On The Road With A Color Notebook Computer

ComputerCraft

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

- Add A Slotless Real-Time Clock
- Low-Cost Peer-To-Peer Networking
- Digital "Darkroom" Imaging & Retouching

0 74820 08559 10

Tapping Unused Text Capabilities Of A VGA System

Build A Buffer To Safely Connect Projects To A Port

Prototype Circuits The Way The Pros Do

MONITOR COMBO'S

Now's the time to add a Monitor Combo to your computer system. The VGA Combo's come with a 2 year warranty, and work AT, 386 and 486 computer systems.

COMBO-MONO **$99**
12" Monographics Monitor with controller card.

COMBO-VGA **$289**
640 x 480 VGA monitor with controller card and 256K video RAM. Works with AT or 386 computers.

COMBO-SVGA **$439**
1024 x 768 Super VGA monitor with controller card and 1 MEG video RAM.

HARD DRIVE COMBO'S

Now's the time to upgrade your computer system with our hard drive combo's. Change your outdated MFM drive to a faster more reliable IDE hard drive. Works with AT, 386 and 486 computers.

COMBO-40 **$225**
40 MEG IDE 28ms hard drive with controller card.

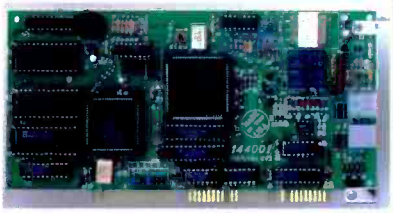
COMBO-105 **$335**
105 MEG IDE 15ms hard drive with controller card.

COMBO-130 **$375**
120 MEG IDE 19ms hard drive with controller card.

COMBO-210 **$649**
210 MEG IDE 15ms hard drive with controller card.

GREAT NEW PRICES!

BOCA 14.4K MODEM



M1440I BOCA V.32BIS, 14.4K Modem Internal **$239**
M1440E BOCA V.32 BIS, 14.4K Modem External **$319**
BOCA Research FAX Send/Receive Modem. Uses Rockwell chip set, transmits and receives FAXES up to 9600 BAUD. Modem transmits and receives data up to 14.4K BAUD. Includes Quicklink II Software. Made in the U.S.A. and comes with BOCA 5-year warranty.

ZOOM MODEMS

AMC-2400	Internal 2400 BAUD Modem	$59
AMX-2400	External 2400 BAUD Modem	$69

MONITORS

RM9502	14" Monochrome VGA Monitor (800 x 350, 400, 480)	$139
RE1420	14" Super VGA Monitor (1024 x 768) Unlimited Colors - 2-year manufacturers' warranty	$359
MON-05	Monochrome TTL Amber (720 x 348) 12"	$89
MON-06	Paper White TTL 14"	$112
MON-10	CGA/RGB (640x240) 14"	$219
MON-07	VGA .41 Dot Pitch 640 x 480 14" - One-year manufacturers' warranty	$239

TRIPP LITE POWER PRODUCTS

Back-Up Systems

Part#	Each
BC-250	$105
BC-400	$169
BC-500	$194
BC-500LAN	$199
BC-600LAN	$269
BC-900LAN	$379
BC-1250LAN	$529
BC-4000LAN	$2549

OMNI Back-Up Systems

Part#	Each
OMNI-450LAN	$299
OMNI-600LAN	$399
OMNI-900LAN	$549
OMNI-1250LAN	$679
OMNI-2000LAN	$1149

TRIPP LITE EST 1922
"THE POWER PEOPLE"

Line Stabilizer/Conditioners

UL listed and 2 year warranty.

Part#	Description	Each
LS-504	500 Watts, 230 Volt, 4 Outlets	$98
LS-600	600 Watts, 2 Outlets	77
LS-604	LS-600 with HI voltage regulation	98
LC-1200	1200 Watts, 4 Outlets	139
LC-1800	1800 Watts, 6 Outlets	188
LC-2000	2000 Watts, 208/220/240 Volt	243
LC-2000X	220/240 V, 2000 watts,6 Outlets	243
LC-2400	2400 watts,110 V, 6 outlets	243
LCR-2400	2400 watt rack mt., 110 V, 14 outlets	287

Modem Fax Protectors

2 year warranty.

Part#	Description	Each
ISOTEL	Lifetime warranty, 4 outlet, 6 ft. cord and modem protector (*Gold Seal)	$59
ISOFAX	ISOBLOK w/ Modem protector	36
TSB	3 stage Modem/Fax protector	38
MP	Economy Modem/Fax protector	14
SMP	1 AC outlet w/modem/fax protector	29
SMP-GS	Lifetime guarantee. (*Gold Seal)	35

TrippLite Isobars

All Isobars come with a lifetime warranty and UL listing.

Part#	Description	Each
IB2-0	2 outlet direct plug-in	$23
IB2-0/20	2 outlet, 20 amp, direct plug-in	39
IB2-6	2 outlet, 6 ft. cord (*Gold Seal)	32
IB4	4 outlet, 6 ft. cord (*Gold Seal)	43
IB4/220	4 outlet, 6 ft. cord, 220 Volt	49
IB6	6 outlet, 6 ft. cord (*Gold Seal)	51
IB8	8 outlet, 12 ft. cord (*Gold Seal)	61
IB-8RM	8 outlet, 12 ft. cord w/remote power switch	69
EUROBAR	4 outlet, 6 ft. cord, 220/240 Volt Euro connectors	52
IBR-12	12 outlet, 19" rack mountable	89

3M DATA CARTRIDGES

DC2000-3M	40 Megabyte	$14.99
DC2000T-3M	Thetamat for Colo. Mem.	17.99
DC2060T-3M	Thetamat for Colo. Mem.	22.99
DC2080R-3M	Rhomat for Irwin 80	15.99
DC2120-3M	120 Megabyte	18.49
DC2120R-3M	Rhomat for Irwin 80	22.99
DC300XL/P	45 Megabyte	18.29
DC600A-3M	60 Megabyte	19.99
DC6150-3M	150 Megabyte	20.99
DC6250-3M	250 Megabyte	24.99
D8-112-3M	8MM up to 5.0 GB	12.39

3M DISKETTES

3-1/2" Diskettes

Part#	Description	Per Box/10
3.5DS	DSDD	$6.99
3.5DS/F	DSDD Formatted	7.49
3.5DSHD	DSHD	13.39
3.5DSHD/F	DSHD Formatted	13.99

5-1/4" Diskettes

Part#	Description	Per Box/10
5.25DS	DSDD	$4.89
5.25DS/F	DSDD Formatted	5.39
5.25DSHD	DSHD	8.49
5.25DSHD/F	DSHD Formatted	9.19

IIT MATH CO-PROCESSORS

100% Compatibility Guaranteed: 386DX, 386SX and 286 systems & software. Lower-Power for Portables • IIT Lifetime Warranty

2C87-12	For 286 up to 12.5 MHz	$56
2C87-20	For 286 up to 20 MHz	64
3C87-16SX	For 386SX up to 16 MHz	72
3C87-20SX	For 386SX up to 20 MHz	72
3C87-25SX	For 386SX up to 25 MHz	75
3C87-25	For 386 up to 25 MHz	92
3C87-33	For 386 up to 33 MHz	95
3C87-40	For 386 up to 40 MHz	123

NEW LOWER PRICES

MEMORY MODULES

256KX9-80	256K x 9-80 NS SIMM	$13.00
256KX9-80SP	256K x 9-80 NS SIPP	15.00
256KX9-70	256K x 9-70 NS SIMM	14.00
1MEGX9-80	1MB x 9-80 NS SIMM	44.00
1MEGX9-80SP	1MB x 9-80 NS SIPP	46.00
1MEGX9-70	1MB x 9-70 NS SIMM	46.00
1MEGX9-70SP	1MB x 9-70 NS SIPP	48.00
1MEGX9-60	1MB x 9-60 NS SIMM	48.00
4MEGX9-60	4MB x 60 NS SIMM	Call

DISK DRIVES

DDD-04	5 1/4 inch DSDD 360K black faceplate	$59
DDD-05	5 1/4 inch DSDD 360K beige faceplate	59
DDH-06	5 1/4 inch DSHD 1.2MB beige faceplate	59
DDH-09	3 1/2 inch 720K beige w/bracket	59
DDH-10	3 1/2 inch 1.44MB beige w/bracket	59
DDH-11	Same as DDH-10 without 5-1/4" Mounting bracket. Fits in 3-1/2" bay	55

3-1/2" Drive Mounting Kits **$9.95**
5.25KITFD Mounts 3-1/2" Floppy drive in 5-1/4" Bay
5.25KITHD Mounts 3-1/2" Hard drive in 5-1/4" Bay

HARD DRIVES

ST-351A	40MB, 28MS IDE, 3-1/2"	$209
ST-3120A	105MB, 15MS IDE, 3-1/2"	$319
ST-3144A	120MB, 19MS IDE, 3-1/2"	$359
ST-1239A	210MB, 15MS IDE, 3-1/2"	$639

SCSI Hard Drives

ST-1239N	Seagate 204MEG, SCSI, 15MS,3-1/2"	$649
ST1480N	Seagate 426MEG, SCSI, 14MS,3-1/2"	$1399
ST-41650N	Seagate 1.4GB, SCSI, 15MS, FH	$2479

MFM Hard Drive

ST-251	40MEG Fixed Disk without Controller ST-251, 5-1/4"	$259

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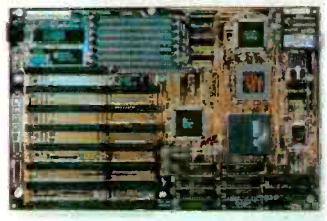
MOTHERBOARDS



Part#	Description	Each
MB286-16	16 MHz 286 Motherboard	$85
MB286-20	20 MHz 286 Motherboard	$95
MB386SX-25	25MHz 286 Motherboard	$159
MB386-33C	33MHz 386 Motherboard	$299
MB486-33	33MHz 486 Motherboard	$659

Descriptions and Prices on Mother Boards Subject to Change.

EXPANSION BOARDS

Part#	Description	Each
IFC-12	Serial Board PC/XT	$11
IFC-25	2 Serial, Parallel, Game Board XT/AT	$16
IFC-13	Parallel Board XT/AT	$9
IFC-20	Game Board XT/AT 2 Ports	$9
IFC-70	BOCA 2 Serial, 2 Parallel I/O Board	$49

DISK CONTROLLER BOARDS

Part#	Description	Each
IFC-14	2 Floppy Controller Board PC/XT	$13
IFC-15	Disk I/O Board Serial, Parallel, Clock, Game PC/XT	$25
IFC-24	Fixed Disk MFM/ 2 Floppy Controller AT	$69
IFC-27-2	AT 2/IDE 2/Floppy Controller	$19
IFC-28	Fixed Disk Controller Board PC/XT XT MFM hard drive controller board.	$47
ST-01	8-Bit SCSI Controller Board	$29
ST-02	8-Bit SCSI/Floppy Controller Board	$47
IN-2000	16-Bit SCSI Hard/Floppy Controller Board	$189

POWER SUPPLIES

Part#	Description	Each
PS-150	150 watt XT Power Supply	$39
PS-200M	200 watt XT power Supply	49
PS-200	200 watt AT Power Supply	59
PS-230	230 watt Large Vertical Case	79
PS-200MINI	200 watt Baby Vertical Case	59

KEYBOARDS

KBY-60 AT Style - LIMITED QUANTITIES $19
AT style, 10 function keys. XT or AT

K-156 Enhanced Style Keyboard (XT,AT) $35
101 keys with regular footprint for XT or AT.
Size: 20 1/2"L x 7 7/8"W x 1 13/16"H.

K-160 Enhanced Style Narrow Footprint $36
Small footprint keyboard with 101 keys and three cable position connection to computer (left, center, nght) for XT or AT. Size: 18 1/2"L x 6 1/2"W x 1 5/16"H.

K-158 Enhanced Style Small Footprint $43
Compact keyboards with 101/102 keys. 22 percent smaller than regular footprint. Size: 15 3/4"L x 7 7/8"W x 1 13/16"H.

K-158-1 Small Footprint Spanish Language $47

KBY-39 Enhanced Style, 12 Function Keys, XT or AT $49

KBY-TRACK Keyboard/Trackball $79
Keyboard with 12 Function Keys and Trackball. Microsoft compatible driver on a 5.25" disk. User selectable XT or AT, 386 or compatible.

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SOUND BLASTER PRO WITH CD-ROM SOFTWARE!

Includes Chess Master 3000 • Ultima VI • Wing Commander

Features:
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SBPRO-CD Sound Blaster Pro With CD-ROM Software $199

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A High-Performance Interface Solution
- Supports 4 serial ports and 2 parallel ports. Parallel Port: LPT1, LPT2, Selectable interrupts: IRQ 5 and 7. Serial Port: COM 1-4, Selectable interrupts: IRQ 2, 3, 4 and 5
- Comes with two DB-37 to DB-25 cable adapters and one DB-37 connector/bracket assembly with ribbon cable
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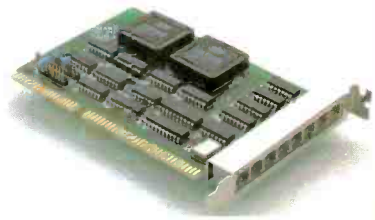
- FIFO Buffering

BOCA RESEARCH INC

IO2BY4 BOCA I/O 2 by 4 $109

BOCA MULTI PORT 1004/1008

A cost-effective interface solution for serial devices.
A high-speed, non-intelligent, multi-port enhancement board. Available in two versions, the board provides either 4 or 8 ports on a single board.
- Choose 4 or 8 ports on a single board
- Install multiple boards into one system
- Utilizes ST16C554 UART technology - each ST16C554 chip is equivalent to four NS16C550s with FIFO buffering
- 8/16 bit interface
- Compatible with ISA & EISA systems
- One 6' RJ-11 cable with DB-25 adapter for each port and software drivers
- Software Drivers on 5.25" diskette for SCO XENIX system V & SCO INIX system V. Software driver not required for PC-MOS/386



BB1004 BOCA 4 Port Board $119
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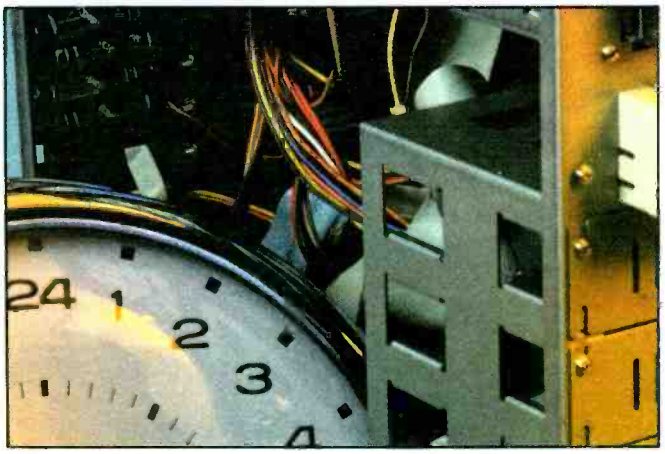
CIRCLE NO. 87 ON FREE INFORMATION CARD

ComputerCraft Volume 2, No. 10 October 1992



14

88

UPGRADING & ENHANCING

APPLICATIONS

REVIEWS

COLUMNS

DEPARTMENTS

ON THE COVER: Our cover photo is a tongue-in-cheek graphic representation of the serious matter of adding a real-time/run-time clock and numerous other timing functions to a PC that doesn't have these functions built in—all without consuming precious expansion-slot space.

Cover Photo by Larry Mulvehill

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!

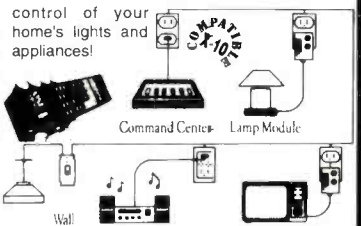
Universal Electronics has just unleashed their newest model remote control, the One-For-All 12. Billed as the most powerful universal remote in the world, the One-For-All 12 replaces 12 of your existing remotes for TVs, VCRs, Cable Boxes, CDs, Audio Products, Satellite Receivers and more! It can even 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 ONLY $69!
HCC-574 Keychain arm/disarm ONLY $21.95
HCC-534 Door/window Sensor ONLY $14.95
HCC-508 Powerhorn 110 DB Siren ONLY $39.95
HCC-554 Wireless Motion Detector ONLY $49.95

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

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. 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**

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**

Base Transceiver

Here's a great chance to expand your X10 or Stanley wireless remote control system to an entire housecode or several house-codes. Set to any house-code; receives unit numbers 1-8 or 9-16. Off-white. By Stanley. Reg. $29.90 HCC-501X **ONLY $16.99**

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**

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**

Stanley Premier Home Control

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

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!**

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!

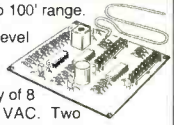
Requires *One-For-All* remote control (see upper left). Remote has special port which connects to your PC's serial port (using our cable and wardware interface). Use the SendIR program to transmit infrared signalss by "pushing buttons" on the remote control. For example type the dos command **SendIR 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!**

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 $4.95

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

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CIRCLE NO. 62 ON FREE INFORMATION CARD

If It Isn't Too Much Trouble . . .

The constancy of upgrading computer systems bedevils most of us as technological advances continually attract us. On another level, as our reputations spread for being computer-wise, we hear more and more from people who "inherited" their first computers from someone close to them who bought a new one. They want our counsel, ". . . if it isn't too much trouble." Relatives, friends, neighbors, friends of friends, the number grows as quickly as the personal-computer phenomenon spreads among the general public.

I'm increasingly facing this. Invariably, the novices' hand-me-down machines are PCs or ATs, usually the former. In either case, the new owners do a little reading about computers and quickly learn that *Windows* is popular and, therefore, they'd like to run it. Without some serious modifications, these old machines can't handle it effectively, of course.

In recent times, I've trod very lightly on issuing advice to novices on upgrading old computers. There are just too many problems that are likely to arise . . . problems that I would be called upon, if only obliquely, to solve . . . problems that even go to the heart of just basic DOS operations, let alone the probable prospect of me winding up doing the upgrade itself. I simply don't have spare time to handle this as calls for such help blossom. Moreover, there are skilled professionals available who do this for a livelihood.

At first glance, upgrading a PC seems rather easy to do. Sometimes it is; other times, it's definitely not. Removing a PC's case can challenge the patience of an all-thumbs newcomer, let alone removing a CPU and plugging into its socket a tiny upgrade card with a more-advanced processor on it. In reality, these are relatively direct actions, but fear of the unknown unnerves neophytes, which is natural.

A greater problem is basic incompatibility of a new component with the system. Upgrade processors aren't necessarily universal replacements. The same is true for other upgrades, such as a new, larger hard drive that might also require replacing the machine's BIOS chip. A new device driver may be needed, too, especially on an older '286 computer. Also tricky is adding a second hard drive, which generally requires changing jumpers and removing a termination resistor.

Even if an upgrade pushes an older machine to the high plateau of running Microsoft *Windows* 3.x well, you may run into software problems. In such cases, some favored programs may have to be upgraded, too. Change from a monochrome video monitor to a color one, from a dot-matrix printer to an ink-jet printer, or what-have-you, and you'll have to change jumper or switch settings.

Some prospective upgrades might terrify even experienced computer users. For example, do you have any apprehensions about installing a compression program instead of spending lots more money on a larger hard drive? Frankly, I always have because I've heard about a host of problems that arise if you're unlucky. But I finally bit the bullet because a 386SX laptop I've been using has "only" a 40M hard drive, which isn't nearly enough to handle some key programs stored on it: DOS, a word processor, a spreadsheet, a CAD program, a desktop-publishing program, *Windows*, various utilities, a chess game, etc., not to mention many megabytes of stored data.

I used IIT's (Integrated Information Technology's) "XtraDrive" software (a hardware board is available, too, but my laptop doesn't have a

(Continued on page 84)

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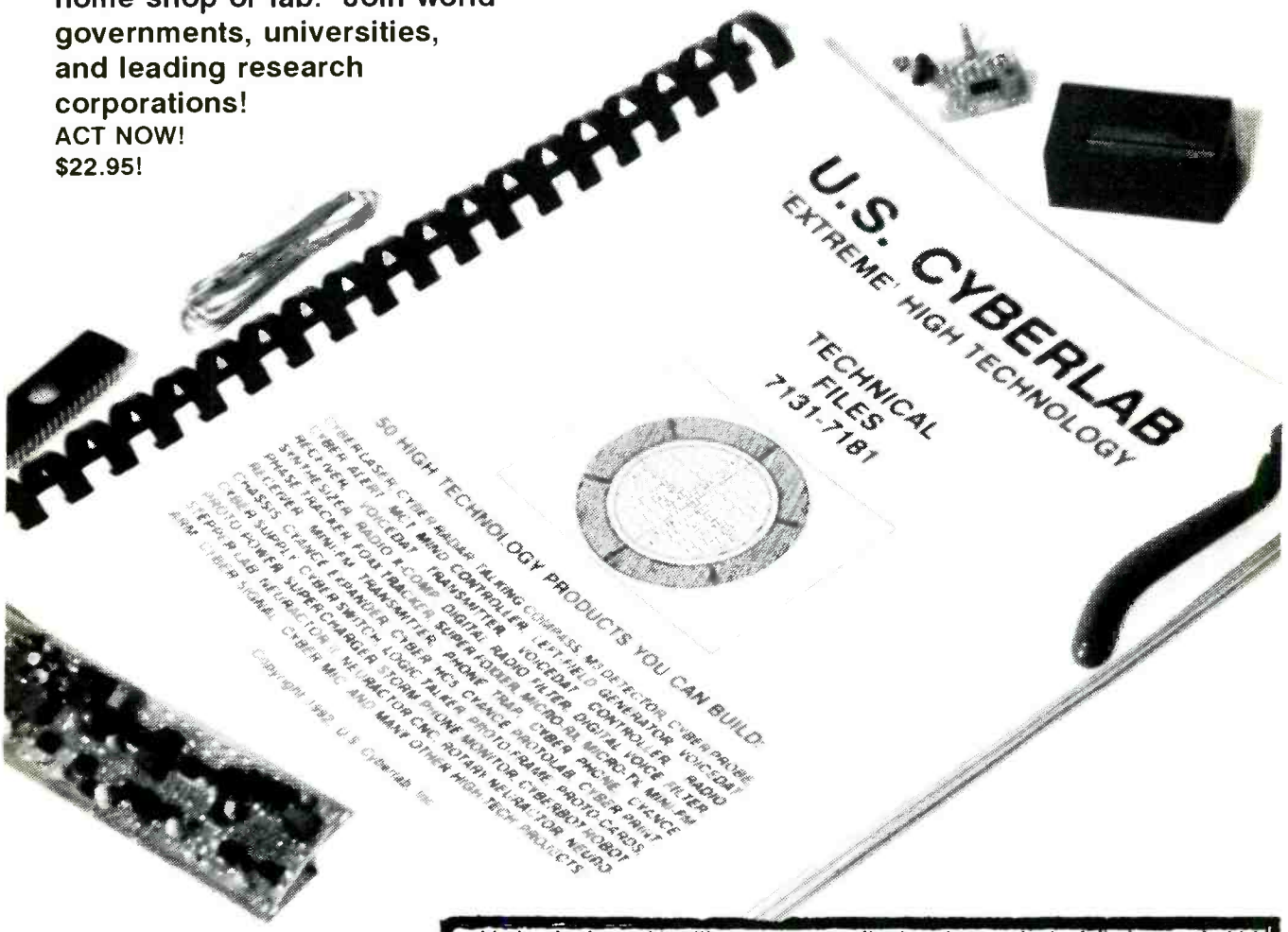

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Football Handicapping. Computer Sports World and Best Bet Software are ready for the football season with their line of pro football handicapping software. The programs make it easier to handicap by providing instant access to ten years of football data, along with the '92 season. "Pointspread Analyzer" ($80) helps identify predictable patterns; "The Expert" ($180) also searches the database for good strategies, with a "Picks" feature that tells which ones apply to any week's schedule; and "Roxy's Power Ratings" ($80) measures strengths and weaknesses of competing teams and predicts the difference in score. For more information, call 702-294-0191.

Intel Advances. Intel Corp. announced retail availability of its OverDrive Processors, a line of single-chip performance upgrades. They're designed to be installed by the PC user, filling the vacant Processor socket found in most Intel 486SX-microprocessor-based computers. They're based on a "speed-doubling" technology that doubles internal speed of their computers' CPUs. According to Intel, tests show that WordPerfect 5.1 runs 62% faster with the OverDrive Processor plugged in. The chip lists for $549 in the 16- and 20-MHz versions, $699 for the 25-MHz version.

Computerized College Applications. "CollegeLink," a new computerized service from Enrollment Collaborative, Inc. (Concord, MA) offers a one-step solution to eliminate the tedious chore of filling out numerous college applications. Students make out one application, while CollegeLink software guides them with error-checking routines and help screens. Using database technology, the service then sends a customized version of it in each school's format to up to 12 chosen colleges. More than 250 undergraduate colleges now accept student applications produced by CollegeLink. Students pay $29.95 plus $3 shipping for the service, which includes software that's available for both IBM/compatible and Macintosh computers. Call 1-800-394-0404.

Woofer Box CAD Program. Blaupunkt developed a CAD program, "BlauBox," for car stereo retailers that allow them to create on-the-spot custom subwoofer designs, printing out scale plans and dimensions used to build the enclosure. The program is said to quickly show consumers the predicted acoustical performance of various woofers and enclosures by entering trunk space dimensions allotted to it. It also discloses crossover parameters and will even print a frequency-response plot of each proposed configuration. Moreover, the popular wedge-shaped enclosure is easily constructed because BlauBox shows the angle to set a blade on a table saw. The program supports ten of the most common acoustic configurations: sealed, vented, etc. BlauBox is available from Blaupunkt dealers for $200. DOS 3.1 or later is required for the IBM PC-format program.

The Write Style

• I enjoyed Ted Needleman's column on "Low-Cost Paint/Draw Programs" (July 1992, *ComputerCraft*). This is the first time I've ever bought a magazine for *only one* article.

I felt that Mr. Needleman wrote this column just for me! Unlike many of the columns in *PC Magazine* and *PC/Computing*, the writing style and technical level in *ComputerCraft* were perfect (for me).

Kazu Konokawa
Hercules, CA

DR DOS Booster

• For the pathetic sheep following the Microsoft (MS) banner and reading "PC" magazines, Mr. Benford's DR DOS 6.0 review (*ComputerCraft*, June 1992) was right on the money. If primary interest is graphics and games, by all means, get MS-DOS and *Windows* and enjoy. On the other hand, if you think of a computer as a tool, if you have an XT or '286 and want to upgrade, or if you are a hacker (using the original definition, not including phone phreaks or pirates) and you don't want frills between you and the operating system, then get DR DOS simply because it is better than MS-DOS.

The review was thoughtful and interesting. I would, however, like to add a few things. DR DOS does not include BASIC. The TaskMAX clipboard is text-based and won't do graphics.

I have both operating systems at my disposal. One boots from the hard disk, the other from a floppy. My latest PC-compatible computer came with MS-DOS 5.0. I got DR DOS 6.0 to compare. DR DOS 6.0 is the superior product.

Ron Loughran
Flemington, WV

Pinouts Wanted

• I've been enjoying your magazine, especially Upgrading & Enhancing. I am having problems finding information on some integrated circuits that are in my GTE XT300e terminal. If anyone has pin diagrams or other operating information on the following ICs: Motorola MC6850P and LM348N; Intel D 2764-4 and D 8749h; ITT TEA 1045-t; and Toshiba TMP 8049p-3767, please contact me.

Steve Petrowski
494 Clubhouse Rd.
Lebanon, CT 06249

Is It or Isn't It?

• At the conclusion of the article on the 68705 microcontroller in the November 1991 issue of *ComputerCraft*, there was mention of an upcoming article and a programmer. Was Nick Goss' article in the June 1992 issue the promised programmer? I have the 68705 programmer project on hold since your first article.

Michael Meany
Hicksville, NY

Yes! It's also a development system.—Ed

Down-Under Fan

• Please find enclosed my subscription renewal. Your magazine is the only one of its kind I have been able to find. As a technician, it is gratifying to find a magazine that caters to hardware enthusiasts. All the Australian magazines are full of software reviews and very basic technical articles. Even the electronics hobbyist magazines have little practical electronics in them. Keep up the good work.

Brian Collins
Stanwell Park, Australia

TV In Your PC

PC/Television from 50/50 Micro Electronics allows a personal computer to become a full-screen TV. It is a standard eight-bit expansion board that incorporates a 119-channel tuner capable of tuning vhf, uhf and cable TV frequencies. Equipped with standard F connectors, PC/Television accepts input from any source that a regular TV receiver might use. Channel selection, video display settings and programmable favorite channels are all selectable through keyboard or mouse. You can separately control audio and video to listen to PC/Television while still using your computer monitor for normal computing applications. The board works with all VGA and SVGA graphics adapters and monitors. $395. *50/50 Micro Electronics, Inc. 550 Lakeside Dr. #8*, Sunnyvale, CA 94086; tel.: 408-730-5050; fax: 408-732-5050.

CIRCLE NO. 16 ON FREE CARD

Powerful Low-Priced Portable

Acer's AcerAnyWare K386S is a powerful portable computer based on AMD's AM386SXL processor with its extensive built-in power-management capabilities. It features an 80M hard drive, 1.4M floppy, a 10″ non-glare triple supertwist LCD screen that provides 32 shades of gray, 2M of RAM (expandable to 8M), full-size keyboard and a package that measures 8.5″ × 11.4″ × 2.3″ and weighs 6.4 pounds. The unit can simultaneously run the internal LCD and an external VGA monitor. In addition to

standard serial and parallel ports, it sports a modem slot, PS/2-compatible keyboard and mouse ports and a super VGA monitor port. $1,595. *Acer America Corp., 2641 Orchard Pkwy., San Jose, CA 95134; tel.: 408-432-6200; fax: 408-456-0471.*

CIRCLE NO. 17 ON FREE CARD

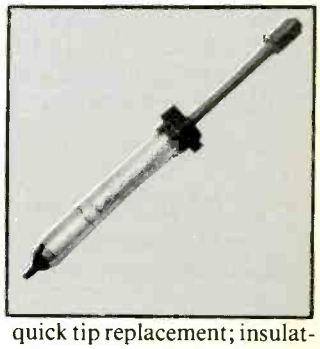
Dongle Buster

The Intelligent Printer Port from Safesoft is an eight-bit expansion card that adds a standard printer port, while also "replacing" a hardware lock device, or "dongle." Software is supplied with the card to read the lock device and store the codes on disk. The Card can then be programmed by these codes, either using a menu-driven program or from a batch file. *SafeSoft Systems Inc., 202-100 Concordia Ave., Winnipeg, MB, Canada R2K 4B8; tel.: 204-669-4639; fax: 204-668-3566.*

CIRCLE NO. 18 ON FREE CARD

Desoldering Tool

The Model DP-5 manual, antistatic desoldering tool from Automated Production Equipment features: durable corrosion-resistant plastic construction; precision metal plunger; high-quality springs; self-cleaning action on each cycle;



quick tip replacement; insulated vacuum pulse; one-hand loading; uniform reset pressure of 11 lb.-in., ±20%; and fully enclosed plunger for operator safety. *Automated Production Equipment, 142 Peconic Ave., Medford, NY 11763; tel.: 516-654-1197; fax: 516-289-4735.*

CIRCLE NO. 19 ON FREE CARD

Drive Doubler

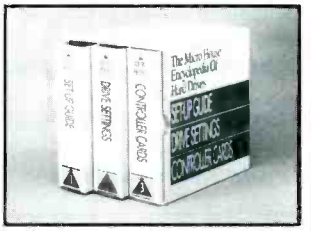
XtraDrive software and hardware from IIT doubles hard-disk capacity quickly, easily and transparently. DOS-based *XtraDrive* software uses a menu-driven installation program to make it easy to install and requires less than 25K of RAM. EMS support is built into the loss-less compression software to free up conventional memory. You can un-install *XtraDrive* without having to reformat your hard disk. It also maintains original drive designations after installation. XtraDrive is fully compatible with *Windows* and safely compresses DOS and Windows swap files.

The XtraDrive Hardware accelerator board contains a proprietary compression algorithm built around the LZ system. When used with *XtraDrive* software, it's claimed to achieve a substantial performance improvement. Compression activities are completely transparent to the user. $99, software; $199, hardware. *IIT, 2445 Mission College Blvd., Santa Clara, CA 95054; tel.: 408-727-1885; fax: 408-980-0432.*

CIRCLE NO. 20 ON FREE CARD

Hard-Drive Encyclopedia

The *Micro House Encyclopedia of Hard Drives* now available from Jensen Tools is a three-volume support tool designed to provide comprehensive technical help for installation upgrading and maintaining multi-vendor hard drives. It contains information on hundreds of drives, including many discontinued makes and models. The information is in



a loose-leaf format to make page replacement and update easy. An electronic version on 5¼" disks is included. The three volumes cover set-up, controller cards and drive settings. Clear drawings detail switch settings and cable connections for both drives and controller cards. $150. *Jensen Tools Inc., 7815 S. 46 St., Phoenix, AZ 85044; tel.: 602-968-6231.*

CIRCLE NO. 22 ON FREE CARD

Novell NetWare 2.2: Self-Teaching Guide

By Peter Stephenson & Glenn Hartwig

(John Wiley & Sons, Inc. Soft cover. 300 pages. $19.95.)

This book is designed to help people who have never learned anything significant about NetWare before. It's intended as a tutorial a student can use at his own pace. Each chapter includes sections that cover specific topics and features. In addition, each chapter contains several sections to reinforce what the student has learned from the text. "Check Yourself" includes a short hands-on practice exercise to be performed on the student's computer. "Practice What You've Learned" sections are similar, except they're longer and more involved and produce results somewhat dependent on the network in use. "Tips" are highlighted ideas and short-cuts scattered throughout the text. "Quick Command Summaries" at the end of each chapter review any short-cut keys, tasks and procedures covered in the chapter.

Ten chapters are devoted to planning a LAN and its environment, beginning the installation process, preparing the network drive, performing advanced installations, setting up printers, setting up users, configuring the network environment, cutting over to the new network and being the network supervisor. Networks can be difficult even for the most experienced administrator. This volume gives the newcomer to nets a fighting chance. If you're new to networks, check out this book.

Back-Up System

Trakker from Colorado Memory Systems is a total back-up system that interfaces to notebook and laptop computers via their parallel ports. Desktop computer users can also benefit, since there's no need to open the case or tie up a slot. Complete with power supply, drive, housing, cable and software, TRAKKER attaches in a minute. TRAKKER 120 and TRAKKER 250 are based on the popular Jumbo 120 and Jumbo 250 tape drives and conform to QIC-40 and QIC-80 industry standards. 120M/$449; 250M/$549. *Colorado Memory Systems, 800 S. Taft Ave., Loveland, CO 80537; tel.: 303-669-8000; fax: 303-667-0921.*

CIRCLE NO. 23 ON FREE CARD

IBM/Lexmark Printer

IBM's new PS/1 Printer (manufactured by its spin-off Lexmark) is a 24-wire narrow-carriage dot-matrix model that prints up to 200 cps in fast draft, 180 cps in draft and 60 cps in letter-quality modes. For crisper graphics, the PS/1 provides 360 × 360-dpi resolution. It comes with a convenient LED operator panel, ribbon cartridge, parallel cable and print drivers for *Windows* and *Microsoft Works*. The paper path is nearly straight, reducing the likelihood of paper jams. $449. *Lexmark International, Inc., 740 New Circle Rd. NW, Lexington, KY 40511-1876; phone, 800-358-5835.*

CIRCLE NO. 21 ON FREE CARD

Windows On The Bible

The Logos *Bible Study Software* for *Windows* 3.0/3.1 enhances biblical study by providing the ability to display biblical texts in Greek and Hebrew, linked side-by-side with English translations. Powerful search and retrieval options are said to be provided that include proximity searches, phonetic look-ups, word and phrase searches and a unique "approximate search" capability that scans for vaguely defined passages of text.

Users can customize the software by creating cross-references between passages of text and multiple topical indices to passages of text. They can add their own notes or commentaries and link them to selected passages of text.

Logos supports DDE capabilities to allow exchange of information with other popular *Windows* products. The package includes both the King James and Revised Standard versions of the Bible. Greek, Hebrew and other modern-language versions are scheduled for release this spring. $129. *Logos Research Systems, Inc., 26 W. Route 70, Ste. 270, Marlton, NJ 08053-3010; tel.: 609-9983-5766; fax, 609-988-8268.*

CIRCLE NO. 24 ON FREE CARD

Microprocessors: Theory and Applications (Intel and Motorola).

By M. Rafiquzzaman, Ph.D.
(Prentice Hall, Hard cover, 468 pages.)

This textbook is suitable for a junior college introduction to microprocessors or similar course. Beyond this, it would be of extremely limited utility. Chapter 1 provides an overview that differentiates between machine, assembly and high-level languages. It also gives examples of day-to-day use of microprocessors and microcomputers. The second chapter is devoted to the architecture of a microcomputer. Topics covered include the bus, clock signals, registers, ALUs, RAM, ROM, read and write operations, I/O, interrupts, DMA and coprocessors. Chapter 3 is devoted to software, including addressing modes, instruction types, and assembly language programming.

The Intel 8085 serves as a model microprocessor in Chapter 4. Covered details include register structure, memory addressing, 8085 instruction set, timing methods, signals, programming I/Os, SID and SOD lines and system design. The Intel 8086 and Motorola MC68000 are given similar treatment in the following two chapters, while Chapter 7 covers the Intel 80386 and Motorola MC68020, true 32-bit microprocessors. Parallel/serial ports, keyboards, cassette recorders, displays and other peripheral-interfacing topics are covered in Chapter 8. Chapter 9 covers interface standards such as RS-232C, RS-422 and RS-423. Real-world applications of microprocessors are covered in Chapter 10.

The last 150 pages of the manual are devoted to appendices mostly made up of specifications sheets and other technical data provided by chip manufacturers.

Advanced Math Software

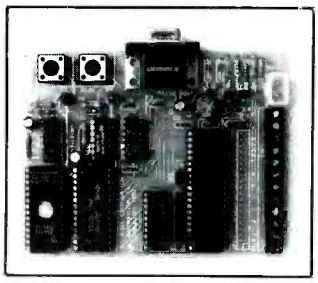
Vanguard Software's new *HyperCalc* is an extendible environment for conducting interactive analysis in engineering and business math. It can automate routine calculations, simulate complex business situations, and even implement rule-based AI systems. The application comes equipped with a library of 200 functions that are used as building blocks in model development. These functions provide such capabilities as integration and differentiation, root solving, regression analysis, simultaneous equations solving, linear programming, statistical analysis, financial calculations and 2D/3D graph plotting.

HyperCalc's capabilities can be extended by creating user-defined models that can be used just like built-in functions. Individually stored models are automatically called up and applied when used as components in new models or referenced in interactive calculations. You need only define how problems are solved once, since the program will automatically apply the appropriate model definitions when solving future problems of the same type. $195. *Vanguard Software, 62 Darling Ave., Smithtown, NY 11787; tel.: 516-979-6863; fax: 516-979-6829.*

CIRCLE NO. 25 ON FREE CARD

8031 Training System

Rigel's new 8031 training system consists of an R-31J Prototyping Board, READS (Rigel's Embedded Applications Development System) and example programs. The R-31J accepts 40-pin DIP 8031/8051 microcontrollers. Digital I/O operations are through 12 screw-type terminal blocks connected to general-purpose ports. R-31J comes with 32K of static RAM. READS allows writing, assembling, downloading, debugging and running applications software in the MCS-51 language on IBM/compatibles. It also contains an editor, cross-assembler and host-to-board communications in a menu-driven environment. Software can be written in BASIC when the R-31J is populated with Intel's 8052 BASIC chip. $130. *Rigel Corp., P.O. Box 90040, Gainesville, FL 32607; tel.: 904-373-4629.*



CIRCLE NO. 26 ON FREE CARD

HF Multimode Data Controller

The MFJ-1214PC Multimode Controller provides for transmitting and receiving RTTY, ASCII, CW, FAX and WeFAX via an IBM/compatible over an hf SSB transceiver. It includes true DCD circuitry with front-panel LED for easy signal tuning. Software included in the package is menu driven. On RTTY, the system provides all standard speeds and shifts. An on-screen tuning indicator, full text editor, automatic CW speed tracking and type-ahead buffer are also incorporated. For instance, with an appropriate receiver, the MFJ-1214 copies weather pictures directly from 16.410 MHz and AP photos on 20.738 MHz. Full documentation is included. Minimum configuration is an 8-MHz IBM/compatible with a graphics adapter. $150. *MFJ Enterprises, Inc., PO Box 494, Mississippi State, MS 39762; tel.: 601-323-5869; fax, 601-323-6551.*

CIRCLE NO. 27 ON FREE CARD

"Elementary, Dr."

ICOM Simulations' new *Sherlock Holmes, Consulting Detective* CD-ROM-based game for both Macintosh and IBM/compatibles makes extensive use of full-motion video to create a truly interactive game environment. More than 90 minutes of video transports players into the role of the famous sleuth and allows them to interact with Sherlock, Dr. Watson and more than 50 other characters. Requires IBM/compatible (286 or better), DOS 4.0 or later, 640K RAM, 256-color VGA card, mouse, Sound Blaster or similar card and an MPC-compatible CD-ROM. $70.

Also, in ICOM's updated *Windows* screen-saver *Intermission* Version 2.0, more than 22 new modules have been added since the previous release, for a total of 56 animated screen-saving displays. It features enhanced system security and password protection. A DOS screen saver is included that can run under DOS or in the *Windows* DOS box. $50. *ICOM Simulations, Inc., 648 S. Wheeling Rd., Wheeling, IL 60090; tel.: 708-520-4440; fax: 708-459-3418.*

CIRCLE NO. 28 ON FREE CARD

New Sound Blaster

Sound Blaster 16, the latest sound card from Creative Labs, is said to provide CD-quality sound for audiophiles, advanced users and professionals while maintaining compatibility with Sound Master Pro. It includes a stereo digital/analog mixer for all audio sources and features a stereo music synthesizer that uses enhanced four-operator FM technology with 20 voices. The system provides 16-bit audio sampling. The board incorporates a built-in 4-watt/channel amplifier, volume, bass and treble controls, MIDI interface and microphone and stereo line-in jacks. $350. *Creative Labs, Inc., 1901 McCarthy Blvd., Milpitas, CA 95035; tel.: 408-428-6600; fax: 408-428-6611.*

CIRCLE NO. 29 ON FREE CARD

What's New!

Desktop-PC UPS

Tripp-Lite's new small-footprint BC 250 standby UPS is designed to protect desktop computers, network routers and bridges, diskless workstations and fax machines. It provides continuous protection without taking up valuable work space. The UL-listed UPS supplies 250 VA continuous power to safely run most desktop computers through brownouts, blackouts and other power-line problems. It uses a large battery for longer life and features two spike-protected ac outlets, ac power and battery indicators and plug-in operation. $169. *Tripp Lite, 500 N. Orleans, Chicago, IL 60610-4188; tel.: 312-329-1777; fax: 312-644-6505.*

CIRCLE NO. 30 ON FREE CARD

Quicken Bookkeeping

Intuit, publisher of Quicken finance software, now offers *QuickBooks*, an accounting program for those of us who don't understand debits and credits. You simply write transactions on such familiar forms as invoices, checks and check registers. Because *QuickBooks* then records all transactions in the correct places, accounting tasks are completed automatically. Other features that make *QuickBooks* easy to use include: QuickTrainer, a help system that assists you at each step in the bookkeeping process; more than 20 detailed lists of present income and expense accounts provided for various businesses that make getting started as simple as typing company name and selecting from a list; and instant access to all transactions in original form at any time. The program also includes 15 preset reports. $140. *Intuit, 155 Linfield Ave., PO Box 3014, Menlo Park, CA 94026-3014; tel.: 415-322-0573.*

CIRCLE NO. 31 ON FREE CARD

SX In A Keyboard

The PC-101 from DataBusiness is a complete 33-MHz 80386SX computer with all peripherals and components installed within a 101-style keyboard. It even includes a slot for an 8- or 16-bit expansion card. Although appreciably smaller than a standard PC and keyboard, the system offers virtually the same power, memory and expansion capabilities. It has a volume control for the internal speaker and two video, three parallel, two serial and one game ports. Internally are a floppy controller with a 1.4M drive, IDE controller and 1M of RAM. Options include 2½" hard drives with capacities ranging from 20M to 120M. Size is 19½" × 9½" × 2¾". $1,495. *Data-Business Systems, 4630 Campus Dr., Ste. 102, Newport Beach, CA 92660; tel.: 714-252-0990; fax: 714-252-1187.*

CIRCLE NO. 32 ON FREE CARD

What's New!

Step-Motor Controller

Command queuing and contouring are new features in *Indexer LPT* version 3.0 from Ability Systems Corp. This software converts an ordinary printer card into a powerful multi-axis step-motor controller. Compatible with numerous motor drivers, it's easy to use and an inexpensive means of motion control. Each printer port supports two axes of motion with signals for step, direction, reduced current, all windings off, high-limit switch, low-limit switch and auxiliary input. Using three printer ports, *Indexer LPT* can control up to six motors simultaneously.

The program supports linear interpolation in up to six simultaneous axes. Any two axes can be used to draw circles and arcs. Circles are traversed by specifying the center point and the direction of travel, clockwise or counterclockwise. Since *Indexer LPT* loads as an MS-DOS device driver and behaves like a disk file, it's compatible with virtually all programming languages, even DOS batch files. A menu-driven diagnosis program makes initial installation easy and provides a convenient platform to exercise motion hardware. $250. *Ability Systems Corp., 1422 Arnold Ave., Roslyn, PA 19001; tel.: 215-657-4338; fax: 215-657-7815.*

CIRCLE NO. 33 ON FREE CARD

Inexpensive True Color

VGAWONDER XL24 from ATI provides 24-bit color (true color) graphics at an inexpensive price. It supports 16.7-million colors at 640 × 480 and virtual 24-bit color at 800 × 600 resolution under *Windows* 3.x. Drivers are included for *AutoCAD, MicroStation, CADKey* and other CAD packages. The program also includes Presentation Manager drivers for OS/2 2.0 at 800 × 600 × 16-color and 1,024 × 768 × 16-color display.

ATI's CODE (COlor Depth Enhancement) feature provides virtual 24-bit color in 800 × 600 resolution. CODE is a custom blending technique that enhances imported 24-bit color images by adjusting pixel colors to provide smooth transitions between colors. The result is claimed to virtually eliminate banding and other color irregularities. $199. *ATI Technologies Inc., 3761 Victoria Park Ave., Scarborough, ONT, Canada M1W 3S2; tel.: 416-756-0718; fax: 416-756-0720.*

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Weller's Portasol P-1 soldering kit can be used as a soldering iron, blow torch, hot blower

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What's New!

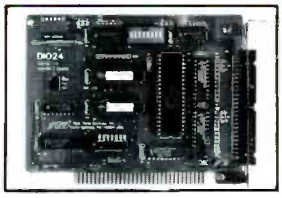
Windows Stethoscope

Maxa Corp. new diagnostic tool for *Windows*, *Stethoscope*, provides comprehensive analysis of the specific system under examination. In addition to listing system hardware inventory (including IRQs), it checks disk resources and memory and suggests optimal *Windows* configuration. *Stethoscope* also gives users valuable tips about upgrading, installing, maintaining or simply learning about the computer. Benchmark tests are included to assist in evaluating your system. *Maxa Corp., 116 Maryland Ave., Ste. 100, Glendale, CA 91206; tel.: 818-543-1300; fax: 818-543-0104.*

CIRCLE NO. 36 ON FREE CARD

Digital I/O Card

Real Time Devices' DIO24 is a low-cost PC-bus opto-22 compatible digital I/O card with 24 digital I/O lines based on the popular 8255 chip. In addition to being able to directly drive opto-22 equipment, it's ideal for such general-purpose digital I/O as driving small lamps, activating relays and sensing switch closure. All signal and power connections to opto-22 equipment are through a single 50-pin connector. Buffer circuitry increases current drive capability of the 8255's I/O lines, permitting them to drive loads up to 16 mA.



A major feature of the DIO24 is its use of a PAL to monitor the 8255's control word to automatically configure buffers for input or output and eliminate manual configuration. The DIO24 supports software enabled IRQs 2 through 7 and a switch-selectable base address. $150. *Real Time Devices, Inc., 820 N University Dr., State College, PA 16804-0906; tel.: 814-234-8087; fax: 814-234-5218.*

CIRCLE NO. 38 ON FREE CARD

KUI For Your GUI

The *Keyboard User Interface* (*KUI*) from Softac is an integrated set of keyboard-oriented functions that gives users better control of *Windows* 3.x with hot keys and an enhanced command-line interface integrated into a pop-up control panel. The program also provides enhanced *Windows* management, a comprehensive keyboard-based mouse simulator using selectable cursor sets. It provides on-the-fly creation of hot keys, from which you can launch and switch between any number of *Windows* and DOS applications.

KUI makes DOS and *Windows* commands such as COPY, RENAME and DELETE conveniently available from the command-line interface box in the main window. The program provides selectable cursors to improve cursor visibility in LCD and super-VGA displays. In addition, *KUI* provides animated screen savers, a file search function and an enhanced set of window management functions. Minimum requirements are *Windows* 3.x, DOS 3.1 or later, 40K of RAM and 330K of disk space. $80. *Softac Corp., 23 Sunset Rd., Winchester, MA 01890; tel.: 617-721-1010.*

CIRCLE NO. 37 ON FREE CARD

Put a "Canned" Clock In Your PC

A new kit from Dallas Semiconductor adds a real-time clock, run-time clock and numerous other timing functions to a PC–without taking up precious slot space

Dallas Semiconductor is probably best known for its PC system clock chips, other timing devices and CMOS chips. The newest product from this innovative electronic component developer and manufacturer is the DS1494 Time-In-a-Can (called TIC for short).

The DS1494 is a unique timing device housed in a can-like case that looks like a very large watch battery; it is the diameter of a dime and about as thick as a stack of four dimes. All of the time-keeping components, support circuitry, memory and the lithium power source are contained in this sealed 16 mm "can." The device functions as a real-time clock for a computer (either as the primary unit or as an add-on), as well as a run-time meter that can keep track of the number of hours a system is turned on, in addition to numerous other timing functions. Dallas claims that the internal lithium power source will keep the TIC "ticking" beyond the year 2002.

The DS1494K Time-In-a-Can Starter Kit consists of the DS1494 device, a serial port adapter for the PC, a two-wire receptacle for the device, a snap-in "can holder," demo software and documentation. The price for the starter kit is $25, and the DS1494 TIC sells for $7.50 in quantities of 1,000.

The device is quite remarkable in the scope of time-keeping features it can support. The real-time clock keeps time in $\frac{1}{256}$-second increments, accurate to within +2 minutes per month, and it also features an elapsed-time meter to measure the duration of an activity as well as a cycle counter that stores the number of on/off cycles for the PC. Security provisions for the device are excellent as well: a unique 48-bit factory-lasered serial number of

identification and traceability is burned into each unit, while the sealed-can design prevents tampering and alteration of the timers and cycle counter.

Programmable interrupts from the real-time clock, elapsed timer and/or cycle counter can be designed into software to use the device for triggering functions and events. The TIC's memory contains 4,096 bits of nonvolatile RAM plus a 256-bit scratchpad. Typical applications incorporating these features include the creation of a stopwatch, alarm clock, logbook, time and date stamp, hour meter, calendar, cycle timer, expiration timer and event scheduler, to name just a few. The demonstration software provided in the starter kit illustrates how these timing functions can be utilized in many application settings.

How It Works

The TIC resides in the host PC inside its receptacle to keep track of the machine's duty cycles, time on and so forth, storing all of this data in its memory. For reading this stored information, the TIC is removed from its receptacle and snapped into the receptacle on the PC serial adapter. The included software is then used to read the data, which is transferred from the TIC to the PC at the rate of 16K bits per second. The data transfer protocol is similar to Morse code, using long pulses to represent binary 1s and short pulses for 0s. The clock and/or duty cycle counters can be reset from the software as well.

The TIC installs easily, requiring only two connections for its receptacle. One lead goes to a +5-volt source, the other to chassis ground. Because these leads are about 12" long, finding a suitable 5-volt dc source inside a PC's system unit shouldn't be a problem. A likely and easily-accessible

The DS1494 Time-In-A-Can from Dallas Semiconductor is a complete real-time system clock with its own power source, 4K-bit memory and more.

point for tapping the needed +5 volts is often found on the jumper posts of many expansion cards (like multi-I/O cards); so tapping off these may also be a viable alternative power source in some installations.

Rather than mounting the TIC and its receptacle inside my PC, I decided to install it externally for two reasons. One was that opening the system unit every time I wanted to read the data contained on the TIC could prove to be a bother. The other was that external mounting would simplify moving the TIC from one PC to another in my office to check average duty cycles for different machines. My solution was to get the +5-volt operating voltage and ground connections from the five-pin DIN keyboard jack. The idea here would be to make a pass-through keyboard connector that could also be tapped for the voltage and ground connections.

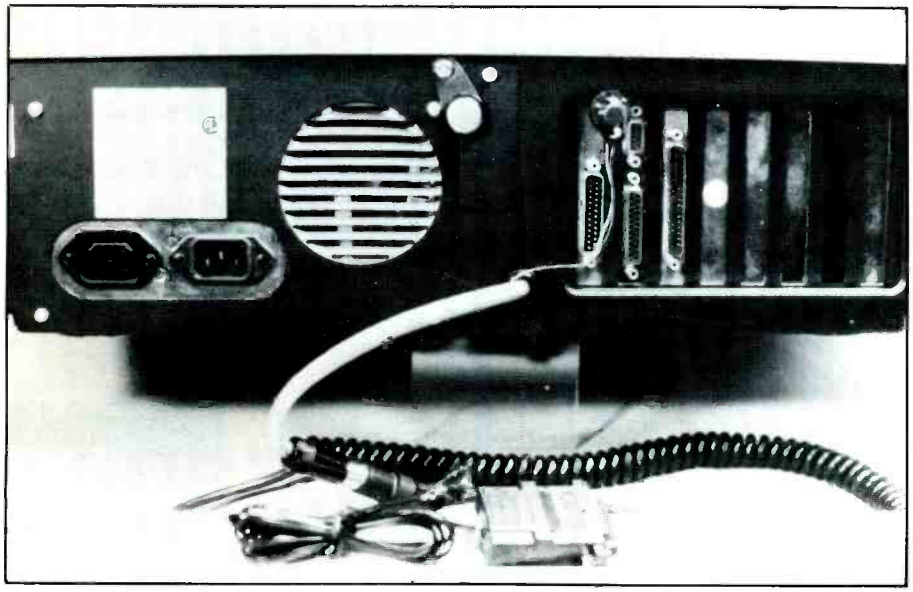
A trip to a local parts retailer was the first order of business, to purchase a five-pin DIN plug and jack pair (Radio Shack Cat. No. 274-003A and 274-006A, respectively) and a length of five-conductor shielded cable.

If you choose external installation, as I did, you'll have a good opportunity to make a keyboard extension cable at the same time. I used a 10" length of cable for this project. If you need some additional length for your keyboard cable, feel free to increase the cable length to 3 feet or longer.

I can't over-stress the importance of keeping all the connections correct in this installation. Connecting the +5-volt lead to the wrong pin can literally fry your keyboard controller, ruin your keyboard or do other serious damage to the system or the DS1494 TIC. To avoid such disastrous pin-assignment confusion, I made a chart on which I listed the pins, their functions and the color of the insulation on the conductors that would be used for each (Table 1).

Using this chart to keep my color code from getting mixed up, I first soldered all five of the wires to the DIN in-line jack, crimped the receptacle shields and slid on the hood. The hood was then pushed onto the cable for the opposite end and the five wires were then soldered to the appropriate pins of the DIN plug. The main difference on this end is that the two leads from the TIC receptacle are also soldered to it, red TIC lead to +5-volt pin 5 and green lead to ground pin 4. Snapping the metal shields on and sliding the hood over them completed the cable assembly.

A snap-in "can holder" is provided, which makes it much easier to remove the TIC from its installed receptacle and insert it in the serially-connected reader's receptacle. I mounted the TIC in its holder at the back of the PC above the keyboard connector, using one of the screws that secure the cover on the system unit. This location makes it very convenient to snap the TIC out of the metering receptacle and into the reader for taking readings and other software-based utilities.



Mounting the TIC externally requires a five-conductor cable with five-pin DIN connectors and a vise or parts holder to make soldering connections a bit easier.

Using Software

The TIC Starter Kit comes with an Application Notes and Design Guide booklet that's chock full of useful information about the device, installation configurations and programming notes on how to use and apply the information gathered by the device. Several excellent application examples are provided on the software diskette, including demonstration programs and technical appendices.

The four executable files supplied on the diskette are:

CLOCK.EXE. Demonstration of major features. Mouse or keyboard driven. Requires VGA or EGA video monitor.

HMETER.EXE. Displays the time and date, equipment on-time and equipment on/off cycle count.

CAN.EXE. Allows user access to all memory and time-keeping functions.

README.EXE. Program used to display the README document, one screen at a time.

Prior to running any of the demo programs, the serial port reading adapter should be attached to the desired COM port and the TIC should be ready for insertion into the reader when prompted. Here's a brief sum-

Table 1. Keyboard Connector Wiring Scheme

Pin No.	Function	Insulation Color
1	Keyboard Clock	Yellow
2	Keyboard Data	Green
3	Spare	Blue
4	Ground	Brown
5	+5 Volts	Red

mary of what each of the three main demo programs do and the available command options:

CLOCK.EXE is run by entering CLOCK by itself for serial port 1 or CLOCK 2 for the reader connected to the second serial port. An on-line help utility for all of the features and functions, this program requires an EGA or VGA monitor to run. A color monitor with mouse is preferred, but monochrome without a mouse will also run. To get help with a mouse double-click on any icon (meter, clock, timer, etc.) and then the "?" in the upper-left corner of the screen. The keyboard equivalent is SHIFT+?.

HMETER.EXE should be run before the DS1494 is snapped into the reader. A screen prompt indicates when the software is ready for insertion of the TIC module into the reader. You execute HMETER by entering HMETER for serial port 1 or HMETER 2 for serial port 2. Available commands are:

I initializes the DS1494. It loads the DOS time into the DS1494 and zeros out the elapse timer and cycle counter.

R (Remove). Prevents the Cycle Counter from incrementing (as an additional on/off cycle) as you remove the DS1494 from the reader.

ESC exits the program.

CAN.EXE gives access to the more-advanced features of the TIC and requires knowledge of the DS1494 data sheet. This is heavy technical material not intended for the average end user. It's invoked by typing CAN for using the reader through COM1 or CAN 2 for COM2. Available commands are:

H accesses help for use in the T (time) register.

S is a toggle for turning on/off sound (a beeper).

T writes time registers in binary format.

W writes all 32 bytes of the current page in hex.

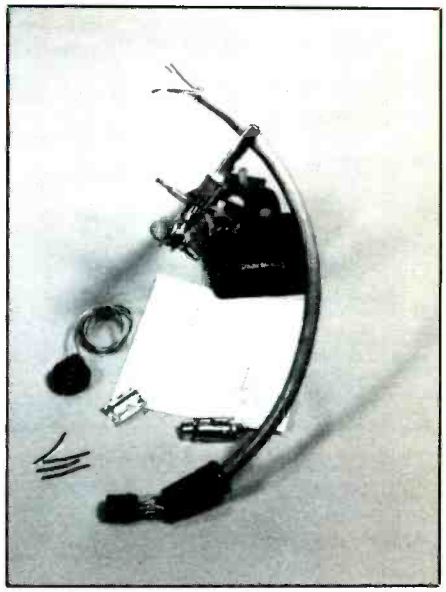
P Writes bytes of the current page in hex. If you follow P with a Tab, writes are text (ASCII).

PageDn decrements from the current page.

PageUp increments from the current page.

Esc exits the program.

Note that a read-only version of the CAN program can be observed in the CLOCK program by pressing the R key while the clock is running with all windows closed.

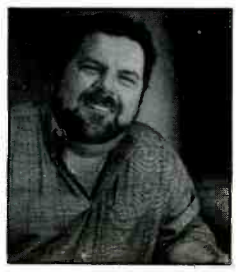


A color-code/connector chart can prevent disastrous consequences from mis-wiring the cable.

Additionally, the diskette includes an appendix subdirectory that provides additional programming support. A second README in this subdirectory describes the APNDX__*.TXT files. The provided README.EXE utility makes perusing these programming notes and examples easier by presenting the information one screen at a time.

Conclusion

The Dallas Semiconductor DS1494 Time-In-a-Can is an excellent device for use as a real-time clock that doesn't require a slot or as an accurate meter for keeping track of system usage. Since installation only requires attaching two thin leads, it's ideal for surface-mount applications where high heat levels are a problem. The data sheets and programming application notes are excellent, and for $25, it represents an incredible bargain for even casual PC users who are interested in tracking their system hours. ■



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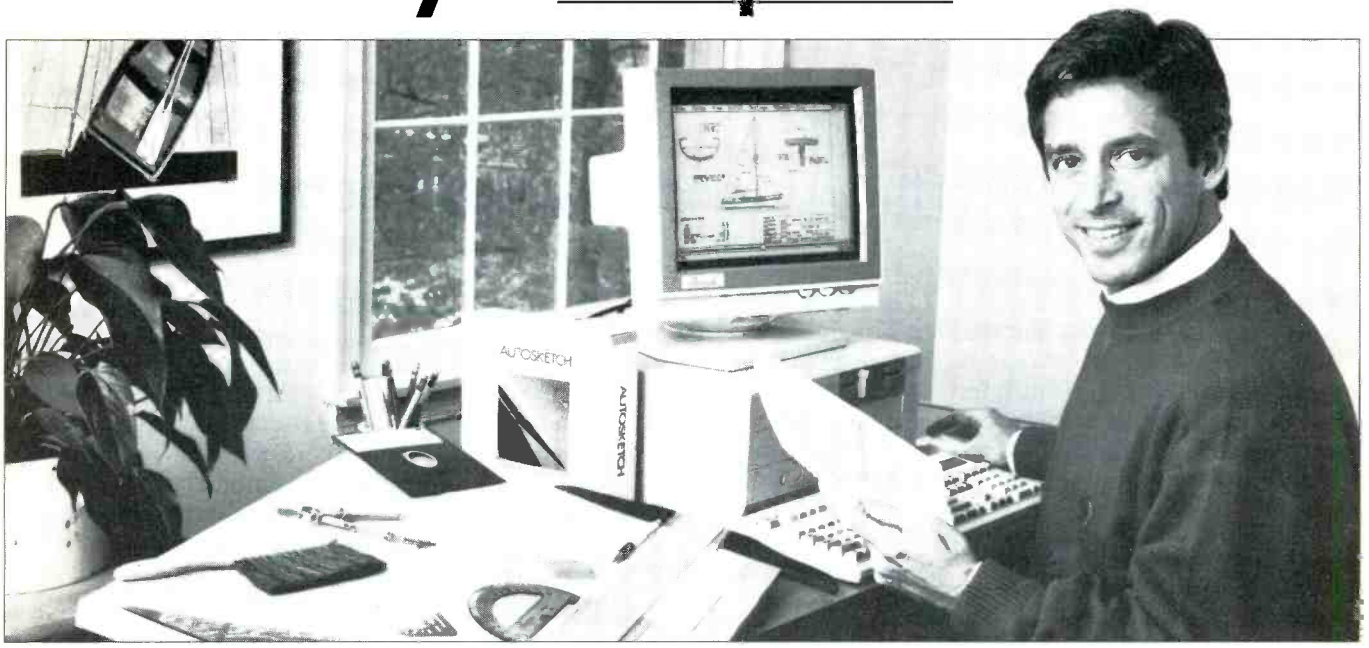

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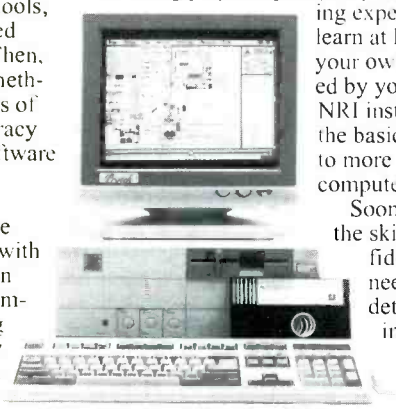

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A User's Guide to Microcontroller Interrupts

What they are, what they do and how to use them

If you write programs that must respond quickly to events that may occur unpredictably, you should be familiar with interrupts. Using interrupts, a microcontroller or other computer can quickly detect and respond to events like the following:

- A sensor generates a warning, such as fluid level, pressure, temperature or motor speed too high or too low.
- A power failure is about to occur (detected by a falling dc voltage or missing ac cycles).
- A timer times out, announcing that it's time to take a measurement or perform another periodic action.
- A counter overflows, indicating that a pre-defined number of events have occurred.
- A byte arrives for processing at a serial port from a peripheral device or network node.
- A user requests action to be taken by pressing a key.

Interrupt-driven programs are fast and efficient. They enable a computer to respond to an event that may occur at any time and return to whatever it was doing before the interrupt occurred. Often, interrupt response must be fast. For example, to prevent delays in serial transmission, a received byte must be detected and processed before the next byte arrives.

Personal computers use interrupts (see the August 1992 *ComputerCraft* for a summary of PC interrupts). But microcontrollers and other single-purpose computer circuits must frequently respond to events in "real-time" as well.

This article serves as a guide to interrupts and interrupt programming for microcontrollers. Though the focus here is on the popular eight-bit Intel 8051, Motorola 68HC11 and Zilog Z8 microcontrollers, the same basic principles apply to any microcontroller circuit. In this article, I'll answer the questions: What happens during an interrupt? When should I use interrupts in my programs? How do the interrupts differ on different microcontrollers? How do I write an interrupt-driven program?

Interrupt Basics

Many computer programs are sequential. They execute a series of instructions, one after the other, in a pre-defined order. For example, an environmental logger might be programmed to continually measure temperature, humidity and ozone levels; plot the results on a chart recorder; and send the data over phone lines to a central office. In a sequential program, the main program loop may at times test conditions and, depending on the result, decide whether or not to branch to a subroutine, but everything happens in its defined sequence, with no "out-of-order" interruptions.

Not all events occur predictably, however. Sometimes a computer must be able to respond fast to an event that may occur without warning.

Detecting a keypress from a keyboard or keypad is a classic example of a use for an interrupt. Of course, a program can check periodically to see if a keypress has occurred. This is called polling, which is a simple,

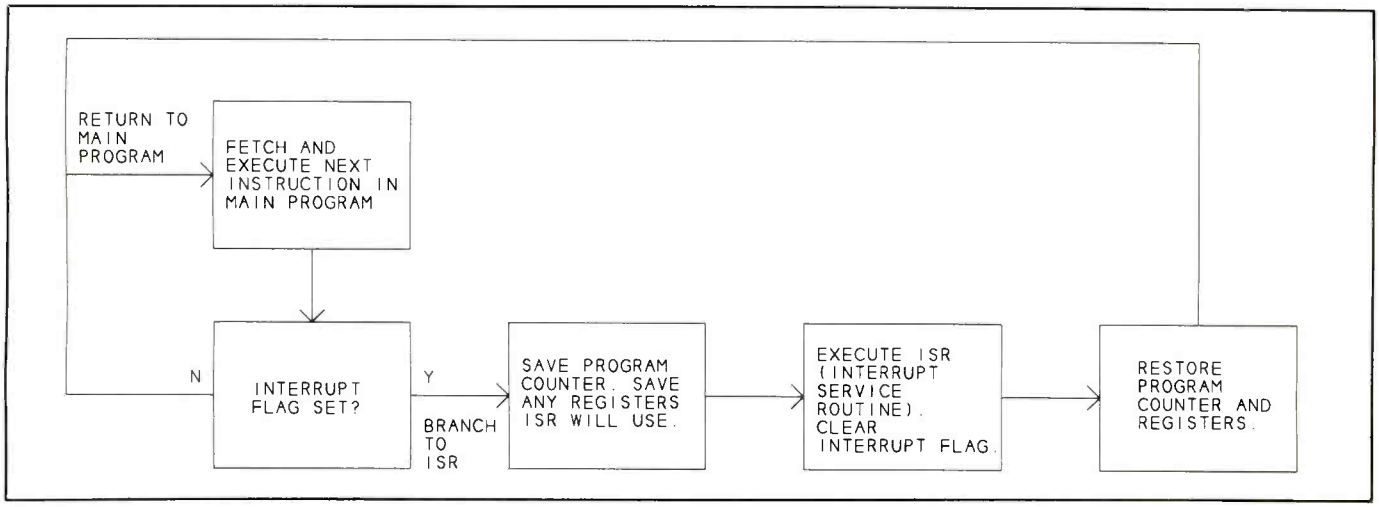

Fig. 1. An interrupt request causes program flow to jump to a special interrupt-service routine.

workable solution for some situations, such as when a display requests the user to press a key and then waits for a response.

Unlike polling, interrupts allow a program to continue with other tasks —reading sensors or plotting results, for example—without having to waste time periodically checking for events that require a response. The computer watches for interrupts automatically, freeing the software (or firmware) from having to do so. The exact process for handling interrupts varies with the device, but most follow the general pattern illustrated in Fig. 1.

You can use interrupts without understanding every detail about them, but some understanding of what's happening inside the device can help you write bug-free programs, or at least help you quickly find interrupt-related bugs that slip through.

As an example of how interrupts work, we'll first look at the 8051 microcontroller and later see how it compares to the HC11, Z8 and other microcontrollers.

Table 1. 8051, Z8 and HC11 Microcontroller Interrupt Comparisons

Microcontroller	8051	Z8	68HC11
Manufacturer	Intel	Zilog	Motorola
Interrupt Sources	5	8 (6 max. at a time)	18
External Interrupts	2	4	2
Level Triggering	Yes	No	Yes
Edge Triggering	Yes	Yes	Yes
Priority Levels	2	(48 possible orders)	2
Maskable/Nonmaskable	5/0	6/0	17/1
Auto-Saved Registers	0	1*	9
Serial Interrupts	1	2	2
Pulser/Timer Interrupts	2	2	12
Illegal Opcode Interrupt	No	No	Yes
Software Interrupt Instruction	No	No	Yes

*16 registers saved with 1 instruction.

Terminology

Before getting into the details, let's review some basic terms related to microcontroller architecture. The ones of most importance are as follows:

A *register* is a special small area of memory used for temporary storage of information. Most registers have pre-defined functions and names. Program counter (PC) and accumulator (ACC) are two examples.

The *program counter* is the register that holds the address of the next instruction the computer will execute.

A *flag* is a register bit or other signal that indicates the status or condition of an interrupt or other program element.

An *interrupt-service routine* (ISR) is a series of instructions, much like a subroutine, that the program will execute when the interrupt occurs. Each interrupt source has its own service routine. An interrupt-service routine ends with a special return-from-interrupt instruction.

An *interrupt-vector address* is a defined location in memory that holds the address at which the interrupt-service routine begins.

The *stack* is a special section of memory used for temporary storage of information. When a program calls an interrupt-service routine, the computer automatically saves the contents of the program counter on the stack so it will know where to return when it exits the interrupt-service routine. The stack may also preserve register contents, values of variables, other information the program will need on exiting the interrupt-service routine.

Saving information on a stack is called pushing, and retrieving from the stack is called popping. Stacks are usually last-in-first-out (LIFO) structures, which means that the last element pushed onto the stack is the first one popped from it.

Servicing Interrupts

In the 8051 microcontroller (and others), interrupts are signaled by flags. Once during each machine cycle, the 8051 checks the interrupt flags to see if any are set. A set flag indicates an event has occurred that requires immediate processing. Checking the flags during each cycle is actually a form of polling, but the polling is built into the hardware, rather than being implemented in software or firmware.

If no flags are set, the 8051 takes no action and proceeds to the next instruction in its program.

If a flag is set, and if the interrupt for that flag has been enabled, the 8051 first finishes executing the instruction in progress. In a few situations, it may execute an additional instruction.

The 8051 then gets ready to service the interrupt by placing the contents of the program counter on the stack. Saving the program counter ensures that the computer will know where to resume when it returns to the main program.

Depending on the interrupt, the computer may also clear the flag that generated the interrupt. For some interrupts, external circuits or software must clear the flag.

The computer then services the interrupt by jumping to the appropriate interrupt-service routine. Each interrupt source has its own interrupt-vector address. For example, in the 8051, the address for external interrupt 0 is 0003h; so when external interrupt 0 occurs, the program jumps to program address 0003h.

The interrupt-vector address normally contains an instruction to jump to another address where the service routine begins. Why not begin the service routine at the vector address, and eliminate the jump? The five interrupt-vector addresses in the 8051 are located between 03 and 23h in program memory, spaced eight bytes apart. Service routines longer than eight bytes overwrite one of the other interrupt-vector addresses. Even if the other interrupts aren't used, it's good programming practice not to use these locations for other code. In fact, you might want to place a return-from-interrupt instruction at each interrupt vector not in use, just in case the interrupt occurs accidentally.

The interrupt-service routine contains the code that does whatever needs to be done to process the inter-

rupt. For example, if the interrupt indicates a keypress, the interrupt service routine might read the keypress and display the results, or take the action requested by the keypress, or whatever applies to the situation.

The interrupt-service routine ends with a RETI (return-from-interrupt) instruction. When RETI executes, the program automatically retrieves the stored value of the program counter from the stack and picks up where it left off in the main program, until the next interrupt occurs.

The above example assumes that only one interrupt occurs at a time. In such a system, interrupt response time for the 8051 is greater than three but less than nine machine cycles, or between 3 and 9 μs with a 12-MHz clock. This is much faster than you could achieve by writing a program that periodically polls interrupt flags or other locations to detect an event.

Different Approaches

Other microcontrollers handle interrupts in similar ways, with some variations. For example, when an interrupt is requested in the Z8, the computer automatically saves the contents of its FLAGS register in addition to the program counter, and a single instruction preserves the contents of 16 registers. The HC11 automatically saves the contents of nine registers when an interrupt occurs. In both cases, the registers' contents are automatically restored on returning to the main program from the interrupt.

Another difference in both the Z8 and HC11 is that each interrupt-vector location holds only a 16-bit address, to which the computer jumps when that interrupt is requested. In contrast, the 8051 leaves you the option of storing a jump instruction or a short interrupt service routine at the interrupt vector address.

Depending on your program's needs, the approaches taken by different devices may or may not be convenient, but you often can work around differences that exist. For example, if you need to save an 8051's register's contents during an interrupt, you can add an instruction that does so in the interrupt-service routine.

Most important, when writing a program that uses interrupts, take the time to read through the section on interrupts in your microcontroller's data book. Don't assume that all devices are alike, or even that all interrupts within a device are treated alike.

As an example of the above, the 8052 automatically clears the overflow flags for timer 0 and timer 1, but it doesn't do it for timer 2. The HC11's applications guide says that, out of habit, many programmers mistakenly include instructions to save and restore register contents in their interrupt-service routines, not realizing that the HC11 does so automatically.

Types of Interrupts

Interrupts come in many flavors. They may be hardware- or software-triggered, high or low priority, external or internal, level- or edge-sensitive and maskable or nonmaskable. Different microcontrollers offer these in different combinations, and not all microcontrollers offer all of them. Here's what the terms mean:

• *Hardware or Software Triggered.* A software-triggered interrupt is generated by executing an instruction that

Listing 1. Demonstration of Interrupt use in the 8051 Microcontroller

```
;8051 interrupt demo

;This program demonstrates the use of interrupts on an 8051
;microcontroller.  It creates a pulse generator, or pulser, at Port 1, bit
;0 (pin 1).  Timer 0 overflow controls the width of the low pulses, and
;timer 1 overflow controls the width of the high pulses.  A high-to-low
;transition at external interrupt 1 (pin 13) turns the pulser on, and a
;high-to-low transition at external interrupt 0 (pin 12) turns the pulser
;off.  The pulser's frequency equals the inverse of the high time plus the
;low time.


;The following are the names of the main program loop and the interrupt
;service routines used.

                    org 0000h
                    ljmp main_program
                    org 0003h
                    ljmp pulser_off       ;ext. interrupt 0 turns pulser off
                    org 000bh
                    ljmp pulser_high      ;timer 0 interrupt sets pulser hi
                    org 0013h
                    ljmp pulser_on        ;ext. interrupt 1 turns pulser on
                    org 001bh
                    ljmp pulser_low       ;timer 1 interrupt sets pulser lo


;The main program sets up the timers for the desired pulse widths, then
;waits for interrupts.

main_program
                    mov tmod, #11h        ;configure timers 0,1 as 16-bit
                                          ;timers, enabled by setting tr0,1
                    setb it1              ;ext. int 1 is edge triggered
                    setb it0              ;ext int. 0 is edge triggered

;A timer interrupt occurs when a timer overflows from FFFFh (65535d) to 0.
;Initial timer values are set to give the desired delay between timer on
;and timer overflow.  The timers count at 1/12 the clock frequency in Mhz,
;so at 12 Mhz, the clocks increment each microsecond.

;At 12 Mhz, the initial timer value = 65536 - desired delay in
;microseconds.  Values are translated into high and low hex bytes, and
;stored as constants.  Hardware and program delays add about 10 microsecs.
;to each delay.  Variations in clock frequency also affect delay times.

;Initial timer values:

timer0_lo equ 9ch                         ;timer 0 has 100 microsec. delay
timer0_hi equ 0ffh                        ;FF9Ch = 10000h - 64h
timer1_lo equ 7ch                         ;timer 1 has 900 microsec. delay
timer1_hi equ 0fch                        ;FC7Ch = 10000h - 0384h

;Enable external interrupts:

                    setb ex1              ;enable external interrupt 1
                    setb ex0              ;enable external interrupt 0
                    setb ea               ;global interrupt enable
```

causes the interrupt. This may be done by setting an interrupt flag in software, or by executing a special software-interrupt instruction. All other interrupts are hardware-triggered, either by an event inside the chip, such as a timer timing out, or by logic levels or transitions on external device pins.

• *Internal or External.* An internal interrupt is triggered inside the chip, and may be a hardware interrupt or a software interrupt. An external interrupt is caused by the existence of or change in a logic level on interrupt pins.

• *Level- and Edge-Triggered.* These terms apply to external interrupts only. A level-triggered interrupt is triggered by a logic level (usually low), while an edge-triggered interrupt is triggered by a rising or falling edge. Because an edge-triggered interrupt is latched, even a very short interrupt pulse will be saved and serviced.

• *Interrupt Priority.* Priority describes which interrupt is serviced first when two or more occur at the same time. Priority may also determine which interrupts can interrupt other interrupt-service routines.

• *Maskable and Nonmaskable.* A maskable interrupt can be disabled by a software instruction. When masked, an interrupt that would otherwise be serviced is ignored. A nonmaskable interrupt can't be disabled; it will be always be serviced.

Interrupt Options

How many interrupts you have available, and what kinds, depends on the device you are using. The following sections compare the interrupts available in the 8051, Z8 and 68HC11. The variations result partly from different design philosophies and partly because the devices are from different eras and aimed at different markets, with older 8051s and Z8s having simpler architectures than newer, higher-end HC11s. Table 1 summarizes these differences.

8051 Interrupts

The basic 8051 (and 8031) has five interrupt sources: two external interrupts at pins 2 and 3 of port 3, two timer interrupts and a single serial interrupt for receive and transmit. The 8052 and 8032 have an additional timer and an interrupt to match.

Each interrupt has a dedicated flag, vector address, enable bit and priority bit. Bit 7 (EA) of interrupt-enable register IE is a global enable. When EA is low, no interrupts are permitted. When EA is high, interrupts may be enabled individually by setting their enable bits (bits 0 through 5 in IE).

The 8051 permits two interrupt priorities, depending on the state of the priority bits. A high-priority interrupt can interrupt a low-priority interrupt.

When two or more interrupts are requested at once, interrupts with equal priority follow a default order. For example, if you set three of the priority bits to 1 and the other two to 0 and all five are requested at once, the three high-priority interrupts are serviced first in their default order, followed by the two low-priority interrupts in their default order.

TF0 and TF1 are timer interrupts that trigger when a timer overflows. The timers can be used as timers, which increment automatically at a defined rate, or as pulse counters, which count transitions on an external pin. Timer interrupts are useful for triggering periodic actions.

```
;Main loop does nothing but wait for interrupts:

loop                sjmp loop           ;wait for interrupts


;On external interrupt 1, the pulser is enabled.  P1.0 goes low, timer
;interrupts are enabled, and timer 0 begins to time out.

pulser_on
                    mov tL0,#timer0_lo  ;initialize timer 0
                    mov th0,#timer0_hi
                    mov tL1,#timer1_lo  ;initialize timer 1
                    mov th1,#timer1_hi
                    setb tr0            ;turn on timer0
                    clr p1.0            ;pulser goes low
                    setb et0            ;enable timer0 interrupt
                    setb et1            ;enable timer1 interrupt
                    reti


;On timer 0 interrupt, pulser goes hi and timer 1 begins to time out

pulser_high
                    setb p1.0            ;pulser goes hi on timer0 overflow
                    setb tr1             ;start timer 1
                    clr tr0              ;stop timer 0
                    mov tL0,#timer0_lo   ;initialize timer 0
                    mov th0,#timer0_hi
                    reti


;On timer 1 interrupt, pulser goes lo and timer 0 begins to time out.

pulser_low
                    clr p1.0            ;pulser goes hi on timer1 overflow
                    setb tr0            ;start timer0
                    clr tr1             ;stop timer1
                    mov tL1,#timer1_lo  ;initialize timer 1
                    mov th1,#timer1_hi
                    reti


;On external interrupt 0, pulser turns off and timer interrupts are
;disabled.

pulser_off
                    clr et0              ;disable timer 0 interrupt
                    clr et1              ;disable timer 1 interrupt
                    clr tr0              ;turn off timer 0
                    clr tr1              ;turn off timer 1
                    reti

                    END
```

The serial interrupt triggers whenever a byte is transmitted or received at the serial port. In one mode, the serial interrupt occurs only when a special ninth bit is set, which usually indicates an address byte has been received. This mode is meant for networking and prevents the chip from having to respond to every transmission on the network, whether it's meant for that chip or not.

The two external interrupts are triggered by circuits external to the 8051. For each, you have a choice of configuring it to trigger on a low level or falling edge.

You can trigger an interrupt in software by setting a flag with program code. For example, if the timer-0 interrupt is enabled, it will trigger when timer 0 overflows, or when the program writes a 1 to TF0, which is timer 0's interrupt flag.

The program in Listing 1 demonstrates the use of interrupts on the 8051. It uses four of the five interrupt sources on the 8051 to create a pulser at a port pin, with programmable high and low times. The many comments in the program explain the code, eliminating the need to discuss the program further here.

Z8 Interrupts

The Z8 microcontroller has eight possible interrupt sources, although only six can be used at a time. Two of the interrupts can have alternate functions. Interrupts 0, 1 and 2 are external interrupts. Interrupt 3 can be configured as a fourth external interrupt or as a serial input interrupt. Interrupt 4 can be configured as a serial output or timer interrupt. Interrupt 5 is a second timer interrupt. One advantage of the Z8 is that it permits up to four external interrupts, compared to the 8051's two.

As in the 8051, each interrupt has a flag that triggers an interrupt-service routine and a mask bit that enables or disables each interrupt. Vector addresses point to the interrupt service routines. Bit 7 of the interrupt mask register (IMR) is a global enable that permits (logic 1) or prohibits (logic 0) all interrupts.

The flags are located in an interrupt-request register (IRQ). As in the 8051, you can trigger an interrupt in software by setting a register bit.

Of the three microcontrollers covered here, the Z8 allows the most flexibility in assigning priorities, using its interrupt priority register (IPR). The interrupts are grouped in pairs, with three bits setting the group priorities, and three other bits setting the priority within each pair. There are 48 possible priority orders in all.

68HC11 Interrupts

The final microcontroller for consideration is the 68HC11. This is a more full-featured device than the basic 8051 and Z8, and its interrupt structure reflects this.

Motorola lists 21 interrupt sources for the HC11, but these include three system resets. (Two are triggered by the computer-operating-properly monitor and clock.) A reset is similar to an interrupt because it occurs unpredictably and changes program flow, but instead of returning control to the interrupted location, a reset resets the program counter. Eliminating the resets leaves 18 interrupt sources, many of which are related to the HC11's on-chip timers and counters.

There are two external interrupts, IRQ and XIRQ. XIRQ is semi-nonmaskable, which means that it is disabled on power-up and the programmer decides when and if to enable it. Once enabled, XIRQ can't be disabled, except by a system reset (or while servicing an XIRQ request). XIRQ is intended for handling serious problems, such as power failure or program runaway.

IRQ can be configured to trigger on a low level or falling edge, while XIRQ is level-sensitive only. In addition to IRQ and XIRQ, interrupts can be triggered by external events at timer and pulse-accumulator input pins.

The special-purpose interrupts provided in the HC11 include:

SCI (serial communications interface), which indicates when a transfer is complete or a fault on synchronous serial interface.

SPI (serial peripheral interface) is used in asynchronous serial communications.

Pulse Accumulator Input Edge detects the presence of an edge at pulse-accumulator pin.

Pulse Accumulator Overflow detects an overflow condition of pulse accumulator.

Timer Overflow indicates that a timer has exceeded its maximum count capacity.

Timer Output Compare 1-5 is triggered after a programmed delay. These can be used to cause an event to occur at a specific time, relative to another event.

Timer Input Capture 1-3 indicates that an event has occurred and stores the time that it occurred.

Real Time Interrupt (RTI) causes periodic interrupts at any of four selectable rates.

Software Interrupt (SWI) is triggered by execution of the SWI instruction. It's used in debug monitors to transfer control to the monitor at a breakpoint.

Illegal Opcode allows the programmer to specify what to do if an illegal opcode is requested.

The priorities of HC11 interrupts are predetermined, with one exception. The programmer can give a single interrupt source highest priority by writing a value to the HRPIO register.

Multiple Interrupts

What can you do if your circuit requires many external interrupts but only one or two interrupt pins are available? Fig. 2 illustrates one solution. In this circuit, four 74LS74 flip-flops store four edge-triggered interrupt requests. A single interrupt pin goes low when any of the four sources requests an interrupt. Four port pins identify the interrupt source, and four other port pins clear the latched interrupts after they're serviced.

In greater detail, the circuit works as follows. A rising edge at any of the interrupt sources clocks a 74LS74 flip-flop and brings its Q output high. This turns on the associated transistor, bringing low the interrupt pin. The interrupt must be configured as a level-triggered interrupt inside the microcontroller, but the flip-flops respond to rising edges.

Once an interrupt has occurred, the software must determine which source requested the interrupt. The Q \ outputs of the flip-flops connect to port pins, which the interrupt-service routine polls, or reads. A low port pin indicates an interrupt was requested by the corresponding source.

After servicing the interrupt, the

program must clear and re-enable the interrupt by bringing the flip-flop's CLEAR input first low and then high. The interrupt flag in the processor must also be cleared.

You can use the Fig. 2 or a similar circuit to detect four, eight or more interrupts with a single interrupt pin. Special interrupt-controller IC chips also exist to help in processing multiple interrupts.

Programming an Interrupt

To write a program that uses an interrupt, you must do the following:

(1) Enable the interrupt. This usually involves setting a global interrupt-enable, as well as the individual interrupt enable. If you have multiple interrupt sources, you should also ensure that their priorities are set as desired in case two or more interrupts are requested simultaneously.

(2) Place an address at the interrupt-vector address and write an interrupt service routine that begins at the vector address. Or, with the 8051, you can store a short (eight-byte or less) interrupt-service routine beginning at the vector address.

(3) If the interrupt-service routine alters a register's contents or other data, and if the main program also uses that register or data, save the information (usually on the stack) and restore it on exiting the interrupt-service routine.

For example, if your interrupt-service routine performs calculations that use the accumulator, you should PUSH the accumulator's contents on the stack at the start of the interrupt-service routine and POP the contents back into the accumulator at the end of the routine. This way, if the main program is in the middle of a calculation when the interrupt is requested, the value in the accumulator will be saved and restored when the program exits the service routine.

You POP data in the reverse order it was PUSHed. Here's an example:

```
PUSH ACC
PUSH R1
(interrupt-service routine using
ACC and R1 goes here)
POP R1
POP ACC
RETI
```

Don't forget that some devices take care of saving the contents of the registers automatically.

(4) Clear the interrupt flag in the service routine, if the device doesn't do so automatically.

Interrupts often must be serviced as quickly as possible. For this reason, many programs written in BASIC, C and other higher-level languages use assembly language for the interrupt-service routines.

If you use BASIC-52 for the 8052, you should be aware that interrupts are called only after the current BASIC-52 statement (*not* the current machine-language instruction) finishes executing. This can take many milliseconds, depending on the statement and clock speed. Because BASIC-52 also relocates the interrupt vectors to 4003h to 402Fh in program memory, your circuits must include

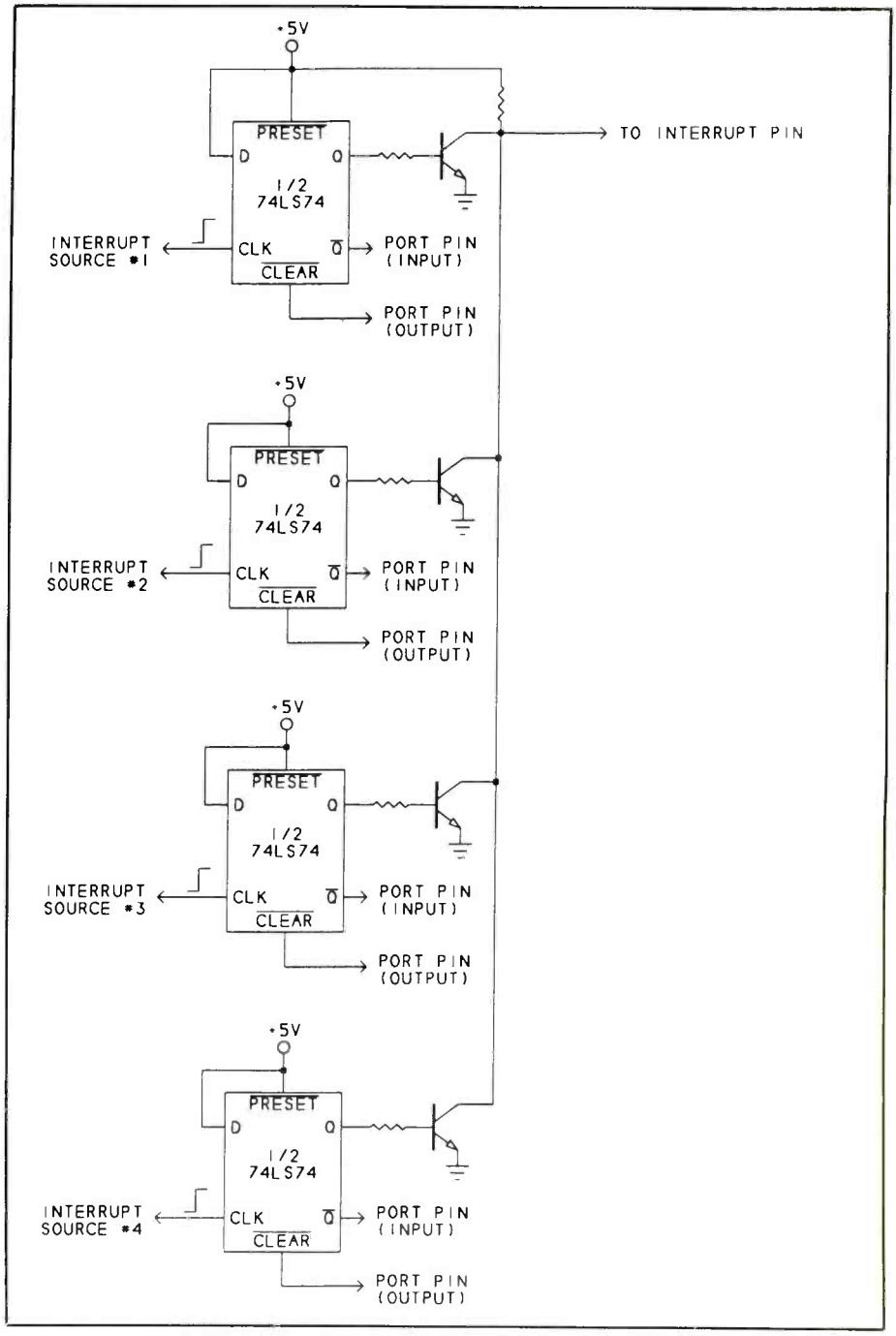

Fig. 2. This circuit illustrates how multiple interrupts can be identified and serviced by a single interrupt pin (and several port pins).

program memory at these locations.

Programming with interrupts can be tricky. There's a lot to remember, and simple mistakes can cause a program to run wild.

Here are a few tips for programming with interrupts:

(1) Keep the interrupt service routines short. This is especially important if interrupts are ignored during an interrupt-service routine. For example, a program that counts pulses at an input pin might miss some pulses if the program is tied up processing a long service routine.

(2) Disable all interrupts while you're writing to the interrupt-priority registers or other locations that affect interrupt servicing. This will ensure that nothing unpredictable will occur if an interrupt is requested while the registers are in unknown states. Some devices do this automatically.

(3) If possible, keep things simple by avoiding nested interrupts, which are interrupts that may be called from within another interrupt service routine. One interrupt at a time is challenge enough!

(4) Read the section on interrupts in your data book. You're sure to discover important, essential details you'd otherwise have overlooked.

Product News

On some different topics, in response to readers who have asked about books relating to microcontrollers, I've had a chance to look at two new titles, as well as some software that offers an integrated programming environment for microcontroller programmers.

The Art of Programming Embedded Systems by Jack G. Ganssle (Academic Press, $49) is a fascinating, information-filled and well-written book that concentrates on programming techniques and challenges unique to microcontrollers and other embedded systems. Included are chapters on designing easy-to-test and debug code and good advice on how to approach a programming task (including a chapter on interrupts).

This book is sprinkled with anecdotes—some humorous, some horrifying—from the author's career in the computer-emulator business. If you're interested in microcontroller programming, you'll enjoy this book.

Microcontrollers: Architecture, Implementation, and Programming by Kenneth Hintz and Daniel Tabak (McGraw Hill, $45) is an introduction to microcontrollers compiled by instructors of a senior-level engineering course. The first half of the book introduces microcontrollers, their instruction sets and the software-development process.

The remainder of this book describes and compares a variety of 4-, 8-, 16- and 32-bit microcontrollers. This book provides several examples, including a smart compass using a 68HC11, a packetized audio mixer using the 80960CA and a command and telemetry interface unit that uses a 80C196KB.

Neither of the above books is for beginners. Both assume you know something about computer hardware and programming, although not necessarily with microcontrollers. Prices for these books are a little steep, but this seems to be the way it is with specialized titles like these. To buy, contact the publishers directly or ask a local bookstore to order them for you.

Armadillo (Life Force Technology, $99) is a programming environment that permits easier switching among an assembler, text editor, communications program and other software you use while writing and assembling programs and uploading and downloading to and from a target microcontroller. It was designed by a programmer who wanted an easier way to do his own programming projects.

The programming environment is especially useful if you use a serial communication link with a program like Motorola's BUFFALO monitor for uploading object files from a PC to a target microcontroller. Instead of having to exit your communication program to access an editor and assembler, you can select your assembler, text editor and other programs from menus and automatically return to the serial link when you exit them.

I used *Armadillo* while writing and testing code for this article and came to enjoy the convenience of easy switching among programs. Demo disks are available, and there's a 30-day money-back guarantee.

Send your comments, suggestions and questions on topics relating to designing, building and programming microcontrollers and other small, dedicated computers to Jan Axelson, ComputerCraft, 76 North Broadway, Hicksville, NY 11801. ■

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Jan Axelson

Peer-to-Peer Networking

A practical low-cost way for computers to communicate with each other and share resources

In many small-businesses and offices, computers are operated stand-alone, accessing only the resources connected directly to them. The computers can't communicate with each other nor can they can share printers, modems, data files, etc. Until recently, if you couldn't afford to spend thousands of dollars to link computer stations and resources in a communication/resource-sharing network, this was the only practical way to go. Relatively new hardware and software, though, now make it possible for computers and peripherals on the same site to economically interconnect with each other and share resources similar to the way mainframe systems do.

A local-area network (LAN) system provides many of the advantages of mainframe networking designs at only a small fraction of the cost. In a LAN, up to 25 or so individual computers can be interconnected to communicate with each other and share system resources. Cost per station on such a network is quite reasonable, considering the benefits obtained.

I recently had an opportunity to evaluate Novell's *Netware Lite* and Artisoft's *LANtastic AI*, two of the leading peer-to-peer network operating systems. In addition to explaining the fundamentals of network systems in general and peer-to-peer systems specifically, this article is a summary of my experiences with these two products.

Network Defined

A network system consists a collection of computers that are interconnected in a manner that any one computer can communicate with any other computer on the net. The interconnections can be made with copper or fiber-optic cables, radio or microwave links, or infrared (IR) or laser links. In many cases, a special-purpose adapter card must be installed in each computer that attaches to the network "cable."

Because the adapter card serves as an interface between computer and network, it must conform to certain electrical and data-processing protocols to operate properly on the network. This interface card is controlled by a device driver that the network operating system (NOS) installs and is usually pretty tightly integrated with the NOS.

A network operating system is a program that resides in a computer's RAM memory. It loads a protocol, provides a device driver for a network interface card, intercepts certain DOS commands and passes these commands to the network interface card.

A protocol is an agreed-upon way of doing things. The fact that we all drive on the right-hand side of the road is an example of a protocol. It's a "standard" to which we all adhere to make it possible for our highway system to work. As it relates to networked computers, a protocol is an agreed-upon way of packaging and sending data from one system to another. Thus, a protocol is a series of rules to which each computer must adhere so that all computers using the same protocol can send and receive data among themselves.

Some of the rules that make up the protocol regard electrical signaling, while others are concerned with station addressing. All the protocol is designed to do is make it possible for data to be transferred between computer systems.

A device driver is a program that provides an interface between the BIOS in the host platform and any additional hardware that has been added to the system through its expansion bus. The device driver makes it possible for the host pc and any additional hardware to be made aware of each other and for the host computer and hardware to inter-operate (exchange data) with each other in a predictable and reliable manner. The device driver intercepts data and commands directed at added hardware and hands these commands off for processing to the devices for which they're meant.

A NOS intercepts certain keyboard commands from a user and hands them over to the network interface card or device driver for processing. Interception can occur because a NOS loads a "redirector" when the program starts. The redirector serves as an extension to the command interpreter and system BIOS. Whenever a user enters a command that the NOS recognizes as a network command, it intercepts the command before it's processed by DOS or the system BIOS and hands it off to the network program and hardware, where it undergoes further processing.

The network program's redirector is completely transparent to any and all commands and calls meant to be handled locally by DOS or the system's BIOS. The name "redirector" is given to this process because it's what it does: it redirects certain calls or commands to other programs or processes instead of letting DOS handle them.

Network Concepts.

At least three "models" of network computing are currently being seriously investigated as a method of maximizing the computing power of each processor owned by a given organization. The most widely known of these models are termed client-server, distributed processing and peer-to-peer.

The client-server model is founded on the idea of a server, which is usually a powerful PC/compatible computer in which are used one or more 486 processors, very-large-capacity hard drives (100M to 1.2G), 6M to 32M of RAM and, in some cases, EISA buses for enhanced throughput. The server is a centralized resource for computer users ("clients") who are connected to it over a network channel. A server can operate as a central point of control over the network by storing user accounts and access rights that define the resources clients can use.

The redirector in a client's workstation permits a user to access such resources on the server as hard-drive space, shared printers and modems by mapping a local resource name to the network resource. Thus, whenever a user accesses the locally assigned name, the redirector recognizes the name as a network resource and hands the request over to the network interface. The network becomes the path between user and resource.

Whatever resource a user wishes to access over the network becomes a "logical extension" of his PC. Client computers can even run programs on the server while staying at their own workstations. Server and workstation can even share processing of these programs in some cases, whereby part of the program runs on the server and another part is run on the client PC.

In essence, the client server model of computing is very similar to the concept of mainframe computing in that a central computer is the ultimate authority over user access rights. It's also a central repository for networked resources, information and data and, in some cases, programs. Users of client computers have the ability to access or process only those items to which the server's administrator provides access.

The distributed-processing model is the Holy Grail of network computing. Distributed processing defines a system in which an operating system that resides on the network links all processing and data-storage capabilities of each computer on the network into a single virtual computer. This virtual computer would optimize use of all attached network resources by "stealing" free processor cycles from each computer on the network and applying those processor clock cycles toward its own ends, running such an extremely processor-intensive application in a parallel fashion by distributing the program's tasks across all processors hooked into the network that have free processor cycles.

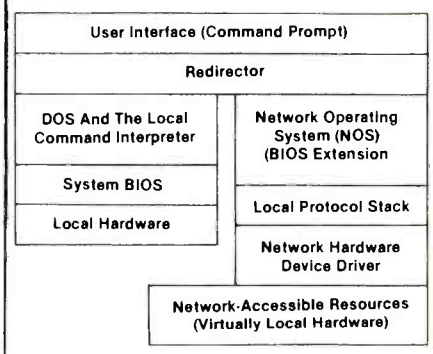
Similarly, the NOS would utilize hard-drive storage space, modems, printers and whatever other resources are attached to the network to suit the needs of the virtual system and its users. Of course, formation of the virtual computer that's a creation of all the devices attached to the network would become nearly as powerful as any super computer in existence to date. This system would also be designed so that users at each attached computer wouldn't be adversely affected by activities of the NOS.

In the peer-to-peer model of network computing, each computer has equal status with every other computer on the network. No central authority controls the activities in which a user at a single station can engage. Instead, individual users on the network define how the resources attached to their computers are to be shared with other users on the network.

If one user has a modem attached

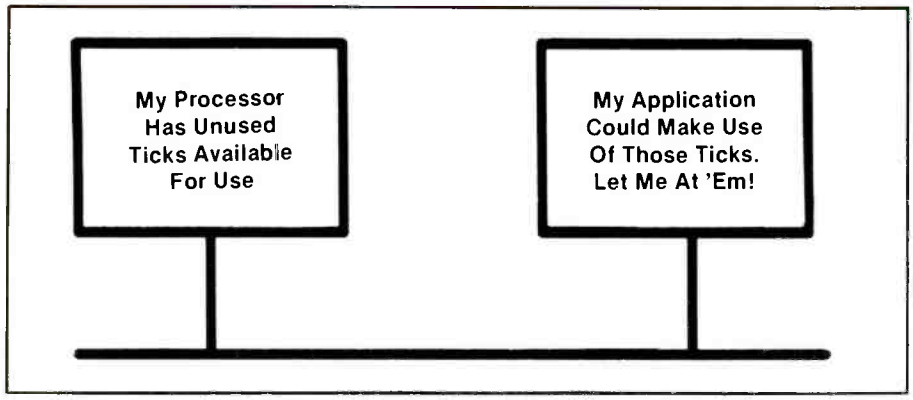
User Interface

A user enters a command to the computer. The redirector examines the command to determine if it is a network command. If it is, the command is handed over to the network operating system for interpretation and processing. The execution path for these commands involves data passage through the protocol stack and device driver, then through the network and, finally, into the network itself.

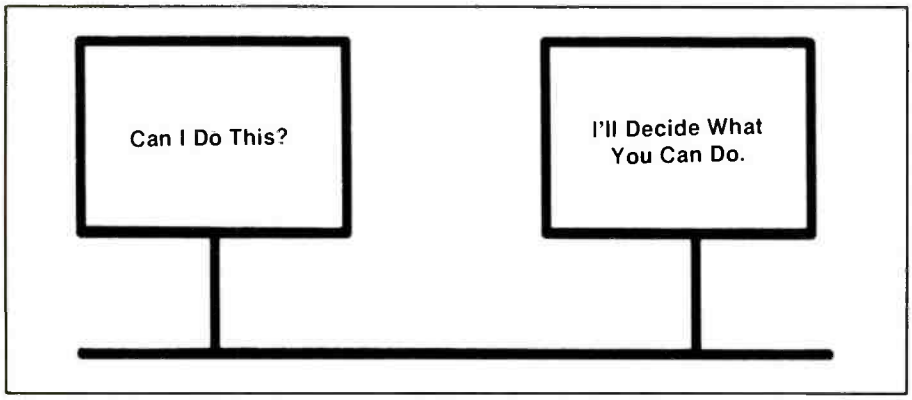


At this point, the computer system destined to receive the request responds to the command. This response is returned to the user by coming in through the network hardware, the data format is "translated" by the protocol interpreter, and the NOS passes the response back to the user through the user interface.

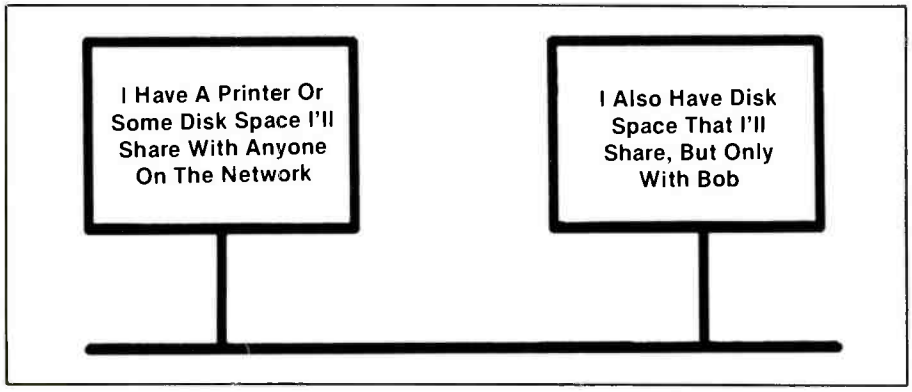
All commands not intercepted by the redirector are local commands and are processed by local BIOS services.



In the distributed-processing model, each computer tracks utilization of its local resources and can make them available to other computers or programs on the network. This would occur with little or no effort on the user's part.



In the client/server model, a central computer determines what access rights each user will have on the network.



In the peer-to-peer network model, each user determines what he will share and what rights are assigned to the resources attached to his local system.

to his computer, for example, he can share the modem with all users on the network through the NOS. Any user with a computer attached to the network can access and use the modem to dial out to other sites. The owner of the modem can revoke user rights to his modem at any time.

In essence peer-to-peer computing makes each user on the network determine the destiny of his PC system by allowing individuals to make decisions about how other users on the network can use their personal computers and the whatever printers, disk space, communication ports, etc. are attached to the network.

Several peer-to-peer operating systems are currently available. Two of the more widely known are *Netware Lite* from Novell and *Lantastic* from Artisoft. Each provides peer-to-peer services for the networked computers that have one of these network operating system programs installed on it. Let's look at each of these in turn.

Netware Lite

Overall, this application installed very easily, though the installation routine did have one disturbing quirk: it uses the ESC key to advance to the next "screen" or phase of installation. This isn't a great problem; it's just unusual enough to create some confusion for new users of the installation program.

The installation program includes drivers for several (if not most) common network interface cards. The program requires the installer to know the I/O address and IRQ levels of the card. This isn't an uncommon practice among programs of this class. During installation, several files were copied to the hard drive, a process that went off without a hitch. I give the installation program in *Netware Lite* high marks for ease of use.

This network program is serialized to prevent unauthorized duplication. The software broadcasts its serial number sometime during the log-on process. If duplicate serial numbers are detected on the network, one or both systems that have it can be "thrown off" the network.

This is a novel protection scheme to guard against unauthorized use of the program, but it requires network users to create some way to uniquely identify a single copy of the program to a single PC. I placed a comment in the CONFIG.SYS file that contained the serial number from the diskette. Though this is a workable solution, I feel this simple step could be automated to make things simpler.

Documentation supplied with *Netware Lite* aren't much better than useless. They continuously refer to a silly train analogy for a computer network. This might make great bedtime reading for kids or nice decorations for the side tables in a dentist's office, it offers no meaningful information to an installer, a fact that becomes increasingly more exasperating if the installer application requires more than "a right out of the box" installation. Needless to say, *Netware Lite*'s documentation gets low marks at best.

My test environment required a NetBIOS emulator (NetBIOS over IPX) that isn't a "native" protocol of *Netware Lite*, which meant that I had to go beyond a straight-out-of-the-box configuration. Even though it's possible to run NetBIOS with *Netware Lite*, the documentation offered no hints on this score.

I had to call in a Novell software engineer to solve this one. The software engineer had to place a call to corporate headquarters, which referred him to some little-known section inside *Netware* 3.11 documents. We were eventually able to get the required NetBIOS environment by creating a SHELL.CFG file. Is Novell counting on each *Netware Lite* buyer to own *Netware* 3.11? If so, what's the point of buying *Lite*?

The NetBIOS application works pretty well over a token ring, but the network program keeps crashing when we run our application on Ethernet (using a variety of different Ethernet cards). This seems to indicate that Netware Lite may still have some bugs that must be ironed out. While offering great potential, the program comes with a cautionary note. Consequently, it doesn't warrant high marks at this time.

Novell has done a pretty good job with *Netware Lite*. It's perfect for a small office or workgroup that will have less than 25 stations on the network. Even so, my advice is to wait for at least one level of revision to come out before buying into it. By then, some bugs will be worked out. Hopefully, future release of the documentation can be improved and a service channel established that can help those of us who want *Netware Lite* to be more than a cookie cutter NOS.

Lantastic AI

Installation of *Lantastic AI* was pretty clean. Unlike its counterpart, *Netware Lite, Lantastic* doesn't require the installer to supply information about the network interface up front. The installation procedure just copied files onto the hard drive. Configuration of this software is saved for later.

Lantastic AI supports many common network interface cards. An installer merely selects a card, and the installation routine copies the appropriate device drivers, but the installer's work is far from done after the installation routine finishes doing its job. Not withstanding other work that remains to be done at this point, this installation routine get a slightly better than average rating.

Like *Netware, Lantastic AI* is serialized to prevent unauthorized duplication. It broadcasts its serial number on the network during log-on. If duplicate serial numbers are detected, one or both systems can be thrown off the network. This networking program is also guilty of doing very little to help users keep their serial-number assignments straight.

Take our situation as a typical for instance. We had four persons installing these systems on 45 PCs. Somehow, the worst thing that could have happened did. A number of systems ended up with same copy of these serial-numbered network programs, which created utter chaos. We very nearly had to re-load each system to get this mess straightened out. This isn't something you want to do more than once.

Now imagine this situation with maybe 100 systems that have been installed for a number of months. If you know how users, their systems and diskettes tend to float around, you can well appreciate why it's necessary to have a way to tie a software serial number to a system in an easily identifiable way. Let's hope the software companies listen to this request.

Lantastic's documentation is definitely a cut above Novell's. Documents provided with the software can answer many of the more fundamental questions an installer is likely to ask. The documentation is very good, but it's by no means complete. Thankfully, *Lantastic* comes with extensive on-line help that proved to be very valuable during installation of this software. *Lantastic*'s documentation, especially its on-line documentation, is very good.

With NetBIOS being a native protocol for *Lantastic*, it was no problem getting my application to talk to NetBIOS. However, getting NetBIOS to talk to the interface device driver was a real challenge. I had to dig pretty deep into the on-line documents to obtain an answer to this one, which I found in the key STARTNET.BAT file. This file starts the NOS. Part of doing this means that it builds the stack (connects the device driver with the protocol stack).

Lantastic implements a stack by connecting the device driver with the NetBIOS redirector through an internal DOS multiplexed data channel. This is a simple enough idea, but it made me think that I'd consider *Lantastic* a challenging install from this point forward.

The device-driver run line in STARTNET.BAT has several flags that define the interface card's I/O address, interrupt level and multiplex channel, among other things. The multiplex channel specified in this run line must be a free multiplex channel that lies within a certain range. This idea was a new one on me; so I was happy that the one I selected first happened to work. I know of no way to determine what multiplex channels may be used by other system resources.

The NETBIOS run line comes right after the device-driver run line. The NETBIOS run line also has several flags to set, one being the multiplex channel that must be set the same as the multiplex channel that was selected in the device-driver run line. This channel serves as the data pipe between the network interface card's device driver and the NETBIOS redirector. After I made these changes to STARTNET.BAT, the stack was properly built and I was on my way.

This installation requires a person who's pretty comfortable around PCs. It isn't recommended for the uninitiated or lighthearted. Other than this, I give *Lantastic* good marks. I encountered no difficulties or problems getting to run once I had it correctly configured.

Lantastic is a great low-cost network-operating systems. It's been on the market for a while and can be considered a "stable" product. It's also a good candidate for the small office or workgroup that will have less than 25 stations on the network.

Final Remarks

Either of these products would be a good choice for an entry-level serverless NOS. The kinds of peer-to-peer networks they represent are precisely what's needed by anyone who wants to network a small office or workgroup but doesn't necessarily want to

Products Mentioned

Lantastic AI, $99/station
Artisoft, Inc.
691 E. River Rd.
Tucson, AZ 85704
Tel.: 1-800-TINY RAM

CIRCLE NO. 169 ON FREE INFORMATION CARD

Netware Lite, $99/station
Novell, Inc.
122 E. 1700 S.
Provo, UT 84606
Tel.: 800-453-1267

CIRCLE NO. 170 ON FREE INFORMATION CARD

System Requirements (both systems): XT and later PC/compatible computer; DOS 3.3 or later; 640K RAM; network adapter card.

CIRCLE NO. 171 ON FREE INFORMATION CARD

invest in a server or a server-based network operating system.

The primary strengths of *Netware Lite* are that it's backed by a company with the largest installed base of network operating systems. The problems with this software are its terrible documentation and the fact that some bugs need to be ironed out. Its primary strengths are that it's a stable product from a well-known company and that it supports NetBIOS as a native protocol. The latter is a very big plus in the PC environment.

If you're planning on networking, you probably have other software running on your systems, such as *Windows* or/and *Windows*-based applications and a slew of DOS-based business applications. Be sure to check out any programs you have installed with these operating systems before you make a buy decision. If you don't, you may end up scrapping some or all of your installed applications for new ones that will work with the network. This kind of "upgrade" can be a chaotic and often disastrously unsuccessful. So avoid them if you possibly can. You'll have to do a little homework to save a lot of trouble and expense.

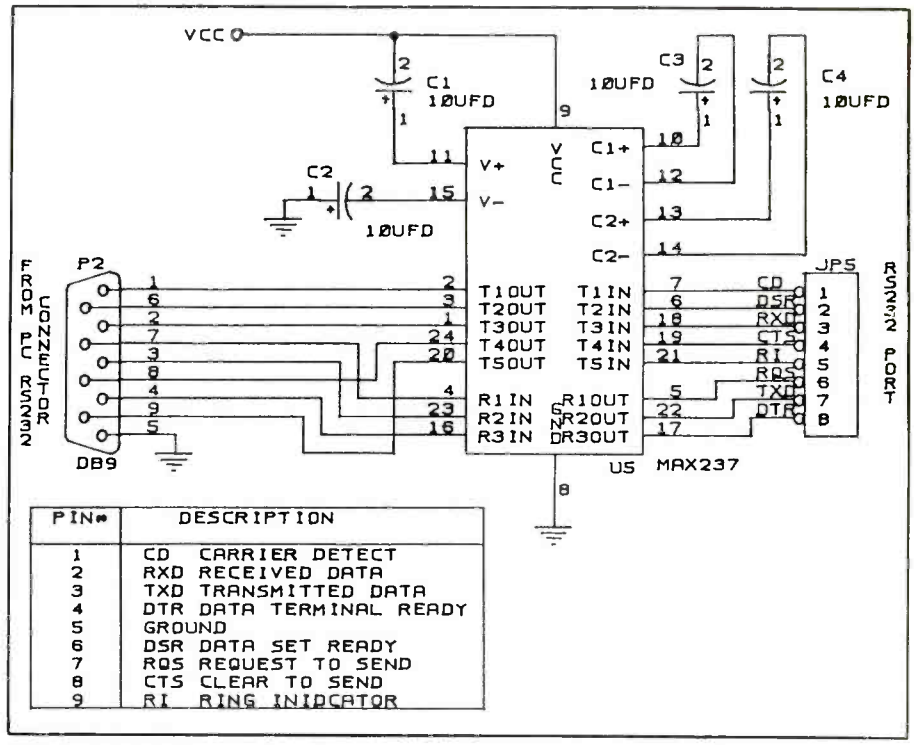
With the foregoing aside, do consider these network systems if you're on a hardware budget and want the benefits peer-to-peer networking can bring to you or someone you know. ■

Serial/Parallel-Port Interface

Provides buffering that permits safe connection of home-built projects to the serial and parallel ports of your PC

There are two ways to get into your PC without using interface cards or I/O devices like keyboards, printers, mice, etc. These are the RS-232 serial and parallel printer ports that are accessible through connectors on the back of your computer. If you want to interface a device to one of these ports, you run the risk of blowing an IC on an I/O board by accidentally shorting some line to ground or applying power where it shouldn't be.

A good way to prevent this mishap from occurring is to insert a buffer between the computer port and your home-built circuits. This can easily be accomplished for the RS-232 serial port and, with some thought, the parallel printer port as well. You can do this with the Serial/Parallel-Port Interface project described here. Using the printer port, with appropriate external logic, can sort of make it a true I/O port.



PIN#	DESCRIPTION
1	CD CARRIER DETECT
2	RXD RECEIVED DATA
3	TXD TRANSMITTED DATA
4	DTR DATA TERMINAL READY
5	GROUND
6	DSR DATA SET READY
7	RQS REQUEST TO SEND
8	CTS CLEAR TO SEND
9	RI RING INDICATOR

Fig. 1. Schematic details of the serial-port portion of the Interface board.

About the Circuit

Buffering the RS-232 port is easy, especially with single-supply converter chips. Maxim Integrated Products and other manufacturers make several chips with drivers that convert RS-232 to CMOS/TTL and CMOS/TTL to RS-232 levels that operate on a single +5-volt power supply. The only external components needed are four 10-μF capacitors.

The Maxim 24-pin "skinny" DIP MAX237 chip I chose for this project contains three RS-232-to-CMOS/TTL and five CMOS/TTL-to-RS-232 converters that very nicely match the standard output lines from a nine-pin RS-232 port. Figure 1 illustrates the simplicity of wiring this chip into the circuit. The only thing to keep in mind is that all signals are inverted by the line drivers and receivers.

In RS-232 jargon, a space is a binary 0 or positive voltage, and a mark is binary 1 or negative voltage. To get a binary 0 onto the RxD line, a 0 voltage level must be put on the corresponding CMOS/TTL RxD line. In most cases, you don't have to be concerned about polarities on the RxD and TxD lines. The UART (universal asynchronous receiver and transmitter) included in virtually all serial interfaces takes care of the situation.

On handshaking lines like DTR, DSR, etc., a positive-voltage space indicates that the line is "on" and that it's okay to send, while a negative-voltage mark signals stop. Applying the same reasoning, a "go ahead" signal in CMOS/TTL is a logic 0 (0 volt) and a stop signal is a CMOS/TTL logic 1 (+5 volts).

A typical IM6402 UART interface is shown in Fig. 2. All UARTs need a clock signal that's usually 16 times the system's baud rate. The baud-rate clock generator consists of 74HC4060 *U1*, 9.8304-MHz crystal *Y1*, resistors *R1* and *R2* and capacitors *C1* and *C2*. The clock generator can run IM6402 UART *U2* at 10 different baud rates,

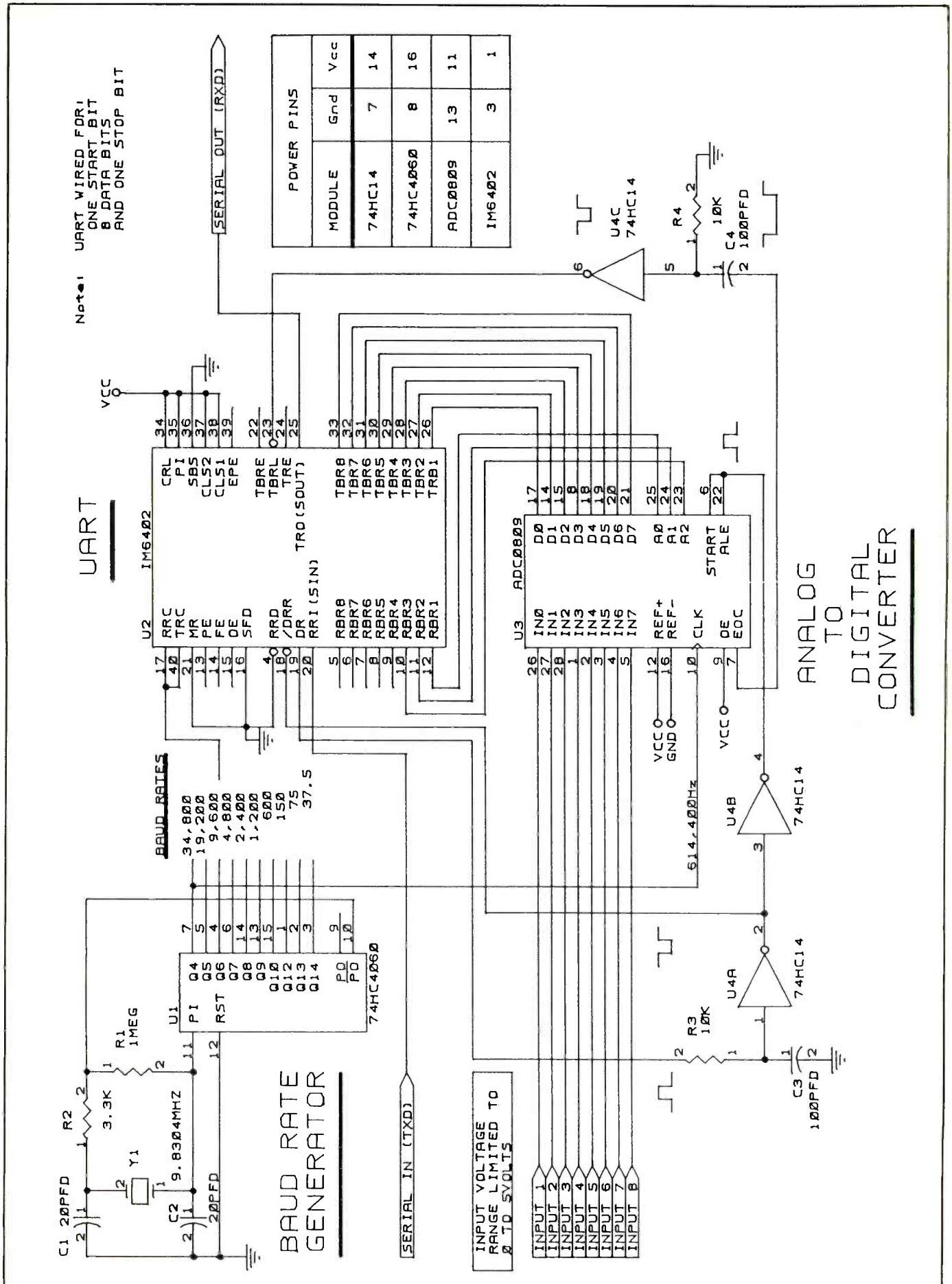


Fig. 2. Schematic details of the serial-port analog-to-digital converter circuit.

as listed in Table 1. Conspicuously, 300 baud is missing from this table. You can't get 300 baud with this scheme. However, when was the last time you used or wanted to use a 300-baud transmission rate?

Eight-input, eight-bit analog-to-digital (A/D) converter *U3* serves a as straightforward serial interface example. As shown, *U2* is set up for one start bit, eight data bits, one stop bit and no parity. Baud rate is selected by connecting pins 17 and 40 of *U2* to one of the 10 output pins of *U1*. The only other connections needed to complete the interface are the RxD and TxD lines from MAX237 *U5* in Fig. 1. RS-232 port lines CD, DTR, DSR, RQS, CTS and RI aren't needed here.

After being converted to TTL levels by *U5*, serial bytes on the TxD line are fed to RRI serial input pin 4 of *U2*. Since *U3* is an eight-input A/D converter, it has to be supplied with an input-select code. This is accomplished by wiring *U2* incoming data bits on pins 12, 11 and 10 (RBR1, RBR2 and RBR3) to *U3* as shown. To read a particular analog input, write the input address to the PC's serial port.

Once a complete character is received by *U3*, it's DR line on data-ready pin 19 goes high. The DR signal is delayed and inverted by *R3, C3* and *U4A*. It's then fed to data-ready reset /DRR at pin 18 of *U2* to reset the DR signal. The inverted DR signal is inverted a second time by *U4B*, after which it's used as both an address-latch enable (ALE) signal and a start signal for *U3*.

When *U3* finishes a conversion, its EOC (end-of-conversion) signal at pin 7 goes low, causing *C4, R4* and *U4C* to generate a approximate 0.05-μs negative-going pulse that's fed to *U2*'s TBRL (transmitter buffer register load) on pin 23. The rising edge of the pulse starts serial transmission.

The eight-bit binary equivalent of the selected analog input is sent to the PC via *U2*'s TRO (transmitter register output) at pin 25 and one of the CMOS/TTL-to-RS-232-level converters in *U5*. The program for this interface is given in Listing 1.

The parallel printer port interface shown in Fig. 3 is a little more complicated than the RS-232 port because it deals with one eight-bit and three four-bit registers. The standard PC printer port register connector wiring is shown in Fig. 4. The Data Output (Dor) part of the port is straightforward. The control port (Cr) and the Data In Low port (Dil) share *P1* con-

PARTS LIST

Semiconductors
U1—74HC03 open-drain quad NAND gate
U2—74HC04 hex inverter
U3,U4—74HC244 dual quad tri-state buffer
U5—MAX-232 level shifter
U6—LM7804 fixed +5-volt regulator

Capacitors
C1 thru C4,C6—10-μF, 16-volt electrolytic
C5—1,000-μF, 16-volt electrolytic with axial leads
C7 thru C10—0.1-μF ceramic disc

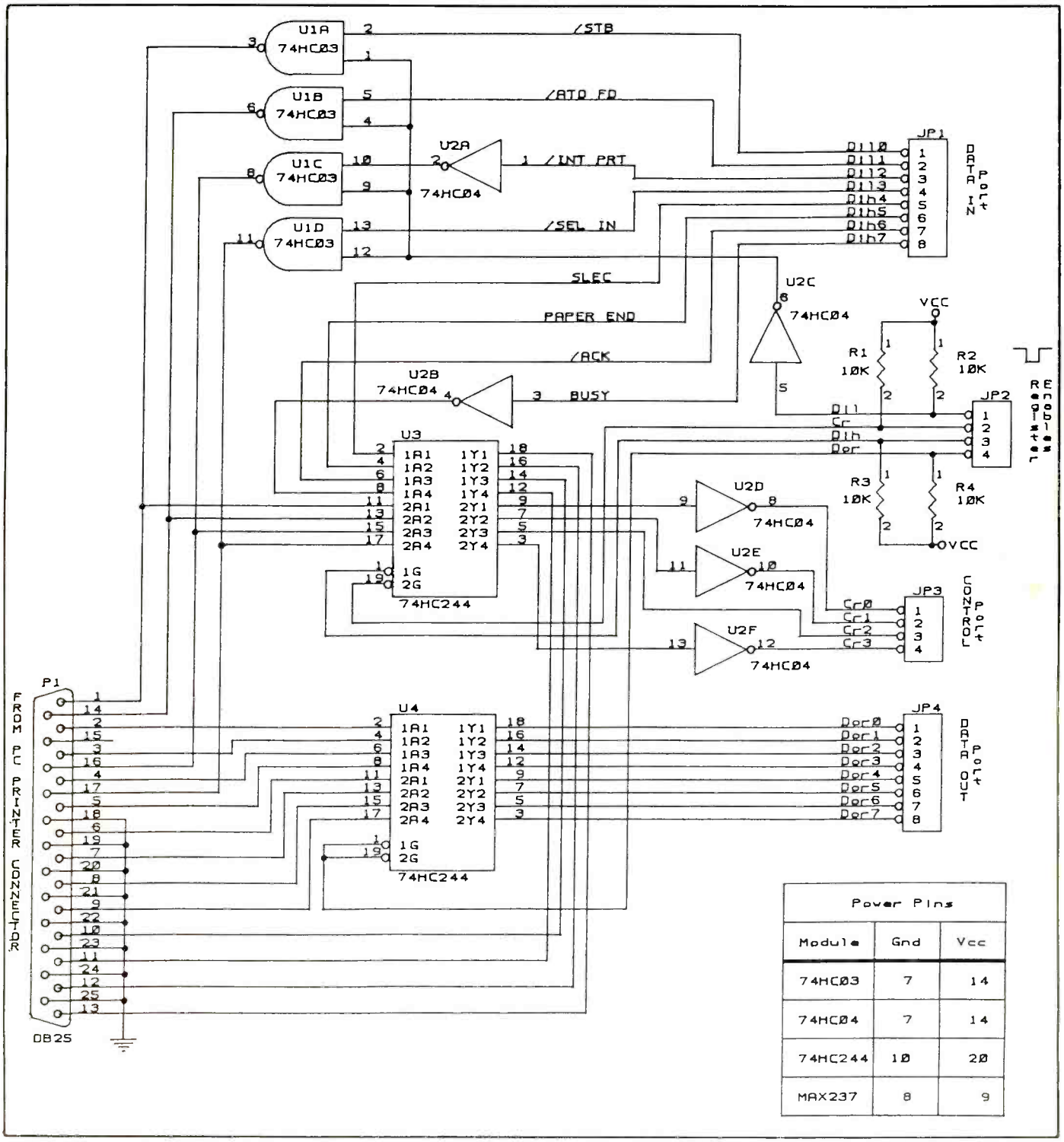
Resistors
R1 thru R4—10,00 ohms, ¼-watt, 5% tolerance

Miscellaneous
JP1,JP3,JP6—Eight-contact, top-entry pc board connector (Digi-Key Cat. No. WM3206 or similar)
JP2,JP4,JP5—Four-contact, top-entry pc board connector (Digi-Key Cat. No. WM3202 or similar)
P1—Right-angle pc-mount DB-25 connector
P2—Right-angle pc-mount DB-9 connector
P3—Power connector
Printed-circuit board; suitable enclosure (see text); sockets for all DIP ICs; 250-mA ac power adapter; serial and parallel cables; machine hardware; spacers; solder; etc.

Note: The following items are available from RJP Electronics Co., 52 Susan Lane, N. Haven, CT 06473: Ready-to-wire pc board with plated-through holes, $15; complete kit of all components (does *not* include ac adapter, cables and enclosure), $30.

Table 1. UART Baud Rates

Baud Rate	Baud Rate × 16 (Hz)
37.50	600
75	1,200
150	2,400
600	9,600
1,200	19,200
2,400	38,400
4,800	76,800
9,600	153,600
19,200	307,200
38,400	614,400



Power Pins		
Module	Gnd	Vcc
74HC03	7	14
74HC04	7	14
74HC244	10	20
MAX237	8	9

Fig. 3. Schematic details of the parallel-port portion of the interface board.

nector pins 1, 14, 16 and 17. The Data In High port looks okay, except for the inverter on Dih7, pin 11 of *P1*.

Figure 4 includes the I/O addresses of the four registers for printer ports LPT1, LPT2 and LPT3. You need these to read and write data. Also for programming purposes, Dor and Cr are output only and Dil and Dih are input only. Note that Dil and Cr have the same addresses. Cr accepts OUT instructions, Dil IN or INP instructions.

Chip *U4* in Fig. 1 connects to pins 2 through 8 on connector *P1* to isolate these data lines for the outside world. Enable lines on pins 1 and 19 of *U4* are tied together and brought out to Register Enable connector *JP2*. Each port register can be made to select or deselect by enable lines (active low) provided by the four-pin Register Enable connector (see Listing 2).

Notice that Dih4, Dih5 and Dih6 are brought directly to *U3*. The fourth Dih

Listing 1

```
'**********************  SAMPLE PROGRAM  **********************
'************************************************************
'ADC0890 analog to digital converter chip controlled by a
'PC's RS232 port using the "Printer/Serial Port Interface
'Board".
'Program is written in QBasic and sequentially selects,
'converts, scales and displays the voltages at the eight ADC
'input pins.
'************************************************************
'             BY:  RONALD J. PORTUGAL, MAY 3, 1992
'************************************************************

CLS
'DEFINITION:  ' Cn = CHANNEL NUMBER

'*** OPENS A SERIAL PORT AT 9600 BAUD, 1 START AND STOP BIT
    NO PARITY.  DS, CS, CD SUPPRESS LINE-STATUS CHECKING.
OPEN "COM1:9600,N,8,1,RS,DS,CS,CD" FOR RANDOM AS #1 LEN = 1

'*** PRINT DISPLAY SCREEN.
    LOCATE 5, 25:    PRINT "INPUT"
    LOCATE 6, 25:    PRINT "NUMBER", "VOLTAGE"
    LOCATE 7, 25:    PRINT "------", "-------"
    LOCATE 22, 23:   PRINT "PRESS ANY KEY TO END PROGRAM"

'**********************  MAIN PROGRAM  **********************

'*** SET UP CONVERTER LOOP
    DO UNTIL k$ <> ""

      '*** END PROGRAM TEST
          k$ = INKEY$

      '*** SELECT INPUT LOOP
          FOR Cn = 0 TO 7

            '*** WRITE INPUT CHANNEL NUMBER TO ADC
                PRINT #1, CHR$(Cn);

            '*** WAIT FOR ADC TO COMPLETE CONVERSION
                DO UNTIL LOF(1) > 0:    LOOP

            '*** READ INPUT BYTE
                V = ASC(INPUT$(1, #1))

            '*** POSITIONS, PRINTS & SCALES ADC READINGS ON VDU
                LOCATE 8 + Cn, 27
                PRINT Cn, USING "  #.##"; V * .01985
          NEXT Cn
    LOOP
END

'************************************************************
```

line is inverted by *U2B*. Including the inverter allows nibbles placed on Dih lines to be correctly read by the PC without requiring nibble-conversion instructions. Inverters on the Dil and Cr register lines correct both outgoing and incoming nibbles.

To unscramble the wired-OR setup on the Cr and Dil lines, some consideration had to be given to the logic states of Cr. If a 0 hex were to be written to Cr, (OUT Cr, &H0 instruction), the output pins of *P1* that correspond to Cr0, Cr1 and Cr3 wouldn't be at 0 volt. The series inverters cause the problem. However, because the wired-OR technique is used, logic 1s are okay, except that Cr2 is a logic 0, which isn't good.

If a 4 is sent to the Cr port, things turn out okay because now all Cr lines are logic 1s. To use the Dil input lines, the Cr register has to be set to 4. Then any nibble placed on the Dil lines,

along with a Dil enable signal at the Register Enable connector, are read into the PC correctly by an INP Dil instruction.

How do you use the port? One easy application is to tie lines Dor0 through Dor7 to a D/A converter and output a sequence of numbers from 0 to 255 decimal to the port. If you're clever, you can generate sine, triangle, ramp and other miscellaneous waveforms. But that's not really any fun.

Sending data to a printer port is pretty mundane. Reading an A/D converter or some other peripheral chip is more interesting. Shown in Fig. 5 are the connections needed for an eight-input, eight-bit ADC0809 A/D converter to the PC Printer/Serial Port Interface board.

The *U1* circuit is a clock generator for the A/D converter. Stages *U3A, U3B* and *U3C* make up an and/or selector for switching either EOC (end of conversion) or D0 (A/D converter data bit 0) onto the Dil0 line. When activated by Dor5, the EOC signal provides a way for the PC to determine when A/D conversion is done and, thus, serves as a polling signal.

The control line sequence is as follows: Dor0, Dor1 and Dor3 provide the A/D converter with the address of the analog input to be converted; Dor4 starts A/D conversion; Dor5 puts the EOC signal on the Dil0 line; and Dor6 enables the A/D converter's output lines and places A/D converter data bit 0 on the Dil0 line.

The sample program in Listing 2 turns off the Cr register, selects the input to be converted and starts the conversion. It then looks for an EOC signal, reads the Dil and Dih registers into the PC, re-assembles the two nibbles into a full byte and converts the reading to volts. Finally, it displays the results. When running this program, turn on Caps Lock to give you a way to gracefully exit the program. The A/D converter inputs should have some source voltage; leaving them floating yields nonsense read- outs.

The purpose of the project is to make interfacing easier. Therefore, I didn't want to include a power supply on the board. Since power requirement for the chips is fairly low, I used an LM7805 regulator and a 9-volt ac-to-dc adapter to supply power. The schematic details for this supply are shown in Fig. 6. Because most adapters can supply 250 to 500 mA of current, I included a + 5-volt power take-off on the Interface board.

Construction

Though it's possible to assemble the Serial/Parallel-Port Interface on perforated board using suitable Wire Wrap or/and soldering hardware, you're much better off using printed-circuit construction. You can etch and drill the double-sided pc board (but not plate-through the via holes) using

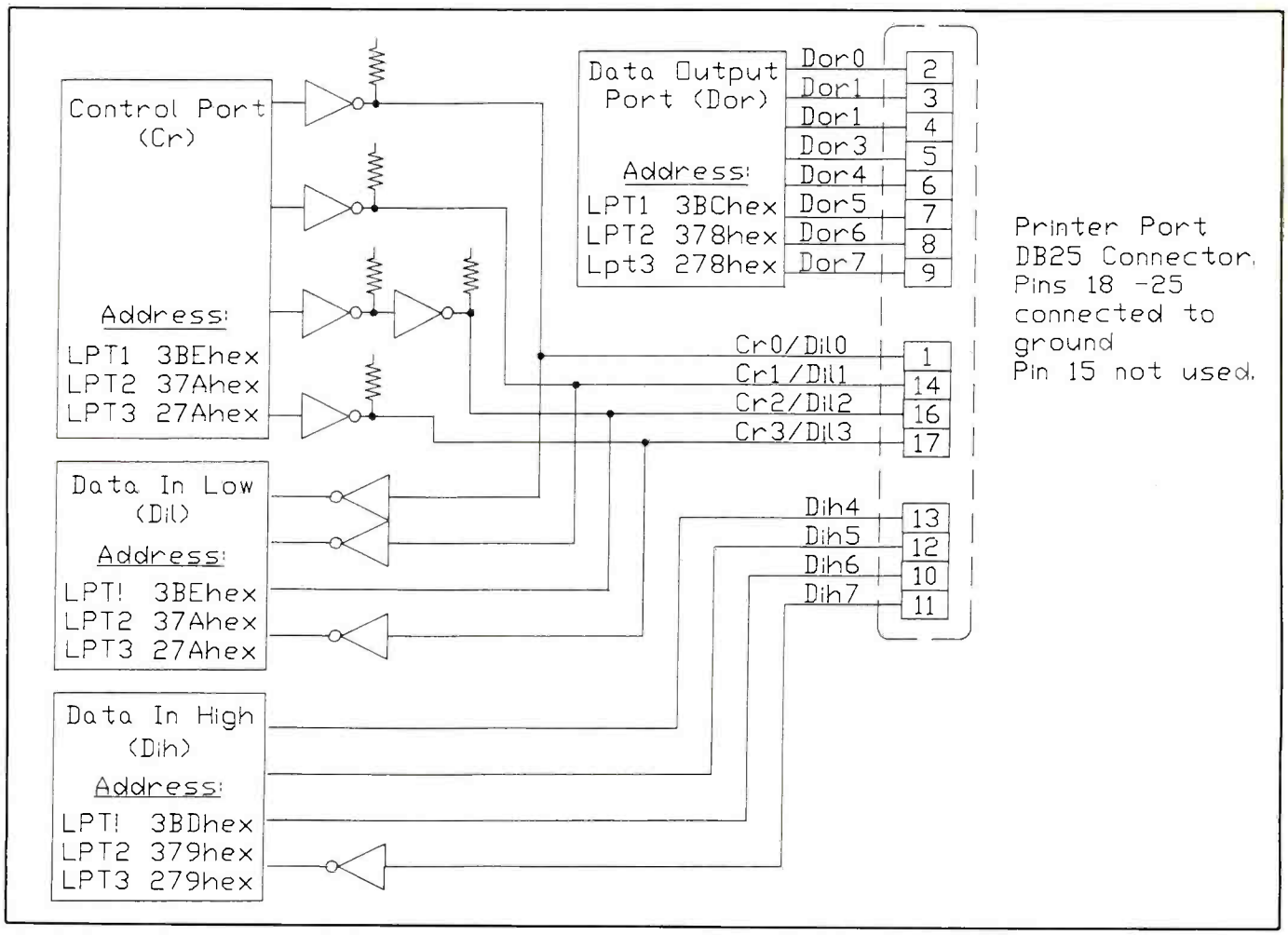


Fig. 4. Connector wiring details for the parallel-port connector.

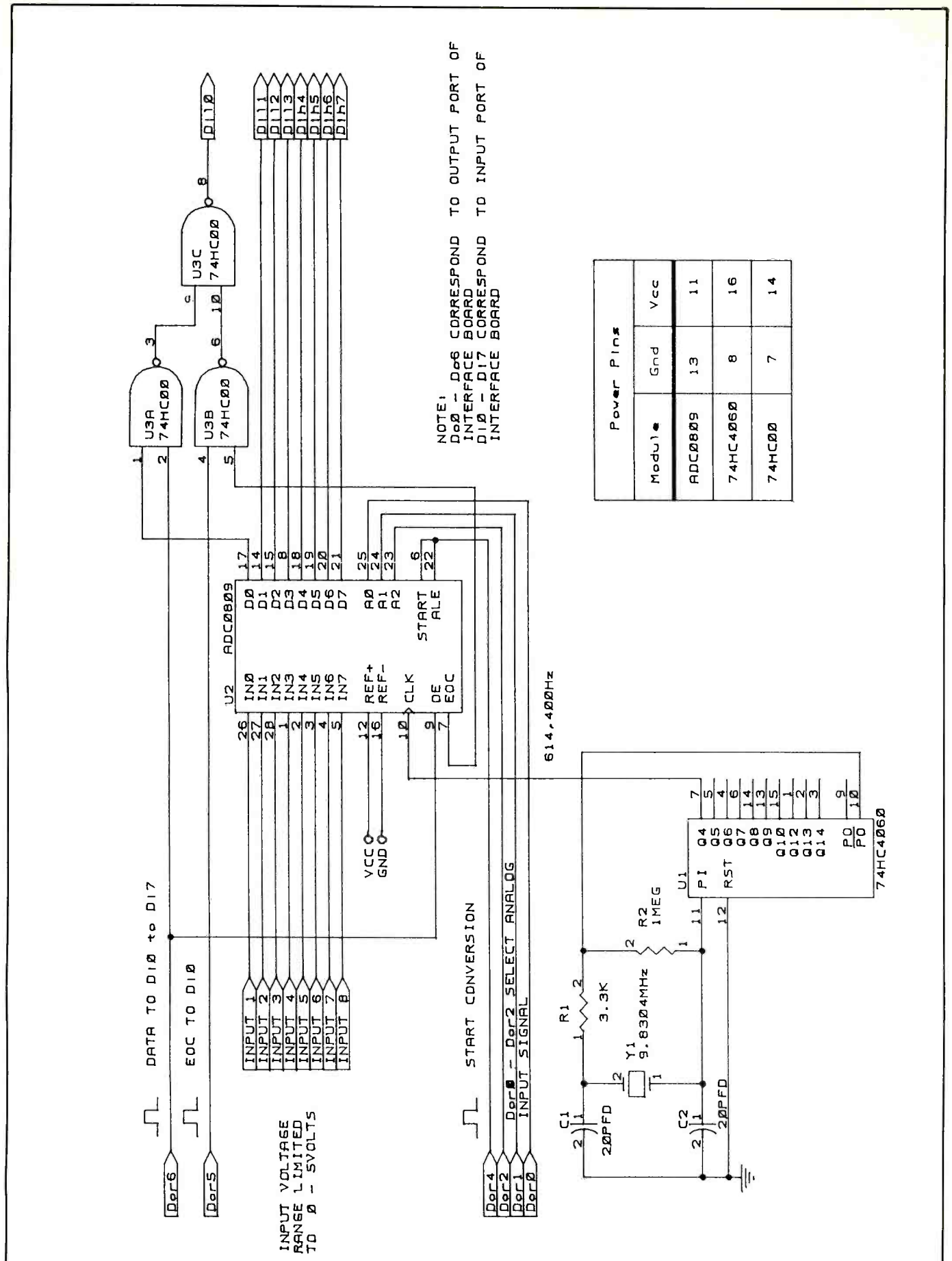


Fig. 5. Schematic details for the parallel printer port analog-to-digital circuit.

Listing 2

```
'|-------------------------------|        ** SAMPLE PROGRAM **
'| PRINTER PORT REGISTER ADDRESSES|        ********************
'|       IN HEX NOTATION         | ADC0809 analog to digital converter chip
'|-------------------------------| controlled by a PC's parallel printer
'| Regs.   LPT1    LPT2    LPT3  | port using the "Printer/Serial Port
'|------  ------  ------  ------ | Interface Board".
'|  Dor     3BC     378     278  |
'|  Dil     3BE     37A     27A  | Program is written in QBasic and
'|  Dih     3BD     379     279  | sequentially selects, converts, scales
'|  Cr      3BE     37A     27A  | and displays the voltages at the eight
'|-------------------------------| ADC input pins.
'*******************************************************************************
'                        BY: RONALD J. PORTUGAL, MAY 3, 1992
'*******************************************************************************
CLS 'DEFINITIONS:
'*** REGISTERS:                                                    QBASIC INST
        Dor = &H3BC             'DATA OUTPUT REGISTER                (OUT)
        Dil = &H3BE             'DATA INPUT REGISTER, LOW  NIBBLE    (INP)
        Dih = &H3BD             'DATA INPUT REGISTER, HIGH NIBBLE    (INP)
         Cr = Dil               'CONTROL REGISTER                    (OUT)
'*** GENERAL:
         St = 16                'ACD START CODE
        Enc = 32                'ENABLE END OF CONVERSION GATE
         Rd = 64                'ENABLE ADC OUTPUTS
        'Cn = CHANNEL NUMBER
        Stt = St + Enc + Cn     'SET ADC START PULSE HIGH
        Stp = Enc + Cn          'SET ADC START PULSE LOW
'*******************************************************************************
        OUT Cr, 4               'DISABLES CONTROL REGISTER OUTPUTS
'*** PRINTS DISPLAY SCREEN
        LOCATE 7, 25:  PRINT "  INPUT"
        LOCATE 8, 25:  PRINT "  NUMBER", "  VOLTAGE"
        LOCATE 9, 25:  PRINT "  ------", "  -------"
        LOCATE 22, 26: PRINT "TO END PROGRAM PRESS <CAP Q>"
'****************************** MAIN PROGRAM ***********************************
DO UNTIL INKEY$ = "Q"

   FOR Cn = 1 TO 8
        '*** SEND START PULSE TO ADC
              OUT Dor, Stt:    OUT Dor, Stp

        '*** WAIT FOR END OF CONVERSION ***
              DO UNTIL A = 1
                    A = INP(Dil):  A = A AND 1
              LOOP

        '*** SET ADC FOR READ OPERATION.
              OUT Dor, Rd + Cn

        '*** INP INSTRUCTIONS READ DATA FROM  LOWER AND UPPER HALVES OF THE
        '*** Di REGISTER.  INSTRUCTION MASKS THE UPPER FOUR BITS OF THE
        '*** LOWER NIBBLE AND LOWER FOUR BITS OF THE UPPER NIBBLE TO ZEROS
        '*** AND THEN FORMS THE RE-ASSEMBLED ADC BYTE.
              V = (INP(Dil) AND &HF) + (INP(Dih) AND &HF0)

        '*** POSITIONS, PRINTS AND SCALES ADC READINGS ON VDU.
              LOCATE 9 + Cn, 28: PRINT Cn, USING "    #.##"; V * .01985

   NEXT Cn
LOOP
END
'*******************************************************************************
```

the actual-size artwork shown in Fig. 7. Alternatively, you can purchase a ready-to-wire board with plated-through holes from the source given in the Note at the end of the Parts List.

To keep the top side of the pc board free of protruding components, *U6*, the capacitors, *P1* and *P2* mount on the solder side. With this in mind, begin wiring the board.

First orient the pc board as shown in Fig. 8. Then begin populating it by installing and soldering into place sockets for all DIP ICs. Do *not* plug the ICs into their respective sockets until after you've conducted preliminary voltage checks and are certain your wiring is okay.

Continue wiring the board by installing and soldering into place the resistors and capacitors. Make sure you properly polarize the electrolytic capacitors before soldering their leads into place. Then install voltage regulator *U6* in the appropriate location, making sure it's properly based before you solder its pins into place.

Next, install and solder into place the jumper blocks labeled JP1 through JP6 and the power-connector block labeled P3. Finish wiring the board by installing and soldering into place the DB-25 and DB-9 connectors in the locations labeled P1 and P2, respectively.

Install 40-40 × 1″ machine screws and ½″ spacers in holes at all four corners of the board to keep the Interface board above your working surface. Alternatively, you can house the board inside any enclosure that will accommodate it, using the machine hardware and spacers. Before mounting the board, cut slots in the enclosure to permit *P1* and *P2* to protrude and

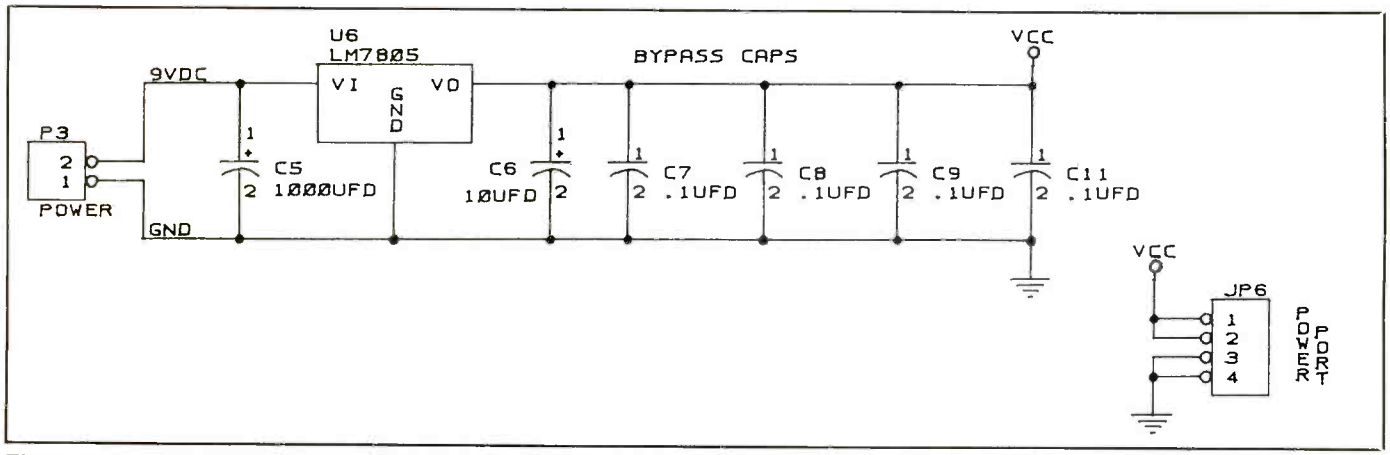


Fig. 6. Schematic details for the Interface's simple dc power supply.

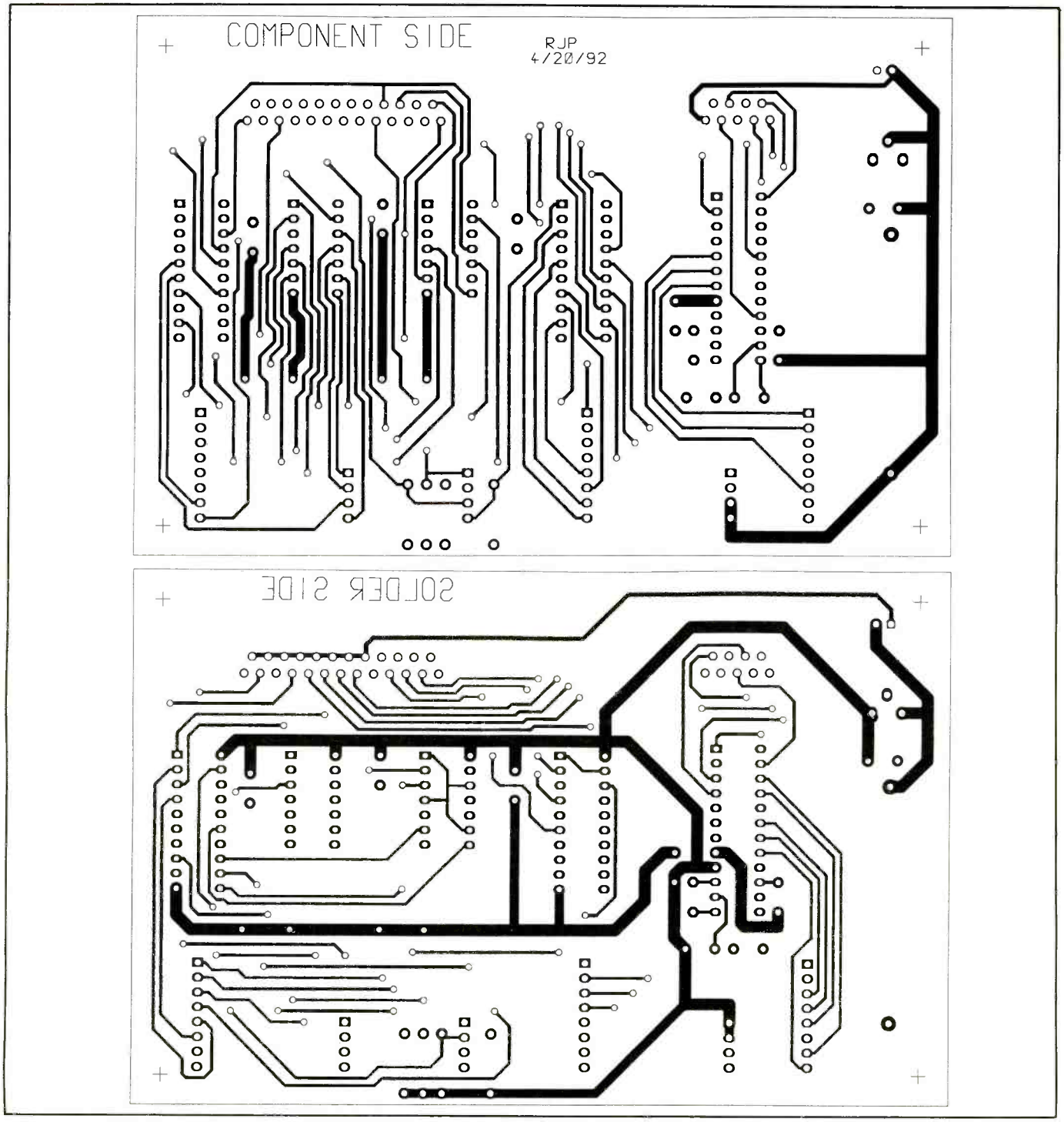


Fig. 7. Actual-size etching-and-drilling guides for the component and solder sides of the Interface's double-sided printed-circuit board.

holes for the mounting hardware for the board itself and the power connector.

The connectors specified in the Parts List for the Interface are standard types: DB-9 for the RS-232 serial and DB-25 for the printer ports. Cables from the PC to the Interface board are straight through, with pin 1 at the computer end being pin 1 at the Interface board end.

Checkout & Use

When you're done assembling the Interface board (the only IC installed on the board at this time should be regulator *U6*), apply power to it. Clip the common lead of a dc voltmeter or DMM set to the dc-volts function to any point on the board that's supposed to be at circuit ground.

With power applied to the circuit board, touch the "hot" meter lead to the VO pin of regulator *U6* and observe the meter reading. It should be approximately +5 volts. The same reading should appear when you

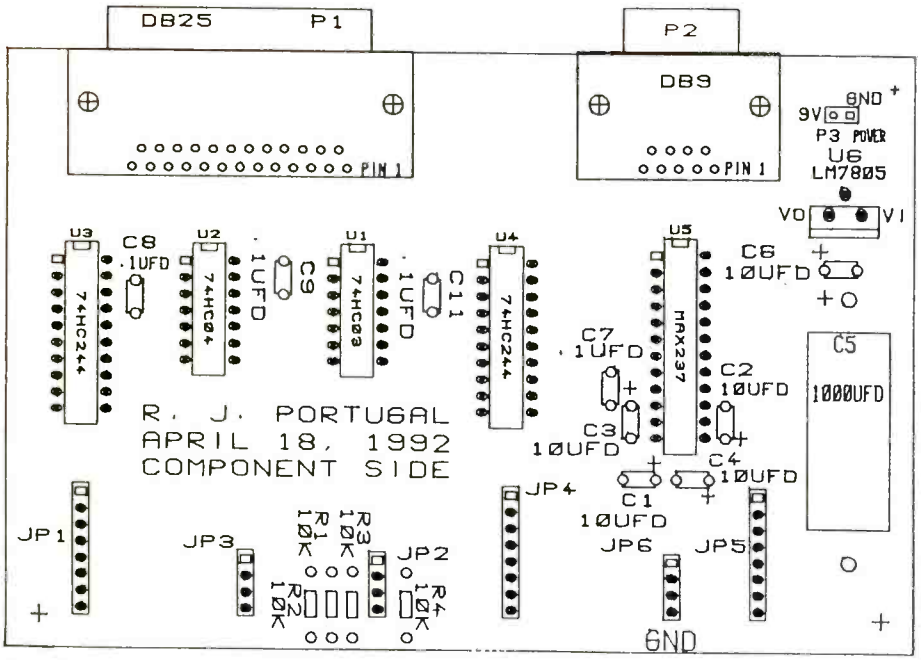


Fig. 8. Wiring guide for the Interface's pc board.

touch the "hot" probe to pin 14 of *U1* and *U2*, pin 20 of *U3* and *U4*, and pin 9 of *U5*. If you fail to obtain the proper reading at any of the specified points, power down and correct the problem before proceeding.

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

Your Serial/Parallel-Port Interface is now ready to be put into service. Figure 9 identifies the signals on the pins of the various jumper blocks on the board. Feel free to photocopy Fig. 9, trim it to size and cement or tape it to the enclosure's inside top panel. If you don't mount your Interface board inside an enclosure, cement the trimmed photocopy of Fig. 9 to heavy card stock and keep it handy.

Use standard serial and parallel cables to connect between the ports on the rear of your PC to *P2* and *P1*, respectively, of the Serial/Parallel-Port Interface. You can breadboard the circuits shown in Fig. 2 and Fig. 4 and use the programs given in the Listings here to experiment with the project to gain familiarity with its use.

Once you're familiar with how the interface works, you can use it to test out your own circuit designs and others you find published in magazines and books with complete safety for your computer. ■

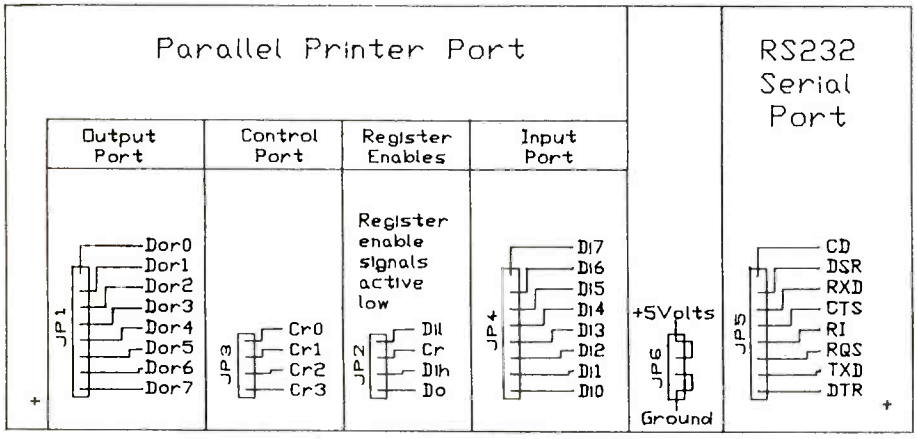


Fig. 9. Signals on the pins of the various jumper blocks on the board.

Tapping the Unused Text Capabilities of Your VGA System

VGA cards can do a lot more in the way of text than what you or the applications you use are tapping

A common lament of hardware designers is that software always lags several years behind hardware development. For example, most new computers have a 386 or 486 CPU, but few of these advanced machines do more than run DOS and *Windows* programs in 8088 mode. The extra power of 32-bit instructions and protected mode built into these processors is rarely tapped at all.

The foregoing is also true of the peripherals attached to your machine. Your computer probably has a VGA or super-VGA video adapter, for example, that in text modes rarely does anything more than emulate the archaic CGA adapters from the earliest IBM PCs. Many modern applications software, including Microsoft *Windows*, push video cards to the limit in graphics modes, but few take advantage of the text-mode power built into these cards.

Few users and fewer application programs seem to realize that VGA cards can do all sorts of text tricks. For example, they can display up to 512 different characters simultaneously, underline any on-screen text, display text in a vast variety of sizes, produce *Windows*-style scrolling of one text screen over another and even display pixel-based graphics on a text screen. I'll show you how to perform some of these tricks this month and explain how they work.

In the Beginning

From the point of view of the CPU, a video adapter has three parts: a BIOS that can be reached through software interrupt 10 hex, a block of video memory and a set of I/O ports. The BIOS routines simply manipulate video memory and the I/O ports in the same way a program does. Their purpose is to simplify the programming interface to the video adapter and to hide some of the differences between video cards.

To the video monitor, the video adapter is the source of dot information and synchronization signals. The monitor itself is simply some interpretive electronics that control one or more electron guns inside a picture tube. Bursts of electrons strike the phosphors on the inside surface of the picture-tube screen in controlled locations. Each burst makes phosphors on the screen glow. A monochrome display has phosphors of one color, while a color display has phosphors of three colors and usually three electron guns that are separately aimed to strike the phosphors of their respective colors.

All popular PC video adapters work with raster, as opposed to vector, displays. The electron gun scans across each row of the screen from left to right, firing at each location the adapter tells it should be lit. At the end of the row, the adapter turns off the gun and sends a horizontal sync signal that "moves" the gun to the beginning of the next row. At the end of the screen, the adapter sends a vertical sync signal that tells the monitor to move the gun back to the top of the display area of the screen.

The video adapter seems quite simple from the point of view of the CPU and display monitor. Internally, the adapter interprets the data in video memory and instructions it receives over the I/O ports and translates the data into a form the video monitor understands, including the necessary sync signals. The adapter's job is complicated by the fact that the CPU (and application programs) want to work with video memory in two very different ways or modes.

Listing 1. DEMOS.BAT Creates All Demonstration Programs

```
@echo off

: This batch file assumes that
: MASM 5.1 or later and LINK are in your
: path.  Add "/DMASM51 /DQUIRKS" to the
: assembly command line if you use
: Borland's TASM.

MASM test;
If Errorlevel==1 GOTO END
LINK test,test1;
If Errorlevel==1 GOTO END

MASM /DFeat=1 test;
If Errorlevel==1 GOTO END
LINK test,test2;
If Errorlevel==1 GOTO END

MASM /DFeat=2 test;
If Errorlevel==1 GOTO END
LINK test,test3;
If Errorlevel==1 GOTO END

MASM /DFeat=3 test;
If Errorlevel==1 GOTO END
LINK test,test4;
If Errorlevel==1 GOTO END

MASM /DFeat=4 test;
If Errorlevel==1 GOTO END
LINK test,test5;
If Errorlevel==1 GOTO END

MASM /DFeat=5 test;
If Errorlevel==1 GOTO END
LINK test,test6;
If Errorlevel==1 GOTO END
:END
```

In graphics modes, each pixel or pel (shortened forms of "picture element") can and must be controlled individually. In text modes, the CPU places character information in video memory and expects the adapter to translate this into the necessary pixels. The monitor doesn't care about whether the adapter is running in text or graphics mode.

In text modes, video memory is divided into a 16-bit word for every on-screen character. If the screen is displaying 25 rows of 80 characters each, $80 \times 25 = 2{,}000$ words, or 4,000 bytes of memory, are required to define the entire screen. The first byte of each word defines the character being displayed in a particular location. The second byte is a list of display instructions called attributes.

To translate a character into screen dots, video adapter cards use a character generator and table of character shape definitions. The Monochrome Display Adapter (MDA) and Color Graphics Adapter (CGA) store character tables in on-card ROMs that are accessible to the character generator but aren't in the CPU's address space.

Enhanced Graphics Adapters (EGA) and Video Graphics Arrays (VGA) broke with this tradition. Their character tables are in normal ROM and are moved to video memory whenever the adapter is put into text mode. Character shapes are accessible to the CPU and can be replaced with user-defined shape tables. This opens a new realm of possibilities, though few programs take advantage of them.

Adapter Organization

In most respects, VGA is a superset of EGA, which it has all but replaced in new computers. EGA was originally built with four main chips, each controllable through I/O ports. While later EGA and most VGA are built on a single chip, they still appear as four chips to the CPU and can be controlled through four sets of I/O ports. The adapter also has a small set of general or external control ports that aren't associated with any of the four original chips.

Each "chip" contains a number of eight-bit registers, some of which hold single values, while in others, individual bits select video adapter features. With one exception, each chip is acces-

Listing 2. Testbed Program For VGA Text-Mode Experiments

```
;  Requires MASM 5.1 or later, or a compatible assembler

;  NOTE: THIS PROGRAM DOES NOT CHECK FOR THE PRESENCE OF
;        A COLOR VGA SYSTEM BUT WILL NOT RUN PROPERLY WITH
;        OTHER VIDEO ADAPTERS.  DO NOT RUN THIS PROGRAM ON
;        UNLESS YOU HAVE A COLOR VGA! UNLESS YOU ALTER IT
;        APPROPRIATELY.

        .model small
        .stack
        .code

;  Definitions of I/O ports:
GRAPHICS  =     3CEh
ATTRIBUTE =     3C0h
SEQUENCER =     3C4h            ; Index and registers at
                                ; same port for sequencer
ifdef Feat                      ;Select the correct feature file
  if Feat EQ 1
    Include Blink.asm
  endif
  if Feat EQ 2
    Include Uline.asm
  endif
  if Feat EQ 3
    Include 50Line.asm
  endif
  if Feat EQ 4
    Include 2Sizes.asm
  endif
  if Feat EQ 5
    Include LrgFont.asm
  endif
endif

;  Useful macros for screen demos:

getkey  macro
        sub     ax,ax           ;Wait for key
        int     16h             ;with Int 16, func. 0
        endm                    ;Key returned in AL

cls     macro
        push    ax              ;Save registers
        push    di
        sub     di,di           ;Start at offset 0
        mov     ax,720h         ;white on black spaces
        mov     cx,25*80        ;Characters on screen
        rep     stosw           ;Fill them all
        pop     di              ;Recover registers
        pop     ax
        endm
display256 macro  attrib        ;Show all characters in one
                                ; attribute
        cls                     ;Clear the screen
        sub     di,di           ;Start at offset 0
        mov     cx,256          ;characters to display
        mov     ah,attrib       ;Attribute in AH
        sub     al,al           ;Start with char. 0
@@:     stosw                   ;Store one
        inc     al              ;Next character
        loop    @B              ;Show all characters
        getkey                  ;Wait for a keystroke
        endm
```

sible through a pair of I/O ports. One port contains an index register that selects which working register can be reached through the other port. One chip, called the attribute controller, has a single I/O port. The first write to the port selects an internal register and the second sets a value in this internal register.

EGA registers are almost all read-only, which means applications can't reliably save and later restore the state of the video system, especially if the computer is running a multitasking operating system or some TSRs. All VGA registers can be read from as well as written to.

Table 1 shows the general organization and addresses of the various "chips." The chips shown with two

```
displayattr macro                   ;Display all attributes
        cls                         ;  using char. in AL
        sub     di,di               ;Start at offset 0
        mov     cx,256              ;256 attributes to display
        sub     ah,ah               ;Start with attr. = 0
@@:     stosw                       ;Save one
        inc     ah                  ;Next attribute
        loop    @b                  ;Show all attributes
        getkey                      ;Wait for keystroke
        endm

;  Program begins here:

begin:
        mov     ax,@data            ;DS ==> our data for
        mov     ds,ax               ;entire program

;  Setup instructions -- gather enough info so that we
;                        can completely restore the video
;                        system before returning to DOS

        .DATA
CRT_MODE        db      0           ;Store current mode
CRTC            dw      0           ;Address of CRTC register

        .CODE
        mov     ax,40h              ;Get BIOS data
        mov     es,ax               ;Use ES to get video data
        mov     ax,es:[63h]         ;Get CRTC I/O address
        mov     [CRTC],ax           ;  and save it
        mov     al,es:[049h]        ;Get current video mode
        mov     CRT_MODE,al         ;  and save it
        mov     ax,3                ;AH = 0, AL = Mode 3
        int     10h                 ;Reset mode & clear screen
        push    es                  ;Save BIOS data pointer

IFDEF   Feature
        CALL    Feature
ENDIF

        mov     ax,0b800h           ;Address of video text buffer
        mov     es,ax               ; in ES for direct writes

        display256  07h             ;White on black, font 1
        display256  0fh             ;White on black, font 2 or intense
        display256  87h             ;White on grey or blink
        display256  01h             ;Underlined, if on

lp1:    cmp     al,01bh             ;Did user hit ESC?
        je      cleanup             ;Yes -- go
        displayattr                 ;Else display all attributes
        jmp     lp1                 ;  and repeat

cleanup:                            ;Restore screen here
        pop     es                  ;Recover BIOS pointer
IFDEF   Feature_cleanup
        CALL    Feature_cleanup
ENDIF
        sub     ax,ax               ;AH = 0
        mov     al,[CRT_MODE]       ;Get original mode
        int     10h                 ;Reset it
        mov     ax,4c00h            ;End program
        int     21h
        end begin
```

addresses can change their locations in the computer's I/O space to emulate either an MDA or CGA system. This switching ability allows EGA or VGA to be used simultaneously with another video adapter. Several debugging systems and some high-end CAD systems can simultaneously use a color video display for normal output and a monochrome for user information.

There isn't room here to detail all I/O registers and their uses. However, don't experiment by plugging random values into registers to see what happens. A poor choice of values in the CRTC chip in particular can destroy the monitor or video adapter. The example programs shown here are all safe and won't pose any danger to any VGA/monitor combination that normally works without problem. A word of warning, though: be sure you copy these programs correctly before you run them.

Memory Organization

A fully populated EGA card and a standard VGA card both contain 256K bytes of video RAM (VRAM). Many VGA cards can contain up to 1M of VRAM. All of this memory must be accessible to the CPU running in real or 8086 mode. However, because the CPU has only 1M of address space in this mode, it should be obvious that you can't dedicate the entire space to the video adapter and still run applications. To cram all of this memory into a reasonable address space, VRAM is divided into 64K pages. Page organization depends on the particular text or graphics mode in use.

In color text modes, the CPU reads data from and writes data to addresses beginning at B8000 hex. The CPU thinks it's writing character codes to even addresses and attributes to odd addresses. However, the video adapter intercepts CPU reads and writes and directs the character codes to page 0 and attributes to page 1. Thus, the character generator can look at one page of VRAM for its data and the attribute controller can simultaneously fetch the information it needs from a different page. The CPU never knows the difference, unless it manipulates the registers directly to put the adapter into a custom mode and then examines each VRAM page separately.

The third page of VRAM is used to store character-definition tables. Normally, just one table is loaded to match the current text mode. But VGA has room for eight tables (EGA can load only four pages). With a single register change or BIOS call, the character generator can be told to use a different table. If the registers are set up correctly, one bit of the attribute byte can be used to choose between any two tables loaded into memory.

Each table holds 256 characters, with each character represented by a block of memory. In the block, each byte holds information for one horizontal line of the character. A bit of 1 represents a dot that should be on, and a 0 represents a dot that should be off. Because there's room in each table for 32 bytes per character, the largest

character can be eight dots (1 byte) wide and 32 dots high.

Demo Programs

The listings that accompany this article illustrate some of the techniques for using VGA's special text-mode capabilities. Each is written in assembly language. Several VGA BIOS routines require use of the CPU's BP register. In almost all high-level languages, BP is used as a stack frame pointer. Some compilers make saving or using BP in interrupt calls very difficult if not impossible to implement.

It appears to me that use of BP is a mistake. My guess, based on nothing more than common programming practice, is that someone at IBM misread BX as BP while coding BIOS routines. No other DOS or hardware BIOS calls that I know of use BP in any way. But whether or not it's a mistake, the use of BP in the video BIOS calls makes a high-level language interface difficult to implement.

I've also depended on some of the features of Microsoft's MASM 5.1 in the listings. You should also be able to assemble them correctly with any MASM 5.1-compatible assembler, including Borland International's TASM. If you use TASM, use the MASM51 and QUIRKS directives to force MASM compatibility.

Listing 1 is a batch file that turns all of the other listings into executable programs. You can also use it as a guide to compiling any of the example programs individually.

Listing 2 is a software test-bed that takes care of the housekeeping and simple screen displays that demonstrate various text features of VGA. Most of the final programs are composed of Listing 2 plus a short demonstration routine. Listing 2 assumes you have an EGA or VGA system with a compatible color monitor. If you don't have such a system, don't try to run the programs. To keep the programs as short as possible, I've omitted code to check for video system compatibility. Also, if you use a screen and font utility like Personic's *UltraVision* (which I highly recommend), disable it while you run the programs.

When you run TEST1.EXE, which is compiled from Listing 2 alone, you'll see five screens of text. The first four display all 256 characters in the normal character set. The only difference between them is the attributes used. Each display remains on-screen until you press a key. The fifth screen shows all possible attributes. Each time you press a key, the character it activates is used for the display. When you finish with the third screen, press ESC to return to a normal DOS screen.

Listing 3, which is used to create TEST2.EXE, shows how to disable blinking to gain an extra set of colors for text. It uses a BIOS call to make the change, but a register change could also be used. In general, I prefer to use the BIOS whenever possible to ensure compatibility with all adapters.

Listing 3 doesn't show all the possibilities of text color. The text attribute byte lets you select among 16 each possible foreground and background attributes. But these 16 values are indexes into a set of palette registers on EGA, and you can set your own color in each palette. On VGA, the palette is another index, into one of 256 DAC registers that actually

Table 1. EGA and VGA "Chips" and I/O Addresses

Chip	Typical Functions	I/O Address (Hex)
CRT Controller	Pixels Per Row Lines Per Screen Cursor Size and Position Alignment of Video Buffer and Screen Display	3B4/3B5 (Mono) or 3D4/3D5 (Color)
Attribute Controller	Palette Selection and Control Border Color Horizontal Panning Video Mode Control VGA Color and DAC Control	3C0
Sequencer Controller	Adapter Reset Adapter Clock Control Character Map Control Memory Mode Control	3C4/3C5
Graphics Controller	Graphics Read and Write Control Color Read and Write Control Graphics Read and Write Modes	3CE/3CF
Other Registers		
Input Status #0 Register		Read: 3C2
Input Status #1 Register		Read: 3BA (Mono) or 3DA (Color)
Miscellaneous Output Register		Write: 3C2; Read: 3CC
Feature Board Control		Write: 3BA or 3DA; Read: 3CA

Note: Many registers are write-only on EGA; all registers can be read on VGA.

Listing 3. NOBLINK.ASM Turns On/OFF Blinking and Adds Eight New Background Text Colors

```
        .Code
feature proc
        mov     ah,10h  ;AH = 10:  BIOS Colors & Blink
        mov     al,3    ;AL = 3:   Adjust blink/intensity
        mov     bl,0    ;BL = 0:   Turn off blinking
        int     10h     ;Call video BIOS
        ret
feature endp
```

Listing 4. ULINE.ASM Demonstrates Hardware Underlining of Text Characters

```
        .data
orig_uline      db      ?       ;Storage for original setting
CRT_POINTS      dw      ?       ;  and for current char. size
        .code
feature proc
        mov     dx,[CRTC]       ;CRTC I/O address
        mov     al,14h          ;Underline register
        cli                     ;No interrupts during select/read
        out     dx,al           ;Select register
        inc     dx              ;Read/write address
        in      al,dx           ;Get current underline posn
        sti                     ;Now interrupts okay

        mov     [orig_uline],al ;Save it for cleanup
        and     al,11100000b    ;Mask off underline bits
        mov     bl,al           ;Save result in BL

        mov     ax,es:[085h]    ;Get current point size
        dec     al              ;POINTS - 1
        and     al,11111b       ;Mask off any extra bits
        or      al,bl           ;Add in extra bits
        mov     ah,al           ;Underline loc. now in AH
        mov     al,14h          ;Register number
        mov     dx,[CRTC]       ;DX has I/O port
        out     dx,ax           ;Sent index # & value
        ret
feature endp


feature_cleanup proc
        mov     dx,[CRTC]       ;Get CRTC I/O port
        mov     al,14h          ;Underline register
        mov     ah,orig_uline   ;Get original underline setting
        out     dx,ax           ;Send them both out
        ret
feature_cleanup endp
```

control the color. You can select which block of DAC registers the palette registers point to, and you can set new values (pointers) in the palette registers and new absolute colors in the DAC registers.

Any good reference on VGA graphics will show you how to set both palette and DAC registers to get the colors you want. The important point is that only 16 total colors can appear on a text screen, but you have full control over which 16 colors you want to use.

Listing 4 shows how to use hardware underlining on a text screen. Normally, underlining is enabled for only monochrome modes, to maintain compatibility with MDA. But you can also use it in color modes.

To enable underlining, you merely have to set the position in which the underline is to appear in each character box. Normally, you'll want to get the current character size, subtract 1 and use this position so that the underline appears on the bottom of each character box. However, you could use hardware underlining to show "strike-outs" or overbars by using different position values.

Listing 5. 50LINE.ASM Sets VGA in 35- or 50-Line Mode

```
        .CODE
feature proc
        mov     ah,11h          ;AH = 11: BIOS Char. Routines
        mov     al,12h          ;Use 11h for 35 lines,
                                ; or 14h for 25 lines
        mov     bl,0            ;RAM table number
        int     10h             ;Now in 50-line mode
        mov     ah,12h          ;AH = 12: BIOS Alt. Select
        mov     bl,20h          ;BL = 20: Use Alt. Print Screen
        int     10h             ;  routine for full screen
        ret
feature endp
```

Any character displayed with a foreground attribute of 1 or 9 and a background attribute of 0 or 8 will appear with the underline bar. Of course, because these attributes also select their normal colors, you may want to adjust the palette registers when you use underlining.

Only historical accident and the limitations of the original CRTC on the MDA and CGA adapters dictate that the screen should contain 25 lines and 80 columns of text. If you want to display more lines on your screen, you can easily do so by selecting a different point size for the text you use.

For VGA, there are normally 400 scan lines on the screen. When you reset or boot your computer or change to one of the default text modes, VGA loads its 16-point character set into memory and programs the CRTC accordingly. The 16-point characters are displayed as 400/16, or 25 lines of text on-screen.

VGA also has internal character tables for 14-point text and 8-point text. If you load the 8-point character set, there will be 400/8 = 50 lines of text. Most good DOS applications support a 50-line display. If you have a good monitor, you may appreciate seeing the extra information on-screen. Listing 5 shows how to set your display into 50-line mode by loading the 8-point character set.

Unusual Fonts

VGA's BIOS has several character font routines that can be used for different effects. All are accessible through the video BIOS (Int 10h) when it's called with AH = 11. The value in AL selects the specific service you wish to use.

If AL is set to 0, 1, 2 or 4, the BIOS will load a character table into memory. The same services are available with AL set to 10h, 11h, 12h or 14h. The difference is that the latter set of services also re-program the CRTC to match the point size of the selected character set.

If AL is set to 3, the value in BL selects two character tables that can be used. If BL is used to select the same character table twice, only characters in the selected table will be used. If it's used to designate two different tables, bit 3 of the attribute byte is used to select the table to use for any individual character.

The format of BL in this service is strange, to say the least. EGA has only four available tables. Bits 0 and 1 select the first table (used when attribute bit 3 is 0), and bits 2 and 3 select the second table. This seems straightforward enough. But VGA has eight available tables. To maintain compatibility with EGA for software that uses a maximum of four tables and still give programs access to all eight VGA tables, the first table is selected with bits 0, 1 and 4 while the second table is selected with bits 2, 3 and 5. Such is the price of compatibility.

There's no need to use fonts of the same size in two different tables. The character generator and CRTC know how many lines to use from each character definition. Listing 6 shows one way to mix fonts of two different sizes.

Rarely do programs use very large characters, although they can be a great help if you want to use a screen to show information to a group of people or for users with diminished vision. Listing 7 shows one way to use characters that are 32 points high.

Another use for alternate character sets, which I haven't demonstrated with a sample program, is to use the second character set and even the upper 128 of the primary character set for pixel graphics on a text screen. In standard 25-line mode, you could use the 384 "free" characters to cover a portion of the screen, perhaps 32 characters wide and 12 high (256 pixels wide = 192 high). By careful selection of the points to turn on and off in each character definition, you could produce any monochrome graphic you wish in this area.

I haven't demonstrated how to use this technique because of a "feature" of the VGA. Normally, VGA uses an 8 = 16 character box (in 25-line mode) but displays characters that use horizontal dots for each. It replicates the eighth dot (usually turned off) in the ninth position so that the box characters connect horizontally, though you can turn off the replication.

To make VGA use just eight horizontal points for each character, which would be required for acceptable graphics, requires changing the timing values in the CRTC chip. This is safe to do, as long as you don't make a mistake entering the new values into a program. However, one mis-type could cause you to end up with a blown monitor and be very angry at both this magazine and me. If you

Listing 6. 2SIZES.ASM Demonstrates Use of Two Different Font Sizes on Same Screen

```
        .DATA
null_font db    32 * 256 dup (0)        ;To erase a font table

        .CODE

feature proc
        push    bp              ;Save registers
        push    es              ; used by BIOS call

        mov     ah,11h          ;AH = 1: BIOS char. services
        mov     al,0            ;AL = 0: Load char. set, no CRTC reset
        mov     bh,32           ;32 points (bytes per char.)
        mov     bl,1            ;Use table #1
        mov     cx,256          ;All 256 characters
        mov     dx,0            ;Start at char. 0
        push    ds
        pop     es              ;ES:BP ==> character set
        mov     bp,offset null_font
        int     10h             ;Use BIOS for load

        mov     al,2            ;Use 1 for 8x14 characters
                                ;  or 4 for 8x16 characters
        mov     bl,1            ;RAM table number
        int     10h             ;Load character font

        mov     al,3            ;AH=11, AL=3: Select tables
        mov     bl,4            ;Tables 0 & 1
        int     10h

        pop     es              ;Restore registers
        pop     bp
        ret
feature endp
```

Listing 7. LRGFONT.ASM Program For Creating and Using a Large Font

```
;               Note: Normally you would want to use a font editor
;                     to create a nicer-looking font.  The technique
;                     here is fast but sloppy

        .DATA
myfont  db      32 * 256 dup (?)

        .CODE
feature proc
        mov     ax,1            ;Use Mode 1 for 40-char. columns
        int     10h             ;  (makes screen look better)

        push    bp              ;Save the registers we'll use
        push    es
        push    ds

        mov     ah,11h          ;AH = 11: BIOS Char. routines
        mov     al,30h          ;Get char. table address
        mov     bh,6            ;Select 8 x 16 font address
        int     10h             ;in ES:BP

        mov     si,bp           ;Now in ES:SI
        mov     dx,ds           ;Get Segment of Myfont
        mov     cx,es           ;  and segment of 8 x 16 font
        mov     ds,cx           ;8 x 16 font addr in DS:SI
        mov     es,dx           ;ES has data segment
        mov     di,offset myfont;ES:SI ==> myfont
        mov     cx,256 * 16     ;Number of bytes in table
@@:     lodsb                   ;Get byte in AL
        stosb                   ;  Store it twice
        stosb                   ;  to double size of font
        loop    @B              ;Do all characters

        mov     ah,11h          ;AH = 11: BIOS Char. routines
        mov     al,10h          ;AL = 10: Load user font &
                                ;  reprogram CRTC appropriately
        mov     bh,32           ;Points (bytes per char.)
        mov     bl,0            ;Put in first memory table
        mov     cx,256          ;Characters in font table
        mov     dx,0            ;Start with char 0
        mov     bp,offset myfont;ES:BP ==> Myfont
        int     10h

        pop     ds              ;Recover registers
        pop     es
        pop     bp
        ret
feature endp
```

want to experiment with the technique, see Richard Wilton's *Programmer's Guide to PC & PS/2 Video Systems* (Microsoft Press). This is an excellent book for all video system programming. It also shows how to split the screen into two sections and scroll one part over another, if you desired.

This has been a very quick look at some of the text capabilities of VGA and compatible video adapters. If it has whetted your appetite for more, I urge you to add two books to your programming collection. One is the Wilton book mentioned above, which is excellent but doesn't describe the VGA registers in detail. The author's example assembly and C language programs make video programming a snap, no matter what you're trying to do. The other book is Richard Ferraro's *Programmer's Guide to the EGA and VGA Cards*, Second Edition (Addison-Wesley Publishing).

Ferraro's and Wilton's books complement each other in many ways. Ferraro adds a detailed discussion of the EGA and VGA registers and their uses. However, because his book is flawed with a large number of typographical errors, you have to read carefully.

If the idea of unique fonts on your text screens appeals to you, a number of EGA/VGA font editors are available as shareware. A very popular one is *FontEdit*. Also, if you have a multisync monitor and VGA card that you use in text modes, you owe it to your eyes to purchase the *UltraVision* program mentioned above. Your screen will be clearer, and you can select the colors and fonts you want to use for each character size. ■

Build a Professional Prototyping System

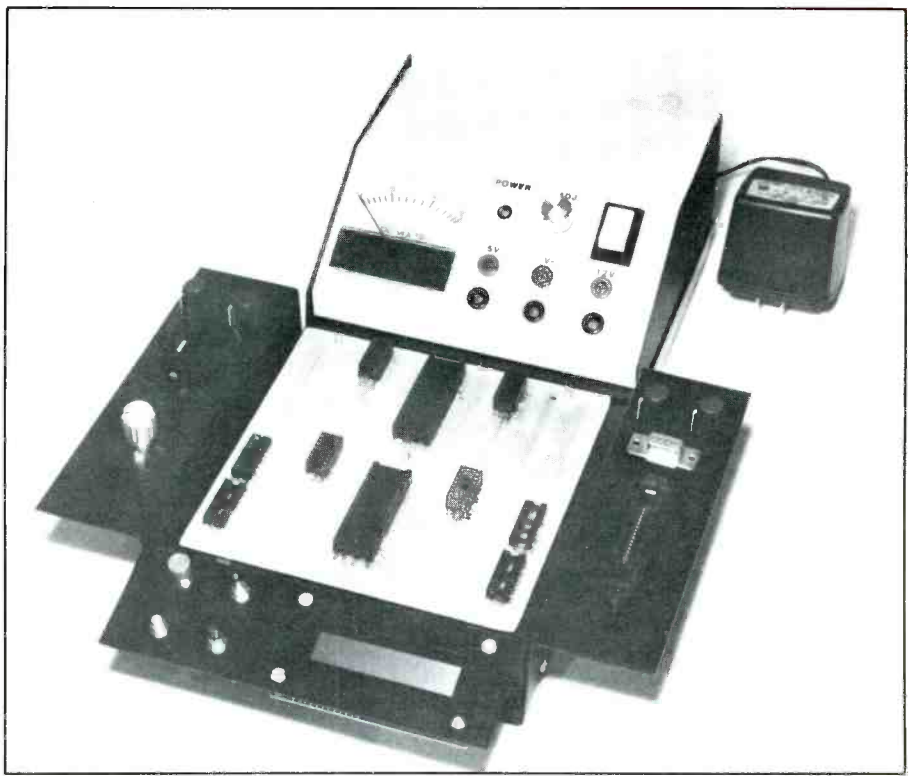
Use it to breadboard and prototype digital, analog and r-f projects the way the pros do

Relatively inexpensive commercial solderless breadboarding systems may look attractive, but they usually leave much to be desired. In such systems, socket contacts often become worn in short order, resulting in poor contact with component leads and jumper wires. Also, most boards don't provide sufficient contacts at locations where multiple connections must be made. Furthermore, component spacing, stray capacitance and inductance between adjacent bus strips all contribute to rendering socket-type prototyping systems all but useless for serious r-f work.

Serious circuit breadboarding for improved initial circuit results demands a superior prototyping system. By using printed-circuit cards instead of solderless breadboarding sockets, our CYANCE Lab is a model of a superior breadboarding system. With it, you use pc cards that are separately designed to handle digital, analog and r-f prototyping needs, rather than a "universal" type of card that hasn't been optimized for any particular technology.

CYANCE Lab's main strength is its ability to grow as your project grows. After breadboarding and "proofing" your circuits, you can save your prototypes for future use with other projects. So, every time you need the same circuit configuration, you don't have to breadboard it anew—just take it off your shelf.

CYANCE Lab is a two-part system. One element is a breadboarding chassis on which you mount the 6″ × 6″ prototyping cards. The other is a multiple-output dc power supply that bolts to the main chassis.



Breadboarding Concepts

When I first began working in electronics, I tended to underestimate the size and complexity of a particular project. Even though years of experience have given me a better handle on the process, I often find that a project grows to fill all available breadboarding space, regardless of instinct weaned on experience. Consequently, the ultimate breadboarding system I had in mind had to be able to grow with a project so that I didn't end up with a sprawling mess on my lab bench. The CYANCE Lab does exactly this in a two-step process.

The CYANCE Lab lets me select which type of prototyping board is appropriate for a given project. If the project involves predominately discrete devices (transistors, resistors, capacitors, etc.), or analog (linear) ICs, I use an Analog Card. If my project is digital in nature, I use a Digital Card. For my r-f projects, I use an RF Card. Nothing could be simpler.

I select the size of prototyping board I think is initially appropriate. For example, if I have a project that looks like it will use about a 50/50 mix of analog and digital circuitry, I select an Analog Half-Card and a Digital Half-

PARTS LIST

Semiconductors

BR1—2-ampere, full-wave bridge rectifier
D1—Red light-emitting diode
U1—7805 fixed +5 volt regulator
U2—7812 fixed +12 volt regulator
U3—LM317 adjustable voltage regulator

Capacitors

C1—3300-μF, 16-volt electrolytic
C2 thru C5—10-μF, 16-volt electrolytic

Resistors

R1—5,000-ohm linear potentiometer
R2—470 ohm, ¼-watt 5% tolerance
R3—1,000-ohm ¼-watt 5% tolerance

Miscellaneous

F1—2-ampere fuse and holder
M1—0-to-15-volt dc panel meter
SW1—Spst rocker or slide switch
Printed-circuit boards (see text); 12-volt, 1-ampere dc power-supply module; red and black banana jacks or five-way binding posts (three of each color); suitable metal work (see text); TO-220 heat sinks for U1, U2 and U3; 4-40 × ⅜" threaded spacers (9); 4-40 × ¼" Phillips-head screws (18); No. 4 Phillips-head sheet-metal screws (4); ½" rubber feet (4); ¼" control knob; ¼" vinyl grommet; hookup wire; solder; etc.

Note: The following items are available from Cyance Kit, Rte. 2 Box 284, Cyber Rd., West Fork, AR 72774; tel.: 501-839-8293: Ready to wire PROTO Power Unit pc board $9.95; complete Proto Power Unit kit of all parts, including painted and silk-screened console case, pc board and all components, $69.95. Also available are a painted Proto Frame with three side rails and hardware, $19.95; Proto Cards, $12.95 each for full-size cards and $6.95 half-size, specify type (Analog, Digital or RF); Complete CYANCE Lab kit with Proto Power Unit, Proto Frame and one of each of all three types of Proto Cards, $99.95. Add $4.95 for P&H per order. Arkansas residents, please add 5% sales tax. MasterCard and Visa are welcome.

Card. To maximize flexibility, the CYANCE LAB supports multiple half- and full-size prototyping cards. Additionally, if I run out of prototyping space on the first "layer," I can simply move to the next level and keep building my project.

Because you want your circuits to work and ultimately become "real-world" projects, the breadboarding system you use should also provide a logical path from circuit schematic to printed-circuit layout. The CYANCE Lab does this by letting you arrange the physical layout of your prototype circuit to emulate the pc board layout

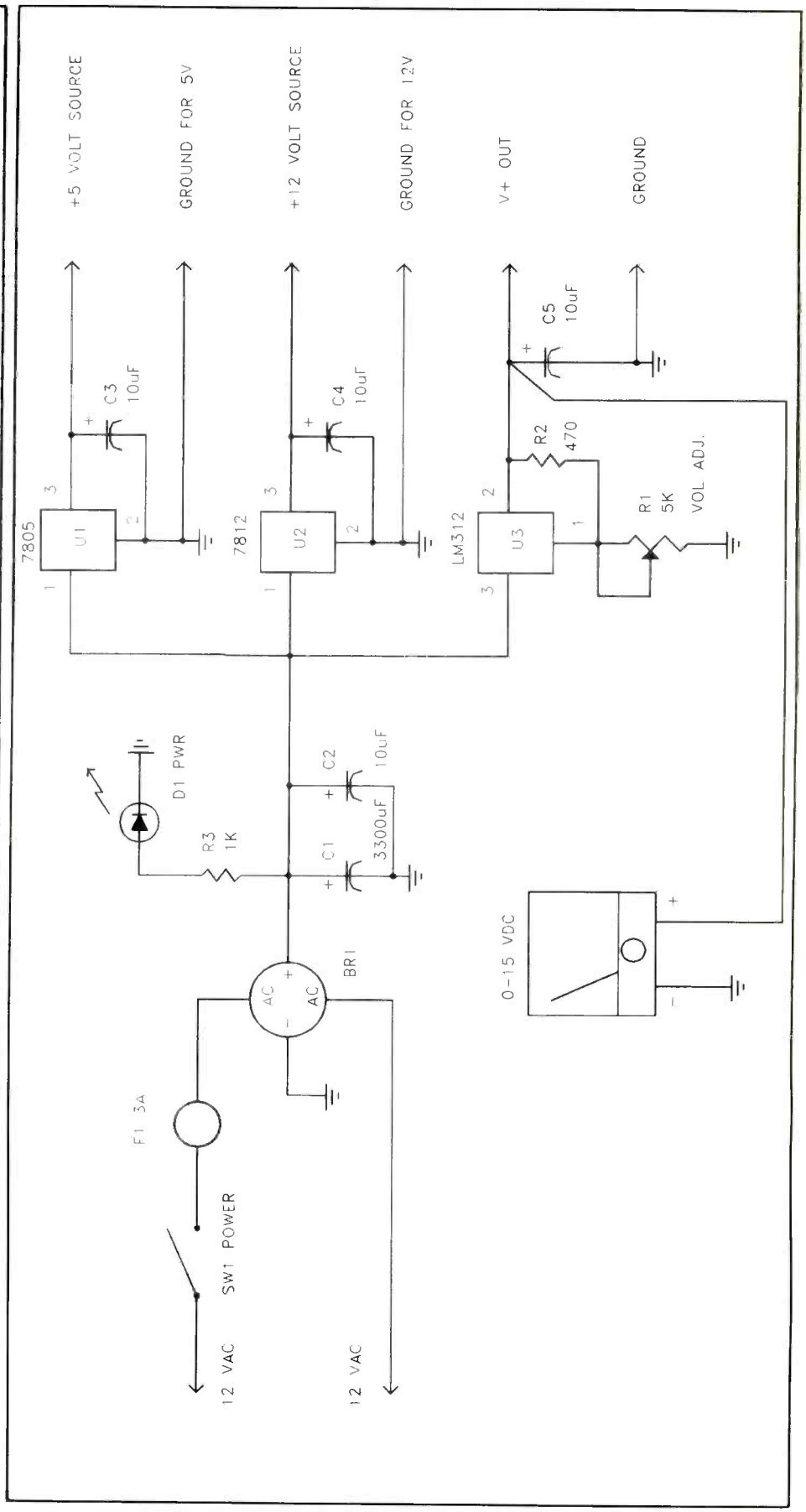


Fig. 1. Schematic diagram of the Proto Power Unit circuitry.

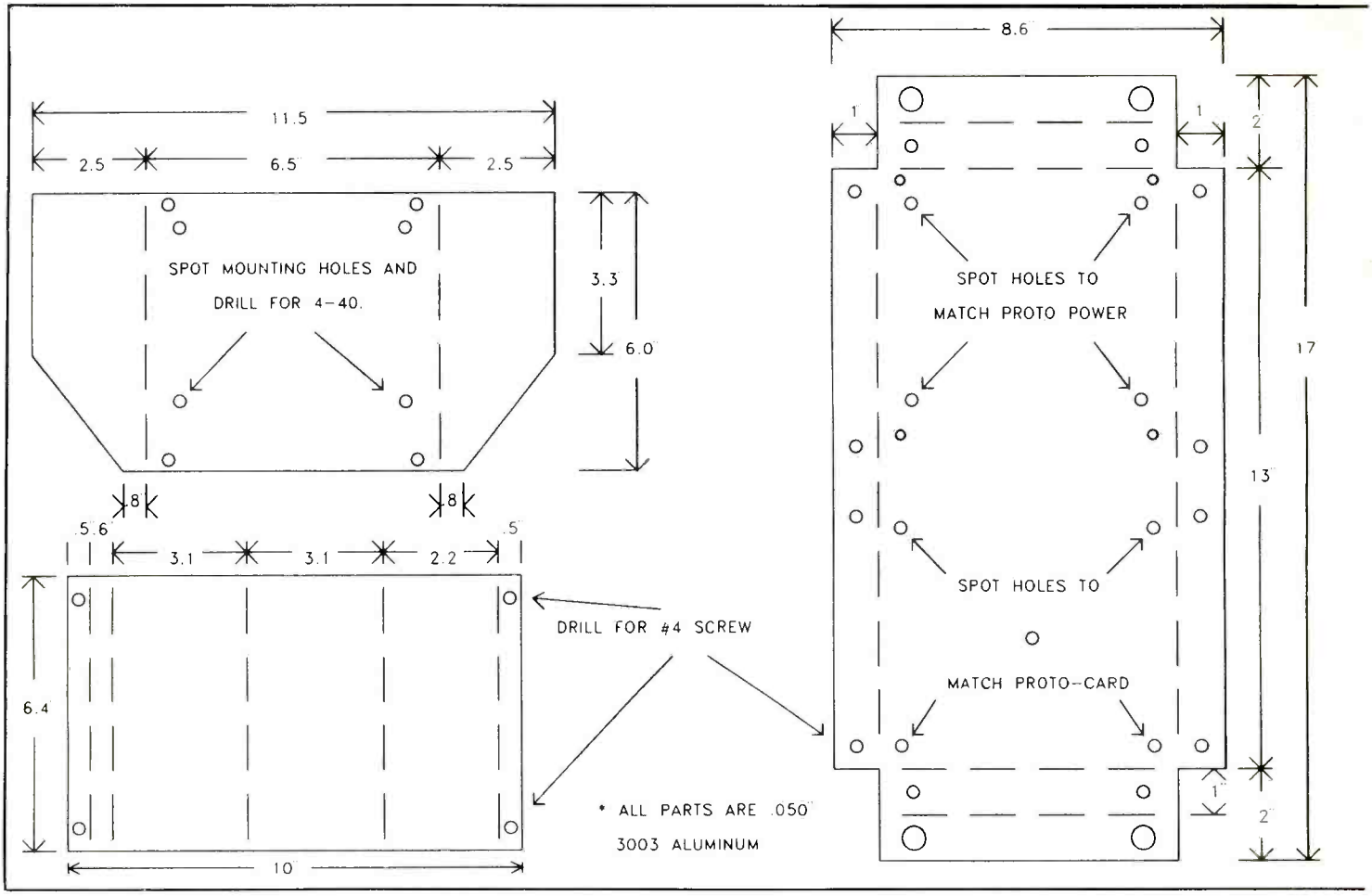


Fig. 2. Mechanical details for fabricating the CYANCE Lab's metal components.

you might want to use after you've "proofed" your circuit design. In this manner, you can optimize circuit characteristics before you spend a lot of time making and re-making the various revisions of the pc pattern.

Your breadboarding system would also let you keep your prototypes intact, without having to dismantle them each time you want to breadboard a new circuit. The CYANCE LAB lets you do this. Via IC sockets and components that are soldered directly to the Proto Cards, you can remove the five mounting screws that hold the cards in place to remove and store the entire prototyped circuit in a safe place, freeing the CYANCE Lab for your next project.

Adding a self-contained multiple-output power supply to the breadboarding system makes prototyping quick and easy. In the CYANCE Lab, a Proto Power Unit provides outputs of +5, +12 and +0.7 to +12 volts.

Finally, the CYANCE Lab provides universal side-rails on which you can mount the various controls needed for a particular circuit design. You can drill or punch these rails to accommodate almost any type of connector or control to provide a quick, rigid mounting medium for them.

About the Circuit

The CYANCE Lab is composed of three basic sections: Proto Power supply, Proto Chassis assembly and Proto Cards (analog, digital and r-f). The Proto Chassis and Proto Cards are passive.

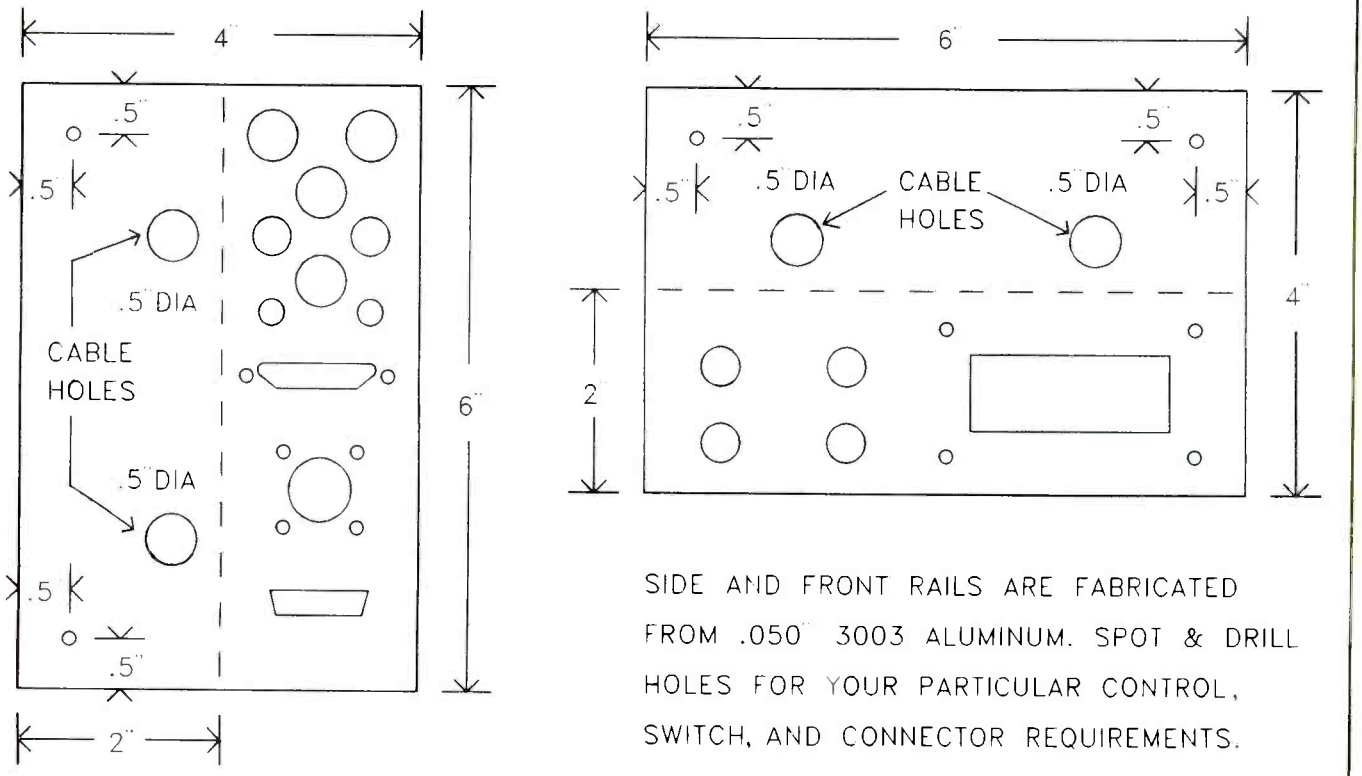
Referring to Fig. 1, note that the input to the Proto Power Unit comes from an external 12-volt, 1-ampere dc external source. This source supplies unregulated power to the Proto Power Unit through fuse *F1*. Two-ampere bridge rectifier *BR1* can be used in conjunction with an external ac transformer, although its primary function is prevention of damage to the unit that might otherwise result if the circuit isn't wired correctly.

Capacitors *C1* and *C2* filter the pulsating dc component left by *BR1* and provide a "charge well" for the *U1*, *U2* and *U3* regulator circuits. The Proto Power Unit can be used in conjunction with just about any external dc supply in the 12-volt range.

Front-panel POWER indicator *D1* is a light-emitting diode that's forward biased by resistor *R3*. Fixed 7809 +5-volt regulator *U1* features internal current and thermal limiting circuitry. Capacitor *C3* provides bypassing for the output of *U1*, which is routed directly to the +5 volt output jack on the front panel.

Fixed +12-volt regulator *U2* operates identically to the *U1* circuit, except that it outputs +12 volts instead of +5 volts. The +12-volt output is bypassed by *C4* and routed to a jack on the front panel.

Chip *U3* is an LM317 adjustable-output regulator that's controlled by



the resistor divider made up of *R1* and *R2*. Potentiometer *R1* is used as a rheostat that provides a variable output adjustment range of from +0.7 to about +12 volts at yet a third jack on the front panel. The 0-to-15-volt meter in this circuit lets you monitor the output voltage from *U3*.

Construction

Building the CYANCE Lab is as relatively easy task. You can fabricate your own Proto Power Unit case and Proto Chassis, using the dimensions given in the Fig. 2 drawings. Alternatively, you can purchase ready-to-use metal parts form the source given in the Note at the end of the Parts List. Once you have the case and chassis ready, fabricate the printed-circuit boards you need for this project: one Proto Power Unit Board and at least one or all three Analog, Digital and RF Cards, depending on your needs.

Fabricate your pc boards, using the actual-size artwork given in Fig. 3, or purchase ready-to-wire ones from the source given in the Note at the end of the Parts List. Note that the RF Card should be fabricated from double-sided pc blank so that you have a solid copper cladding on the bottom of the card to serve as a ground plane. Whenever you need to ground a point in an r-f circuit, simply drill a hole at the appropriate location, feed through a short length of solid bare wire and solder to the copper on both sides of the card.

At this stage, the only board you have to wire is the one for the Proto Power Unit. Begin populating this board with the passive components. Refer to Fig. 4 for details. When you mount voltage regulators *U1, U2* and *U3*, apply heat-sink compound between the back of each device and the heat sinks you mount on it.

Wrap up construction of the Proto Power Unit by mounting the circuit-board assembly inside the enclosure using 4-40 × ¼" spacers and wiring the various supply input and output lines to the chassis-mounted connectors, power switch, meter and jack.

Before proceeding to final assembly, it's a good idea to check out operation of the Proto Power Unit. For this, you need a dc voltmeter or a multimeter set to the dc-volts function.

Clip the common meter lead to any convenient point that's supposed to be at circuit ground and connect the "hot" lead to the positive lead of *C1*. Briefly plug the external transformer unit into an ac outlet. The potential at the *C1* connection point should be +16 to +18 volts with no load. If not, immediately unplug the external transformer from the ac outlet and recheck all your wiring. Don't proceed until you've corrected the problem.

Next, touch the meter's "hot" probe to the +5-volt output jack on the front panel of the Proto Power Unit, plug the transformer into the ac outlet and verify that the output is about +4.5

volts. If so, move over to the + 12-volt jack and note if the reading is about 11.5 volts. Finally, move the "hot" probe to the adjustable-output jack and vary *R1* over its entire range to check that this circuit is working properly. Again, if you fail to obtain the proper reading at either point, power down and correct the problem.

Having ascertained that the Proto Power Unit is operating properly, you can finish the mechanical assembly.

Attach the side rails to the Proto Chassis with No. 4 sheet-metal screws. If you purchased the kit, these rails come with a few holes pre-punched for various standard components. However, feel free to drill any size or shape holes you may need. The whole idea of the CYANCE Lab is adaptability to specific needs. Extra side rails are easy to fabricate and can be obtained from the source given in the Parts List.

Mount the Proto Power Unit on the Proto Chassis by threading four 4-40 × ⅜" screws through the base of the Proto Chassis and into the Proto Power Unit's printed-circuit board spacers. Make sure the case of the Proto Power Unit is aligned flush with the Proto Chassis before tightening the screws. Then attach the top cover of the Proto Power Unit with four No. 4 sheet-metal screws from the underside of the Proto Chassis.

Secure five 4-40 × ⅜" spacers to the base of the Proto Chassis with five 4-40 × ¼" screws. Individual Proto Cards later mount on these spacers and can be stacked using male/female ½" or 1" spacers.

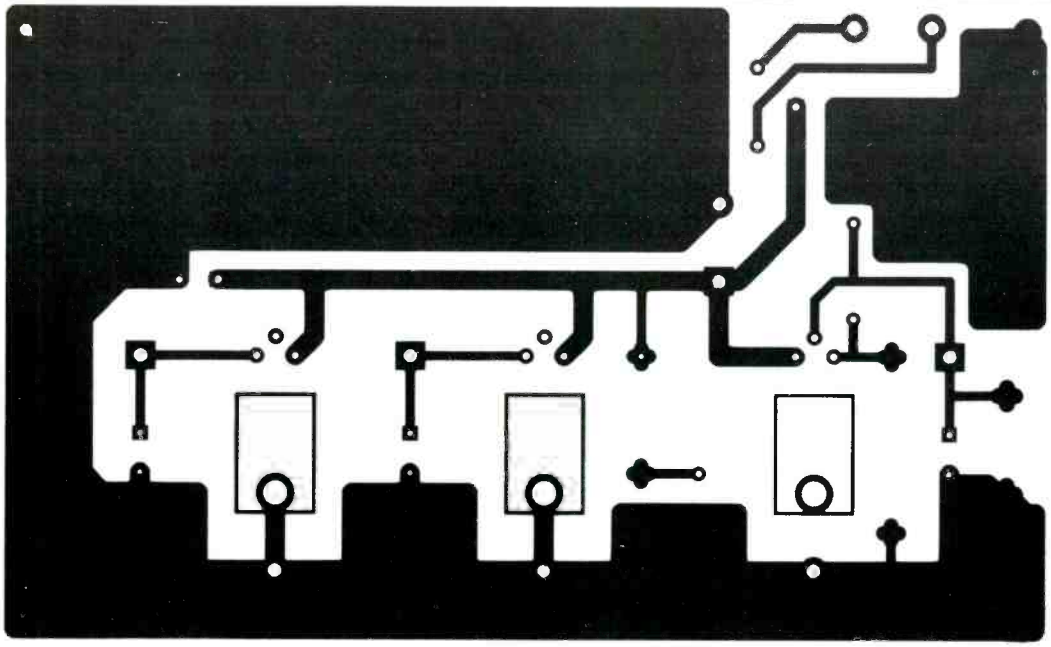
Using the CYANCE Lab

When you're ready to start using your CYANCE Lab breadboarding system, keep in mind that Proto Cards mount with the conductor traces facing up—not on the so-called "component side," as is usually done. In this project, the component and solder sides are one and the same. This arrangement lets you wire point to point and eliminates having to remove a Proto Card when you have to change components.

Go about your prototyping in a logical manner. Here are a few suggestions you might find helpful:

(1) Because you can have as many Proto Cards as you wish, don't try to re-use the cards from one project to

(A)



(B)

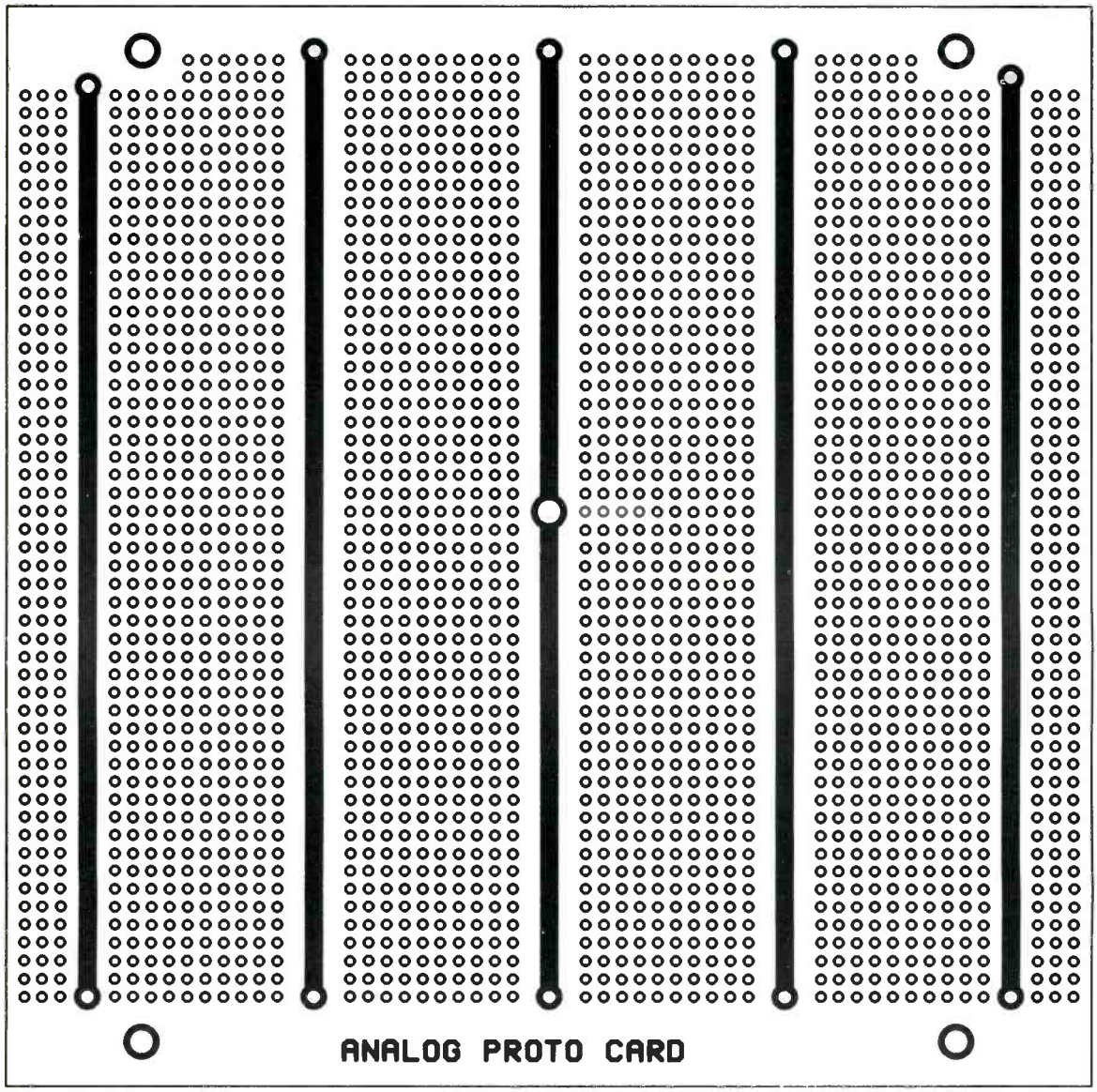
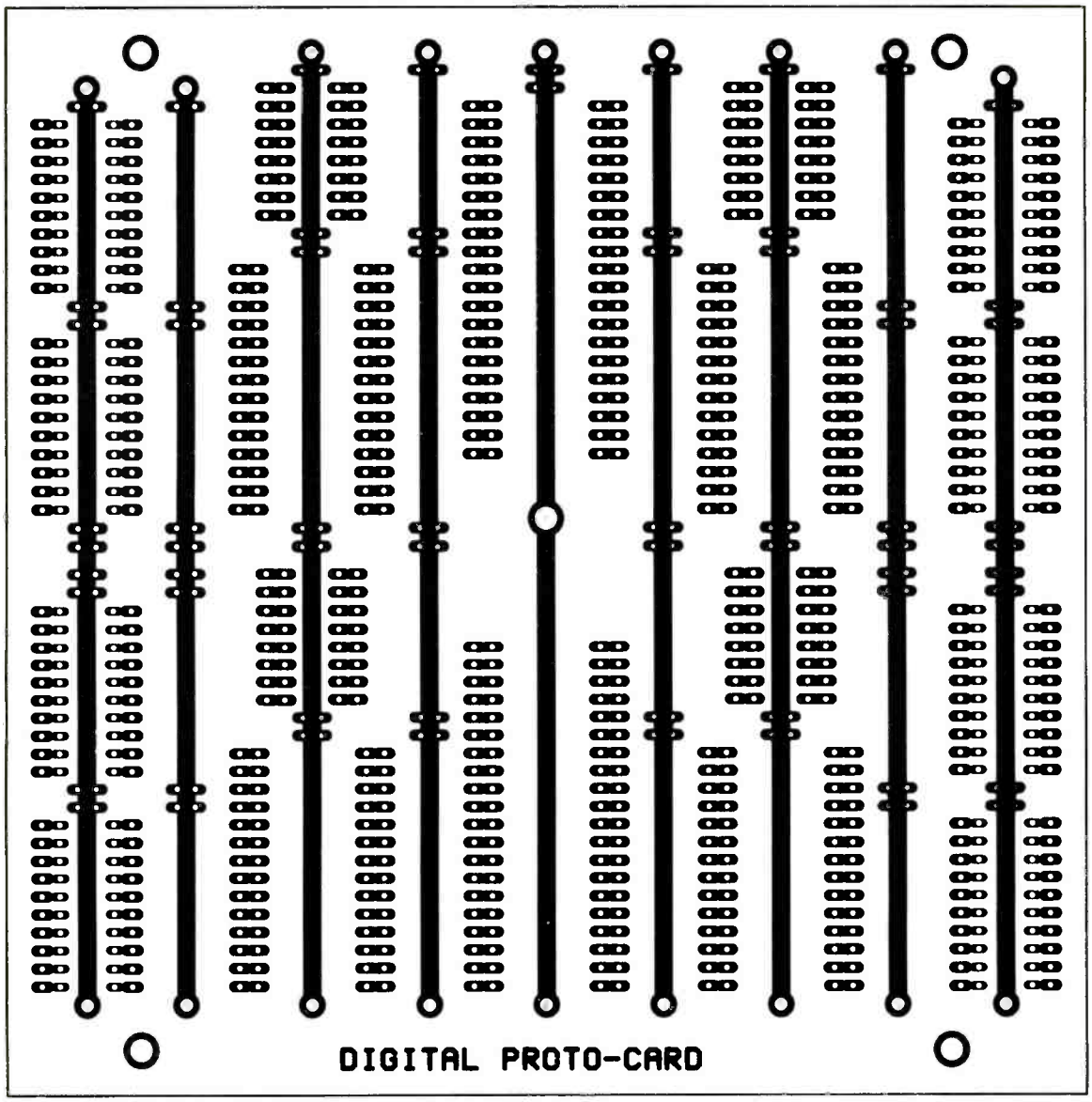


Fig. 3. Actual-size etching-and-drilling guides for the (A) Proto Power Unit; (B) Analog Proto Card; (C) Digital Proto Card; and (D) RF Proto Card.



(B)

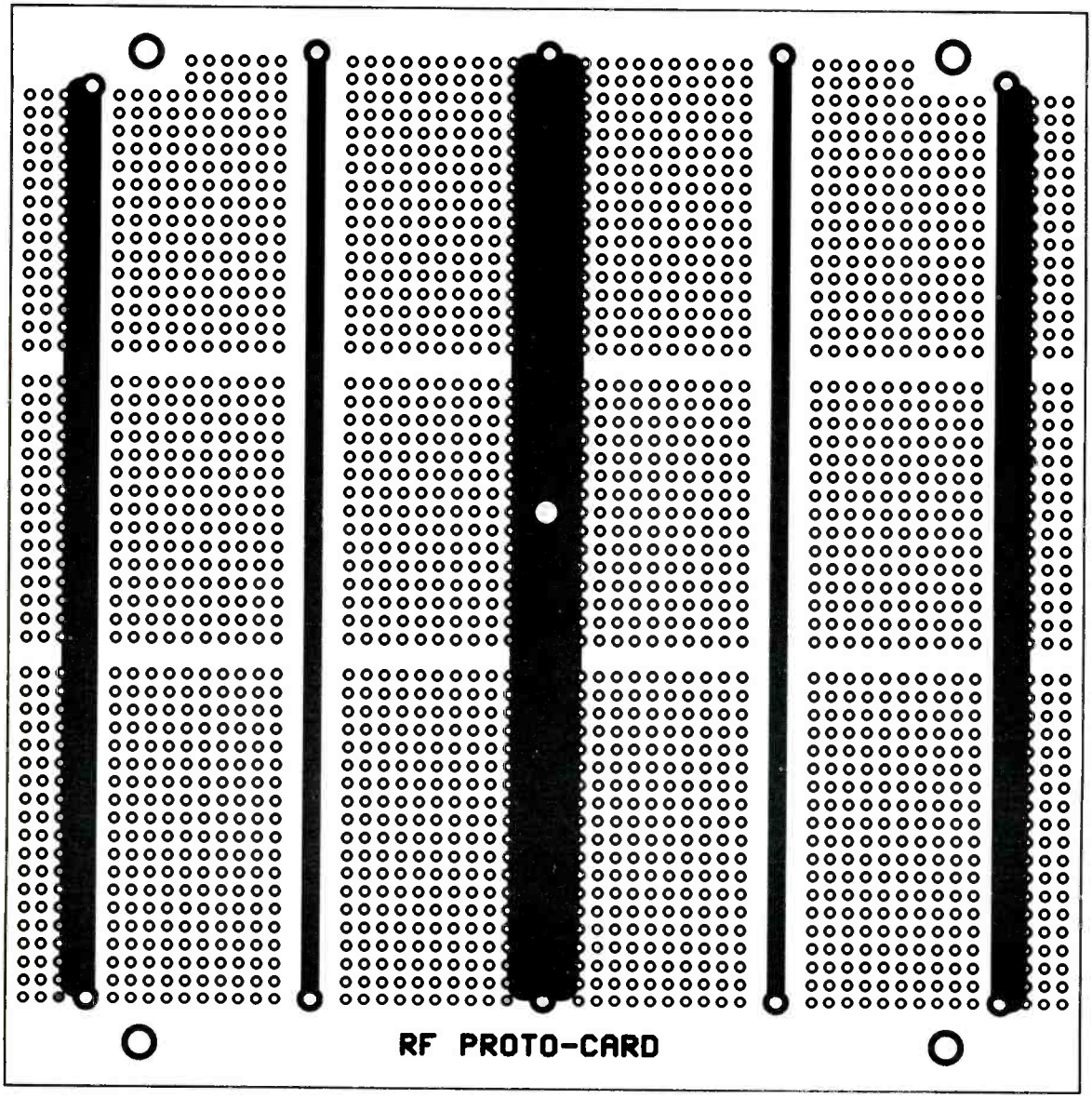
the next. If a particular circuit is worth building, take the time to do it right and keep as the final version of the circuit wired on the Proto Card you used to build and proof it.

Perhaps because they're so quick and easy to use, solderless-socket systems can teach bad breadboarding habits. Many experimenters fall into the habit of "hacking" or "shotgunning" circuits that don't work because they aren't thorough and fail to follow through when a particular circuit fails to work the first time out. So don't fall into bad habits. Instead, be deliberate about your breadboarding. Take the extra time to thoroughly analyze your circuits before actually breadboarding them, to avoid having to correct time-consuming problems in the long run.

(2) I don't like sockets. If you do, though, don't hesitate to populate your Proto Cards with them. In some cases, of course, you must use sockets, such as for programmable devices like EPROMs and microcontrollers. If you do use sockets, make sure they're premium-quality gold-plated (pin-barrel) ones to avoid problems over the long haul. I've seen more equipment fail because of oxidized IC socket pins and connectors than from bad solder joints and defective components combined.

If you work carefully, chances are extremely good that you won't burn out ICs. Modern integrated circuits are unbelievably tough and will often take abuse undreamed of by older-technology devices. Don't be afraid to solder ICs directly on a Proto Card. If you have to replace a soldered-in IC, simply clip it's leads off next to the body of the device and remove the pins with some solder wick or vacuum-type desoldering tool.

(3) When using the Proto Cards, remember that proper grounding can spell the difference between a functional layout and failure. Many builders string together grounds haphazardly. In mixed-signal breadboards, analog and digital ground paths



(C)

should "sum" or meet at a single point as close as possible to the system ground lead coming from the Proto Power Unit. Similarly, route high-current ground paths separately from critical signal ground paths and connect them directly to the ground terminal in the power supply.

Let's look at one example of good breadboarding. Say you want to breadboard a digital circuit to filter audio signals coming from a radio or microphone. Place the digital portion of the filter as far away as practical from the high-gain portion of the audio (analog) circuit, "catch" all ground pins of the digital devices and terminate them as close as possible to the ground connection on the Proto Power Unit.

Likewise, you'd want to completely separate the ground bus for the audio portion of the circuit from the digital section and terminate it at the ground connection of the Proto Power Unit. Furthermore, if you included, say, an LM386 audio power amplifier in the circuit, you'd want to keep its ground bus separate from both other ground buses to prevent high current in the ground path to the LM386 from inducing signal fluctuations in the high-gain portion of the audio circuit that could result in circuit feedback and consequent circuit oscillation. In a similar fashion, attaching the LM386 ground to the digital ground path might induce switching noise in the audio output to the speaker. The moral is to always pay close attention to the grounds on your breadboarded circuits.

(4) Use bypass capacitors generously. I bypass IC power-supply pins with 1-μF tantalum capacitors. This varies, depending on the number of devices, their proximity to each other and the rest of the circuit and frequencies in use. You may find that larger-value bypass capacitors are necessary to serve as "charge wells" for high-current ICs. In many cases, you may find that 0.1- or 0.01-μF capacitors are more effective. Use of an oscilloscope

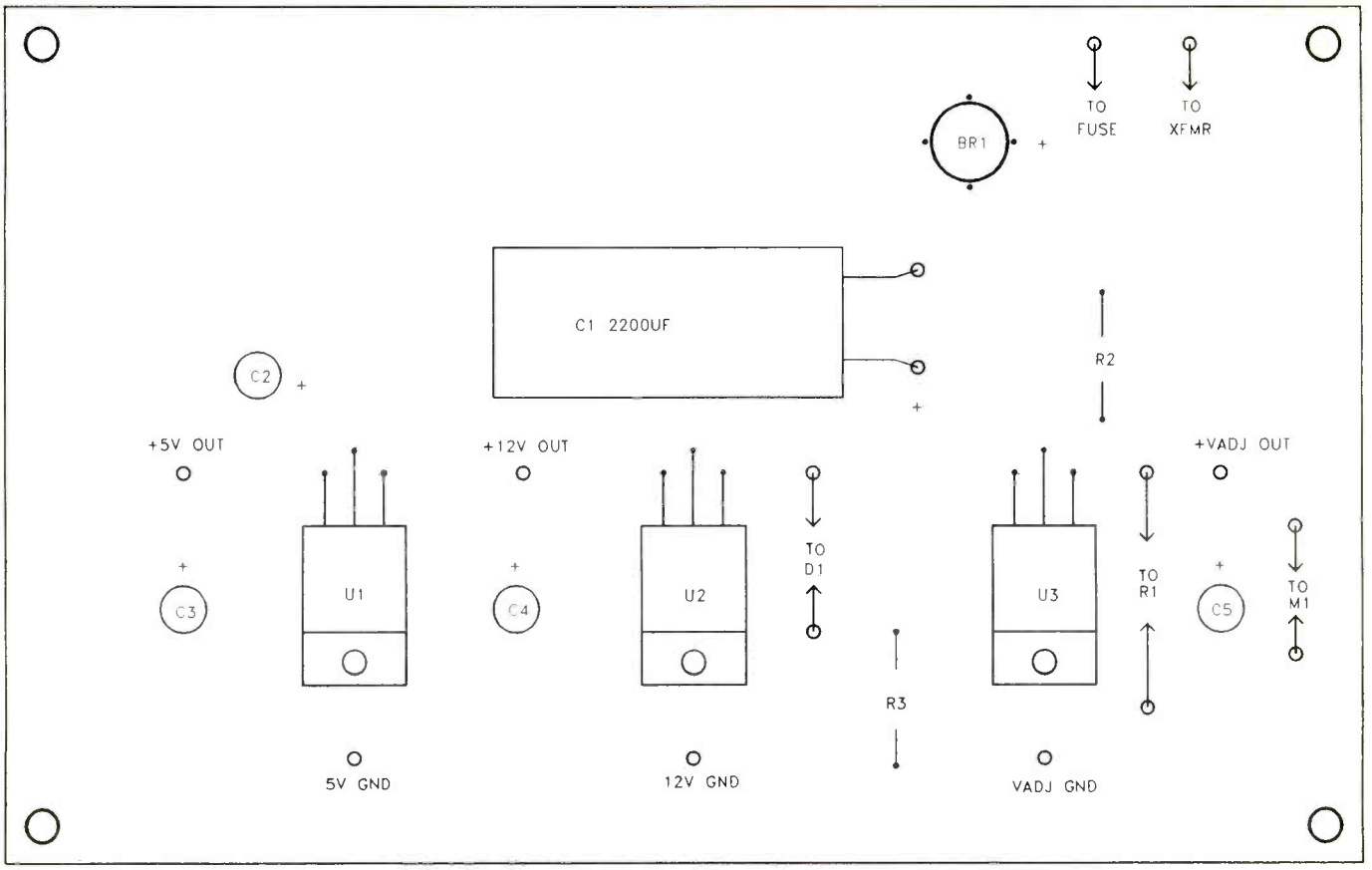


Fig. 4. Wiring guide for printed-circuit board.

on the supply pins is usually a pretty good supply noise indicator.

It's also important to note that in some cases bypass capacitors can end up "floating" thin ground traces. Avoid this by always making certain the ground bus is large enough to accommodate large fluctuations in the supply rail. Otherwise, the bypass capacitor can end up pulling the ground bus right along with the supply pin.

(5) Neatness counts and may even be mandatory, depending on the circuit design you're breadboarding. Don't create a rat's nest over a critical IC that might have to be moved or changed later. Dress your leads with functionality in mind. The only exception to the neatness rule is in r-f circuits, in which direct point-to-point techniques work best in most cases. It's critical, particularly at vhf and beyond, to keep leads as short as possible. To achieve maximum performance, it's necessary to attach components directly to the pins of the ICs themselves in r-f circuits to minimize stray capacitance and inductance.

Notice in the lead photo that the front "apron" rail of the CYANCE Lab is pre-punched for a two-line by 20-character LCD display. I find such a display to be very useful for my microcontroller projects. I usually remove this rail and keep it with my controller card.

If you anticipate having very large size projects that take up a lot of board space, consider building a second Proto Chassis to use by itself without a Proto Power Unit. With just the Proto Chassis, you can occupy the areas normally used by both the Proto Card and Proto Power Unit to accommodate a double-length prototyping board. Additionally, you can run side rails clear around the unit to accommodate all manner of switches, controls, jacks and connectors as needed.

With the CYANCE Lab, you'll find new breadboarding freedom. Just remember to keep your work neat and modular. With a "library" of prebuilt circuits for your CYANCE Lab, future breadboarding projects will be as fun and easy to implement as this project has been to build.

I like to keep all my breadboarded circuits around in case I need them as part of a future project. You should consider doing the same. For example, if you breadboard a controller circuit with input switches and an LCD panel, make it modular by putting it on a Digital Half Card and keep it handy for future use. The next time you need such a controller, you'll already have it ready to mount on the Proto Chassis. It's that simple. ■

Nick Goss

The Digital Darkroom: Logitech's FotoMan Camera and Three Retouching Software Packages

If you read my past article on capturing images on a PC (*ComputerCraft*, December 1991), you already know that there are several devices and means available for capturing real-life images using a video camera, camcorder or digital still camera. Logitech has thrown its hat into the image-capture ring and provided us with another way to capture and integrate images on PCs with its innovative FotoMan camera.

FotoMan is really unique because it doesn't use a mini-floppy disk for image storage (as does the Canon Xapshot). Nor does it require an image-capture/frame-grabber board to import images it takes into a PC. Logitech's approach stores images in RAM inside the FotoMan camera and downloads the photos via a cable that connects to a PC's serial port.

The heart of the system is the 6¾"L × 3¼"W × 1¼"D FotoMan camera, which weighs about 10 ounces. A fixed-focus 8.5-mm lens with an aperture of f/4.5 is mounted slightly above the center of the FotoMan, with the shutter release button located directly below it. This lens is a good general-purpose length, being the approximate equivalent of a 55-mm lens on a 35-mm camera. The focusing range of the lens is 3 feet to infinity.

A built-in flash, mounted next to the viewfinder at the top of the FotoMan, provides either main or fill lighting, depending on the shooting situation. Equivalent film sensitivity is approximately ASA 200 without the accessory neutral-density filter in place or ASA 25 with the filter mounted. The flash is rated at guide number 27*ft at ASA 200 and has an effective shooting range from 4 to 10 feet.

While the FotoMan camera is, indeed, the primary component, several other necessary support items comprise the complete FotoMan outfit. The inventory includes a neutral-density filter, adapter ring, camera base, stand, battery charger, 9-to-25-pin serial-port adapter, 6-foot camera-to-computer serial cable, both 5¼" and 3½" program disks and manuals.

A pouch-style carrying case is also available for the FotoMan camera, but it isn't provided with the camera. To obtain it, purchasers of the FotoMan must mail in their registration cards to receive the pouch directly from Logitech (there's no additional charge for it).

The camera can snap up to 32 photos and store them in DRAM for transfer via a serial cable into a PC. Once images are downloaded to the PC, they can be cleared from the camera's memory to make room for 32 more images. Unlike Canon Xapshot disks or camcorder videotapes, both of which allow you to keep original images forever by simply replacing the magnetic media, FotoMan's maximum in-camera capacity for retaining images is limited to 32.

When fully charged, the Ni-Cd battery inside FotoMan holds picture data in memory for only about 24 hours without the recharger attached. So keeping the recharger handy and plugged into the unit is a good idea. Supported file types for saving images include PCX, BMP and TIF (compressed, uncompressed and CCITT).

FotoMan captures images at 256 gray levels, with an actual aspect ratio of 376 × 240 pixels (which is corrected to 376 × 284 by FotoMan software). Aspect ratio correction is required because the pixels aren't square in photos snapped with the FotoMan, which have a 4:3 aspect ratio. The software corrects this to a 1:1 ratio so that photos are free of distortion, whether taken horizontally or vertically. Resolution is equivalent to 75 dpi, which produces a photo that measures approximately 5" × 3½", or roughly the size of a "jumbo" 35-mm print.

Prior to installing FotoMan software, you must charge the camera's internal Ni-Cd battery for at least 30 minutes, since taking a test photo is a requisite portion of installation to ensure that the FotoMan and the PC are communicating correctly with each other. The charger is a small 117-volt-ac-operated unit that outputs 12 volts dc at 300 mA. It plugs into the base of the camera and takes about 6 hours to fully charge the battery. A full charge provides enough power to snap 32 shots with flash and download if you work quickly and are using a reasonably fast (25-MHz or better) computer.

Internal battery drain is heavier when images are being transferred from FotoMan to the host PC. Therefore, the longer it takes to download, the more it depletes the battery's charge. Because keeping the charger plugged into FotoMan while downloading preserves the charge, this method is recommended, if possible.

Snapping pictures, previewing images and downloading are accomplished via the *FotoMan* application you run under *Windows*. *FotoTouch*, another application, is used for retouching and manipulating FotoMan images. Both applications install under *Windows*, using either the RUN command line from the Program Manager or the File Manager to launch the INSTALL.EXE application. Aside from specifying a subdirectory name in which FotoMan software is to reside, installation is almost completely automated.

As a last step in installation, you're directed to connect the FotoMan camera to your PC via the serial cable, specify which serial port is being used (COM1 or COM2) and snap a test picture. If you properly connected everything, the flash fires and the camera beeps as it processes the new photo. Within a couple of minutes a preview of the newly acquired image appears on-screen as a thumbnail photo.

Again borrowing from the look and feel of 35-mm photography, the FotoMan software screen resembles a 35-mm contact sheet on which each of the 32 FotoMan images is displayed as a contact print along with its corresponding frame number. The software lets you assign each frame a unique identification name, if desired, although the software will automatically assign frame identifiers consisting of the date and the frame number (such as, MAR31__01.TIF). The photographer's name can be included for identifying each frame as well.

I should mention that photos can also be taken with the FotoMan even when it isn't connected to a PC via its serial umbilical cable. FotoMan's internal Ni-Cd battery provides power for the flash and acquiring images on the go. Rather than

tripping the shutter via software, as in the *FotoMan* application, snapping shots with the camera in "mobile" mode merely requires pressing the shutter button after you frame the subject in the viewfinder.

While the look and feel of 35-mm film photography is preserved with the contact-sheet-style display screen and 3½" × 5" "print" size, the design of the FotoMan camera more closely resembles a simple box camera with a fixed-focus/fixed-aperture lens. And like a box camera, the photos it produces aren't candidates for gallery exposition.

Although exposure and flash intensity are controlled automatically, the fixed focus and aperture of the lens don't always afford the widest latitude, which often results in overexposed shots of close subjects and underexposed shots of distant ones. To compensate for this, an adapter ring and Hoya 37-mm neutral-density filter are provided, which effectively cuts the amount of light entering the lens. This helps for close-up shots but doesn't do a thing for distant shots. However, any pictures that come out less than perfect can be corrected and embellished in the software "darkroom" provided by the *FotoTouch* software.

Logitech and other manufacturers in the computer industry, including Hewlett Packard, have cooperated to standardize the image-acquisition process across applications. This new standard is known as CLASP (Connecting Link for Application Source Peripherals), and FotoMan is a CLASP imaging source recognized by such CLASP-aware applications running under *Windows* as the *FotoTouch* image editing software. This CLASP standard will probably gain wide acceptance by software developers because of the major manufacturers backing it and the fact that some standardized image format is sorely needed.

Once you downloaded images from FotoMan to the PC's hard disk, you're ready to use them in DPT or WP applications just as they are. Alternatively, you can use the *FotoTouch* software to first modify, manipulate or embellish it. Of course, you can also use any of the better third-party image-enhancement software products currently available if you prefer. (I'll give you a close look at three of these programs a bit later on.)

FotoTouch is basically an evolved and somewhat-reworked version of the Ansel Image Editing software Logitech provides with its ScanMan 256 hand scanner. This application runs under *Windows* and is very easy to use, although it's somewhat limited in overall features and capabilities. The main elements for manipulating images are present in the program, however, and are accessed via drop-down menus.

The Transform menu contains selections that permit you to flip an image vertically and horizontally, rotate it right and left and de-skew it. No scaling function for changing image size is supported, although a menu choice for scaling appears at half-intensity on this menu bar.

The Image menu provides selections for lightening, darkening, smoothing, sharpening, inversing (negative), equalizing and setting threshold.

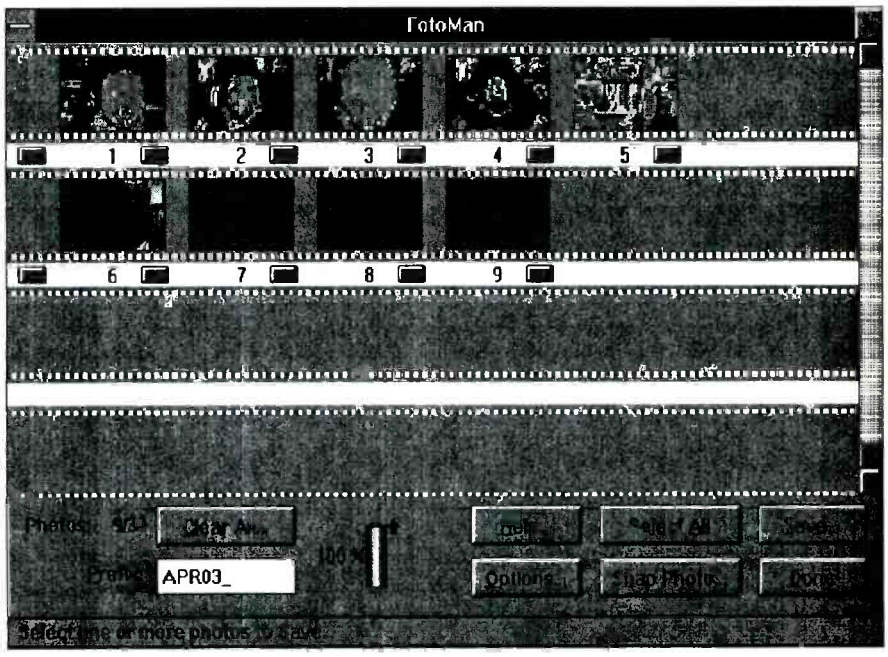
The Equalize option is interesting. It takes a measurement of the the lightest and darkest sections of a photo and automatically creates a middle-ground setting for the overall photo based on these measurements. While some additional manual adjustment may be required to optimize an image, the Equalize function takes otherwise unusable photos (such as the very dark shot in the accompanying examples) and corrects them automatically. Unfortunately, no contrast adjustment is provided in the software, limiting the amount of enhancement you can perform.

Various brush and line styles are available from the tools menu, but there's no provision for adding text matter included in the software. This further limits its overall usefulness. And since the FotoMan camera is capable of capturing images in only black and white, the *FotoTouch* software, likewise, can process only black-and-white images. If you have a need to be able to manipulate and enhance color images, as well as black-and-white ones, you'll need one of the other image-processing packages reviewed later.

Though FotoMan and its software worked just fine running under *Windows* 3.0 (aside from being incompatible with Bitstream *FaceLift*), I encountered numerous problems with it when I installed it on two systems running under *Windows* 3.1 (the final release). I got messages like "WN007 caused a General Protection Fault in module FOTOMAN.DS at 0001:-087E" whenever I attempted to download a FotoMan image from the camera to my hard drive in a .TIF file format. I noted that .PCX and other formats functioned properly, but the .TIF file type caused the application to repeatedly bomb.

Using the *FotoTouch* utility to print images was another problem area. The supplied documentation advises users who have Bitstream *FaceLift* installed to turn it off prior to printing images from *FotoTouch* because some incompatibility problem exists and only blank pages result if *FaceLift* is active. Since *Windows* must be reloaded any time *FaceLift*'s active/inactive status is changed, this was a nuisance under *Windows* 3.0, but it was a viable work-around.

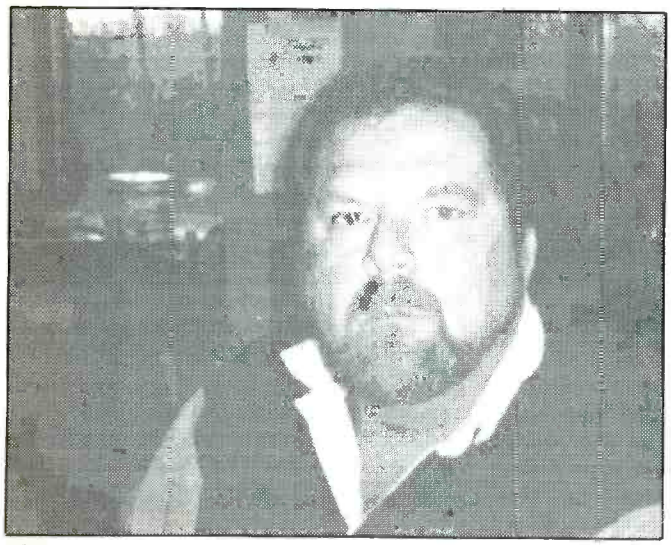
Under *Windows* 3.1, even with *FaceLift* switched to inactive, it isn't possible to print images using the *FotoTouch* software; a black rectangle appears on the output page instead of the photo. I don't know for sure, but I'm willing to bet that the *FotoTouch* software has an intolerance problem with Microsoft's *TrueType* font-scaling technology (which is a standard part of *Windows* 3.1), just as it does for *FaceLift*. At any rate, users who are thinking of using FotoMan and *FotoTouch* software under *Windows* 3.1 would do well to wait for these incompatibility problems to



FotoMan's software displays capture snapshots in a contact-sheet format.

(A)

(B)



(D)

(E)

PhotoMan photo with neutral-density filter with no retouching (A) and after equalizing with FotoTouch(B) and enhancing with Image Prep (C), PictureEze (D) and PhotoFinish (E) software.

be resolved and Logitech to issue a software update.

FotoTouch software is fairly good at processing and enhancing images captured with the FotoMan camera, but there are some other products on the market that offer greater flexibility and manipulatory capabilities. In addition to being able to handle black-and-white images, these other *Windows*-based products are all color-capable as well. Let's take a look at three of them now.

Image-Processing Software

ImagePrep

Computer Presentations' *ImagePrep* software is a *Windows*-based graphics utility that provides support for virtually any type of captured files with BMP, TGA, TIF, PCX, GIF, DVA or EPS file types. The program has the capability to convert, enhance and manipulate image files and to capture screens (applications, desktops or selected areas of either) using a hotkey. Captured screens are saved to the *Windows* clipboard for use in any application that can support them.

This is the first utility of its kind to offer JPEG-like compression and decompression of 24-bit graphics files under *Windows*. This is a particularly noteworthy feature, since graphics files take up lots of hard-disk space and compression can dramatically reduce required storage space. There's a catch, though: compressed images can be stored in only the proprietary .CPI format of the program.

A unique feature of *ImagePrep* is its contour tool that prepares raster images for use with vector-based trace tools like CorelTRACE or the Trace utility in *GEM Artline* 2.0. This feature alone is worth the price of the package for users of vector-based products since it significantly increases the effectiveness of a tracing tool's ability to work with scanned and video-captured images.

The program also supports image scaling with anti-aliasing to preserve aspect ratios, 90°-increment rotation, flip, mirror and a unique feature that permits merging multiple images. A full complement of processing filters for sharpening, smoothing and adjusting color, balance, gamma, brightness and contrast are all provided from drop-down menus, as well as palette

(C)

and dithering controls.

Like Logitech's *FotoTouch, ImagePrep* isn't capable of introducing or adding type to a photo. Nor does it offer any utility for erasing, retouching or adding lines or other graphic elements to the image, although it does support image printing via *Windows*' Print Manager. In addition to handling black-and-white images, *ImagePrep* can process color images. It's a remarkably easy program to use, and it provides lots of interesting and useful image-processing capabilities. If you don't need text or line-drawing capabilities in your image processing, *ImagePrep* is a good choice.

PictureEze

Application Techniques' *PictureEze* is touted principally as a graphics file converter program. Though it does indeed do file conversions, it also does a lot more. As you might expect, however, it's particularly rich in the variety of file formats it can handle (both B&W and color images are supported), as illustrated in Table 1.

A full complement of editing and enhancing controls is provided. These controls can be accessed from various drop-down menus that bear the titles File, Edit, View, Effects, Preferences and Help. *PictureEze* excels in two areas.

One is its ability to provide views of the image at preset magnifications ranging from 25% to 400% of actual image size, as well as any desired magnification apart from the presets simply by entering desired size. The other really strong area is its cropping ability, which is among the easiest to use I've encountered.

PictureEze has no capabilities for adding type, boxes, lines or other effects to a picture. Nor can it be used to retouch specific areas of an image. Only overall changes to a picture, like brightness, contrast, smoothing and sharpening, can be effected. For any type of image conversion or general manipulation, *PictureEze* is another excellent choice.

PhotoFinish

If you've used ZSoft's *PC Paintbrush IV Plus* or *Publisher's Paintbrush* you'll have almost no learning curve whatsoever when using *PhotoFinish* for the first time. Control layout and features for this product are virtually identical to those in both of the other ZSoft products. Borrowing lots of the features and capabilities of these other products, *PhotoFinish* has some custom touches specifically designed for processing photographic images. The result is a feature-rich package that's unquestionably the "king of the heap" when it comes to image-enhancement software.

ZSoft's *PhotoFinish* is a full-featured digital darkroom that can handle color and black-and-white images in a variety of file formats, including PCX, BMP, EPS, GIF, MSP, TARGA (TGA, VDA, ICB and VST extensions) and TIF (compressed, uncompressed and CCITT Group 3).

In addition to all of the standard correcting and enhancing features, like adjusting brightness, contrast, smoothing, sharpening, flipping, rotating and scaling, *PhotoFinish* adds numerous functions to the basic menu. These include an ability to store and recall customized color pallettes (or grayscale pallettes), creating fills and tiles for backgrounds, stitching (joining together two or more scanner passes to form a single image) and direct scanner support for numerous devices.

PhotoFinish also conforms to the new CLASP standard, which allows it to acquire images directly from other CLASP-compliant devices like the Logitech FotoMan. Dozens of popular flatbed and hand scanners are also supported. This is a great time-saving feature since the same application can be used for acquiring the image as well as editing and enhancing it.

PhotoFinish integrates well with other *Windows*-supported features, including an ability to save to the clipboard and its support of both Bitstream *FaceLift* and Microsoft's *TrueType* scalable-font technologies. Of all the image-processing software products covered here, *PhotoFinish* is the only one that permits adding or integrating text matter with the image, using any scalable fonts available to *Windows*. This is a particularly handy feature since it facilitates adding a border and caption to an image file prior to importing the embellished image into a DTP or WP application.

One of *PhotoFinish*'s handiest features is its ability to display multiple versions of the same (or different) images on-screen

Alternative Imaging Options

While Logitech's FotoMan is a useful device that combines portability with convenience, you should take into consideration two major tradeoffs before making a buy decision. One is image quality. FotoMan doesn't produce the ultra-high-resolution images that are possible when using even a low-end camcorder and an image-capture board.

The other tradeoff is price. Listing at $799, FotoMan isn't inexpensive. In fact, at this price, you might want to consider purchasing a camcorder and an image-capture board instead. For example, I've seen some standard VHS camcorders offered in C.O.M.B., Damark and other mail-order consumer-electronics catalogs for as little as $499. A good color image-capture board will set you back about $250, street price.

In addition to capturing video images, you can use a camcorder for other traditional uses. And don't forget that a camcorder provides a zoom lens and an adjustable aperture that are free of the constraints imposed by the Fotoman's fixed focus and aperture. Of course, you'll have to add in the price of software for manipulating the captured images, but it is still an attractive alternative that gives you B&W, as well as color, imagery.

A second alternative is to consider a Canon Xapshot, image-capture board and retouching software package. I've seen such "bundled" packages advertised for about the same price (or slightly less) as the basic FotoMan package itself, so that's something to consider.

Table 1. Files PictureEze Can Convert

File Type	Publisher/Application
BBM	Electronic Arts/Deluxe Paint
BMP	Microsoft/Windows Bitmap
BTM	Algor/Algor Bitmap
CE	Digital Vision/Computer Eyes
CUT	Media Cybernetics/Dr. Halo
DIB	IBM/Microsoft/OS/2 Bitmap
EPS	Adobe/EPS (TIFF Preview Only)
GIF	CompuServe/Graphics Interchange Format
IFF	Amiga/Interchange File Format
IMG	Digital Research/GEM Image
LBM	Electronic Arts/Deluxe Paint
MAC	Claris/MacPaint
MSP	Microsoft/Paint
PCX	Z-Soft/PC Paintbrush
PIC	Paul Mace/Pictor and Grasp
PNT	Claris/MacPaint
PZI	Application Technologies/Pizazz Plus
RIX	RIX Softworks/WinRIX
RLE	Microsoft/Windows Bitmap
SC?	Rix Softworks/ColorRIX
TGA	Truevision/TARGA
TIF	Aldus/Microsoft/Tag Image File
VMG	Rix Softworks/ColorRIX
WIN	Truevision/TARGA
WPG	WordPerfect/WordPerfect Graphics

Products Reviewed

FotoMan, $799
Logitech Inc.
6505 Kaiser Dr.
Fremont, CA 94555
Tel.: 1-800-231-7717 or 510-713-4510
CIRCLE NO. 163 ON FREE INFORMATION CARD

Imageprep 4.0, $149
Computer Presentations, Inc.
1117 Cypress St.
Cincinnati, OH 45206
Tel.: 513-281-3222
CIRCLE NO. 164 ON FREE INFORMATION CARD

PictureEze, $149
Application Techniques, Inc.
10 Lomar Park Dr.
Pepperell, MA 01463
Tel.: 508-433-5201
CIRCLE NO. 165 ON FREE INFORMATION CARD

PhotoFinish, $199
ZSoft Corp.
450 Franklin Rd., Ste. 100
Marietta, GA 30067
Tel.: 404-428-0008
CIRCLE NO. 166 ON FREE INFORMATION CARD

simultaneously for comparison purposes. This is an invaluable aid when retouching or changing gradient/contrast values. It allows you to have an immediate frame of reference by comparing enhancements to the untouched original image.

Multiple zoom levels are also supported, making it easy to edit fine details of an image. Preset zooms provide magnification levels of 25%, 33%, 50%, 200%, 300%, 400%, 600% and 1,600% of actual image size (no user-selectable zoom ranges are supported).

PhotoFinish is my overall choice for *Windows*-based image-enhancement and retouching software. It provides all of the image manipulation features I need while allowing me to add graphics and text in any font I wish. Its direct support of scanners and CLASP-compliant devices are other pluses in a PC world that's becoming increasingly dominated by *Windows*. ■

Tom Benford

Inexpensive Pocket EPROM Programmer Provides Most of the Functionality of Larger Programmers

Do you have a need for an EPROM programmer but blanch at the high cost of the bewildering variety of commercial products? If so, relief is on the way. Intronics' handy little Pocket Programmer offers most of the functionality of its larger and considerably more expensive cousins at a fraction of their cost.

The Pocket Programmer is the least expensive EPROM programmer I've seen to date. It costs only $129 plus $3 for shipping and includes the programmer, power adapter, 5¼" 360K floppy disk on which are both the required PC communication software and system documentation, the latter in ASCII file format. It's easy to install, set up and use, too.

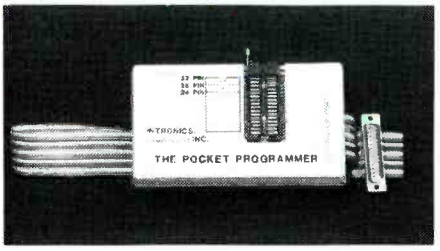
The Particulars

Unlike most other commercial programmers that connect to a host computer via an RS-232 serial link, this one is designed to work from a printer port of any IBM/compatible computer. This approach has several advantages, not the least of which is elimination of the configuration hassles often encountered when setting up an RS-232 port for baud rate, parity, etc. If you have over-taxed serial ports and a multitude of switch boxes you'll appreciate the reduction of wiring hassles inherent with this parallel-port design.

Although the Pocket Programmer can't handle nearly as many devices as its much more expensive cousins on the market, it can burn almost any EPROM commonly used by electronics hobbyists and computer hardware enthusiasts. For example, it accommodates the complete 27xxx line of devices, including the CMOS units. In fact, dozens of devices and manufactures are currently supported, and none requires use of adapter sockets that can often significantly add to the cost of a programmer.

While more than a dozen EPROMs are presently supported, don't expect to directly program microcontroller chips. According to a company spokesman, Intronics is working on a module that will enable the Pocket Programmer to burn 687xx series microprocessors, but no firm marketing date has been set for such a product.

Although I use mostly 2764A chips in my projects, I did test the Pocket Programmer with several other EPROMs, among them, 27C64, 27128A, 27256 and 57256 devices. All of the EPROMs programmed correctly through at least four complete erase/burn cycles.



I also tested the Pocket Programmer on five different PC/compatible machines, including an IBM PS/2 Model 70, a Toshiba T3100SX portable, a Zeos 386SX Notebook, a CompuAdd 286/12-MHz and an AST Premium 386. Intronics is batting 0.800 with this handy little programmer right out of the box. It worked well on every machine except the AST.

Every time I tried to burn a chip using the AST computer, the programmer's software returned a cryptic "PROM did not Program" message. Because the parallel port works fine with an Epson printer, I thought the problem had to be caused by some interface incompatibility. A phone call to Intronics solved the problem, which was installation of a second printer port at a cost of about $50.

Setup & Use

As you would expect, the amount of time it takes to program an EPROM depends mainly on the size of the device. Table 1 lists the times required to burn four different devices (the 57256 is really the same as a 27256). The data shows a nearly linear size/time relationship, indicating that the Pocket Programmer burns at a constant rate of about 630 bytes per second. At this rate, programming a 512K × 8 bit EPROM (the largest the Pocket Programmer handles) would take about 14 minutes.

Another factor that influences programming time is the speed of the host computer. The tests for deriving Table 1 were run on the T3100SX, which operates at about 1.85 MIPS, or 7.62 times faster than the original IBM PC. I encountered significantly longer programming times with the 80286-based machine. For example, programming a 27128A took 25 seconds on

Table 1. Programming Times For Common EPROMs *

Device	Time Required
2716A	4 seconds
2764A	13 seconds
27128	26 seconds
27256	51 seconds
57256	51 seconds

With a Toshiba T3100SX portable computer.

```
PROGRAM TYPE = BYTE PROGRAM  EPROM TYPE = 2716  VPP = 25 VOLTS
-------------------------------------------------------------------
1 - IS EPROM ERASED ?              2 - PROGRAM EPROM FROM BUFFER
3 - VERIFY EPROM TO BUFFER         4 - MOVE EPROM TO BUFFER
5 - PROGRAM COMPARE                6 - FILL BUFFER WITH FF'S
7 - CREATE BIOS CHECK SUM          8 - CHANGE EPROM TYPE
9 - CHANGE VPP VOLTAGE            10 - CHANGE PROGRAM TYPE
11 - CHANGE BUFFER ADDRESS        12 - SAVE CURRENT CONFIGURATION

FILE TYPE = BINARY  BUFFER CHECKSUM = 0378  DEFAULT DISK DRIVE = C
-------------------------------------------------------------------
13 - SAVE BUFFER TO DISK          14 - LOAD BUFFER FROM DISK
15 - APPEND FILES TO BUFFER       16 - DIRECTORY
17 - CHANGE DEFAULT DRIVE         18 - CHANGE FILE TYPE

START OF BUFFER = 70000 START OF EPROM = 00000  END OF EPROM = 007FF
-------------------------------------------------------------------
19 - DUMP MEMORY                  20 - FILL MEMORYWITH BYTE
21 - EDIT MEMORY                  22 - FIND BYTE SEQUENCE
23 - MOVE MEMORY                  24 - HELP
0 - QUIT

?                                    LAST FUNCTION USED - 1
-------------------------------------------------------------------
```

Fig. 1. Printout of the Main Menu presented by the software that interfaces the Pocket Programmer to an IBM/compatible computer.

the 286 versus only 13 seconds on the 386SX machine.

The Pocket Programmer is very easy to install and use. To set it up, I connected it to an available parallel port on my IBM computer. Then I powered it using the supplied ac wall adapter. Finally, I copied the system software to my hard disk (I could have run the software directly from a floppy disk had I chosen to do so). Typing EPROM at the DOS prompt and hitting Enter, I was ready to go.

With a correctly configured system and the Pocket Programmer powered, the software automatically identified which port (LPT1, LPT2 or LPT3) to which the programmer was connected. If the Pocket Programmer is attached to an incorrect port, or if power isn't applied to it, an on-screen message indicates that the programmer can't be located.

The first screen that came up required entry of the type of device to be programmed. Next, I plugged the EPROM I wanted to program into the ZIF socket on the Pocket Programmer. The instructions warn against plugging in the EPROM before identifying the type of EPROM to be programmed.

Next to appear on-screen was the system's main menu, which looks like that reproduced in Fig. 1. Though most items in this menu are self-explanatory, a few require elaboration:

10 - CHANGE PROGRAM TYPE allows the Pocket Programmer to work with both eight and 16-bit microprocessors by letting you configure the software to read in every byte in a file, only high-order bytes or only low-order bytes. If you need to create PROMs for 16-bit micro systems, you'll find this to be an extremely useful feature, one that few other low-cost programmers incorporate.

11 - CHANGE BUFFER ADDRESS permits you to change the location of the programmer's buffer within the memory map of the host PC. Because entering an inappropriate number here could have catastrophic consequences, I suggest you leave this option alone until you've gained some experience in programming EPROMs.

12 - SAVE CURRENT CONFIGURATION lets you save to disk the current configuration of the software, which then supplies the default values the next time you execute the program. The only major item not to save is the device type, which must be entered every time the program is run.

14 - LOAD BUFFER FROM DISK permits you to load a file from disk into the host computer's memory as a precursor to burning the EPROM. File types supported are Motorola S-records, Intel Hex and binary. When using menu option 18, keep in mind that Intronics calls both Motorola and Intel formats "Hex." While the software doesn't distinguish between formats on-screen, it correctly loads both types of files during processing.

13 - SAVE BUFFER TO DISK lets you save the buffer to disk once the EPROM's data is copied to the buffer using option 4. Option 18 has no effect here because the unit can save data to disk in only binary format.

Comments

Intronics' Pocket Programmer is almost certain to be a commercial success, especially since not everyone needs all the functionality of more-expensive EPROM programmers. Furthermore, the Pocket Programmer's ease of setup and small size are highly attractive if you need a programmer infrequently or have a need to travel with one frequently.

Given the foregoing, if you need an EPROM programmer, give this one strong consideration. Given its low cost, ease of setup and use and the fact that it does just about everything it's claimed to do, I think you'll be very happy if you buy and use one. And there's an extra bonus in the fact that the Pocket Programmer is compact enough to fit neatly into a jacket pocket or, along with its ac adapter, into a briefcase without taking up much room. ■

In Brief

Pocket Programmer, $129
Intronics, Inc.
P.O. Box 13723
Edwardsville, KS 66113
Tel.: 913-422-2094

CIRCLE NO. 168 ON FREE INFORMATION CARD

Joseph Desposito

3-Volt Flash Memory, Step-Down Controller, Active SCSI Terminator, 16-channel PC/AT D/A Board and 2M-Bit Video RAM

By all indications, systems that operate at 3 volts are the wave of the future in digital electronics. Therefore, this time around, I lead off with a flash memory device that operates at this voltage level.

3-Volt Flash Memory

Atmel Corp.'s (2125 O'Nel Dr., San Jose, CA 95131) AT29LV512 3-volt-only flash memory is designed for portable electronics applications. This low-voltage 512K-bit flash nonvolatile, read/write memory offers power reductions of up to 90% in the flash memory sections of various hand-held and portable computing machines and telecommunications gear.

Flash is a class of nonvolatile memories that can be rewritten while within a system. This device type combines the most useful features of electrically erasable programmable read-only memories (EEPROMs), such as off-site programmability, with the cost savings and ease-of-use of electrically programmable read-only memories (EPROMs). Atmel was the first manufacturer to develop flash memories that operate on a single-voltage supply.

The AT29LV512 is a 524,288-bit device, designated as a Programmable Erasable Read-Only Memory (PEROM). The device is organized as 65,536 × 8 bits and offers speeds to 200 ns. It requires only 10 mA in active mode and only 20 μA in standby mode.

One of the critical Atmel technological improvements lowers the internal current requirement for programming the device's two-transistor memory cell to less than 100 nA. This is several orders of magnitude below the 1 mA to 10 mA per bit typically needed for devices with single-transistor cell devices.

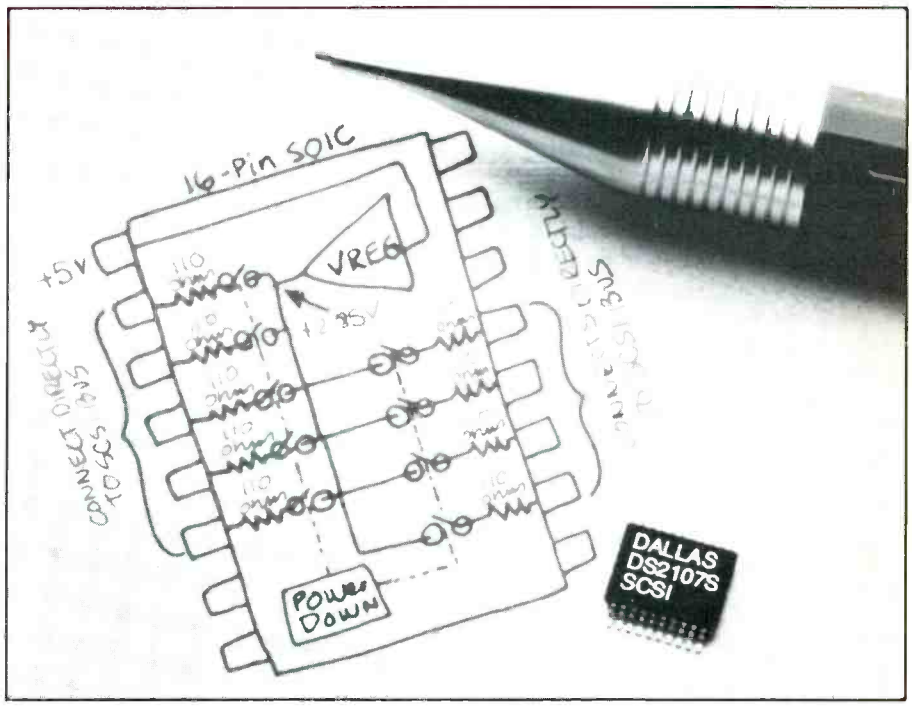
Additionally, Atmel refined the design of its charge-pump system so that it's more efficient and capable of fast, accurate programming at lower supply voltages. The circuitry for read and write operations within the Atmel device has been enhanced with voltage isolation to permit high-yield manufacture of 3-volt devices.

The AT29LV512 is organized into many small sectors for efficient, fast programmability. Each sector contains 128 bytes to allow maximum flexibility in code updating. Each 128-byte sector in the device is programmed in less than 10 ms, giving the device an effective byte-write time of 78 μs. Automatic erase and sector write contribute to the high byte-programming speed of the device.

A key reason for the simplicity in programming Atmel flash memories is an internal invisible-to-the-user automatic erase feature. Competing devices require a complete device erase, or for those with large sectors (4K to 16K bytes), a complete sector erase before new data can be entered into the circuit.

Low-voltage memories give designers the opportunity to reduce the number of batteries in a system or substantially extend the life of the same number of batteries. Atmel's flash memories will be used in palm- and lap-top computers, cellular telephones and other portable telecommunications gear, as well as portable and automobile-based entertainment systems.

The Atmel 3-volt flash memory is processed with 0.6-micron CMOS technology. It's available in 32-pin DIP, PLCC and TSOP packages. The AT29LV512 is priced at $9.90 for a 200-ns commercial temperature range plastic DIP in quantities of 10,000.



Dallas Semiconductor's DS2107 SCSI Terminator combines nine precise termination resistors and an accurate voltage reference on a single integrated chip.

Step-Down Controller

Linear Technology's (1630 McCarthy Blvd., Milpitas, CA 95035) LT1432 is a controller for step-down switching regulators for use in high-efficiency power supplies for notebook and palm-top computers and portable data-gathering instruments. The new device features a low-power sleep mode for systems with a sleep/resume feature built into them.

The LT1432 is a control chip designed to operate with the LT1170 and LT1270 family of switching regulators to make a very-high-efficiency 5-volt step-down (buck) switching regulator. A minimum of external components is needed.

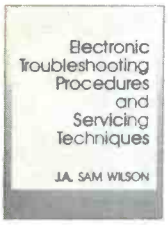
The controller includes an accurate current limiter that uses only 60 mV of sense voltage and uses "free" pc board trace material for the sense resistor. In addition to sleep/resume operation, it features a logic-controlled electronic shutdown that

(Continued on page 74)

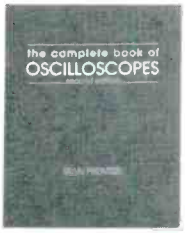
3804P $19.95
Softcover

586023-XX $26.95
Counts as 2

1367P $29.95
Counts as 2

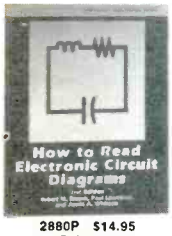


9370-XX $38.60
Counts as 2



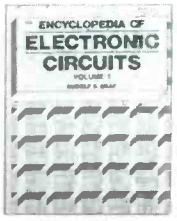
3825 $26.95

3738 $26.95

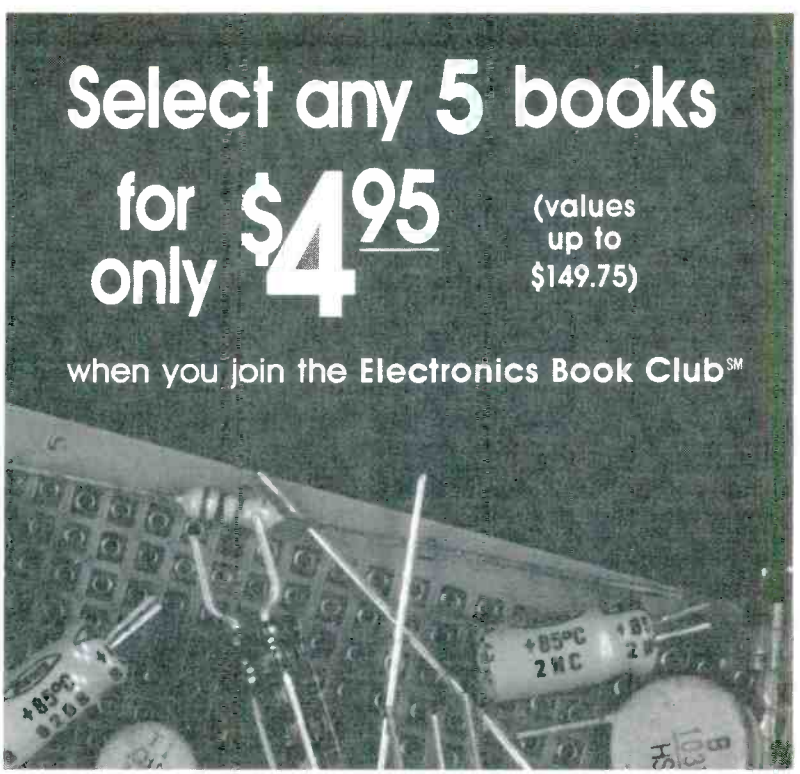


2880P $14.95
Softcover

3279-XX $36.95
Counts as 2



1938-XXX $60.00
Counts as 3



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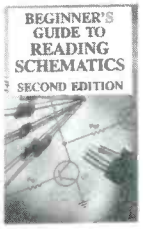

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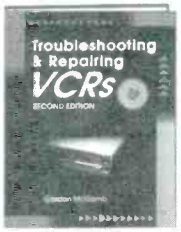

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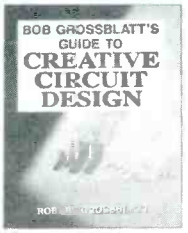

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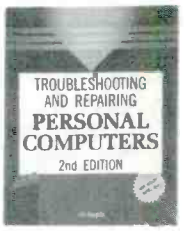

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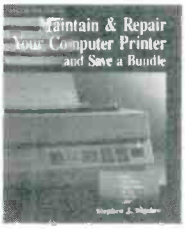

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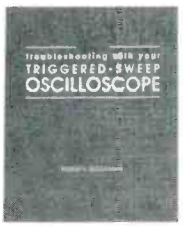

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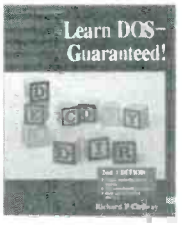

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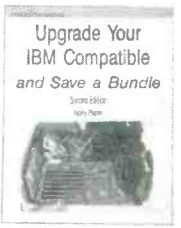

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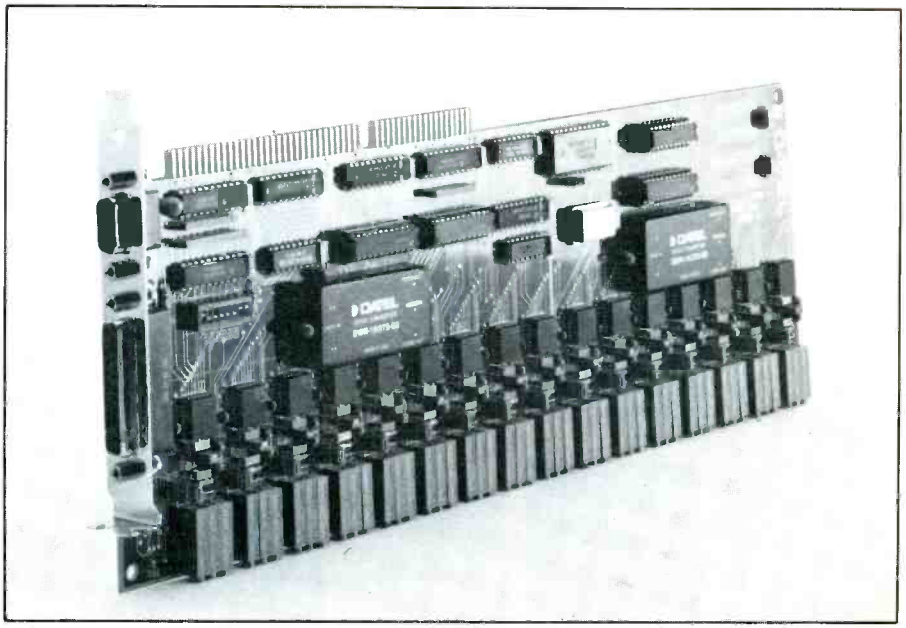


Datel's PC-422 phase-synchronous analog output card can update all eight or 16 D/A channels simultaneously, with no time skew between channels.

draws only 15 μA of battery current. The switching regulator operates down to a 6-volt input.

The LT1432 has a logic-controlled burst mode that achieves high efficiency at very light load currents (0 to 100 mA), such as in sleep/resume systems. In normal switching mode, standby power loss is about 60 mW, which limits efficiency at light loads. In burst mode, standby loss is reduced to approximately 15 mW.

The LT1432 operates with inputs from 6 to 30 volts. It's accurately preset to +5 volts output. The device uses a small 25 to 50 μH inductor.

The LT1432 is available in eight-pin surface-mount and eight-pin DIP packages. Price for the LT1432 in eight-pin plastic DIP in 100-up quantity is $2.35 each. The LT1170/LT1270 family is available in a surface-mount version of the five-pin T0-220 package.

Active SCSI Terminator

A new chip from Dallas Semiconductor (4401 S. Bellwood Pkwy., Dallas, TX 75244) quiets transmission lines with precise termination. As the length of the SCSI bus increases to accommodate additional peripherals, the DS2107 SCSI Terminator can electrically move the termination point. Fully compliant with SCSI and SCSI-2 standards, the DS2107 connects and disconnects from the system bus under software control via a power-down pin.

The DS2107 measures only 0.2″ × 0.3″ and is housed in a 20-pin TSOP package. Its less-than-50-mil thickness makes it suitable for new extremely space-conscious 1.8″ disk drives and other notebook peripherals. The chip is also available in a 16-pin SOIC.

Existing termination schemes plug a resistor SIP into a socket on the PC board. When termination is no longer at the end of the bus because a peripheral has been added to the system, you must take apart the system and pull the resistor SIP out of its socket with pliers. To circumvent having to do this, many disk drives and peripherals are made with no termination, which requires you to purchase and install an extra end plug.

The DS2107 monolithic IC is a non-mechanical solution to these problems. Now peripheral manufacturers can embed active termination that's turned on and off under software control, eliminating the need for the end user to take apart his system or purchase additional components.

The DS2107 provides active termination for nine signal lines. This ×9 modularity accommodates SCSI buses, which have 18, 27, or 45 lines actively terminated.

This all-CMOS chip integrates an accurate voltage reference and nine precise, switched 110-ohm (+1%) termination resistors in a single package that can be surface mounted (see Fig. 1). Voltage regulator and resistors are precisely set by writing digital codes with a laser.

Active termination matches the resistor to the characteristic impedance of the bus to eliminate reflections on the transmission lines. Active termination also saves power over passive techniques.

The DS2107 SCSI Terminator 16-pin SOIC sells for $2.80 each in quantities of 10,000 and up.

16-channel D/A Board

Phase-synchronous analog outputs are needed in many signal processing, communications, DSP and ATE applications. The PC-422, from Datel (11 Cabot Blvd., Mansfield, MA 02048) can update all eight or 16 D/A channels simultaneously, with no time skew between channels. Datel designed the board for use in IBM-PC/AT and compatible 16-bit computers. The concurrent feature is particularly useful in artificial waveform generation.

Each analog output channel on the PC-422 uses 12-bit D/A resolution and a 3 μs settling time, offering fast 330-kHz update rates per channel. Four output ranges with 5 or 10 volts full-scale are individually selected for each channel. Special buffering allows all eight or 16 channels to be updated at over 1 MHz from very-high-speed block transfers or DMA.

A crystal-stabilized software-programmable timer trigger requests D/A updates using status or interrupt. An external trigger can also be software selected for precise tracking of external events. The entire system is suitable for background D/A refresh while foreground processing continues. General-purpose digital I/O is included (four inputs and four outputs). So, too, is a spare 16-bit counter for control of external devices.

The PC-422 receives all power from the AT bus and includes quiet on-board dc/dc power converters. Two models are available. The PC422A has eight channels and lists for $995 in single quantity. The 16-channel PC-422B is $1,695. Both boards include a comprehensive user's manual. A $50 Model PC-422SET software utility exercises the board completely and includes a disk file playback mode. The source code to PC-422SET is the $250 Model PC-422SRC.

2M Dual-Ported Video RAM

NEC Electronics (401 Ellis St., P.O. Box 7241, Mountain View, CA 94039) has 2-megabit third-generation VRAM for use in sophisticated graphics systems. It's specifically designed to handle the wider-bandwidth data and faster display refresh inherent in graphics applications.

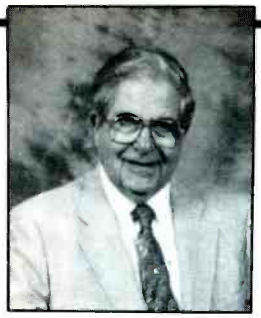
Designed using an advanced CMOS process, the PD482234 and PD482235 are upward-compatible with NEC's 1M version and are single-chip replacements for earlier two-chip solutions. Both products offer higher density, lower power consumption and increased reliability, which are necessary for both personal computer and engineering workstation systems.

The fast page buffer PD482234 and hyper page version PD482235 include dual ports. With one port for the CPU and one for the display, processor efficiency is doubled. The fast page version includes a 70-ns DRAM port that provides faster frame updates. NEC's new hyper page mode includes extended data output, allowing cycle times of 35 ns.

All JEDEC standard features on the 1M VRAM products are included on the 2M version to ensure compatibility. In addition to the hyper page mode, the following new features have been added: serial write cycle; split write and masked write transfer; serial I/O direction switch; and stopping column control.

Current performance trends in personal-computer and workstation markets include faster graphics, higher resolutions, additional colors and grayscales for a variety of applications. NEC's 2M VRAM is designed for use in image and digital signal processing, communications, multimedia, multi-processor systems and disk buffer applications.

Both the PD482234 and PD482235 are available in 40-pin plastic SOJ, 40-pin shrink ZIP and 44-pin TSOP packages. They're priced at $30 each in sample quantities. ■



Illegal Hacking and the Government, On-Line Selling and Shareware Update

On July 8, 1992, U.S. attorney for the Southern District of New York Otto Obermier held a press conference to announce the indictment of five computer hackers, members of a group called MOD for "Masters of Disaster" or "Masters of Deception." The indictment named Julio "Outlaw" Fernandez, 18, John "Corrupt" Lee, 21, Mark "Phiber Optic" Abene, 20 and Paul "Scorpion" Strika, 22. In addition to alleged illegal acts involving computers, this group was also charged with conspiracy.

The indictment alleges that "the members of MOD would gain access to and control of computer systems in order to enhance their image and prestige among other computer hackers; to harass and intimidate rival hackers and people they did not like; to obtain telephone credit information, account numbers and other listings of value which they could sell to others." Morton Rosenfield has also been indicted and pled guilty to purchasing credit information and access codes from persons named "Julio" and "John."

The Assistant U.S. Attorney also announced the outcome of a court action in which Alfredo De La Fe, had pled guilty on June 19, 1992 to use and sales of telephone numbers and codes for Private Branch Exchanges (PBX). De La Fe said he'd sold PBX numbers belonging to Bugle Boy Industries to a co-conspirator, who used them in a call-selling operation. He also said he and a person he knew as "Corrupt" had made illegal conference long-distance calls. Both De La Fe and Rosenfield face a maximum sentence of five years in prison if convicted and a fine of $250,000, which is twice the gross gain or loss incurred.

Obermier stated that this was the first investigative use of court-authorized wiretaps to obtain both conversation and data of computer hackers and that it demonstrates the federal government's ability to deal with criminal conduct in an age of high technology. There's a bill pending in Congress to allow the government, under court authorization, to intercept digital transmissions. The government is concerned that transmission of data by optical means through fiber-optic networks may prevent its ability to intercept information without cooperation of communications companies.

The government seeks authorization from Congress and help from communications companies to be able to intercept digital data from computers. Many groups have expressed concern about this, claiming it to be an invasion of privacy and an erosion of first-amendment rights in the electronic age.

A number of charges were leveled against the MODs and others whom they aided and abetted and performed various acts that caused losses to Southwestern Bell. All of the indicted hackers were charged with some type of unlawful access to one or more of the computer systems belonging to Southwestern Bell, BT North America, New York Telephone, ITT, TRW, Trans Union, Pacific Bell, Martian Marietta Electronics, Tymnet and many other organizations.

Besides use of wiretaps to detect hacker intrusions into computers, one other reason this may well be a landmark case is that the hackers are charged with other co-conspirators with whom they aided and abetted and performed various computer activities that resulted in a $370,000 loss to Southwestern Bell.

When asked how the losses in the indictment were calculated, Assistant U.S. Attorney Fishbien said there was no breakdown beyond that stated in the indictment that specified "expenses and losses to locate and replace computer programs and other information that had been modified, or otherwise corrupted; expenses to determine the scope of the unauthorized intrusions; and expenses for new computers and security devices to prevent continued access by the defendants and others whom they added and abetted."

This is the same as trying to force a burglar to pay to install a complete alarm system that wasn't in place at the time he broke in. It goes quite a few steps beyond what has been thought of as restitution. In addition, in previous cases involving losses claimed by telephone companies, the courts have found these to be completely exaggerated and thrown out the cases. While the government should and must keep after hackers and others who use our networks for illegal purposes, we must guard against precedent-setting decisions that erode our liberty and rights under the Constitution.

On-Line Sales

Meanwhile, on the commercial networks, more and more computer companies are going on-line both to sell equipment and provide information and technical support. On CompuServe (CIS), over 100 companies maintain bulletin boards in support of their software or equipment.

If you're seeking help these days you'll find it's a lot easier to go to a forum on one of the services, even if you have to wait a day for help or advice. It may be better than holding the telephone while music plays in your ear from up to 3,000 miles away, all the while paying for on-going phone charges. Even if you're calling an 800 number at no cost for the call, your time is too valuable to waste.

Many companies are also turning to the use of 900 numbers, where you pay a stiff penalty for having problems with their software. With this trend, it begins to pay to read the manuals before calling for help!

On America On Line (AOL), many of the same companies have their forums in interactive mode, while others use the standard message format. The nice thing about the interactive forum is that you can often get an answer from another user who just happens to be on the network. Notable among the manufacturers found only on AOL are Gateway 2000, Geoworks, Broderbund, Diamond Computer, Berkeley Software and Dac Easy. Sierra On Line, Spectrum Holobyte, Timeworks Iomega Corp. and Radius Microsoft can be found on both AOL and CIS. Many others can be found on Genie, but more and more are moving to AOL.

Shareware Update

By the time you read this, there'll be a new network devoted to *Windows*, called WINNET. It will run on the General Videotext (Delphi and BIX) and will be independent of Microsoft. It claims that it will

be the place where *Windows* users can go to get help and meet other people who have similar interests.

Meanwhile, Microsoft is directing more and more people to its forums on Compuserve because the company can't keep up with the traffic on its phone-support lines. If you're in real trouble with *Windows*, expect very long delays on the phone. You're better off on-line if you can wait to get on-line help. The alternative is to get help from the manual. Also, I've found the *Windows Resource Kit* I bought with my *Windows* 3.1 upgrade is one of the best investments I ever made. I urge all *Windows* users to get one.

I'd like to assure anyone who downloads it from bulletin boards that today's shareware is high in quality. All distributors and on-line boards that have shareware for downloading are careful these days about product quality. There are major shareware systems that are as good as any commercial product.

One of the finest DOS editors I've ever seen is BOXER.EXE, which you can find on almost all major networks and obtain from most distributors. I've mentioned this one before, but there's a new revision out. If you write any programs, you owe it to yourself to try BOXER.

PC Write is one of the oldest word processors around for DOS systems. It has undergone constant upgrading and is still as good as most commercial competitors. *PD File* and *Wampum* are great databases and *Procomm, Qmodem* and *Telemate* are the best you can get in communications programs. They're all shareware applications. Although *Procomm* has gone commercial these days, the shareware versions are still out there.

Don't be concerned about downloading these programs from major commercial services. They're all scanned for viruses. To be on the safe side, though, I still download to a floppy disk and then I scan before and after I use it. When I'm sure the floppy disk is clean, I copy to my hard drive. Even then, I scan for viruses every week, just to be sure.

Most commercial services like AOL, CompuServe, Delphi and GEnie carry the latest versions of McAffee virus programs. They're as good as or better than most commercial virus programs, and they'll cause you a lot less problems with your computer system.

If you feel you need help in selecting shareware, you can now ask advice from one of the most well-known experts, Dr. File Finder himself, Mike Challan. He'll soon be found at the PC World area of America On Line, listed under "the Magazine Rack." Mike has written several books on software and is Editor-In-Chief of Shareware Magazine.

The most popular downloads these days on most networks include the following:

4DOS 4.0 program files, listed as 4DOS4P.ZIP
4DOS 4.0 manual files, listed as 4DOS4D.ZIP
Back & Forth Professional 2.0 DOS Task Switcher (five files)
EasyAs Spreadsheet, listed as ASEASY.ZIP
PC-File 5.01 (three disks), listed as PCFFILE (1-3).ZIP
PC-Write 3.04 (three disks), listed as PCWRITE (1-3).ZIP
Duke Nukem (game), listed as DUKE.ZIP
Commander Keen (game) listed as KEEN.ZIP
Graphics Workshop, listed as GROWKS.ZIP

Back & Forth Professional Version 2.0 by Sandi and Shane Stamp is a task switcher for DOS that permits as many as 20 files to be open at one time. It's a fine piece of work that has won every shareware award and is well worth the time to download the five disks. This program works on MS/PC-DOS and DR DOS and with 4DOS. If you want to do multi-tasking but don't want to use *Windows*, use this great system. Find it on many BBS and commercial services.

4DOS is a substitute for COMMAND.COM in DOS 5.0. Many users have claimed that it's a better COMMAND file than that supplied by Microsoft in DOS 5.0. One of the important ones who says so is Alfred Glossbrenner in his new book, *DOS 5*, published by Random House. This 2"-thick book is expensive, listing for almost as much as DOS 5.0 itself. In my opinion, it's worth every cent. I consider myself rather well informed when it comes to the arcane aspects of DOS, but I can always learn something from one of Glossbrenner's books. I've taken to using this book as a reference and as solace for the times I fell like taking an ax to my computer when *Windows* or some other program blows up in my face. ■

Note Bookin'

When it comes to running GUI environments and applications, notebook computers aren't usually the first platform that comes to mind. Their monochrome LCD displays can't provide the cinnabars, chartreuses and cyans that fully empower the GUI, but they do contribute poor contrast and slow refresh rates that increase stress and decrease productivity. This is changing, though, as the quality of color displays goes up and prices fall. Thin-film-trasistor (TFT), active-matrix color LCD panels now make running *Windows* and OS/2 every bit as easy and productive as a cathode-ray-tube (CRT) monitor does.

If you're not familiar with active-matrix devices, all you need to know is that they're the sharpest, brightest, fastest things the thin side of a phosphor dot. TFTs derive superior performance from a huge number of transistors. Where ordinary passive LCDs use a transistor to control an entire column or row (with three dye layers for color), color TFTs have three transistors on every pixel. They react quickly, render highly saturated colors and provide superior contrast. They're very easy on the eyes, and cursors don't disappear when they move across the screen.

There are very few limits with a color machine like the NEC UltraLite SL/25C I use. For several weeks, I've been using the UltraLite to run *Windows*. It's the first of all the many portables I've had—including Osbornes, Kaypros, the original Compaqs, NEC's first MultiSpeeds and latest Toshiba T3300 monochrome notebook—that makes me want to use it even when I'm in the office, which I do. Using it to take notes at conferences, like the recent Seybold Digital World in Beverly Hills, is irresistible.

Later this month (July 26, 27 and 28), I'm going to learn how it feels to tote my whole office with me when I, the UltraLite and a 540M Lightek ex-DRIVE go to National Semiconductor's "Communicating the Future" symposium (in Napa California). The added storage will let me use *Windows* with as many applications, and as much data, as I have in my office desktop machine.

It will also let me plan my ground travel in Oakland and Napa (and a side trip to Sunnyvale) with Klynas Engineering's DOS application, *Streets on a Disk*. This is a graphical application, with menus and mouse support. *Streets* displays maps with a resolution of 26 feet. It calculates mileage, distance, travel time and fuel requirements. You can use it to search for streets, places, intersections, addresses, cities, zip-code areas, boundaries and more. It can automatically identify locations from mailing-list addresses or longitude-and-latitude coordinates and place them on its maps. You can annotate locations with substantial notes, including addresses and telephone numbers—even PCX images.

Streets will also automatically create and print routes, including travel directions, and arrange their optimal order. And if you have a global positioning system (GPS) receiver and add an option, *Streets* can even display the location of as many as 50 vehicles.

At 85M, the UltraLite's hard drive is a little small for jobs like running several *Windows* applications or *Streets on a Disk* (its detailed maps are huge). Fortunately, NEC machines generally have great compatibility, and the UltraLite's parallel port is no exception. In the office, I just plug the portable ex-DRIVE into it and dump all the extra files out for off-line storage. The drive is off-line only while I'm on the road, though. The Lightek is actually fast enough to run *Windows* on it when I'm in the office.

I also wanted enough space to run several *Windows* applications together, or to run OS/2. So, I added a 6M Kingston memory card to bring system memory to its maximum of 8M.

UltraLite's 25-MHz clock is fast enough to get the work done, but I've boosted its speed with a 25-MHz Intel 80387SL that supports *Windows*-based number crunchers. It also runs my Autodesk DOS applications, including *AutoCAD, 3D Studio* and *James Gleick's Chaos, The Software,* named for the book, which it illuminates splendidly. Even *Streets* takes advantage of a coprocessor when it's available. (Interestingly, a Cyrix 83S87 coprocessor I tested also worked with the UltraLite, but it didn't perform identically with the transcendental test in Intel's version of the IEEE test suite.)

NEC could have messed up the whole thing by putting a lesser-quality keyboard or eliminating power management or inadequate ports on the UltraLite, but it didn't. The keyboard is great, and not only are parallel, serial, mouse, keyboard, VGA and floppy ports built in, but there's even an expansion port that connects the UltraLite to a portable docking station. (NEC didn't send one of these expansion units with the UltraLite, but it should be possible to further increase extended memory on its bus.) When you run out of juice, just hit the stand-by button, and you can change the 1-pound, 2.5-hour battery without dropping a bit.

In addition to its capacity for memory expansion, the UltraLite features an optional internal fax-modem and an attachable sidecar-style numeric pad. There's a high-density microfloppy drive, too.

Back-stepping a moment, there are still a couple of hitches with TFTs. If just one transistor fails, it creates a flaw that can't be fixed. Also, with three transistors per pixel, the chance of getting a good panel falls precipitously as size increases. (A 640 × 480 VGA display has close to a million integrated circuits.) As a result, nearly all early production ended up in tiny personal TV receivers. Yields are increasing now, and vendors are accepting not-quite-perfect units to raise the number still higher.

At the recent Lap and Palmtop show in Los Angeles, a Toshiba representative told me that his company tolerated an even dozen flaws before rejecting a panel. My UltraLite has four to six bad pixels—three always lit, two usually lit and one usually off. Nevertheless, you have to look hard to find bad pixels (except on a totally black screen, where they tend to disappear). They don't interfere with the majority of applications at all.

The important thing is that prices for the UltraLite have fallen to under $6,000. That's about $2,000 less than first-generation machines cost. I'll gladly forfeit a few pixels at $200 to $500 apiece.

Word to Your Whatever

One of my favorite DOS (and Mac) word-processing products is now available for *Windows*. I've been waiting for *The American Heritage Electronic Dictionary* to

make the transition since it first shipped on those other platforms. Even as just a spelling checker, I like it. You'll find all the everyday words, like "sesquipedalian" (perhaps the only self-defining word in the English language). However, *AHD* also has real meaning.

AHD actually has many meanings. It's a genuine dictionary, with 115,000 words and definitions. You can even search for the meaning of entries by hunting for a key word or two. In fact, my first experience with *AHD* made use of this very feature. I had just concluded an interview with Jerry Pournelle and turned to him when I was unable to recall the spelling of a word I knew that perfectly described his upstairs lair at Chaos Manor. Using a copy of the DOS *AHD* he'd just received, he instantly found "aerie" by searching for the words "eagle," "nest" and "high."

Search criteria can be combined by logical operators for union, intersection, exclusion and delimiters for ordering operations. The results of any search—either synonyms or words in definitions—become the subject of another search with just a double click of the mouse button. Clicking on a Copy button gets them on the clipboard fast.

There are several other features besides the dictionary and search. Synonyms (from Roget's Thesaurus) are also included, as are functions that create anagrams and find crossword-puzzle solutions (using wildcards).

Not only is the *AHD* now available for *Windows*, it's available from at least two licensed sources besides the original publisher, Houghton Mifflin. Both Wordstar's Writing Tools Group, Inc. and Systems Compatibility Corp. have versions.

Wordstar's product, *The American Heritage Dictionary, Windows Edition*, is a stand-alone dictionary that lets you automatically install it in the menus of Microsoft *Word for Windows* (1.1 or 2.0), *WordPerfect for Windows* and *Ami Pro*. In my copy of *Word for Windows*, for instance, it installed a macro. When I ran the macro, it added the dictionary to my menu.

It also runs independently with any *Windows* program that uses text—including *Wordstar for Windows* itself. You have only to open the *AHD*, and it appears on the system menu of any window. Copy a word to the clipboard and click on the system menu entry, and the dictionary's paste function takes it from there.

The Systems Compatibility *AHD* comes bundled in the company's *Windows* version of *The Writer's Toolkit*. The complete toolkit, on 10 3½" disks, consists of a grammar checker—the Houghton Mifflin *CorrecText Grammar and Style Checker*—and six references: the *AHD, Roget's II Electronic Thesaurus*, the Houghton Mifflin *Abbreviation Program*, the *Written Word III—Principles of Grammar & Style*, the *Concise Columbia Dictionary of Quotations* and *The Dictionary of Common Knowledge*. The installation program allows you to install any or all of these tools, as required, and will uninstall them for you as well. Uninstall is a useful feature that more application vendors should offer.

The Writer's Toolkit has the advantage of including a grammar checker, as well as several references. That's a lot of value if you need the extra features. However, its *AHD* isn't nearly as easy to use as Wordstar's, which uses the graphical interface to its fullest advantage. Boolean operators, for example, are entered with buttons. The *Toolkit* requires you to know its conventions—like a DOS program—and enter operators yourself. And it isn't nearly as flexible in allowing found words to become the subject of further searches.

Wordstar uses distinct windows for its different functions. *Toolkit* has a more modal approach. *Toolkit* is much slower than Wordstar's *AHD*. Wordstar required about 5 seconds to find "aerie." The same search required longer than 2.5 minutes in *Toolkit*. *Toolkit* doesn't install itself on system menus, either.

Incidentally, the definition the *AHD* gives for sesquipedalian is "Long and ponderous; polysyllabic." It also provides the noun form (sesquipedal); pronunciations, hyphenation points, parts of speech and definitions for each; a sample sentence; and an etymology. Idiomatic usage is provided when appropriate. Altogether, there are 116,000 words—a sizable list. It couldn't find Archaeopteryx, though. (I guess there are some words that simply require a larger reference.)

Enter the Reference

That's the *Reference Software International Dictionary* based on the *Random House Webster's Dictionary & Thesaurus*, College Edition. With 180,000 words and a 1991 publication date, you can find not only Archaeopteryx but lots of current usage, such as "sexual harassment," that an older reference like the *American Heritage* lacks. The electronic *Random House* also maintains biographical and geographical data from the print version that isn't found in the electronic *AHD*.

There are many similarities, as well as a few differences, between the *Random House* and the other two electronic dictionaries. It has all the search capabilities of the other two (with approximately the speed of the Wordstar version) and adds a browse function to those. It also imports words from other *Windows* applications, but it interacts with them more like a DOS TSR than a GUI application. Rather than access words from the clipboard, you highlight them and then call up the dictionary with a hot key (Ctrl-Shift-D and Ctrl-Shift-T are the defaults). This works fine with other *Windows* applications but not DOS applications—even if they can copy to the clipboard (*MS Word*, for instance). The *Random House* interface does have its advantages, though. You can replace a word in your text with a highlighted synonym, antonym or word in a definition, using a single button click.

The Random House Thesaurus, College Edition, claims fewer words than the *Roget's* (275,000 versus 500,000). Nevertheless, I frequently preferred its examples and synonyms over *Roget's*. It also includes antonyms the others don't. As with Wordstar's *AHD*, any found word can become the subject of another search.

Memory Has No Memory

When a computer crashes, you're bound to lose data that hasn't been previously saved. *Windows* files are no exception, but with two types of *Windows* accessory files, there's a way you can often recover most or all your information you haven't previously saved. The only special requirement is that the *Windows* TEMP directory mustn't be located on a RAM disk. (Using a RAM disk isn't a good idea in any event, since *Windows* can optimize its own performance if you give it the RAM drive's memory.)

The *Windows* accessories are so minimal that they're easy to overlook. Nonetheless, CARDFILE and CALENDAR can be combined to make a simple but useful personal-information manager. Neither offers anything special, but CARDFILE can store whatever you put into a 3" × 5" card file—including graphics. It also seeks phone numbers automatically and dials them with your modem. The calendar is missing one essential feature—a text search—but the pair's real virtue is ease of use.

Both CARDFILE and CALENDAR regularly store changes in temporary files (whenever you change cards or dates) that can be viewed with any ASCII editor. (Not all data is in ASCII, but any text you enter is.) *Windows* saves changes to both types of files with just one exception: changes to the current calendar date can be preserved only by saving the file. Any other change creates a record in one of the .TMP files in the TEMP directory.

After a crash, you can check for the temporary files and recover them manually, but it's easier to run *Windows* from a batch file. First, check for temporary files

of the format ~MW*.TMP. They're stored on the drive identified in the environment as the *Windows* temporary work area. (From the DOS prompt, use the SET command and look for the TEMP = keyword.) If these files exist when *Windows* is closed, they probably contain data that hasn't been saved. Have the batch job pause and alert you, or automatically rename them to ~MW*.tm!, before *Windows* is allowed to load. (Once *Windows* loads, it creates a second set of temporary files that will confuse things if the old files haven't been renamed.)

You should edit all files with non-zero sizes to restore lost data and then delete them. I recommend calling the batch file something like CRASH.BAT if you plan to use it only after a crash. You can also name it WIN and use it regularly. However, if you call it WIN, be sure to place it in a directory that precedes the *Windows* directory on the system's PATH. Otherwise, the WIN.COM file will take precedence over it.

Not only does this strategy provide a convenient way to recover appointments, telephone numbers and other vital information that haven't been saved, but you can use this feature to reduce the frequency of saves. Large card files, especially, can require a long time to save, and it's much faster to just page up a card. That's enough to enter the data into the temporary file, and simply changing cards or dates like this is all you ordinarily need to do. It even gives you the ability to undo subsequent errors with the Edit Restore command. Furthermore, managing these files is essential to prevent them from accumulating from successive crashes.

There's also a little trick you can do with the CARDFILE based on this temporary save if it's ever necessary to store a card out of its normal sort sequence. Just open the index line with the Edit menu or F6 key and enter enough characters (at the beginning of the line) to insert the card at the desired point in the sort. Then, without changing cards, use the Edit Restore command to delete the extraneous characters from the index line. The card will stay out-of-sequence until you reopen its index line. Follow that by changing cards. ■

Products Mentioned

40M to 540M ex-DRIVE, $469 to $2,195
Lightek
948 Cherry St.
Kent, OH 44240
Tel.: 216-673-5358
CIRCLE NO. 158 ON FREE INFORMATION CARD

Streets on a Disk Base Package, Version 5.0, $225
Maps, $40 to $225
Klynas Engineering
Box 499
Simi Valley, CA 93062
Tel.: 805-529-1717
CIRCLE NO. 159 ON FREE INFORMATION CARD

The American Heritage Electronic Dictionary, $99
WordStar International, Inc.
Writing Tools Group, Inc.
201 Alameda del Prado
Novato, CA 94948
Tel.: 415-382-0606
CIRCLE NO. 160 ON FREE INFORMATION CARD

The Writer's Toolkit, Windows Edition, $129
Systems Compatibility Corp.
401 N. Wabash, Ste. 600
Chicago, IL 60611
Tel.: 312-329-0700
CIRCLE NO. 161 ON FREE INFORMATION CARD

Random House Webster's Electronic Dictionary & Thesaurus, College Edition, $99
Reference Software Int'l.
330 Townsend, Ste. 131
San Francisco, CA 94107
Tel.: 415-541-0222
CIRCLE NO. 162 ON FREE INFORMATION CARD

Ted Needleman

All the Text That's Fit to Print

A few columns ago, I took a look at two low-cost graphics programs (*Picture Wizard* and *Windows DRAW!*) that let you do a fair amount of text manipulation. With these and other popular graphics packages, you can rotate text, fit text to a curve and size and color text, among other operations. Sometimes, though, you really want more. Now you can have it, and at a quite reasonable price.

Bitstream is best known for text. Its *FontWare* was the first really successful PCL (H-P LaserJet-compatible) font scaling technology, and the company followed it up with the equally popular Speedo font technology used in *FaceLift*. So when Bitstream answered the problem of mixing graphics and text, it took an approach 180° different from the graphics software companies. The result is a *Windows* 3.x-compatible package called *MakeUp*.

MakeUp is promoted as "special effects for type." While it certainly accomplishes this feat, I think Bitstream is being a little too modest. Along with some truly outstanding typographic capabilities, which I'll get to in a moment, *MakeUp* has much of the functionality of the low-cost "draw" packages I've been playing with recently. These capabilities include a nice selection of clipart (about 200 pieces, some in color), extensive file import/export abilities and object draw tools.

Bitstream even throws into *MakeUp* five free typefaces (Americana Bold, Poster Bodoni, Bitstream Oz Handicraft, Revue, and VAG Rounded) in PostScript Type 1, *TrueType* and Bitstream Speedo formats.

As with most *Windows*-based programs, the toolbar with pull-down menus is arrayed across the top of the screen, and additional menus appear when appropriate. There's not an overwhelming number of icons in the toolbar, which on first glance might lead you to underestimate the software's capabilities. Don't be fooled, though. The nested menus under each icon are very well organized and provide a remarkable amount of functionality with just a few mouse clicks.

MakeUp's apparent simplicity hides some very sophisticated capabilities. The software has extensive file-import and file-export capabilities which make it perfect as an adjunct to other graphics and desktop-publishing packages. You can import files in 22 different formats: *AutoCAD* DXF, CompuServe GIF, CGM, EPS,

MakeUp comes with more than 200 pieces of clipart and the capability to manipulate text in some amazing ways.

GEM Bitmap (IMG), HP-GL (HGL), PIF, IBM *Storyboard* (PIC), Macintosh PICT (PCT), *MacPaint* (MAC), Micrografx *Charisma* (GRF), Micrografx *Designer* (DRW), Micrografx *DRAW!* (PIC), MS-PAINT (MSP), PCX, TIF, *Windows* Clipboard Bitmap (CLP), *Windows* Metafile (WMF), *Windows*/OS/2 Bitmap (BMP), *WordPerfect* Bitmap (WPG), and *WordPerfect* Clipart (WPG). Whew! The file-export menu lists only 16 formats, with the Macintosh file formats dropped and the SCODL Film Recorder SCD format added. There are plenty of straight-ahead graphics packages that don't come close to offering this kind of file versatility!

MakeUp also includes an unusual FOTOSHOOT tool I haven't seen anywhere else. It's a bit hard to explain, but very easy to use. What it does is let you bring up a page layout program while you're running *MakeUp*, mark up an area in the layout page where you want to fit a graphic and move an outline of this area back into *MakeUp*. Then you create your graphic to fit the outline, and you've got a perfect fit when it's moved into the page-layout program.

If you've ever had to go back and forth trying to tweak a graphics image to fit available space (and I have, lots of times), you'll find the FOTOSHOOT feature alone worth the price of the package.

Bitstream's package has lots of other nice features, too. One I like a lot is Blending. On a high-end package like *Designer* or *CorelDRAW*, it's called "tweening." You take two objects, either of which can be a graphic or a text object, and the program can metamorphose from one object to the other over the number of steps you specify beforehand.

If you like color effects, *MakeUp* takes gradients a step further. Called Washes, it's a multiple color gradient (with up to 5 different colors). You can wash individual letters, words or phrases, either vertically or horizontally.

MakeUp's greatest strengths, though, are in the areas of text manipulation and effects. Squeezing text, curving it into arcs and circles and pouring it into different shapes takes just a few clicks of a mouse button. Click on another icon, and you can add perspective to your text with 3D effects, add a shadow, emboss it and rotate it. An unusual mask effect lets the background peek-through a text "stencil."

Machine requirements for *MakeUp* are modest: a 286-class PC or higher. Since it runs under *Windows* 3.0 or 3.1 (you need 3.1 to use *TrueType* fonts), the realistic minimum system I'd recommend is a 386SX. Bitstream specifies 2M RAM as a minimum, with 4M recommended. You won't need lots of hard-disk space for the software, but with any graphics-oriented program, lots of free hard-disk space is always a good idea.

MakeUp is a terrific program. It's quickly become an essential tool for me, and I highly recommend it. At a list price of under $150, it's a bargain.

TrueType Font Pack

One of the things I like best about *Windows* 3.1 is the *TrueType* technology Microsoft incorporates into it. If you're not familiar with it, *TrueType* (originally

Bitstream's TrueType Font Pack provides all these typefaces in various weights and italics.

developed by Apple) is a font technology that provides on-the-fly scaling for screen and printer fonts. You don't have to generate a huge number of fonts in all sizes you anticipate you might need. You just select from a pick list of installed *TrueType* fonts and click on the font size you want. If you really want 22.5 point type, just type it in, and the *TrueType* engine will scale the type to exactly this size. *Windows* comes with a small variety of *TrueType* typefaces and has been very successful in marketing an add-on pack of additional typefaces.

Of course, *TrueType* isn't the only scalable-font technology. Adobe has ATM (*Adobe Type Manager*), and Bitstream's *Facelift* incorporates the Speedo font-scaling system. But *TrueType* is embedded in *Windows* 3.1, and is the only scaling technology that's completely transparent to the user.

Not to be left out of this lucrative market, Bitstream has introduced two *TrueType* font packs. With its huge type library, if these are successful, it's likely that there will be plenty more on the way. I've had the opportunity to work with only the first Font Pack (the second was just released as this is being written). Bitstream's first Font Pack offers 40 fonts for $79.95, while the new font pack has 20 more fonts for $39.95.

Installing the fonts is as easy as clicking into the *Windows* Control Panel's Font selection, clicking on Add Fonts and specifying the drive in which the floppy disk resides. Choose one, several fonts or all fonts, and in a few minutes the task is finished. Bitstream recommends 1.5M of hard-disk space if you're going to transfer all available typefaces in the Font Pack.

Having reproduced the different typefaces included in the package, it's clearly visible that there are a lot less than 40. No, Bitstream isn't trying to cheat you, but it's common industry practice to count each of the different weights of a typeface (and in non-scalable fonts, the point size) as a different font. So for each of the dozen or so typefaces in the package, there are Roman, Bold, Italic and sometimes condensed versions of the same face. Each is a separate font.

In the real world, it isn't really necessary to install the bold and italic versions of a typeface. You can get these versions by just clicking on the bold or italic buttons in most *Windows* applications—and save some disk space to boot.

I like the particular selection of faces Bitstream includes in this type collection. And the price, especially when you buy via mail-order or discount software store, is inexpensive. On the other hand, I sometimes think I'm becoming a "font junkie." The softfonts section in my *Windows* WIN.INI file runs more than two pages long. Between the scalable and non-scalable fonts, I must have more than 20M of disk space tied up. One of these days, I'm going to have to do some pruning, because with all of these fonts installed, I doubt I've used more than a dozen of them, tops, and only two or three of them with any great regularity. At the same time, like all of the power tools residing unused in my garage, it's a nice warm feeling to know they're all there if I need them.

Take a look at Bitstream's Font Packs. If you like the fonts, they're a good deal.

SuperPrint

Windows applications like *MakeUp* are fun to use, but as an avid *Windows* user, printing in the *Windows* environment is usually painfully slooooow! Print speed has slightly improved with *Windows* 3.1, but on the three printers I use most frequently (A Star LaserJet-compatible, the H-P DeskJet 500C color printer I reviewed a few issues back and NEC PS-Mate color thermal printer), it's still a torturous process to print out a proof document, make corrections and print another copy. And even with *Windows*' vaunted multitasking capability, it still takes a hefty amount of time before I can click the printing into the background and continue working in another *Windows* application in the foreground.

I've looked at a number of solutions that claim to speed this tedious process, including replacements for the *Windows* Print Manager, hardware and software printer buffers and even a hardware *Windows* printer accelerator I'll review in an upcoming column. Of these, some worked better than others, but the best and most cost-effective solution I've tried so far is Zenographics' *SuperPrint*.

SuperPrint has three components, SuperText, SuperQueue, and SuperDriver, each of which can be used alone or in concert with the others.

SuperText allows you to enjoy the same on-the-fly font scaling technology that's available when using *Windows*' own *TrueType* fonts, regardless of whose fonts you're actually using. When you install and configure SuperText, you specify a number of "foundries" that scale the fonts you're using for both printer and screen.

Supported fonts include Adobe PostScript Type 1 (with hints), Bitstream *Facelift* Speedo and FontWare fonts, Digital Typeface Nimbus Q fonts, Agfa Intellifonts and Hewlett Packard Soft Fonts. Fonts can be scaled to RAM (the fastest method) or to a disk cache (better for long documents). You can save the scaled fonts for direct use in future documents. I didn't find the font-scaling process tedious enough to want to waste disk space saving fonts, which also seems to defeat the whole concept of on-the fly font scaling.

Once you've set up the SuperText software, using the on-the-fly capability is just a matter of selecting a typeface and font size in your application. The rest of the operation is transparent to you. SuperText even comes with 35 typefaces. Included are Nimbus Roman, Nimbus Sans, Nimbus Mono, URW SymbolPS, ITC Avant Garde, Century Schoolbook, Palermo, Nimbus Sans Narrow, ITC Bookman, ITC Zapf Chancery, ITC Zapf Dingbats and Bitstream Charter. Most are provided in bold, italic, and bold italic, which accounts for the "35" typefaces quoted in the documentation.

The second part of the SuperPrint package is SuperQueue. This largely takes over the function of *Windows*' PrintManager, except that it really does work in the background. Zenographics claims up to a four times throughput on long documents

when using both SuperDriver and SuperQueue. In several months of using the product, I'd estimate in most of my printing situations that actual speed-up is between 25% and 40%. Where the real time savings come in is that the system is released back to you almost immediately. While printing in the background does slow system response somewhat, especially on a 16-MHz 386SX, the slow-down seems to be much less than experienced when using PrintManager running as a minimized icon. On my main 486 33-MHz system, printing hardly seems to have any effect on the application I'm running in the foreground.

The third component of the SuperPrint system are the SuperDrivers. These are added to the printer driver panel in *Windows*' Control Panel Printers box. There are SuperDrivers for a wide variety of dot-matrix, inkjet and laser printers. There's even a fax SuperDriver that's compatible with the CAS standard used by Intel and many other fax modem manufacturers. You can also convert a document into a TIFF, Targa, BMP or PCX file by using the Bitmap SuperDriver.

You select a SuperDriver in the Printer Control Panel the same way that you'd choose any printer. When you go to print, the SuperDriver creates a metafile that's stored on-disk and then handed to the SuperQueue or PrintManager for printing.

SuperDriver not only speeds up the printing of complex graphics pages, but it also gives you a measure of additional image control over the page that you're printing. You can adjust the brightness and contrast, and if you're printing to a color printer like the DeskJet 500C, you can also make a number of color corrections.

SuperPrint is supplied with both 5¼" and 3½" diskettes, and installs in about 10 minutes. The excellent manual explains not only all available functions, it also tells you how to best set up *SuperPrint*'s components to make best use of the features. If you're like me, you can just choose the "quick install" and worry about tuning the software after you've had some experience using it.

SuperPrint can run on an AT-class or later system under *Windows* 3.0 or 3.1 and requires a hard disk with at least 3M free. Having used it for a while, I suggest that if you generally have very long documents, very complex documents or like to print multiple copies of your documents 5M to 10M of free disk space is a more-reasonable expectation.

SuperDriver creates one metafile per print job. If you're printing 20 copies of a multi-page document, the metafile can get pretty large. Queue up a few of these metafiles in SuperQueue, and pretty soon you get an error message from SuperDriver when it can't find any more free disk space.

I'd tried a much earlier version of *SuperPrint* several years ago, and wasn't very happy with it. I'm glad, though, that I overcame my hesitation to give it another try. Version 2.2 is terrific. Having tried it with a variety of systems and printers, I've seen a definite improvement in printing on each of them. If you do any amount of *Windows* printing, you need *SuperPrint*. The time you'll save will more than pay back its reasonable $149 cost. ■

Products Mentioned

MakeUp, $149
True-Type Font Pack #1, $79
True-Type Font Pack #2, $39
Bitstream, Inc.
215 First St.
Cambridge, MA 02142-1270
Tel.: 800-522-FONT
CIRCLE NO. 156 ON FREE INFORMATION CARD

SuperPrint, $149
Zenographics
4 Executive Cir.
Irvine, CA 92714
Tel.: 714-851-6352
CIRCLE NO. 157 ON FREE INFORMATION CARD

It's now Raven II, and the updated vehicle flaunts high-density titanium armor, modified bi-phasal cannon, a new fusion engine and improvements to its on-board computer that links itself to a powerful super-intelligent counterpart at home base. Raven II is ready for the evil Arcturian onslaught. But are you ready?

Stellar 7 and sequel *Nova 9* are successful games in that they fully deliver design intent. Both games are true arcade experiences, interesting and challenging. The key to success for these games may be simplicity and ease of operation. Yet they aren't so simple that play sessions become an exercise for an itchy trigger finger. The Gir Draxon story is acceptable. Documentation is excellent, and both games leap with action right from the start. An arcade gamer can easily do worse than strapping a joystick to *Nova 9*.

D/Generation

The time is the near future. A secret genetics experimental project is out of control. At Genoq Corporation, the security system is on full alert. It blasts any moving object. All Genoq employees are either killed or trapped. An intelligent artificial life form has taken over. It owns the uncanny ability to alter is appearance to look like ordinary objects, ranging from a room to a chair. The name of the life form is D/Generation.

You land your jetpack on the roof of Genoq during a crisp Singapore night. With you is an important package that must be delivered to Genoq's head scientist. No one greets you. As you enter the building, the door locks itself behind you. You find the receptionist hiding behind her desk. She tells you that the head scientist desperately needs that package. You have to hand-deliver the package, rescue any survivors along the way and avoid getting killed by the hyperactive security system.

D/Generation is a fast-paced arcade game that requires the consideration and solutions to traps, puzzles and a fair story. It has more than 120 rooms to explore, each of which can reveal a useful tool, a valuable weapon or quick death. Players begin the game with five lives. Trial and error decimates the count, but that's the only way to learn.

An interesting feature of *D/Generation* is the manner by which story clues are discovered. When a survivor is found, you question him to find out if he has something important to tell. You listen carefully and then conduct the survivor through traps and security systems to the safety of the roof top. This might sound overly difficult when thinking about attacks by dangerous life forms and smart security. It's difficult, but not overly difficult. Resources enough exist so that it's possible to get through all the commotion.

You may have to die many times, but that's part of the arcade tradition. Using quick reflexes of hand and mind, *D/Generation* can be played with fun and frolic. It's graphics are good and general game concept seems to be well-concocted. This is a game that won't disappoint the average arcade gamer.

4D Boxing

Not completely an arcade game and not fully a gambit into strategy, *4D Boxing* is nonetheless an entertaining play. Besides presenting an overall solid performance, the game excels at portraying authentic-looking boxing technique. The technique is fluid enough that the three-dimensional polygon figures punch, jab, thrust and dance like human boxers.

In this game, the technique that successfully mimics human pugilistic movement is called Tru-Motion. The manual doesn't reveal any details about Tru-Motion, but it does explain that the specialized programming method was inspired by watching hours of human boxers on video tape. Human boxers were analyzed as they went through natural but complex ranges of punches and blocks. Polygon graphics were added to provide fast, fluid action.

Tru-Motion is convincing. The boxers behave much like their human models. In fact, one can sit and watch the demo for extended periods of time, wondering just how much effort went into the technique. Wonder wears off after a while, and then it's time to play the game.

Clearly, much labor was spent on Tru-Motion itself, but the rest of the game shoulders its part in supporting the game platform. The user interface for controlling the boxers deserves worthy mention. You can use the numeric keypad when playing against the computer. Two human opponents can face-off with keyboard, joy-sticks or a combination thereof.

Whichever controlling device you use

spare expansion slot in which to plug it). Trying to be as cautious as possible, I eliminated an add-on memory manager I was using, which itself has caused some people operating difficulties, though my experience has been good with it. Following the manual's clear, simple instructions, which were displayed on-screen anyway, the software loaded in about 23 minutes without a hint of a hitch.

My available RAM decreased by 42K, while hard-disk storage dropped a bit more than 0.5 megabyte (or 2,611,200 bytes to 2,033,664 bytes available storage space). However, I gained a virtual disk D: with 42.6 megabytes. Moving a chess program from drive C: to drive D:, then erasing the program on drive C: (after verifying that it was, indeed, copied to drive D:), boosted available drive C: storage to 2,719,744 bytes while reducing drive D: to 41,861,120 bytes. Fantastic!

Average file compression was 1.72:1.0. The compression program also has a file-defragmentation utility. It revealed that I had five fragmented files with 14 breaks on drive C:. Activating the defragmentation utility set my drive in order in 10.6 minutes. Intoxicated by all this, I switched more programs from drive C: to drive D: and added some new programs to drive D: that I wasn't able to work with before the compression program gave me the storage space to do so.

It has been a few weeks now since I doubled my hard-drive's storage capacity the inexpensive way, and I'm pleased to report that everything has performed perfectly since! I also installed the program on an old 10-MHz AT machine, and it worked like a charm, too. No nightmares with this installation, thankfully. I'd even recommend its use to a newcomer (although I'd make it clear that everything on the existing hard drive must be backed up).

Art Salsberg

for your boxer, though, it takes practice to build up enough finesse to block at the right time or land an accurate blow. With more practice, you may even get good enough to "float like a butterfly and sting like a bee," as Muhammad Ali was fond of saying.

Other features of *4D Boxing* include excellent camera angles that can pan and zoom under user control. You can even run an instant replay to repeat those really good moves. Players can pick from ready boxers or create new ones with specific characteristics.

If you really like boxing and would like to lash on some gloves and go at it, *4D Boxing* is challenging, entertaining without having to suffer the realities of broken noses and busted teeth.

New Wing Commander Installment

Special Operations II is another installment of *Wing Commander*. *Wing Commander* is part arcade game owing to its dynamic and engrossing space combat sequences. *Special Operations II* continues the tale of the heated war between the Earth Confederation and the feline Kilrathi. Treason, murder and mayhem take their stand as human and cat fight to the death. This installment requires the full *Wing Commander II* program to run. ■

Bird's Eye View

Nova 9, $34.95
Sierra On-Line/Dynamix
P.O. Box 485
Coarsegold, CA 93614
Tel.: 800-326-6654

Requirements

Memory	640K, Hard Disk
Graphics	VGA, EGA, Tandy
Sound	Thunderboard, Pro Audio Spectrum, AdLib, Roland, Sound Blaster
Controllers	Keyboard, Joystick, Mouse

Evaluation

Documentation	Excellent
Graphics	Excellent
Learning Curve	Short
Complexity	Medium
Playability	Excellent

In Brief: Dazzling arcade game with brilliant colors and fast, smooth graphics. One of the best.

CIRCLE NO. 154 ON FREE INFORMATION CARD

Bird's Eye View

D/Generation, $29.95
The Software Toolworks
60 Leveroni Ct.
Novato, CA 94949
Tel.: 800-234-3088

Requirements

Memory	512K, Hard Disk
Graphics	VGA, EGA, CGA
Sound	AdLib, Sound Blaster
Controllers	Keyboard, Joystick

Evaluation

Documentation	Fair
Graphics	Good
Learning Curve	Medium
Complexity	Medium
Playability	Good

In Brief: Science fiction arcade game with tough puzzles and clever traps. Interesting play for the arcade fan.

CIRCLE NO. 153 ON FREE INFORMATION CARD

Bird's Eye View

4D Boxing, $49.95
Electronic Arts
1450 Fashion Island Blvd.
San Mateo, CA 94404
Tel.: 800-245-4525

Requirements

Memory	640K, Hard drive
Graphics	VGA, MCGA, EGA, CGA
Sound	AdLib, Tandy, Sound Blaster
Controllers	Keyboard, Joystick, Mouse

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Medium
Complexity	Medium
Playability	Good

In Brief: Mixture of boxing arcade and boxing strategy. Main attraction is lifelike, fluid motion of the fighters.

CIRCLE NO. 155 ON FREE INFORMATION CARD

ComputerCraft Mart

Classified Commercial Rates: $1 per word, 15-word minimum ($15.00) prepaid. (Word count includes name and address; ZIP code and abbreviation each count as one word; P.O. Box number and telephone number count as two words each.) Indicate free category heading (Computers, Software, Electronics, Video or Miscellaneous). A special heading is available for a $6 surcharge. First word only is set boldface caps at no charge. Add 25¢ for each additional boldface word.
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80C52-BASIC microcontroller board. BASIC interpreter, 32K RAM, 16K EPROM, EPROM programmer, RS232, expansion connector. Bare board with manual, schematics $19.95 +$3 P&H. 80C52-BASIC microprocessor chip $24.95 +$1 P&H. Assembled and tested $119.95 +$5 P&H. MD residents include sales tax. SASE for info. Prologic Designs, P.O. Box 19026, Baltimore, MD 21204.

"HOW TO BUILD YOUR OWN PERSONAL COMPUTER" Instructional Video $24.95, Do-it-yourself kits available with free video. Call for component pricing, 800-658-6570.

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PCB HOLE PUNCHER. This hand tool makes fast, clean IC pad holes in your PC boards. Easier than drilling! $19.95 ppd. TENSOR, Box 2543, Thunder Bay, Ontario, P7B 5G1 Canada.

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Advertisers' Index

We'd like to see your company listed here too. Contact Margaret Milanese at 516-681-2922 to work out an advertising program tailored to suit your needs.

Arcade Fever

Do you have it? It's characterized by callused fingers, nervous twitches and a glazed-over look in the eyes. Those people who do have it can't pass by a computer without tapping the keyboard or walk by a shopping mall arcade without meandering in and dropping a few bucks on exciting video games. If you have "arcade fever," here are some goodies that will add fuel to your habit.

Nova 9

This game is number two in an arcade tradition that began with *Stellar 7*. Dynamix, creators of *Stellar 7* and *Nova 9* supplies the computer-game world with two excellent titles. Nemesis, megalomaniac and all-around bad space-guy is Gir Draxon. He's a meanie who wants to rule the universe. (What else is new?) The only things standing in his way are the planet Earth, a special ground attack vehicle known as Raven and you, a talented computer gamer.

Stellar 7 premiered with highly detailed 256-color graphics. Intense and fast, *Stellar 7* was a "straight shooting" game with clean action, visual brilliance and smooth animation. Players take to the battle via the Raven, Earth's most sophisticated fighting machine.

Game players engage the enemy Arcturian forces in seven different star systems. The first system is defeated easily enough, but the enemy gets tougher and more clever as players advance to succeeding star systems. Raven pilots who are skilled enough perform single-combat against the Arcturian Supreme Overlord himself—and Draxon is no space orphan when it comes to fighting.

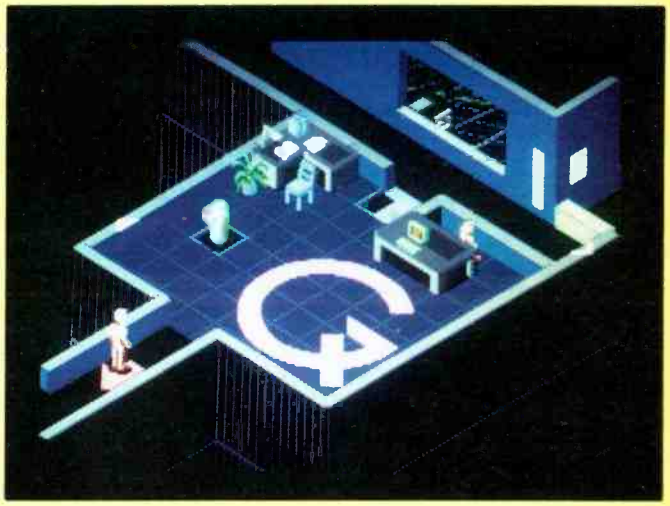
As always, given enough tries, right wins and Earth is saved. Gir Draxon is defeated and presumed dead, although his body is never found.

Reports come in unexplored star system Nova 9. They tell of a humanoid creature who is spreading across the nine planets of the Nova system. He or it is spreading like a dank plague. It would appear that Draxon is back to old habits.

During Draxon's period of inactivity, the Raven's design has seen improvement.

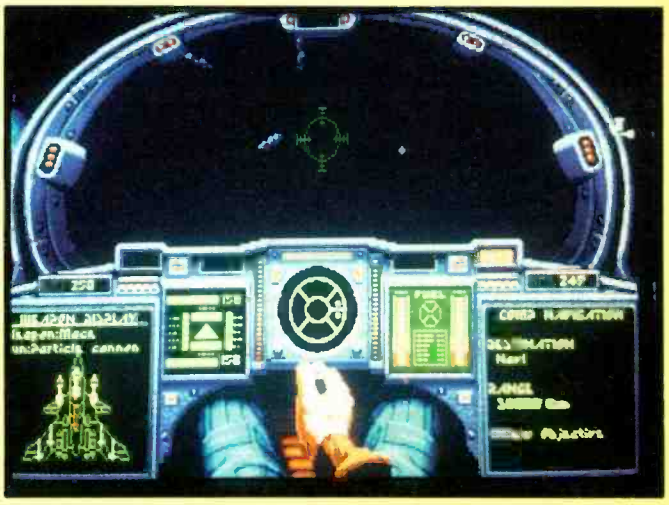
(Continued on page 84)

View from the Raven in Nova 9.



First look at Genoq's traps in D/Generation.

Two fighters square off in 4D Boxing.



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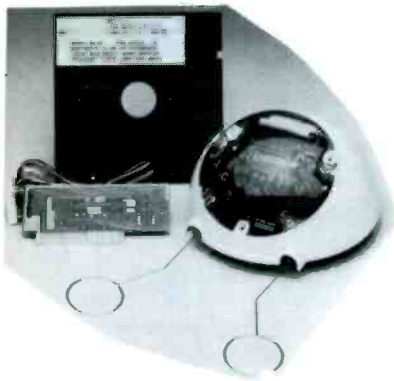
LS9200	TOSHIBA	670nm	3 mW	85 mA	2.3 V	49.99	47.99	43.19
LS9201	TOSHIBA	670nm	5 mW	80 mA	2.4 V	59.99	56.99	51.29
LS9211	TOSHIBA	670nm	5 mW	50 mA	2.3 V	69.99	66.49	59.84
LS9215	TOSHIBA	670nm	10 mW	45 mA	2.4 V	109.99	104.49	94.04
LS3200	NEC	670nm	3 mW	85 mA	2.2 V	59.99	56.99	51.29
LS022	SHARP	780nm	5 mW	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

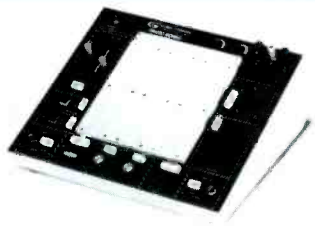


The pen mechanism included with the robot allows it to draw. In addition to drawing straight lines, it can also accurately draw circles, and even draw out words and short phrases. WAO II comes with 128 x 4 bits RAM and 2K ROM, and is programmed directly via the keypad attached to it. With its built-in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



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- 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
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  +5 VDC @ 1.0 amp, ripple – 5 mV
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  +5 – to +15 VDC @ 0.5 amp, ripple – 5 mV
- **Variable DC output**
  –5 – to –15 VDC @ 0.5 amp, ripple – 5 mV
- **Frequency generator**
  frequency range: 0.1 Hz to 100 KHz in 6 ranges
  output voltage: 0 to ± 10V (20 Vp-p)
  output impedance: 600 (except TTL)
  output current: 10mA max., short circuit protected
  output waveforms: sine, square, triange, TTL
  sine wave: distortion 3% (10 Hz to 100 KHz)
  TTL pulse: rise and fall time 25ns drive 20 TTL loads
  Square wave: rise and fall time ± 1.5 s
- **Logic indicators**
  8 LED's, active high, 1.4 volt (nominal) threshold, inputs protected to ± 20 volts
- **Debounced pushbuttons (pulsers)**
  2 push-button operated, open-collector output pulsers, each with 1 normally-open, 1 normally-closed output. Each output can sink up to 250 mA
- **Potentiometers**
  1 – 1K , 1 10K , all leads available and uncommitted
- **BNC connectors**
  2 BNC connectors pin available and uncommitted shell connected to ground
- **Speaker**
  0.25 W, 8
- **Breadboarding area**
  2520 uncommitted tie points
- **Dimensions**
  11.5" long x 16" wide x 6.5" high
- **Input**
  3 wire AC line input (117 V, 60 Hz typical)
- **Weight**
  7 lbs.

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

IDC BENCH ASSEMBLY PRESS

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

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

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

COLLIMATING PEN

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

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

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

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

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

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

LASER DIODE MODULE

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

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

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

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

COLLIMATING LENS

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

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

DUAL MODE LASER POINTER

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

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

He-Ne TUBES

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

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

POWER SUPPLY

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

STOCK #	PRICE
PS1003	$19.99

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STOCK #	PRICE
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STOCK #	PRICE
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