,P5—0.250″ mini-barrier terminal block
SW1—Eight-position DIP switch
Printed-circuit board; pcb extractor clips (2); 4-40 × ⅜″ machine screw; 4-40 Keps nut; solder; etc.

Relay Output Card

Semiconductors

Q1 thru Q8—VN0300 power FET
U1—74HC373 octal latch
U2—74HC85 four-bit comparator
U3—74HC02 quad two-input NOR gate
U4—7805 fixed +5-volt regulator

Capacitors

C1,C2—10-μF, 16-volt electrolytic

Resistors

SIP1,SIP2—Eight-element 10,000-ohm SIP resistor pack

Miscellaneous

P1,P2,P3—0.156″ Molex pc-mount female connector
P4,P5—0.250″ mini-barrier terminal block
SW1—Eight-position DIP switch
Printed-circuit board; pcb extractor clips (2); 4-40 × ⅜″ machine screw; 4-40 Keps nut; TO-220 heat sink; solder; etc.

Triac Output Card

Semiconductors

Q1 thru Q4—10-ampere triac in TO-220 case
U1—74HC373 octal latch
U2—74HC85 four-bit comparator
U3—74HC02 quad two-input NOR gate
U4—7805 fixed +5-volt regulator
U5 thru U8—MOC-3010 optical isolator

Capacitors

C1,C2—10-μ, 16-volt electrolytic
C3 thru C6—0.22-μ Mylar

Resistors

R1 thru R4—470 ohms, ¼-watt, 5% tolerance
R5,R6,R9,R10—180 ohms, ½-watt, 5% tolerance
R7,R8—Not used
R11 thru R14—1,200 ohms, ½-watt, 5% tolerance
SIP1,SIP2—Eight-element 10,000-ohm SIP resistor pack

Miscellaneous

P1,P2,P3—0.156″ Molex pc-mount female connector
P4,P5—0.250″ mini-barrier terminal block
SW1—Eight-position DIP switch
Printed-circuit board; pcb extractor clips (2); 4-40 × ⅜″ machine screw; 4-40 Keps nut; TO-220 heat sink; solder; etc.

Opto-Iso Board

Semiconductors

U1—74HC245 octal bus transceiver
U2—74HC85 four-bit comparator
U3—74HC02 quad two-input NOR gate
U4—7805 fixed +5-volt regulator
U5 thru U8—HCPL-300 optical coupler

Capacitors

C1,C2—10-μ, 16-volt electrolytic
C3 thru C6—10-μF, 16-volt electrolytic (optional; see text)

Resistors

R1,R2,R4,R5,R7,R8,R10,R11—22,000 ohms, ½-watt, 5% tolerance
R3,R6,R9,R12—Select value for proper shunt bias (see text)
SIP1,SIP2—Eight-element 10,000-ohm SIP resistor pack

Miscellaneous

P1,P2,P3—0.156″ Molex pc-mount female connector
P4,P5—0.250″ mini-barrier terminal block
SW1—Eight-position DIP switch
Printed-circuit board; pcb extractor clips (2); 4-40 × ⅜″ machine screw; 4-40 Keps nut; TO-220 heat sink; solder; etc.

8-Channel Analog Input Card

Semiconductors

U1—ADC0808 eight-channel, eight-bit analog-to-digital converter
U2—74HC85 four-bit comparator
U3—74HC02 quad two-input NOR gate
U4—7805 fixed +5-volt regulator
U5—74HC74 dual flip-flop
U6—74HC04 hex inverter

Capacitors

C1,C2—10-μ, 16-volt electrolytic
C3—1-μ, 16-volt electrolytic
C4—0.001-μ, 100-volt Mylar

Resistors

SIP1,SIP2—Eight-element 10,000-ohm SIP resistor pack
R1,R2—1,000 ohms, ¼-watt, 5% tolerance

Miscellaneous

P1,P2,P3—0.156″ Molex pc-mount female connector
P4,P5—0.250″ mini-barrier terminal block
SW1—Eight-position DIP switch
Printed-circuit board; pcb extractor clips (2); 4-40 × ⅜″ machine screw; 4-40 Keps nut; TO-220 heat sink; solder; etc.

I/O Bus Card

SIP1,SIP2—Eight-element 4,700-ohm SIP resistor pack

Miscellaneous

Printed-circuit board; eight-pin straight-tine Molex pc-type connectors; 4-40 × ½″ spacers; 4-40 × ⅜″ machine screws; rubber feet; solder; etc.

Note: The following items are available from Cyance Kit, Rte. 3, 284 Cyber Rd., West Fork, AR 72774 (tel.: 501-839-8293): complete kits of all parts for: Digital Input and Digital output Cards, $39.95 each; Relay Output Card, $69.95; Triac Output and Opto-Iso Input Cards, $55.95 each; and 8-Channel Analog Input Card, $44.95. Also available are: ready-to-wire pc boards, $9.95 each; the CYDAT enclosure with 10-slot card rack, $39.95; MC68HC705C8 controller motherboard, $69.95; MC68705-C8S EPROM, $22.95; membrane front-panel LCD display, $24.95. Add $4 for UPS delivery per order. Arkansas residents, please add 5% sales tax. MasterCard and Visa welcome.

in *U5* through *U8* can be biased on. Power-line input and output pins along connector *P4* are, consequently, controlled by triacs *Q1* through *Q4* and associated circuitry.

Power lines must be ac signals from 12 volts to not more than 220 volts ac. Maximum line loads are a function of the particular triac chosen and the surface area and efficiency of the individual heat sinks used.

In Fig. 6 is shown the circuitry for the Opto-Iso Input Card, which is virtually identical to that of the Digital Input Card. Exceptions are added optical isolators *U5* through *U8*, which are HCPL-3700 ac/dc-to-logic interface optical couplers.

The Opto-Iso Input Card can accommodate a wide range of inputs, from about 4 to beyond 250 volts ac/dc, depending upon the values chosen for the R_x and R_p input resistors, as detailed by the manufacturer's specification information.

Pads are provided on the printed-circuit artwork for mounting *C3* through *C6*, which have a value that's typically about 10 μF. These capacitors filter the pulsating-dc signal component derived from the HCPL-3700's bridge rectifier. The capacitors should be used only when ac signals are being monitored because they add a significant amount of sample charge/discharge time when sampling dc signals.

Operation of the card ID decode function circuitry on the 8-Channel Analog Card (Fig. 7) is identical to that employed by the Digital Input Card. ADC0808 eight-channel, eight-bit A/D converter *U1* attaches directly to connectors *P2* through *P5*.

Analog input signals in the range from 0 to 5 volts dc are sampled internally by *U1*, after which they're quantized and then output through the Data Bus to the controller engine. The analog channel select of *U1* is controlled by positions 1 through 4 of *P3*. A 1-MHz system clock is made up of *U5* and *U6*. 74HC04 or 74LS04 hex inverter *U5* makes up a 2-MHz oscillator, the output of which clocks *U5*.

Configured as a simple divide-by-2 circuit, the 74HC74 dual-D flip-flop's inverted output at pin 8 provides the system clock required for the internal conversion processes of *U1*. It takes about 100 microseconds for *U1* to perform a conversion. The conversion se-

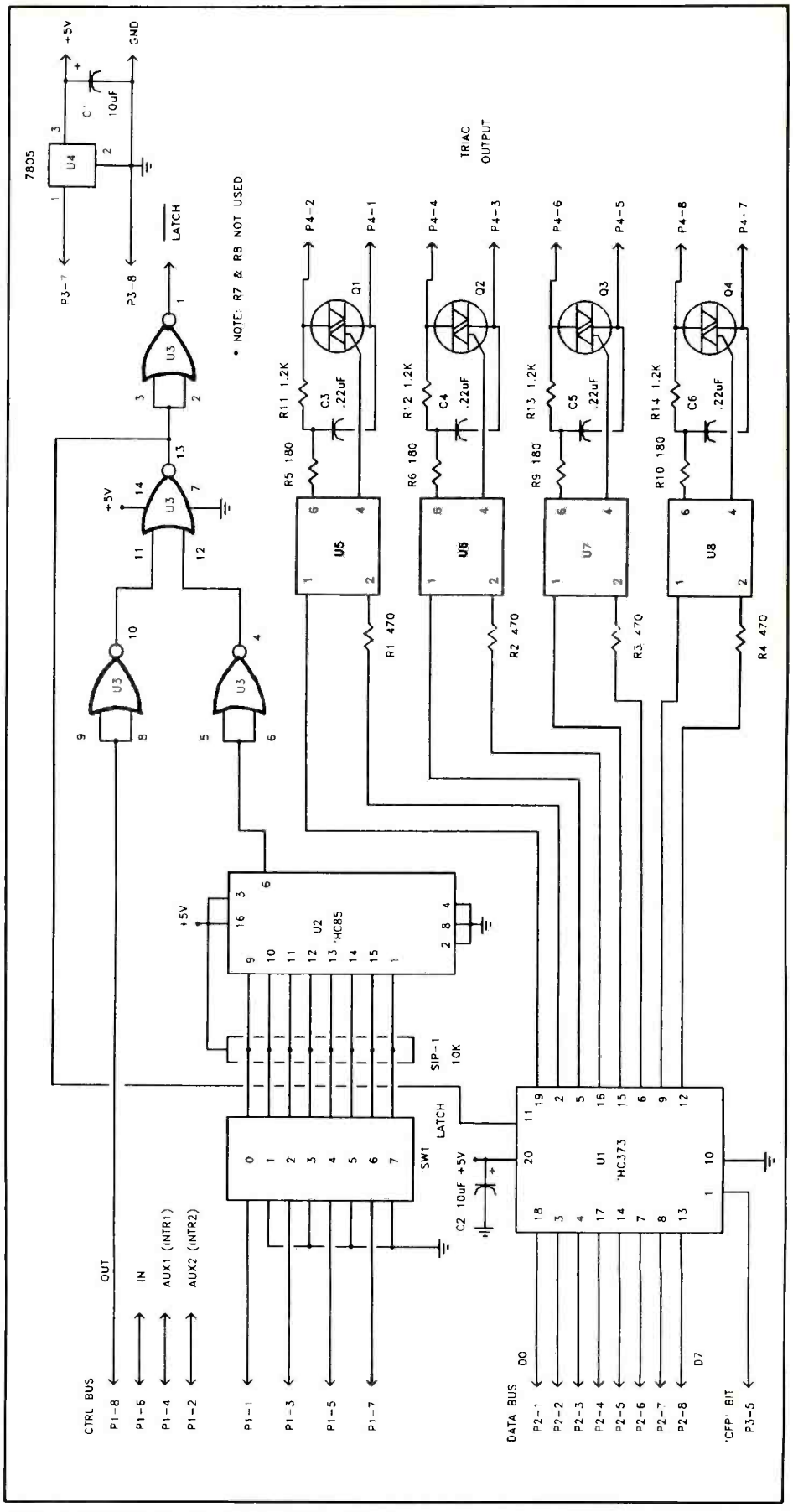


Fig. 5. Circuit details for the Triac Card.

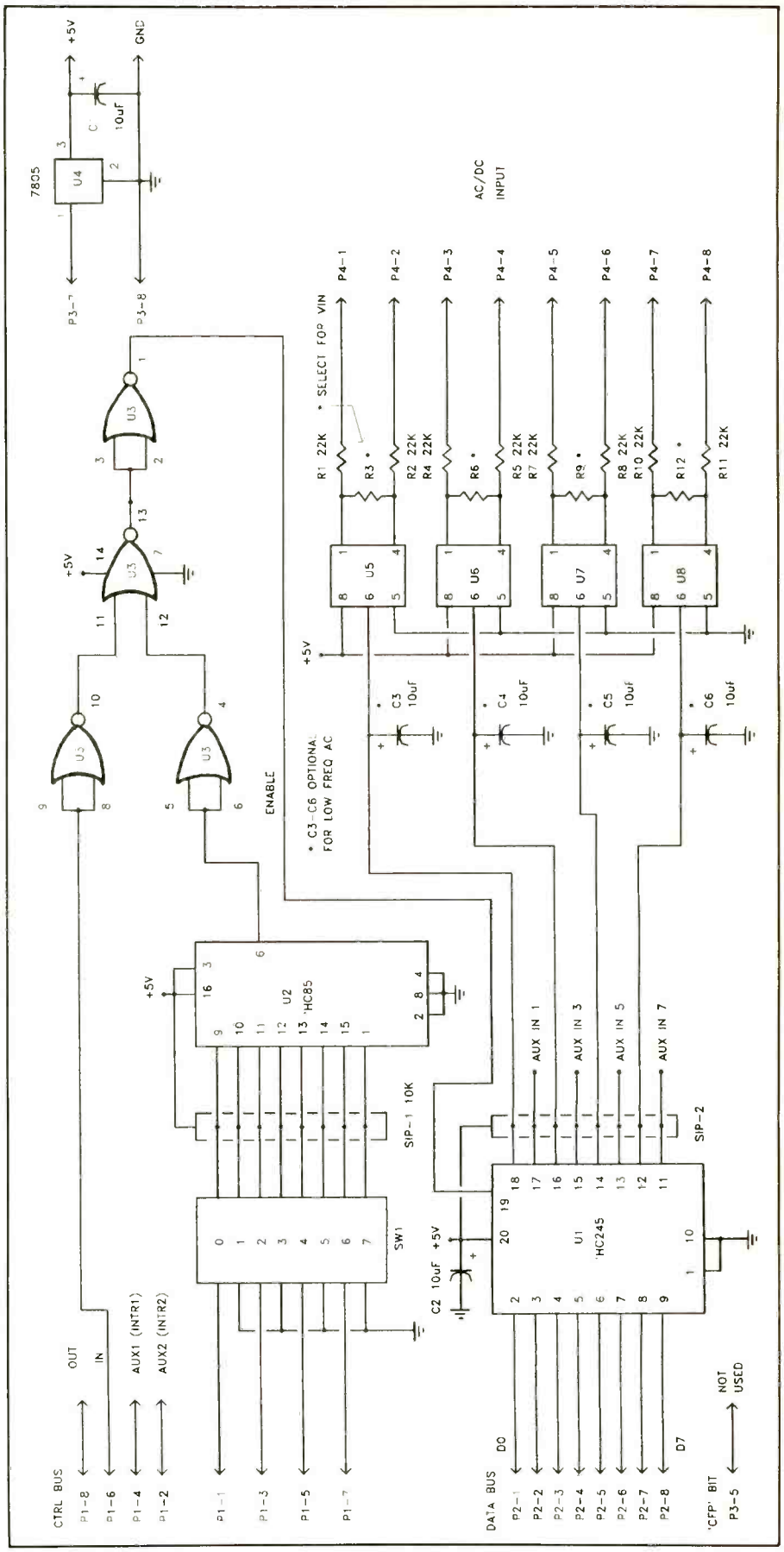


Fig. 6. Circuit details for the Opto-Iso Card.

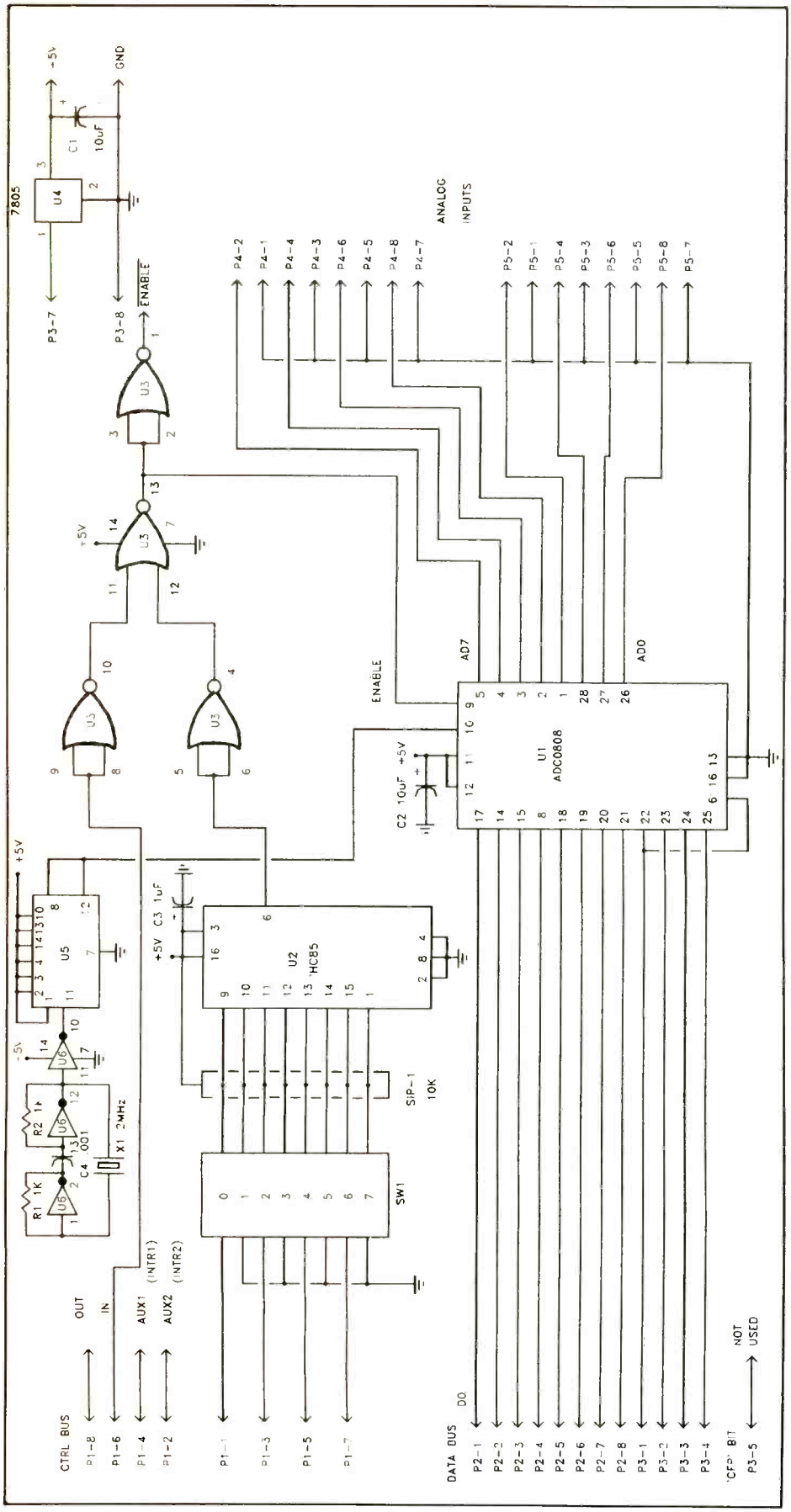


Fig. 7. Circuit details for the 8-Channel Analog Card.

quence is initiated when the device is selected by a high-going pulse on pin 22. After timing-out for an appropriate period of time, the CYDAT Controller is free to sample the converted data on data bus connector *P2*.

Coming Next Month

This concludes the first part of this article. Next month, we'll finish up with details on how to build the CYDAT Universal Data Collector/Controller, discuss details of an MC68HC05C8 controller interface for the CYDAT system and give controller engine operating concepts.

Nick Goss

Computer-Circuit Tidbits

Building power-on and manual reset circuits

Computer and most other digital hardware share certain circuit concepts that help make them work better. These include power-on and manual-reset circuits that are used to initialize the digital circuit to some given state at turn-on. While ready-built computers and digital instruments have these circuits already built into them, projects you build yourself must incorporate them. In this article, we'll examine how these circuits operate and how you can build them into your own digital and computer projects.

The Circuits

A reset circuit is used to generate a pulse that can be used by computer circuits to initialize the system to a predetermined power-up condition. A power-on reset generates a single pulse when dc power is applied to initialize the circuit and then goes dormant as long as power remains applied. Manual reset, on the other hand, produces a pulse only when triggered by closing a switch (usually located on the front panel of the equipment, where it can easily be reached by anyone using the equipment).

Reset-pulse duration depends on the application. However, for most low- to moderate-speed digital circuits, values between 1 and 10 milliseconds (1 to 10 ms, or 0.001 to 0.010 second) are common. In this article, we'll assume a mean value of 5 ms.

For any given circuit, the reaction time of the combined components is the driving factor in determining reset-pulse duration. Pulse duration must be longer than the sum of all other circuit effects that must occur during a reset operation. The 5-ms duration selected here is adequate for most purposes (indeed, different values will typically be shorter because circuits generally react in nanoseconds and low microseconds).

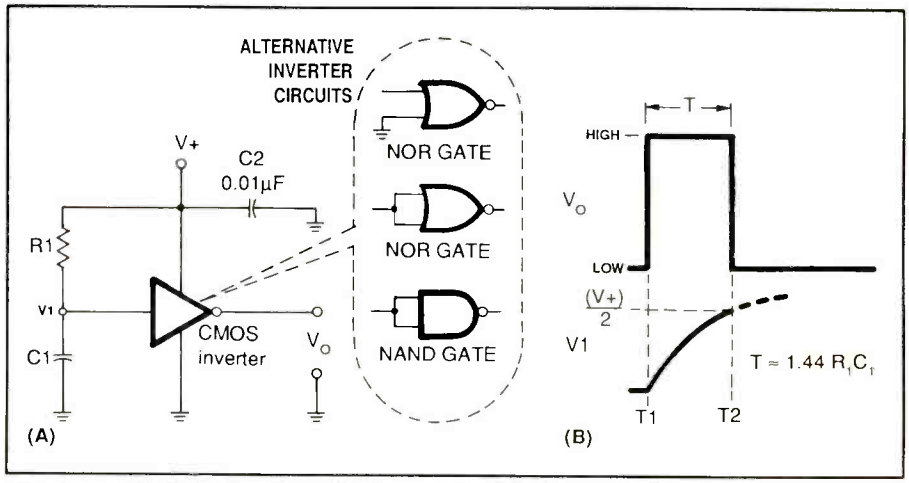


Fig. 1. (A) Power-on reset circuit; (B) timing waveform.

The basis for most reset circuits is either the monostable or the half-monostable multivibrator circuit. These circuits output a single pulse for each input trigger pulse. Shown in Fig. 1(A) is a circuit you can use for power-on reset applications. It's made from a CMOS digital inverter.

Several CMOS chips are inverters in their own right or contain individual inverter elements, among other functions. Inverters can also be made from NAND and NOR gates, as shown in the Fig. 1(A) inset. A NAND gate is made into an inverter by connecting together all its inputs. Similarly, a NOR gate with all its inputs connected together is also an inverter. However, the NOR gate also exhibits inverter action if one input is used as the input terminal, and all other inputs are grounded.

Inverters follow a very simple rule. Their outputs are always the inverse of their inputs. Digital signals are binary in nature, meaning that they take on only one of two possible states. These are variously called 1 and 0, high and low or true and false. If the input is high, the inverter's output is always low, and vice-versa.

Although several different voltage definitions exist for high and low when CMOS devices are used, it's common to use the TTL definition in which high is a potential greater than +2.4 volts but less than +5 volts and low is a potential between 0 volt and 0.80 volt. These values assume that the power potentials applied to the CMOS power-supply terminals of the device are +5 volts and ground (0 volt).

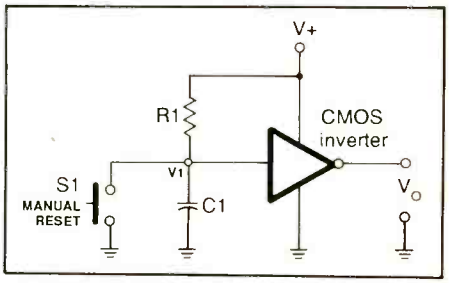


Fig. 2. Addition of S1 makes the circuit both a power-on and a master reset.

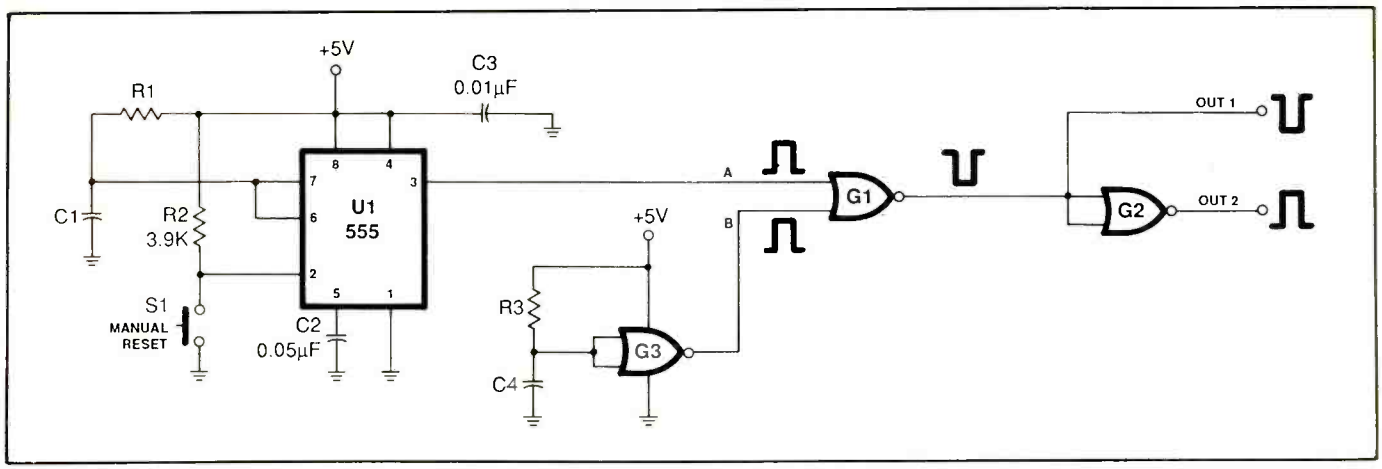


Fig. 3. A power-on reset and one-shot circuit for manual reset in which a NOR gate combines the two pulses into a single pulse signal.

If other voltages are used, high and low conditions are defined differently. For a CMOS device, the switch-over point between low and high is one-half the difference between the V+ and V− power-supply voltages. In most digital circuits, V− power supply is set to 0, rather than a negative voltage. Therefore, the switching point is V+/2. A low in this case is a potential that's close to ground, which for all practical purposes is 0, and a high is close to V+. Switching between them causes a high to drop lower than V+/2 or for a low to snap up higher than V+/2.

The Fig. 1(A) power-on reset circuit consists of a series RC network made up of *R1* and *C1* and connected so that capacitor voltage V1 is the input signal to the inverter. When power is initially applied, V1 is 0 and the inverter sees a low condition. Thus, as soon as the inverter "comes alive" after V+ is applied, the input thinks it sees a low.

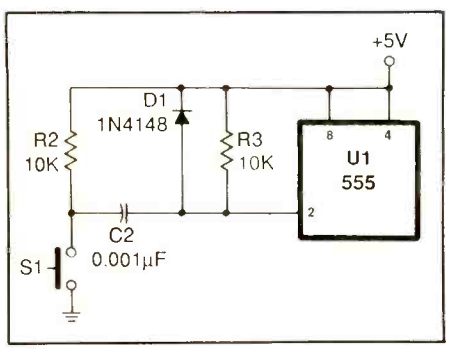


Fig. 4. Capacitor coupling improves on the Fig. 3 circuit.

Consequently, the output of the inverter snaps high, producing the reset pulse. The same V+ potential also starts charging the capacitor through resistor *R1*.

When the voltage rises to V+/2, the inverter sees the condition for a high, which causes its output to snap low. The approximate time required to make this transition and, thus, the duration of the output pulse T in Fig. 3(B), is found using the formula C1R1 = 1.44T, where: *T* is in seconds, *R1* is resistance in ohms and *C1* is the capacitance in farads. For the desired 5 ms, the time constant of the *R1C1* network must be:

$$\begin{aligned} R1C1 &= T/1.44 \\ &= 0.005/1.44 \\ &= 0.0035 \end{aligned}$$

Thus, any combination of *R1* and *C1* that produces a result of 0.0035 second will work. A 51,000-ohm resistor and a 0.1-μF capacitor results in pulse duration *T* that's very close to the desired 5 ms.

Capacitor voltage V1 will rise past V+/2 to V+ and remains there as long as power is applied to the circuit. For all practical purposes, the V+ end point is reached after 5R1C1 (five time constants).

A manual reset also produces a single output pulse that resets the digital circuitry but remains dormant until a trigger signal is received. The trigger is supplied by pressing a pushbutton switch on the front panel of the project. Figure 2 shows how the power-on reset circuit can be modified to also provide a manual reset capability. Switch *S1* is a normally-open spst pushbutton switch and is connected so that it shunts the capacitor.

Operation of the Fig. 2 circuit is simple. On power-up, it acts like any other power-on reset circuit. Capacitor voltage V1 is at V+ for a short time after the reset pulse drops low again. During this period, the reset circuit is dormant. Closing *S1* causes the voltage across *C1* to drop to 0 as the charge on the capacitor flows through the switch. Because *C1* is at the low condition when the switch is released, the output of the inverter snaps high again for normal duration T.

An alternate power-on plus manual-reset circuit is shown in Fig. 3. Here, a 555 timer is used to produce the manual reset pulse, the Fig. 1(A) half-monostable circuit to produce the power-on reset pulse (gate G3) and a NOR gate to combine the two of them (G1). Another NOR gate (G2) is used as an output inverter. Because several CMOS two-input NOR gates are often found in the same IC package, the power-on reset generator shown in Fig. 3 (gate G3) and output inverter are NOR gates with their inputs strapped together.

Rules of operation for the NOR gate are simple. If a high is applied to either input, the output is low. If a low is applied to both inputs, the output is high. If either signal source, (*U1* or G3) produces a positive output pulse, the output of G1 is a negative-going pulse. If a negative-going reset pulse

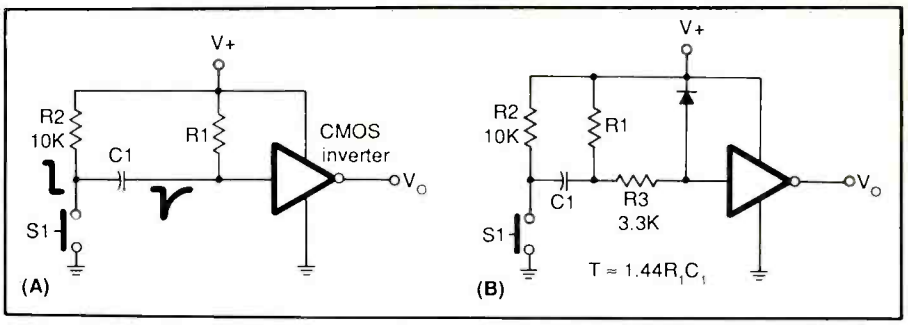


Fig. 5. (A) Simple manual reset circuit using a CMOS inverted; (B) improved circuit.

is needed, the output of G1 can be used directly. However, if a positive-going pulse is needed, the output of G2 is used instead.

The manual reset pulse generator is based on the 555 timer. In the monostable multivibrator circuit configuration shown here, output pin 3 remains low until a trigger signal is applied to pin 2. The requirements placed on the trigger signal are that it must drop from a voltage greater than 2V + /3 to a value less than V + /3. When this occurs, output pin 3 snaps high. The output pin remains high for a period of 1.1R1C1 after the trigger pin voltage returns to greater than 2V + /3.

In Fig. 3, the reset switch is connected from trigger input pin 3 of the 555 timer to ground. Pin 2 is normally held high by *R2*. This pull-up resistor will have a value of 2,700 to 27,000 ohms, depending on supply voltage (not critical). The value shown in commonly used with 5-volt dc power supplies.

One problem associated with the Fig. 3 manual-reset circuit is that the output pulse remains high as long as the switch is closed. In some cases, this is an advantage, but it's usually undesirable. A better solution is to make the circuit output once—immediately after *S1* is closed—and only once, until after *S1* is opened and is once again closed.

Shown in Fig. 4 is a modified manual-reset circuit in which trigger switch *S1* is capacitor-coupled to the input of the 555 timer. Two pull-up resistors are used: *R2* keeps the switch at V + when *S1* is open, and *R3* is used to keep trigger input pin 3 of the 555 timer normally high. Closing *S1* grounds one end of *C2*, causing the capacitor to begin charging. Because the initial potential across *C2* is zero, the 555 trigger input momentarily sees a low condition and triggers the output pulse.

If the switch remains closed, *C2* will charge to V + , at which point, the trigger input once again goes dormant and remains dormant after *S1* is opened. In this condition, the charge on *C1* bleeds off through *R1* and *R2*.

Diode *D1* in Fig. 4 is used to clip the input signal to the 555 trigger pin. Because the resistors and capacitors form a differentiator network, the output will actually be two spikes, one positive-going and the other negative-going. The unwanted spike is clipped by forward-biasing *D1*.

Other capacitor-coupled manual reset circuits are shown in Fig. 5. These

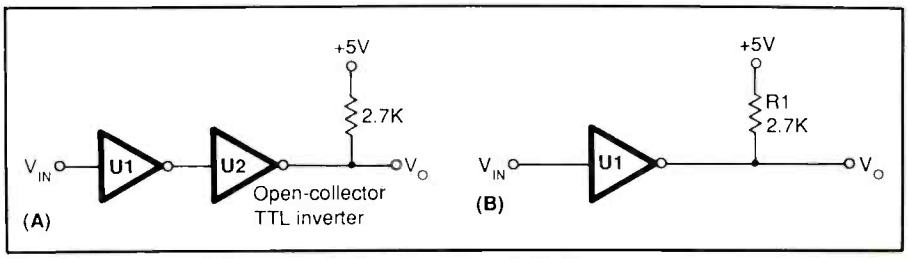


Fig. 6. Increased drive capacity include using (A) TTL open-collector inverter and (B) open-collector TTL noninverter.

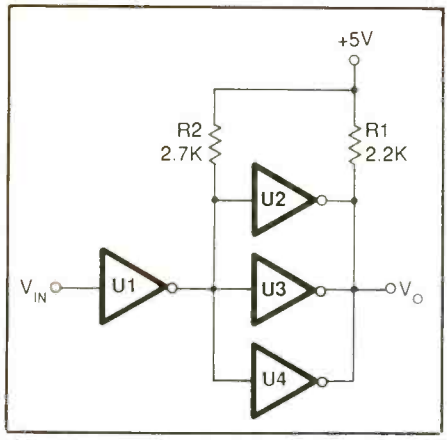


Fig. 7. This wired-OR circuit configuration combines several TTL open-collector inverters to boost drive power.

needed to keep the sense of the output pulse the same as it was at the input. Thus, a high at V_{in} produces a high at V_o. An open-collector device has an npn output transistor that needs a collector load resistor to V+ for it to work. This 2,700-ohm resistor serves as a pull-up to V+ for the output. Devices such as the 7406 or 7416 TTL inverters will work nicely.

Circuit B in Fig. 6 uses a TTL noninverting buffer as the output device. Like circuit A, circuit B uses an open-collector TTL part (7407 or 7417) and a pull-up resistor to V+. Circuits A and B will work with both TTL and CMOS systems.

Still another variant is shown in Fig. 7. This circuit increases the drive power substantially by connecting together the outputs of several open-collector inverters in a wired-OR configuration. Pull-up resistor *R1* serves all three inverters. Except for use of three parallel connected inverters, this circuit is similar to Fig. 5(A).

The 7406 and 7416 TTL devices are hex inverters. Their six internal open-collector inverters share common V+ and ground connections. If one inverter (*U1*) is used for the input, up to five additional inverters can be wire-ORed to form a high-power output driver.

As you can see from the foregoing, power-on and manual-reset circuits are at the very heart of digital electronic and computer circuits. They initialize these circuits at turn-on and make the world sensible again after a "glitch" messes up things. ■

replace the 555 manual-reset circuit in Fig. 3. Circuits A and B in Fig. 5 are based on CMOS inverter circuits, as was the power-on reset circuit.

After power-up, the input of the inverter in Fig. 5(A) is high because *R1* acts as a pull-up resistor to V+. Hence, the output of the circuit is low. Both ends of *C1* are at the same potential close to 0 volt. Closing *S1* grounds one side of *C1*. Because capacitor voltage is near 0, the input of the CMOS inverter momentarily drops low until the charge on the capacitor reaches a certain point. A modified version that provides better triggering and reset uses a snubber resistor and diode (like the 555 version shown in Fig. 4).

Increasing Drive Capacity

The power-on and manual-reset circuits discussed so far will suffice for most applications. However, when a large number of digital devices must be simultaneously reset, a different tactic is needed. For these cases, an output buffer circuit is required.

One of the easiest ways to improve the output drive capacity of reset circuits is to use B series CMOS devices like the 4001B, instead of the simple 4001 or 4001A. This series of devices inherently has a greater drive capacity than the older A series devices.

Alternative schemes are shown in Fig. 6. Circuit A uses TTL or CMOS inverter *U1* to drive open-collector TTL inverter (U2). Two inverters are

Remote Microcontroller Reset

Simple circuit remotely resets a microcontroller via an RS-232 serial port on a host PC

A popular application is remote gathering of data and distant control of devices. Embedded microcontrollers are often used to off-load a central computer, while remaining under its control. This is a good cost-effective application, but it does leave one problem: resetting.

There will always be a time when resetting is required and the operation restarted. Although some controllers automatically reset after a power failure, this doesn't address the need to reset when a processor mysteriously hangs up, a looping situation occurs, etc. There are three ways to do this.

One way, obviously the most undesirable one, is to alert a person to manually perform a reset operation. Another is to run wires to the remote unit to handle the reset function. However, this introduces a host of other problems, including electrical noise. The third, and best, approach is to add a reset circuit to the communication cables already going to the microcontroller. Such a simple system, which we'll describe, activates reset on demand by the host computer in the system.

About the Circuit

RS-232 asynchronous specifications make provision for a special "break" character that can be used to get the attention of a station. This break character is a continuous-space condition of 150 milliseconds (ms) duration. Though rarely used, it comes in handy for our Remote Microcontroller Reset circuit. The reset function is activated when a 55-ms or longer break condition is sent by the host PC. This is accomplished by sending a byte containing a hexadecimal 00 at a bit rate of 150 or less.

The communication port doesn't have to be re-configured when a break character is used to activate a reset. You simply send a break, delay 100 ms and resume normal communications. To activate a reset without a break character, open the host PC's communication port at a bit rate of 150 or less and send one byte of hex 00, delay 100 ms, re-configure the communication port to your normal bit rate and resume normal communications.

By programming the microcontroller to send back a power-on return code to the first transmission after a power-on or reset, the host computer can determine if a reset has operated in the proper manner.

Though the Remote Microcontroller Reset circuit shown schematically in Fig. 1 was initially designed for the Intel 8x31 series of processors, it can be used for almost any other processor you wish to use. In operation, receive output pin 12 of MAX232 translator *U1* is near +5 volts when no serial characters are being sent or the line is physically disconnected.

A reset function is performed by 555 timer *U2*, which is configured as a pulse-omission detector (or hold-over single-shot multivibrator). It's triggered and controlled by *Q1*. Output pin 3 goes to ground only if the output of *U1* stays at ground level longer than the time constant for *U2*.

When no communication is taking place or the serial line is disconnected, pin 12 of *U1* will be near +5 volts. This keeps *Q1* conducting and, through *D1*, prevents *U2* from timing.

When communication takes place, the serial line goes near ground potential only during the space time of the transmitted character, during which the 555 starts timing out. With the component values specified, the time constant is 42.9 ms. The *U2* output changes (goes to near ground) only if the input to *Q1* is at ground potential for longer than 42.9 ms, which is why the circuit detects a break character or a byte of 0s at a 150 or lesser bit rate. At a bit rate of 150, the total time the input to *Q1* is at ground is 59.9 ms.

To reset the microcontroller, the output at pin 3 of *U2* is routed through *D2* to the reset line (for Intel 8x48/49 processors) or through level translator *Q2* (for Intel 8x31 series processors). Resistor *R4* in the collector circuit of *Q2* affects the discharge rate of the reset capacitor by about 10 ms when a 10-μF reset capacitor is used.

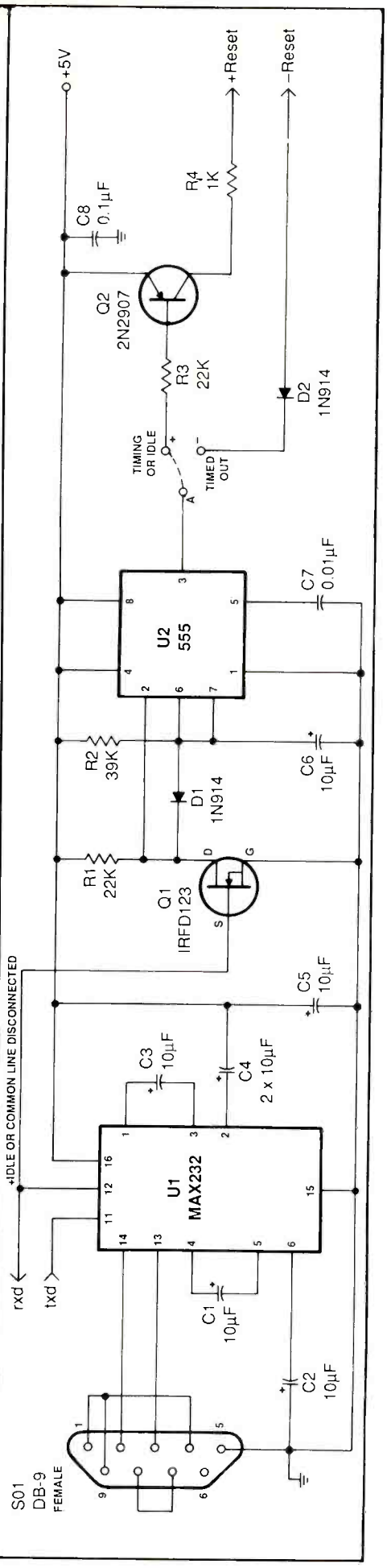
Construction

Because the Remote Microcontroller Reset circuit is very simple in terms of component count, you can use any method of assembly that suits you to build this project. For example, you could design and fabricate a printed-circuit board on which to mount the components. Alternatively, you can use perforated board with holes on 0.1" centers and suitable Wire Wrap or soldering hardware to interconnect the various components. In either case, it's a good idea to use sockets for the two DIP ICs.

Build the circuit completely, but *don't* plug the ICs into their respective sockets until after you've conducted voltage checks and are certain that your wiring is correct. Make sure when you install the electrolytic capacitors and diodes that they're properly polarized before soldering their leads into place. Similarly, make sure the basing is correct for the transistors before soldering their leads into place.

For the voltage tests, you need a dc voltmeter or a multimeter set to the dc-volts function. Clip the meter's common lead to any point in the circuit that's supposed to be at ground potential. Connect a source of 5 volts dc to the circuit (observe proper polarity), and touch the meter's "hot" probe to pin 16 of the *U1* and pins 4 and 8 of the *U2* sockets and observe the

Fig. 1. Schematic diagram of the Remote Microcontroller Reset circuit.



PARTS LIST

Semiconductors
D1,D2—1N914 signal diode
Q1—IRFD123 power FET
Q2—2N2907 silicon pnp transistor
U1—MAX232 RS-232 interface (Maxim)
U2—555 timer

Capacitors
C1,C2,C3,C5,C6—10-µF, 16-volt electrolytic
C4—Two 10-µF, 16-volt electrolytics in parallel
C7—0.01-µF ceramic disc
C8—0.1-µF ceramic disc

Resistors (¼-watt, 5% tolerance)
R1,R3—22,000 ohms
R2—39,000 ohms
R4—1,000 ohms

Miscellaneous
SO1—Printed-circuit- or chassis-mount DB-9 female connector; printed-circuit board or perforated board with holes on 0.1" centers and suitable Wire Wrap or soldering hardware (see text); project-to-PC cable (see text); hookup wire; solder; etc.

readings obtained. They should be +5 volts or close to it in all three cases. If not, power down and correct the problem before proceeding.

When you're certain that your wiring is correct, power down and plug the ICs into their respective sockets. Make sure each is properly oriented and that no pins overhang the sockets or fold under between the integrated circuits and sockets.

When you install the Remote Microcontroller Reset circuit in your system, make sure you connect the txd and rxd lines coming from pins 11 and 12, respectively, of *U1* to the microcontroller.

Power for the Remote Microcontroller Reset circuit comes from the microcontroller system in which you install the circuit. Use a standard serial cable terminated in a DB-9 male connector on the project end and a connector that matches the serial port on the PC on the other end. Finally, install a jumper wire between points A and + or A and −, depending on the needs of your particular system (see above).

Install this Remote Microcontroller Reset circuit in your next project, and when your remote won't answer back . . . *reset* it! ■

PostScript Power for PC/Compatibles

If you're ready to buy a new computer printer and want true PostScript compatibility, check out the JetScript-CX printer from The Printer Works. This hot printer features a Canon CX laser engine, 100% Adobe PostScript page-description language with 35 resident fonts and a whole lot more, all for only $895. This is less than half what you'd pay for other PostScript laser printers from even discount houses. At this price, there isn't a better bargain around in a PostScript laser printer.

You're probably thinking that at this price, there must be a catch. If so, you're correct. However, considering what $895 gets you, you'll find that the relatively minor potential negatives (which I'll cover later on in this write-up) are a small price to pay for true PostScript printing.

How The Printer Works is able to put together a true PostScript laser printer for such a low price is an interesting story in itself (see JetScript-CX Evolution box).

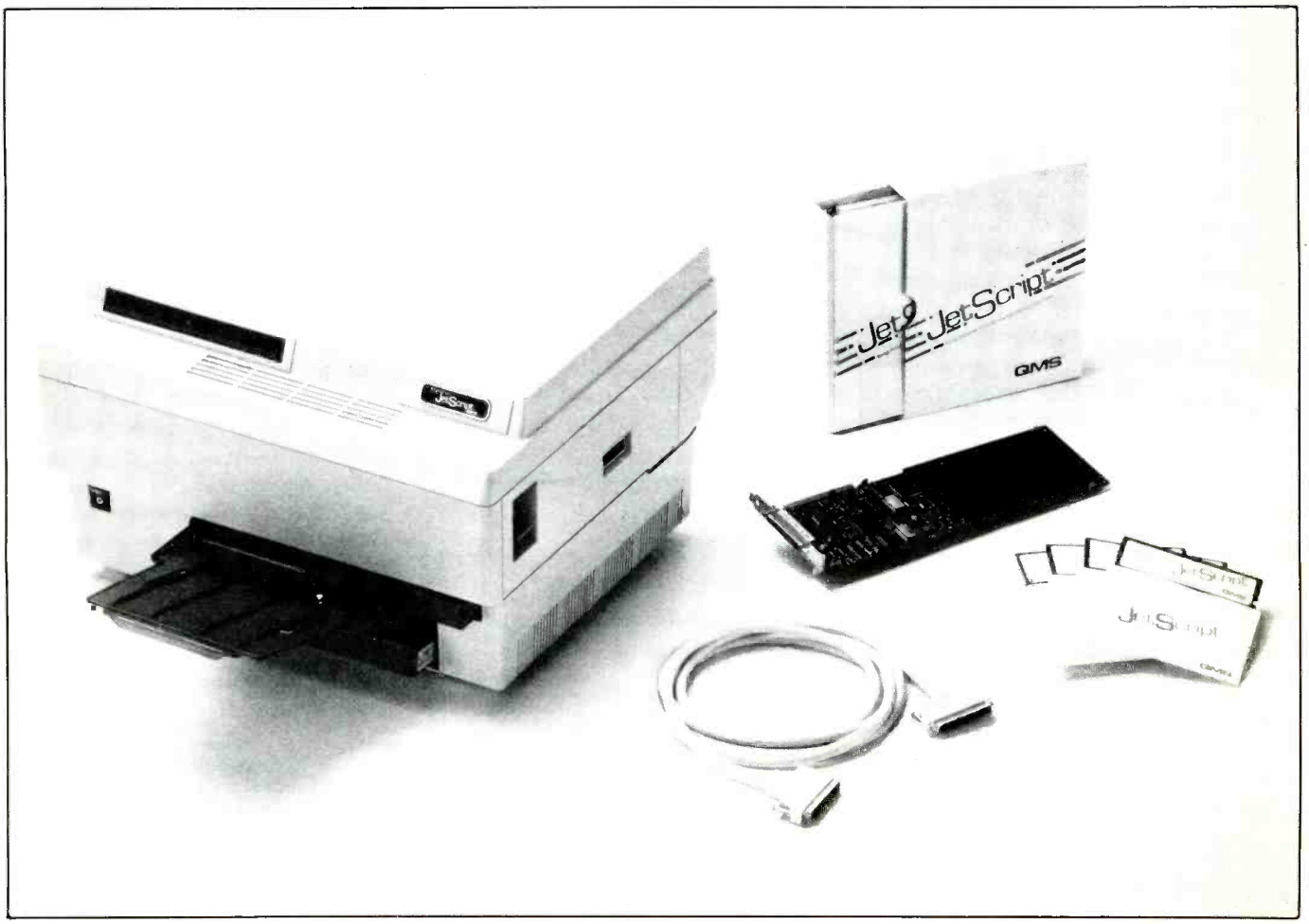
System Details

The JetScript-CX is a three-piece system package that consists of two hardware items and software on floppy disks. The hardware consists of a Canon LBP-CX print engine (a complete printer in its own right) and a PC PostScript controller card, the latter made by QMS.

The QMS JetScript software consists of four high-density 5¼" floppy disks. Contained on these diskettes are utilities for providing status reports, paper-source control, printing files/samples and aligning the printer. They also provide compatibility with some 500 software programs that contain PostScript drivers. A final diskette supplied in the package contains The Printer Works' own proprietary software utilities.

The controller card features a 68000 MPU that runs at 16 MHz and 3M of dedicated RAM. Using the PC bus, data transfer speed is rated at 90,000 characters per second. Data-transfer from the JetScript card to the print engine is rated at 1.0M bits/second.

The printer uses the Adobe PostScript page-description language and supports interactive PostScript programming. Included are the 35 licensed resident fonts illustrated in Fig. 1. These can be scaled from 4 points upward and rotated to any angle in 1° increments. All typefaces have international character sets, and optional host-resident downloadable typefaces are available. The system accepts all Adobe downloadable typefaces as well, a sampling of which is shown in Fig. 2.



JetScript Evolution

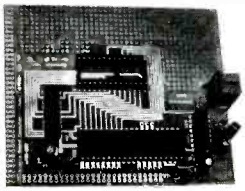
When PostScript printing just began to become a mainstream activity, laser-printer manufacturing giant Hewlett Packard found that many of its customers were demanding this capability in their LaserJet printers. Bowing to demand, HP contracted with QMS (manufacturer of PostScript laser printers) to make a PC-based PostScript laser controller for the company's LaserJet printers. Under terms of the contract, HP was obligated to buy thousands of these controller cards.

These PostScript controller cards feature a 68000 CPU and 3M of on-board RAM. They're designed for the PC-type ISA-bus platform and can be installed in an 8- or a 16-bit expansion slot. These well-made cards use surface-mount technology and represent a great dedicated-task coprocessor assembly for the PC.

Unfortunately for HP, about the time the card hit the street, at a price of about $2,500 per card, PostScript-compatible laser-printer prices had begun to drop dramatically. Stiff competition from lower-cost products left Hewlett Packard with thousands of PostScript cards it couldn't sell at the targeted price. HP tried to cancel its order with QMS. QMS sued and won. In the end, HP was forced to fulfill its contract obligation.

At about the same time, with fax technology just starting to catch on, Federal Express decided to market its own fax service. The company bought 12,000 eight-page-per-minute Canon CX laser engines (the same ones in Apple LaserWriters and Hewlett Packard LaserJets). Fed Ex fell prey the ensuing boom in affordable personal fax machines. By the time the company was ready to market its fax service, the cost of fax machines had dropped so low that consumers wouldn't avail themselves of the projected service. Like HP, Federal Express was stuck with a warehouse filled with laser printers.

On the scene appears The Printer Works with deals to help bail Hewlett Packard and Federal Express out of their troubles. The Printer Works bought all of the HP and Fed Ex inventory for a song. The company then married the printers, controller cards and some software in a laser-printer package that's almost irresistibly priced for people who want PostScript capabilities.



Times Roman **Times Bold** *Times Italic* ***Times Bold Italic***	ITC Avant Garde Book **ITC Avant Garde Demi** *ITC Avant Garde Book Oblique* ***ITC Avant Garde Demi Oblique***
Helvetica **Helvetica Bold** *Helvetica Oblique* ***Helvetica Bold Oblique***	Palatino Roman **Palatino Bold** *Palatino Italic* ***Palatino Bold Italic***
New Century Schoolbook Roman **New Century Schoolbook Bold** *New Century Schoolbook Italic* ***New Century Schoolbook Bold Italic***	ITC Bookman Light **ITC Bookman Demi** *ITC Bookman Light Italic* ***ITC Bookman Demi Italic***
Helvetica Narrow Helvetica Narrow Bold *Helvetica Narrow Oblique* *Helvetica Narrow Bold Oblique*	*Zapf Chancery Medium Italic*
Courier Courier Bold *Courier Oblique* *Courier Bold Oblique*	Symbol ΑΒΧΔΕΦΓ αβχδεφγ Zapf Dingbats ✡✢✣✤✥✦✧ ❂❁❄❄❅❆

Fig. 1. Printout of the 35 residents fonts supplied with JetScript-CX laser printer.

Up to full legal-size page bit-mapped graphics can be printed by the JetScript system. All text and graphics can be scaled, rotated, pattern-filled, halftoned, shadowed and cropped. Automatic printout of a start-up page shows PostScript version, typeface families available and printer name.

Installation

Installing the JetScript-CX laser printer was a snap, thanks to documentation that's a cut above average. If you have any mechanical ability whatsoever, can read and follow simple directions and follow simple illustrations, you can successfully install this PostScript printing system in about 30 minutes.

The add-in ccontroller card configures as a parallel port, with LPT2 the recommended default. Before you install the controller in your PC/compatible computer, you must set two on-card jumpers, one to define the I/O address of the card and the other to set the interrupt level. Then you open the system unit of your computer, plug the card into any available 8- or 16-bit expansion slot and replace the cover.

The laser engine comes very well packed in its original carton. After removing the engine from the carton, you open it and remove from the interior some shipping material. Then you install the supplied toner cartridge and close the printer engine.

To finish physical installation, you connect the ends of the supplied 10-foot cable between the connector on the back of the printer and the selected LPT port connector on the back of your computer.

The only thing remaining to complete installation is to load the supplied software onto your hard disk. You do this by entering a device driver into your system's CONFIG.SYS file. If you want the PostScript code to download automatically at boot-up, you can start the process by adding a single line to your system's AUTO-

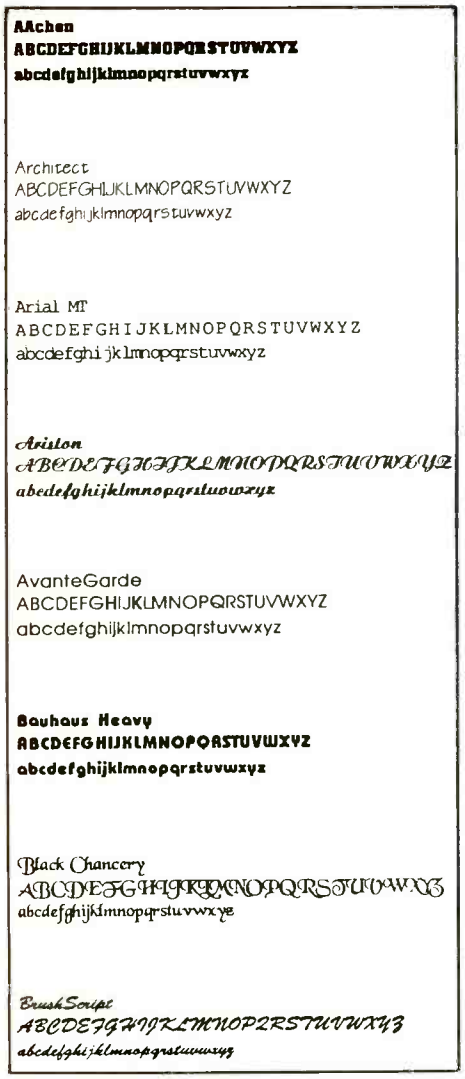


Fig. 2. Printout of some samples of other PostScript-compatible fonts.

EXEC.BAT file. At this point, you can also install the 35 fonts, diagnostic utilities and downloading utility for creating fonts on the fly from the supplied diskettes.

With hardware and software installation complete, you're ready to begin printing a wide variety of fonts and beautifully rendered artwork.

User Comments

There can be little doubt that the JetScript-CX is a powerhouse bargain, giving the PC user print quality that rivals the best there is around. However, you'll have to weigh a few potential negatives. Because the original manufacturers don't continue to upgrade this system, there's a slight possibility that it will lag behind state-of-the-art at some point in time. The system uses up an expansion slot on your computer's motherboard, which shouldn't be a problem unless your system is already loaded. The system takes time to download code into the coprocessor card before it can be used (about 20 seconds on my 33-MHz 486 system). Finally, coprocessor code and diagnostics take require about 2M of hard-disk space.

Potential negatives aside, the nice things about the JetScript-CX system are its unbeatable price/performance ratio and impeccable print quality. The Printer Works' warranty is above average. Since the laser engine is made by Canon, parts and service are widely available. As a tribute to their reliability, some Canon laser engines have reportedly printed more than a million pages and are still going strong.

Interestingly, The Printer Works views the JetScript-CX printer system as being expandable. The company has announced upgrades that enhance the performance (speed and dots per inch, to name two) of these systems. Finally, the printer works with many popular programs, including *Windows* applications, *WordPerfect*, a number of CAD packages and any other program that can output to a PostScript spooler or file.

This may well be one of the best laser-printer bargains you're likely to find anywhere. Be advised, though, that once The Printer Works' stock of JetScript-CX printers is exhausted, they're gone forever. So if you think this particular printer might be the one for you, don't hesitate to order it now. ■

About PostScript

PostScript was originally developed by Adobe Systems. It's a page-description language that has been adopted as a standard by the computer industry. Among its key features are an ability to scale fonts to any size, rotate to any angle, and fill letters with grayscales or patterns. Line art can be scaled without distortion, and images can be reduced to fit a page size. A big plus is that PostScript printers can input bit-mapped graphics directly.

More than 5,000 typefaces can be used by devices that are compatible with PostScript. Because these typefaces download in software, no hardware or font cartridges need be purchased separately.

A number of popular desktop-publishing software applications support output to a PostScript printer. If a PostScript printer is used with a program that can produce PostScript output, the output features of the program are greatly enhanced.

In Brief

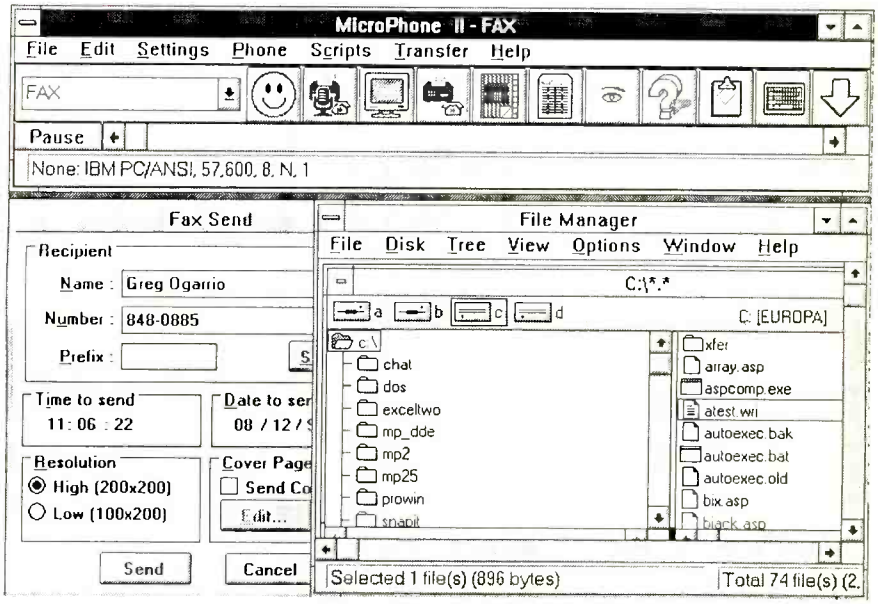
JetScript-CX printer, $895
The Printer Works
3481 Arden Rd.
Hayward, CA 94545
Tel.: 800-235-6116 (800-225-6116 in California) or 415-887-6116
System Requirements: XT- or AT-compatible or IBM PS/2 Model 25 or 30 computer; 2M hard-disk space; full-length expansion slot; LPT1 or LPT2 port address.

CIRCLE NO. 101 ON FREE INFORMATION CARD

Blown to Bits

I'm sure it couldn't have been true, but a few years ago, it seemed to me that every modem came with the same software bundle: Bit Software's *BitCom*. Today, it's much less common for modems to include third-party communications software. Of five fax/data modems I'm currently evaluating, only two, Macronix's new MaxLite/PC 1440 and the Complete PC's Complete Communicator came bundled with their own communications software. MaxLite comes with *COMit* communications software. For the Complete Communicator, once again, it's *BitCom*.

No modem I can recall, then or now, comes with bundled communications software for *Windows*. Frankly, this is a shame. There are few things I like less than arranging a telecommunications setup with an inexperienced user at the other end of the continent running an obscure DOS package like *Mystictalk* or *Surrealcom*. You could save lives in these cases with a good GUI communications package. Thankfully, there are a number of them for *Windows*.

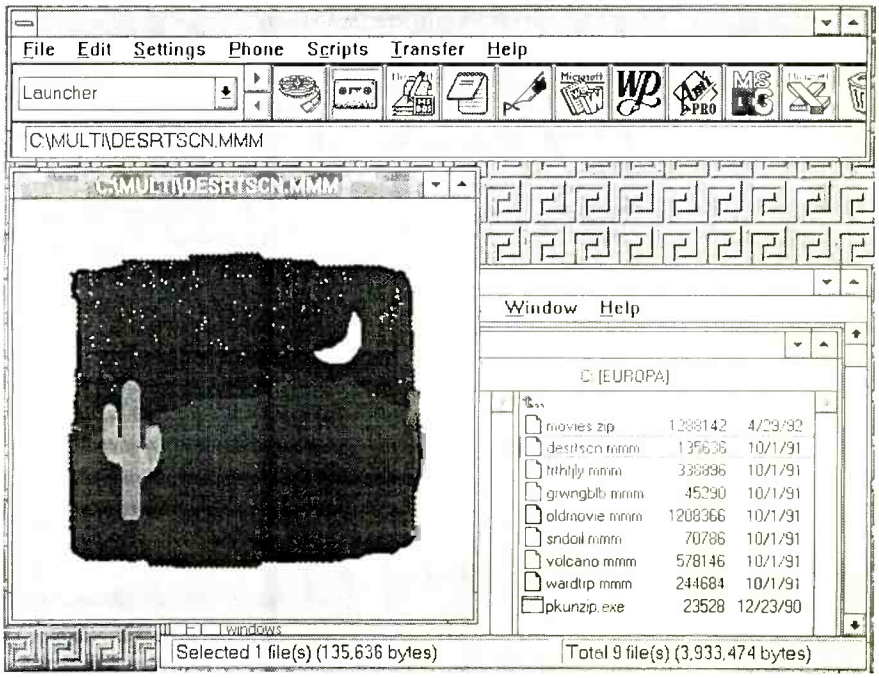


User can just drag a file from the File Manager and drop it on MicroPhone Pro's fax icon to fax the document.

MicroPhone II 2.0

The ease of use a GUI imparts to software is especially helpful in dealing with the arcane conventions of telecommunications. *MicroPhone* from Software Ventures was an early entry in this category. It has a couple of drawbacks. It's been slow providing transfer protocols. For example, Kermit still isn't supported. Software Ventures doesn't expect to add it until near year-end. Also, the program hasn't offered many terminal emulations. Nonetheless, several more popular protocols (filling out the alphabet from Xmodem to Zmodem, including Ymodem-G) were added to the second release, and *MicroPhone* has several common terminal types, too.

The important advantage *MicroPhone* has had came from its Mac heritage. Software Ventures knew how to take advantage of the *Windows* interface. Besides the typical menus and GUI conventions, *MicroPhone* has a powerful scripting language that practically writes itself. You can select your syntax from lists and just add your variables, literals and constants—something like making soup from a dry



Similarly, user can drag Movie files from the File Manager and drop them onto MicroPhone's icon bar to play the movie.

mix. You insert lines from the template directly into your script with a single click or keystroke.

Inexperienced programmers benefit from elimination of syntax errors, experienced ones from elimination of most typos. Too, everyone will love the quick parser that lets you know immediately if you have a valid script. However, if a script still crashes, you can easily find the problem with *MicroPhone*'s trace facility. I don't think I've seen a more complete development system built into a communications package.

Procomm Plus for Windows

DataStorm Technologies has entered the fray, too, with a *Windows* version of *Procomm Plus*. Like its DOS forebears, *Procomm Plus for Windows* (*PPW*) is especially strong in the very areas where the *'Phone* is weakest. *PPW* includes 32 terminal emulations, all those popular tail-of-the-alphabet-modem protocols and both Kermit and Compuserve B+.

There's a viewer for GIF files. And, like DOS versions of *Procomm, PPW* has a large scroll-able buffer to hold your current session. It also offers a *Windows* scripting language, *Aspect*, with a rich—make that enormous—set of more than 400 commands.

Carrying the *PPW* manual could qualify you for an honorary doctorate from Schwartzenegger U. Moreover, DataStorm did a creditable job on the interface, offering a toolbar—the graphical analog of the latest buzzword in GUIs—and 40 programmable "meta keys" or buttons.

Procomm also supports any Asynchronous Communications Server (ACS) through INT 14. And it supports DDE, which lets you send data to documents in other applications, receive data from other applications, and send commands directly to other DDE-capable applications. You can even use it to build turnkey systems that incorporate other applications—including multimedia presentations.

BitCom, Too

Don't count out *BitCom*,either. It isn't bundled as widely as before, but Bit Software is offering more products through distribution. A *Windows* version of *BitCom* is available. It has all the features required to satisfy the vast majority of occasional users. There are a scripting language; Kermit, Xmodem, Ymodem and Zmodem transfer protocols; phone book in the *dBASE*-file format; toolbar; and row of customizable function buttons.

BitCom is a simple, inexpensive product, much like its DOS antecedents. A minimalist approach, perhaps, but one that takes maximum advantage of available resources: using the *Windows* notepad as a text file viewer and editor, for example, and *dBASE*-compatible applications with directory files.

Now for the Fax

Fax software is a different story. Going by the units I've seen, it appears that many of today's super-fast fax/modems do come with their own software. However, not all of them come with a full send/receive *Windows* version.

The Practical Modem 14400FXSA V.32bis and Logicode Quicktel V.32bis 14,400-bps S&R Fax/Modem, for instance, offer 14,400-bps transmission rates for both fax and data. Each comes with *Quick Link II* send/receive fax software for DOS. Intel's SatisFAXtion Modems ship with DCA's *CrossTalk Communicator*, Intel's send/receive fax software for DOS, and Intel's FAXability send-only fax product for *Windows*. (Intel also offers two optional send/receive after-market fax products for *Windows*: *FAXability Plus* and *FAXability Plus/OCR*. Both are compatible with any CAS, CCITT Class 1, CCITT Class 2 and Sierra Sendfax class modems.)

Macronix is the exception. Its MaxLite/PC 1440 pocket modem comes with MXB-FAX and MXPOP for DOS, but the company also bundles *Windows* fax software, Delrina's *WinFax Lite*, with it. Of course, the MaxLite/PC is exceptional in other ways as well. It's one of the first combination 14,400-bps send/receive fax (V.17 Group III) and 14,400-bps data modems (V.32bis) in a portable form factor.

BitFax

Bit Software also has an entry in this category. It's similar to the company's communications product in design, utility and cost. Fax documents are sent to *BitFax* by printing them with a WYSIWYG driver that appears in the standard *Windows* list of printer drivers. It's a method common to other products, like *WinFax*, too.

You merely select the driver from the Setup Printer menu. This makes it easy to get perfect faxes from any *Windows* application, but the lack of *BitFax* import filters complicates the procedure for bringing documents in from non-*Windows* applications. Despite this minor drawback, it's an inexpensive and effective solution for the majority of applications—assuming a significant commitment to *Windows*.

Not everything in BitFax is Jake, though. I discovered that the Escape key doesn't activate Cancel buttons. This is contrary to the convention used in most *Windows* applications, but it's typical of the bumpy road DOS developers sometimes take to GUI applications.

The Pro

Modems that combine fax and data communication are becoming increasingly common. All the modems I've mentioned in this article feature both. Even proprietary laptop modems, like the NEC UltraLite Image Modem Plus Series, now combine fax and data. Data rates of 14,400-bps are not only common but increasingly inexpensive.

The MaxLite, which already has plenty of company at slower rates, is being joined by a several other pocket-sized portables in this rarefied atmosphere. Yet, whether it's *BitFax, WinFax Lite* or some other product like Alien Software's *Faxit Software for Windows*, no vendor has integrated fax and data software to match this hardware. Does this make sense? Not to Software Ventures. In about two weeks, and well before this column appears in print, Software Ventures will debut *MicroPhone Pro* with both—data and fax capabilities—together for the first time. The program is an aggregation of *MicroPhone* and *WinFax Lite*, but with a high level of integration.

Pro includes support for DDE, and it is fully compatible with *Windows* 3.1 multimedia. Like *Procomm Plus for Windows, MicroPhone Pro* can send and receive multimedia files and control presentations directly within the applications.

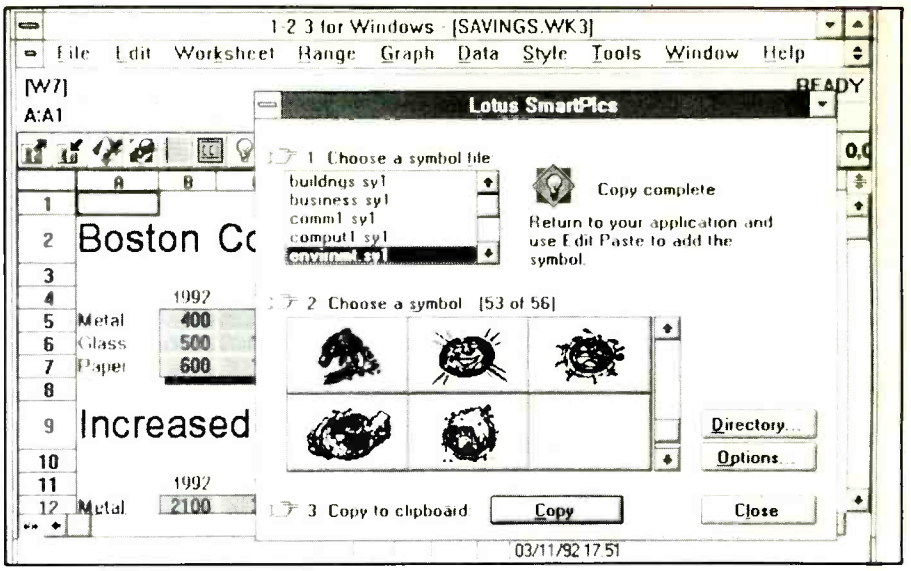
The combination of fax, data and DDE will make this the first application in which it's possible to develop turnkey communications applications supported by a multimedia interface, complete with multimedia help and training. Given video, sound and MIDI, it's difficult to imagine an application that will remain intractable to development under *MicroPhone Pro*. If a task is complicated, so what? Just tell the user what to do, or add a video that shows how to do it.

There's more. This development potential is especially attractive when you consider the clever tools that will be available. In addition to *MicroPhone*'s scripting language, syntax templates and trace facility, *Pro* has a customizable toolbar that's awesome in its elegant simplicity. With an undocumented beta copy of the program, I was quickly able to write scripts that launched applications and passed them parameters via the toolbar.

Scripts are easily added to buttons and repositioned at will, appearing as either icons or text. You can also add scripts to menu items as an alternative to, or in association with, the toolbar. Pick whatever makes the most sense to your application and its end user.

A few weeks ago, I heard Nicholas Negroponte, founder and director of MIT's Media Labs, address a group of analysts at a National Semiconductor communications symposium. One of his key points was that multimedia means adding richness and control of the interface. Pro's support of DDE gives developers access to both richness and control. And its script-construction syntax-parsing and execution-trace tools offer the highest level of development support I've seen in any *Windows* commercial product.

Taken as a whole, the *Pro* system represents a real breakthrough. It's obviously going to have a significant impact on the level of turnkey communications applications. Furthermore, Software Ventures promises that transfer protocols and terminal emulations will finally be getting high priority with its developers. By year end, this should be the hottest communications package for not just *Windows*, but the PC as well.



Lotus "SmartPics" clipart browser makes it easy to find and paste artwork into Windows documents.

Is It Getting GUI Out There Yet?

As an advocate of the GUI, it's easy to fall into the trap of believing that everyone's using one—especially when, after you've used one for some time and have become accustomed to its benefits, you begin to find it hard to understand why anyone would willingly not use one. But that's not the case. GUIs aren't widespread. If you're an average user, you're probably not using one on a regular basis.

Part of the reason GUI growth has lagged is that graphical applications themselves, often the reason a GUI is first adopted, aren't that prevalent. In fact, according to an estimate by Lotus Development Corp., graphics penetration across the universe of all users is only 15% or 20% for dedicated packages (compared with a market penetration for word-processing applications of 85% or 90%). If people aren't using graphical applications, then it's a small wonder that they're not into a GUI environment.

Also, not surprisingly, Lotus wouldn't be collecting these statistics if it weren't positioning products to do something about them. *SmartPics* is a new *Windows* product from Lotus that's intended to "lower the barriers to graphics use," according to the Cambridge-based publisher. The complete package boasts 11M of images (2,165), on seven high-density diskettes, in both color and gray-scale. There's also a high-contrast option for line art, fax and older H-P (Series I) printers.

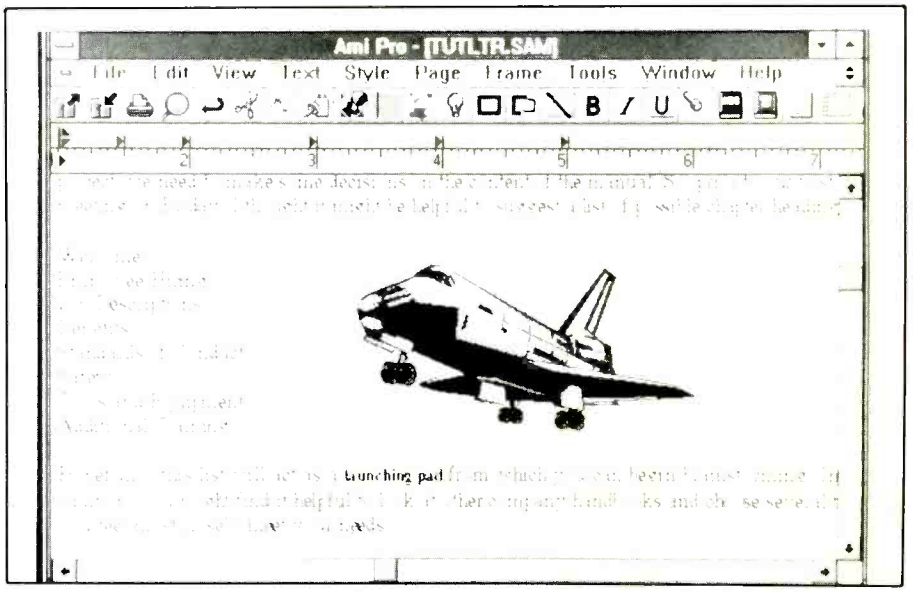
Images are provided as both editable vector art and bitmaps, but not as TIFF or PIC files. *SmartPics* stores them in its own proprietary SY1 format. However, the program can translate them into *Windows*' WMF, the original BMP, and device-independent bitmap (DIB) files (which also have the BMP extension).

SmartPics is designed for the corporate communicator, not the graphics professional. Styles range from cartoons to representational art. Most images aren't too complex, but they're scalable over a significant range of sizes, without appearing either overly busy or too simple. Content will probably support any business presentation you can come up with including military, religious, and secular holiday topics.

Quite contemporary technology, such as pen computers, is represented. There are also an assortment of display fonts and plenty of symbols and flowchart icons, some maps and a number of backgrounds. There was only one circuit board (a PC adapter card) and just two chips (both DIPs), however.

In addition to providing a substantial inventory at a modest price, *SmartPics* also has a reasonably good browser (adapted from *Freelance for Windows*). It's relatively easy to pick an assortment of related images and scroll through their thumbnails nine at a time. It should be fast enough to suit most people.

I was just a little disappointed that Lotus didn't allow the user to select the number



An example of the high quality of SmartPics clipart pasted into an "Ami Pro" document.

of thumbnails that can be viewed. Then, you could decide when you must compare more choices at once or to minimize the space they take on-screen. And the ability to see a single thumbnail at a time could really help in identifying more complex graphics. As it is, you can fall back on the documentation, which includes a sample of each image, as well as a subject index (something else I'd like Lotus to add).

I don't know if Lotus has removed any barriers with *SmartPics*, but the program's simple graphics do make it easy to achieve quality results. Putting them in documents is a snap. You can copy images to the clipboard with a button click or by double clicking directly on the thumbnail (itself a button that both puts a copy on the clipboard and closes *SmartPics*).

You can also use object linking and embedding (OLE) to launch *SmartPics* without leaving an application. OLE works with *SmartPics* from within applications like *Excel, Persuasion, Power Point, WordPerfect for Windows* and *Word for Windows*. In *Word for Windows*, for instance, you just select Object on the Insert menu. For Lotus applications like *Ami Pro* and *1-2-3 for Windows*, Lotus even includes an icon that can be added to its SmartIcon pallets.

The only disadvantage to OLE is that you lose the ability to automatically bring up Microsoft Draw when you double click on the graphic's frame. Instead, *SmartPics* appears. This allows you to quickly change the graphic with another, but not edit it. If you frequently need to make minor changes, to colors perhaps, using the clipboard is simpler.

Bookshelf

When it shipped in 1981, the IBM PC quickly gained popularity in corporations, but it took years longer to become a standard in the home. It was expensive for the home market, and most of the software for it was dear, too. But early in its transition to a standard, the PC benefited from a vast pool of existing shareware and public-domain software. Although it was originally written for CP/M, authors proved willing to port those programs, or develop new ones, for the new system. One of my favorites at the time was *PC-Sweep*, a ported CP/M utility and one of the first good file managers.

Today, shareware remains a popular way for individual users to find suitable software without risk, but it's also finding its way into large organizations. An increasing number of corporations maintain shareware libraries and recommend the programs to their end users.

There's shareware for *Windows*, too, and the list is growing. My first GUI Guts column included a review of one product, the *Amish Utilities*, which had its roots in shareware (Amish Software's *Big Desk*). Wilson WindowWare alone offers several titles with shareware origins: *WinBatch* language for batch processing under *Windows*; *WinEdit* programmer's editor; *WinCheck* personal finance manager; *CommandPost*, a file manager and shell; and *File Commander*, a menu extension to the *Windows* File Manager.

Metz also offers several *Windows*-specific titles, including a desktop organizer called *Task Manager*, file manager called *Desktop Navigator* and quite a few others. And there are many companies like Amish with one or two titles. Numbers and Co., for example, offers one of these, called *Whiskers*, a utility that lets you assign functions to your mouse keys, for only $15. Other useful shareware titles help to create icons, search for files, entertain you and much more.

Now there are a number of reference works that can help you find what you need. The latest edition of Brian Livingston's tome, *Windows 3.1 Secrets* ($40, IDG Books), has more pages devoted to its index than some small publications have in total. It includes a large section of the author's top shareware picks and includes enough documentation to give a clear idea of what each program does and, in many cases, descriptions of all features. What's more, this book comes with three high-density diskettes that contain more than 40 compressed shareware, freeware and public-domain programs. Most of Livingston's picks, including several from Wilson and Metz, as well as *Whiskers*, are included.

The *Windows Shareware Book* ($40, Wiley) by Michael Banks, includes a single diskette with 34 compressed programs. (I noticed only one program that overlapped between the two.) Banks doesn't list documentation, but he describes each program's purpose. He includes an overview of each, details of its operation, screen shots and examples. Among the chapters for each type of software—utilities, games, communications, etc.—Banks devotes one to the sources of shareware: bulletin-board services like America Online, BIX, CompuServe and GEnie.

For Mac devotees, Ruffin Prevost and Rob Terrell's *The Mac Shareware 500* ($40, Ventana Press) is devoted exclusively to Mac shareware available through American Online. It comes with America Online's starter kit: software, a waiver of the first month's membership fee and five free hours of on-line time. Remember, when Apple claims that the Mac is the computer for the "rest" of us, it isn't using the word in the sense of "repose." If you've been sleeping on your Mac, get this book and get busy.

Also on the bookshelf is *Now That I Have OS/2 2.0 On My Computer, What Do I Do Next? Mastering the Workplace Shell* ($23, Van Nostrand Reinhold). Authors Steven Levenson and Eli Hertz have written a simple and profusely illustrated introduction to the IBM operating system. It's just the basics, though. The closest they come to configuring OS/2 is a listing of files from the installation diskettes.

The authors managed to include one chapter that provides details of almost every application written for release 2.0. (I'm not kidding. There's a chapter devoted to Describe, and that's still within two or three applications of being everything written specifically for OS/2 2.0.)

An interesting piece of trivia from page 220: Ctrl + Alt + Shift + O lists the 2.0 development team and graphic of the Florida coast. (You were able to do the same type of thing in *Windows* 3.0. Typing WIN3, while holding down F3, followed by a Back Space, displayed the list in place of your wallpaper. If anyone knows how to do it in 3.1, drop me a line and I'll share it.)

Products Mentioned

BitCom or BitFax for Windows, $79; Bundled together, $149
Bit Software
755 Ames Ave.
Milpitas, CA 95035
Tel.: 408-263-2197

CIRCLE NO. 105 ON FREE INFORMATION CARD

MicroPhone Pro, $195
Software Ventures
2907 Claremont Ave., Ste. 220
Berkeley, CA 94705
Tel.: 510-644-3232

CIRCLE NO. 106 ON FREE INFORMATION CARD

Procomm Plus for Windows, $149; Upgrade from DOS version, $69
Datastorm Technologies
3212 Lemone Blvd.
Box 1471
Columbia, MO 65205
Tel.: 314-443-3282

CIRCLE NO. 107 ON FREE INFORMATION CARD

SmartPics, $149; Node license, $49
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
Tel.: 617-577-8500

CIRCLE NO. 108 ON FREE INFORMATION CARD

Joseph Desposito

The ESP 8680 and the PC/CHIP

This month, I devote my entire column to a new product called the ESP 8680, explaining in detail the chip that's the heart of this product. So, without further adieu, I'll get right to it.

ESP 8680 Module

Dover Electronics' (1198 Boston Ave., Longmont, CO 80501) ESP 8680 (the "ESP" stands for "extremely small package") is designed for developers who require off-the-shelf PC-compatible controller solutions in space- or power-constrained applications. The module is based on the Chips and Technology 8680 single-chip XT, known as PC/CHIP, which incorporates core logic, an 8086-equivalent processor running at 14 MHz, CGA graphics, I/O and memory and power management features. To the inherent low power consumption and high performance of the 8680 chip, Dover has added up to 1M of RAM, a 256K ROM chip that holds DOS and BIOS data and 128K of user code, a PCMCIA (Personal Computer Memory Card International Association) standard interface and an ISA bus interface. The ISA bus interface allows you to add miniature expansion boards to the module.

The ESP 8680 has a 1.7″ × 5.2″ form factor. To enhance durability and reliability, an ESP 8680 development kit is packaged in a metal card cage in which the modules lock into place on all sides via backplane connections, card guides and face plates.

To configure a system, you start with the ESP 8680 core module. Then you choose a power supply board that accepts your

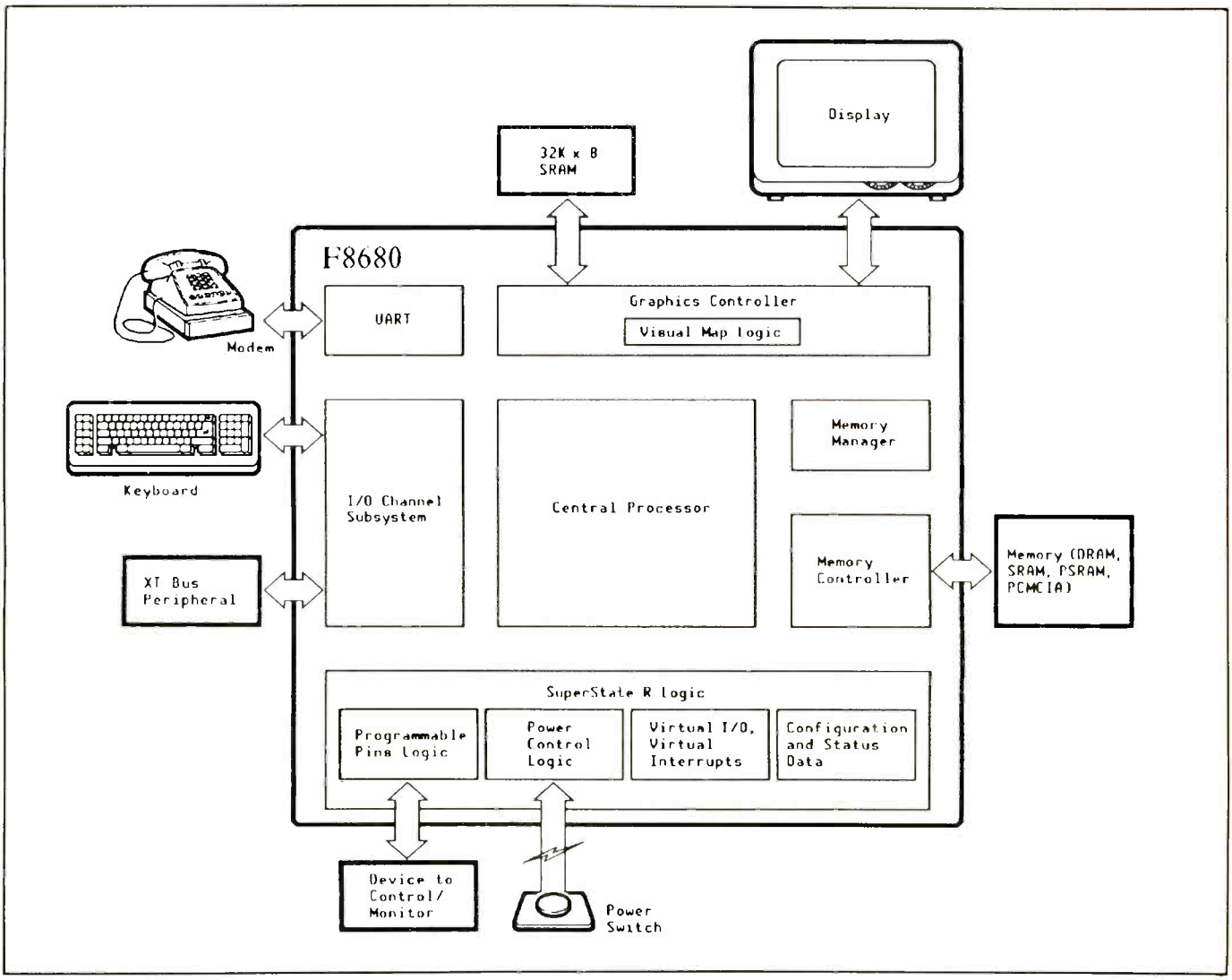


Fig. 1. Block diagram of Chips and Technologies' PC/CHIP.

available input and provides necessary outputs and add modules with such features as additional RAM, barcode reading, modem, fax, packet radio, network interface, SCSI, ADCs and DACs and static memory. The modules stack in a backplane on a 0.5" pitch.

The ESP 8680 provides a low-power solution to space-constrained problems. It's suitable for a variety of uses, such as handheld portable units, wall-mounted controls and miniature instrumentation. The ESP 8680 development kit has a suggested retail price of $995.

The PC/CHIP

Chips and Technologies' (3050 Zanker Rd., San Jose, CA 95134) PC/CHIP is a single-chip solution for PC-compatible computers. The PC/CHIP offers low power consumption, high performance, direct PCMCIA card support, power management and flexible memory support. It has feature enhancements to accommodate technology requirements for battery-operated systems, embedded control applications, low-cost notebook and palmtop system computers and pen-based systems. A block diagram of the PC/CHIP is shown in Fig. 1.

The F8680 PC/CHIP introduces a new operating environment, called SuperState R mode, that transparently mitigates between system hardware and software protocols. It's separate from the normal operating environment of DOS and system BIOS. If a hardware design includes any extensions to the PC architecture (power-control circuitry, PCMCIA memory card slots, etc.), these extensions can be managed in SuperState R mode and, thus, are transparent to normal DOS and BIOS operations.

SuperState R mode initializes the F8680 chip and then provides the facilities for extended PC functionality. It isn't a BIOS. Rather, it's code that's linked to the PC compatible BIOS that initializes the F8680 according to specifications at boot-up time. It provides such basic system services as chip initialization, DMA emulation and real-time clock emulation during normal system operation. On start-up, an initial jump from the BIOS to the SuperState R mode takes place.

There are four avenues of entry into SuperState R mode: I/O calls, interrupt calls, an external SuperState R interrupt and the SuperState R timer tic, which is activated by a programmed time interval. The SuperState R table identifies the I/O call and interrupt call the designer wants reviewed through SuperState R. Once these calls occur, they're trapped and directed into the SuperState R control

registers. The F8680 chip is always in SuperState R mode after a reset or initial power-up.

The F8680 PC/CHIP provides functionality comparable to a PC-compatible system with a significantly superior 8086 processor. Above this, the F8680 chip provides independent management features through hardware and microcode enhancements. Enhancement schemes involve such new concepts as:

- SuperState R supervisory mode used to execute system management code in an environment protected from applications;
- Virtual I/O mechanism that intercepts I/O operations from monitoring and servicing by SuperState R code;
- Virtual Interrupts mechanism that intercepts interrupts for monitoring and servicing by SuperState R code;
- Visual Map contrast control facility that guarantees that applications written for a color display will be viewable on a monochrome LCD panel.

With Virtual I/O, which is programmed and maintained while in SuperState R mode, I/O operations to every port can be monitored, redirected, emulated or suppressed. This enables the manufacturer to take advantage of more appropriate hardware technology for a system without the risk of software incompatibilities. An example of device emulation is use of a PCMCIA memory card instead of a floppy-disk drive for mass storage in a handheld system.

In an application program, when doing the typical calls for naming a file, the application software "thinks" it's saving data to the floppy disk. What's actually occurring is trapping of the I/O call and redirecting the data to be saved to a memory card through the SuperState R operating environment. All this activity occurs without the modification or knowledge of the application software, operating system or BIOS. Consequently, the Virtual I/O feature can be used to emulate operation of a device that isn't actually present. When adequately comprehensive emulation code is used, applications can't distinguish Virtual I/O operation from true I/O with a peripheral device.

Virtual Interrupts let any system interrupt, whether caused by a hardware IRQ or a software INT instruction, be trapped and examined by SuperState R code. Trapping occurs before any TSR program or interrupt handler sees the interrupt. Once trapped, SuperState R code can substitute register values and pass the call back for normal interrupt handling, or it can emulate the interrupt handler itself and bypass the normal mechanism. Emulating the interrupt handler is especially useful when handling file-access interrupts.

The F8680 PC/CHIP has a great number of other hardware features. Among the things it does are:

- Provides fully static operation, allowing a complete power-down with no loss of data.
- Integrates PC-compatible functions and such popular peripheral devices as a graphics controller, UART and continuous time of day clock.
- Activates oscillator power and enables internal clocks in the proper sequence at power-up/power-down times to eliminate the need for external logic.
- Provides a practical mechanism for bank switching memory, thus allowing EMS memory addressing and memory card addressing with no external mapping logic.
- Eliminates the need for external decode logic by providing up to four programmable chip-select decodes.
- Provides a flexible memory mapping mechanism to make the most efficient use of virtually any memory configuration.
- Allows hardware configuration to be performed under software control, maximizing hardware design flexibility.
- Addresses 16M of memory, linearly, through SuperState R mode.

These features relieve the designer of the burden of adapting hardware design to the chip. Instead, a designer can program the F8680 chip to adapt to a particular hardware design.

In addition to the features already mentioned, the F8680 chip provides many hardware and software features that allow designers to create effective, yet unobtrusive, power-management mechanisms into a system. Through SuperState R, advanced levels of management are available that utilize SmartSleep, a software algorithm that takes advantage of the monitoring system of SuperState R mode, thereby determining the appropriate time to assert one of several modes.

Sleep mode is initiated by a halt instruction to the CPU. The sleep state is transparent to the BIOS, DOS and application programs because sleep-mode transitions are trapped through the SuperState R Virtualization feature.

Suspend mode is initialized only when the 32-kHz clock is running. The F8680 chip continues to keep time and maintain configuration parameters while it's in the Suspend mode.

Drowsy mode reduces power consumption by adding 1 to 128 idle cycles between each CPU instruction. The number of cycles is programmable through the F8680 configuration register. The CPU and system continue to run at a normal clock frequency. However, CPU cycles occur at a slower rate. Power savings are the result of lower memory and peripheral access over a period of time.

Such thorough monitoring permits ef-

ficient power-down decisions to be made on a port-by-port basis. If no I/O calls are made to a particular device over a certain period of time, the slow-down or complete turn-off of that device can occur through SuperState R. In addition, SuperState R mode permits shadowing of the peripheral device port value within the SuperState block. When the operating system software monitoring routine takes place, the value of the powered-down port is read from the SuperState block, rather than the actual port. This efficient use of power translates into longer battery life.

The F8680 chip operates at a nominal +5 volts. Its full operating range is +2.7 to +5.5 volts. The F8680 chip's operational speed is reduced at lower voltages.

The F8680 hardware is intended to be PC-compatible on the interface level of operation. Integrating all subsystems into a single physical package results in a substantial overall performance improvement over the standard PC.

The CPU is compatible with the 8088 and 8086 instruction set. A few more instructions have been added to acknowledge SuperState R and recognize a full 26-bit address space. The CPU has a four-stage pipeline that streamlines the instructions, increasing performance. This fully static device runs from 0 to 14 MHz.

The CPU executes the entire instruction set of the 8086 processor, as well as the new SuperState R instruction set. Moreover, it incorporates 24-bit segment registers and several new registers to support SuperState R operation.

The memory controller generates cycles for dynamic RAM, static RAM, pseudo-SRAM, PCMCIA-standard memory, ROM and the XT bus. Page mode is supported with both byte and word requests.

The graphics controller supports both CRT and LCD-panel displays with a fully CGA-compatible register set. A Visual Map feature overcomes a problem that arises with monochrome LCD panels used with text-mode applications written for a color display. Many controllers map colors to shades of gray, but colors that are close in intensity are barely distinguishable on a monochrome display. The problem is pronounced when text-mode foreground colors are mapped to the same shade of gray—the text disappears.

The Visual Map feature programs each possible foreground and background color combination into a table as a specific combination of shades of gray. Each combination provides contrast that's closer to that of a color display.

The standard PC subsystem is, for the most part, implemented in hardware. The interrupt controller is a hardware equivalent of the 8259A component, and the timer is a hardware equivalent of the 8254 component for those functions available in a PC-compatible environment. The DMA controller isn't actually present in hardware but is emulated by a combination of hardware, microcode and software. From a hardware aspect, the PC subsystem is completely compatible with that of the PC computer.

The F8680 chip provides a UART that's compatible with the National Semiconductor NS16C450 chip. The user can assign the UART to respond as either COM1 or COM2 or disable it.

The F8680 chip provides a complete set of PCMCIA interface signals. When the interface isn't used, some of these signals can be used as general-purpose status monitoring inputs. The interface can also be used as a general purpose 16-bit input/output port. ■

Annual Shareware Industry Awards; Censorship on the Networks; Windows Network; IBM Responds; AOL's E-Mail Gateway

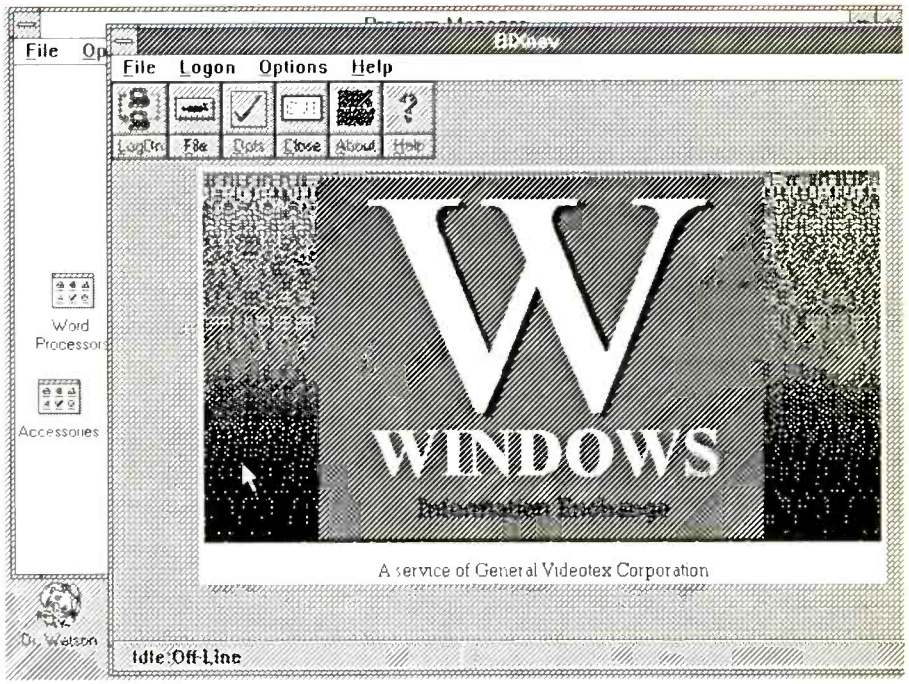
The Shareware Industry holds elections for the best programs of the year. It nominates candidates and awards titles to what members consider to be the best software in many categories. All nominated programs are excellent. To be recognized by the fellow members of the Shareware Industry as the best is, indeed, a great honor. All these programs are available on various BBSes and on-line services like CIS, Ziffnet, AOL, GEnie and Delphi and from shareware distributors like PC Sig and Public Brand Software. Here's a run-down of this year's nominees and winners:

For Best Utility, nominees were: *4DOS* from J.P. Software; *Icon Master* from Philip Kaufman; *PKZIP* from PK Ware; and *Zipket* from Eric Isaacson. The Winner is *4DOS*, considered by many to be a more-powerful command processor and Shell for DOS than the Microsoft Shell provided with DOS 5.0. It takes over the role of COMMAND.COM to manage the DOS command line.

4DOS offers extensive batch-file enhancements, has a complete pop-up Help file and is also compatible with DR DOS Version 5, *Windows* 3.x and *DESQview*. It takes advantage of extended and expanded memory and memory managers that let programs load high (*QEMM* and such) for 286, 386 and 486 processors. Keep in mind that *4DOS* is a DOS enhancement product. It is *not* an operating system on its own. You still must have DOS loaded in your system. This program takes 33 minutes to download at 2,400 baud.

For Best Application Program, nominees were: *As Easy As* from Trius Inc.; *PC-File* from Buttonware; *PC Write* from Quicksoft; *Procomm* from Datastorm Technologies; *Qedit* from Semware; and *Telix* from Exis Inc. And the winner is *As Easy As*, an easy-to-use but powerful spreadsheet program.

For Best Graphics and Tools, nominees were: *Paint Shop* from Robert Voit; *Cooper Graphics Series* from Jim Cooper; *Draft Choice* from Trius Inc.; *Desktop Paint/Desktop Paint 256* from Steve Palmer; and *Graphics Workshop* from Steve Rimmer. The winner is *Paint Shop*, a very useful paint and art package.



General Videotex Corp.'s WIX Windows network (actually access shell) that accesses the BIX network.

For Best Business and Finance software, nominees were: *Medlin Accounting Series* from Jerry Medlin; *Checkmate Plus* from Custom Technologies; *AMTax* from AM Software; *Painless Accounting Series* from Kendall Pierce; *Takin Care of Business* from Hooper International; and *WinCheck* from Wilson WindowsWare. This was the hardest category to judge because of the unusually high quality of the nominees. The winner is *Medlin Accounting Series*, a complete accounting package for small business that competes with many commercial products. (I would have picked *Takin Care of Business*, but it would have been a very close call. *Painless Accounting* is also a great package.)

Nominated for Best Programming Language and Tools were: *A86/D86 Assembler* from Eric Isaacson; *Technojocks Turbo* and *Object Toolbox* from Bob Ainsbury; and *Window Boss* and *Data Clerk* from Philip Mongelluzzo. The winner is *A86 Assembler*. An Assembler (A86) and Debugger (D86) that are as fine a piece of work as any product from a large commercial company. It claims to be 98.83% MASM-compatible. There's a companion package on most BBSes for the AFIX Package for A86 that modifies 61 different ASM files from *PC Magazine*'s Utilities to make them compatible with A86. This means that there are over 2 megabytes of publicly available source code for the A86 Assembler.

Nominated for Best Educational Software were: *Animated Series* from Tom Gutherie IV; *Amy's First Primer* from Bob Robinson; *PD-Fasttype* from Bill Letendre; *School Now* from Andy Motes; and *Tutor.Com* from Tom Simondi. The winner is *Animated Series*.

In the Best Entertainment Software, nominees were: *Commander Keen* Series

from Apogee Software Productions (producer) and ID Software (programmer); *Chinese Checkers* from ImagiSoft; *Duke Nukem* from Apogee Software Productions; *EGA Trek* from Niels Anderson; and *Solarian II* from Ben Haller. And the the winner is *Commander Keen*.

Nominated for Best Home or Hobby Software were: *SkyGlobe* from Mark Haney; *Meal Manger* from Thomas Johnson; *Family Tree Journal* from Richard Cherry; and *Brothers Keeper* from John Steed. And the winner is *SkyGlobe*.

Best Math or Engineering Software nominees were: *KwikStat* from Alan Elliott; *Math Plot* from Philip Sherrod; and *Mecury* from Roger Schilafly. The winner is *KwikStat*.

There's a category for the best new product, too. Programs nominated for 1992 were: *Surefire* from Peter and Mindy Makuta; *QuickMenu* from Glenn Tippetts; *IconMaster* from Philip Kaufman; *Paint Shop Pro* from Robert Voit; *Cosmos Cosmic Adventures* from Apogee Software Productions; and *Chinese Checkers* from ImaiSoft. The winner is *Surefire*.

The Peoples Choice Award went to *4DOS*.

Best In Show programs nominated were: *4DOS*; A86; *As Easy As*; and *Commander Keen* Series. The winner is *Commander Keen* Series.

Censorship on the Networks

Every so often, there's a hue and cry from members of cyberspace that one or another public network is censoring their comments, and the cry of censorship and first-amendment rights is heard all over the networks. In the past CompuServe has been accused, and so has Prodigy. Now it's GEnie's turn.

I received a communication via Internet from Michael Lepore, who apparently broadcast it to members of the press and sent a copy to J.F. Welch, Chairman of the Board of GE, regarding an alleged case of censorship in the Religion and Philosophy Roundtable on GEnie. The alleged censorship was of a message placed by Mark Dotson under the name Doulos, inquiring if another roundtabe member who commented about the Koran had actually read the sacred book of Islam.

GEnie is supposed to have deleted this message. When Doulos protested, he was placed on "read-only" status for three days. To my mind, this imposition of punishment wasn't called for as a result of the protest. If GEnie removed the seemingly innocent message for whatever reason, all it had to say was that it was "cleaning house" or regaining space. This is a normal operation, and sometimes messages do get removed.

The people who run GEnie should have noted the protest (I'm sure this isn't their first) and messaged that the protest was duly noted. Instead someone over-reacted. To launch a campaign of protest about alleged censorship is also over-reacting.

Networks are private, not common carriers. They retain the right to carry or not messages from subscribers. You may not like this, but it's a fact. In the past, GEnie hasn't censored material placed on its network. I think GEnie should be given the benefit of doubt, unless a definite pattern of censorship emerges.

Windows Network?

With the popularity of *Windows* 3.x, it was inevitable that an on-line network would evolve featuring *Windows*. Now it has. General Videotex Corp., owners of Delphi (which recently took over BIX, the Byte On Line Network), just introduced WIX, supposed to be a *Windows* network. It's not actually a *Windows* network; rather, it's an access shell for BIX, called BIXnav. It installs under the *Windows*' Program Manager and automatically accesses the BIX network.

WIX places you in an area of BIX devoted to *Windows*, just as Ziffnet is a service on Compuserve. The WIX area contains several conferences of interest, mainly WINMAG, sponsored by *Windows* magazine and containing the full text of the magazine.

I received a trial account on WIX to try the new system and a copy of BIXnav. Having used BIX in the past without BIXnav, I think it's a great improvement and encourage people to use the service more. Frankly, I seldom ventured on to BIX before this. Using it, you see the standard *Windows* page with a row of icons across the top menu bar. You select operations by clicking on them. The icons change at different levels of the system, making it easy to learn to navigate the service. Although it isn't a graphic system, as AOL is, BIXnav does utilize the GUI features of *Windows* quite effectively.

The WIX area seems to be a place where people with *Windows* problems can get a lot of help. I think it has a good future.

IBM Responds

Some top IBM executives appeared on Ziffnet in July to frankly discuss problems users are having with OS/2 2.0 and answer questions about IBM policies in general. This was a very frank discussion, and the top IBM people made the company's position very clear on many matters. I think this portends a more-responsive IBM, at least where the PC world is concerned.

IBM is very much aware of the uphill fight it will have to establish OS/2 as a contender in the operating-system war. Most comments on the net regarded problems users have installing OS/2 2.0 and running the system. There were many inquires about the rumored split of the personal-computer systems from the main corporation. It was conceded that this is in the talking stages. By the time you read this, it may well be a fact. This may be the solution to IBM's problems with the flexibility required to compete effectively in this fast-moving industry.

The greatest successes IBM had in this field came when Entry Level Systems were an independent business unit and introduced the PC, XT and AT computer lines. It was only when the personal-computer systems were rolled back under tight corporate control that IBM started to lose market share and the age of clones exploded on the scene.

AOL's E-Mail Gateway

America On Line, the fastest growing on-line network, now has an international E-mail gateway through Internet. The new gateway allows AOL subscribers to send and receive mail from CompuServe, MCI Mail, AppleLink, SprintMail and all other Internet-connected systems, without requiring a separate account on these services. AOL subscribers aren't charged extra for this service.

Using this access has been made very simple. When received, a message appears in the usual Mail window and can be read or printed. To reply, all a subscriber has to do is simply click on a "Reply" button and type his answer exactly as he would reply to a message on the AOL mail system. The system takes care of all the complicated routing of the message.

America On Line's address on Internet is aol@com. Internet users who would like more information on America On Line can send a request to info@aol,com or call 1-800-827-6364.

America On Line has also improved its Macintosh system to include the very simple download procedures for software previously available to PC users. This includes the ability to select programs for download but delay downloading until later in the session. It also permits a download to be interrupted and then continued at a later period in the session.

AOL has also started the Electronic University, which provides undergraduate and graduate courses recognized by several colleges and the New York Board of Regents. There have been other on-line college-level courses, of course, but to my knowledge, this the most complete offering by a recognized facility of higher education. ■

Windows Draw 3.0

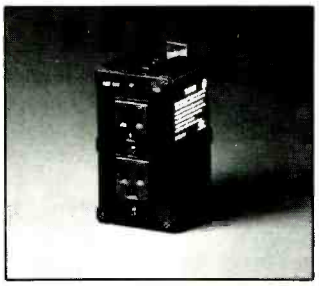
Micrografx's *Windows Draw* version 3.0 includes OLE support and enhanced functionality that has been optimized for *Windows* 3.1, plus 32 resident *TrueType* fonts. OLE support in *Windows Draw* means you can link or embed a drawing in a document created with a word-processing or desktop-publishing program. You simply double-click on the drawing in the document to open *Windows Draw* and make changes. The drawing is updated automatically in the word-processing or desktop-publishing document.

Draw includes all basic drawing features and some advanced ones, including the ability to convert type to curves and manipulate the shape of the letters. $150 ($25 upgrade). *Microografx, Inc., 1303 Arapaho, Richardson, TX 75081; tel.: 800-733-3729; fax: 214-234-2410.*

CIRCLE NO. 10 ON FREE CARD

Surge Suppresser With Diagnostics

Tripp Lite's new TMC428 is a surge suppresser with built-in diagnostic indicators to pinpoint power and wiring problems. It's ideal for protecting telephone systems, computers and other sensitive electronic devices. The unit has a direct plug-in design with two surge-protected and noise-filtered ac outlets. Sine-wave tracking provides fast and accurate



surge suppression. Separate multi-color LED indicators display ac power present, power protection circuitry status and wiring faults, missing ground or other wiring errors.

Tripp Lite will repair or replace both the TMC428 and connected equipment if damaged by a surge, for life. Housed in a durable metal case, the TMC428 provides noise filtering with surge suppression up to 13,000-ampere spikes. $60. *Tripp Lite, 500 N. Orleans, Chicago, IL 60610-4188; Tel.: 312-329-1777; fax: 312-644-6505.*

CIRCLE NO. 11 ON FREE CARD

Printer Sharing & Keyboard Computer

Parallel Link from Linksys is a printer-sharing device that permits upwards of 30 IBM/compatible computers to share a single printer. Using a simple daisy-chain design and RJ-11-type telephone wiring, Parallel Link works with up to 4,000 feet of wire with no degradation in power. Transfer rates of 256K bps can be obtained. Protocol and switching are handled by the parallel-port adapter, eliminating the need for software drivers and bus cards. Parallel Link can be used in combination with other printer-sharing devices.

The KeyboardPC, also from Linksys, is a complete 386SX computer built into a standard 101-key keyboard. It includes an on-board CPU, 1M of RAM (expandable to 16M), AMI keyboard and BIOS, SVGA controller, IDE disk controller, 16-bit 2/3 LAN card slot and PS/2 mouse. Standard internal ports include one game, two serial and three parallel. External ports are provided for monitor, barcode reader or scanner and floppy/tape drives. Options include math coprocessors, 32K cache buffer, internal floppy and hard drives, 2,400-bps modem and LAN card. $109/$99 per Parallel Link transmitter/receiver; $1,095 and up for KeyboardPC. *Linksys, PO Box 18558, Irvine, CA 92713; tel.: 714-261-1288; fax: 714-261-8868.*

CIRCLE NO. 12 ON FREE CARD

Ted Needleman

'Tis Almost the Season

With another holiday season almost upon us, I thought it might be nice to spend this and the next column on some computer-related items you might want to pick up for those you love. Of course, if something catches your fancy, you can always photocopy this column and leave it in strategic places for a hint. Or you can just splurge and treat yourself.

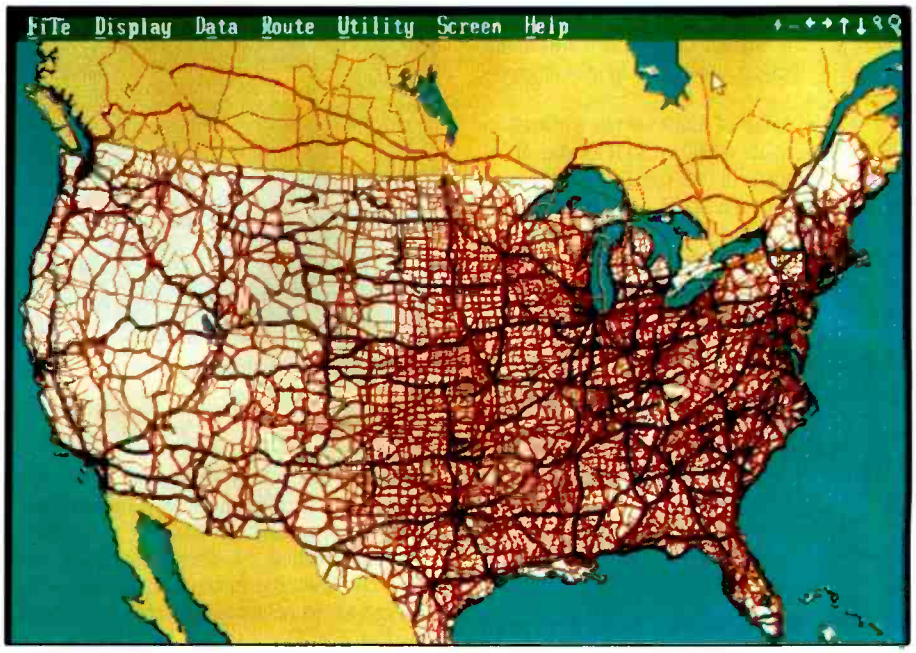
Smart Label Printer Plus

One problem I've always had since I traded my typewriter in for full-time PC-based word processing is labels. I really appreciate the look laser-printed correspondence presents, but, frankly, getting an address on an envelope is a real pain. Over the years, I've used a variety of methods. For regular #10 business envelopes, *Word for Windows* 2.0 and several other WYSIWYG word processors now have an automatic label button. Highlight the address in your letter, click on the envelope button, and you can hand-feed an envelope and have it come out nicely printed.

If you have a larger, 9″ × 11″ or so envelope, you're out of luck with this method. These envelopes are too large to feed through most laser printers. My method of dealing with this type of envelope has been to use one-up laser labels mounted on a #10-size carrier. Paper Direct sells labels like these (mentioned several months ago in this column), as does label supplier MAATCO (available from many stationery suppliers). These single laser labels are also a good solution to a specific problem, even if they are just a bit expensive (about $30 for 250 labels).

The best all-around solution I've found so far to the label problem is a small dedicated label printer from Seiko Instruments called the Smart Label Printer Plus. The SLP Plus is small enough, at 3.6″W × 6.1″H and light enough (at 1 pound) to sit quietly on top of my PC, where it isn't noticeable and is out of the way until I need it. It's connected to a serial port and has its own small cube-type power supply. When I need a label, a few keystrokes activates its TSR program in either DOS or *Windows* and I quickly and very quietly have my label.

Actually, the Seiko Label Printer isn't all that new. It was originally introduced several years ago. Last year, it was improved with several additional fonts and had the "Plus" tacked onto its name. The latest version again improves upon what's already a pretty nice product by adding software that lets the printer be used under either DOS or *Windows*. For Mac users, there's even a Mac version of the software, along with a Mac-compatible serial cable.



U.S. Major-route-map screen from "Automap."

Hooking up the Smart Label Printer Plus is a snap. Just plug in the small power supply and connect the interface cable between the printer and one of your PC's serial ports. The cable has both 25- and 9-pin connectors. So you can use it with just about any serial port.

Installing the DOS and *Window* software takes just a few minutes more, and the procedure is almost completely automated. About the only thing you need do is specify which port (COM1 through COM4) the printer's connected to, whether you want the software installed as a TSR (terminate-and-stay-resident) program each time you boot your PC (you can also run the software as a stand-alone program only when you want it), and whether you wish to specify a different set of hot keys.

Once software and printer are installed, using the Smart Label Printer Plus is just as easy. In DOS, type Alt/S (or whatever other hot-key combination you've selected), and the SLP + menu appears. This lets you capture an address, enter your own text, select fonts and sizes and create or access a database of addresses. You can capture and add limited graphics to the label and even specify that POSTNET bar codes be added to your mailing labels to speed its processing by the Post Office.

When you select the address-capture function, the software looks to find an address on the document you currently have open. If it can't find what it thinks is an address (or if it finds something that you don't consider an address), you can switch to manual and position the capture box as you wish. Hit the Enter key, and the address in the box is captured. You're then returned to the SLP + program, where you can edit the captured address, store it in a database and/or print it out.

When you select print, the address is sent to the printer, and control is passed back to the PC while the label is being printed. The program for *Windows* works pretty much the same way, except that you activate the program by clicking on the SLP icon in the Accessories Group.

When using the Smart Label Printer Plus, you're restricted to the fonts built into the printer. You can't download fonts. This isn't much of a limitation because the printer comes with 30 different typefaces in a variety of point sizes and orientations,

and more than 70 different graphics you can use to create custom borders. You can print labels flush left, centered and aligned or with all lines centered. Need equal top and bottom margins or flush to the top or bottom? It's easy, as is printing labels for file folders, either horizontally or vertically.

The labels are printed on special thermal label stock that comes in white or clear. Each roll contains 130 labels. Under normal conditions, the labels stay legible for over a year, unless they're left in strong sunlight or continuously in bright fluorescent light.

At a list price of $249 for the Smart Label Printer plus with both DOS and *Windows* software ($199 for DOS-only and Mac versions), the SMP + is a bit of an extravagance. Mail-order prices generally run about $50 less than list, and you can always buy the DOS-only version and later upgrade to the *Windows* software for $49.95 should you have the need.

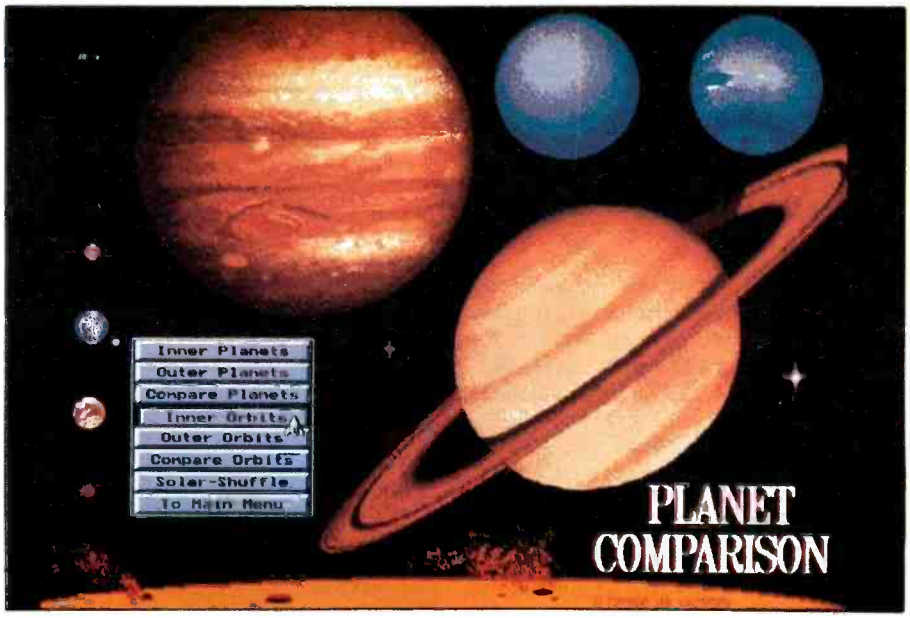
I have to admit that I'm impressed with the Smart Label Printer Plus. Though it just does labels, it does them well. And there's a certain elegance to a product that doesn't try to be all things to all people. I love having the SLP + there when I need it. It's an extravagance, but aren't you worth it?

Orbits, Bodyworks & Automap

I have no formal training in education, but as a parent to a hoard of kids, I can assure you that the best thing you can do for children is to encourage their natural curiosity. This isn't always easy, especially the tenth time within five minutes that you get asked the same question. But a child's wonder at the things around him is something that's very precious and needs to be nurtured. You should always grab the opportunity whenever it's presented. When you're not around, there's some terrific software available that encourages kids to explore with it.

Two such programs are *Orbits* and *Bodyworks* from Software Marketing Corp. *Orbits* is billed as an interactive space simulator and space atlas. But don't let the high-sounding description scare you off. What it really does is present a fun way to learn about the solar system. If a user is sophisticated (and old) enough to understand it, it gives him a very nicely done orbital mission simulator. Your younger children/relatives will enjoy looking at the views of the planets and watch the motions of the planets and moons, while those just a few years older can study the interior structures of the Sun, Moon and planets, even printing out comparative charts.

Orbits is easy to install on a hard disk that has at least 2M of free space. Just put Disk 1 in your floppy drive, log onto the drive, and type install. The program



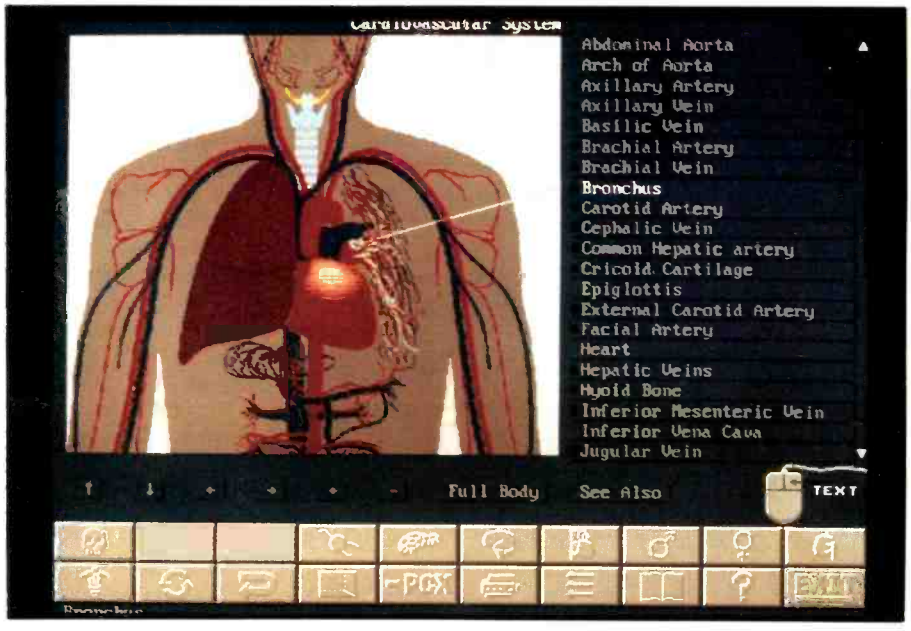
Planet Comparison screen from "Orbits."

prompts you when you need to change disks. You can also run *Orbits* from a floppy, swapping disks in and out as needed.

Once installed, run the program and use the pull-down menu bar across the top of the screen to select an object to study or another activity, such as the orbital simulator or Solar-Shuffle. If you have a mouse and its driver is installed as part of your boot-up process, you can point-and-click to make your selections.

If you and the kids get tired of looking at the serious stuff, you can play the interesting Solar-Shuffle, a jigsaw-type puzzle, or run one of the different orbital mission simulations.

My one criticism of *Orbits* is that you can't print any of the beautiful screens. There's generic printer support, and you can (and must) select a printer port if you're going to print. But all that you'll be able to get from the printer is a rather plain representation of the comparative reports. Nor can you export the graphics to a file, such as a .PCX file, for use in another application. This is where *Windows*-based applications really shine. Unless specifically disabled, you can always capture a *Win-*



Cardiovascular System screen from "Bodyworks."

dows screen to the clipboard and use it in other applications.

Orbits isn't a program your kids will use for hours on end. Eventually, they'll get bored enough to let you take a crack at it. But at a list of $59.95, (about $35 mail-order), it's about the price of a planetarium admission and cheaper than two trips to the video arcade. And your kids might just learn something while having fun. Software Marketing doesn't give an age range for *Orbits*, but any bright youngster over eight or so should be able to use the program and teen-agers will find it interesting and entertaining.

When you and your kids have had enough tripping among the planets, Software Marketing has another delightful program that will let you get under your skin, called *Bodyworks*. Like *Orbits*, *Bodyworks* installs easily, but it must be run from a hard disk with at least 2.5M of free space. As with other Software Marketing software I looked at, if a mouse and driver are installed, they can be used to navigate aground the program.

While *Orbits* lets you explore outer space, *Bodyworks* is a discovery program with a both a much smaller and much wider scope—the human body. It allows you to graphically display and study all of major structures, systems and body functions with just a few mouse clicks or keypresses.

When you first start the program, you're presented with a head-to-toe presentation. Use the cursor to zoom in on an area of interest or select one of the command buttons to narrow down to a specific system. The buttons provide 10 system choices: skeletal, digestive, muscular, lymphatic, endochrine, nervous, cardiovascular, male and female reproductive and urinary. The particular system chosen is displayed graphically on-screen, and you can zoom in and out to different areas of the body. You can also point to specific structures and get an explanation of what you're seeing or a more general discussion of the particular system you're studying.

A second set of command buttons gives you access to health-related text on AIDS, drugs, first aid and sports injuries. None of these discussions is much more than overviews, but they are interesting to read, and a good way to break the ice and lead into a more detailed discussion should you want to talk with your kids about one or more of these subjects. Another button presents animations where available. These short, but very visually effective animations demonstrate things like how the blood moves through the heart, and breathing moves air through the lungs.

Bodyworks has somewhat better printer support than *Orbits*. At least you can specify whether you're using an Epson-compatible dot-matrix or an HP LaserJet printer. *Bodyworks* also allows you to export graphics into a .PCX file. You can then use them in one of the many graphics and word-processing programs that support this popular file format.

I don't really recommend *Bodyworks* for younger children. They may be interested, but until the age of nine or ten, most kids have a difficult time understanding that all of that stuff on-screen really represents things that lie underneath our skin. Pre-teens and teen-agers, though, will find *Bodyworks* a fascinating introduction to human biology and anatomy. And *Bodyworks* is very helpful in explaining (and understanding) an illness or injury.

At a list price of $79.95 (mail-order, about $60), *Bodyworks* isn't for everyone. But if you have the slightest interest in learning about the miraculous human machine, it's one of the most interesting ways, short of taking a course in medical school, to start exploring it.

The third package from Software Marketing I looked at, *Automap*, doesn't let you explore either inner or outer space. Rather, it lets you wend your way along the highways and byways of the U.S.

There are a number of atlas-type programs available, like *PC-USA* and The Software Toolworks packages I've reviewed in this column in the past. *Automap* has some of the features of these other packages in that it lets you zero in on individual locals throughout the USA and get interesting information on these areas. But its true strength is where it differs from the other atlases.

In addition to points of interest, *Automap* is a computerized road atlas that can provide you with point-to-point driving instructions from almost any two points in the U.S. You just specify starting city and state and ending city and state, and *Automap* calculates quickest route, shortest route, and a number of alternate routes. It even gives you the estimated time between waypoints and highway exits and a total estimated time for your trip.

You can then print a detailed list of driving instructions for any or all routes that *Automap* found. If you want, you can even print a map to go with the directions, but map quality, even on a laser printer, is nowhere near as good as a standard road map. Using an *Automap*-generated map at night in a moving car can present quite a challenge.

I've belonged to several auto clubs that provide custom travel directions. And while the AAA's TripTic strip maps are terrific on a long trip, my trips generally tend to be on the spur of the moment. So auto-club maps and directions usually wind up waiting for me on my return. I've used *Automap*'s routings several times now, and, while I don't always agree with their precise routes, they always get me there and back without a problem. I especially like their format, which gives approximate time between checkpoints, based on the driving speed you specify in the program's preference section (the default is 55 mph). If you've ever worked with a gas station map and tried to figure what the distance from the tip of your thumb to your knuckle means in minutes of driving time, you'll really appreciate *Automap*.

I've seen *Automap* for sale at a variety of prices, ranging from $69 to $49. My copy came bundled on a CD-ROM from Software Toolworks with a copy of Toolworks' *US Atlas*. ■

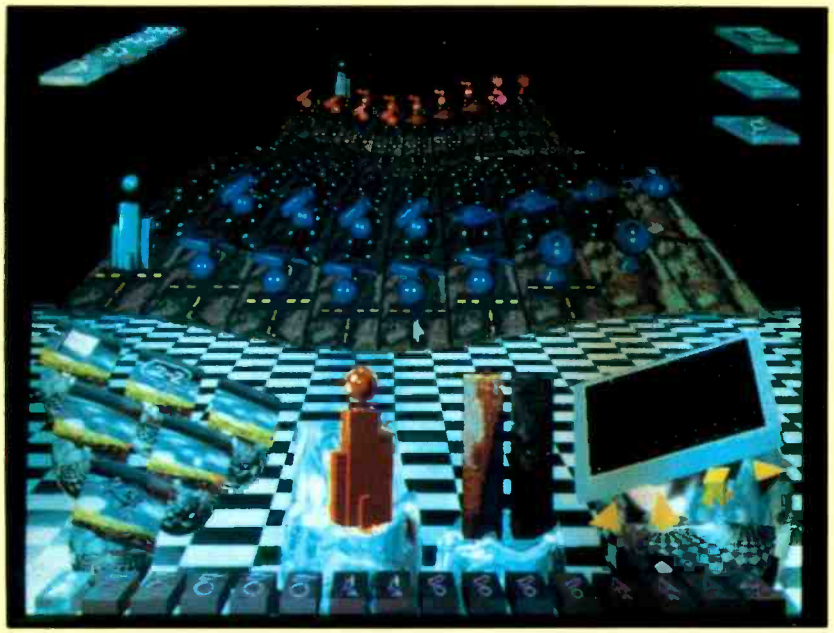
Products Mentioned

Smart Label Printer Plus
DOS-only and Mac Version, $199.95
Windows and DOS Version, $249.95
Seiko Instruments USA, Inc.
1130 Ringwood Ct.
San Jose, CA 95131
Tel.: 408-922-5900

CIRCLE NO. 102 ON FREE INFORMATION CARD

Orbits, $59.95
Bodyworks, $79.95
Automap, $69.95
Software Marketing Corp.
9831 S. 51 St., C-113
Phoenix, AZ 85044
Tel.: 602-893-2400

CIRCLE NO. 103 ON FREE INFORMATION CARD



Stunning playing field of "Theater of War."

ance. Graphics stand at 640 × 400 or 640 × 480, which is very unusual for a game of this kind. In fact, *Theatre of War* boasts that it's the world's first Super-VGA game. If true, the statement is accurate only by degree. Another manufacturer, Access Software, has marketed a Super-VGA version of *Links*, its award-winning golf simulator.

Whether first or second in producing a Super-VGA game, the visuals in *Theatre of War* are nearly mesmerizing. Not only are the graphics high in resolution, but they're extremely fast, thanks to VESA (Video Electronics Standards Association), the group responsible for pulling together a real standard for Super-VGA graphics, something the computer industry has been seriously lacking. The only hitch in the standard is that each kind of video card must have a special VESA driver before it can display VESA graphics.

Theatre of War comes packaged with VESA drivers for several kinds of video cards, including those based on the popular ET-4000 chip-set from Tseng Labs.

An inhospitable world of "Global Effect."

The second innovation is that *Theatre of War* mixes the traditional military strategy of a board game with the real-time capability of a computer. The result is a fast-moving, quick-thinking chess-like game where wasting time can get your forces killed.

The playing field is a two-dimensional matrix with inanimate players lined up similar to chess pieces. Play begins and each player moves soldiers and vehicles as he sees fit—all at the same time. Thus, game play moves swiftly and decisions are made without delay or remorse.

Game pieces move just about anywhere they like, restricted by their own measures of speed and endurance. Swordsmen and Archers of the Medieval set move more slowly than the Chariot. Foot soldiers of the Great War march along, and Tanks go faster. Aircraft of the Contemporary play era are much speedier.

Each piece, no matter what the playing era, has its own characteristics of strength, health and attack posture. In like manner, each play piece essentially modifies the playing square it occupies at any given time, making it obey its singular properties. If all this sounds complex, be assured that it most certainly is. After all, a highly strategic, real-time war game isn't for the faint-of-will.

Three-Sixty is taking a kind of gamble in hoping that its novel game concept will catch on with the computer strategist. It may do so for no other reason than the game's unusual approach to an old pastime. Toward this end, more documentation would be helpful.

Presently, the game manual describes all moves and characteristics of each playing piece in all three playing eras. However, it misses a discussion of how to use the strengths and weaknesses of the pieces. There's no tutorial of any sort and no tips on common pitfalls. There are no examples for study and no reasoning on offensive or defensive procedure.

The 22 pages of the instruction manual are too brief for a game with the scope of *Theatre of War*. The task of learning to play the game is comparable to teaching someone the moves of chess pieces but never explaining chess strategy. Such a student could hardly learn to play very well.

Don't let my criticism put you off looking at this game, though. *Theatre of War* is a bold attempt at something different. I applaud its authors for being so courageous. As with any worthwhile pursuit, the harder you have to work at it, the more satisfying the reward.

Global Effect

Games about environment and Mother Earth increase in number. One of them,

Bird's Eye View

Theatre of War, $49.95
Electronic Arts
1450 Fashion Island Blvd.
San Mateo, CA 94404
Tel.: 415-571-7171

Requirements

Memory	640K, 2M for Super-VGA
Graphics	MCGA, VGA, Super-VGA
Sound	Ad Lib, Sound Blaster, Sound Blaster Pro
Controllers	Keyboard, Mouse (recommended)

Evaluation

Documentation	Poor
Graphics	Excellent
Learning Curve	Long
Complexity	Difficult
Playability	Good

In Brief: Innovative real-time war game with Super-VGA resolution. Must have at least '286 computer and hard drive.

CIRCLE NO. 112 ON FREE INFORMATION CARD

Bird's Eye View

Global Effect, $49.95
Electronic Arts
1450 Fashion Island Blvd.
San Mateo, CA 94404
Tel.: 415-571-7171

Requirements

Memory	640K
Graphics	VGA
Sound	Ad Lib, Sound Blaster, Roland
Controllers	Keyboard, Mouse (required)

Evaluation

Documentation	Good
Graphics	Good
Learning Curve	Medium
Complexity	Medium
Playability	Poor

In Brief: Simulation of cause and effect for an entire world. Teaches value of making careful decisions.

CIRCLE NO. 113 ON FREE INFORMATION CARD

Bird's Eye View

Crisis In The Kremlin, $69.95
Spectrum Holobyte
2490 Mariner Square Loop
Alameda, CA 94501
Tel.: 510-522-3584

Requirements

Memory	640K, Hard Drive
Graphics	EGA, VGA
Sound	Ad Lib, Roland, Sound Blaster
Controllers	Keyboard, Mouse (recommended)

Evaluation

Documentation	Good
Graphics	Good
Learning Curve	Short
Complexity	Medium
Playability	Excellent

In Brief: Simulated look at policy-making, budgeting and governing the former Soviet Union.

CIRCLE NO. 111 ON FREE INFORMATION CARD

Global Effect, is a simulation of controlling the many interactive systems of life, both human and natural.

Perhaps in the not-too-distant future, governments will advance beyond those of today. Control of cities and civilization is handled from central points. Players of *Global Effect* take the role of a government leader.

Game play starts with selecting a particular scenario from several potentials. Choices include the Unstable World, where Earth is very young and subject to earthquakes and volcanic activity. Unstable World has large mountain ranges and desert tracts and comparatively little forest. This hostile environment offers high challenge.

Other scenarios include Post Nuclear, Post Industrial and Fossil Fuel worlds. Each has its special challenges. Players who can't find a suitable world in which to play can custom-create one with user-defined parameters.

Power players of this game must be careful to make sound decisions because seemingly small changes in society can create devastating effects that take years to manifest themselves. For example, too much industry depletes the ozone layer. Too few trees may trigger a build-up in carbon-dioxide. Too much industry pollutes the air and starts global warming. If not given much thought, so many potentially threatening sequences of cause and effect can generate a relentlessly destructive cascade toward oblivion.

Documentation and graphics for *Global Effect* are effective for this kind of game. Game interface is a series of menus, easily selected by computer mouse. I'd like to criticize game designers—both at Millennium and others as well—for using icons to represent information objects or menu selections. Icons are generally a good idea, especially for a graphic interface like Microsoft *Windows*. But, at a count of 30 or so, *Global Effect*'s interface (and interfaces of other games) simply has too many icons, which forces users to spend a lot of time memorizing pictures and mentally connecting them with specific actions. Furthermore, the icons are rather small and sometimes difficult to distinguish when they're similar in appearance. Finally, a game designer's arbitrary choice for a particular icon is often just that: arbitrary. This may not be very meaningful for anyone else.

Global Effect helps smooth the "iconism" problem with a colorful explanatory pictorial that names all icons. But why not use text names in the game, perhaps in place of or along with the icons? It isn't unreasonable to think most people who operate computers can also read text with some understanding. Once most of the icons are memorized, however, *Global Effect* is interesting to play and holds a challenge.

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Power Play

Abuse of power is common. At one time or another, almost everyone has abused power and produced a detrimental effect. In contrast, computer games offer the opportunity to abuse power with no bad results to others.

Crisis In the Kremlin

The political world won't soon forget Mikhail Gorbachev. When he was in power, Spectrum Holobyte was working on a game to simulate the difficulties of leading the former Soviet Union into a more democratic society. The game is called *Crisis in the Kremlin*. Power players in this game choose from three different potential directions for the Soviet Union. The political directions are largely determined by the specific political party selected.

One faction is the Hard-Liners who want to maintain the rigid authoritarian regime that characterized the Soviet Union under the 18-year reign of Leonid Brezhnev. This venerable Soviet tradition controls all production and distribution, with government-subsidized food and housing. Western nations are profoundly distrusted and there's strong military and KGB presence.

Another faction, the Nationalists, wants to end centralized authority. It would like to see a free-enterprise economic system and political autonomy for local regions. Not completely democratic in ideal, it regards a large military force as unaffordable extravagance and complex bureaucracy as burdensome. Boris Yeltsin is a Nationalist.

The remaining faction, the Reformists, wants to preserve the Soviet Union but considers the old ideas of centralized authority as inefficient. It believes that the twin policy of *Glasnost* and *Perestroika* can help streamline state operations. This faction is more concerned with the welfare of citizens than in military ventures. It would rather cooperate with the West than continue an extravagant military budget. Ex-President Gorbachev was the leader of this movement.

Although players have three choices from which to choose for political direction, it's particularly intriguing to adopt Gorbachev's ideas and see how well one can do. The challenge is to make decisions that are good enough to remain in office for 30 years. To do this in an environment of mixed and opposing ideas is, indeed, a challenge.

Immediate trouble in "Crisis in the Kremlin".

The game begins as the player defines the year's policy for the nation. Care must be taken because radical policy changes, especially in the first year of power, can alienate friends and anger enemies. If continued unabated, too many changes implemented too soon will cause a quick demise by military revolt.

Decision-making is the crux of game play. News items and other important information are reported by the official news agency. More-detailed facts come by way of several Ministry departments and the KGB director. Reports include descriptions of social unrest, crop disasters and activity of Western espionage. Each piece of data is important. Problems arise. Advisors advise. But only you can make the decisions that cause ripple effects for years.

Graphics for *Crisis in the Kremlin* aren't particularly striking. This is of little concern, though, because news information and decision-making overrides other game aspects. This is good because the nature of the game forces mental involvement to the extent that graphics and other cosmetics become extraneous.

Complimenting fluid game play is interesting documentation that highlights Soviet geography, history and tradition. Players who want to delve deeper into Soviet life can read the accompanying book *Klass* by David K. Willis, a former Moscow correspondent for the *Christian Science Monitor*. Willis offers an inside look at status, rank and privilege in the Soviet Union. Book and intriguing game combine to create a dynamic educational experience.

Theatre of War

Traditional board games represent an ideal location for power play. On a lattice-work of light and dark squares, wars are fought, empires destroyed and blood spilled. Mindless men and machines selflessly obey orders given by an omnipotent strategist.

Theatre of War is a military strategy game from Three-Sixty, Inc., which wargame aficionados will recognize as the designer of *Harpoon*, the excellent naval strategy game, and *Megafortress*, a B-52 flight simulator based on the novel *Flight of the Old Dog* by Dale Brown. *Theatre of War* keeps the efforts of this particular game-producer within bounds of what seems to be its forte: war strategy. Nevertheless, this new release has two innovations that beg discussion.

The innovation immediately noticeable is the game's full, rich, colorful appear-

(Continued on page 86)

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