THE PRACTICAL MAGAZINE FOR PERSONAL COMPUTERS & MICROCONTROLLERS

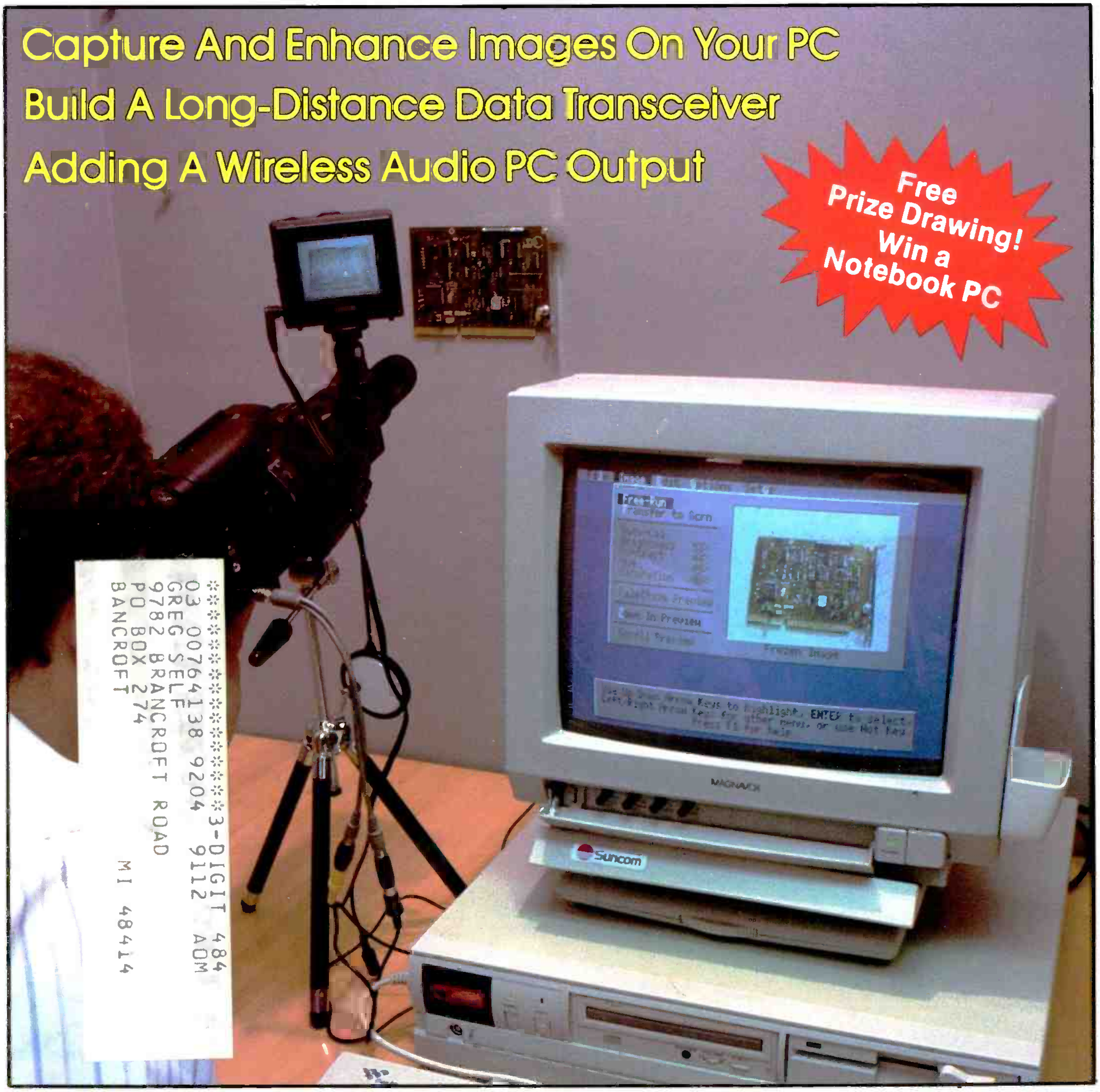
ComputerCraft

Formerly MODERN ELECTRONICS

December 1991 $2.95
(Canada $3.95)

Capture And Enhance Images On Your PC
Build A Long-Distance Data Transceiver
Adding A Wireless Audio PC Output

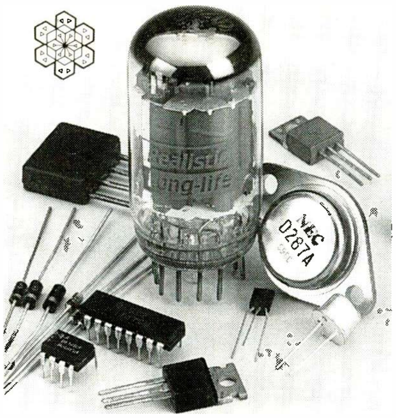
Free Prize Drawing! Win a Notebook PC



Fly Air Combat With Chuck Yeager
Experimenting With The Z8 Microcontroller
1991 Cumulative Article Index

RADIO SHACK

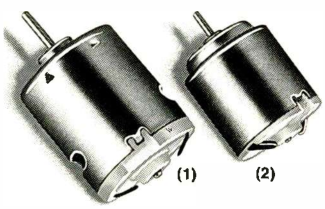
THE PARTS PLACE℠



Special-Order Hotline. Your Radio Shack store can special-order over 10,000 items from our main warehouse—tubes, ICs, microprocessors, transistors, diodes, crystals, styli, computer accessories—even SAMS® service manuals.

Range-Doubler Multitester. With extra resolution on V/A ranges plus 50,000 ohms-per-volt DC sensitivity. 125mV and 25 µA ranges. Continuity sounder. Measures to 1000 VDC in 12 ranges, 1000 VAC in eight ranges, 10 amps DC in 10 ranges, 20 megs in four ranges. #22-214 . . . . **39.95**

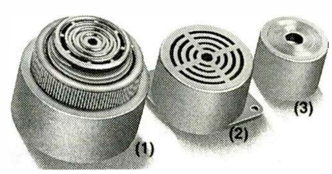
Digital Logic Probe. So handy! LEDs and tone outputs reveal logic states instantly. Check operation and pinpoint problems in all types of digital circuits—TTL, LS and CMOS, memory, microcomputer and peripheral ICs. #22-303 . . . . **16.95**



(1) High-Speed 12VDC Motor. Up to 15,200 RPM no load. About 2" long. #273-255 . . . . **2.99**

(2) Low-Voltage DC Motor. From 1½ to 3VDC. About 1½" long. 8300 RPM max. #273-223 . . . . **99¢**

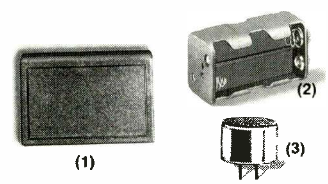
NEW! Infrared Sensor. For security systems and electronics projects requiring remote control. Use it to identify and locate near-infrared radiation emanating from an LED or laser source. #276-099 . . . . **95¢**



(1) Pulsating or Continuous Piezo Buzzer. 90 dB at 12VDC. #273-068 . . . . **8.49**

(2) "Ding-Dong Chime". 80 dB at 12VDC. #273-071 . . . . **8.99**

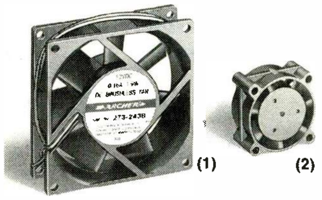
(3) PC-Mount Piezo. 78 dB. From 3 to 20VDC. #273-065 . . . . . **2.49**



(1) PC-Mount Omnidirectional Electret Mike Element. 20-15,000 Hz. #270-090 . . . . **1.79**

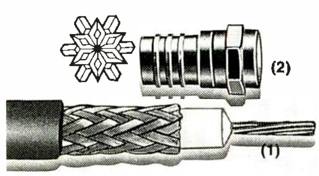
(2) Transmitter Case. #270-293 . . . . **3.99**

(3) Battery Holder. 4 "AA", 9V-type snap. #270-383 . . . . . . **1.29**



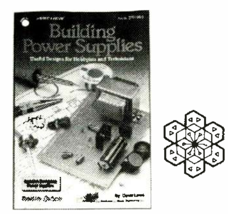
(1) 12VDC Brushless 3" Fan. Ball bearings for long life. Low sound level—34 dB. 27 CFM. #273-243 . . . . **14.95**

(2) 12VDC Brushless Micro Fan. Rated 150 mA. 3.5 CFM airflow. #273-244 . . . . **17.95**

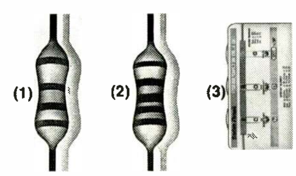


(1) NEW! QS-56 75-Ohm TV/VCR/FM Connectors. For use with RG6QS Quad Shield cable. #278-232 . . . . **Pkg. of 2/99¢**

(2) Archer® Coax Cable. Four layers of shielding for CATV. #278-1317 . . . . **31¢ Per Ft.**



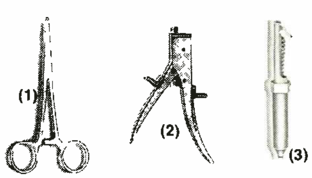
Building Power Supplies. Explains how power supplies work, both regulated and unregulated. Also includes plans and instructions on how to build five power supplies—three linear and two switching. #276-5025 . . . . . . **4.95**



(1) ¼-Watt Carbon-Film Resistors. 5%. #271-312, **Set 100/7.95**

(2) ¼-Watt Metal-Film Resistors. 1%. #271-309, **Set 50/2.99**

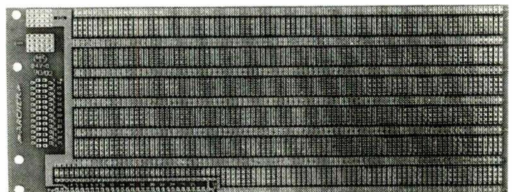
(3) Color Code Pocket Guide. Resistor, capacitor, inductor values. #271-1210 . . . . **79¢**



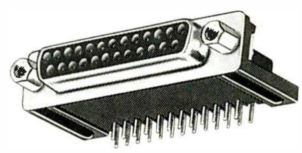
(1) Locking Stainless Steel Forceps. #64-1866 . . . . **4.95**

(2) Nibbling Tool. Cuts up to 18-ga. steel. #64-823 . . . . **10.95**

(3) Desoldering Tool. #64-2120 . . . . **6.95**



NEW! Archer® Experimenter's Plug-In Card. Great for experimenters. Build your own serial port card. PC/XT-compatible prototype card for breadboarding digital/analog circuits. Plated through-holes with .100" centers, power and ground bus grids, 8-bit 3¹/₆₂ plated-edge contacts, I/O mounting area for 25-pin d-sub connector (at right). #276-1598 . . . . **29.95**



NEW! 25-Pin Female D-Sub Connector. Right-angle mounting, designed for Experimenter's PC/XT-Compatible Plug-In Card (at left) to provide standard 25-pin input/output port. #276-1504 . . . . **2.39**

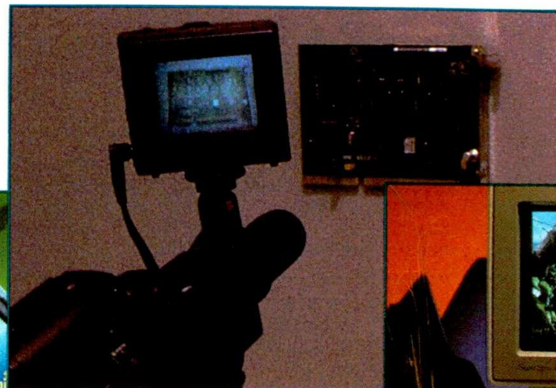
Since 1921 Radio Shack has been the place to obtain up-to-date electronic parts as well as quality tools, test equipment and accessories at low prices. Nearly 7000 locations to serve you—NOBODY COMPARES

Prices apply at participating Radio Shack stores and dealers. Radio Shack is a division of Tandy Corporation

Radio Shack® SINCE 1921
AMERICA'S TECHNOLOGY STORE℠

CIRCLE NO. 90 ON FREE INFORMATION CARD

ComputerCraft
Formerly MODERN ELECTRONICS
Volume 1, No. 9 December 1991



20

87

77

UPGRADING & ENHANCING

APPLICATIONS

REVIEWS

COLUMNS

DEPARTMENTS

ON THE COVER: Capturing images from a video camera for storage and enhancement work on a PC.

Cover Photo: by Liz Benford

B. G. MICRO

P. O. Box 280298 Dallas, Texas 75228
(214) 271-5546
FAX (214) 271-2462

MasterCard VISA

SEND FOR FREE CATALOG! OVER 150 NEW ITEMS!

FAN

Brand New from McLean Eng.
A Division of Zero Corp.
Square 4-11/16" by 1.5"
Thick 10" Wire Leads
120V - 60hz - .12 amps - 110CFM
Metal Housing - 5 Plastic Blades
UL and CSA Approved
$5.95 ea.

BATTERY

Brand New - '91 Date Code
Rechargeable Sealed Battery
6 Volts @ 4 Amp/h
Measures: 4" Tall - 2-3/4" Wide
1-3/4" Thick - A Steal at
$6.95 ea. or 4 for $25.50

DISPLAY DEVICES

4MT07 By Futaba
Vacuum Fluorescent Clock
And Timer - 4 Digit Display
Easy to Read - Easy to Use.
.3" Character Height
With Data 79¢

LTP 1157AE
1.2" 5x7 Matrix Displays
5x7 Array with x.y select.
This Red Orange Matrix Can Be Stacked Horizontally. Choice of Two Matrix Orientation-Cathode Column, Anode Row. Great For "Moving Message" Signs.
$1.19 Ea., 8/$6.95, 100/$75.00

74LS

LS00	.14	LS114	.25	LS241	.60
LS01	.14	LS122	.35	LS242	.65
LS02	.14	LS123	.45	LS243	.50
LS03	.14	LS124	1.35	LS244	.55
LS04	.14	LS125	.30	LS245	.55
LS05	.14	LS126	.35	LS251	.45
LS08	.14	LS132	.35	LS253	.40
LS09	.14	LS133	.25	LS257	.35
LS10	.14	LS136	.28	LS258	.45
LS11	.14	LS138	.35	LS259	1.00
LS12	.20	LS139	.35	LS260	.40
LS13	.25	LS145	.75	LS266	.30
LS14	.30	LS148	.35	LS273	.75
LS15	.20	LS151	.35	LS279	.30
LS20	.14	LS153	.35	LS280	.80
LS21	.16	LS154	.85	LS283	.35
LS22	.16	LS155	.50	LS290	.70
LS26	.14	LS156	.42	LS293	.50
LS27	.20	LS157	.30	LS298	.65
LS28	.15	LS158	.25	LS299	1.00
LS30	.14	LS160	.25	LS322	1.30
LS32	.16	LS161	.35	LS323	2.25
LS33	.25	LS162	.45	LS348	.75
LS37	.24	LS163	.36	LS353	1.00
LS38	.24	LS164	.45	LS357	.80
LS42	.35	LS165	.60	LS363	.75
LS51	.15	LS166	.75	LS364	.75
LS54	.20	LS169	.90	LS365	.30
LS55	.20	LS170	.45	LS366	.28
LS73	.33	LS173	.60	LS367	.35
LS74	.22	LS174	.35	LS368	.30
LS75	.25	LS175	.35	LS373	.50
LS83	.30	LS181	1.25	LS374	.45
LS85	.45	LS191	.45	LS375	.35
LS86	.20	LS192	.65	LS377	.75
LS90	.35	LS193	.65	LS378	.80
LS92	.30	LS194	.40	LS390	.80
LS93	.25	LS195	.52	LS393	.75
LS95	.30	LS196	.55	LS399	1.00
LS96	.33	LS197	.75	LS541	1.20
LS107	.28	LS221	.50	LS645	.75
LS109	.20	LS240	.50	LS646	.75
LS112	.25			LS670	.80
LS113	.25			25LS2569	1.50

THE $25 NETWORK

Try The 1st Truly Low Cost LAN

- Connect 2 or 3 PCs, XTs, ATs
- Uses serial ports and 5 wire cable
- Runs at 115 K baud
- Runs in background, totally transparent
- Share any device, any file, any time
- Needs only 14K of ram

Skeptical: We make believers!

SUPER BUYS

DTMF

SSI-202 Decoder	2.25
8870 Decoder	2.25
5087 Generator	2.00
5089 Generator	2.10

2N4401
Super 2N3904 NPN
Switching Transistor
40V-TO-92 — P.C. Leads
15/1.00 1000/20.00

80C32
C-MOS By Matra - 12MHZ
3.95

LM350T	2.65
LM338K	4.95
16L8-15 TI-B-PAL	1.25
8088-2	3.25
8742	7.00

WIRE WRAP

Dual Wrap - 2 Level

14 Pin	10/2.50	100/20.00
16 Pin	10/2.50	100/20.00
20 Pin	10/3.50	100/30.00

SOCKETS

Low Profile SOLDER TAIL

6 Pin	14/1.00
8 Pin	13/1.00
14 Pin	13/1.00
16 Pin	13/1.00
18 Pin	13/1.00
20 Pin	13/1.00
22 Pin	13/1.00
24 Pin	8/1.00
28 Pin	7/1.00
40 Pin	7/1.00
68 Pin PLCC	.79
84 Pin PLCC	.89

BUY $10
GET $1.00 - FREE CHOICE

6500/6800

6502	2.00	6821	1.00
6520	1.25	6845P	2.20
6522	2.70	6845S	2.20
6530	3.00	6850	1.75
6532	4.25	6852	3.50
6545	2.10	6860	3.95
6551	2.40	68681	3.00
6800	1.40	68A09EP	1.29
6802	2.50	68A40	4.00
6803	3.00	68A54	3.00
6805	2.95	68B09	4.00
6809EP	2.75	68B10	2.00
6809P	2.50	68B45	4.95
6810	1.25	68B54	4.00

TEXT TO SPEECH BOARD

PC/XT COMPATIBLE. MAKE YOUR COMPUTER TALK!

PRICE CUT **$69.95**
ASSEMBLED & TESTED
ADD $3.50 SHIPPING & HANDLING

A VERY POWERFUL AND AMAZING SPEECH CARD. USES THE GENERAL INSTRUMENTS SPO256-AL2 SPEECH CHIP AND THE CTS256A-AL2 TEXT TO SPEECH CONVERTER.

THIS BOARD USES ONE SLOT ON THE MOTHERBOARD AND REQUIRES A COM SERIAL PORT. BOARD MAY ALSO BE USED IN A STAND ALONE ENVIRONMENT (EXTERNAL POWER SUPPLY) WITH ALMOST ANY COMPUTER THAT HAS A RS232 SERIAL PORT. TO USE THE BOARD IT IS ONLY NECESSARY TO SEND ENGLISH TEXT TO THE RS232 INPUT ON THE BOARD. THE BOARD INCLUDES A 1500 BYTE TEXT BUFFER AND HANDSHAKE LINE TO ALLOW YOU TO SEND DATA TO THE BOARD: THE SAME AS YOU WOULD SEND DATA TO AN RS232 SERIAL PRINTER. YOU CAN SET UP BATCH FILES THAT WILL MAKE YOUR COMPUTER GREET YOU WITH "GOOD MORNING MASTER," ETC. EVERY TIME YOU TURN IT ON.

DEMONSTRATION SOFTWARE AND A LIBRARY BUILDING PROGRAM ARE INCLUDED ON A 5¼ INCH PC/XT DISKETTE. FULL DOCUMENTATION AND SCHEMATICS ARE ALSO INCLUDED.

FOR INFORMATION ON A LOW COST SPEECH SYNTHESIZER SYSTEM FOR THE VISUALLY IMPAIRED, PLEASE SEND FOR FREE PACKET T.M.1.

STAND ALONE POWER SUPPLY FOR ABOVE
ADD $2.50 SHIPPING & HANDLING
$19.99

STATIC RAM

2016-2KX8 200 n.s.	1.00
2101-1 - 256X4 500 n.s.	.75
21L02-1 350 n.s.	.65
2102AL-4 L.P. 450 n.s.	.49
2111-1 256X4 500 n.s.	1.00
2112A-2	2.50
2114L-3 1KX4 300 n.s.	.45
2125A-2 1KX1 70 n.s.	1.70
2147 4KX1	1.95
6116P-4	1.00
6117	1.20
6264-15	1.40
62256 32KX8	5.75

DYNAMIC RAM

2108-4 8KX1	1.50
2118-4 16KX1-5Volt	.70
4027-4KX1-250 n.s.	.80
4116-16KX1-250 n.s.	.40
4116-16KX1-200 n.s.	.75
4116 16KX1-150 n.s.	.90
4164 150 n.s.	.49 or 9/3.50
4164 120 n.s.	1.10
4164-100 n.s.	1.40
TMS4416-16KX4-150 n.s.	2.75
4464-150 n.s.	1.60
4464-120 n.s.	1.75
4464-100 n.s.	1.95
4464-80 n.s.	2.10
41256 150 n.s.	1.25 or 9/9.95
41256 120 n.s.	1.40
41256 100 n.s.	1.45
41256-80 n.s.	1.65
41256-60 n.s.	2.30
1 Meg - 100 n.s.	4.90
1 Meg - 80 n.s.	5.20
414256-80 n.s. 256 x 4	5.40

SIPPS & SIMMS AVAILABLE

THREE CHIP SET

B.G. SPECIAL
16450, 1488, 1489 — $6.95
16550, 1488, 1489 — $13.50

EPROM SPECIAL

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

Your Choice

2708	1.20	10/8.00
2716	1.75	10/15.00
2532	2.00	10/17.50
2732	2.00	10/17.50
2764	2.25	10/20.00
27128	3.20	10/27.50
27256	3.85	10/32.50
27512	5.10	10/45.00

8000/80000

8031	2.95	8251	1.10
80C32 12	3.95	8253-5	1.75
8035	1.00	8254	1.80
8039	1.00	8255	1.50
8085	1.55	8255-5	1.75
8086	1.55	8257	1.50
8087	87.50	8259A	1.85
8087-1	167.50	8259C-5	2.10
8087-2	127.50	8275	10.95
8088	2.20	8279	2.25
8088-2	3.25	8284	1.49
8155	2.25	8286	3.50
8156	2.25	8287	2.49
8202A	8.00	8288	3.50
8212	1.25	8530	3.00
8214	2.00	8741	7.00
8216	1.25	8742	7.00
8224	1.25	8748	7.00
8228	1.75	8749	7.00
8237-5	2.80	8755	7.00
8243	1.75	80286-8 PLCC	8.50
8250	2.95	80287-8	125.00
(16450)	6.50	80287-10	135.00
(16550)	13.00	V-20-10MHZ	6.50

SEND FOR FREE CATALOG! OVER 150 NEW ITEMS!

TERMS: (Unless specified elsewhere) Add $3.25 postage, we pay balance. Orders over $50.00 add 85¢ for insurance. No C.O.D. Texas Res. add 8¼% Tax. 90 Day Money Back Guarantee on all items. All items subject to prior sale. Prices subject to change without notice. Foreign order - US funds only. We cannot ship to Mexico or Puerto Rico. Countries other than Canada, add $9.00 shipping and handling.

CIRCLE NO. 104 ON FREE INFORMATION CARD

Editorial

WINning

Microsoft *Windows* 3.0 has had an enormous impact upon PC computing since its introduction in May 1990. With some 4-million copies shipped, millions of PC users have now tasted working with a graphical user interface (GUI) and a mouse pointing device. Macintosh users have enjoyed this from the onset, of course, in a faster, better form than the new *Windows* offers, although initially without color provisions, not to mention much higher relative cost and very limited expansion provisions.

Most *Windows* 3.0 owners, however, haven't yet truly savored this new operating environment for a variety of reasons. Firstly, it took some time for third-party applications programs for *Windows* 3.0 to reach critical mass. Although there are plenty of such programs marketed now, at this writing, *WordPerfect* for *Windows* has not yet been released; *Ventura Publisher* for *Windows* has just been introduced; and so on.

Furthermore, *Windows* 3.0 has some serious shortcomings, especially how slow it runs. Additionally, its File Manager is simply too basic and unrecoverable applications errors pop up too often.

Added to this is the heavy burden of *Windows* 3.0 memory requirements, dictating more RAM and higher-capacity hard drives for many users, not to mention the desirability of using at least a 386SX machine. Top this off with added expenditures for new *Windows* application programs, and you'll understand why lots of 3.0 owners have been reluctant to go all the way.

As a result, a high percentage of *Windows* 3.0 owners use only non--*Windows* applications at this time. Yes, some of 3.0's built-in programs are used, especially the *Solitaire* game, but a great many *Windows* owners employ the new environment mostly for its memory-management facilities. With the new DOS 5.0's ability here, at least in the upper memory area, even this attribute is diluted a bit. The upshot is that I believe that a high percentage of *Windows* 3.0 software is hardly used at all!

Nevertheless, *Windows* 3.0 has been a shot in the arm for the personal-computer industry. Without doubt, more 386 machines have been sold as a result of it, along with more memory boards and chips, more mouse devices, *et al.* The software industry, too, is enjoying the sales opportunity presented by revamping their programs for operating under the *Windows* environment. It's a shot in the arm for many of them. It also allows some software companies to encroach on sales territory held by leaders in specific applications areas.

I have no doubts that, come *Windows* 3.1 and IBM's OS/2 (likely to be quite a marketing battle), and the wearing down of PC users through ballyhoo and the like, that GUIs will take over in time. With easier training for new programs, the attractiveness of desktop publishing and the promise of multi-media, it's a sure winner down the line.

Art Salsberg

from the Staff of ComputerCraft.

EDITORIAL STAFF

Art Salsberg
Editor-in-Chief

Alexander W. Burawa
Managing Editor

Dorothy Kehrwieder
Production Manager

Emily Kreutz
Production

Elizabeth Ryan
Art Director

Barbara Terzo
Assistant Art Director

Susan Reale
Artist

Pat Le Blanc
Florence V. Martin
Phototypographers

Hal Keith
Illustrator

Bruce Morgan
Photographer

Bud Aaron, Roger C. Alford, Jan Axelson, Tom Benford, Hardin Brothers, TJ Byers, Joe Desposito, Nick Goss, John McCormick, Martin Meyer, Forrest Mims III, Ted Needleman, Peter R. O'Dell, SF Sparrow
Contributing Editors

BUSINESS STAFF

Richard A. Ross
Publisher

Art Salsberg
Associate Publisher

Dorothy Kehrwieder
General Manager

Frank V. Fuzia
Controller

Catherine Ross
Circulation Director

Melissa Kehrwieder
Carol Minervini
Data Processing

Denise Pyne
Customer Service

ADVERTISING SALES

Eric Teitelbaum
Margaret Milanese

(516) 681-2922
FAX: (516) 681-2926

Karen Nauth
Sales Assistant

Offices: 76 North Broadway, Hicksville, NY 11801. Telephone: (516) 681-2922. FAX (516) 681-2926. ComputerCraft (ISSN 1055-5072) is published monthly by CQ Communications, Inc. Subscription prices (payable in US Dollars only): Domestic—one year $18.97, two years $36.00, three years $53.00; Canada/Mexico—one year $21.00, two years $40.00, three years $59.00; Foreign—one year $23.00, two years $44.00, three years $65.00. Foreign Air Mail—one year $76.00, two years $150.00, three years $224.00.

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

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

TO ORDER (800) 531-5369 FAX (512) 344-2985 TO ORDER (800) 531-5369 FAX (512) 344-2985 TO ORDER (800) 531-5369 FAX1 (512) 344-2985

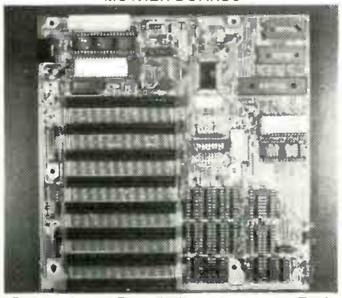
AltexElectronics, Inc.

TO ORDER CALL 1(800) 531-5369

Mail Order Dept., 11342 IH-35 North, San Antonio, TX 78233 - (512) 637-3200; Hours 7am-7pm M-F, 10-2pm Sat. FAX (512) 344-2985

TERMS: For C.O.D. orders add $3.30. Minimum $25. For orders under $99 add $3.00 handling charge plus FRT. For orders over $99, actual FRT charges apply. P.O.'s accepted from approved accounts. Texas residents add 8 1/4% sales tax. All returns require RMA# and must be returned in original condition. Subject to 15% restocking fee. Prices and product descriptions subject to change. **CALL FOR CURRENT PRICING.** We are not responsible for typographical errors.

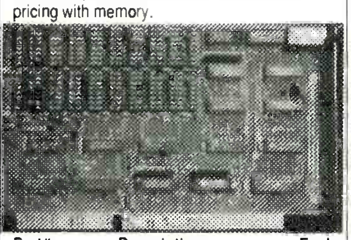
MOTHER BOARDS



Part#	Description	Each
D11-XT	Turbo 10 MHz Mini XT Motherboard	$69
D11XT-640	Same as D11-XT w/640K installed	$109
DFI286-12/E	12 MHz 286 Mini Motherboard	$99
DFI286-16/E	16 MHz 286 Mini Motherboard	$109
MB386SX	Turbo 386 16 MHz SX Motherboard	$229
MB386-25	386 25 MHz Motherboard	$369
MB386-33C	386 33 MHz Motherboard	$459

MEMORY BOARDS

All memory boards come with 0/K. Call for pricing with memory.



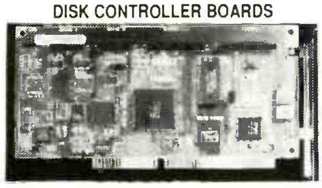
Part#	Description	Each
MEMO-576	576K Ramboard	$23
MEMO-2000A	EMS 4.0 Memory Board, 2 MEG AT	$89
MEMO-2000X	EMS 4.0 Memory Board, 2 MEG XT	$79
MEGALITH	Enhanced EMS Memory Board, 4 MEG AT	$119
IFC-47	128K AT Memory Board	$67
IFC-60	AT Plus - Up to 8 MEG RAM	$119
IFC-60A	AT Memory Board 8 MEG Using SIMMS	$119
IFC-62	PS-2 MOD 50 60 EMS up to 2 MEG	$129
IFC-64	PS-2 - EMS up to 2 MEG	$99

IIT MATH CO-PROCESSORS

2C87-12	For 286 up to 12.5 MHz	$89
2C87-20	For 286 up to 20 MHz	119
3C87-16SX	For 386SX up to 16 MHz	129
3C87-20SX	For 386SX up to 20 MHz	149
3C87-25	For 386 up to 25 MHz	179
3C87-33	For 386 up to 33 MHz	199

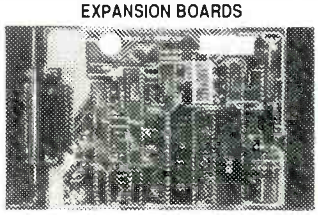
CALL FOR PRICING ON DYNAMIC MEMORY AND MEMORY MODULES

DISK CONTROLLER BOARDS



Part#	Description	Each
IFC-16	2 Floppy Controller Board XT/AT	$25
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-26	Floppy, Fixed Disk RLL Controller AT	$129
IFC-27	AT 2 IDE 4/Floppy Controller	$29
IFC-27X	XT 2/IDE 4/Floppy Controller	$69
IFC-28	XT MFM Hard Drive Controller Board	$40
IFC-29	RLL Fixed Disk Controller Board PC/XT	$57
IFC-54	Add On Floppy Board XT/AT	$49
ST-01	8 Bit SCSI Controller	$29
ST-02	8 Bit SCSI/Floppy Controller Board	$47
IN-2000	16 Bit SCSI Hard/Floppy	$225

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-19	Clock Board PC/XT	$10
IFC-19B	Chipchip for PC/XT	$24
IFC-20	Game Board XT/AT, 2 Ports	$9

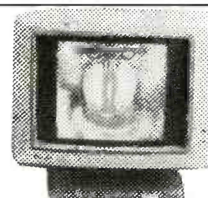
COMMUNICATION BOARDS

Part#	Description	Each
MS-400X	Multi-Serial Board for PC/XT	$69
MS-400A	Multi-Serial Board for PC/AT	$99
MS-422X	Dual RS-232/422 Serial Card for PC/XT	$59
MS-422A	Dual RS-232/422 Serial Card for PC/AT	$69
MU-440	Multi-User Board	$139

VIDEO BOARDS

Part#	Description	Each
IFC-32	Mono Board w/printer port XT/AT	$16
IFC-33	Color Graphics w/printer port XT/AT	$25
IFC-42	640x480 VGA Card	$69
IFC-42C	BOCA Super VGA Card	$159
VG-3000	Video Adapter Board w/256K	$79
VG-7000	Super VGA w/512K	$139

RELISYS MONITORS

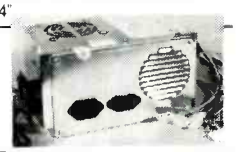


Part#	Description	Each
RM9503	Monochrome PS/2 (800 x 350, 400, 480)	$149
RE9514	Super VGA (1024 x 768) Unlimited Colors	$359

LASER MONITORS

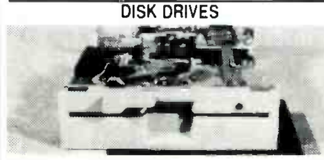
Part#	Description	Each
MON-05	Monochrome TTL Amber 12"	$89
MON-06	Paper White TTL 14"	$112
MON-10	CGA/RGB (640 x 240) 14"	$239
MON-07	VGA .41 Dot Pitch (640 x 480) 14"	$269
MON-08	Super VGA (1024 x 768) Unlimited Colors 14"	$399

POWER SUPPLIES



Part#	Description	Each
PS-150	150 watt XT Power Supply	$39
PS-150UL	Same as PS-150 - UL Listed	$69
PS-200M	200 watt XT power Supply	$49
PS-200MUL	Same as PS-200M - UL Listed	$89
PS-200	200 watt AT Power Supply	$59
PS-200UL	Same as PS-200 - UL Listed	$89
PS-220	220 watt Vertical Case Power Supply	$79
PS-200MINI	200 watt Baby Vertical Case Power Supply	$59

DISK DRIVES



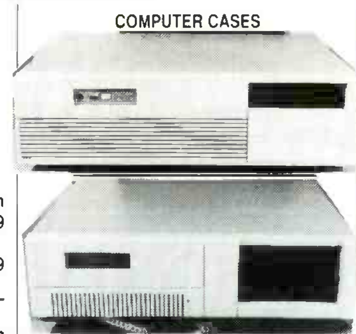
Part#	Description	Each
DDD-04	5 1/4 inch DSDD 360K black faceplate	$59
DDD-05	5 1/4 inch DSDD 360K beige faceplate	$59
DDH-06	5 1/4 inch DSHD 1.2MB beige faceplate	$75
DDH-09	3 1/2 inch 720K beige w/brkt	$69
DDH-10	3 1/2 inch 1.44MB beige w/brkt	$79
RAIL01	AT Drive Rail Kit	$1.99
FP-BLK	1/2 Height Black Faceplate	$2.49

3 1/2" DRIVE MOUNTING KITS

Mounts a 3 1/2" drive in a 5 1/4" half-height drive bay.

Part#	Description	Each
5.25KITFD	Floppy Drive Kit	$9.95
5.25KITHD	Hard Drive Kit	$9.95

COMPUTER CASES



Part#	Description	Each
STC-03	Baby AT Case	$39
STC-04	Regular AT Case	$59
DAB-103	DFI Slimline Case w/200 Watt Power Supply	$139
STC-05	Baby Vertical w/200 Watt Power Supply	$89
CASE-TH8	Regular Vertical w/300 Watt Power Supply	$249

KEYBOARDS

Part#	Description	Each
K-156	(XT,AT) 101 keys with regular footprint for XT or AT. Size: 20 1/2"L x 7 7/8"W x 1 13/16"H.	$49
K-160	Narrow Footprint 101 keys XT or AT. Size: 18 1/2"L x 6 1/2"W x 1 5/16"H.	$49
K-158	Small Footprint 101/102 keys. 22 percent smaller than regular footprint. Size: 15 3/4"L x 7 7/8"W x 1 13/16"H.	$49
K-158-1	Small Footprint Spanish Language	$55

HARD DRIVES

Part#	Description	Each
ST-225	20 MB MFM 65 MS Hard Drive 5-1/4"	$199
ST-238	30 MB RLL 65 MS Hard Drive 5-1/4"	$219
ST-251	40 MB MFM 28 MS Hard Drive 5-1/4"	$259
ST-157	40 MB 28 MS IDE Hard Drive 3-1/2"	$209
ST-1102A	89 MB IDE 19 MS Hard Drive 3-1/2"	$359
ST-296N	84 MB SCSI 19 MS Hard Drive 5-1/4"	$369
ST-1144A	130 MB IDE 19 MS Hard Drive 3-1/2"	$419
ST-1239A	210 MB IDE 15 MS Hard Drive 3-1/2"	$639
ST-1239N	204 MB SCSI 15 MS 10MPBS Data Transfer Rate Hard Drive 3-1/2"	$649

TO ORDER (800) 531-5369 FAX (512) 344-2985 TO ORDER (800) 531-5369 FAX (512) 344-2985 TO ORDER (800) 531-5369 FAX (512) 344-2985

Reader Feedback

• It will be a few weeks until our repaired hard-Disk drives are returned and we can test the following ourselves. In "Hard-Disk Replacement Encounters" (*ComputerCraft*, May 1991), we believe that FDISK would have allowed author O'Dell to name the D drive as the primary "boot" (?) drive. It's unusual using the C drive for filing purposes and also more difficult to boot from drive D since some software assumes the default is drive C. We're fairly sure, however, that FDISK would be preferred for a "faster hard-disk solution." Booting could also be done from the slower hard drive, with an AUTOEXEC.BAT file vectoring immediately to the faster drive.

Lawrence E. McFarland
Carmel, NY

• The Ring Director II project featured in your October 1991 issue was of great interest to me. Your readers might be interested in an inexpensive IBM PC-compatible program called *RemoteControl* that provides the same utility. *RemoteControl* software also provides a ring-back mode that permits two or more telephone devices to share the same telephone line. Typically, the software is used to switch incoming calls between a fax machine and modem or a modem and an answering machine. Like Ring Director II, the latest version of *RemoteControl* software also supports RingMate service.

We sell *RemoteControl* through direct order for $35 plus $4 S&H.

Charles Edlington
President
Electronic Technologies
3985 S. Rochester Rd., Ste. H
Rochester, MI 48307-5135
Tel.: 313-656-0630

• I recently came across Jan Axelson's article, "A Low-Cost Development System" in the June 1991 issue of *ComputerCraft*. I am really glad that *Modern Electronics* (now *ComputerCraft*) has taken it upon itself to pioneer in this area with the electronics-cum-computer hobbyist in mind. There are a few such magazines, like the *Elector-Electronics* in Britain and the *MX User, MSX Computing*, which wrote on the Z80A-based MSX standard (CP/M) computers that came from Japanese companies to compete with Commodore 64 home computer.

Chinnappan Kuriakose
Mt. Vernon, NY

• Congratulations on the name change! It has moved your magazine from the electronics rack to the more-popular computer rack in my neighborhood magazine store.

A. Werblinski
Verdun, Quebec, Canada

A Question Of Safety

• I was very interested in Art Salsberg's review, "A Whole-House Surge Protector" in the August issue. However, I question the Electra Guard's effectiveness if connected through existing circuit breakers as shown. In power surges I have experienced, one or more breakers were tripped by the surge. If the breakers connected to Electra Guard were tripped, that would seem to remove all protection from the other circuits by rendering Electra Guard effectively disconnected.

William E. Baker
Independence, MO

When "tripped," Electra Guard opens the input line.—Ed.

UNICORN ELECTRONICS

10010 Canoga Ave., Unit B-8
Chatsworth, CA 91311

SINCE 1983 — YOUR I.C. SOURCE — AND MUCH MORE!!
NO SHIPPING CHARGES ON PRE-PAID ORDERS!*
NO CREDIT CARD SURCHARGE!
SCHOOL P.O.'s WELCOME!

LASER DIODES

STOCK #	MFG.	WAVE-LENGTH	OUTPUT POWER	OPER. CURR.	OPER. VOLT.	PRICE
LS9220	TOSHIBA	660 nm	3 mW	85 mA	2.5v	129.99
LS9200	TOSHIBA	670 nm	3 mW	85 mA	2.3v	49.99
LS9201	TOSHIBA	670 nm	5 mW	80 mA	2.4v	59.99
LS9211	TOSHIBA	670 nm	5 mW	50 mA	2.3v	69.99
LS9215	TOSHIBA	670 nm	10 mW	45 mA	2.4v	109.99
LS3200	NEC	670 nm	3 mW	85 mA	2.2v	79.99
LS022	SHARP	780 nm	5 mW	65 mA	1.75v	19.99
SB1053	PHILLIPS	820 nm	10 mW	90 mA	2.3v	9.99

Dynamic RAMS

STOCK #	DESC.	SPEED	1-24	25-99	100+
41256-60	256K x 1	60 ns	2.59	2.46	2.21
41256-80	256K x 1	80 ns	2.19	2.08	1.87
41256-100	256K x 1	100 ns	1.99	1.89	1.70
41256-120	256K x 1	120 ns	1.89	1.80	1.62
41256-150	256K x 1	150 ns	1.79	1.70	1.53
511000-70	1 meg x 1	70 ns	5.49	5.22	4.70
511000-80	1 meg x 1	80 ns	5.29	5.03	4.53
511000-10	1 meg x 1	100 ns	5.09	4.84	4.36
514256-70	256K x 4	70 ns	6.49	6.17	5.55
514256-80	256K x 4	80 ns	6.09	5.79	5.21
514256-10	256K x 4	100 ns	5.69	5.41	4.87
541000-80	4 meg x 1	80 ns	26.99	25.64	23.08
544256-80	1 meg x 4	80 ns	31.99	30.39	27.35

EPROMS

STOCK #	SPEED	1-24	25-99	100+
2716	450 ns	3.29	3.13	2.82
2732	450 ns	4.19	3.98	3.58
2732A	250 ns	3.29	3.13	2.82
2764	250 ns	3.49	3.32	2.99
2764A	250 ns	3.09	2.94	2.65
27128	250 ns	4.79	4.55	4.10
27C128	250 ns	4.79	4.55	4.10
27256	250 ns	4.59	4.36	3.92
27C256	250 ns	4.29	4.08	3.67
27512	250 ns	5.49	5.22	4.70
27C512	250 ns	5.49	5.22	4.70
27C1024	200 ns	10.99	10.44	9.40
27C2048	200 ns	21.99	20.89	18.80

LASER TUBES

STOCK #	WAVELENGTH	OUTPUT POWER (MIN.)	OUTPUT POWER (MAX.)	BEAM DIAM.	BEAM DIVERG.	POLARIZATION	OPERATING VOLTAGE	OPER. CURR.	FIRING VOLT.	MIN. SERIES RES.	SIZE D X L (IN MM)	WT. (GM.)	BRH CL.	PRICE 1-9	10+
LT7770	543nm (Green)	0.5mW	1.0mW	0.71mm	≤ 1.2 mrad	random	1750v ± 110v	6.5 mA	≤ 8 kV	81k Ω	37 x 350	200	II	799.99	749.99
LT7650	632.8nm (Red)	0.5mW	2.0mW	0.49mm	≤ 1.7 mrad	>100:1	1000v ± 100v	3 5 mA	< 7 kV	68k Ω	25 x 146	70	IIIa	529.99	479.99
LT7656	632.8nm (Red)	0.5mW	2.0mW	0.34mm	≤ 2.4 mrad	random	1050v ± 100v	2 8 mA	≤ 8 kV	82k Ω	22 5 x 118	60	IIIa	134.99	124.99
LT7655	632.8nm (Red)	0.5mW	2.0mW	0.49mm	≤ 1.7 mrad	random	1000v ± 100v	3.5 mA	≤ 7 kV	68k Ω	25 x 150	70	IIIa	144.99	134.99
LT7655S	632.8nm (Red)	1.0mW	2 0mW	0 49mm	≤ 1.7 mrad	random	1000v ± 100v	3.5 mA	≤ 7 kV	68k Ω	25 x 150	70	IIIa	159.99	144.99
LT7632	632.8nm (Red)	1.2mW	3.0mW	0.61mm	≤ 3.0 mrad	random	1300v ± 100v	3.5 mA	≤ 7 kV	81k Ω	20 x 210	70	IIIa	249.99	229.99
LT7621S	632.8nm (Red)	2.0mW	5.0mW	0.75mm	≤ 1.2 mrad	random	1300v ± 100v	5 0 mA	≤ 7 kV	68k Ω	30 x 255	140	IIIa	204.99	191.99
LT7634	632.8nm (Red)	2.0mW	5.0mW	0.75mm	≤ 1.2 mrad	>500.1	1300v ± 100v	5.0 mA	≤ 7 kV	68k Ω	30 x 255	140	IIIa	209.99	194.99
LT7621MM	632.8nm (Red)	5.0mW	15mW	1.0mm	≤ 2 5 mrad	random	1250v ± 100v	6 5 mA	≤ 7 kV	68k Ω	30 x 255	140	IIIb	359.99	334.99
LT7627	632.8nm (Red)	5.0mW	15mW	0.80mm	≤ 1 1 mrad	random	1900v ± 100v	6 5 mA	≤ 8 kV	81k Ω	37 x 350	200	IIIb	369.99	344.99
LT7628	632.8nm (Red)	5.0mW	15mW	0.80mm	≤ 1.1 mrad	>500.1	1900v ± 100v	6.5 mA	≤ 8 kV	81k Ω	37 x 350	200	IIIb	389.99	364.99
LT7627MM	632.8nm (Red)	10mW	30mW	1 2mm	≤ 4 0 mrad	random	1750v ± 100v	6.5 mA	≤ 8 kV	81k Ω	37 x 350	200	IIIb	479.99	444.99

Laser Pointer

- Output: 3.5 mW
- Wavelength: 670NM
- Power Supply: 2xAAA Batteries (included)
- Beam: Approx. 3" @ 100 yards

Quantity Discounts Available

STOCK # LSPOINT — **PRICE** $199.99

Power Supply

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

STOCK # PS1003 — **PRICE** $19.99

Collimator Pen

- Output: 2.5 mW (max.)
- Current: 90-150 mA
- Op. Volt.: 2.2-2.5V
- Wavelength: 820NM
- Data Sheet inc.

STOCK # SB1052 — **PRICE** $39.99

Disc Drive & Computer Cleaning Kit

Not just a drive cleaner-but a complete computer cleaning kit. Includes swabs, head cleaning fluid, anti-static cleaner, screen wipes and cleaning diskette.

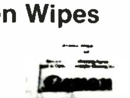
STOCK #		PRICE
SB1099	3½" Kit	$6.99
SB1100	5¼" Kit	$6.99

Disc Drive Head-Cleaning Kit

Includes cleaning fluid and head-cleaning diskette

STOCK #		PRICE
SB1105	3½" Drive Kit	$1.99
SB1106	5¼" Drive Kit	$1.99

Anti-Static Screen Wipes



For static-sensitive applications. Dispenser packs, individually wrapped.

STOCK #		PRICE
SB1104	Dispenser pack of 25 wipes	$1.99
SB1107	Dispenser pack of 100 wipes	$4.99

Robotic Arm Kit

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

STOCK # YO1 — **PRICE** $49.99

Avoider Robot Kit

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

STOCK # MV912 — **PRICE** $49.99

ORDER LINE — (800) 824-3432

INTERNATIONAL ORDERS — (818) 341-8833

FAX ORDERS — (818) 998-7975

TECHNICAL SUPPORT — (818) 341-8833

VISA MasterCard

- 15.00 MINIMUM ORDER
- UPS BLUE, RED & FEDERAL EXPRESS SHIPPING AVAILABLE
- OPEN MON-FRI 9:00 AM - 6:00 PM, SAT 10:00 AM - 3:00 PM PDT
- CA RESIDENTS ADD 8¼ % SALES TAX
- CALL FOR QUANTITY DISCOUNTS
- CALL FOR FREE CATALOG (FOR 1ST CLASS DELIVERY OR CATALOGS DELIVERED OUTSIDE THE U.S. — SEND $2.00)
- WE CARRY A COMPLETE LINE OF ELECTRONIC COMPONENTS

*NO SHIPPING CHARGES ON PRE-PAID ORDERS DELIVERED IN THE CONTINENTAL U.S.

CIRCLE NO. 157 ON FREE INFORMATION CARD

PCradio. ARDIS, an IBM/Motorola partnership, will produce a notebook-size PC that provides nationwide communications--radio, cellular or telephone. Designated IBM Model 9075, it's awaiting FCC approval. The under-6.4-lb. portable features ruggedized construction, a 80C186 CPU running at 5 to 10 MHz, 640K system RAM, an expansion slot accommodating a memory card with up to 2MB, a 640 x 200 LCD fold-down display and integrated data communications modems for wireless and landline communications. It also can send or receive fax copies over cellular networks and send-only over landlines. Designed for mobile and portable applications, its radio-frequency modem can communicate nationally over the ARDIS nationwide data network.

Taxing BBS Software Downloads. New York State, scratching for more tax revenue, is reported to be subjecting BBSs to a sales tax for any software downloaded from their files. If the software doesn't have a price, the Tax and Finance office will determine one, we're told. Some sysops have closed down software transfers until the air is cleared on all this. Hams are concerned about the new tax rules, too, wondering if packet radio BBS transfers are included.

New Software Protection Schemes. A new PC software security standard, PCDES (PC Data Encryption Standard), challenges long-time standard Data Encryption Standard (DES). The new alternative consists of three "plug-in" algorithms that are said to run up to 40 times faster than the old DES, developed in the 1970s.

A software protection module that features an expiration timer was introduced By Dallas Semiconductor (Dallas, TX). The DS1407 plugs into the parallel port of a personal computer. Using just one signal wire and self-powered by an embedded lithium energy source, the device is said to leave the port unencumbered by its presence. The DS1407's expiration timer facilitates software trial or lease plans based on elapsed time or calendar time. The module contains a 64-bit authorization code, too. a developer's kit costs $60.

Super Nintendo Arrives. Super NES has arrived in time for Christmas shopping, with projected sales of 2-million hardware units and 6-million software units by year-end 1991! Using 16-bit technology, the system features enhanced graphics (a 32,768-color palette), digital stereo sound from eight channels and multiple scrolling screens that provide 3D image effect capabilities. Introduced last year in Japan as Super Famicom, 1.6-million units were reported to be sold in five months.

Multimedia News. Yamaha's Systems Technology Division (San Jose, CA) new MAGIC three-chip set for multimedia PC use combines a host of functions that include advanced stereo digital audio, MIDI functions with on-board timers and joy-stick port and a bevy of sound generators....Sony, too, introduced new multimedia gear in the form of a $795 all-purpose multi-disc player, the MDP-1100. It's said to be the first multi-disc player to control video discs and digital audio CDs by computer, infrared control and videodiscs supporting bar-code programming.

Quality Brand Name Components, Reasonable Prices and

THE BEST WARRANTY IN THE INDUSTRY!

CPC Offers More STANDARD Features:

- Intel CPU (AMD on 386-40Mhz System)
- AMI Bios (Award Bios on EISA Systems)
- 4MB RAM Installed (2MB on 386SX)
- 64-256K Cache SRAM on 386-33, 40 & 486 Systems
- 1.2 & 1.44 Teac Floppy Drives
- 120MB Conner Hard Drive (90MB on 386SX) w/ 64K Built in Disk Cache
- 1:1 Interleave 2HD/2FD IDE Adapter
- SCSI Interface Available
- 101 Key Enhanced Tactile Keyboard
- 1 Parallel, 2 Serial, Game Port
- Clock- Calendar Built-In
- 16Bit Tseng 4000 SVGA Card w/1MB Installed opt. 700,000 Color Sierra RAM-DAC Avail.
- 14" NON-Interlaced SVGA 1024x768 .28mm Monitor, opt. Trinitron-NI. Call for 16" & 20" Monitors.
- Desktop or Mini Tower Case Standard opt. Full Size Tower
- Microsoft MS-DOS v5.0
- Microsoft Quick Basic
- MS-Windows 3.0 w/Mouse (add $60)
- Custom Configurations with NO LIMITATIONS!

386SX-16Mhz $1499.00	**386-25Mhz** $1795.00
386-33Mhz $1995.00	**386-40Mhz** $2150.00
486-33Mhz $2545.00	**486-33Mhz EISA** $CALL

386sx-16 notebook
2MB RAM
40MB Hard DRive
VGA Backlit LCD
Carrying Case
7Lbs
$1975

CALL Today for Literature on any of our Products!

Discover the CPC Advantage:

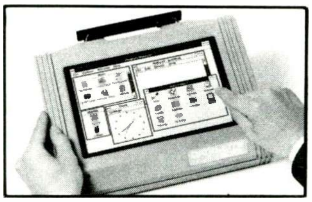
- **FREE Federal Express Shipping on Complete Systems**
- **FREE 1 Year On-Site Pickup Service On-Site Service Available**
- **FREE Overnight Replacement Parts**
- **Toll FREE Technical Support**
- **25 Day Money Back Guarentee**
- **Best Warranty in the Industry:**
  - **3 Year Parts on Electronics** (Mother Board, Memory, HD/FD/IO & Video Controllers)
  - **2 Year Parts on Mechanics** (Hard Drive, Floppy Drives, Power Supply, Keyboard)
  - **Lifetime Labor**
  - **24-48hr Warranty turn around.**

CPC Computer Products
327 Quinnipiac Ave. North Haven, CT 06473

1-800-272-7281
In CT Call: (203) 776-8725
Fax: (203) 776-3958

Pen Notebook Computer

MicroSlate's new Datellite 300 features its "pen 'n touch"™ interface in a NATO-approved package with 16-MHz 386SX, 120M hard disk, 1M RAM (16M optional) and VGA touch-screen LCD. Weighing under 7

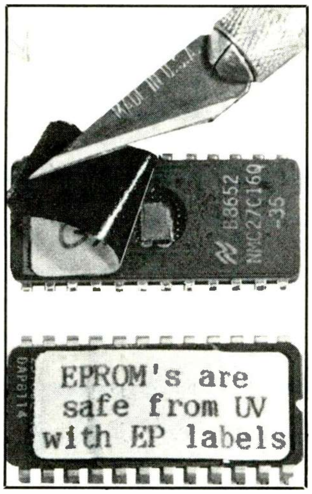


pounds, the unit fits inside a 12⅝"W × 10"D × 2¾"H rugged case. In addition to the regular ports, the Datellite 300 has a built-in SCSI interface. Battery life is rated at approximately 4 hours before recharging. A simple-to-use applications generator makes for rapid program development. The 300 supports MicroSoft's new *Pen-Windows* program and is expected to support GO Corp.'s *Penpoint* software. $5,995.

CIRCLE NO. 1 ON FREE CARD

EPROM Labels Block UV

Datak Corp. now offers UV-blocking labels for EPROMs and PAL devices that can be written or typed on with ball-point pen, soft lead pencil, a typewriter or a platen-feed



computer printer. Up to three typed lines can be accommodated. Label construction consists of a white write-on polyurethane layer, a UV-blocking black vinyl layer and a pressure-sensitive acrylic adhesive layer. These 1.1" × 0.46" labels are sized to fit neatly on top of 24-pin devices with 0.6" row spacing and are flexible enough to conform to all EPROM packages, including those with raised windows. Once in place, the label is permanent. However, it can be removed without leaving behind any adhesive residue. $4 for 147 labels.

CIRCLE NO. 2 ON FREE CARD

Portable Tape Backup

The ADPI "One For All" portable tape backup system is a convenient solution for backing up data from multiple PCs. It offers 160M of storage on one CT600 digital cassette, with a transfer rate

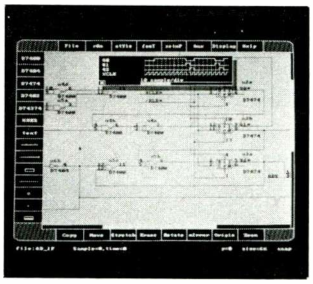
of 4.5M per minute. No controller card or special adapter is required for the unit since it plugs directly into a parallel printer port. The software is menu-driven and provides on-line help, prompts and status windows. It operates from the DOS command line and features read-after-write verification. Large backups can be carried on several tapes. "One For All" features a convenient recessed handle for easy carrying. It measures 9½"D × 5½"H × 3¾"W and weighs 6 lb. $1,495.

CIRCLE NO. 16 ON FREE CARD

Schematic Editor Supports Circuit Simulation

The latest version of Mental Automation's *SuperCAD*, a schematic editor, works with both digital and analog simulators via compatible netlists and built-in waveform displays. A logic analyzer view shows digital simulation results, while an oscilloscope view shows analog simulation (SPICE) results.

SuperCAD is a full-featured schematic-entry package that runs on IBM/compatible computers with 512K RAM, graphics adapter, MicroSoft-compatible mouse and DOS 2.0 or later. In addition to a schematic editor, the package includes a netlist gen-

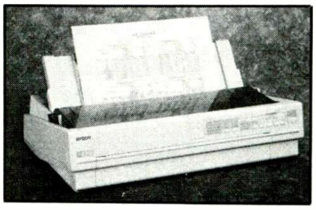


erator, library parts builder, electrical rules checker and parts-list extractor. Parts libraries include generic TTL and CMOS, memory, PLDs, 4000-series CMOS, analog and microprocessors. Many parts include separately selectable DIP or surface-mount pinouts; gate parts include De Morgan equivalent symbols. $99.

CIRCLE NO. 24 ON FREE CARD

DMP With Scalable Fonts

Epson America's LQ-1070 is a new wide-carriage 24-pin printer with the ESC/P 2 enhanced-graphics mode that permits scalable fonts (8 to 32 points). Other features include an 8K buffer, new case design, faster speeds, four paper paths (top, rear, bottom and front). Draft speed is rated at 315 cps, letter quality

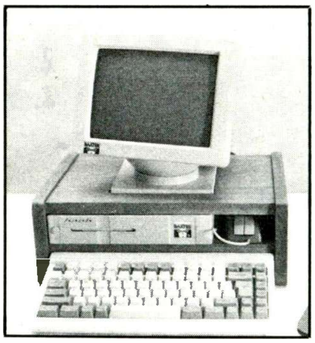


at 70 cps. Drivers are included for most popular software. Options include film ribbon for sharpest output and cut-sheet feeders. $699.

CIRCLE NO. 26 ON FREE CARD

Designer Computers

Baxter Computer has a new line of "Bookshelf" computers for people who are looking for something other than



the traditional beige housing. Based on a compact motherboard, the new computers feature a fine hardwood casing, several designer styles and colorful exteriors to match popular office design themes. Measuring a mere 9⅜"W × 6¾"D, the Baxter "A" platform is available with a 286 or 386SX CPU. The shoe-box-shaped Baxter "B" comes with either a 286 or 25-MHz 386DX. Hard disks are currently available in 40M, 80M and 120M sizes.

Both series come with a single 1.4M floppy drive and 1M (286) or 2M (386) RAM. The buyer has a choice of a special cut-back micro keyboard or a regular 101-key design. Normal ports, including VGA, are standard, along with a single half-size-card expansion slot. The power supply is external. $1,100 and up.

CIRCLE NO. 25 ON FREE CARD

Upgrading PCs

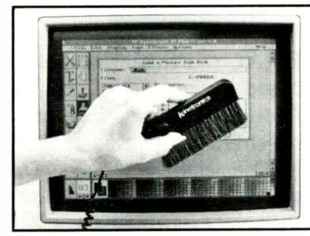
By Bud Aaron & Alex Aaron
(Osborne/McGraw-Hill. Soft cover. 459 pages. $19.95.)

This is likely to be of much greater interest to the computer neophyte than the power user. Chapter 1 starts out with the ubiquitous "History of the Computer" and "Why Upgrade?" sections. Chapters 2 and 3 serve as a guide to lifting the lid on your own computer and being able to recognize the major components. Chapters 4 through 6 cover simple additions, ranging from printers and mice to expansion boards to floppy and hard disk drives.

Upgrades at the component level (memory chips, power supplies, accelerator cards, BIOS chips, etc.) show up in Chapters 7 and 8. The authors cover operating-system essentials in Chapters 9 and 10; CONFIG.SYS and AUTOEXEC.BAT receive the most attention. Troubleshooting and building your own computer round out the the topics in Chapters 11 and 12. In addition, several appendices contain often-needed information, such as charts of hard-drive heads, tracks and cylinders.

The authors' style is simple and direct, and the writing is clear. Illustrations are good and will benefit those people who perform upgrades. If you have an older computer and are thinking about upgrading it yourself, this volume could serve as a handy reference, particularly if you've never tackled a similar project. If you are an old hand to the DOS/IBM/compatible world, let this one pass.

Screen Cleaner



Kinetronics' CompuWisk is said to effectively remove the static charge from computer screens and static-prone office furniture while whisking away dirt and dust. It's made of a special blend of soft natural hair and dissipative synthetic fibers. The 12-foot coil cord has a built-in resistor to eliminate static shocks and is easily attached to ground. This protects against accidental static discharge that can affect memory, garble data or cause CPU lock-up. The device mounts to a computer for out-of-the-way storage. The brush can be cleaned by unsnapping it from the card and rinsing it in shampoo and water. $40.

CIRCLE NO. 27 ON FREE CARD

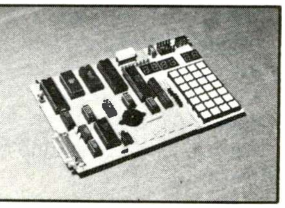
Disk-Cache Program

The Aldridge Company's *Cache86* disk-caching program improves the performance of most computers lacking a cache. The *Cache86* driver comes as four different executable programs that are optimized for a specific type memory or machine. *Cache86* uses either expanded or extended memory (or regular memory) with the drivers requiring 5K of conventional memory or less to produce a cache of up to 4M. The program is compatible with all popular hard drives, all current DOS versions (including DR-DOS), and current applications, such as *Windows*.

CIRCLE NO. 28 ON FREE CARD

Micro Trainer

EMAC's Primer Trainer is based on an 8085 CPU and features a 20-key keypad, a six-character seven-segment LED, eight-position DIP switch input port, output port with eight status LEDs, six-bit



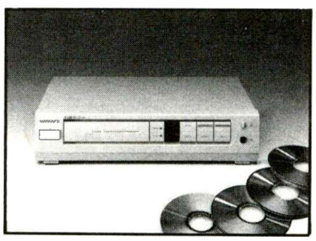
A/D converter, six-bit D/A converter and 14-bit timer with speaker output. An expansion port is also included, allowing interfacing of circuits of the user's own design.

An EPROM carries the monitor operating system that enables the user to examine and change contents of memory and registers. Primer comes standard in kit form, permitting the user to gain experience in circuit-board assembly and soldering. Among optional upgrades available are 8K RAM, RS-232 port, software, single stepping and four additional keys. $100 in lots of 10.

CIRCLE NO. 29 ON FREE CARD

Combination CD-ROM/Audio Player

Philips Consumer Electronics is shipping an external combination CD-ROM drive/stand-alone CD-audio player, the Magnavox CDD461RS. It can play audio CDs independently of the computer to which it's



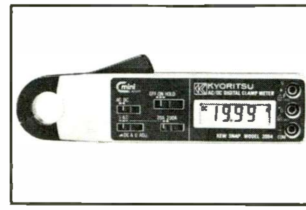
attached. The front panel has a volume control and headphone jack. CD-ROM disks have a storage capacity of up to 757M. The package is bundled with the *New Grolier Electronic Encyclopedia*, *Microsoft Bookshelf*, *PC Globe* Electronic Atlas and *PC-SIG Library*. Included also are a PC XT/AT interface card, Microsoft CD-ROM extensions, cables and an installation program.

Magnavox eliminated the caddy normally found in CD-ROM drives. Access time is less than 700 ms, with average data transfer rates greater than 150K/s. The package measures 14.2"W × 11.8"D × 3.5"H and a video monitor can be placed atop it to conserve space. $550.

CIRCLE NO. 30 ON FREE CARD

Clamp-On VOM

The Kyoritsu Electrical Instruments Works Model 2004

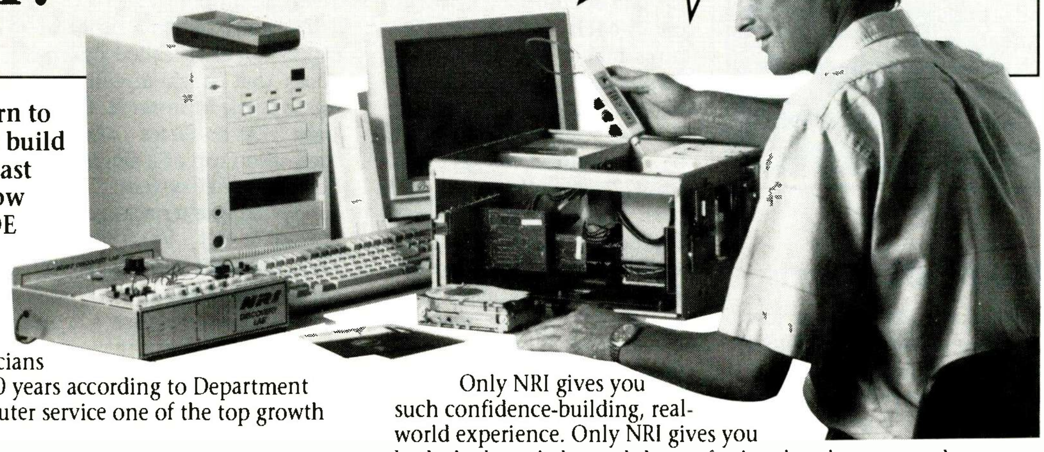


clamp-on VOM measures both ac and dc current from 0.01 to 200 amperes by merely clamping its 19-mm jaw around a current-carrying conductor. The small size of the 2004 allows for low-current readings at 10-mA resolution in tight areas. Readout is shown on a 3½-digit LCD. The specially designed magnetic sensing jaw with Hall sensing elements allows for accurate readings on both ac and dc currents. Frequency response for ac measurement is from 40 Hz to 1 kHz. Measurement ranges are: current, 20/200 amperes ac/dc; voltage to 500 volts ac/200 volts dc; and resistance to 200 ohms. $295.

CIRCLE NO. 31 ON FREE CARD

Learn to troubleshoot and service today's computer systems as you build a powerful 386sx/20 MHz computer!

**NEW!
386sx/20 MHz
computer, 40 meg
hard drive!**



Train the NRI way—and learn to service all computers as you build your own powerful West Coast 386sx/20 MHz computer, now with 1 meg RAM, 40 meg IDE hard drive, and exciting new diagnostic hardware and software!

Jobs for computer service technicians will almost double in the next 10 years according to Department of Labor statistics, making computer service one of the top growth fields in the nation.

Now you can cash in on this exciting opportunity—either as a full-time industry technician or in a computer service business of your own—once you've mastered electronics and computers the NRI way.

Get real-world skills as you train with and keep a powerful 386sx-based computer system plus Microsoft® Works software

Only NRI gives you hands-on training with the finest example of state-of-the-art technology: the powerful new West Coast 386sx/20 MHz computer. As you assemble this fully IBM PC/AT-compatible machine, you actually see for yourself how each section of your computer works.

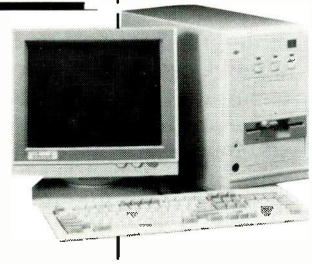
You assemble and test your computer's "intelligent" keyboard, install the power supply and 5¼" high-density floppy disk drive, then interface the high-resolution monitor.

Your hands-on training continues as you install a powerful 40 meg IDE hard drive—today's most-wanted computer peripheral—now included in your course to dramatically increase your computer's data storage capacity while giving you lightning-quick data access.

Plus you now work with today's most popular integrated software package, Microsoft Works, learning to use its word processing, spreadsheet, database, and communications utilities for your own personal and professional applications.

But that's not all!

NEW! Ultra-X diagnostic hardware and software for fast, accurate troubleshooting



Now you train with and keep the latest in diagnostic hardware and software: the extraordinary R.A.C.E.R. plug-in diagnostic card and QuickTech menu-driven software, both from Ultra-X. Using these state-of-the-art tools, you learn to quickly identify and service virtually any computer problem on XT, AT 80286/80386, and compatible machines.

Only NRI gives you such confidence-building, real-world experience. Only NRI gives you both the knowledge and the professional tools to succeed as today's in-demand computer service technician.

No experience needed...NRI builds it in

With NRI training, you learn at your own convenience in your own home. No classroom pressures, no night school, no need to quit your present job until you're ready to make your move.

NRI starts you with the basics of electronics and computers, building on that foundation step by step until you have the knowledge and skills you need for success.

And all throughout your training you've got the full support of your personal NRI instructor and the entire NRI technical staff, always ready to answer your questions and help you achieve your training goals.

Send for your FREE catalog today!

Send today for NRI's big, free catalog that describes every aspect of NRI's innovative computer training, as well as hands-on training in other growing high-tech career fields.

If the coupon is missing, write to: NRI Schools, McGraw-Hill Continuing Education Center, 4401 Connecticut Avenue, NW, Washington, DC 20008.

SEND CARD TODAY FOR FREE NRI CATALOG

NRI Schools
McGraw-Hill Continuing Education Center
4401 Connecticut Avenue, NW, Washington, DC 20008

✔ Check one FREE catalog only

- ☐ MICROCOMPUTER SERVICING
- ☐ TV/Video/Audio Servicing
- ☐ Telecommunications
- ☐ Industrial Electronics & Robotics
- ☐ Security Electronics
- ☐ Electronic Music Technology
- ☐ Basic Electronics
- ☐ Computer Programming
- ☐ PC Software Engineering Using C
- ☐ Desktop Publishing & Design
- ☐ Word Processing Home Business
- ☐ Bookkeeping & Accounting
- ☐ Air Conditioning, Heating, & Refrigeration
- ☐ Building Construction
- ☐ Small Engine Repair
- ☐ Automotive Servicing

☐ For career courses approved under GI Bill, check for details.

Name (please print) Age

Address

City/State/Zip

Accredited Member, National Home Study Council

4-121

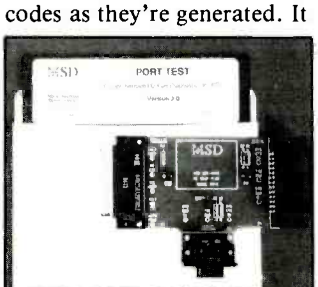
Free Catalog

The MCM catalog contains listings for more than 17,000 parts and components, 600 of them new to this edition. Among product categories listed are: semiconductors, TV parts, computer equipment, power centers and regulators, telephone parts and accessories, connectors, tools, batteries, speakers and more.

CIRCLE NO. 38 ON FREE CARD

Diagnostic Boards

Post Code Master is a low-cost plug-in card for AT (ISA) bus computers from Micro-Systems Development. It enables the user to debug PCs, even when the monitor or disk drives don't work. When a PC is powered up, the BIOS performs a series of tests and verifications. Before each test, it outputs a code. If a test fails, the last code output indicates the failure. Post Code Master captures and displays Power On Self Test (POST) codes as they're generated. It comes with a complete explanation of codes for most BIOS manufacturers. $59.

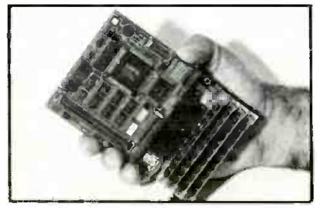


Port Test is a second plug-in board that provides complete diagnostic service for serial and parallel ports. It displays installed ports, performs thorough internal and external diagnostics and allows you to change port addresses. It also provides many useful utilities to enable the user to locate external connectors, resolve address and interrupt conflicts, locate bad components and more. $89.

CIRCLE NO. 32 ON FREE CARD

Miniature 386SX Board

Zykronix has a new single-board 386SX AT-compatible system that measures only 6″ × 4″ × 1.3″ and weighs just 6 ounces. The "Little Monster II" can be equipped with a 20- or 25-MHz 386SX. Its features include a multi-density floppy disk controller, battery backed real-time clock, dual RS-232 serial ports (one can be configured as RS-485/RS-422), parallel port, IDE hard drive interface, math coprocessor socket and an ISA-signal-compatible Zykro-Bus. The unit requires only a single 5-volt dc supply.



Zykronix offers a series of expansion cards called Zykro-Slices that stack directly on top of Little Monster II. Up to eight Zykro-Slices can be stacked on top of a single Little Monster II system. $1,695 for development package with 2M of RAM, VGA Zykro-Slice, cable set, and all technical documentation.

CIRCLE NO. 33 ON FREE CARD

8052AH Music Development Tool

Music Converter from Suncoast Technologies is an 8502AH development tool that easily transforms a listing of standard musical notations to Intel's Pulse Width Modulation (PWM) Reload format. *Music Converter* takes this PWM information and creates a ready-to-load-and-run BASIC program using READ and DATA statements to create the musical sounds. The program is ready to upload to an 8052AH BASIC Microcontroller via a standard communications program. $25.

CIRCLE NO. 34 ON FREE CARD

Flat-Bed Scanner

The Datatrek Sirius 32 is an advanced flat-bed desktop scanner that scans both text and graphics at 300 × 300 dpi. Screen size is 8½″ × 14″, and an optional automatic document feed allows the unit to scan up to 25 pages at once. The unit supports 32 Windows and features 51 adjustable steps for contrast and brightness control. It provides a maximum scanning speed of 10 seconds for a full 8½″ × 11″ document. Resolution ranges from 1% to 100% in 1% steps.

Fifteen patterns with various grain sizes and gray levels are built in for halftones. The Sirius 32 is designed to operate in a wide range of environments at input voltages ranging from 90 to 130 volts ac or 180 to 264 volts ac. Power frequency can range from 47 to 73 Hz. Size is 21″ × 13⅞″ × 5⅙″ and weight is 17.8 lbs. $1,399; half-size interface card, cable and *DStart* software that operates under *Windows* 3.0 begin at $395.

CIRCLE NO. 35 ON FREE CARD

PC Magazine Guide To Notebook & Laptop Computers

By Bill Howard
(Ziff-Davis Press. Soft cover. 415 pages. $29.95.)

Thinking about purchasing a laptop or notebook computer? This book is chock-full of valuable information and guidance for the newcomer, including a lot of matter relating to PCs in general. On the other hand, if you're an experienced, savvy laptop user, chances are that you'll find little new in this volume.

The first four chapters amount to guidelines for making your first laptop purchase. After a short history of the laptop-computer market in Chapter 1, the author discusses important laptop features in Chapters 2 and 3. Chapter 4 is on buying the right computer at the right price.

Chapter 5 talks at length about taking your portable on the road and the problems you're apt to encounter. Communications on the road is covered in Chapter 6. By following Howard's advice on tapping into the telephone wiring in your hotel, you'll be able to handle virtually any situation you encounter.

If you have need of interfacing a laptop with a LAN, you'll find some good advice on the associated problems in Chapter 7. Chapter 8 is devoted to software considerations and advice on minimizing the hard-disk space software occupies. Next is a discussion of hardware accessories, including printers, mice substitutes and other electro-mechanical marvels. The expositional portion of the book concludes with a discussion of resources available, ranging from magazines to electronic forums such as CompuServe to trade shows.

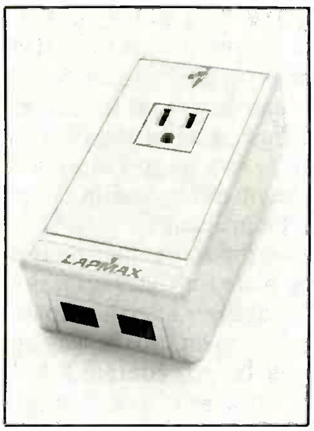
Several appendices cover other topics, including troubleshooting, input/output operations and connectors, international voltage standards, Hayes modem commands, E-mail, and more. A 3½″ disk comes with the book and has 18 utilities on it, including a virus detector and disinfector.

Bill Howard is an excellent writer, and it's apparent that he knows the laptop market. His writing style is personable and easy to follow, making for easy reading. If you're new to laptops, this book is a good buy. On the other hand, if you're already familiar with laptops, you may find little of interest in this one.

Laptop Protection

LAPMAX from Panamax protects laptop and notebook computers from damage and data loss resulting from irregularities within the electrical environment. Data loss can occur when the power supply is connected to the ac mains, the modem is connected to a telephone line or both. LAPMAX features one protected ac outlet and a pair of telephone connectors for modem protection. An indicator light tells the user that power protection is present. The LAPMAX also has a catastrophic surge eliminator that protects the equipment off-line in case of a devastating surge, such as a lightning strike. Weight is 11 ounces. $89.

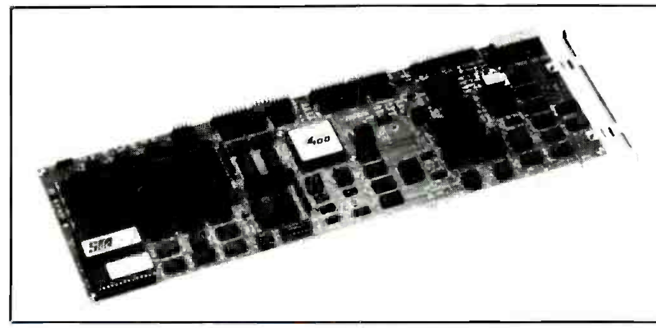
CIRCLE NO. 36 ON FREE CARD



Low-Cost Printer Sharing

ASP Computer Products has a free booklet that details its line of printer-sharing devices. The booklet features the SimpLan SeverJet that permits connecting up to 12 computers to a single HP LaserJet printer. Computers can be located up to 1,200 feet from the printer. The system uses inexpensive RJ11 telephone cable. Prices start at $395.

CIRCLE NO. 39 ON FREE CARD



Caching Controllers

Specialty Development Corp. (SDC) has the Series 400 line of caching disk controllers that are compatible with any AT-class computer (ISA bus). The Series 400 accelerate disk-intensive tasks by up to 10 times. Programs load and execute in a a fraction of normal time. Available in IDE, ESDI and SCSI formats, the Series 400 use RAM caches ranging in size from 512K to 4M, which results in an average data-access time of less than 0.27 ms. The cache uses standard 100-ns 256K or 1M SIMMS that users can add in pairs as needed. Each controller is "intelligent," built around a 16-bit Z280 microprocessor to create a self-contained parallel computer that manages and controls mass storage, disk caching and disk input/output. This frees the CPU for other tasks. The Series 400 emulates the industry-standard WD-1003 controller interface, ensuring compatibility with all standard operating systems. $845.

CIRCLE NO. 37 ON FREE CARD

CIRCLE NO. 77 ON FREE INFORMATION CARD

PC Image Acquisition

Part 1

Grabbing, digitizing and using images can be a snap

It's often been said that a picture is worth a thousand words. In the world of PCs, there are many ways to work with pictures. One method is to capture an image from a video source, which is the subject we'll be covering in this article.

Video digitizers and frame grabbers provide a convenient and easy means of doing it from a video camera, still digital camera, VCR or videodisc player. The result is saved to disk in the PC in several popular image formats. Here it can be manipulated and enhanced and have special effects added as desired. There are numerous applications that can process and use "captured" images, including desktop publishing, art-and-paint programs, many word processors, multimedia applications and a great deal more.

An explanation of terminology is in order here. An image or frame "grabber" denotes a real-time device that can capture an image in 1/30 second or less. So it can be used with pictures in motion. A video digitizer, in contrast, requires several seconds to capture an image rather than "grabbing" it instantaneously. Therefore, most of its utility is restricted to essentially still pictures.

Apart from the time required to complete a capture, the two types of devices perform the same basic function of transforming an incoming video image into a file of digital information that can be used by the computer. For the sake of simplicity, I'll refer to both types of devices as "digitizers," but keep the distinction in mind.

All digitizer and grabber cards have some things in common, although their capabilities, features and prices can vary a great deal. The five boards I cover here represent a good cross-section of what's available and each has it's own noteworthy features. Examined here, too, is an external digitizer that doesn't require an expansion slot. But first, let's cover what these image-capture devices have in common.

All five boards mount in any available eight-bit expansion slot, though some are half-sized and others are full-length. The external unit plugs into the PC's parallel printer port. All have some "video-in" provision (phono jack, S-VHS jack or both) to import the video image. Either jumpers or DIP switches are used for changing interrupts and/or port addresses to resolve conflicts with other installed devices.

This time around, we focus on the techniques used to capture an image for immediate viewing and later use, installation of the hardware needed to accomplish this and hands-on reviews of five internal boards and one external unit. Next month, in the conclusion of this two-part article, our focus will be on the software needed to make the hardware work and evaluate four image-integration software packages.

Installation

Installing a video digitizer board is a fairly easy affair that can usually be accomplished in well under ½ hour. Aside from the connection to a video source, this is basically the same procedure as for any expansion-card installation. In a nutshell, here's what it involves:

(1) Disconnect the ac power cord from the PC and remove the video monitor, keyboard and any other cables or devices.

(2) Remove the system unit's cover retaining screws and slide or lift off the cover.

(3) Select an available expansion slot that can be accessed from the rear of the PC, since you'll have to connect your "video in" source cable to the jack(s) on the bracket.

(4) Check the jumper and/or DIP-switch settings on the digitizer board to confirm that they're set to factory defaults, as indicated in the owners manual (this is *very* important if you have to do any troubleshooting later on to correct a problem).

(5) Remove the screw that retains the blocking plate for the chosen slot and plug the digitizer into the expansion slot so that it seats all the way in. Since digitizer boards contain RAM and other static-sensitive components, try to handle the card by its edges only.

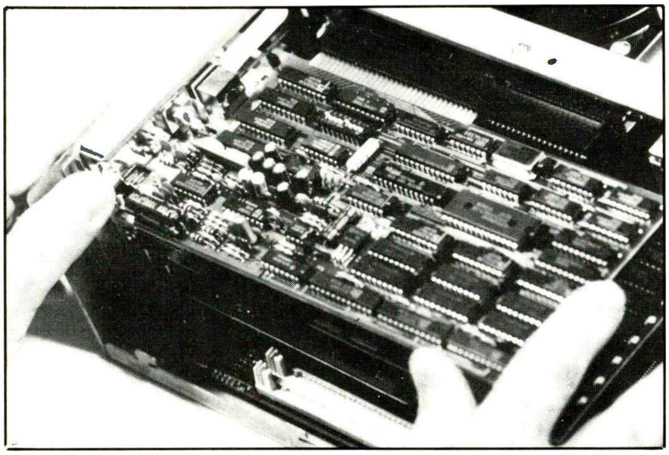
(6) Secure the card with the blocking-plate screw you removed and reinstall the system unit's cover, securing it with the appropriate screws.

(7) Reconnect the keyboard, monitor and anything else you removed prior to the installation.

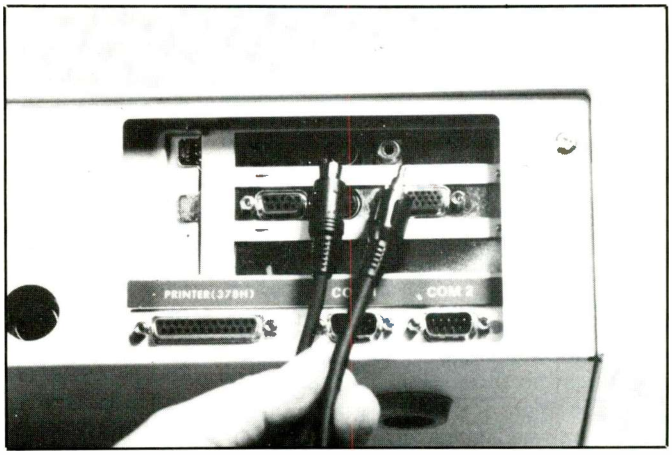
(8) Power-up your PC and install the software that came with the digitizer board. Most digitizers require an active video source to be connected to check the installation; so that's the next step.

(9) Some digitizers have phono jacks, some S-VHS jacks and some (like the Everex "Vision 8") have nine-pin D-style connectors. Using the appropriate cable, connect one end to the video-out terminal of your video source (VCR, camcorder, video camera) and the other end to the video-in jack on the digitizer board's bracket at the rear of the PC. Activate the camera, VCR or whatever video source you're using and you should be able to preview or capture an image using the board's software.

If all doesn't go as expected at this point, first check your video cable connection to make sure the source's



Video digitizer boards contain RAM and other static-sensitive devices. So avoid touching components and handle by edges only. Make sure the card is firmly seated in the slot before securing it with the bracket-retainer screw.



Once the appropriate capture software is installed, a video source is required to test the board. The ComputerEyes/RT shown in this example has jacks for both S-VHS (at left) and composite video via a phono jack (at right).

video-out is going to the digitizer's video-in (improper connection between the two devices is the most frequent cause of malfunction). If everything's okay with the cable connection, next check the video source itself to make sure there's, indeed, an image to capture (lens cap removed from camera, videotape in the VCR, power turned on, etc.).

If everything checks out up to this point but the system still isn't functioning properly, there may be a jumper or port-assignment conflict with another device in your PC. Check the manufacturer's installation instructions carefully again and if this is the area of suspicion, turn off everything and disassemble the system again.

Before changing board settings, I've found that it's more sensible to remove any devices suspected of conflicting with the new board. If you're very careful, you can plug in the keyboard and monitor and give everything a test run to see if removing the suspected offender corrects the problem before closing everything up again. The key word here is to be careful. When turning your PC on without the system cover in place a very real shock hazard exists, not to mention the danger of something falling inside the PC and wreaking all kinds of havoc.

If a device conflict proves to be the culprit and you've isolated the cause, shut off everything again and remove the digitizer board so that you can change the settings. You can also replace any other boards you removed at this time. Be sure to make a note of the revised settings so that you'll be able to configure the software setup to match the physical settings on the digitizer board. Reassemble the system, turn it on and everything should check out satisfactorily.

It has been my experience that factory default settings usually work just as they are. Occasionally, though, you might run into a conflict, particularly if you have lots of other peripherals connected to your PC. Devices like hand scanners, bus mice, multi-user and peripheral-sharing boards and sound/MIDI boards all have the potential for conflict with a video digitizer board. So be on the lookout if you have any of these items installed in your PC.

Since the externally-connected device mentioned earlier plugs into the parallel port of the PC, no jumpers or DIP switches are provided. This digitizer, Frugalvision, uses the default parallel port address assignment (usually 378H). So device conflicts should never be a problem (the printer must be unplugged from the port before the Frugalvision can be connected; there's no "through" connection on the digitizer).

The Video Source

Virtually any video source that generates an NTSC signal via a composite or S-VHS jack can be used with an image digitizer, although jack arrangements may vary from device to device. Almost all video digitizer boards have the popular phono video-in jack, and you'll occasionally find a board that can also accept S-VHS input.

Of the six image-capture devices covered here, four use the popular phono jack for video-in (the ComputerEyes/RT provides an S-VHS jack in addition to the phono-jack input). One, the Everex Vision 8 board, uses nine-pin D-style jacks for video-in and video-out (monitor) connections. Not only is this arrangement not standard, it also necessitates either purchasing or making special hook-up cables to mate with the D connectors on one end and the video source at the other. The IDEC Frugalvision/6 uses an r-f-style screw-on connector for video-in—also a non-standard arrangement.

Every video camera, camcorder, VCR, laserdisc player and digital still camera I've come across provides at least one video-out terminal (usually a phono jack, although some devices provide S-VHS signal output also). Standard hook-up or patch cables work fine for connecting these devices to the video digitizer board.

Occasionally you'll find a device that deviates from the accepted norm to some degree, as in the case of NEC's PV-S98A VCR. The video-out terminal of this high-end VCR uses a BNC-type jack instead of the usual phono jack. So a trip to your local

Image Data Bit-Types Explained

The terms 8-bit, 16-bit and 24-bit, when used to describe image capture and file format types, refer to how many bits each pixel has to display color or gray-scale information. Obviously, graphics boards and video monitors capable of displaying the resolution employed must be used.

Eight-bit images are commonly used for black-and-white captures, although the eight-bit format is capable of storing 256 colors or shades of gray.

Sixteen-bit images are capable of handling 32,000 colors and, subsequently, produce images with more definition and depth. They also require more storage space since the image file sizes are larger.

Twenty-four-bit images have 16.7-*million* colors and produce images with the best definition and depth. The reason for this is that the more colors the board is able to capture, the better the image looks. The eye discerns depth and definition through the use of color, since human vision is attuned to the color spectrum, rather than to grey-scale viewing. (The human eye is capable of discerning about 4-million shades of color, as opposed to a maximum of about 64 shades of gray.)

Radio Shack store is in order to purchase an adapter to go from phono to BNC. (Why NEC did this puzzles me, since the unit is equipped with standard phono video- and audio-in jacks as well as S-VHS terminals.)

Regardless of the video source you're using, the all-important thing to keep in mind about the link is to have the source's video-out signal going into the digitizer's video-in jack.

One of the niftiest image-recording devices I've come across is the Canon Xapshot Still Video Camera. This compact unit is about the size of your hand and slips easily into a jacket pocket. Rather than recording images on film, it uses a CCD (charge coupled device) image sensor to record pictures digitally on a miniature floppy disk that holds 50 pictures. Recorded images can be viewed on any TV receiver or video monitor and can also be copied as still pictures to video tape so that you can erase the disk for reuse. Since the Xapshot's combination recharger/ac adapter also provides a phono-type video output jack, it's ideal for transferring images to your computer via a video digitizer.

The Xapshot's small size, light weight, simple point-and-shoot operation and moderate cost (about $400) makes it highly transportable for use where a bulkier video camera or camcorder might otherwise be employed. Another plus of the Xapshot's digital still format is that you can hold an image as long as you wish with none of the flicker or wavering usually present on even the best of VCRs in still-frame mode. Image quality, while not quite as good as that of an expensive digital camcorder, is still excellent and more than adequate for transfer to desktop-publishing or other PC applications.

Image Formats

Capturing an image is only half the ballgame, so to speak. Once captured, you'll have to save the image to your hard (or floppy disk) in a format that will allow you to incorporate it into your intended software application. Some of the most popular (and universally accepted) image formats include .PCX, .TIF and .TGA. Five of the six image-capture devices here use .PCX and .TIF formats, with the exception, once again, being the Everex Vision 8 board, which saves in (of all things!) AT&T image format that isn't compatible with anything else. There's an optional *Free Style 8* paint program for use with this board that can save images in the .TGA format, but that's an extra-cost item.

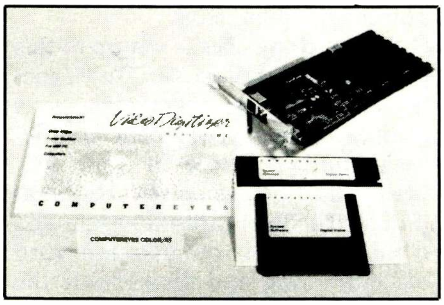
Being able to save a captured image in .PCX or .TIF format gives lots of latitude for editing and embellishing the image with popular full-featured paint programs like *PC Paintbrush IV Plus* from ZSoft. With a program like this, you can retrieve a captured image, change or remove the background, alter brightness or contrast levels and even add text matter or additional graphics like a border. The modified image can then be output to your printer or saved and used in another application, such as *Ventura Publisher*.

Hijaak from Inset Systems is a very useful program that handles conversions to and from dozens of popular image formats (including Amiga and various fax-board formats). The software also permits inverting colors (for example, black-on-white to white-on-black), as well as capturing images on your video display via a TSR utility. If you intend to do lots of image digitizing and manipulation, *Hijaak* will certainly be a welcome addition to your graphics toolbox.

Let's take a close look at each of these image-capture products, followed by software that permits integrating captured images into your applications. (Images pictured here were output via *Ventura Publisher* 3.0; screen density is 60 lines.)

Real-Time

ComputerEyes/RT
(8/16/24-bit color board), $600
Digital Vision, Inc.
270 Bridge St.
Dedham, MA 02026
617-329-5400
System Requirements: PC, XT, AT, 386 or 486; DOS 2.1 or later; eight-bit expansion slot; 640K base memory; composite NTSC video source; VGA color display.



ComputerEyes/RT is a ¾-length board that's crammed with components and RAM chips. Software supplied with the board is the evolved version of that supplied with the ComputerEyes B/W Digitizer covered later. In addition to offering the same pull-down menus, on-line help and self-explanatory prompts, the RT software also provides the unique (and handy) capability of previewing the live video source right on the VGA screen.

Due to resolution constraints, motion of the image (from a live or taped source, if any) is somewhat "strobed" but you can, nevertheless, get a good indication of exposure, framing and composition before instantaneously freezing the image and temporarily storing it to the board's RAM. Once frozen, you can transfer it to screen for further scrutiny, enhancement, modification and saving to disk. A full complement of enhance-

ment and manipulation functions is provided, along with your choice of numerous video mode selections.

Although the RT is indeed a real-time color capture board, it also does a marvelous job of capturing images in black-and-white as well with a 64-gray-shade palette. Additionally, you can choose 8-, 16- or 24-bit image captures in a variety of formats, including .PCX, .TIF, .TGA (Targa) and many more.

Jumper/address selection is accomplished via an eight-position DIP-switch arrangement. Video input can accommodate NTSC composite and S-VHS sources via phono-type and S-VHS jacks, both of which are located on the board's mounting bracket.

A few words are in order regarding the documentation supplied with the board. It's unquestionably the best supplied with any of the digitizers covered here (followed closely by the VideoLinx: Framegrabber). In addition to explaining virtually everything you could want to know about the board and software options, it also provides invaluable practical tips on how to acquire the best possible images for your intended applications, such as Xerox *Ventura Publisher* and Aldus *Pagemaker*, and it's all presented in a clear, easy-to-understand manner. Kudos to Digital Vision on a superb product in all respects.

While $599.95 suggested list price is a bit more than some users may want to spend, if you're interested in color-image captures and the ability to make super high-quality black-and-white captures, this is the board of choice. System requirements make it appealing even to XT users, unlike some of the other boards, which require huge amounts of RAM memory and/or separate video monitors to view the source video on. This board does more and does it better than other boards costing hundreds of dollars more, and it's my personal favorite for DTP applications.

While not covered here in this digitizer roundup, I should also mention that Digital Vision also has a lower-priced color capture board, the Computer Eyes Pro. But the Pro (which lists at $275) isn't a real-time device and requires several seconds to digitize an image.

Everex Vision 8 (eight-bit color board), $895
Vision Technologies
(Div. of Everex Systems Inc.)
48431 Milmont Dr.
Fremont, CA 94538
4150683-2900
System Requirements: PC, XT, AT, 386 or 486; DOS 2.0 or later; one eight-bit expansion slot; 512K base memory; analog monitor; 1M of EMS RAM for color frame grabbing; RGB or NTSC video source.

When I first opened the Vision 8 box, I was impressed by the densely-populated, full-length board it contained. I was somewhat surprised to find that the enclosed connecting cable had a nine-pin D-type connector on one end and BNC jacks at the other. Therefore, I suspected hook-up wasn't going to be a very straightforward matter, a suspicion that proved correct. The box also contained a user's manual and a single 5¼" floppy disk.

The BNC connectors are color-coded —red, green, blue, black and white—and are intended for connecting to discrete analog monitors that can accept individual RGB inputs. The green channel can be used to drive a composite color monitor or a black-and-white composite monitor in gray scales. The white connector provides a sync signal, while the black connector provides black-and-white signal information (this is only used with the Vision 8A, which is a monochrome version of the board). An additional cable (not included) is required to connect the Vision 8 to a camera or other video source.

Both the manual and the utility software supplied with the board are surprisingly very poor. While the manual goes into sufficient detail about setting jumpers and providing information about signal levels required and produced by the board and how to connect the video devices, it really falls short when it comes to covering the utility software. Several setup and diagnostic test programs on the disk are described in some detail. But the real meat—how to capture an image and save it to disk—isn't covered at all.

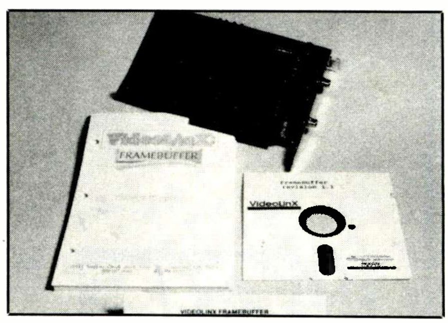
Through trial and error I found the appropriate "grab" programs (GRAB.EXE, GRABMONO.EXE, BWGRAB.EXE, SAVEPIC.EXE, LOADPIC.EXE), which provided a starting point. After extensive experimenting, I found that the GRAB.EXE program was the best one to use with my setup, and I proceeded to capture and save the image with the SAVEPIC.EXE program. To confirm I had an image, I reloaded it using LOADPIC.EXE and everything seemed okay, except that the native file type the Vision 8 saves to (AT&T Type 1) isn't mainstream by any stretch of the imagination. I decided it was time for a technical support call to Everex to find out if I was overlooking something.

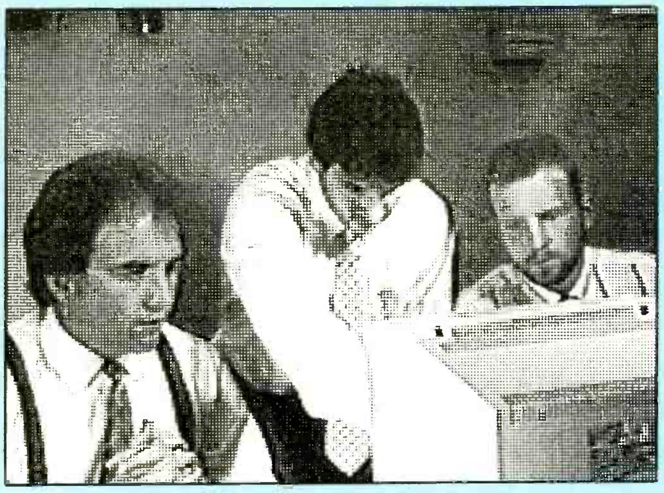
The tech-support department contact was quite surprised to find out that the Vision 8 used the AT&T graphic file format—seems he didn't know that! After about 18 minutes of long-distance call time from New Jersey to California (most of which was on hold while the support person conferred with his colleagues), it was decided that I needed the optional (extra-cost) *FreeStyle 8* paint software package to do anything really useful with the board to save images in .TGA (Targa) file format. Also included with *FreeStyle 8* is a utility (XFORM8.EXE) that converts from .TGA to .PCX, .TIF or .EPS (Encapsulated PostScript) file types and also permits altering image brightness and contrast prior to conversion.

If this seems like a lot to go through just to get a black-and-white image you can use in your DTP or other application, it is! And while the board will do a black-and-white image grab in 1/30 second, if you want to do a color capture it will take three passes (requiring a stationary image) and 1M of EMS to grab in color. To top it off, the quality of the captured image isn't anything remarkable (see accompanying actual output samples); so that's not even a saving grace for the Vision 8 board.

It wouldn't make sense to pay big bucks for this board, spend more money to purchase an additional cable and spend even more money for the *FreeStyle 8* paint program just to capture a video image in a usable format. There are plenty of less-expensive and easier-to-use products that will do as good or better a job.

VideoLinx: Framebuffer
(8/16/24-bit color board), $695
Brown Wagh Publishing
130-D Knowles Dr.
Los Gatos, CA 95030
408-378-3838
System Requirements: 286, 386 or 486; DOS 3.1 or later; eight-bit expansion slot; 640K base memory (1M recommended); 1M EMS RAM; CGA graphics (minimum); composite NTSC video source.

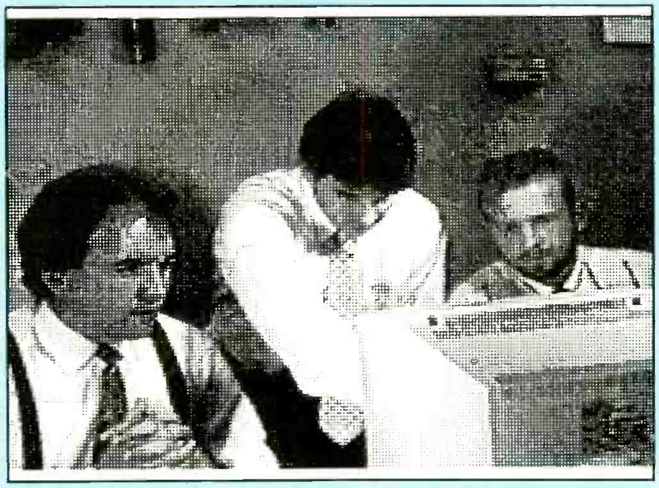




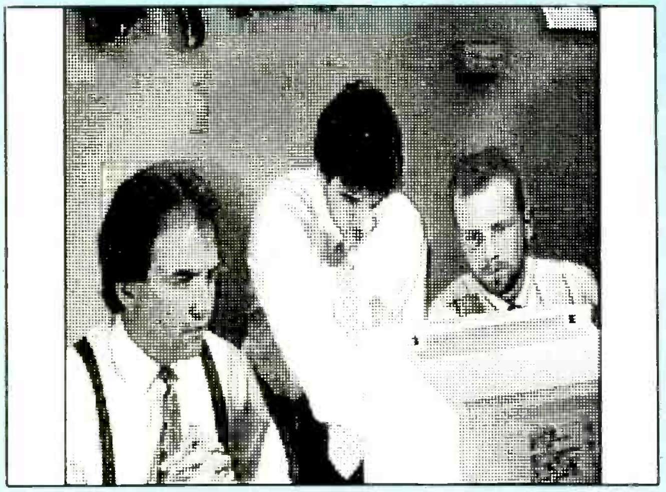
ComputerEyes/RT color frame grabber

ComputerEyes B/W PC digitizer

IDEC Supervision/8 frame grabber



Videolinx:Framegrabber.



Everex Vision 8 image-capture board

IDEC FrugalVision B/W external digitizer

These are actual output samples of the same video image captured with different boards. The video image was taken from video tape. It was recorded as a video still shot with a Panasonic PV-535 digital VHS camcorder. In all samples shown here, the respective image captures were stored as eight-bit black-and-white uncompressed TIFF files with solid grays. Print output was done using Xerox *Ventura Publisher* 3.0 and an Okidata OL840 PostScript laser printer. No enhancing or retouching was performed. All images appear as they were captured. Outline boxes around the images illustrate how aspect ratios, which determine height/width radios, vary from digitizer to digitizer. Solid black bands at the bottoms of both IDEC captures are the result of using the "square aspect ratio" option during capture to negate the elongated effect illustrated in the Everex sample (the Everex software doesn't provide a correction option for alleviating this effect).

VideoLinx: Framebuffer packs an amazing number of ICs, RAM chips and other components on a ¾-length card that mounts in a "short" slot of any AT or higher-class PC. This particular board, while being a true real-time frame grabber, does much more, which explains why minimum system requirements are so hefty. In addition to capturing a video image, it also permits manipulation of the image and output to NTSC video.

The 75-page user's manual supplied with the board is excellent in its completeness and organization, as well as providing a wealth of background. Topics like interlace, color, sync, genlocks, timebase correction, overscan and more are explained in understandable terms so a user can comprehend what's involved in taking a composite video signal, digitizing it for computer manipulation and then returning it to composite form again for display or recording on an NTSC device.

Any required changes to the address settings are accomplished via jumpers on the board, although the default settings will work just fine in most instances. Installation is quick. When completed, you use two phono-type jacks that are accessible from the rear of the PC: one for composite video-in and the other for composite video-out. Connecting a composite monitor to the video-out port permits monitoring the image while the video source is running or monitoring it while "frozen" in RAM. While an actual capture is taking place, however, the video screen blanks.

To take full advantage of this board, it's desirable to have a VGA card with at least 256K of video RAM and a good VGA color monitor (a 1M high-resolution VGA board is even better), although for B&W image captures you don't need this heavy artillery.

Several utilities are provided on the software diskette, in addition to the main program, FBMENU.EXE, which is the control center for the board. Various tests and diagnostic/color-bar displays are also invoked from this main menu program, which provides other useful information on current system status, video mode, date, time and so forth. The File sub-menu permits importing and exporting images, in addition to loading and saving those captured with the FrameBuffer itself. Particularly rich in the file types it supports, Targa files (.TGA) can be saved to disk in 8-, 16- or 24-bit format, .TIF files in 8- or 24-bit format and 8-bit .PCX files.

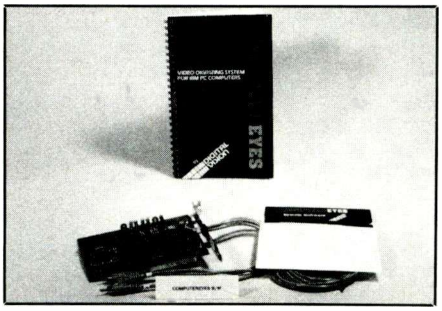
Additional file support includes .ORGB (a trio of 746 × 484 RGB files, each representing the red, green and blue phases of a color capture), .OBW (746 × 484 eight-bit B&W file), and .01 (compact ".0" and ".1" format files). Special drivers and utilities are also included to handle AutoDesk's *3D Studio, AutoShade* and *RenderMan*.

An Options submenu permits altering the size of the image for export to those formats that permit variation (.PCX, .TIF, .TGA). Aspect ratio, black level and image-flicker can also be adjusted or controlled from this menu, as well as additional functions like reserved colors for genlocking and overlaying captured images on a video (similar to "chroma keying").

If all you want to do is capture real-time images for use in other applications, this board may be "overkill" for you, since it carries a steep price tag and requires lots of muscle in the PC to run it. However, if you're interested in producing multimedia or output of computer-generated as well as captured images to NTSC video, this board is an excellent way to go.

Non-Real-Time

ComputerEyes Digitizer (eight-bit B&W board), $250
Digital Vision, Inc.
270 Bridge St.
Dedham, MA 02026
617-329-5400
System Requirements: PC, XT, AT, 386 or 486; DOS 2.1 or later; eight-bit expansion slot; 384K base memory; composite NTSC video source.



An "oldie but goodie," the ComputerEyes B/W Video Digitizer has been around for quite a few years. It was one of the first video-digitizer boards available for IBM-compatible PCs. A lightly populated half-size board that uses an eight-position DIP switch for address setting, it installs easily and configures in a snap. While this is the lowest-price internal digitizer board covered here, it has trade-offs, as might be expected. For example, it's slow. Acquiring an image takes 6 seconds in Fast mode and 12 seconds in Normal mode. Therefore, real-time captures are out of the question.

If you're using a video source that can provide a stable still image, such as with a digital still camera or freeze-frame with a digital camcorder ("paused" videotape images aren't good sources), this won't be a problem. However, getting live subjects to stay perfectly still for 6 seconds may not always be possible.

Rather than bracket-mounted jacks, the ComputerEyes B/W Digitizer has three phono-type jacks attached to 3-foot lengths of shielded cable that emanate from a rubber-grommeted hole in the board's bracket. One cable is fitted with a female phono jack that bears a "V" label that designates it as the video-in terminal for connection with the video source. The other two cables each terminate in phono plugs and are labeled "C" and "M." "C" permits connection to a composite color video monitor to view the video source, while "M" serves to connect a composite monochrome monitor.

The ComputerEyes capture software supplied with the board is menu-driven and very easy to use, with on-line help available at all times. If you need additional clarification or want more information on any of the controls, settings or options, the user's manual supplied is also top-notch.

In addition to providing numerous graphics modes for Hercules, CGA, EGA and VGA, several subset choices for each are also available, such as high contrast, dithered intensity levels, solid intensity levels and false color. Scan speed and capture phases can also be altered to provide additional flexibility, and changing modes, speed or phases is a simple matter of highlighting a desired choice from the appropriate menu and hitting Enter to lock it in. The configuration is automatically updated to reflect any changes made in preferences so they'll be reinstated at the same levels when you use the board in the future.

The software permits captured image data to be saved in "raw" format, as well as in CE, PIC and SS screen formats, which can be reloaded and further manipulated with the ComputerEyes software itself or with such other products as *Fantasy* and *Splash!*. You can also save captured images in .PIC, .TIF, .MSP (MicroSoft Paint), .PCX and .IMG (GEM applications) formats for use as desired.

While not a "real-time" capture board, the ComputerEyes B/W Video Digitizer is an economical, versatile and dependable unit. It has lots of flexibility in its capture and enhancement options, it's easy to use and it delivers good results. But like all non-real-time devices, it is slow.

IDEC Supervision/8 Image Grabber (eight-bit B&W board), $270
IDEC, Inc.
1195 Doylestown Pike

(continued on page 82)

MICRO-TECH USA

1-206-235-4345

America's largest PD/Shareware Distributor

Currently over 200,000 programs available and growing! Order our 200+ page catalog for just $7.95.
Limited offer: 4 free disks of your choice. 100% guaranteed high quality and virus free.

PRINTING

☐ **Typesetter PC**
Great desktop publishing program. Mix graphics, test fonts. Requires 512K, 9 pin printer

☐ **Form Master:**
Create your own business forms and legal form's. Rated best form program.

☐ **Letter Heads Plus**
Design and print custom letterhead, envelopes and labels.

WORD PROCESSING

☐ **PC Write 3.03**
Top rated program with spell checker. A must for the writer.

☐ **Intext**
New word processing in 7 European languages.

☐ **Hyper-world (4 disks)**
New hyper text word processor and free form database with appointment calendar.

GRAPHICS

☐ **PC-Key draw**
Powerful CAD design system. (4 disks)

☐ **Dancad 3D** (2 disks)
The best there is for 3D wireframe with all conceivable options.

☐ **Printmaster Graphics Library #4**
New 400 great graphics.

☐ **Printshop Graphics Library #3 and #4**
2 disks. Over 600 graphics. All new.

☐ **Charts unlimited**
A design tool for creating any kind of chart.

WINDOWS

☐ **Icons**
Over 250 icons to be used with Windows 3.0

☐ **Unicom**
At last a super communications program for Windows. Supports X, Y, and Z modem protocols among others.

☐ **Window Press**
Great form maker for Windows 3.0 or with different fonts, lines, arcs, circles, pies, bars, etc. Precision to 1/10 mm. Source code included.

WORD PERFECT 5.0/5.1

☐ **PC - Draft III** (2 disks)
☐ **WP - Arts/Graphics** (2 disks)
☐ **WP - Learning System** (2 disks)
☐ **WP - Macros** (2 disks)
☐ **WP - Menu-mice** (2 disks)
☐ **WP - Tools** (2 disks)

BUSINESS/ACCOUNTING

☐ **PC Payroll**
A complete menu-driven payroll system (2 disks)

☐ **PC Loans**
Keep track of those nasty loans

☐ **Year Planner**
A super calendar and organizer program

☐ **Employee Management System 4.0**
Highly accurate personality/position analysis

☐ **PC Yellow Pages (5 disks)**
One of the most effective marketing tools I've seen. Address merge, labels, fax mail, built in database registered version comes complete with data for your own area (HD required)

DATA BASE

☐ **Wampum**
An excellent d-base compatible package.

☐ **PC File 5.0 (3 disks)**
Jim Button's best. PC mag editors choice (Req 3.0 DOS or up)

SPREAD SHEETS

☐ **123 Power Worksheets (2 disks)**
Powerful worksheets for Lotus 1-2-3.

☐ **Lotus Templates**
Some ready-made templates. Don't spend hundreds and miss this one. It's a bargain for sure.

UTILITIES

☐ **HD Backup**
An easy to use program for backing up your hard drive

☐ **Quick Cache** (2 disks)
This one will speed up your computer big time.

☐ **Virus Killers**
Several virus programs on one disk. Why buy them separate?

☐ **Back & Forth**
New load up to 20 programs at once. You won't believe it until you see it. Order this one now! (HD required)

GAMES

☐ **PC Risk**
You played it on a board. Now play it on a computer. Same as the board game, but a lot less.

☐ **3D Chess**
This one is good. You can even ask the computer for help.

☐ **Striker**
Fly your copter through enemy fire. Arcade quality game.

☐ **PC Rail Road**
A must for model train buffs. Control your trains on increasingly complex layouts but don't worry. An automatic collision avoidance system is built in. It took a few minutes to evaluate this one and hours to turn it off!

☐ **Megapoly**
You have inherited $100.000. Your challenge is to become rich in 20 years. Very good game.

☐ **Dominate**
A computer wargame. Better and more sophisticated and involved than Risk.

We have the best in games for mono, CGA, VGA, and Super VGA.

PRICE BREAK

1-9	$2.50 ea.	10-19	$2.00 ea.
20-49	$1.50 ea.	50-99	$1.00 ea.
Over 100	$0.89 ea.		

All new selections's with updates every month. Select 4 free disks with purchase of catalog.
Important: For multi-disk sets, count all disks in a set.

Please specify ☐ 5.25" ☐ 3.5" (add $1.00 each)

Name ______________________

Address ______________________

City/State/Zip ______________________ Ph ( ) __________

VISA/MC # ______________________ Exp. Date __________

Signature ______________________

Disks Ordered ______ x $______ = $ ______
For a catalogue, add $7.95 $ ______
For 3.5" disks, add $1.00 each $ ______
Shipping and Handling $ 4.00
Foreign Shipping, add $6.00 $ ______
Washington State Residents add 8.2% sales tax $ ______
Total $ ______

Method of payment
☐ check ☐ money order ☐ VISA/Mastercard

MICRO-TECH USA
P.O. Box 59403, Renton, WA 98058-0403

CIRCLE NO. 151 ON FREE INFORMATION CARD

HOW TO GET A FREE $2,499 NOTEBOOK COMPUTER

Dear Reader:

We know that most of you rely on ComputerCraft to provide you with meaningful information every month on PC and microcontroller hardware and software. To help us meet your wants even better, we'd appreciate it if you would answer the questions posed on the card opposite this page. *Doing so will make you eligible for our drawing for a free Tandy Notebook Computer!*

As you know, notebook computers have taken the country by storm. Their light weight, small size, and battery/ac power provisions make them exceptionally versatile for both on-the-road and on-the-desk use.

The Prize Winner Will Get a Tandy 80286 Model 2810 HD Computer

that weights only 6.7 lbs. It comes with a 20 MB 23-ms hard disk drive and a 3½" 1.44MB floppy disk drive, 1MB of RAM expandable to 5MB, a full-size 84-key keyboard, and a high-resolution VGA fluorescent-backlit LCD screen.

This remarkably small (1.7" H × 12.2" W ×10" D), though very powerful machine comes with an ac adapter/charger, DB-25 parallel and DB-9 serial ports, the TEMM memory manager, MSDOS 4.01 and DeskMate 3 Version 3.5 productivity software already installed on the hard disk. The latter consists of word processing, worksheet financial analysis, address book, a filer, calendar, alarm, telecommunications, a drawing program and PC-Link® online information service programs. Additionally, DeskMate's Graphical User Interface lets you organize your programs and activate them by point-and-click means.

It's rechargeable Ni-Cd battery life is up to 3½ hours, with quick charge in just two hours, while power management provisions maximize battery life during all phases of operation. Furthermore, a user-controlled Suspend mode allows you to set a time for the system to shut down completely.

The speedy (16-MHz 80C286 microprocessor) machine has a host of optional accessories, too, including a 2400-bps internal modem, memory upgrade boards, 287XLT math coprocessor, carrying cases, and a power/auto adapter. You can also plug in your external color video monitor while at a desk to get full-screen 640 ×480 color graphics.

And the Tandy 2810 HD includes some niceties such as FCC Class-B certification, a "Power View" LED battery-status system located on top of the case for viewing at all times without lifting the display, and a Resume mode to return you to the exact place you left in an application.

Just fill out the Reader Poll card at the right to put yourself into the running for this terrific prize. We appreciate your assistance. Thanks.

Sincerely,

Art Salsberg
Editor/Associate Publisher

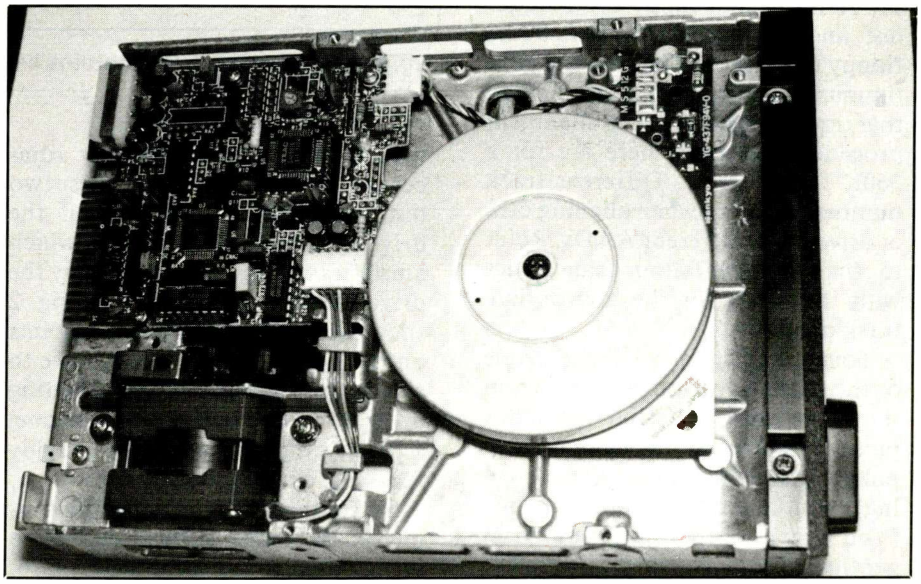
P.S. **Questionnaires must be postmarked no later than December 16, 1991 to be entered in the prize drawing.** CQ Communications, Inc. employees or relatives are not eligible. The winner will be drawn by a random method and notified before Christmas.

Aligning PC Floppy-Disk Drives

Some things you should know how to do to keep your PC drives performing in top physical form

Floppy-disk drives in PCs are electromechanical devices. As such, they're subject to becoming misaligned over a period of time. Misalignment can manifest itself in several ways. For example, you might note that programs, data and work files on floppies may load erratically or not at all, a floppy formatted on the drive in another computer may fail to be recognized in your computer, etc. If you've been experiencing such problems and have determined that your drive needs to be aligned, or you just want to check alignment yourself, you need a few tools and a couple of special diskettes to prepare for the alignment procedure.

The basic tools you need include a medium regular screwdriver, medium phillips screwdriver and basic dual-channel oscilloscope with external trigger. One channel of the scope must have the capability of being inverted. On diskette, you must have a program that will turn on the floppy-disk drive and allow you to select heads and seek to the different tracks. You also need an analog alignment diskette. Dysan's *Interrogator* provides track-selection routines. A shareware program that does basically the same thing, *Drive Tester* by John L. Dickinson, is also available on some BBSs. Dysan offers a number of AADs for various drives. Some popular ones are: Part No. 800180 (Model 224/2A) for 5¼", 360K drives; Part No. 810251 (Model 206-34) for 5¼", 1.2M drives; and Part No. 810234 (Model 350/2A) for 3½", 720K and 1.44M drives.



Alignment Procedure

To gain physical access to your floppy-disk drive, power down your computer and remove its cover. This will expose the computer's chassis so that you can remove the floppy-disk drive from its bay. On an XT system, this will involve removing two screws on one side of the drive. On an AT system this, involves removing two screws at the front of the drive and sliding the drive on its slide rails out of the bay.

Before removing the drive completely from its bay, disconnect the four-conductor cable that comes from the power supply and the 34-pin conductor cable coming from the drive controller (see Fig. 1). When disconnecting the latter cable, note the orientation of the color stripe on the cable so that when you restore the drive to its bay you can plug the cable into it in the proper orientation. There's no need to make a note of the orientation of the power cable because the connector on it can plug into the connector on the drive in only one direction.

With the drive removed from the computer, place it on-edge on the computer's power supply, drive-bay housing or other location. Position it close enough to permit the drive to be reconnected to its cables and operated with the bottom of it completely accessible.

Reconnect the power and controller cables to the drive. If the power cable can't reach the drive, use a Y-type power adapter cable that converts one power cable to extend to extend the existing cable. Y-type cables are available at most computer-supply stores.

Most floppy-disk drives include test points (small wires that stick up from the circuit board) for diagnostic and alignment purposes. These are often labeled TP*x* (where *x* is the test-point number). Ideally, you should have a manual that describes where the various test points are on your particular floppy-disk drive. If you don't have a manual, you'll have to probe around until you find the signals you need.

First, find one or more ground points on the drive to which you can clip your scope's ground leads, such as screws on the drive, which are generally grounded. Set your scope for a sweep rate of 1 ms/div and Channel 1 for a dc-coupled vertical deflection of 1 V/div. Also set the scope for normal Channel 1 triggering.

Turn on your computer and run your track-selection program. Insert the AAD in the floppy drive under test, and seek to track 16, head 0 (the floppy drive should be running continuously at this point). Keep in mind that track numbers for the alignment procedure described here are for a 360K floppy drive. Different track numbers are used when aligning other drives with different AADs. Refer to the documentation that comes with the AAD for the appropriate track numbers.

Touch the Channel 1 signal probe of the scope to various test points on the drive until you find the index pulse. This is usually a positive-going pulse (it's sometimes negative-going), with a width of about 3.5 ms. (You may have to adjust scope trigger threshold level to get the signal to appear in normal triggering mode.) The leading edge of the signal should be at the left edge of your scope's screen graticule.

Changing the sweep rate to 20 ms/div should display two pulses that are approximately 200 ms apart. Point A on Fig. 2 shows the location of the index-pulse test point on my Teac Model FD-55BV-06-U 360K 5¼" floppy drive.

Leaving the Channel 1 probe connected to the index-pulse test point, connect the external-trigger probe to the same test point. Switch the scope trigger from the external trigger input and adjust the scope's trigger level until the index pulses are again (or still) visible on the display.

Remove the Channel 1 probe from the index-pulse test point. Set Channel 1 for an ac-coupled input at 50 mV/div, leaving the sweep rate at 20 ms/div. Move the Channel 1 probe to other test points until a signal pattern like that shown in Fig. 3(A) appears.

Making a note of the location of this test point, find another test point with a similar signal (usually adjacent to the first test point). These two test points are the outputs of the drive's differential amplifier, which amplifies the signal picked up by the drive's read head. Points B in Fig. 2 show the locations of these test points on my Teac drive. You may have to adjust the vertical-deflection setting up or down one position on Channel 1 to get a signal level that's roughly full-scale on the scope screen.

Set Channel 2 for an ac-coupled input at the same vertical-deflection setting as that for Channel 1. Also, activate the Channel 2 "invert" mode and select the "add" display option to combine the Channel 1 and inverted Channel 2 input signals into a single (differential) signal on the scope's screen.

Connect the Channel 1 probe to one of the drive's amplifier test points and the Channel 2 probe to the other. The "cat's-eye" pattern shown in Fig. 3(A) should appear on your scope display. Again, you may have to adjust the vertical-deflection levels of the two scope inputs up or down one setting to maintain a roughly full-scale signal that doesn't exceed the screen display area. Make sure the Channels 1 and 2 vertical-deflection settings are kept the same.

Use the displayed pattern to determine your drive's radial alignment. When the two lobes of the pattern have equal (or near-equal) vertical amplitude, the heads are perfectly aligned, as shown in Fig. 3(A). If the left lobe is smaller than the right, the drive heads are misaligned toward

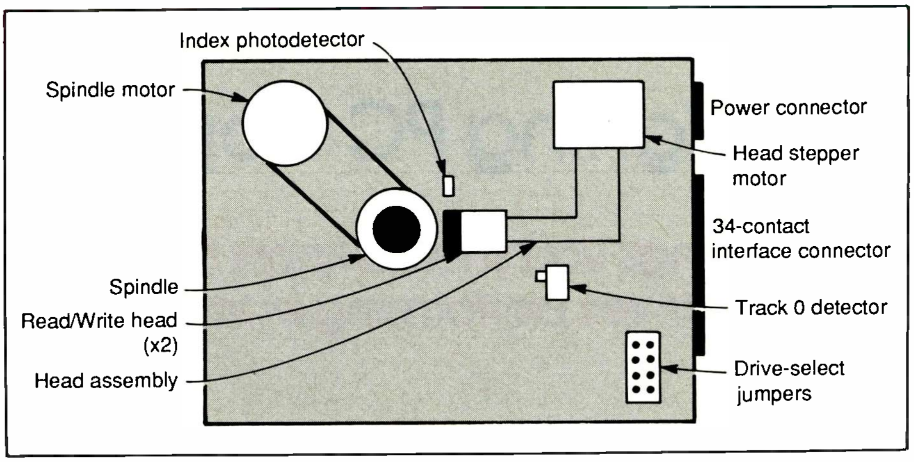


Fig. 1. A floppy-disk drive contains several major components, as detailed here.

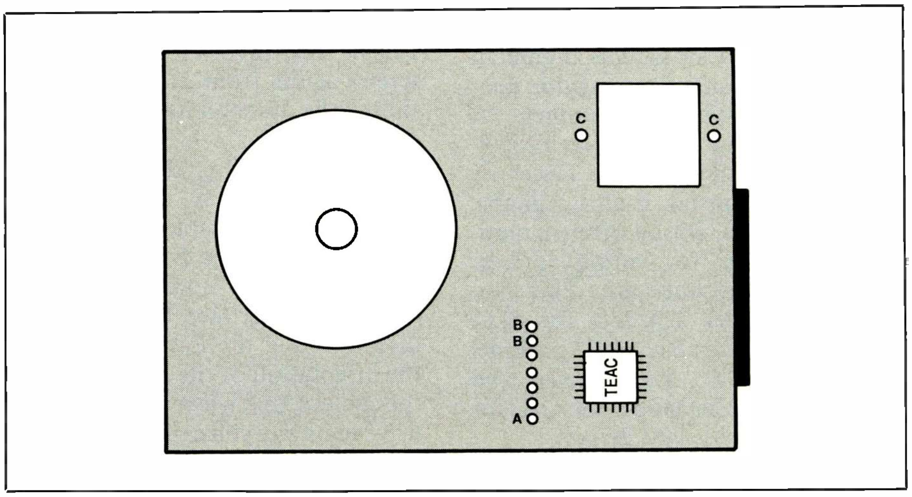


Fig. 2. Bottom view of the Teac floppy-disk drive used for alignment in text. Key test points and adjustment screws include (A) index pulse test point; (B) differential-amplifier test points; and (C) stepper-motor adjustment screws for correcting radial alignment problems.

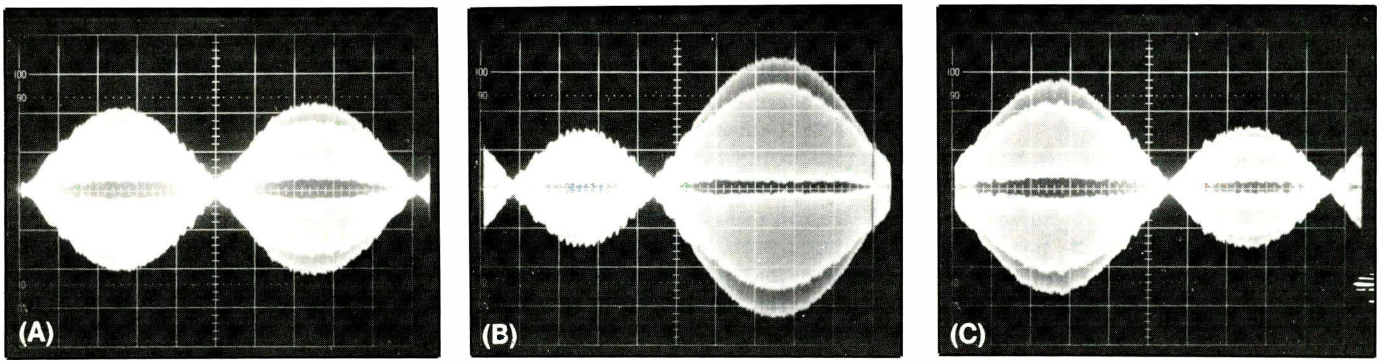


Fig. 3. Oscilloscope displays for: (A) perfectly aligned heads; (B) heads misaligned toward Track 15; and (C) heads misaligned toward Track 17.

track 15, as illustrated in Fig. 3(B). If the right lobe is smaller, the drive heads are misaligned toward track 17, as in Fig. 3(C).

After looking at the pattern for head 0, select head 1 and observe the pattern for it. Since both heads are part of the same head assembly, they must be aligned together. It's sometimes difficult to get the displayed pattern for both heads exactly perfect. To be considered within an acceptable tolerance, the vertical amplitude of the smaller lobe must be at least 70% of the amplitude of the larger lobe. This must be true of the pattern for each of the two drive heads. If this isn't the case, adjust the heads obtain better radial alignment.

To adjust the radial alignment of the drive's heads, slightly loosen the positioning screws on the stepper motor (points C in Fig. 2). Rotate the motor slightly until the signal pattern is correct on the scope screen, within tolerance for both heads. Tighten the screws, making sure the test pattern doesn't change in the process.

When the displayed pattern is correct for both drive heads, seek to track 10 and then back to track 16 to ascertain that alignment is still good. Similarly, seek to track 26 and then back to track 16, once again verifying proper radial alignment. If radial alignment is still off, repeat the adjustment procedure.

If you consistently obtain a noticeably different test pattern, depending on whether you reached track 16 from track 10 or from track 26, you have a stepper hysteresis problem. This can be caused by loose stepper motor positioning screws (make sure they're tight). However, it's more often caused by a defective stepper motor. If the problem is substantial, this would generally be cause for replacing the drive.

With radial alignment done, check azimuth alignment (the extent to which the heads are rotated clockwise or counterclockwise from parallel with the track). Select head 0 and seek to track 34. Set sweep rate to 1 ms/div, and adjust vertical deflection down one setting if required to keep the test pattern from spilling off the scope screen.

A very narrow index pulse, followed by three sets of azimuth test signals should appear on the scope screen, as in Fig. 4(A). From left to right, these are the 12-, 15- and 18-minute azimuth-test burst sets (there are 60 minutes in one degree of rotation).

The Fig. 4(A) test pattern is for a well-aligned drive. The center bars of each burst set should be about the same amplitude and larger than the outer bars of the burst set, which should also be about the same amplitude. If this is the case for all three of the test bursts, the heads show no azimuth rotation and are properly aligned. Be sure you check the azimuth test pattern for head 1 as well.

If the test bursts aren't perfect like those in Fig. 4(A), you can determine the approximate extent of head rotation from the test pattern. Most likely, one test burst will have either its two left bars or its two right bars at

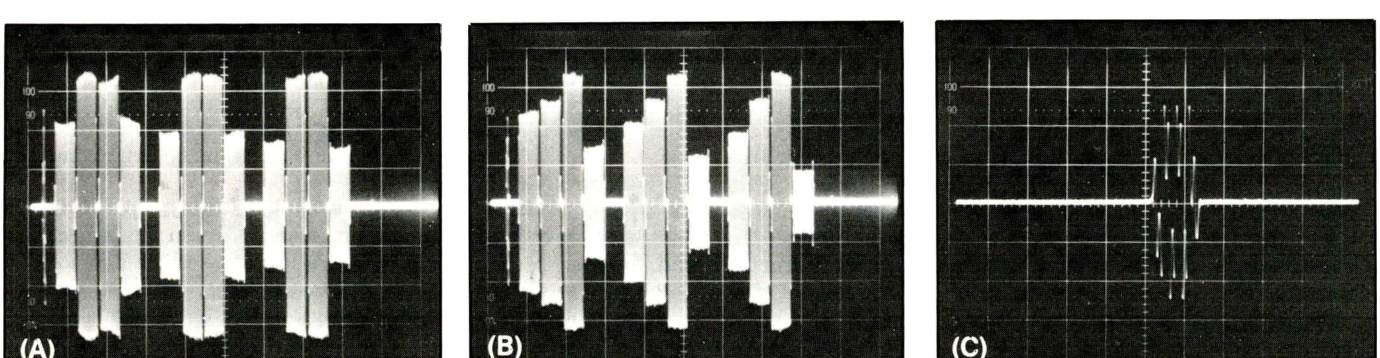


Fig. 4. Azimuth test patterns show: (A) well-aligned drive with no head rotation; (B) drive with a slight head rotation, approaching – 12 minutes; and (C) index timing test pulse signal.

about the same amplitude (or approaching the same amplitude). Which of the three test burst sets exhibiting this pattern determines the extent of head rotation. If the 12-minute burst set shows this pattern, the head is rotated about 12 minutes, if the 15-minute burst set shows this pattern, the head is rotated about 15 minutes, etc..

If the two equal-sized bars are on the left side of the burst set, the head exhibits a negative (clockwise) rotation. Otherwise, it's exhibiting a positive rotation. Fig. 4(B) shows the azimuth test pattern for a head approaching an azimuth rotation of – 12 minutes, since the left two bars of the 12-minute test burst set are approaching the same size but aren't quite there.

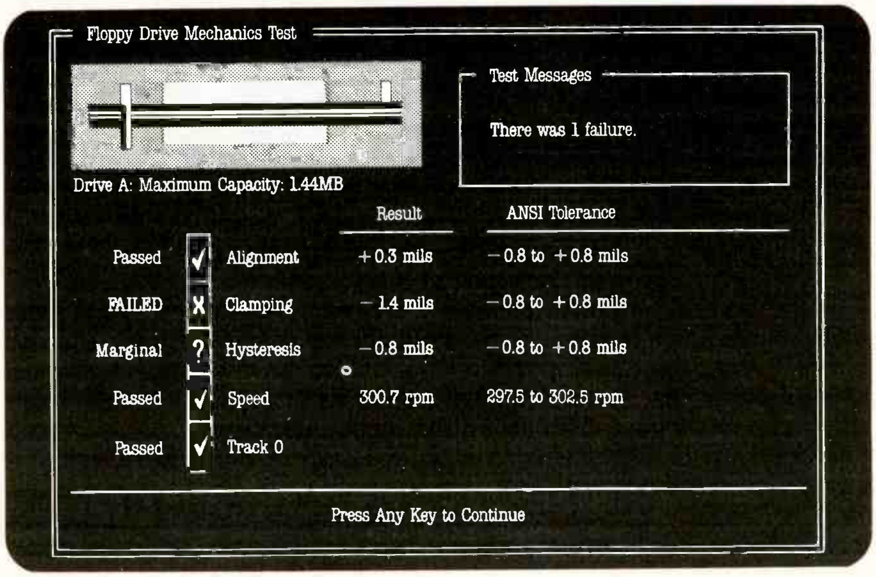
Different manufacturers specify different limits for acceptable drive azimuth rotation. Most consider up to 18 minutes of rotation acceptable, although I prefer to use 15 minutes maximum as a general rule. Having aligned many drives, I rarely see a head with an azimuth rotation of more than about 12 minutes. The adjustment to correct an azimuth rotation problem is difficult to perform and is best left to a trained technician. There are generally two screws on each drive head for making this adjustment.

The final test to be performed is to check the index/sector photodetector timing. This verifies the timing between the time the drive's optical sensor detects the index hole in the rotating disc and the time a special index signal is found on the AAD.

Keeping the heads at track 34, set scope sweep rate to 50 μs/div. You should see an index test pulse displayed, with a width of about 50 microseconds. Assuming your scope's trigger point is the left edge of the graticule, the leading edge of the index test pulse should be between 100

Commercial Test Software Packages

In addition to Dysan's *Interrogator* floppy-disk drive alignment software examined in the main article, there are a bevy of other similar packages available. They include Accurite Technology's *Drive Probe*, DiagSoft's *QA-Floppy*, Landmark/SuperSoft's *Align-it* and Touchstone Technology's *Check It Floppy Drive Alignment System*. Each offers advanced utilities that can be used to check out and maintain optimum performance of 3½" and 5¼" floppy-disk drives in 360K to 1.44M capacities for IBM PC series and compatible computers.



Drive Probe's comprehensive diagnostic package can be used to monitor drive integrity and to inspect, repair, align, debug and evaluate a drive, with no need for additional test equipment. A user can run an automatic sequence of drive alignment tests for a quick report on a drive's status. Tests can also be run individually to provide a real-time display of results for easy drive adjustment. *Disk Probe* also has the ability to test high-speed 600-rpm drives used for volume duplication and supports Mountain Computer protocol and Ventuno autoloaders through a PC's serial port.

Self-booting *QAFloppy* provides extensive floppy-disk testing and analysis and a fast, precise means of diagnosing and aligning floppy drives, often without requiring system assembly. It gives a user the option of displaying numerical data or printing out a hard copy of test results.

Alignit is a disk-drive cleaning system, as well as a diagnostic and alignment system. It includes a "Gold Standard" feature that lets a user align the drives in all computers on the same site to the same in-house standard. In addition to the usual different-size and different-density test/alignment diskettes, this package includes pre-lubricated cleaning diskettes that are good for 180 cleanings each. Alignments are performed to within 0.3 mm according to ANSI standards.

Check It Floppy Drive Testing System offers automatic drive-type selection. It features a message window that gives instructions and reports on the number of errors discovered; a quick-indicating Checklist that reports on whether the components of a disk drive passed or failed each test; and test results displayed in tolerances within 0.1 mm according to ANSI specifications for drive alignment.

Disk Probe and *QAFloppy* include Dysan's High-Resolution Diagnostics (HRD). *Check It Floppy Drive Testing System* provides an exclusive Mini-Spiral™ alignment disk from ASKY, Inc. that provides an absolute reference point to compare against a drive's current condition.

Tests available in these packages include: spindle motor speed, diskette eccentricity, radial head alignment, azimuth head alignment, index to data timing, positioner hysteresis and effective head width. *Check It* also includes a Clamping test that determines if a drive clamping mechanism is defective.

Products Mentioned

Disk Probe
Accurite Technologies Inc.
321 Charcot Ave.
San Jose, CA 95131-1107
408-433-1980

QAFloppy
DiagSoft, Inc.
5615 Scotts Valley Dr. No. 140
Scotts Valley, CA 95066
408-438-8247

Interrogator
Dysan
218 Railroad Ave.
Milpitas, CA 95036
408-945-3930

Alignit
Landmark/SuperSoft
703 Grand Central St.
Clearwater, FL 34616
800-683-6866 or 813-443-1331

Check It Floppy Drive Testing System
Touchstone Software Corp.
2130 Main St., Ste. 250
Huntington Beach, CA 92648
714-969-7700

and 300 μs from the trigger point (between two and six horizontal divisions on the scope display). Verify this for head 1, too.

If the pulse isn't within this range, you must adjust the position of the index photodetector. Most drives have one or two screws that hold the photodetector assembly in place. These must be loosened slightly to permit the photodetector assembly to be moved until the index test pulse is within the specified limits for both heads. (*Caution:* a small movement of the photodetector can result in a huge movement of the signal on your scope screen.) Once this is achieved, tighten the screws and confirm again that the timing is still within specs for both heads.

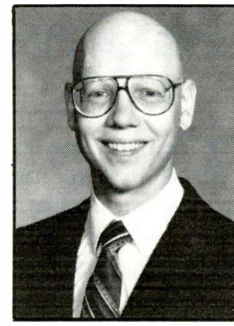
One some floppy drives, like my Teac, the position of the circuit board with the LED for the index photodetector must be adjusted instead of adjusting the position of the photodetector itself. In such cases, slightly loosen the two screws that hold the LED circuit board, and adjust board positioning until the index test pulse on the scope screen is within specs for both heads. This done, tighten the screws and once again confirm proper index pulse timing.

The alignment check and adjustment procedure is now complete. You may want to run through all alignment checks one more time to make sure everything still looks good. If so, you can exit the track-selection program, remove the AAD and power-down your computer. Reinstall your aligned floppy drive by reversing the procedure described above for removing the drive.

In Closing

With the proper equipment, you can easily align your own floppy-disk drives. Regular checkups and maintenance will keep you and your floppies happy.

One final word: Floppy drives are now available for as little as $50. If you find that your drive has major problems that can't be fixed by the procedures outlined here, it's generally better and less costly to replace the drive than to have it serviced at a computer service center. ■



Roger Alford

Build a Data Transceiver System

Allows two computers separated by long distances to transmit and receive data over cables at up to 9,600-baud

Transferring data between a personal computer and a remote information service or BBS is a common computer activity today. A modem is the way to go for applications like these, but modems aren't suitable or even the best approach in some applications. Two computers (or a computer and another device like a terminal) can be interconnected via their serial ports, using a null modem if necessary, provided the communicating distance doesn't exceed a few tens of feet.

When the distance is too great for direct RS-232 interconnection, a transceiver is needed. In this article, we provide plans for building a data transceiver system that permits data to be transferred between any two devices equipped with serial I/O ports. Transmission rate can be up to 9,600 baud and possibly greater under ideal conditions.

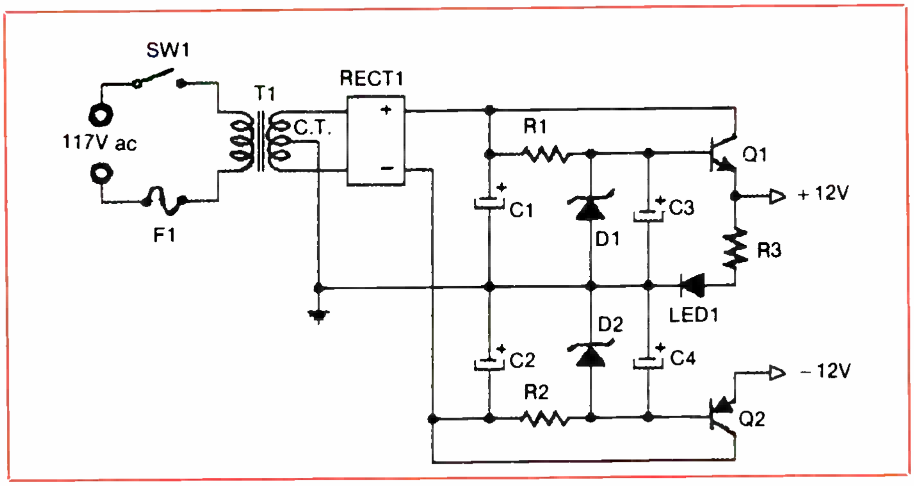


Fig. 1. Schematic diagram of power-supply portion of transceiver's circuitry.

Some Background

A modem link works by generating carrier signals at frequencies selected to permit full-duplex (two-way) data transfer over the standard telephone network. In such a system, a fixed-frequency carrier signal is modulated with other signals that represent the presence of logic 0 and 1 bits that computers and other digital devices require to communicate. At high baud rates, the needed circuitry is very sophisticated.

Slow- and medium-speed modems are less sophisticated than high-speed ones, making them less expensive to manufacture. Because 9,600-baud modems use very complex circuitry, they're also quite expensive. Our data transceiver permits two digital devices to be interconnected via a cable when communicating distance is significantly greater than the allowable limit for RS-232 use. It uses radio-frequency (r-f) carrier signals as the interconnecting medium. These signals are sent over a three-conductor 75-ohm coaxial cable or ordinary twisted-pair cables. Cable length can be hundreds or even thousands of feet, depending on their quality. Ideally, a pair of coaxial cables would be used to obtain maximum communicating distance.

Full-duplex data transfer requires use of two different carrier frequencies, which must be high enough to ensure that the full bandwidth is available. Our data transceivers use nominal carrier frequencies of 160 and 226 kHz. These are high enough for transmission at 9,600 baud but not high enough that they can be transmitted long distances without undergoing significant loss over ordinary three-conductor coaxial or twisted-pair cable. They also obviate the need for overly sophisticated electronics.

Note that 226 is 160 times the square root of 2. Therefore, using the formula for the resonant frequency of an LC circuit, you can calculate that a 226-kHz signal frequency requires half the capacitance of a 160-kHz frequency with the same value of inductance.

Modulation of the carrier signal consists simply of switching on and off the carrier to simulate the required logic states. Carrier presence indicates a logic 1, while its absence represents a logic 0. With asynchronous data transfer, the carrier is always present except when sending a start bit or 0 bit.

In theory, the receiver is very simple. It detects presences and absences of the carrier from the originating transceiver and converts the result to dc voltages that conform to the RS-232 standard (−12 volts indicates a logic 1 and +12 volts a logic 0). Absence of a carrier for an interval longer than about 40 milliseconds, which is longer than the interval to transfer a null byte at 300 baud, is interpreted as loss of carrier.

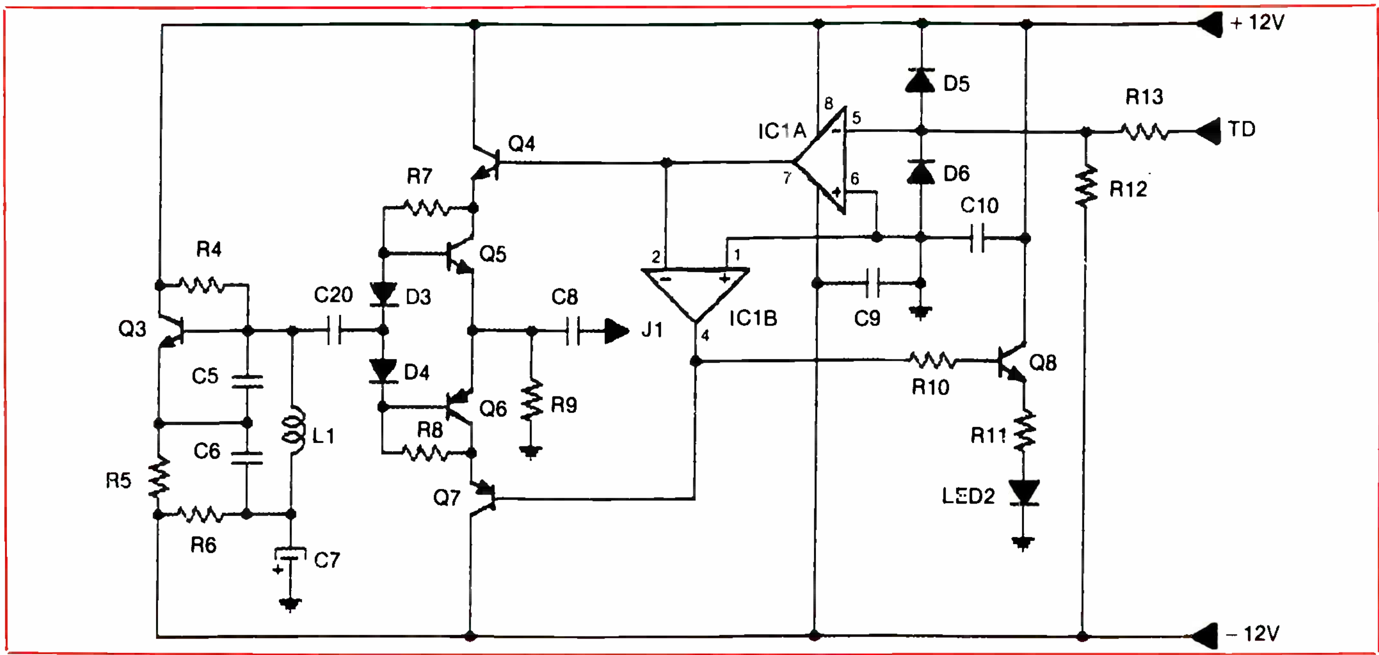


Fig. 2. Schematic diagram of transmitter portion of transceiver's circuitry.

The simplicity of this method of data transfer makes these units much more versatile than modems. Baud rate is irrelevant if it isn't too high. In fact, pulses of almost any duration can be transferred, making it possible to connect almost any type of pulse generator to a remote device that, in turn, interprets the meaning of the pulses.

As an example of the above, the output from an A/D (analog-to-digital) converter that generates a pulse whose duration is a measure of the input voltage level could be sent to a computer or other device, and the converter could be triggered to sample the input by a signal sent to it. The only caveat is that pulse duration must be significantly greater than the period of the carrier signal.

About the Circuit

Each data transceiver contains three major circuits: power supply, transmitter and receiver, shown schematically in Fig. 1, Fig. 2 and Fig. 3.

The Fig. 1 power supply provides regulated sources of +12 volts and −12 volts. The raw supply is provided by center-tapped transformer *T1* and full-wave rectifier *RECT1* with filter capacitors *C1* and *C2*.

The regulators consist of transistors *Q1* in the +12-volt line and *Q2* in the −12-volt line. The base voltages of *Q1* and *Q2* are held constant by 12.2-volt zener diodes *D1* and *D2*, which hold the respective emitter voltages constant at near 12 volts.

The Fig. 2 transmitter includes a Colpitts oscillator built around *Q3* and an amplifier consisting of the *Q5* and *Q6* stages that's keyed off or on by the TD input signal.

The resonant LC circuit that determines the frequency of the carrier signal consists of 100-μH choke *L1* and capacitors *C5* and *C6* in series. Capacitor values of 0.01-μF are in series for 226 kHz and in parallel for 160 kHz. Actual frequency will be a bit higher than calculated by the formula for the resonant frequency, due to a somewhat lower inductance that results from interaction of the magnetic flux with nearby conducting surfaces. However, this is mitigated by the design of the conductor pattern and mounting the choke coil so that it stands well above the circuit board.

The amplifier is a complementary-symmetry voltage-follower that generates an ac output voltage across an 82-ohm load resistor. The keying circuit consists of *Q4* and *Q7* that are switched on or off by the outputs from the two op amps inside *IC1*. The non-inverting (+) inputs of the op amps are grounded to allow them to function as simple inverters.

If the TD input is negative, grounded or open, the output of *IC1A* is positive, and the output of *IC1B* is negative. This causes *Q4*, *Q7*, *D3* and *D4* to conduct, allowing the signal from the oscillator to reach the bases of *Q5* and *Q6*. The voltage at the emitters of these transistors follows the voltage at the junction formed by *C20, D3* and *D4*.

If the TD input is positive, as it will be for a logic 0, the outputs of the op amps will be reversed, cutting off *Q4* and *Q7* and preventing *D3* and *D4* from conducting. This blocks the oscillator signal from reaching the bases of *Q5* and *Q6*.

With the output of *IC1B* positive, current flows through *R10* and the base of *Q8*, switching on this transistor and causing *LED2* to light. When *LED2* lights, it provides a visual indication that data is being transmitted. Diodes *D5* and *D6* limit the voltage at the input of *IC1A* to prevent damage if the input at TD exceeds the supply voltages.

To equalize the r-f output voltage at either 226 or 160 kHz, the value of *R4* should consist of two 15,000-ohm resistors in parallel for 160 kHz. This increases the base current of *Q3* at 160 kHz and, consequently, the current circulating in the LC circuit, which has a lower reactance at the lower frequency.

The receiver (Fig. 3) consists of tuned r-f amplifier/notch filter *IC2A*, detector *IC2B*, inverter *IC3A* and

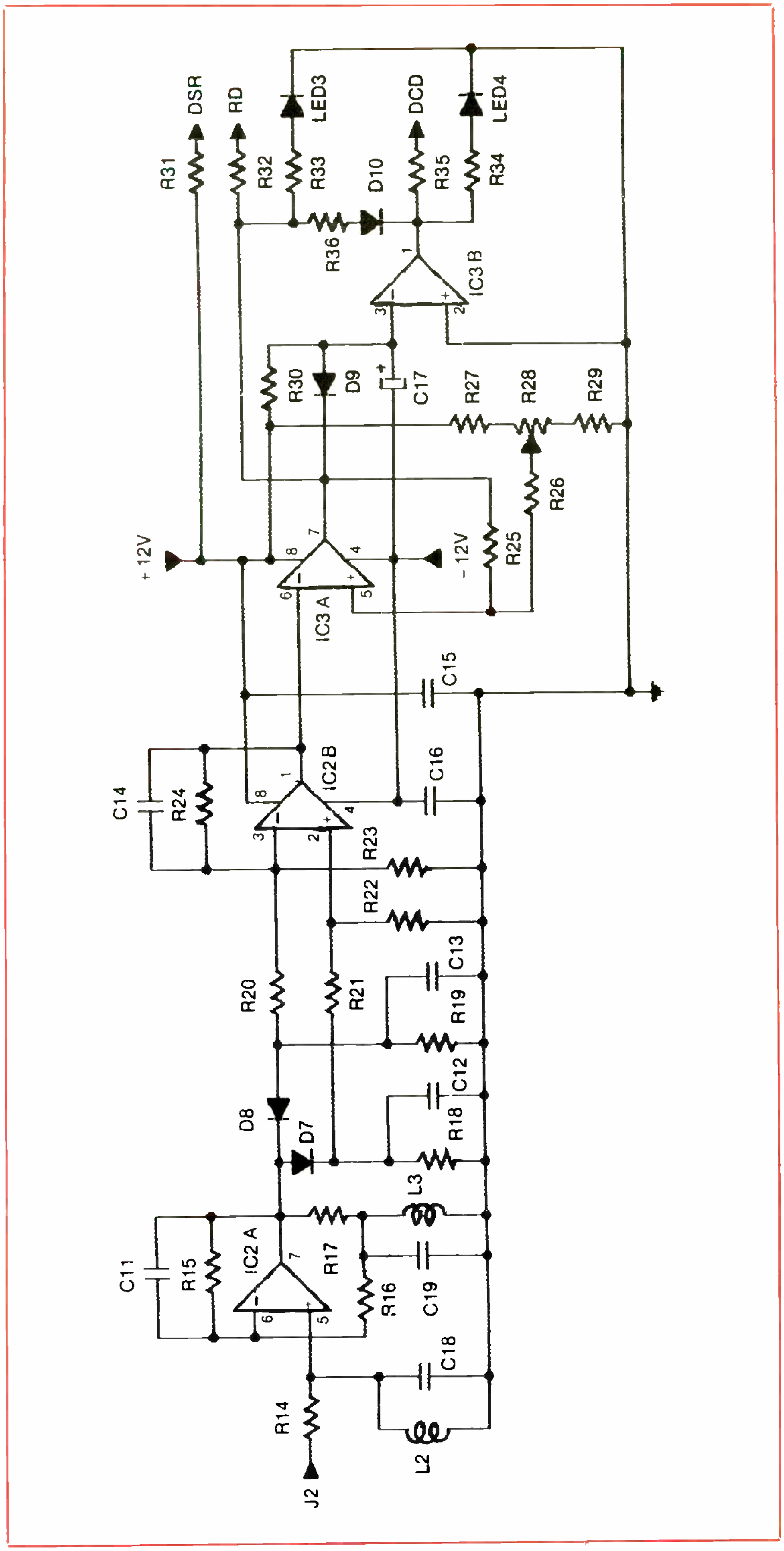


Fig. 3. Schematic diagram of receiver portion of transceiver's circuitry.

carrier-loss detector *IC3B*. The r-f amplifier is tuned to the remote transmitter frequency by *L2* and *C18*. Inductor *L3* and capacitor *C19* are tuned to the local transmitter frequency and increase negative feedback at that frequency to suppress the response to the local transmitter's carrier signal.

The detector uses *D7* and *D8* to rectify both halves of the ac output from the amplifier. RC networks *R18/C12* and *R19/C13* remove some of the ripple from the rectified signal. When a sufficiently strong signal is present, the polarity of the rectified voltages is such that the output of *IC2B* will be positive.

The required 0.6-volt drop across *D7* and *D8* prevents conduction if the output signal from the amplifier is below that level. If the amplitudes of the local and remote carrier signals at the output of *IC1A* are just right, the local signal will be below detection threshold and the output of *IC2B* will be 0 when the remote carrier isn't present. The output from the detector is converted to the RS-232 signal voltages by *IC3A*.

Positive feedback at the junction of *R25* and *R26* provides a hysteresis band centered on the voltage at the wiper of *R28*. The hysteresis rejects low-level noise from the detector and keeps the pulses clean. Potentiometer *R28* permits adjustment to select the transition point at which the output switches state to result in output pulses of the same interval as the original pulses at the TD input of the remote transmitter. This is necessary because the pulses from the detector look like truncated cones.

When logic-0 pulses are received and the output of *IC3A* is positive, *LED3* will be on to indicate that data is being received. When *IC3A*'s output is negative (carrier present), *D9* conducts and discharges *C17*. When no carrier is present (logic-0 pulses received), *C17* charges through *R30*.

For as long as data is being transferred, logic-1 pulses cause *C17* to discharge before the voltage at the non-inverting input of *IC3B* reaches zero, the output of *IC3B* will be positive and *LED4* will be on. However, if the carrier is lost for more than about 40 milliseconds, the output of *IC3B* goes negative and *LED4* extinguishes. Also, *D10* conducts and

PARTS LIST

Semiconductors
D1,D2—12.2-volt zener diode
D3 thru D10—1N914 silicon diode
IC1,IC2,IC3—LF353N or TL082 dual operational amplifier
LED1—Red or green light-emitting diode in T-1¾ case
LED2—Red light-emitting diode in T-1¾ case
LED3—Green light-emitting diode in T-1¾ case
LED4—Yellow light-emitting diode in T-1¾ case
Q1,Q3,Q4,Q5,Q8—MPS2222A transistor
Q2,Q6,Q7—MPS2907 transistor
Capacitors
C1,C2—2,200-µF, 35-volt electrolytic
C3,C4,C7—10-µF, 35-volt electrolytic
C5,C6,C18,C19—0.01-µF, 50-volt electrolytic
C8,C9,C10,C15,C16,C20—0.1-µF, 35-volt electrolytic
C11,C14—47-pF, 50-volt Mylar or ceramic disc
C12,C13—0.0047-µF Mylar or ceramic disc
C17—1-µF, 35-volt tantalum
Resistors
(½-watt, 5% tolerance)
R1,R2,R29—470 ohms
R3,R11,R16 thru R19,R33,R34,R36—1,000 ohms
R9—82 ohms
R31,R32,R35—330 ohms
(¼-watt, 5% tolerance)
R4,R7,R8—15,000 ohms
R5—3,300 ohms
R6,R27—4,700 ohms
R10—33,000 ohms
R12,R30—56,000 ohms
R13,R15,R21,R22,R23—10,000 ohms
R14—1,500 ohms
R24,R25—100,000 ohms
R26—2,200 ohms
R28—4,700-ohm, pc-mount trimmer potentiometer
Miscellaneous
L1,L2,L3—100-µH coil
RECT1—1-ampere bridge-rectifier assembly
J1,J2—Chassis-mount coaxial connector [278-212]; (optional—see text)
J3—DB-25 chassis-mount female connector
S1—Spst toggle switch
T1—25.2-volt, 450-mA, center-tapped power transformer
Printed-circuit boards (see text); suitable enclosure [270-272] or similar (see text); four-lug screw-type terminal strip; panel clips for T-1¾ LEDs; fuse holder and 1-ampere slow-blow fuse); ac line cord with plug; sockets for ICs; dry-transfer lettering kit; clear acrylic spray; machine hardware; hookup wire; solder; etc.

Note: Numbers in brackets are Radio Shack Catalog Numbers.

drops the voltage at the junction of *R33* and *R36* to about zero, extinguishing RD indicator *LED3*.

The receiver permits full-duplex data transfer, even when the input signal includes both local and remote transmitter signals, as it will if both signals use the same path. Rejection of the local signal is imperfect. However, with proper connection and careful adjustment, operation at 9,600 baud is extremely reliable.

If line losses are significant, the lower remote-signal-to-local-signal ratio may degrade the performance. This can be avoided by providing two separate transmission paths (a three-conductor cable with two signal lines and a ground or two coaxial cables). Adjustment won't be as critical, and longer cables with considerable loss can be tolerated. It may be possible to transfer at 19,200 baud. Use of two of the conductors in a four-conductor telephone cable for the signals and the ground wire in the electrical wiring have worked reliably over a relatively short distance.

The receiver is too sensitive for correct operation at the full signal strength of the transmitter. For this reason, an attenuator should be used to reduce the input signal strength. The cable should be terminated at the receiver end with an 82-ohm resistor.

If a single signal path is used, the 82-ohm load resistor in the transmitter serves this purpose. If the transmission medium consists of separate signal paths for each frequency, an external 82-ohm resistor should be used to terminate each line at the receiver end. It should be used to connect the line to the receiver.

If line losses are insignificant, connect the receiver to the line through a 2,200-ohm resistor. Try a lower value if line losses have already resulted in some attenuation. If the remote transmitter frequency is 226 kHz, connect a 330-ohm resistor from the receiver input to ground, since the receiver is more sensitive at the higher frequency, due to the higher reactance of the LC circuit elements.

All connections to and from the transceiver and computer are made via a DB-25 connector (identified in the Parts List as *J3*) and cable assembly. These points are labeled TD in Fig. 2 and DCD, DSR and RD in Fig. 3.

Construction

Everything you need to build the transceivers is available from your local Radio Shack store for about $150, including enclosures.

For reliable operation, it's recommended that you assemble and wire your transceivers on printed-circuit boards. Actual-size etching-and-drilling guides are given in Fig. 4: (A) transmitter/receiver, (B) power-supply and (C) LED-display boards. These boards are designed to fit nicely inside the Radio Shack enclosures mentioned in the Parts List.

The Fig. 4(A) board is designed so that the transmitter and receiver sections can be separated by cutting the board after it's etched and before any holes are drilled. For full duplex operation, you need two complete boards. Simplex operation requires only one transmitter and one receiver.

Once the boards have been etched and drilled, populate them using the wiring guide shown in Fig. 5(A) for the appropriate portion of the Fig. 4(A) board. Begin populating this board by installing and soldering into place the socket for *IC1*. (Do *not* plug the IC into this or any other socket until after you've conducted preliminary voltage tests and are certain that your wiring is correct.)

Plug into the board and solder into place the resistors, capacitors, diodes and transistors. Make sure the diodes and electrolytic capacitor are properly oriented and transistors are properly based before soldering any of their leads into place.

Now plug the leads of *L1* into the indicated holes in the board and adjust the positioning of this coil so that it's ½" above the surface of the board. Solder the coil's leads into place.

Orient the second portion of the

Fig. 4(A) board as shown in Fig. 5(B). As with the previous board, begin populating it with the sockets for the ICs. Then install the resistors, capacitors and diodes, observing proper polarity for the electrolytic capacitor and orientations for the diodes. Plug in and solder into place trimmer control *R28*.

Next, use suitable lengths of insulated solid hookup wire to install and solder into place the jumpers that go from just outside the box on the left side of Fig. 5(B) to the various points on the board. Use solid bare wire for the jumper between *C14* and *C16*.

Install and solder into place *L2* and *L3*. However, this time around, position the coils so that they're ¼" above the surface of the board. Temporarily set aside this circuit board assembly.

The transmitter/receiver board is designed so that the tuning capacitors can be connected in parallel for 160 kHz in the transmitter section and in series for 226 kHz in the receiver section. Use jumper wires in place of capacitors that aren't used in the receiver for 160 kHz.

Three 0.01-μF capacitors and one jumper are required in each receiver. They must be connected so that *C18* tunes the receiver to the frequency of the remote transmitter and *C19* tunes the rejection notch to the local transmitter frequency.

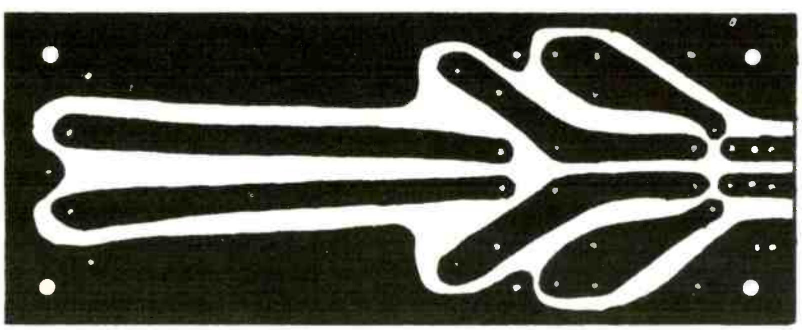
Solder a 15,000-ohm resistor to the leads of *R4* on the component side of the 160-kHz transmitter circuit-board assembly.

Place the Fig. 4(B) power-supply board in front of you as shown in Fig. 5(C) and install and solder into place the rectifier assembly and transistors. Make sure each is properly based before soldering its leads into place. Next, install and solder into place the resistors and diodes. Make sure the latter are properly oriented. Then install and solder into place the capacitors, again making sure each is properly oriented.

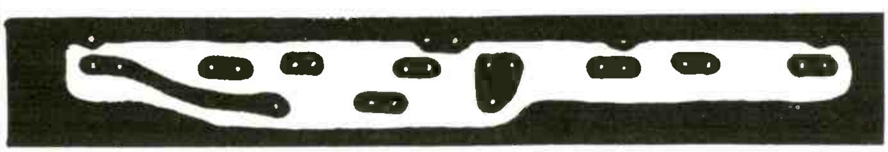
Now, referring to Fig. 5(D), wire the remaining board as shown. Install and solder into place the resistors and then the diode, making sure it's properly oriented. Finish up by installing and soldering into place the LEDs. Again, make sure each is properly oriented.

Plug the secondary leads into the indicated holes in the power-supply

(A)



(B)



(C)

Fig. 4. Actual-size etching-and-drilling guides for: (A) transmitter/receiver, (B) power-supply and (C) display board.

board and solder them into place, as shown in Fig. 5(C). Then twist together the transformer primary leads and line-cord conductors and place a wire nut on each connection to thoroughly insulate it from the other and anything else.

Clip the common lead of a dc voltmeter or multimeter set to the dc-volts function to the positive (+) lead of *C2*. Place the power-supply board on an insulated surface and plug the line cord into a 117-volt ac outlet. Touch the "hot" probe of the meter to the junction of the *Q1* emitter and *R3* and note if you obtain a reading of +12 volts. If so, touch the "hot" probe to the emitter lead of *Q2* and note if you obtain a reading of −12 volts.

Should you fail to obtain the proper reading at either or both points mentioned, power down the project and correct the problem. Do *not* proceed until you're certain that this circuit board has been properly wired.

Once you're sure the power supply is working properly, strip ¼" of insulation from both ends of 19 5" lengths of hookup wire. If you're using stranded wire, tightly twist together the fine conductors at both ends of each wire and sparingly tin with solder.

Plug one end of eight wires into the holes labeled +12V, −12V and GND in the power-supply board. There should be three wires for the +12V and GND holes (plug two wires into one hole in each case and enlarge the hole slightly to accommodate them if needed) and two wires for the −12V holes. It's advisable that you use color-coded insulation on these wires to easily identify polarities. Plug one end of three more wires into the holes labeled A through D in the LED display board and solder into place.

Plug the free ends of the wires coming from the +12V, −12V and GND in the power-supply board into the identically labeled holes in the transmitter and receiver boards and solder into place. Plug the remaining +12V and GND wires coming from the power-supply board into the holes labeled A and GND in the display board and solder into place.

Plug one end of the remaining wires into the TDI and TD holes in the transmitter board and DSR, RD, DCD, RDI and DCDI holes in the transmitter board. Solder all connections.

Finish interconnecting the boards by plugging the free ends of the wires coming from the display board into the same-labeled holes in the transmitter and receiver boards (A to A, B to B, and so on) and solder into place. Double check all wiring to make sure that no ICs are in the sockets.

Prepare two short lengths of coaxial cable that will terminate in coaxial jacks that will serve as the input and output connectors. Plug the shields and a short black-insulated hookup wire into the ground holes in the transmitter and receiver boards for both units. Likewise, plug a red-insulated hookup wire and inner conductor of the coaxial cables into the signal holes in all four boards. Solder all eight connections. The coaxial cable will terminate in coaxial connectors, the hookup wires in a four-contact screw-type terminal strip mounted on the rear panels of the enclosures in which the transceivers are housed. Temporarily terminate the cables and wires in the appropriate connectors.

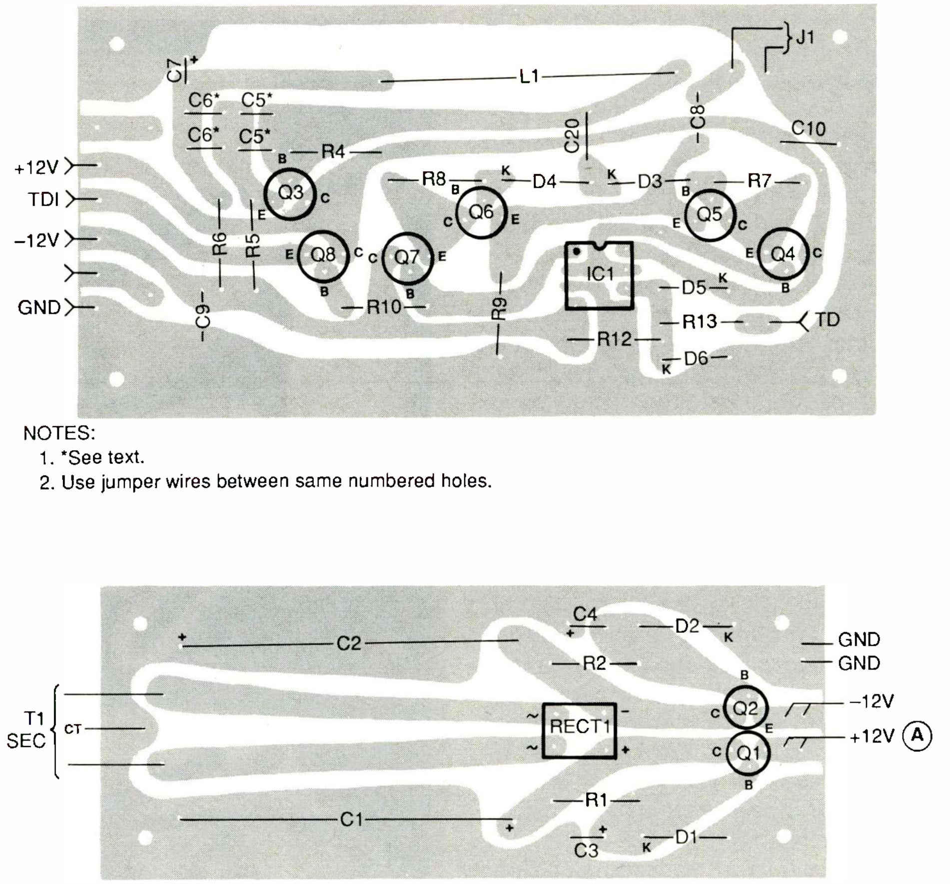
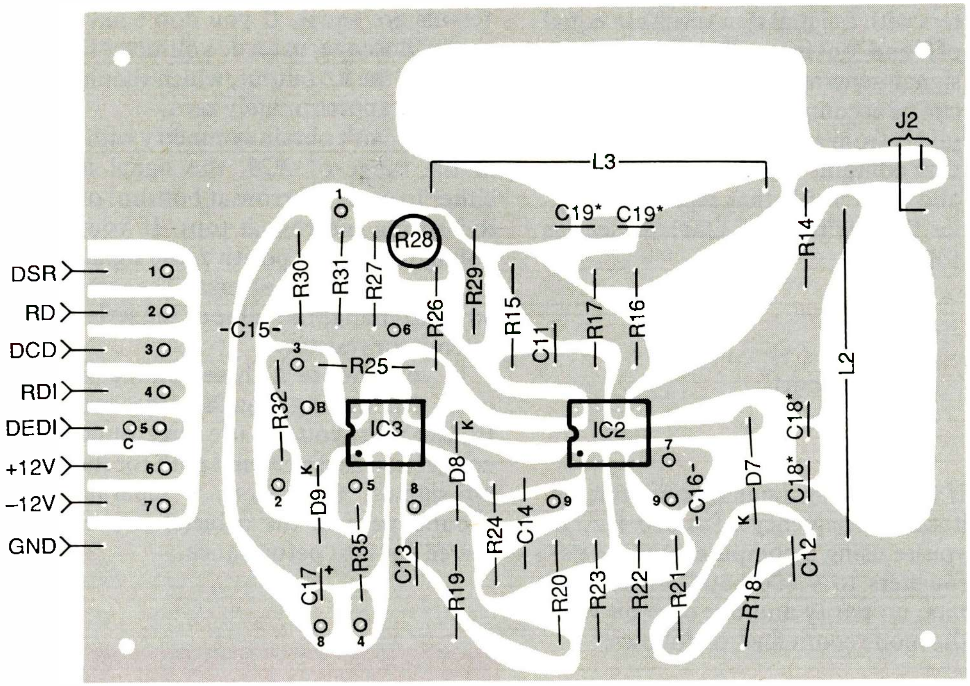


Fig. 5. Wiring guides for: (A) transmitter, (B) receiver, (C) power-supply and (D) display boards.

Checkout & Adjustment

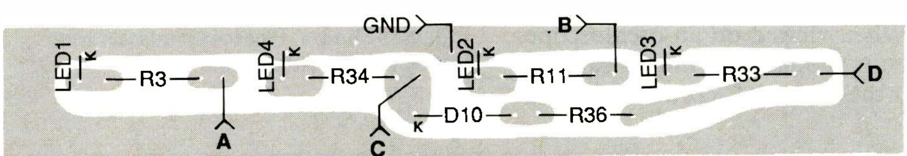
The best time to test the circuit-board assemblies is before mounting them in their enclosures. With no ICs plugged into the sockets on the transmitter and receiver boards, the only active component that can conduct when power is applied is *Q3*. You can view the output of the oscillator with an oscilloscope or measure it with an ac voltmeter.

The signal across *L1* should have an amplitude of about 2.5 volts rms. With *IC1* plugged into its socket (be sure to power down before plugging this or any other IC into its socket), the signal across *R9* should be between 1.5 and 2 volts and should drop to 0 volt when +12 volts is ap-



(B)

NOTES:
1. *See text.
2. Use jumper wires between same numbered holes.



(D)

plied to the TD input. When the units pass these tests, power down and plug the ICs into their respective sockets on all boards. Make sure each is properly oriented and that no pins overhang the sockets or fold under between sockets and ICs.

When testing the receivers, the two units must be connected to each other, with the transmitter outputs going to the inputs of the opposing units through 2,200-ohm resistors. Shunt the input of the 226-kHz receiver with a 330-ohm resistor.

On power-up, the RD output of each transceiver should be negative, with the DCD outputs positive. You may have to adjust the settings of *R28* in either or both units to obtain these results. If this fails, test for a positive output at pin 1 and about 1 volt rms at pin 7 of *IC2*. The RD and DCD outputs should reverse if the transmitter is turned or keyed off.

Having confirmed that the units are operating properly, power down and install them in their separate enclosures. Be aware that layout inside in the enclosure is an important consideration.

To keep the inductors as far away from as much metal as possible, mount the receiver board with its right edge ¾" from the right edge of the enclosure and the power transformer and power-supply board in the remaining space on the left.

Drill holes for the LED panel clips ½" from the top edge of the front panel of the enclosure. The LEDs are arranged 1" apart in a single row. Locate the hole for the POWER switch ½" from the left edge of the panel.

Center the cutout for the DB-25 connector in the rear panel. Center the INPUT and OUTPUT coaxial connectors ⅜" from the right edge one above the other. Center the four-position terminal strip between the DB-25 and coaxial-connector cutouts, flush with the top of the DB-25 connector.

Drill a hole ⅜" from the left edge of the rear panel. Then drill the mounting holes for the power transformer, power-supply board, transmitter board, receiver board and fuse holder through the floor of the enclosure.

When you're done machining the enclosure, deburr all holes and cutouts to remove sharp edges. Place a rubber grommet in the ac line-cord holes. Then use a dry-transfer lettering kit to label the various LEDs, switch and connectors. Spray onto the lettering two or more light coats of clear acrylic to protect the legends.

Mount the fuse holder and power transformer to the floor of the enclosure with suitable machine hardware, placing a two-lug terminal strip on the mounting screw nearer the fuse holder. Then mount the power-supply, transmitter and receiver boards in their respective locations, using ½" spacers and machine hardware. Place a panel clip in each LED hole in the front panel. Then mount the display board in place by plugging the domed cases of the LEDs into the clips.

Mount the screw-type terminal strip, BNC connectors and DB-25 connector in their respective locations on the rear panel. Route the ac line cord through its grommet-lined hole into the enclosure and tie a strain-relieving knot in it about 6" from the end inside the enclosure. Wire the primary side of the power transformer as per Fig. 1. Use the terminal strip for the connection that ties one side of the ac line cord directly to one primary lead of *T1*. Form a series circuit with the other ac line cord conductor, fuse holder, POWER switch and other *T1* primary lead.

Carefully terminate and solder the free ends of the of the following wires coming from the transmitter and receiver boards to the DB-25 connector in this sequence:

TD to pin 2
RD to pin 3
DSR to pin 6
GND to pin 7

DCD to pin 8

You may also want to use a wire to connect RTS pin 4 to CTS pin 5 on the DB-25 connector.

The screw-type terminal strip on

the rear panel provides for all external connections. The LED display board connects to ground, + 12 volts TDI, RDI and DCDI. Bring three wires through the hole over the terminal strip for the transmitter output, receiver input and ground connections, and connect these to three of the screw terminals. The attenuator resistor(s) can be connected externally to the receiver input. If a single-path cable is to be used, connect together both the transmitter outputs and one end of the 2,200-ohm resistor, otherwise connect an 82-ohm resistor across the line from the remote transmitter.

Final Adjustment

Preliminary adjustment is best done with a short three-conductor cable so that the local transmitter doesn't cause interference. Final adjustment should be done with the actual cable and the transceivers at the locations where they'll be used. An oscilloscope is very helpful when adjusting the response of the receivers, but it isn't absolutely essential.

It is necessary to key the transmitters with a signal that results in equal off and on intervals. If a suitable signal generator isn't available, this can be accomplished by sending capital Us from a computer. Create a file that contains many records with Us and a batch file that repeatedly copies the file to the COM1 device, as follows:

```
echo off
:begin
copy file com1
goto begin
```

If you're using a signal generator, set it for a frequency of 4,800 Hz. If you're using a computer, set the parameters to 9,600 baud, eight data bits, no parity and one stop bit with the mode command, as follows:

```
mode com1:9600,N,8,1
```

When viewed on an oscilloscope, the RD should be symmetrical. Adjust the setting of *R28* so that the intervals are equal. If you don't have an oscilloscope, use a dc voltmeter to measure the RD output, which should measure approximately zero.

If you can't obtain symmetry within the range of *R28*, the signal is either to weak (narrow at bottom) or too strong (narrow at top). If your voltage reading is positive, the signal is too weak, and vice-versa. The remedy is to change the value of the series attenuator resistor.

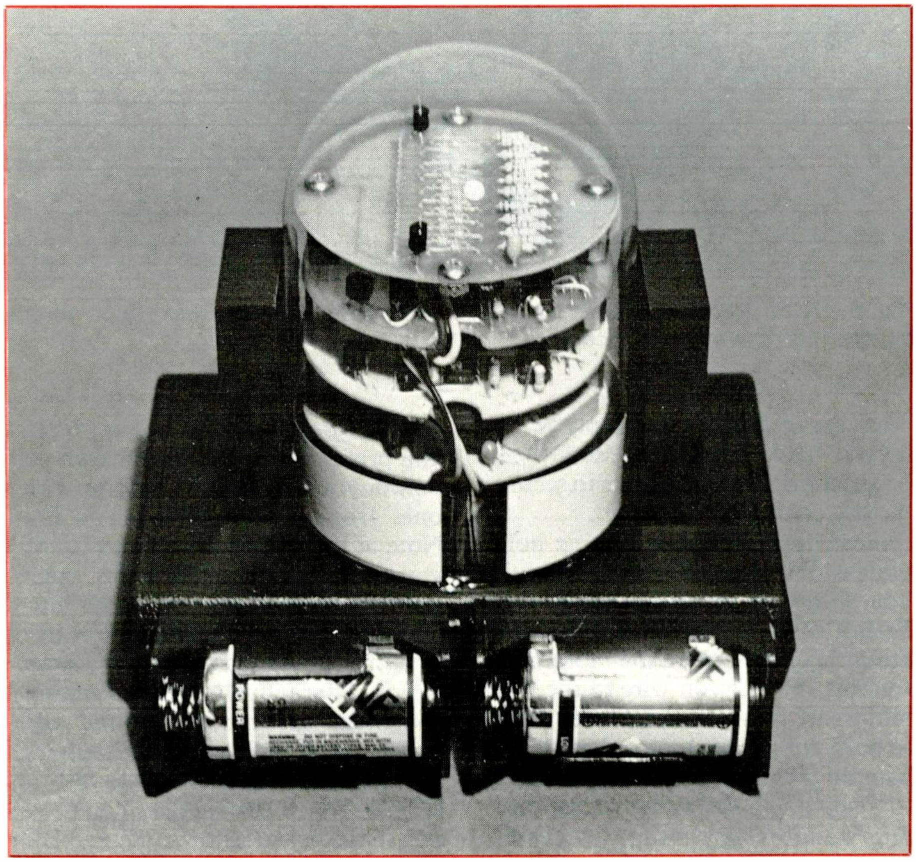
If you choose a three-conductor cable for linking together the two transceivers, you can use the ground connection as the ground path for the r-f signals. Of course, a separate ground path in the cable(s) is preferred for best peformance. ■

Author Help

If you encounter difficulty getting this project to work, you can consult the author by calling 717-964-3536 during daytime hours. Please call no later than 7:00 P.M. Eastern Time.

CyberBot: A Neural-Network Robot
Conclusion
Details for building and using this cybernetic device

Last month in Part 1 of this article, we introduced you to Neural Networks in general and how they pertain to the CyberBot project you will build from details presented this month. Now let's get down to building your own CyberBot.



Construction

We'll start with construction of the base and drive assembly. Because the traction drive wheels are molded and machined from Nylon stock, it might be difficult for you to fabricate these from scratch. To circumvent this difficulty, you can purchase a complete kit of everything needed to build this robot, including motors, Nylon parts and base from the source given in the Note at the end of the Parts List.

In this article, we'll assume you're building CyberBot from the kit. The traction drive consists of four wheels, four wheel shafts, eight Nylon washers and eight self-adhesive Nylon pillow blocks, as illustrated in Fig. 5.

Begin by removing any adhesive protection tabs and pressing the units into place against the inside bottom of the case. Positioning isn't critical, so long as the wheels are able to turn freely when mounted. Next, slide an axle into place and put sequentially onto the axle a washer, a wheel (with rubber drive band in place) and another washer. Repeat this operation for the other three wheels. Test-roll the base across a table top to check for proper wheel alignment. If necessary, adjust alignment.

Next, cement the shoulder washer retainers onto the motor shaft ends. Super glue (cyanoacrylate) is recommended for this and the next operation. Using super glue for a temporary bond, mount the motor to the case. If you have some super glue accelerator, use it carefully to speed up the polymerizing (setting) process. (Super glue Accelerator is available from Loctite Corp. as "TAKPAK." It is worth its weight in gold when using super glue!)

When the motors are solidly in place, test each in turn by temporarily connecting a 1.5-volt C cell across it. Make sure the motor drives the traction wheels without "throwing" the rubber drive bands. If all is adjusted properly begin applying epoxy cement to the cases of the motors and the base. If the motors aren't properly aligned, carefully break them loose and cement them again before epoxying them in place. You can use 5-minute epoxy cement. If you're the more patient type, use regular epoxy cement and allow it to set overnight.

With motors securely in place, transfer the mounting hole positions of the C-cell holders onto the top part of CyberBot's base (lead photo). You can drill these holes with a drill

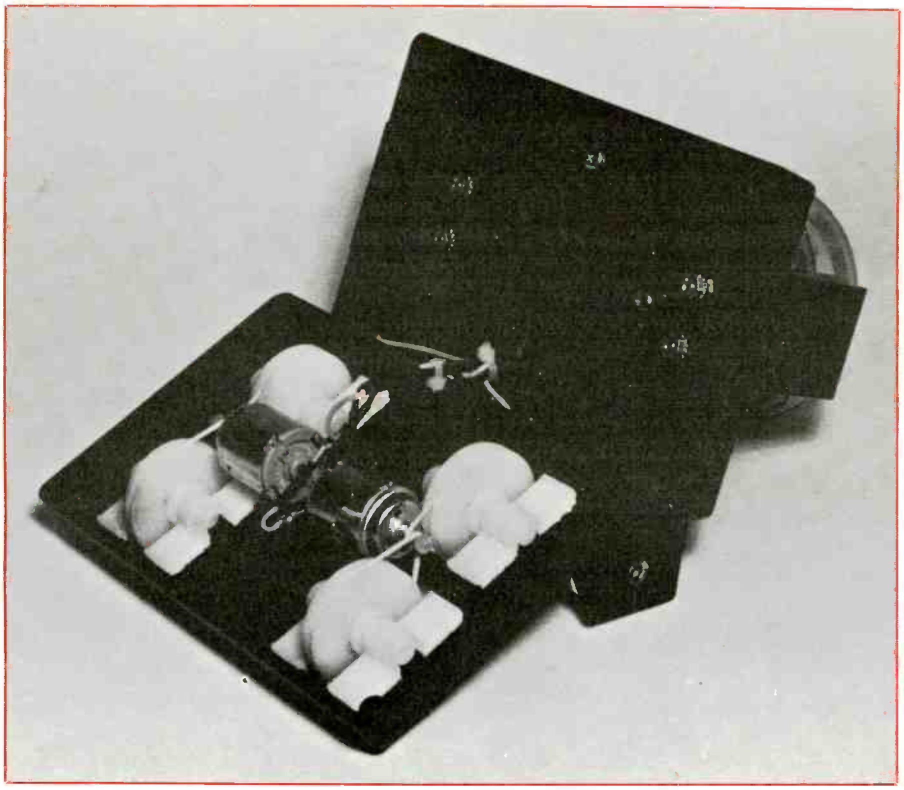


Fig. 5. Nylon traction wheels mount to base with self-adhering Nylon pillar blocks, motors with epoxy cement.

PARTS LIST

Optical Neuron Circuit

Semiconductors
Q1—FPT-100 npn silicon phototransistor
Q2—VN0300 hex field-effect transistor
U1—78L05 fixed +5-volt regulator
U2—LM358 dual operational amplifier
U3,U4,U5,U6—X9103 EEPOT (Xicor)
Capacitors
C1—1-μF, 16-volt tantalum
C2—10-μF, 16-volt tantalum
Resistors (¼-watt, 5% tolerance)
R1—1,000 ohms
R3—100,000 ohms
R4—10,000 ohms
R5—2,200 ohms
R6,R7,R8—22,000 ohms
R2—1-megohm pc-mount trimmer potentiometer
Miscellaneous
P1A—18-pin male strip connector
P1B—18-pin female strip connector
Printed-circuit board; 9-volt alkaline battery and snap connector; 4-40 × ½″ female tapped standoffs (3); hookup wire; solder; etc.

Monitor Circuit

Semiconductors
LED1 thru LED18—Red "Poly" light-emitting diode
Q1,Q2—VN0300 hex field-effect transistor
Capacitors
C1—10-μF, 16-volt tantalum
Resistors (¼-watt, 10% tolerance)
R1 thru R18—10,000 ohms
Miscellaneous
P1B—18-pin female strip connector
Printed-circuit board; 4-40 × ½″ tapped standoffs (3); 4-40 × ⅜″ machine screws (3); hookup wire; solder; etc.

press, hand drill, or by simply twirling a sharp X-acto knife. Use 4-40 × ⅜″ machine screws and nuts to secure the battery holders in place.

Next, transfer the mounting hole dimensions from the printed-circuit board artwork to the top of the CyberBot case and then drill the three mounting holes. Wire the motors by running the +3-volt wire to the two motors. (Cross wire them when back to back for proper motor direction.) Run the common battery-supply line to a spade lug and mount 1″ aluminum standoffs on the top of the case. Finally, drill a ¼″ hole through the back of the top lid of the base and line it with a grommet to secure the left and right drive motor control lines that run from this assembly up to the Mood and Reflex Card.

As a final cosmetic touch (and future expansion platform) mount two black shoulder modules on the top of the base using four 4-40 × ⅜″ machine screws and nuts. With CyberBot's base and traction motor assemblies built, it's time to turn our attention to the printed circuit cards.

You can fabricate your own single-sided circuit cards using the actual-size artwork provided in Fig. 6. If you prefer not to make your own pc board, you can obtain ready-to-wire ones from the source given in the Note at the end of the Parts List. If you do decide to go this route, exercise care when cutting the cards into circles. If you have a band saw or jigsaw, the circular shape will be a snap to cut. Alternatively, you can simply rough-cut the outline around the border circle with a diagonal cutters and finish by filing smooth with a straight file or belt sander. You need two of the boards shown in Fig. 6(B), one for each "eye."

On a final note, cut out and finish the cable channel half-round hole at the back of each of the printed circuit cards. This space allows the cables to run inside the glass Cyber dome.

Referring to Fig. 7 for the board depicted in Fig. 6(A) and Fig. 8 for the board depicted in Fig. 6(B), begin populating the cards. Remember that there are two Fig. 6(B) Eye Neuron cards. However, start wiring with the Mood and Reflex Card. Mount and solder into place a 40-pin socket in the U1 location.

Mount the remaining components on the Mood and Reflex Card, double checking your work as you go. Mount all but *R1, X1, Q1, Q2* and the three-pin host computer serial connector on the component side of the board. These five items go on the *solder* side of the board. (Refer to Fig. 3 when making the RS-232 host computer cable for pinout details for the DB-25 connector it uses.) Then mount the male 18-pin strip connector on the component side of the card assembly, and finish by soldering the 9-volt battery clip into place, allowing for the short jumpers that will run

Mood & Reflex Circuit

Semiconductors
Q1,Q2—MJE3055 npn power transistor
U1—MC68HC705C8S microprocessor
U2—MAX232 RS-232 interface
U3—LM358 dual operational amplifier
U4—78L05 fixed +5-volt regulator
Capacitors
C1,C2—22-pf ceramic disc
C3,C4,C6,C7,C8—10-μF, 16-volt tantalum
C5,C9—1-μF, 16-volt tantalum
Resistors (¼-watt, 5% tolerance)
R1—4.7 megohms
R2,R5,R9—10,000 ohms
R3,R6,R10,R11—100,000 ohms
R4,R7—100 ohms
R8—10,000-ohms SIP resistor network
Miscellaneous
P1A—18-pin male strip connector
SO1—40-pin DIP IC socket
SW1—Eight-position DIP switch
XTAL—2.00-MHz crystal
Printed-circuit board; 9-volt alkaline battery and snap connector; female 4-40 × 1″ tapped standoffs (3); hookup wire; solder; etc.

Note: A complete kit of parts for the CyberBot project can be obtained for $99.95 from U.S. Cyberlab, Inc., Rte. 2 Box 284, West Fork, AR 72774 (501-839-8293). Also available from the same source are: a kit containing ready-to-wire Mood/Reflex Card, Optical Neuron Cards (two) and Monitor Card, $19.95; traction drive/base assembly kit, $39.95; preprogrammed MC68HC705C8S microprocessor and source-code documentation, $24.95; Cyber Programmer Development system with software and instructions, $89.95; glass Cyber dome, $12.95. Add $4.95 for P&H (no extra charge for COD orders placed by phone). Arkansas residents, please add state sales tax.

up to the next card.

Construct the Optical (Eye) Neuron cards in a similar manner. On these, mount the male strip connectors on the component side of the card and female strip connector on the solder side. Make sure to space the female connector so that it mates firmly with the male connector below it when ½″ standoffs are in place. On the Left Neuron Card, mount *Q1* on the left side when facing the front. There's only one *Q1* transistor per card assembly.

Next, configure the cards for left

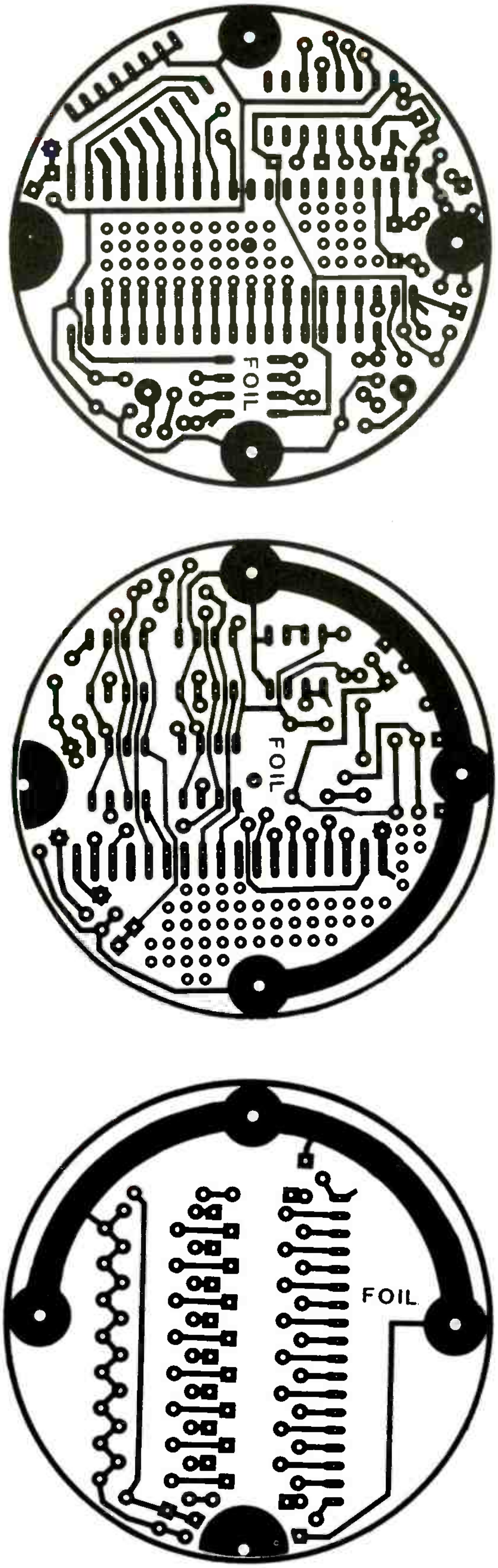


Fig. 6. Actual-size etching-and-drilling guides for (A) Mood and Reflex Card, (B) Optical Neuron Card (project requires two of these) and (C) Monitor Card.

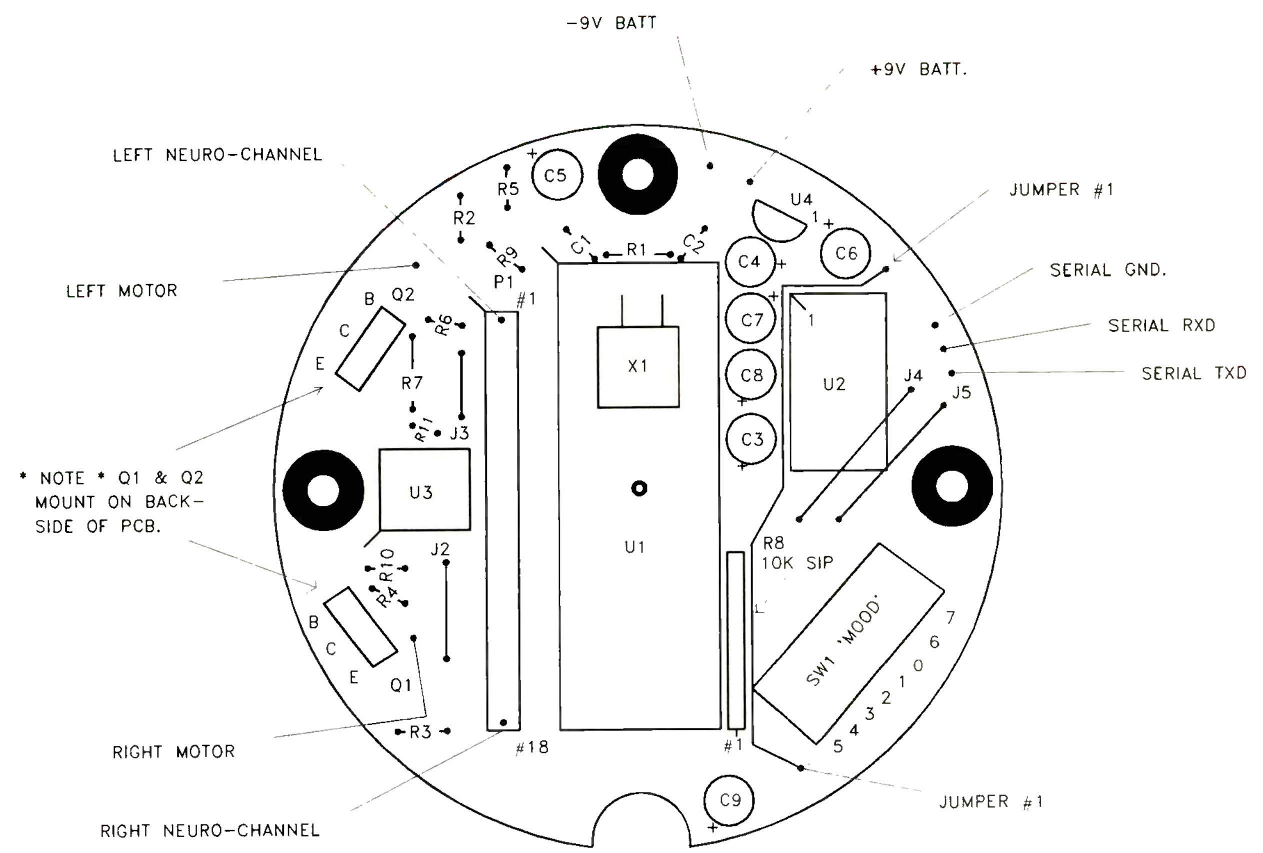


Fig. 7. Wiring details for Mood and Reflex Card.

and right operation by jumpering them per instructions given in Fig. 7 and Fig. 8. These jumpers let the microprocessor address the appropriate cards, while on the same data bus.

The Monitor Card is very straightforward. Follow the pictorial layout detailed in Fig. 9 as you mount and solder the individual LEDs, FETS and passive components into place. Female connector *P1* mounts on the conductor side of the printed-circuit card. The schematic diagram for the monitor circuitry is shown in Fig. 10.

Final assembly makes use of male/female threaded standoffs to assemble the neural "stack." Two 9-volt batteries power the electronics, each driving two cards. Battery 1 supplies the Mood and Reflex Card and the Left Eye Neuron Card (the latter, the lower of the two "eyes"). These cards connect with two short 1" to 2" power-supply jumper wires.

Battery 2 supplies the Right Eye Neuron Card and Monitor Card. These cards are also interconnected by a short power cable. On plain white paper, letter the name "CYBERBOT" using a dry-transfer lettering kit with ⅜" letters or some fancy type composed on your computer if you have this capability. Slide this name strip inside the base of the glass Cyber dome. Your CyberBot is now ready for testing.

Testing the Project

After double-checking the component placement and wiring on each of the cards, perform a quick voltage test. Briefly connect a 9-volt battery to its battery clip. (Note: Be extremely careful when connecting the 9-volt battery. It *must* be connected to its clip in proper polarity! If you even briefly touch the battery terminals in the wrong direction, CyberBot can be seriously damaged.)

With a dc voltmeter or multimeter set to the dc-volts function, check for proper operating voltages on the Mood and Reflex Card, before you plug microprocessor *U1* into its socket. When you're confident that all supply voltages are okay, assemble the CyberBot stack.

Final test of CyberBot should be conducted in a darkened room. A small amount of light is fine, as long as you avoid bright lights that might confuse CyberBot.

With the 9-volt batteries connected, place both 1.5-volt alkaline C cells in their holders on the rear of the CyberBot unit. Place CyberBot in mood 0 mode by setting position 0 of *SW1* to ON. Adjust both Eye Neuron Cards so that they produce no motion in the tractor-drive unit until the light of a flashlight activates them. That is, with the flashlight turned away from CyberBot, the motors should be off. When the flashlight is directed toward the phototransistors, the respective drive motor should activate.

Place CyberBot on a tile or concrete floor facing you. (Short nap carpeting, like indoor/outdoor, will also work.) CyberBot should just sit there without moving. Shining the beam from the flashlight directly on the front of CyberBot from 5 to 10 feet away should cause the project to spring to life and move toward you.

You'll probably notice that CyberBot will correct any "wandering" by switching on and off the appropriate drive motors to correct its course on its way to you. This will probably manifest itself as a slight swaying back and forth as it searches for your light. This is normal for the neural network and can be fine tuned in software later.

Next switch CyberBot into the mood 1 mode by setting *SW1* position 0 to OFF and position 1 to ON. Doing this causes CyberBot to reconfigure itself from a photovore to a photophobic. You'll notice the monitor LEDs flicker, indicating the downloading of new mood information to the dendrites. Again, place CyberBot on the floor and shine the flashlight directly into the front of the unit from about 5 to 10 feet away. This time, CyberBot will turn away from the light, avoiding any direct contact with it. If all checks out as described so far, your new CyberBot is in working order.

Programming & Use

The actual software documentation for CyberBot is too complex and lengthy to include here. However, complete software documentation is available from the source given in the Note at the end of the Parts List. With this package, you receive a preprogrammed MC68HC705C8S microprocessor, source-code documentation and a discussion of the theory of operation. As mentioned earlier, an inexpensive development system that allows you to alter the internal MC68HC705C8 software to your own specification is also available from the same source.

Here are some interesting scenarios for you to experiment with:

(1) In Mood 0 (inactive non-seeking photovore) try varying the dendritic values for *U4*. This will let you change the relative "desire" of CyberBot for light. Make note of how this affects the robot's response to your flashlight.

(2) In Mood 2 (active seeking photovore), note how interested does Cy-

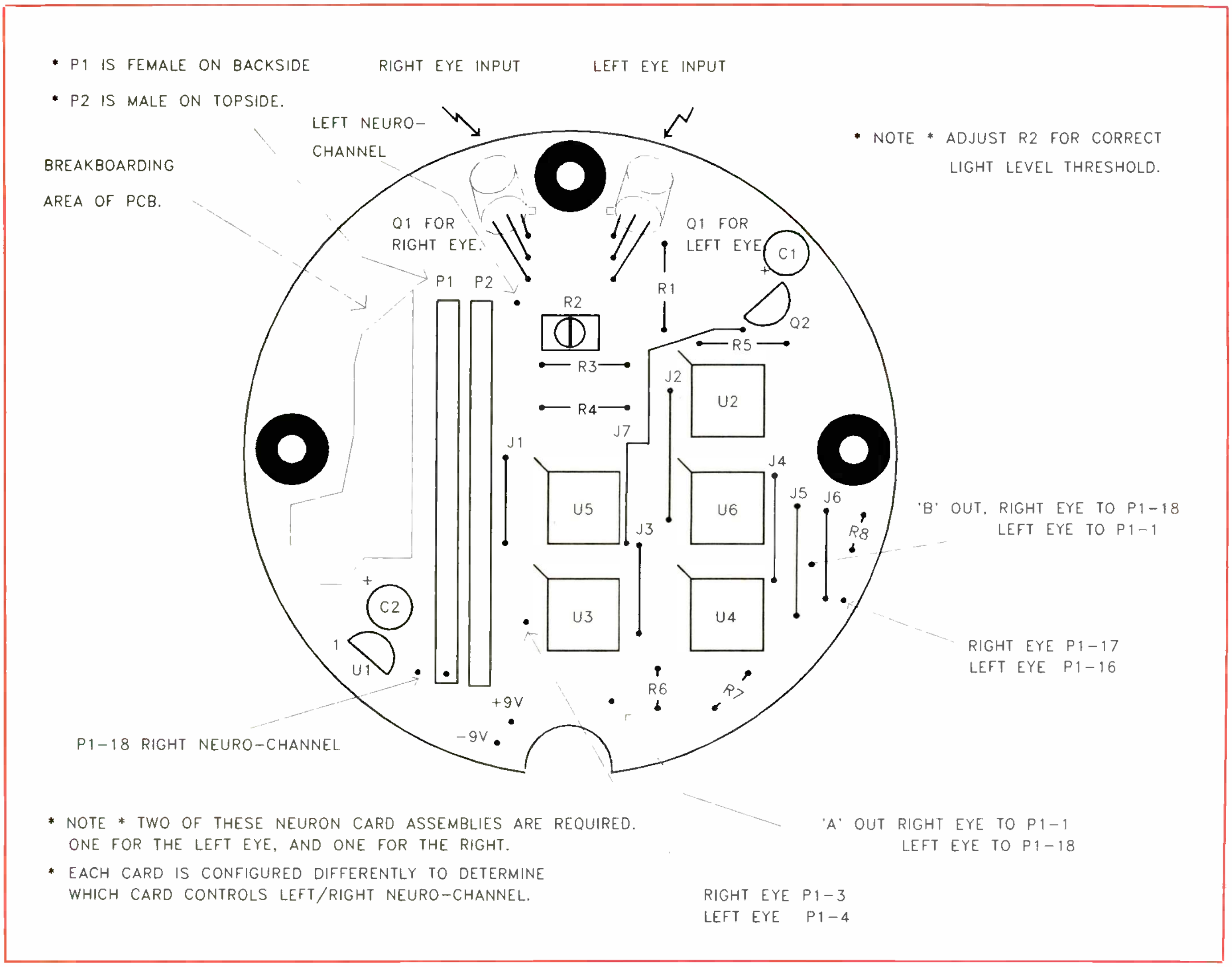


Fig. 8. Wiring details for Optical Neuron Card.

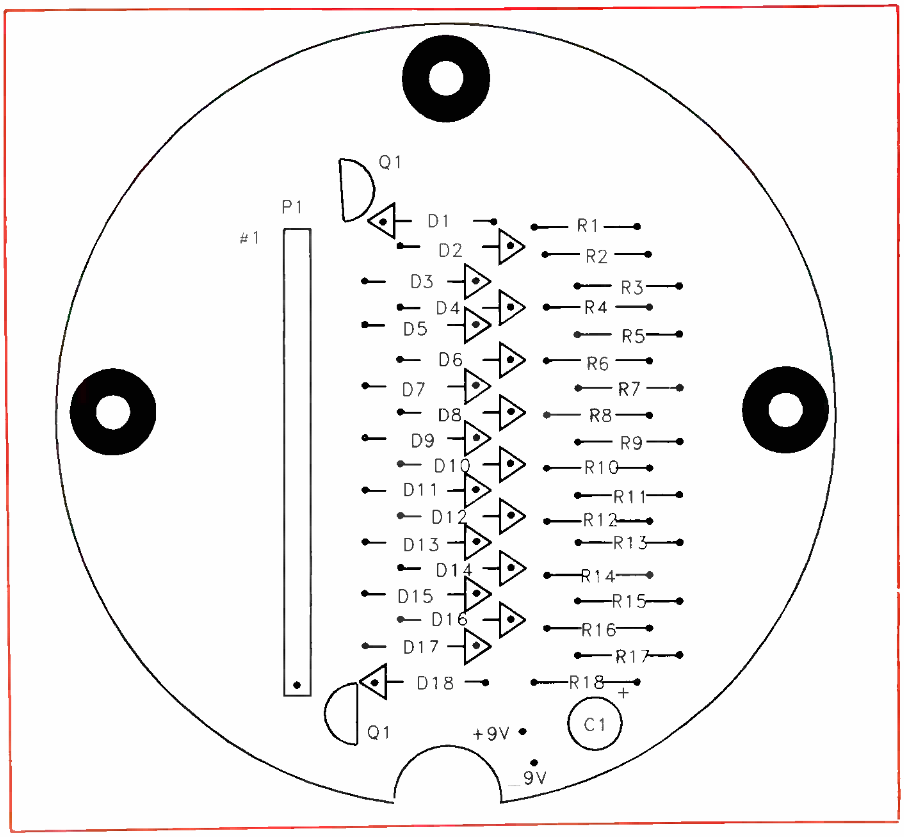


Fig. 9. Wiring details for Monitor Card.

berBot seems to be in your flashlight. Does it have trouble finding you from more than 10 feet distance?

(3) In Mood 1 (inactive photophobic), does CyberBot really avoid your flashlight? If so, does changing the dendritic values for *U6* make much of a difference in its behavior?

(4) In Mood 3 (active avoidance photophobic), does your flashlight really "force" CyberBot to change direction suddenly, or does the robot seem casually indifferent to the light source?

(5) In Mood 4 (active psychotic) does CyberBot's action seem totally erratic, or can you detect a pseudo-random pattern to its activities?

(6) With a 35-mm camera mounted on the ceiling above the darkened room, you can make a time exposure of CyberBot in Mood 4. When developed, the photograph can help to reveal its pseudo-random behavior. What happens when you place a fixed light-source in one corner of the room, for example?

(7) In Mood 2 (active seeking photovore) does CyberBot reveal a pat-

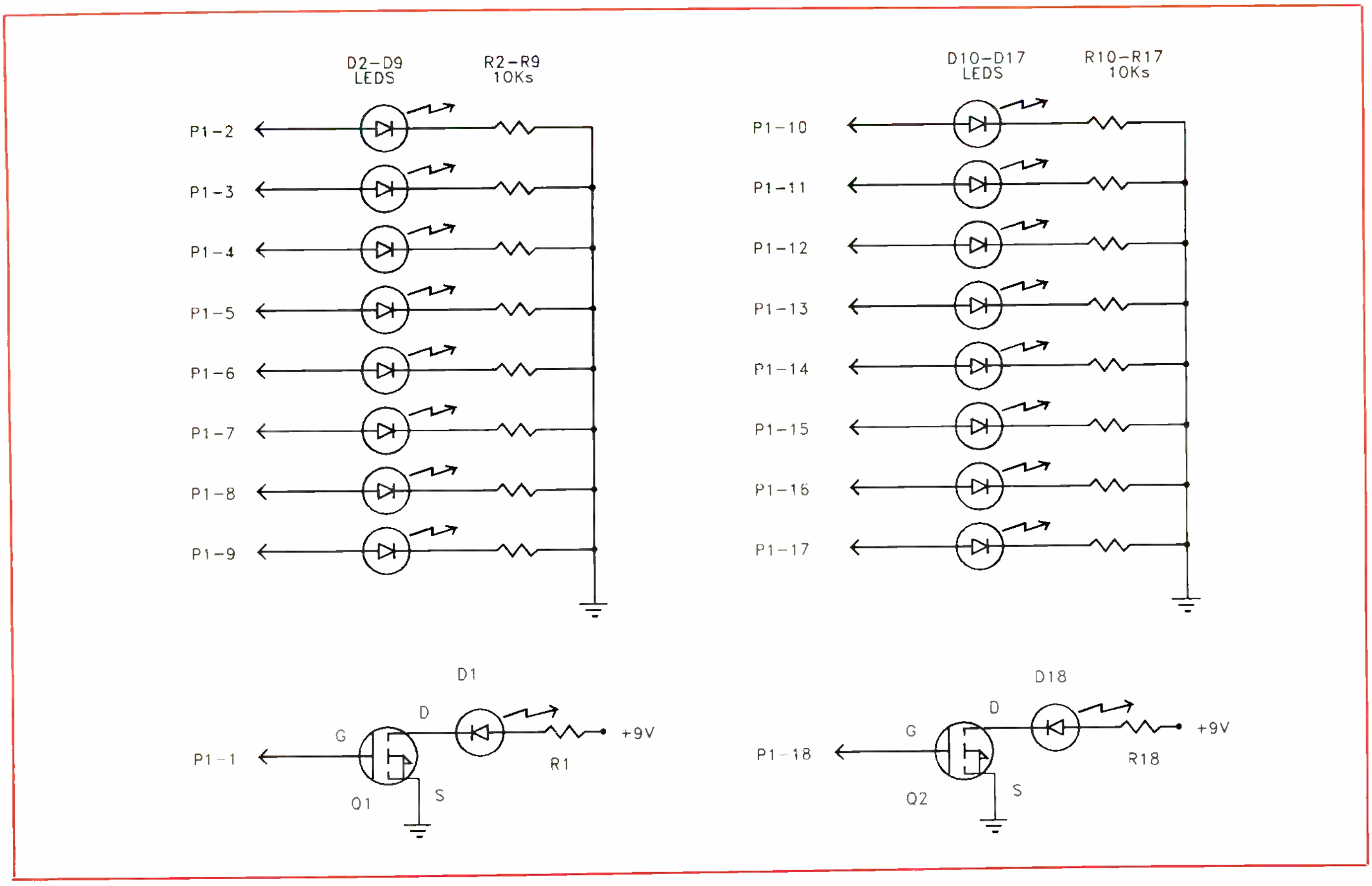


Fig. 10. Schematic diagram of circuitry that goes on Monitor Card assembly.

tern similar to the one observed in (6) above? Can you change the programming and dendritic values to vary this pattern? Perhaps you can find a way to make the neural network truly random in operation.

(8) If you had more than one CyberBot in a room, would you expect them to all behave in the same fashion, or would you expect each unit to behave in a slightly different manner, owing to individual "mannerisms" often found in organic logic systems?

(9) Can you design your own Audio Neuron Card by using the Optical Neuron Card as an example? If so, what effect would it have on your CyberBot?

(10) Can you design your own Tactile Neuron Card (using microswitches mounted in the "shoulders" of CyberBot) that would avoid any obstacle in CyberBot's path? If so, how would you re-configure the motor drive neurons to allow CyberBot to back-up and move away from objects in its path?

Experimenting with CyberBot is fun and an interesting experience. Almost any type of neural condition can be emulated by CyberBot. CyberBot can also be expanded to include an Audio Neuron Card that will allow the unit to track sounds in the room, just like it seeks light with the Optical Neuron Card. Additionally, CyberBot can be fitted with a Tactile Neuron Card to allow it to navigate an obstacle course, avoiding any objects in its path to the light.

There are some interesting new "neural-slice" ICs on the market that may be perfect for your application. Also, some breadboarding pads have been provided on the Neuron cards for you to use in experimenting with CyberBot. Try your hand at your own modifications to CyberBot.

Nick Goss

Experimenting With the Z8 Single-Chip Microcomputer

It may not be the latest microcomputer chip, but it has plenty of life in it to get specialized jobs done

It's easy to forget that you don't have to use the latest technology in every project. However enticing the newest technological wonders may be, they often aren't required, or even the best suited, for a particular task. Something that's been around a while may be simpler to use, and cheaper as well. In the computer world, the Z8 is a single-chip microcomputer that has been in use for over a decade—a long time in terms of computer years—but still has plenty of life in it.

Zilog, Inc., probably best known for its popular Z80 microprocessor. manufactures the Z8. In contrast to the Z80, the Z8 is a complete single-chip microcomputer, with memory and bit-programmable I/O ports, as well as counter/timers and a UART (universal asynchronous receiver/transmitter) for serial communication. A special version of the chip, the Z8671, contains a BASIC interpreter in ROM for easy program development.

In this article, we'll explore the world of the Z8671 and other Z8s, including their architecture, interfacing, programming and resources for Z8 system design and programming.

About the Z8

The Z8 is especially suited for use in dedicated devices in which a program is embedded in EPROM or other memory device and, along with support circuitry, executes a single function or group of related functions. Possible Z8 projects include data-acquisition systems, motor controllers, programmable pulse or other waveform generators, electronic games, automotive applications, telephone switchers, intelligent instruments, process control and anywhere you might use a single-chip microcomputer or microcontroller.

The Z8 comes in many versions, ranging from ROM-less units to the Super8 series with expanded features and instruction set. Our focus here is on the Z8671, but the main features, with the exception of BASIC/Debug capabilities, are the same as or similar to those in other versions. At less than $10, the Z8671 offers a low-cost introduction to single-chip microcomputing.

For more on the Z8, Zilog publishes a *Z8 Family Design Book* that's several books in one, including data book, technical manual, application-note series, programmer's guide and

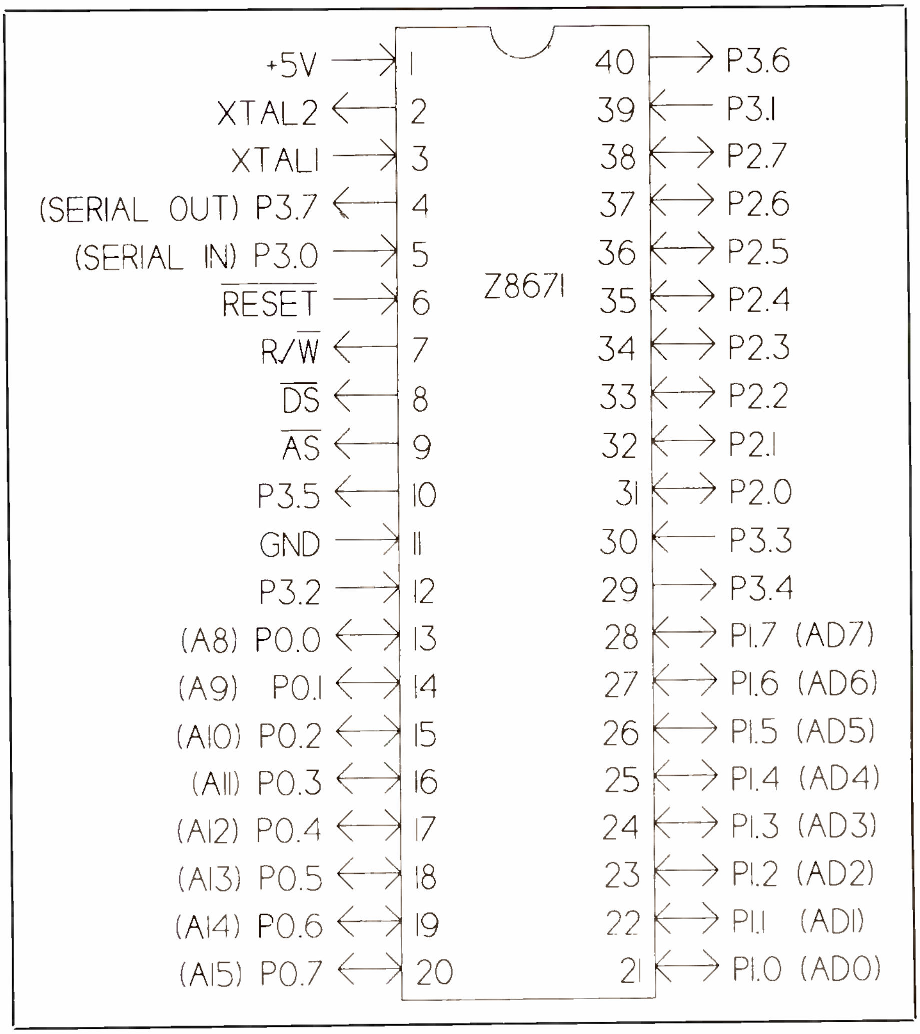


Fig. 1. Pinout of the Z8671 single-chip microcomputer with BASIC/Debug programmed into on-bound ROM.

subroutine library. A separate *Z8671 BASIC/Debug Reference Manual* describes BASIC/Debug. See the Sources box elsewhere in this article for more on these and other resources mentioned.

The Z8671's BASIC/Debug is a bare-bones programming language, with just 15 keywords. Still, it has enough capability for writing many types of programs. In addition, you can use it as a simple debugger for testing programs in BASIC or assembly language. BASIC/Debug makes it easy to examine and modify on-chip and external memory and to load and run programs written in assembly language.

Figure 1 gives the pinout of the Z8671. This IC can address up to 124 kilobytes of external memory: 62K each of data and program memory. An additional 2K of internal ROM contains BASIC/Debug. For smaller systems, the Data Memory Select (DM) control signal can be ignored, for a maximum 62K of combined data and program memory.

Two of the Z8671's four eight-bit I/O ports are dedicated to external memory access. Port 1 is a multiplexed address/data bus, Port 0 is the high-address bus for accessing external memory.

Two of Port 3's pins provide the serial interface to the UART in the Z8671, allowing communication with other serial interfaces, such as an RS-232 port on a PC.

The remaining port pins can be used as desired. Those pins with alternate functions (interrupt request, timer input and output, etc.) can be used for general-purpose input/output applications if the alternate functions aren't needed.

A Development System

Shown in Fig. 2 is a basic system that can be used for experimenting with the Z8671. I built this circuit with Wire Wrap hardware on perforated board. The circuit could also be built using point-to-point wiring, or by designing and making a printed-circuit board for it.

If you'd rather not build your own development system from scratch, the Sources box lists manufacturers of assembled and tested boards that contain a Z8, memory, serial interface and other circuit elements to use as a base on which to build your designs and experiments.

The Fig. 2 circuit contains a Z8671 with BASIC/Debug; 2K of RAM; a socket for a 2-kilobyte EPROM, EEPROM, or nonvolatile RAM; a serial interface for communicating with a desktop computer or terminal; 14 free port pins; and 34K of free memory area for connecting to additional memory devices or other circuit elements.

The circuit's serial interface connects to an RS-232 serial port on a desktop, or host, computer or terminal. By running a communications program on the host computer, you can communicate with the Z8, write and run programs in BASIC, upload BASIC and assembly-language programs from your host computer to the Z8 and download programs from the Z8 to the host.

The crystal frequency of 7.3728 MHz divides down for accurate baud rates for serial communication (according to the formula given in the Z8 manual).

The two memory ICs are RAM and either EPROM, EEPROM or battery-backed (nonvolatile) RAM for permanent program storage. The memory interface is typical of many other eight-bit systems. For each byte transferred between external memory and the Z8, the lower eight bits of the address are latched to the memory IC through an 74LS373 transparent latch, and the higher address bits and data bits interface directly to the memory ICs. The Z8's Read/Write (R/W) and Data Strobe (DS) control signals interface to the memory ICs' Output Enable (OE) and Write Enable (WE) pins.

On power-up, BASIC/Debug selects the Z8's slower extended-bus timing mode. So access time of the memory chips isn't critical.

The two halves of a 74LS139 2-to-4-line decoder provide address decoding, which selects and enables the memory ICs, and a baud-rate selector. Unused outputs of the 74LS139 can be used to select additional devices at specific addresses in the system.

The RAM is mapped from 800h to FFFh (h = hexadecimal). Any memory reads or writes to addresses in this range will access the RAM. The EPROM/EEPROM/NVRAM socket is mapped from 1000h to 17FFh. An EEPROM or NVRAM in this socket can be write-protected by jumpering its WE line to +5 volts. Addresses from 0 to 7FFh aren't used in external memory because this is where the internal ROM for the Z8 is located.

A baud-rate selector is provided by three 74LS125 tri-state buffers. When BASIC/Debug boots, it examines memory location FFFDh for a baud-rate setting to use for serial communication. In the Fig. 2 circuit, all memory accesses from C000h to FFFFh will access the baud-rate selector. (To free up portions of this memory area, additional address decoding could be added.) Jumpers or toggle or slide switches set desired baud rate, or you can hard-wire in a single rate, if you prefer.

Free areas of memory include a 2K block at 1800h, and 16K blocks at 4000h and 8000h. These can be used to access additional memory or other components.

The final circuit element is the serial interface, provided by the popular MAX232 chip. This chip converts the TTL-level outputs of the Z8671 to valid RS-232 transmit levels, and in the other direction converts received RS-232 signals to TTL levels for input to the Z8671.

The serial interface is required for program development when using BASIC/Debug. For final projects that don't use the interface, the MAX232 can be left out.

The circuit in Fig. 2 is powered by a regulated +5-volt supply. A 0.5-ampere supply is more than adequate.

To use the system, you connect its serial interface to a serial connector on the host computer (usually a 25- or nine-pin male subminiature D-type connector). Figure 2 shows the pin connections for a typical 25-pin male D connector. For a nine-pin male D connector, the pinout is typically as follows: pin 2—receive (data in); pin 3—transmit (data out); and pin 5—ground.

Since RS-232 connections are notoriously unpredictable, always verify that your wiring is correct. Check the pinout on the host computer's serial connector to verify that its data output connects to an input on the MAX232 and that the MAX232's

**Sorry, sir, the computers are busy—
I'll have to help you in person.**

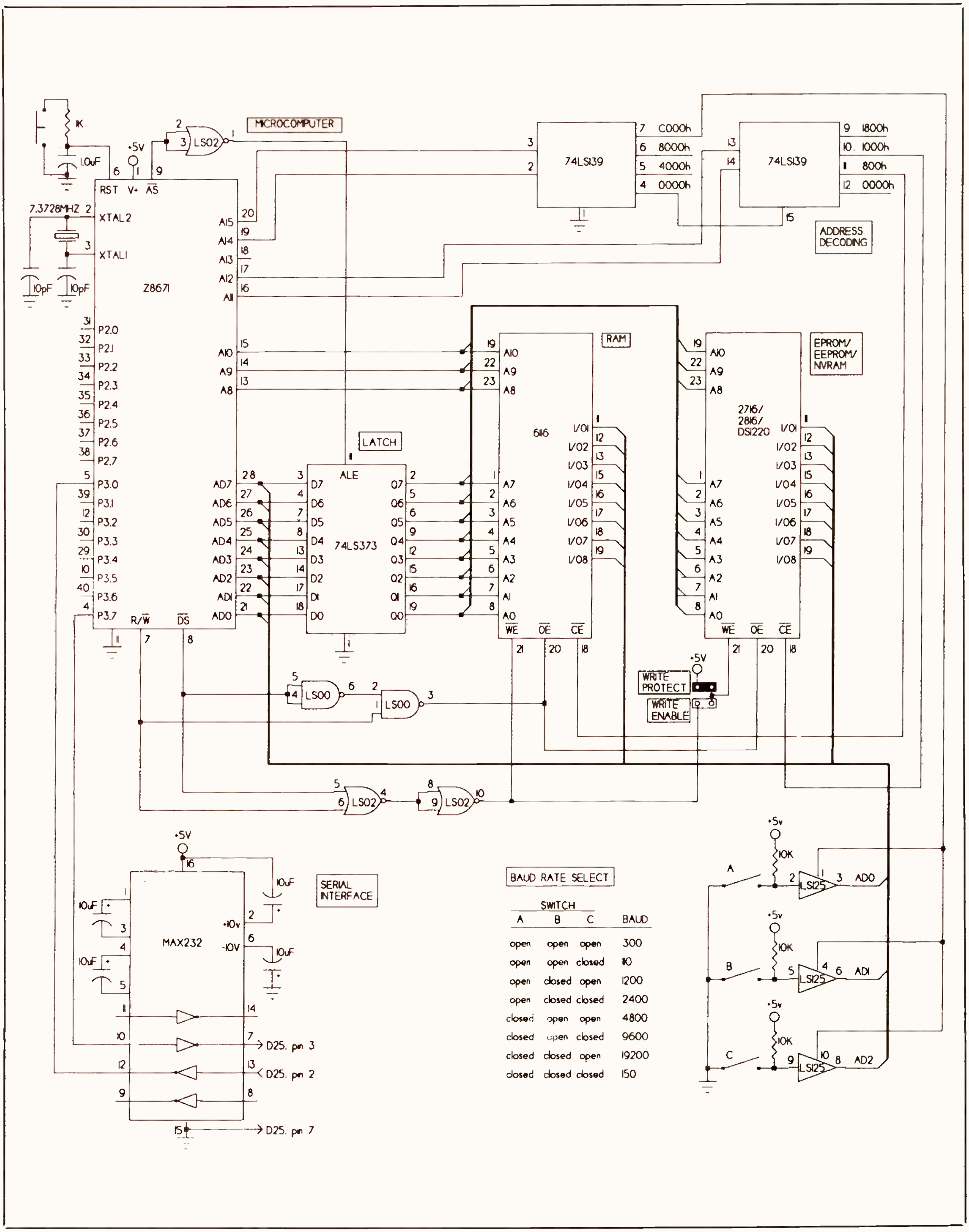


Fig. 2. A development system for the Z8671, including RAM, nonvolatile memory and serial interface.

output connects to an input on the host computer.

To communicate with the Z8671, run a communications program (*Procomm, Kermit* or whatever other one you prefer) on the host, setting the communications protocol for the baud rate you've selected on the Z8671 board, with eight data bits, no parity and one or two stop bits. (The Z8 adds two stop bits to transmitted data, and received data must have at least one stop bit.)

Using BASIC/Debug

When the Z8671 powers up or is reset, the ":" BASIC/Debug prompt appears on the host computer's screen. From here, you can write and run programs in BASIC, execute statements in immediate mode and upload and download programs.

Figure 3 shows BASIC/Debug's keywords and operators. If you're used to QuickBASIC, or even GW BASIC, BASIC/Debug will seem primitive. You won't find control structures like WHILE . . . WEND or even FOR . . . NEXT loops. Only integer variables and calculations are allowed, and 26 variables—from A to Z—are the maximum.

BASIC/Debug does, however, permit you to write and execute many simple programs quickly. For its intended use, the elaborate text-formatting, graphics and similar capabilities found in other BASICs aren't needed. Listing 1 shows an example BASIC/Debug program that prompts for a memory location and then prints the contents of the 16 bytes beginning at that location.

GO	Unconditionally branches to a machine-language subroutine.
GOSUB	Unconditionally branches to a subroutine specified by line number.
GOTO	Unconditionally branches to a line number.
IF/THEN	Initiates a conditional operation or branch.
LET	Assigns the value of an expression to a variable or memory location.
INPUT/IN	Requests information from the user with "?" prompt, then reads input values (separated by commas) from the keyboard and stores the values in the indicated variables. INPUT discards values remaining from previous IN, INPUT, or RUN statements. IN uses values left in the buffer, then requests new data.
LIST	Displays program listing.
NEW	Resets R4-R5, indicating that RAM is ready to store a new program.
PRINT/ PRINT HEX	Displays text messages or numeric values. PRINT HEX displays values in hexadecimal.
REM	Indicates unexecuted comment or remark.
RETURN	Ends a subroutine by returning control to the line following a GOSUB.
RUN	Causes the current program to execute.
STOP	Ends program execution and clears GOSUB stack.
USR	Unconditionally branches to a machine-language subroutine. Can pass and return up to two variables.
+	Addition
-	Subtraction
*	Multiplication
/	Signed division (range: -32768 to +32767)
\	Unsigned division (range: 0 to 65535)
=	equal
<=	less than or equal
<	less than
<>	not equal
>	greater than
>=	greater than or equal
AND	logical AND
%	hexadecimal (otherwise decimal)
@	indirect byte address
^	indirect word address

Fig. 3. Keywords, operators and special characters available in BASIC/Debug.

In BASIC/Debug, reading from and writing to external and internal memory, including ports and other registers, uses the signal character @, rather than BASIC's usual PEEK and POKE statements. For example, the statement PRINT @2048 causes the contents of memory location 2048 to be displayed on the host computer's screen. A % prefix indicates hexadecimal. Therefore, the statement PRINT @%800 gives the same result as the previous example.

The statement @%900@%F8 writes the value F8h to location 900h.

At times, you may want to examine or modify the value of a 16-bit word, rather than an eight-bit byte. For example, BASIC/Debug stores the address of the first location in external RAM in Registers 8 and 9. To determine this value, you could read both registers and add their weighted values, but there's an easier way. The signal character " " references a 16-bit word consisting of the specified byte and the one following it. So the statement PRINT 8 displays the 16-bit value (from 0 to 65,535) stored in Registers 8 and 9.

Although BASIC/Debug has no FOR...NEXT loops, you can accomplish the same thing by using an index, or count, variable, an IF...THEN statement that tests the value of the index variable and calls a subroutine if the IF statement is true. Listing 1 uses this technique to step through the 16 values it displays.

BASIC/Debug indicates syntax and other errors by number only. The numeric codes are explained in the BASIC/Debug manual; so at first you'll want to keep this handy as you program. You'll soon memorize the codes that pop up often.

BASIC/Debug's line editor lets you backspace to correct typing mistakes, but once you press RETURN, the entire line must be typed again to make a change. Instead of entering a long, involved program from within BASIC/Debug, you can write a program with a text editor that produces pure ASCII output, and then use your communications software to upload the program to the Z8 system's memory. In the other direction, downloading a program to the host computer is an easy way to save your code for re-loading.

Most communications programs include functions for uploading and downloading files. These are the same functions used for sending and receiving files to and from a BBS, and the procedure is similar when transferring files from and to the Z8671. Select ASCII format for the transfer, and use a LIST statement to download the current BASIC/Debug program to the host computer. Uploading a program in ASCII format will store it in RAM as if you had typed it in at the keyboard.

On power-up, BASIC/Debug tests external memory non-destructively, beginning at 800h, to see how much RAM the system contains. A pointer to the high boundary of RAM is stored in an internal register. A small area of RAM is reserved for storing variables, the input line buffer and GOSUB stack.

Circuits that have a program stored in EPROM may have no need for external RAM. In this situation, BASIC/Debug uses the Z8's internal registers for storage, with some operating limitations due to the reduced memory available.

If a program is stored in nonvolatile memory, BASIC/Debug can run it automatically on power-up. On power-up, BASIC/Debug checks external memory location 1020h, and if it finds a program, automatically runs it. This feature allows you to develop a program in RAM, then transfer it to EPROM, EEPROM or nonvolatile RAM for permanent storage and automatic starting.

If you've developed a program in RAM and want to save it to a file for use with an EPROM programmer, you need to save the code exactly as it's stored in the RAM. Although LIST works well for downloading files for later uploading, the LIST statement adds line feeds and translates line numbers from binary format to ASCII; so it's not suitable for downloading files for EPROM programming.

A solution is to download the file in binary format. Listing 2 is a short program that writes the current program in RAM to the serial port in binary format. This listing can be appended to any BASIC/Debug program and called with GOTO 10000. To use this technique, the host computer must be able to receive and save files in the binary format. ASCII downloading protocols strip nulls and/or the eighth bit of each byte; so it won't work for this purpose.

Another option for saving a BASIC program is to copy the program directly into a nonvolatile RAM or EEPROM. Listing 3 is a program that can be appended to a BASIC/Debug program to copy the current program to memory beginning at 1020h. GOTO 10000 causes the program to be copied. After copying, the WE line of the nonvolatile RAM or EEPROM must be jumpered to +5 volts to prevent overwriting and provide autostarting. Or the IC can be removed and inserted into an EPROM programmer that can then copy the contents into an EPROM.

Port 2's pins and the six remaining Port 3 pins can be used to interface to switches, LCD or LED displays, analog-to-digital or digital-to-analog converters or other devices and components. The ports have active pull-ups and pull-downs that are compatible with TTL loads. As Fig. 1 shows, the direction of Port 3's pins is fixed, while Port 2's pins can be programmed individually to serve as inputs or outputs.

Zilog's BASIC/Debug manual contains definitions and examples of each keyword, as well as sections on how BASIC/Debug uses memory and programming tips for maximum execution speed and minimum memory use.

Assembly-Language Programming

For functions that BASIC/Debug can't handle, you can program in as-

Listing 1. BASIC/Debug Program Prompts for a Memory Location and Displays Values Stored in 16 Locations, Beginning With Requested Location.

```
10 PRINT "beginning address?"
20 INPUT X:REM beginning memory location to display
30 A=0
40 IF A<16 THEN 100
50 STOP
100 PRINT HEX(@(X+A)):REM display stored value
110 A=A+1
120 GOTO 40
```

Listing 2. Program Transmits BASIC/Debug Program in Binary Format to the Z8671's Serial Port.

```
10000 X=0
10010 GO @%61,@(%800+X):REM write byte to serial port
10020 IF @(%800+X)=%FF THEN STOP
10030 X=X+1
10040 GOTO 10010
```

Listing 3. Program Copies a Program From RAM Into EEPROM or Nonvolatile RAM for Permanent Storage.

```
10000 X=0
10010 @(%1020+X)=@(%800+X):REM copy RAM byte to NV memory
10020 IF @(%1020+X)=%FF THEN STOP
10030 X=X+1
10040 GOTO 10010
```

sembly language and call the program from BASIC/Debug. For low-cost (free) assembly-language programming, I discovered two versions of a freeware Z8 cross-assembler on the Circuit Cellar Ink BBS (see Sources box). Z8CA1PC.ARC for MS-DOS computers assembles programs in Intel hex, Motorola S-record or a special Z8 file format. Z8CA1AM.ARC is an Amiga version of the same assembler.

After assembling a program, you can program an EPROM or other memory IC with the assembled code or simply upload the file into the Z8's external RAM for testing.

The special Z8 file format is handy for uploading to RAM. A short (five-line) BASIC/Debug program, along with a communications program, uploads a program assembled in Z8 format to the desired location in memory in the Z8 system. Once the program is loaded into memory, you can call it from BASIC/Debug with a GO @ statement. More details on this and how to use the assembler are given in the documentation files.

Full-featured Z8 assemblers are available as well from Zilog and others. Another possibility is to use a universal cross-assembler that supports the Z8. Such a cross-assembler is a single program that assembles programs for a variety of microcomputers from different families.

A convenient feature of the Z8's architecture is that any of its general-purpose registers can be used as an accumulator, address pointer, index register or on-chip stack. This contrasts with many other devices in which specific registers are dedicated to these purposes, and, for example, all calculations must be funneled through an accumulator.

An inconvenient Z8 feature is that several of its internal registers are write-only. To configure the I/O ports, you write values to their mode registers, but there's no way of reading the values back.

Packaging options for the Z8671 include a 40-pin DIP (dual in-line package) and a 44-pin surface-mount chip carrier. Besides the Z8671, other Z8 versions (none of these have BASIC/Debug) include the following:

Z8681/82—A ROM-less version. Like the Z8671, but without BASIC/Debug in ROM. Assembly-language or compiled programs must be stored in external memory.

Z8603/13—A ROM-less version with a piggyback socket for a 2716 or 2732 EPROM. This space-saving version allows you store a program in EPROM without having to wire the EPROM to the Z8. Since standard EPROMs are used, no special adapters are required for your EPROM programmer, unlike many other microcomputers that have embedded into them EPROMs.

Z8601/11—Contains mask-programmed user program in 2K or 4K of ROM. For mass production of chips with a single program.

Z8600—A 28-pin version.

Z86C91—A CMOS ROM-less version.

Z8800—A Super8 version, with improved instruction set that includes multiply and divide instructions, Boolean and BCD (binary-coded decimal) operations, DMA (direct memory access) controller, ability to run at 20 MHz and other improvements.

Z86C27/97 DTC digital television controller. An application-specific version, containing a Z8, an on-screen-display video controller and 13 pulse-width-modulator outputs. It's meant for use in color-television control products. Zilog is continuing to develop other application-specific Z8s meant for specialized markets.

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

Next time: low-power designs for battery-powered projects.

Jan Axelson

Sources

BASICON, Inc.
14273 NW Science Park Dr.
Portland, OR 97229
Voice: 503-626-1012
FAX: 503-643-4686
MC-1z microcontroller board with Z8 BASIC/Debug, expander module, Z8 assembler

Circuit Cellar Ink BBS
Modem: 203-871-1988
300/1,200/2,400 bps, 8-N-1
Z8 cross assemblers

Jameco
1355 Shoreway Rd.
Belmont, CA 94002
Voice: 415-592-8097
FAX: 415-592-2503
Z8 chips

JDR Microdevices
2233 Samaritan Dr.
San Jose, CA 95124
Voice: 1-800-538-5000
FAX: 1-800-538-5005
Z8 chips

Micromint
4 Park St.
Vernon, CT 06066
Voice: 203-871-6170
FAX: 203-872-2204
BCC11 Z8 BASIC Computer, expansion boards, Z8 FORTH chip

PseudoCorp.
716 Thimble Shoals Blvd.
Suite E
Newport News, VA 23606
Voice: 804-873-1947
FAX: 804-873-2154
Z8 assembler, disassembler, simulator

Software Science
3750 Roundbottom Rd.
Cincinnati, OH 45244
Voice: 513-561-2060
ProtoQuick Z8 development board, application notes

Zilog, Inc.
210 Hacienda Ave.
Campbell, CA 95008-6609
Voice: 408-370-8000
Z8 single-chip microcomputer; *Z8 Family Design Handbook* (No. 03-8275-03); Z8671 *BASIC/Debug Reference Manual* (No. 03-3149-03) ■

Computer Viruses

The ins and outs of computer viral infections

Some children believe in ogres and bogeymen. Rational adults, like those of us who use computers, are supposed to be too mature and intelligent for such nonsense. But if you walk into a users-group meeting and start a conversation about computer viruses, you'll find a credulous audience that will shudder at each mention of computer infection. And some users are ready to blame everything from a misaligned disk drive to a file misplaced in the directory tree on some insidious virus attack.

Unlike bogeymen, computer viruses do exist and can wreak a great deal of harm. But they don't seem nearly as prevalent as some publishers of anti-viral software, and some members of the mass media, want us to believe. Besides, if you're careful, you can keep viruses out of your computer system and off your company's network. And part of that care is understanding just what a virus can and can't do.

A virus is nothing more than a program or piece of a program that someone has written. If it attacks your computer system, you or someone else put it there and ran it. A virus can't magically leap across phone lines. In fact, it can't do anything until you run it or the program that contains it. Of course, few people would purposely harm their computers and data by installing a virus. Usually, the virus programmer gets you to run the virus by hiding it in a useful or entertaining program. Once you run the virus, it can perform whatever actions its programmer intended. Unfortunately, that's often some form of maliciousness.

Several kinds of malicious programs often get lumped together under the generic term "computer virus." But each has a different purpose and effect, and each requires a different form of detection and prevention.

The simplest kind of malicious program is called a "logic bomb." Often inserted into a normal application program, a logic bomb seems to do nothing at all—until it detects some condition inside the computer. This may be a specific date on the computer's clock, a special string typed on the keyboard or anything else a program can detect. When the condition occurs, the logic bomb comes to life and performs its maliciousness. Logic bombs are sometimes hidden in a company accounting or database program, put there by a disgruntled programmer or other employee.

"A virus can't magically leap across phone lines . . . you or someone else put it there."

In the past, some shareware programs contained logic bombs to force users to register the software or stop using it. But such programs soon were erased from bulletin boards and shareware diskettes because of user uproar over lost data files and threats of lawsuits and criminal prosecution against anyone who deliberately wrote a program that would destroy other people's data.

Another simple but malicious program is called a "Trojan." The name comes from the Trojan horse the Greeks used to enter and capture the city of Troy. A Trojan is a program that seems to be doing something interesting or entertaining but is secretly erasing files or reformatting your hard disk while it's running.

Trojans are the simplest malicious programs to write and often the easiest to detect. The program's wild claims often make a Trojan easy to spot. For example, would you run a free utility that was only 4,000 bytes long and claimed to speed up all of your spreadsheet calculations by a factor of four? If so, I've got a bridge you might like to buy.

"Worms" are a little more complex than Trojans and logic bombs. A worm's goal is usually to work as long as possible on your computer without attracting your attention. As a worm runs, it "wiggles" through your data, either in disk files or in memory, changing random bits or bytes. More insidious, the result in a text file might look like just a few extra typographical errors that your spelling checker missed. The result in an important spreadsheet file or accounting program could be disastrous to your business.

The problem with a skillfully-written worm program is that you may not detect it until you've used the corrupted data for an important purpose or overwritten your last pre-worm backup disks or tape. Some worms make very subtle changes that aren't immediately obvious.

A "virus" is more complex than a logic bomb, Trojan or worm, but it may contain elements of any or all of them. A virus is a block of program code that knows how to copy itself from a running program to one or more executable programs on your disk. When those programs are run, the virus is executed again and can infect still other programs. Viruses that contain a worm or logic bomb can infect dozens, hundreds or even thousands of executable programs before they're detected and eradicated.

Techniques that viruses use to infect programs aren't at all complex. The structure of .COM and .EXE executable files are well-documented.

An assembly-language programmer can easily write code that can insert itself into either kind of program file and that will be executed before the underlying program begins.

Viruses are often written to insert themselves into COMMAND.COM, the program that provides the DOS user interface and runs every time you boot your computer. From COMMAND.COM, they can spread to every file on your system.

Other viruses infect the boot records on your hard drive or floppy disks. The boot record is a short program that runs whenever you boot up your computer. Normally, all it does is load and execute the core of DOS. The boot record on a floppy data disk simply displays a message that states on-screen that it's a non-system disk. If a virus can infect the boot record, you'll run it every time you boot your computer.

The damage that a virus does is, of course, a decision made by whoever wrote the original program code. An early and famous virus printed "Gimme a cookie" on the screen. As soon as the user typed "cookie," the message disappeared and the user could continue working. However, once the cookie virus infected a program, the message appeared with increasing frequency until the application was no longer usable. Other relatively benign viruses use up all free disk space or hide all subdirectories.

More malicious programs erase files or subdirectories, reformat the hard disk or try to boost the video card output frequency so high that the monitor will self-destruct. In other words, their perpetrators are dangerous criminals who have no respect for anyone else's property. For some reason, these people find amusement in destroying unknown victims' computer systems.

Detecting a Virus

There are several commercial and shareware programs that will detect viruses that have infested computers and help you prevent future attacks. These programs generally use one or more of the following tactics.

A virus works by adding its own code to an executable file already on your disk, either making the file longer or replacing some of the code or data already in the file. If you know that a file hasn't been infected, it's an easy matter to make sure that a virus never attacks it.

A simple way to protect a file is to make sure that its length never changes, and that is the first line of defense of many protection programs. If the length of an executable file does change, and if you haven't written and modified the program yourself, then it's likely that a virus has attacked it.

A more thorough method of making sure an executable file doesn't change is to calculate a unique number for each file. Simple programs find the sum of all bytes or two-byte words in the file, which is called a checksum. More complex but surer methods use one or more CRC (Cylindrical Redundancy Check) algorithms to find a unique number for every file. A clever programmer can hide new code in a program without affecting the checksum, but it's extremely difficult to fool a CRC algorithm.

Anti-viral programs that use this strategy read all important or all executable files and record the length and CRC or checksum of each in a database. They later scan through the files, perhaps each time a program is run, to make sure that neither the length nor number has changed.

However, some legitimate application programs record user options in their own executable files. For example, if you change screen colors or key mappings, an application might record the new information in the .EXE file instead of an options file. When this happens, a virus-checking program might refuse to let the program execute because it will have a new CRC or perhaps new length. Partially because of this potential conflict with virus-checkers, this simple way of recording user options seems to be losing popularity.

Another problem with this antiviral strategy is that it makes program development difficult. If you're writing your own programs, even simple utilities or games, you'll want to exclude them from the checks until you've finished developing them. If you don't like this, a virus-checker will object to every new version you compile.

Like every program, every virus is a unique collection of bytes. Once someone has identified a virus, it doesn't take too much work to find a string of bytes that are unique to the virus. An anti-viral program can then scan through every file on your disk and look for that signature string. If it finds the string in a file, that file is probably infected.

This is the thinking behind a large group of virus-detection programs. They contain the signatures of dozens of known viruses. They can scan all executable files on your disk looking for each string. If they find a match, they report which program file appears to be infected.

Such programs are great for identifying and finding a virus that may already be infecting your system. The search takes a while, of course, but it's thorough. And these virus-hunting programs manage to avoid most of the problems and inconveniences of the programs that collect file length and CRCs.

But a virus-hunting program is only as good as its list of signature strings. If you use such a program, you must make sure that you always have the latest version in order to catch the most-recent (and, therefore, probably most-prevalent) viruses.

The strategies I've discussed so far may help you keep your computer virus-free, but they won't protect you from non-virus Trojans and logic bombs. To keep such programs from doing damage, there are "watch" programs that sit in your computer's memory and keep a sharp lookout for unexpected attempts to access your hard disk directly, change the system date or perform other mischief.

These programs work by monitoring the interrupt calls all programs make to use DOS and BIOS services. Some interrupt services are normal and benign, and these watchful programs let calls to these services proceed as normal. But other service requests are suspicious: why should an application program attempt to read your hard disk directly, for example? And why should any program want to reformat your hard disk?

These programs give DOS the low-level access to your computer it needs, but they keep application programs well-behaved. If you do run a program or infected application that tries to maliciously attack your system, a watch program may be able to ward off the attack.

However, you may have some utilities on your disk that legitimately use low-level services. If you do, you'll have to turn off the watch program each time you run one of these special utilities.

Avoiding Problems

You can use special programs to protect your computer from a virus. Some of those programs are very expensive, but they're undoubtedly worthwhile for large networks and other computers with sensitive data. But with a few simple steps, you can do a lot to protect your system without resorting to anti-viral utilities.

Your computer can't be hurt unless you (or someone else) loads and runs a viral or malicious program. If you avoid such programs, you have nothing to worry about. Of course, you can also escape having a cold by avoiding cold viruses. But doing so is nearly impossible. It's much easier to avoid infected computer programs, however.

The first rule is to get all your software from safe sources. Write your own software, buy commercial programs in shrink-wrapped packages, download programs from only major information services and bulletin boards, and buy shareware disks from only very reputable dealers. None of these steps absolutely ensures that your system won't be harmed, but they go a long way towards meeting that goal.

It's possible that a bug in your own, hand-crafted program may harm data on your disk. Most programmers know how to avoid this kind of catastrophe by taking such actions as running potentially dangerous programs from floppy disk and using modern debuggers to thoroughly test the dangerous sections of code.

It's also possible that a commercial program might be infected with a virus. At least one company has accidentally shipped an infected application with a virus that came from a game on a free-lance programmer's machine. But most software companies take many precautions to make sure that their software is virus-free because their reputations and, consequently, businesses could be ruined with one mistake.

The same is true for information services like CompuServe and major bulletin boards. Operators of these services test programs thoroughly and run several virus checkers before making any program available for downloading. Their time and efforts are justified by the confidence that their users have in the software that's available.

Don't ever run a program that comes from "a friend of a friend," especially if it's a pirated application or game. This warning also extends to programs that show up unsolicited in the mail. If you were malicious enough to want to infect other people's computers with a virus, how would you get them to run the infecting program? How about distributing a "free" or "beta" copy of a major application or game? Or by shipping a disk to everyone on a computer mailing list. Put on a label that says "Type A: RUNME," and your virus will start to spread quickly.

Operators of small bulletin boards can't always afford the time to check each new program thoroughly. If you download a program from a bulletin board, make sure that it has been available for at least a couple of weeks. By that time, someone else who downloaded it will have tried it and warned the BBS operator if the program contains a virus.

A second way to protect your system is to back up your hard disk regularly. If a malicious program should attack your computer and delete files or reformat your hard disk, you'll be able to restore the system easily and quickly. Unfortunately, most schemes for backing up data aren't satisfactory for anti-virus backups. It's quite possible to restore infected files from backup disks or tape and have a still-infected computer.

In addition to using a normal rotating backup system that would normally protect your data, you should also make occasional archive backups of your entire hard disk. These backups should be put away and not over-written, at least not for several months. If your system is attacked, you can go back to the last backup you know to be clean and work forward from there, restoring more-recent files from your daily backups as you test their validity with an anti-viral program.

"Don't ever run a program that comes from a 'friend of a friend'."

This kind of backup sounds expensive because you'll have to dedicate several diskettes or tapes for archival purposes. But it's a lot cheaper than losing an entire system because of a virus. You'll have to decide how much your data and custom applications are worth.

One insidious effect of some active viruses is that they can infect distribution files on floppy disks when you install new software. For that reason, it's prudent to put a write-protect tab of every distribution diskette you obtain, copy the entire diskette to a new disk and then install the program from the copy.

If you want to invest in an anti-virus program, there are many to choose from. *Viruscan* ($25) and *Clean-Up* ($35) are a pair of popular shareware programs from McAfee Associates. The first scans your files and disk boot sectors looking for known virus "signature" strings. You can use *Clean-Up* to remove most viruses from infected program files.

Flu_Shot+ from Software Concepts Design ($19) is a popular watch program that has several interesting enhancements. You can give it a list of programs (such as the DOS FORMAT utility and your favorite TSRs) that have the right to act "suspiciously." It will let those programs behave normally but will trap most virus activities.

If you prefer commercial software, you'll find many anti-viral programs available. Central Point Software's *Anti-Virus* program combines both watch and scan programs. It knows the signature strings of 800 viruses and lets you add new signatures as additional viruses are trapped and identified. You can download new strings from Central Point's bulletin board and from its CompuServe forum.

No matter what program you choose, make sure that you can get frequent updates. An anti-viral program that can identify only last year's viruses is worse than useless because it will give you a false sense of security. Several new viruses appear each month, and you should be able to get updates of an anti-viral scan program every four to six weeks.

I'm afraid that this discussion of viruses has made them sound like the bogeyman that some people think they are. But if you take simple precautions, you may never see a virus on your computer at all. In 10 years, none of my computers has been infected, even though I load and test dozens of new programs monthly.

The people who write and distribute viruses are the computer equivalent of vandals and thugs. I don't spend my time huddled in a corner of my house in case someone decides to vandalize it, nor do I spend my computing time putting up every virus protection measure I can think of. I'm aware of the potential for infestation and take some simple precautions, including frequent and thorough backups.

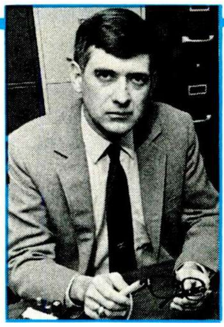
If you really want to worry about your computer, think about how much data is crammed onto the small surfaces of your hard disk and about how a few quantum events could destroy crucial bits or how a speck of dust or a worn bearing could wipe out your entire hard disk. Or worry about the possibility of a lightning bolt striking your power system and zapping all the electronics in your computer. Both are probably as likely to occur as a virus infection on most individual computers.

You probably take reasonable precautions against both of those risks and then forget about them. You should do the same about the risk of a computer virus infection.

USE YOUR FREE INFORMATION CARD

Free Product Information

Readers can obtain free information on products advertised, as well as for some editorially mentioned products. Simply circle the appropriate number printed below an advertisement onto the CC "Free Information Service" card bound into this issue. After filling in your name and address, just mail the postpaid card. Your request will be forwarded directly to the advertiser with a mailing label prepared by our reader-service department.



Forrest M. Mims III

A Wireless Audio Output Port For Your Computer

In the October 1991 issue, I described an optical interface port that permits a computer to control external devices without a direct wire connection between computer and device being controlled. Briefly recapping, the technique consists of attaching one or more light-sensitive photodiodes to the computer's monitor. When a pixel adjacent to a photodiode is illuminated, the resulting photocurrent is amplified and used to actuate a relay.

One limitation of the optical interface port is that it doesn't work with liquid-crystal displays that aren't equipped with a back light. And a drawback of the method is that the photodiode, or optical fiber that leads to the photodiode, must be physically attached to the screen (unless you use a miniature lens assembly to view the screen from a distance).

An alternative to both limitations that doesn't require a direct wire link between a computer and device being controlled is an audio output port. This kind of port will work with most computers that can be programmed to produce a tone—and it doesn't require a physical connection to the computer.

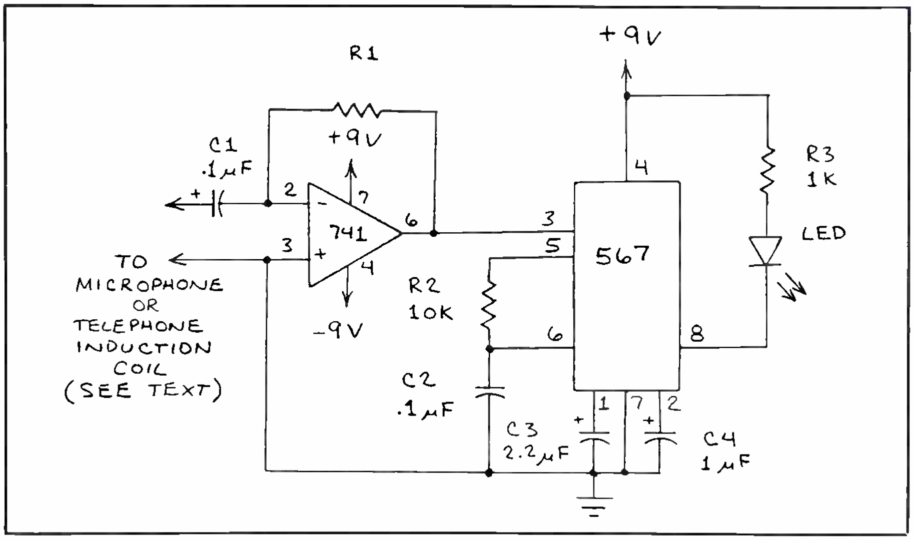


Fig. 1. An audio interface port for a personal computer.

Why a Wireless Port?

Standard methods for controlling an external device with a computer use the computer's serial port or parallel printer port. The computer's bus can also be used for this purpose. Of course, these methods require that wires be connected between the computer and whatever is to be controlled. They also use up a port socket or expansion slot.

Optical and audio interface ports require no wire connection to the computer. Therefore, they can provide complete electrical isolation between computer and device being controlled. They don't occupy a card slot or serial port. They can also be used with other kinds of electronic devices. For example, an optical interface can detect when an indicator light is on or off. An audio interface can detect sounds produced by a smoke alarm, microwave oven, alarm clock and digital timer. Therefore, both optical and audio interface ports might be adapted for use by people who lack normal hearing or vision capabilities.

Audio Output Port Design

A basic audio port requires an audio transducer (microphone or induction coil), an audio amplifier and a relay driver. This combination will respond to sounds from a computer, but better results will be obtained if your circuit includes a frequency discriminator or filter that responds only to a sound of a particular frequency. Circuits like this, known as tuned amplifiers, active filters and tone decoders, significantly reduce the amount of false triggering that would otherwise occur.

There are several ways to design tuned amplifiers. One is to use a resistor-capacitor network and an op amp. The result is an active tuned filter. Another is to use a switched-capacitor filter.

No matter which way the tuned amplifier is designed, all it does is pass a signal to which it's tuned. Therefore, some kind of output detector is required before the signal will trigger a relay. One way around this is to use a phase-locked loop (PLL) instead of a tuned amplifier.

Phase-locked Loops

A phase-locked loop is a sophisticated analog or digital circuit that automatically tracks the fluctuating frequency of an input signal. A particularly useful PLL for our purpose is the 567 tone decoder. This eight-pin chip includes an adjustable internal oscillator. When an incoming frequency matches the frequency of the 567's oscillator, the loop's error voltage that signifies the difference between the two frequencies falls to zero and the chip's pin 8 output goes low. The output goes high when the incoming signal is removed or if its frequency shifts away from that of the 567.

In Fig. 1 is shown a simple 567 audio interface you can build. The circuit will work with a microphone if the computer produces a sufficiently loud tone. Since many computers don't produce a loud enough tone, I prefer to replace the microphone with a standard telephone induction coil. The coil must be mounted within a few centimeters of the computer's speaker. Since the induction coil is an electromagnetic device, it will only work with magnetic speakers, not the piezoelectric variety that's used in some small computers.

The 741 op amp boosts the strength of the signal from the microphone or induction coil and passes it directly to input pin

3 of the 567 PLL tone decoder. The tone-detection frequency of the 567 is determined by the values of *R2* and *C2*, using the formula F = 1.1/R2C2. The value of *R2* should be between 2,000 and 20,000 ohms. With the values shown in Fig. 1, the expected detection frequency is approximately 1.1 kHz. The actual detection frequency, however, is affected by tolerance variations of the components in the circuit. Therefore, I wasn't surprised when the prototype circuit I built yielded a center frequency close to 1 kHz.

The bandpass of the 567 is determined by the value of *C4*. The value of this capacitor in microfarads should be n/f, where *f* is the 567 center frequency and *n* ranges from 1,300 (for a bandpass of up to 14% of f) to 62,000 (for a bandpass of as little as 2% of f). The usable bandpass of the prototype circuit extended from 936 to 1,081 Hz. This is the range over which the 567 was triggered when the circuit was used with a computer.

Since the 567 is specified for operation at a potential ranging from 4.75 to 9 volts, the power supply voltage shouldn't exceed ±9 volts. I used two 9-volt batteries to power the prototype circuit.

The Fig. 1 circuit drives a LED through current-limiting resistor *R3*. The LED is helpful for adjusting the circuit and checking its operation. For practical applications, the LED and *R3* can be replaced with a low-voltage relay that switches on over a range of from 5 to 9 volts. The relay's coil should have a resistance of at least several hundred ohms. I used a Radio Shack Cat. No. 275-005 relay with the prototype circuit. This relay has a 500-ohm coil and pulls in at from 7 to 9 volts. It's spdt contacts can switch up to 2 amperes.

Caution: To avoid the possibility of a dangerous electrical shock, you must properly insulate and protect all connections if you use a relay to switch power to any ac-line-operated device.

Testing the Audio Port

I experimented with the basic Fig. 1 circuit with several computers. Since the 567 requires a minimum input signal level of around 2 volts or so, the sound from only one computer was loud enough for a microphone to be used without removing the computer's cabinet. Therefore, I replaced the microphone with an induction coil and achieved much better results. Another benefit of using an induction coil is that the circuit is immune to interference from ambient sounds.

If the speaker in the computer is installed close to the case and if the case is made from plastic, you might be able to attach the induction coil's suction cup directly to the case. First, you have to determine the exact location of the speaker. One way to do this is to instruct your computer to generate a tone that lasts for 10 seconds or more while you move the induction coil around the case and observe the result.

The BASIC statement for creating an audio tone is SOUND F,T, (where F is the frequency in Hz and T is the duration). Therefore, go to BASIC and type SOUND 1000, 1000 and hit ENTER. Then begin probing with the induction coil while observing the output LED. If the LED flickers or flashes, you're close. Move the coil slowly until the LED stays illuminated. Mark the exact location of the best spot on the enclosure with a small piece of tape.

If the LED doesn't light, the center frequency of the 567 is out of range or the computer's speaker is too far from the cabinet wall. First, try changing the frequency of the tone generated by the computer by varying F in the SOUND statement. For example, SOUND 1100, 1000 will produce a 1.1 kHz tone.

If changes in the SOUND statement don't work and if you're sure you've assembled the circuit properly, then you'll have to place the induction coil closer to the computer's speaker. Some computers feature an external audio port. You can connect a small amplifier with a speaker to this and then place the induction coil adjacent to this external speaker.

If your computer doesn't have an audio port, you must remove the computer's case to gain better access to the speaker. Switch off the computer, remove the power cord from its receptacle and remove the case. Then reconnect the power cord and switch on the computer.

Caution: Make sure the computer is switched off and the power is disconnected *before* removing the computer's case. Dangerous electrical voltages are present in the power-supply portion of a computer powered by the ac line. Therefore, do *not* touch any exposed cards or components inside the computer when the case is removed.

After the computer is running again, enter a SOUND statement and place the induction coil adjacent to the back or front of the speaker. Change the SOUND

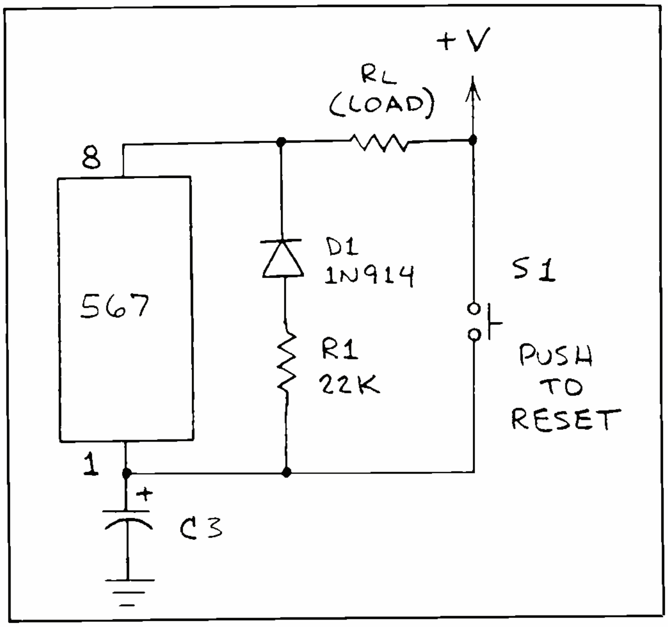


Fig. 2. A latching circuit for the audio interface circuit.

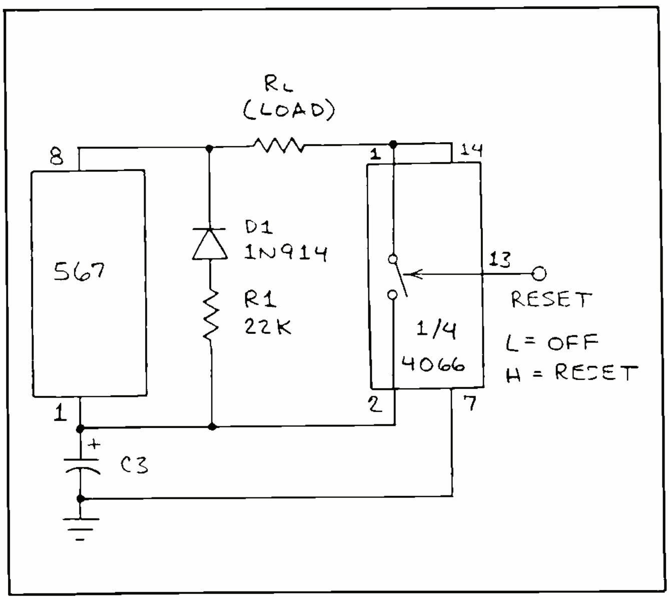


Fig. 3. A digitally resettable latching circuit for the audio interface circuit.

F value as necessary until the LED glows continually.

This simple routine will let you make quick changes in F:

```
10 INPUT "FREQUENCY";F
20 SOUND F,25
30 GOTO 10
```

When entered and run, this routine will ask you to enter any desired frequency. It will then generate that frequency for several seconds and ask you to enter another choice.

Another way to check the response of the 567 is to use a routine that generates a stepped series of tones. For example:

```
10 'STEPPED TONE GENERATOR
20 FOR F = 900 TO 1100
30 PRINT F
40 SOUND F,1
50 NEXT F
```

This routine cycles through the frequencies between 900 and 1,100 Hz at 1-Hz intervals. The PRINT statement is optional, but I've found it very helpful to see the tone frequency displayed on-screen. Since the bandpass of the 567 is considerably broader than 1 Hz, you can speed up the process by amending line 20 to include a STEP feature. For example,

```
20 FOR F = 900 TO 1100 STEP 20
```

will advance the tone frequency in steps of 20 Hz.

After the audio port responds to a tone of known frequency, it's interesting to determine the minimum duration tone to which it will respond. This question is of more than passing interest when the 567 is set to detect low frequencies. At very-low audio frequencies, the 567 may require up to a second or so to lock onto a tone. Knowing the minimum tone duration is also important when it's necessary to speed up a program.

A routine, which may not work with all versions of BASIC, will help you determine the minimum duration tone to which your circuit will respond follows:

```
10 'MINIMUM TONE DURATION
   CHECK
20 FOR T = .1 TO 1 STEP .1
30 FOR D = 1 TO 200: NEXT D
40 SOUND 1000,T
50 PRINT T
60 NEXT T
```

If you watch the screen as the circuit runs, you'll be able to quickly determine the minimum tone duration required by your 567 circuit.

Incidentally, if you go to the trouble of removing your computer's cabinet, you may want to try a microphone input. I found that both a microphone and an induction coil would work well with one computer—but only when the cabinet was removed so I could place these transducers closer to the speaker.

If none of the suggestions given above work, carefully check the wiring of your interface circuit. If you have a signal generator, connect it to a small speaker or speaker amplifier to produce an adjustable tone. When adjusted to the proper frequency, this should trigger your interface. Use the square-wave setting if the sine-wave setting doesn't work.

An oscilloscope is very handy for troubleshooting the circuit. Connect the scope's input probe to pin 3 of the 567 and ground. If the signal from the computer (or signal generator) exceeds a few volts, the 567 should trigger.

Adding to the Circuit

The output of the basic Fig. 1 circuit switches on only when a tone of appropriate frequency is present. In many applications, it's important to be able to latch the output after only a brief tone. In Fig. 2 is shown a simple latch circuit you can add to the 567. The circuit can be reset after it has latched simply by pressing *S1*.

Figure 3 shows another latching circuit for the 567. This circuit is identical to the one in Fig. 2, except that the manual RESET switch has been replaced by an analog switch to permit the circuit to be reset by a logic signal.

You can also use an array of 567s to detect the presence of a series of tones of different frequencies. This will permit your computer to control several external

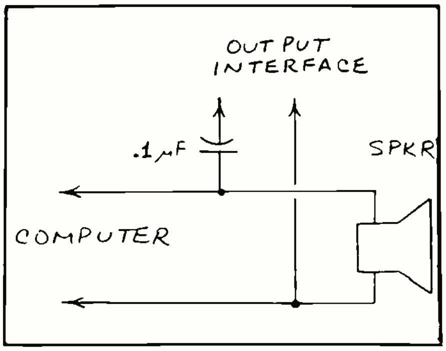


Fig. 4. How to connect the audio interface circuit directly to the computer's speaker.

devices. You can even use one tone to switch on an external device and a second tone to switch it off. To do this, simply add a latching circuit with a logic reset line (Fig. 3) to the 567 that switches on the external device. Use a second 567 tuned to a different frequency to reset the logic line of the first 567.

Direct Audio Connection

The Fig. 1 circuit requires absolutely no wire connections between computer and audio output port. If you must open your computer to gain access to its speaker, you may be tempted to consider a direct wire connection between the computer's speaker leads and the audio port.

I found that a 0.1-µF capacitor connected as shown in Fig. 4 permitted a direct link between my computer's speaker and the audio port circuit. However, this method may not work in all cases, since the voltage may be too low.

Before making a direct electrical connection to your computer, check its warranty. Some manufacturers won't honor their warranties if a machine has been altered or modified.

Going Further

There are many variations to the basic audio output port method described here. For example, if you use a microphone and add another gain stage to the input amplifier, the circuit should respond to tones produced by many kinds of computers.

Another possibility is to use a dual-tone, multi-frequency (DTMF) decoder chip to decode the signals from such devices as computer modems and automatic telephone dialers. This will give a dozen or so output ports.

Yet another possibility is to design an audio interface that responds specifically to error beeps from your computer when you're some distance away. The interface can then trigger an audible alarm, flash a light, activate an intercom or even shut down the computer, printer or other output device.

Joseph Desposito

40-MHz DRAM Controller, Fast 4M and 16M DRAMs, IC DRAM Cards, Supervisory Circuits and Low-Power Transceivers

This month's column presents new developments on the DRAM scene in regard to controllers, chips and cards.

40-MHz DRAM Controller

A programmable DRAM controller that interfaces Motorola's MC68EC030 embedded control microprocessor directly with small, fast memory arrays has been developed by Samsung Semiconductor (3725 N. First St., San Jose, CA 95134). Introduction of this next-generation memory controller follows a long period of cooperative design with Motorola.

The new DRAM controller is the KS84EC30-40CL, which supports small, fast memory arrays, driving up to nine devices at 40-MHz. This controller is capable of supporting a sustained bus throughput of 49 M/s when used in conjunction with 80-ns fast page-mode DRAMs. It's the next generation of the system accelerator DRAM controllers introduced by Samsung in mid-1988 and complements the recent introduction of 40-MHz versions of the KS84C31-40CL and KS84C32-40CL.

Flexibility of this controller is obtained with a 26-bit programmable-mode register that allows the user to select such functions as support of synchronous and asynchronous access methods; page, burst or interleaved access; latching of address bits; programmed insertion of wait states in the CPU cycle; RAS refresh option that's virtually transparent to the CPU; column address setup and row address hold times; and the ability to fine-tune the control signals.

Other features include page, nibble and static column accesses, byte operation with four independent CAS outputs, built-in delay line, TTL-compatible inputs, on-chip high-capacitive load drivers and an ability to operate in a synchronous or asynchronous mode.

The controller also offers page-detection logic, which permits accessing data randomly within a page for use with page-mode and static-column DRAMs. Support for burst-memory access helps improve cache hit rate when used with caching systems.

The device has a maximum current drain of 125 mA while active and 25 mA in standby mode. The controller is ideal for low-power applications because it can automatically refresh DRAMs in a powered-down state without any CPU input.

The KS84EC30-40CL controller is manufactured on Samsung's 1.2-micron CMOS fabrication line in San Jose. It's mounted in a 68-pin plastic leadless chip carrier (PLCC). Price is $23.48 in lots of 1,000 or more pieces.

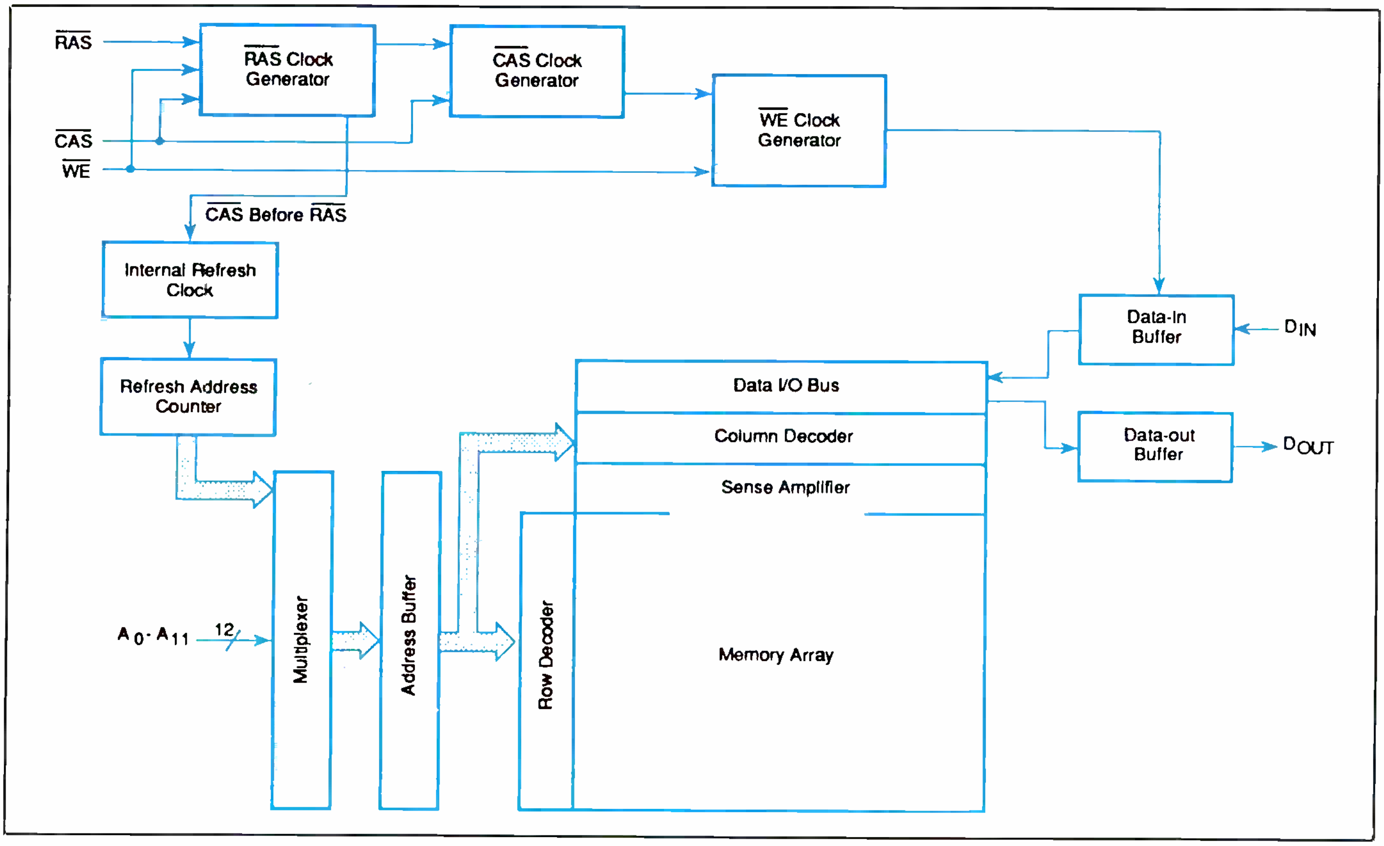


Fig. 1. Block diagram of NEC's 16M-bit fast dynamic RAM.

Fast 4M- & 16M-bit DRAMs

NEC Electronics Inc. (401 Ellis St., P.O. Box 7241, Mountain View, CA 94039) has added several fast 4-megabit DRAMs to its broad family of memory products. The µPD424100, µPD424400 and others have access times of 60 ns.

These DRAM products are based on 0.7-micron CMOS process, with stacked capacitor storage-cell technology, providing high storage capacity and excellent immunity to soft errors. The products have either 4M × 1 or 1M × 4 organization with fast-page, nibble static column and write-per-bit options available. Each version uses a 5-volt power supply and has both standard and low-power options. Pricing is $22.80 each in 100-piece quantity.

All popular packaging options will be available for each version: 26/20-pin 300- and 350-mil plastic small-outline J-lead (SOJ), 20-pin plastic zig-zag in-line package (ZIP) and 26/20-pin plastic thin small-outline package (TSOP) with reverse and normal leads.

NEC Electronics also announced that it's sampling a new 16M-bit CMOS DRAM, advancing its memory product line to the next generation.

The µPD4216100 and µPD4216400 are manufactured using the 0.55-micron CMOS process and incorporate stacked-capacitor storage cells. This technology provides high storage capacity, as well as excellent immunity to soft errors. The 16-megabit offering is the third generation of NEC products to utilize three-dimensional capacitor storage cells.

The products will be available in 70-, 80- and 100-ns versions and will include fast page, nibble, static column and write-per-bit modes. They operate at 5 volts, with an internal step-down to 3.3 volts, making any future transition to 3.3 volts much easier. Customers can also choose between 2K or 4K refresh cycles. All versions of these chips feature an internal test mode as well.

Initial organizations include 16M × 1 (µPD4216100) and 4M × 4 (µPD4216400). A block diagram of the µPD4216100 is shown in Fig. 1. The company has plans to market additional organizations by early 1992, depending on customer requirements. NEC will provide SOJ, ZIP and TSOP Type II packages for all versions of the product. NEC's 16M DRAM is available immediately in sample quantities for $300 each.

Typically, DRAMs are used in computers that require large memory density and high data rates, ranging from personal computers to massive parallel systems. NEC's 16M-bit DRAM will be used initially in workstations and other high-performance processing applications.

New IC DRAM Cards

Micron Technology (2805 E. Columbia Rd., Boise, ID 83706) introduced JEDEC standard, 88-pin, 4M and 8M IC DRAM cards as part of its expanding component product line for portable computers. These cards provide low-power, external-memory upgrades for portable computers and can be used in x16-, x18-, x32- and x36-bit systems.

The IC DRAM Card was developed to meet the need for portable computer memory upgrades that could be installed without opening, and possibly damaging, the system unit. Micron's IC DRAM Cards are manufactured with Micron's TSOP chips, using low-power DRAMs surface-mounted on both sides of an ultra-thin printed-circuit board. The board has the outline of a credit card and a total thickness of only 3.3 mm.

Additional features include buffered input signals to ensure compatibility across platforms, individual memory-bank selection for lower power consumption, parity to correct data errors and stainless-steel panels to provide better protection and heat dissipation than is possible with plastic.

Engineering samples of the 4M IC DRAM Card (MT12DC136), in 1 M × 36 or 2 M × 18 configurations, and 8M IC DRAM Card (MT24DC236), in 2M × 36 or 4M × 18 configurations, are anticipated in the third quarter of this year, with production quantities for delivery anticipated in fourth quarter.

Microprocessor Supervisory Circuit

Linear Technology Corp. (1630 McCarthy Blvd., Milpitas, CA 95035) now offers microprocessor supervisory circuits in surface-mount packaging and guarantees reset assertion down to 1 volt with any member of its LTC690 family of microprocessor supervisory circuits.

The LTC690 family offers single-chip solutions for power-supply monitors and battery control functions in microprocessor-based systems. Family members are plug-compatible with the MAX690 family. Chip-enable gating is 35 ns maximum (versus 200 ns maximum for the MAX690 family). Supply currents are 1.5 mA maximum (versus 5 mA maximum for the MAX690 family).

The LTC690 and LTC694 are supplied in eight-pin SO or eight-pin plastic DIP packages. They provide four functions: power-on reset, battery backup for

CMOS RAM, watchdog timer and power-failure/low voltage (battery) monitor.

The LTC691 and LTC695 are supplied in 16-pin SO or 16-pin DIP packaging. They include three additional functions: CMOS RAM write protection, adjustable reset and watchdog timeout and separate watchdog, battery backup and low V_{CC} status outputs.

The LTC690 family uses a charge-pumped NMOS power FET as the V_{OUT} power switch. This achieves a lower supply current and eliminates problems encountered when external pull-up resistors are used on digital outputs.

The LTC690 family is available in commercial and industrial grades. Pricing in 100-and-up quantity for commercial grade in plastic DIP is $3.80 for the LTC690 and LTC694 and $4.15 for the LTC691 and LTC695.

Dual RS-232 Transceivers

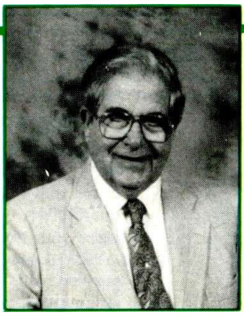
Maxim Integrated Products (120 San Gabriel Dr., Sunnyvale, CA 94086) announced three new +5-volt-powered RS-232 dual drivers/receivers designed specifically for systems that require low-power operation. The MAX220's low supply current makes it suitable for systems that constantly transmit and receive data. It needs only 2 mA maximum (0.5 mA typical) supply current.

The MAX222/242 are well-suited for systems that intermittently transmit and receive data because of their shut-down mode feature. Supply current (loaded) is reduced from 13.5 mA during normal operation to 10 μA in shut-down mode. Using shut-down mode, the MAX222/242 save up to 67 mW of power when not receiving or transmitting data.

The MAX222 transceiver features a shut-down mode that disables the device and turns off all driver and receiver outputs. The MAX242 is identical to the MAX222, except for an additional feature: a pin that has three-state controls for the driver and receiver outputs, allowing bussed (party-line) configurations and the receivers to remain on in shut-down mode to receive incoming data.

The low-power MAX222 and MAX242 operate with space-saving 0.1-μF external charge-pump capacitors and are guaranteed for data rates up to 116K bps. The MAX220 operates at a guaranteed 20K bps. MAX220 is offered in 16-pin DIP and SO packages and MAX222/242 is offered in 18-pin DIP and SO packages. Temperature ranges include commercial, extended industrial, and military.

Prices for the MAX220/222/242 start at $2.65, commercial grade in a plastic DIP package in 1,000-piece lots. ■



Stan Veit

Low Cost, High Speed Modems Are Here!

The news this month is that prices on 9,600 bit-per-second (bps) modems for data, are now at reasonable levels. And more and more BBSs and on-line services are equipped to operate at this speed. There are internal modems available in the $300 to $400 price range that are equipped with all the features you might want. The new modems can operate at CCITT V.32/V.42bis and NMP 5 data compression, which can give you an effective throughput of 38,400 bps! Don't confuse these modems with FAX modems, which transmit FAX at 9,600 bps and data at only 2,400 bps.

I can almost hear you readers saying: "Whoa! What do these 'V' numbers mean to me and why should I get a new modem? A few months ago, you were telling me to buy a 2,400-baud, Hayes-compatible modem instead of a 1,200-baud unit. Now you're upping the ante!" I plead guilty. At that time, the 9,600-bps modems I'm now talking about were selling for $500 to $1,000. I didn't venture to discuss them since the average computer user would hardly ever dial the few sources that were transmitting at 9,600 bps at that time.

In the last few months, the magic of large-scale integration (LSI) resulted in lower manufacturing costs for modems, and both BBS owners and users have increased their communicating speed. I still recommend 2,400-baud modems for beginners and the person who only occasionally uses a modem. Many 2,400-baud modems are now selling below $100 in discount stores.

CCITT & V Specifications

The CCITT is the international specification group that sets standards for telecommunications. V.32 is its designation for 9,600-bps communication. The V.42 is the specification for error checking and V.42b is is the specification for data compression (MNP5 is an alternate specification that's also used). By compressing the 9,600 baud, the same amount of data as would be transmitted at 38,400 baud without compression can be transmitted at 9,600 baud.

To make this work, both transmitter and receiver must be using the same specification for error checking and data compression. That is why many modems work with both the V.42bis and NMP 5 specifications. Both must also be operating at the same baud rate, or the modem will drop back to the slower baud rate.

This requirement for standardization has been the rub with 9,600-bps communications. Until recently, there have been several methods of compressing data, and no one in his right mind would cast any method in silicon. Now the international body has spoken, and LSI manufacturers have responded with chip sets, such as the Rockwell RC9696/12 Data Pump, which make low-cost modem boards possible.

These new modems are fully Hayes-compatible for 286, 386 and 486 computers. They have fall-back to 2,400, 1,200 and 300 baud to accommodate line conditions. Some of the more expensive 9,600-bps modems will resume higher speeds after fallback. While they may not be for everyone, the higher-speed modems represent a significant upgrade for many users.

BPS Versus Baud

You'll notice that in the above discussion, I used the term "bps" rather than "baud" when discussing 9,600-bps communications. The reason for this is that at high data rates like 9,600 bps we aren't actually operating at 9,600 baud! If this seems strange to you, it's because we've always used the terms "bps" and "baud" interchangeably.

The definition of "baud" is somewhat complicated. Our telephone system is designed to transmit sound, which is sinusoidal, not the square waves employed in streams of data bits. Modems convert the data bits into tones of varying frequencies, and Frequency Shift Keying (FSK) is used as a means of modulation. The unit of measurement we call "baud" is the number of frequency shifts occurring in 1 second. One baud would convey exactly one data bit in 1 second.

Telephone circuits have been built that can operate clearly up to about 2,400 baud. We can, therefore, equate 2,400 bps with 2,400 baud. Above that speed, it becomes more difficult and would require special conditioned telephone lines. So with a little electronic trickery, we use 1 baud to transmit four bits of information for each baud. We actually transmit 9,600 data bits per second, but the system is only operating at 2,400 baud! Not satisfied with this magic, we compress the data before transmission and get an effective throughput of 38,400 bits per second. Eventually, we'll increase the quality of our telephone system even more and achieve speeds of 19,200 bps before applying compression!

Even though the cost of modems has decreased, the use of 9,600 bps may come with an increased cost. Data services haven't all increased transmission speed, or have done so at much greater cost to the user. CompuServe, for example, asks $22.50 per hour connect charge for 9,600 bps versus $12.50 for 2,400-baud connect time. GEnie charges $18.50 per hour for 9,600-bps access in non-prime time and $30.00 per hour in prime time. In addition, only the standard hourly rates apply when accessing at 9,600 bps. Delphi does not yet support 9,600 bps, mainly because it operates the public carriers, Tymnet (Sprintnet) and Telenet, which don't yet support this speed.

BBS Sysops are way ahead of commercial services in adopting increased transmission speeds. Many local BBSs have already converted and are all free or almost free. Check with Sysops in your area to find out how many of them offer 9,600 bps or plan to offer it.

Shareware Catalog

Access to shareware is one of the most desirable features of on-line operations. Finding the right program from among thousands offered on-line can be expensive and frustrating. Now the Association of Shareware Publishers has made it easier for you if you're a CompuServe subscriber.

A Forum on CompuServe is devoted mainly to the interests of Shareware authors, but it now contains a complete catalog of shareware available for downloading. (You can reach it with the command: GO SHAREWARE.) The name of this file is Catalog.Zip, and I consider it one of the most valuable things you can download.

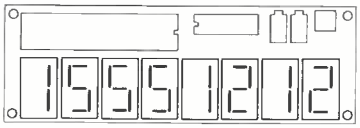
I must warn you that it takes 57 minutes to receive at 1,200 baud, using Y-modem, but the price of the download is still cheaper and more up-to-date than the *Encyclopedia of Shareware*, Third Edition for new shareware. The *Encyclopedia*, published by *PC Sig*, is still the most complete historical listing of all shareware. At $19.95, it's a bargain that every on-line user should own.

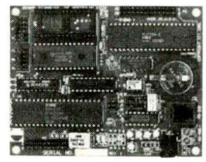
Adventuring on AOL

For users who seek adventure, America On Line (AOL) has just added the ultimate on-line game called "Neverwinter Nights." This is a "Dungeons & Dragons"-type game with interactive capabilities. You can join with other players in adventuring on-screen through realistic graphic scenes. Beginners can meet with expert players and accompany them through the dangers of Neverwinter land. This is interactive gaming as it should be. Graphics in this adventure are excellent and are an example of what VGA can do in an interactive mode. You're going to see a great many more of this kind of on-screen, interactive games and novels, both on-line and computer based.

Another feature of AOL is its excellent casino games, which are available at all times. Players are given credits with which to play, with the idea being to increase their stakes and try to get into the exclusive Millionaire's Club. You can play Blackjack, Stud Poker, Slots or Bingo. The Casino is divided into numbered tables, where you can play for different bet levels. These games are much more interesting because of their excellent graphics and the ability to talk with other players during play. Views of the cards, tables and even the dealer's hand are high-resolution VGA graphics.

For those who want to ask me questions or ask for help on-line, I may be reached on CompuServe as 70210,300; on BIX, AOL, Prodigy , Delphi or The Well as SVEIT; MCI Mail as Stan Veit. Let me hear from you. ■





Ted Needleman

Micro Express Debuts a New 386 Machine Built Around AMD's 40-MHz Chip

Last time, I gave a bit of background on problems that arise in trying to measure computer "performance." I also explained the rationale behind DiagSoft's *Power Meter,* the tool I've started using as a benchmark for testing computers. This time around, I've put *Power Meter* to work in evaluating a 386/40 system from Micro Express.

Before I get into my evaluation of the Micro Express 386/40 computer, however, some background information on how it became possible for manufacturers like Micro Express to produce 40-MHz 386 machines.

A Brief History Lesson

Micro Express' 386/40 is a bit different from most of the MS-DOS PCs now being sold because it doesn't use an Intel CPU. Though Intel manufactures the CPUs for almost all MS-DOS-based PCs now in use, this wasn't always the case. In the days when eight-bit computers reigned, the most popular operating system was CP/M. It ran Zilog the 8080 and Z80 CPUs.

When IBM decided that its PC, introduced 10 years ago this past August, would be a 16-bit system, the company looked at the then-available CPUs. In 1981, already a number of 16-bit systems were being sold. Alpha Micro, for example, used proprietary chips with an instruction set similar to that being used in the Digital Equipment Corp. PDP-11 minicomputer. And Texas Instruments was selling a micro based on its own CPU design. IBM chose Intel's 8088. The rest is history.

Even with this giant leg up from IBM, Intel hasn't always been the only supplier of CPUs for MS-DOS-based PCs. Early on, NEC cloned several versions of the 8088/8086—the V20 and V30. They were enhanced over the Intel processors and offered better speed and performance and an expanded instruction set with several additional commands.

Although its CPUs proved extremely compatible with their Intel equivalents, NEC had only modest success with the V20 and V30. No software developer dreamed of using the extra commands. To do so would leave 99% of the market unable to make use of the product. Somewhat better performance wasn't enough of an inducement to gain NEC's CPUs any appreciable market share, though they're still occasionally found in low-cost XT-type systems.

When IBM introduced its 80286-based ATs, things changed in the CPU marketplace. Intel couldn't keep up with the demand for the 286, and rather than have manufacturers of PCs looking around for a different CPU, the company decided to second-source the chip with a number of other companies, most notably Harris Semiconductor and Advanced Micro Devices. Both companies were already well-known in the semiconductor industry, and AMD was fairly closely tied to Intel, having signed in 1982 an agreement with Intel to share technology.

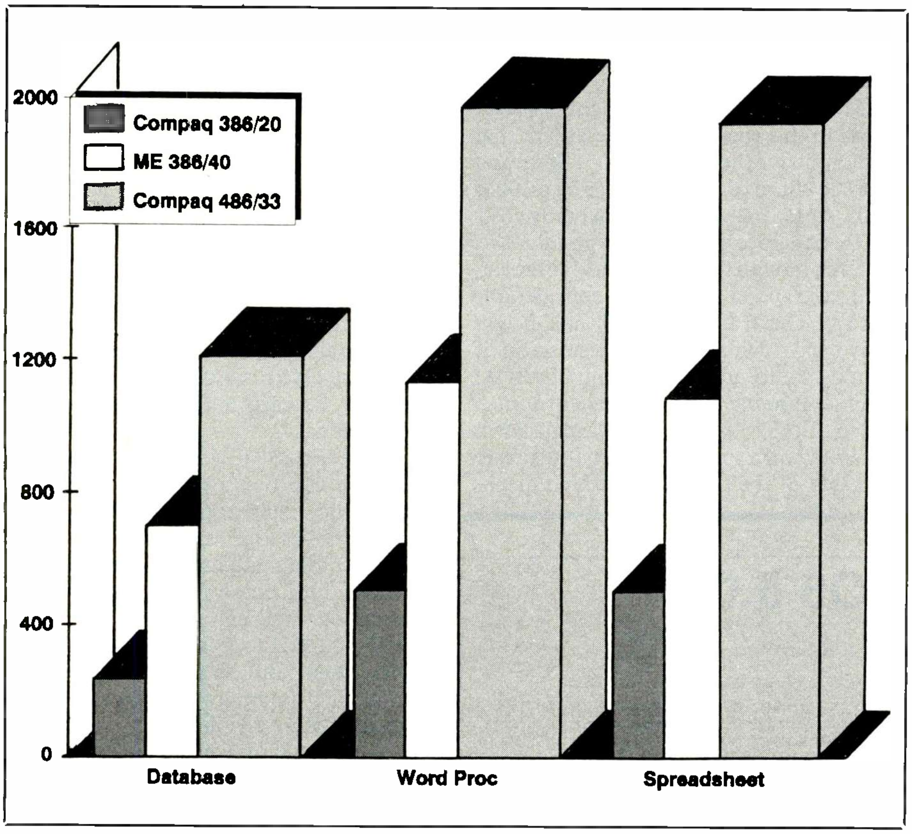
In addition to becoming a second source for the 286 CPU, AMD went a step further. It had the first high-speed versions of this chip. In fact, many of the 16- and 20-MHz 286 PCs now being sold have AMD—not Intel—CPUs in them.

With the next generation of 16-bit CPUs, the 80386 family, Intel had a change of heart. By this time, production facilities had been ramped up. Intel saw no need to share the market. Except for granting IBM a license to manufacture some of its own 386 chips, Intel decided not to second source the CPU. This came as a surprise to the companies that had built quite a large business as a secondary supplier of CPUs to the MS-DOS PC marketplace. Notable among these companies was AMD.

In the opinion of Advanced Micro Devices, the 1982 agreement with Intel gave it the right to use the microcode developed by Intel for the 386 in its own version of this CPU. A lawsuit ensued, with AMD claiming breach of contract and restraint of trade. At the same time, AMD decided to reverse engineer the 386, which by this time had become the *de facto* standard CPU for computers using the MS-DOS operating system.

AMD's opening shot in its war against Intel was to bring out an 80287 numeric coprocessor chip at a low-ball price of $99, hundreds of dollars less than Intel's price for the same device. Intel sued to stop AMD from selling the coprocessor but was unsuccessful.

Earlier this year, satisfied with the compatibility and performance of its reverse-engineered CPU, AMD announced the AMD386 family, starting with a high-end 40-MHz version. Intel sued again to stop AMD from selling the CPU and to keep AMD from using the designation



386. Once again, Intel was unsuccessful.

AMD's 40-MHz 386 CPU offers a few benefits beyond those that bear the Intel label. Its 40-MHz operating speed is about a 20% improvement over Intel's 33-MHz limit. Additionally, AMD has further boosted its CPU's performance by reducing the number of clock cycles needed to execute certain instructions. With a motherboard design that takes advantage of these features, this resulted in PCs that offer much of the performance obtained with a 25-MHz 486 but for considerably lower cost.

Meanwhile, Intel hasn't exactly stood by waiting for AMD to gobble up its lucrative 386 market (which hasn't occurred). Its fourth-generation CPU, the i486, is fast becoming the choice for business PC users, and an SX version of the 486 chip, with its built-in numeric coprocessor disabled, has been introduced to entice 386 users to migrate upwards. The 50-MHz version of the 486, introduced in mid-year, will define the upper limits of PCs—if Intel ever gets it working properly. Shipments of the 486SX began during the summer, but production had to be halted when chips kept failing quality assurance tests. Intel has stated that the tests are faulty, not the chips. But if QA tests can't be trusted, there's no way to tell if the CPUs themselves meet specifications.

All this leaves AMD somewhat in limbo. Its 40-MHz 386 CPU is clearly an exceptional component, but motherboard designers haven't made a mad rush to bring out new motherboards based on it. Nor have PC vendors been all that quick to offer systems built around the AMD CPU. With the i486 being today's "hot" CPU, vendors would rather invest in tomorrow's technology than yesterday's.

New lines are being drawn in the 386 market, with 20- and 25-MHz 386SX systems at the bottom and 386/33DX machines at the top of the 386 system line. Once-popular 25-MHz 386DX machines are quickly and quietly disappearing.

At the time this is being written (early September), Fall COMDEX is about six weeks away. It will be interesting to see if vendors are exhibiting AMD-based systems or if this powerful alternative CPU will wind up in a back seat, relegated to mail-order purveyors of PCs. With the direct-marketing channel accounting for a good percentage of the PCs sold in this country, this doesn't necessarily mean the kiss of death for the AMD CPU.

Most recently, several major computer vendors have announced new notebook PCs based on AMD's low-power 25-MHz chip sets, which must be heartening for AMD. In addition, AMD just brought a $2-billion lawsuit against Intel, charging restraint of trade and lost profits from Intel's breach of its 1982 agreement. Even with all of this going on, AMD has yet to start showing its reverse-engineered version of the 486 family.

What does all this maneuvering have to do with you? For one thing, it means you'll be able to get some really good buys in hardware over the next several months, as vendors prune and reorganize their product line-ups. For another, it means you'll be able to get enhanced 486-like performance, from systems like the Micro Express evaluated next, at substantially lower prices than you would expect to pay for a 486 machine.

Micro Express ME 386-40

Just as several tiers exist when it comes to dealer-marketed PCs (with IBM, Apple and Compaq the first tier), direct market (or mail-order) systems also have less- and better-known vendors. Micro Express is probably not as well known as Dell, Zeos, CompuAdd, Gateway and Northgate, but this company has been around for several years. During that time, it has garnered a reputation for providing high-quality systems with excellent performance at great prices. The AMD-powered 386-40 system I tested bears out my past impressions of Micro Express products as excellent values.

Visually, the Micro Express looks pretty much like any other PC. It's housed in a baby-AT style case that measures a compact 16½"D × 14½"W × 6½"H; that's about ½" taller than most desktop systems. This small system-unit case belies the power of the system and its expansion capabilities.

While past Micro Express systems I've looked at have had motherboards from AMI (American Megatrends) or Micronetics, the 386-40 uses one from a somewhat lesser-known company—Advanced Integration Resources. Though it isn't as popular as the other companies mentioned, AIR produces a very nicely laid-out motherboard meant especially for the AMD 386/40 CPU. It had no last-minute engineering jumpers.

System RAM caching is becoming somewhat commonplace, especially in higher-performance 386 and 486 designs. The AIR motherboard features a 64K write-back cache that can be expanded up to 256K if you need greater performance. Of course, not all applications derive an appreciable increase in performance from a larger system cache. It depends upon the extent to which the application moves data around within the PC's RAM memory. In addition to the 64K RAM cache, the motherboard also supports BIOS shadowing, another performance booster that relocates system BIOS and video-card BIOS into much faster RAM above the 640K DOS barrier.

Micro Express populates the 386-40 system with 4M of RAM, a nice touch in these days when you consider that you need a minimum of 2M to run *Windows* on a 386 system. You have your choice of keyboards: standard 101-key enhanced-AT style or a somewhat more compact layout with a built-in trackball. Without a video card, hard-disk drive or monitor, but including a 220-watt power supply and your choice of either a 1.44M 3½″ or 1.2M 5¼″ floppy drive, base system price is $1,544. A special package that includes a Super VGA card and a 14″ color monitor, second floppy drive and 80M IDE hard disk with your choice of either MS-DOS 3.3 or 4.01 lists for $2,599. The new MS-DOS 5.0 upgrade will cost you an additional $25.

My review unit was configured pretty close to this special package, except that it didn't have the second floppy drive and the 80M hard disk was replace by a 100M unit. At $2,564, my system actually costs a few dollars less than the "special."

Even though the case is fairly compact, you can expand the PC to a considerable extent. There are three 5¼″ half-height drive bays with external access. So if you'd like to add an internal CD-ROM drive or tape backup unit, there's room to do so. The 3½″ form factor hard disk was mounted on a special bracket attached to the side of the drive bays, which means that the hard disk doesn't use up a bay.

There are also plenty of free expansion slots. The AIR motherboard has eight 16-bit ISA slots. Only two of them were filled in my review unit, one with the VGA adapter and the other with a multifunction card that contains a floppy/hard disk controller and serial and parallel ports. Two serial ports are available, with the DB-style connector for the second port mounted in a cutout in the case, rather than on an expansion-slot cover that basically uses up a slot, as is all too common. With six open slots, adding a scanner, fax card and many other goodies becomes easy.

The ME 386-40 even has a socket for a numeric coprocessor. While Micro Express's documentation, which is generic across its 386 line, states that this socket can accommodate an Intel coprocessor, it can't. Intel doesn't make an 80387 coprocessor that can run at the AMD CPU's 40-MHz speed. At this time, only Cyrix does, and its coprocessor chip is available from Micro Express and a multitude of other suppliers.

All these components contribute to an outstanding system. In comparing the Micro Express to a 20-MHz Compaq DeskPro 386 and a 33-MHz Compaq DeskPro 486, the only two systems I had access to while performing this review, the ME 386-40 falls about in the middle. It has a bit more than twice the speed of the 386/20 in most of *Power Meter*'s application tests and about half the speed of the 486/33 machine.

In previous tests I ran with other sets of benchmarks on systems I had to return before I settled on *Power Meter* as my standard, the Micro Express performed at much the same level as several 25-MHz 486 PCs from other vendors, except in simulations that took advantage of the i486's built-in numeric coprocessor.

There are a few situations where I think a 486-based system is more appropriate, such as heavy database management and file servers in a large network. With 33-MHz 486 prices continuously falling, it's not unlikely that in six or nine months you might be able to buy a 33-MHz 486 for just a few hundred dollars more than a 386/40. At this time, though, the Micro Express ME 386-40 is a great performer and an excellent value.

Product Mentioned

ME 386-40; $2,564 (configured as detailed in text)
Micro Express
1801 Carnegie Ave.
Santa Ana, CA 92705
714-852-1400

CIRCLE NO. 134 ON FREE INFORMATION CARD

Computer Games

(from page 87)

begins as if an old war bird like Yeager is telling a story: "There I was in my. . . ." You then select which plane to fly, such as the F-86. Custom design continues, "There I was in my F-86 at. . . ." You choose your preferred altitude. The game prompts you for other values like number, skill level and type of enemy planes, ending up with a complete scenario. This is a good way to get to some quick dogfighting.

The game's other features include a flight-recording option that keeps a visual record of player encounters and the ability to be the enemy, perhaps in a MIG-15. Players can re-enact historical scenarios from all three conflict eras. It can be interesting trying to make history repeat itself.

Enemy fighters are tenacious and appear to exhibit some maneuvering intelligence. This can be a real challenge, extending game play for long minutes during a seemingly simple encounter. *Air Combat* is a good flight simulator that offers many hours of play with different aircraft and varying skill levels. Compared to Yeager's previous simulators that lacked combat, this one is an able counterweight. ■

CIRCLE NO. 50 ON FREE INFORMATION CARD

Bird's Eye View

Chuck Yeager's Air Combat, $59.95
Electronic Arts
1820 Gateway Dr.
San Mateo, CA 94404
415-571-7171

Requirements:

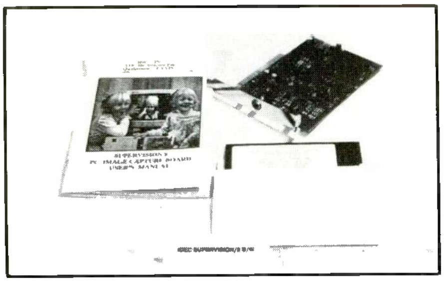
RAM Memory	640K
Graphics	VGA, MCGA, EGA, CGA
Sound	Sound Blaster, AdLib, CMS, Tandy, Covox
Controllers	Joystick, Mouse

Evaluation

Documentation	Good
Graphics	Good
Learning	Curve Medium
Complexity	Medium
Play Length	Short
Playability	Medium

In Brief: Good flight simulator that aims to teach principles of real air combat as seen by Yeager. VGA graphics, joystick and 386 computer recommended for best performance.

Quakertown, PA 18951
215-538-2600
System Requirements: PC, XT, AT, 386 or 486; DOS 2.1 or later; eight-bit expansion slot; 384K base memory; composite NTSC video source.



Also a lightly populated half-size card, the IDEC SuperVision/8 uses jumpers as a configuration medium for changing address assignments. A single phono-type jack resides in the middle of the card's mounting bracket to accommodate the source video input.

One of the things that makes the SuperVision/8 very noteworthy is that it captures a black-and-white image in only 1/60 second—twice as fast as the other grabbers covered here. The board also lets you preview the source image right on the computer monitor prior to freezing and capturing it.

Installation and setup is painless and uncomplicated (as it should be), thanks to a well-organized and clearly-written user's manual. In addition to providing all information needed to install and set up the board, a copy of the schematic is also included (IDEC is the only manufacturer covered here who actually provides the paper for the circuit). This is probably a throwback to earlier days when the board was offered in kit form for $100 less than the assembled price. According to IDEC, the kit was discontinued because of an inordinate amount of technical-support calls received from less-than-proficient kit builders.

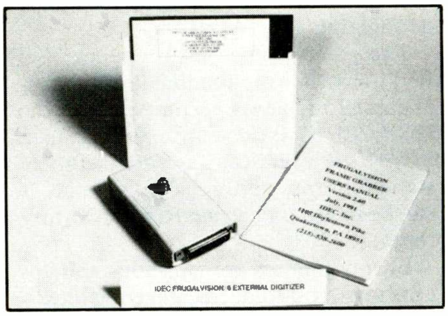
Software included with the board is well-designed, easy to use and includes some nice features not found with the other image-capture devices examined here. For example, it includes a "print image" utility from the main menu that permits instant dumping of the captured image to a laser or dot-matrix printer. This is most convenient for "proofing" the image. All of the other products reviewed here require you to use an outside application (like *Ventura Publisher* or *PC Paintbrush*) to output a captured image to the printer.

Supervision/8 software also gives a nice selection of image manipulation and enhancement options, including flipping horizontally and vertically, negative imaging, changing aspect ratio, altering brightness/contrast, blurring/sharpening, and more. CGA, EGA and VGA video modes are supported in 2, 4 and 64 gray levels, respectively.

Captured images can be saved in .TIF, .PCX, .BIF and .GIF formats for use within other applications. The board is also capable of color imaging by using an optional *Zip Colorkit* ($75), which consists of specialized software that supports .PCX, .TIF, .GIF, .PIW and .PIF file formats. It includes acetate filters for creating a color image by capturing red, green and blue video images and combining them (since this takes three passes, one for each of the three colors, a stationary image is required).

If you're looking for an inexpensive black-and-white grabber board that can capture in real-time, the SuperVision/8 is a good choice.

IDEC Frugalvision/6 Video Digitizer
(eight-bit B&W external), $100
IDEC, Inc.
1195 Doylestown Pike
Quakertown, PA 18951
215-538-2600
System Requirements: PC, XT, AT, 386 or 486; DOS 2.1 or later; parallel port; 384K base memory; stationary composite NTSC video source.



The Frugalvision/6 is a really exciting, low-cost digitizing product that's the perfect answer for those who need to capture images and don't have deep pockets.

What makes it so innovative? For starters it's an *external* unit. Because there's no board to install, there's no need to open your PC's system unit. It simply connects to the PC's parallel printer port. And since it's an external unit, Frugalvison is ideal for use with a laptop or notebook computer for those on the move. This compact digitizer is slightly longer than a pack of cigarettes and about as wide, but not quite as thick.

The video-in signal is handled via an r-f-type screw-on connector (like the 75-ohm antenna connection on a TV receiver) mounted on the top of the unit. A 25-pin D-connector on one end facilitates mating with the computer's parallel printer port, while the opposite end of the

Image-Capture Boards Comparisons

Product Name	Price	Image Format	Video Input	Video Output	Real-Time	Color, B&W	Unit Configuration	.PCX/.TIF	Printed Documentation	Software Rating	Value Rating
Everex Vision 8	$895	8 Bits	9 Pin	9 Pin (Monitor)	Yes[1]	Yes	Full Slot	No	Poor	Poor	Poor
ComputerEyes B/W	$250	8 Bits	Phono	Phono (Monitor)	No	B&W	½ Slot	Yes	Very Good	Very Good	Good
IDEC SuperVision/8	$270	8 Bits	Phono		Yes	B&W[2]	½ Slot	Yes	Good	Very Good	Very Good
Videolinx: Framegrabber	$695	8/16/24 Bits	Phono	Phono	Yes	Both	¾ Slot	Yes	Excellent	Excellent	Excellent
ComputerEyes/RT	$600	8/16/24 Bits	Phono, S-VHS		Yes	Both	¾ Slot	Yes	Excellent	Excellent	Excellent
IDEC FrugalVision/6[3]	$100	8 Bits	F-61		No	B&W	External	Yes	Good	Excellent	Excellent

1 Color captures require a stationary image for three scan passes (R,G,B).
2 Optional color filter/software kit available. Stationary image required for three scan passes (R,G,B).
3 External unit connects to computer's parallel port. All others are internal cards designed to plug into a computer's expansion bus.

unit contains a compartment to house the 9-volt alkaline battery that provides power for the unit.

Another innovative feature is its under-$100 price tag. You'd be hard-pressed to find a hand scanner for $100, let alone a video digitizer; so Frugalvision is aptly named.

There are some tradeoffs associated with Frugalvision (what did you expect for $100?), but they won't be major stumbling blocks for many users. The first is that Frugalvision isn't a real-time framegrabber. Moreover, an image capture takes about 8 full seconds and requires an absolutely still video image (a digital still or a live video image of a still subject yields best results; a videotaped image held in pause mode on a VCR produces a capture with distortion waves throughout it due to the video heads rotating while in contact with the stationary tape). As with the ComputerEyes B/W Digitizer, using a digital still camera like the Canon Xapshot or a camcorder capable of doing a digital still-frame gets around this problem nicely.

Another tradeoff is the Frugalvision/6's 256 × 244-pixel resolution, which isn't as fine as the other units covered here. Depending on your final intended use for the captured images, this may or may not be a major consideration. The captured images, while quite acceptable for most DTP applications, aren't as rich in detail or gray-scale variation as those obtained with the other products I've reviewed (see accompanying actual output samples). But then, again, you can't have everything for $100, right?

On the other side of the scale, however, in addition to low cost, Frugalvision offers portability, instant attachment and detachment to any PC's parallel port and the ability to be used with a laptop or notebook computer without requiring a standard expansion slot.

Software provided with Frugalvison is virtually identical to what IDEC supplies with the Supervision/8 reviewed earlier. All the same handy features are present, including direct output of captured images to a printer without the need to load an external application package. File formats of .PCX, .TIF, .GIF and .BIF are provided for saving images, along with a rich menu of image enhancement and manipulation options.

For field applications like capturing images of buildings, doing warehouse inventory and other such "mobile" uses, Frugalvision is an attractive and innovative device for getting a video signal into a PC for processing, at an unbeatable price.

Tune in next month for the conclusion of this article. ■

Photos by Liz Benford

Article Cumulative Index

January 1991 through December 1991

Articles

*(*Construction Projects)*

Applications

Upgrading/Enhancing

Wake-Up by Phone, Computer* by Nick Goss .... Jul

Reviews

(For more product reviews, see "Ted Needleman" under "Columns" listing.)

Columns

Editorial *by Art Salsberg*

Joseph Desposito

Forrest M. Mims III

Ted Needleman

The World On-Line

By Stan Veit

Order Back Issues of

ComputerCraft

ORDER FORM

Please send me the following issues @ $3.50 each:

Month(s) & Year(s): ______________________________

____

Number ordered @ $3.50 each: ________ Total Payment Enclosed: ________

NAME: ______________________________

ADDRESS: ______________________________

CITY: ______________ STATE: ________ ZIP: ________

Chuck Yeager's Air Combat

"Never say die." These three words of advice come from retired General Chuck Yeager, a man who needs no introduction to pilots of real aircraft. Computer pilots may recognize the name from previous quality flight simulators that were published by Electronic Arts.

The first computer game to bear Yeager's name was *Advanced Flight Trainer*. That game was an interesting move at the time because it had no combat at all. When computer gamers think of flight simulators, air combat is usually not far behind. Yeager's *Advanced Flight Trainer* was different. It's purpose was to celebrate the wonder and skill of flight. In doing so, players were treated to as much experience and insight from Yeager that game designers could reasonably put into the game.

Advanced Flight Trainer was a very good game that strove to accurately teach the principles of real flying, with Yeager as guide. Perhaps the game's only flaw was it's graphics, which weren't quite comparable to the standards of the time.

A second version of the *Advanced Flight Trainer* was later released. It had much better graphics and a higher degree of integration of Yeager insights with player tutelage. Again, game designers were helping computer pilots appreciate the finer points of flight. Most of the game manual was spent on education about lift, drag, stalls, turns, throttle, navigation, rudder and so on. Much time was also spent on aerial maneuvers like the Immelman and Cuban 8.

Step-by-step instructions on individual subjects were highlighted by a session of formation flying with Yeager, in demonstration of flying technique. An audio cassette was included with the game. Called "Flying Insights," the cassette contained flight tips and exciting comments on some of Yeager's real-life experiences. This second version of *Advanced Flight Trainer* logged some nice improvements. For computer pilots who'd rather fly than dogfight, it was a welcome addition to the game market.

Yeager is back for a third shot at computer games. The new offering concerns itself with air combat. Some flight-simulation fans had been wondering if Electronic Arts and Chuck Yeager would eventually focus on combat. Yeager flew plenty of combat. An air-combat simulator retaining the precision and quality of the *Advanced Flight Trainers* could be a lot of fun. Chuck Yeager's *Air Combat* is, indeed, fun—and more.

As gamers have come to expect from Yeager and Electronic Arts, *Air Combat* is high on player instruction. The Ground School section of the game manual has the usual treatise on flight basics. An interesting addition not normally found in game manuals are diagrams and explanations of flight envelope. The flight envelope is a great way of getting a snapshot of aircraft performance. Exceeding flight characteristics in the game, as in real life, can create some problems that may be difficult to overcome.

While in flight, a player can view the envelope of his current aircraft with a press of a key. The manual goes on to explain air combat maneuvers, tactics and gunnery, in readable and fairly clear language. Of course, Yeager usually adds a savvy comment or two.

Air Combat's graphics are certainly comparable to industry standard, including use of a graduated horizon, which has come into vogue of late. The terrain is a bit sparse, lacking highly detailed objects. But this has been a design of previous Yeager/Electronic Arts games. But this is of minor concern because the terrain shifts and scrolls properly to maintain an excellent illusion of motion. On the other had, visually sighted aircraft are accurate and detailed and clouds are done very well.

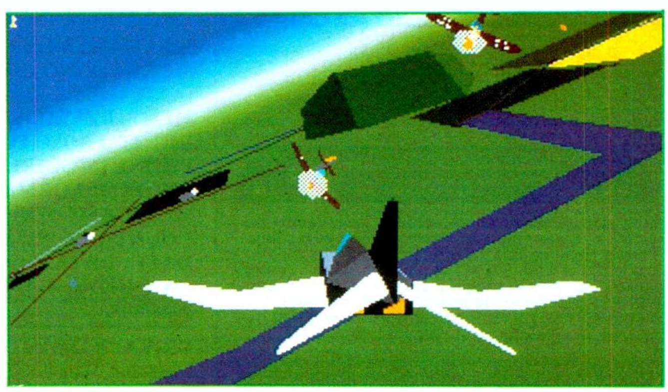
Air Combat is divided into three parts: World War II, the Korean War and Vietnam. As a result, the game limits itself on the kind of aircraft that can be flown. The most sophisticated aircraft available is the F-4E Phantom II. This apparent limitation doesn't detract appreciably from game play because there are six different planes from which to choose. More importantly, each plane has its own flight characteristics; so piloting each is a different learning experience. This is very commendable in view of many multi-aircraft flight simulators, where the varying aircraft are different only in name and appearance.

Playing *Air Combat*, you can be sure that the Phantom will handle differently than the F-105D Thunderchief; and the P-51 Mustang doesn't fly quite like the P-47 Thunderbolt. This surely adds pleasure to playing.

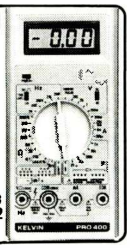
Another interesting feature of the game is that a player can, within limits, custom design a combat encounter. It

(continued on page 81)

Flying as the enemy in a MIG-15.



The Phantom takes on prop planes.



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, Communications, Electronics, Video** or **Miscellaneous**). A special heading is available for a $6 surcharge. First word only is set boldface caps at no charge. Add 20% for additional boldface words.

Non-Commercial Rates: FREE to subscribers, as space permits; maximum 15 words. A recent **COMPUTERCRAFT** mailing label must accompany ad.

(All advertisers with P.O. Box addresses must supply permanent address and telephone number. Copy is subject to publisher approval.)

Mailing Information: Copy must be received by the publisher by the 25th of the third month preceding the cover date. Send Advertising material with check or money order or credit card information (Visa or MasterCard only) with number and expiration date to: **COMPUTERCRAFT**, Classified Department, 76 N. Broadway, Hicksville, NY 11801.

VIDEO

VHS-VCR Repair Solutions Sets I, II, III, IV, V, VI. Each contains 150 symptoms and cures, updated cross reference chart, free assistance, $11.95 each all six $59.95. Eagle Electronics Box A, 52053 Locks Lane, Granger, IN 46530.

TV NOTCH FILTERS PHONE RECORDING EQUIPMENT, BROCHURE $1.00. MICRO THinc. BOX 63/6025, MARGATE, FL 33063. 1-305-752-9202.

CABLE T.V. DESCRAMBLERS, Converters, Guaranteed, **LOWEST PRICES**, CNC Concepts Inc., P.O. Box 34503, Minneapolis, MN 55434, 1-800-535-1843.

NIZO S-80 10X ZOOM SUPER-8 camera, $75. Dan Stoicheff, 605 Montgomery, Laurel, MD 20707. (301) 498-8915.

ELECTRONICS

KINETIKITS from **KINETICO:** electronic kits outputting light or sound. Free catalog: **KINETICO**, P.O. Box 1634, NY, NY 10114-0508.

SURVEILLANCE - COUNTERSURVEILLANCE. Guaranteed lowest prices! Unbelievable, Detectors, Jammers, Transmitters, Phone Security, Cameras, Personal Protection, Books, More! Huge catalog $5.00 (Refundable) PROTECTOR P.O. Box 520294-B, Salt Lake City, UT 84152.

MAKE $75,000 TO $250,000 YEARLY OR MORE FIXING IBM COLOR MONITORS, (AND MOST BRANDS). NO INVESTMENT, RECESSION PROOF. START DOING IT FROM YOUR HOME (A TELEPHONE REQUIRED) BASIC ELECTRONICS OK. INFORMATION: USA, CANADA $2.00 CASH FOR BROCHURE, OTHER COUNTRIES $15.00 US FUNDS. RANDALL DATA DISPLAY, BOX 2168-M, VAN NUYS, CA 91404, USA. FAX: 818-990-7803.

PRIVACY Device Detects Hardwire Taps On Modular Plug-In Telephones, (Most Common). $69. Check, VISA, M/C, AMEX, Disc. Twilight Enterprises, 1-800-833-2681.

8031 MICROCONTROLLER SYSTEMS. Assembled and Tested systems from $49.95. Cross-assemblers and C cross-compilers from $50.00. Quantity discounts make our products the ideal platform for educational use and short production runs. Cottage Resources Corporation, Suite 3-672, 1405 Stevenson Drive, Springfield, IL 62703. 217-529-7679.

PAN-COMM INT'L CATALOG. Over 350 Kits, Plans, Books about Licensed/unlicensed AM/FM broadcasting, Ham/CB/SW/DX electronics amplifiers, 1750M transmitters, Surveillance devices, Computers/Software, Science Projects, MORE. $1.00 refundable. Box 130-ME9, Paradise, CA 95967.

REMOTE CAR STARTERS. All vehicles. **PLANS:** ($12.95) Schlitzer. 414 Alva., Grand Prairie, TX 75051, 214-642-0338.

ALPHA/THETA BRAINWAVE STIMULATION SOFTWARE for IBM or 100% clones. Requires color monitor and EGA or VGA. Select colors, patterns and frequencies, WARNING EPILEPTICS MUST NOT USE! 5 1/4" $19.95, 3 1/2" $21.95. Templehof, Dept. 113-CC, Box 19300, Austin, TX 78760-9300

SATELLITE TV DESCRAMBLER. Build your own. Easy instructions. Parts list. Circuit board. Wiring diagram. $9.95. ABG ENTERPRISES: 27081B, Halifax, NS. Canada B3H-4M8.

TEST turn-ons SA8580, SA8550, SA8500, SA8570/90, Zenith All. Jerrold Starcom 6/7, Tocom-VIP, $44.95. Each 1 pc Boxes. SA 8580, Starcom 7 B/B, Pioneer 6110, Tocom VIP, $279.95, Each. 1-800-74-CABLE.

COMPUTERS

LOGTROLLER, Temperature logger and controller. 8052BASIC microcontroller. Plans, $9.00. TENSOR, Box 2543, Thunder Bay, Ontario, P7B 5G1.

COMPUTER BOARDS for process control applications based on the 8051, 80C196, 68HC11, and 68332 processors. Bare boards or assembled and tested. Disk and EPROM based software also available. Contact Allen Systems at 614-488-7122.

BARCODES Get in on an industry that is growing by 20% each year with **THE BARCODE COURSE. THE BARCODE COURSE** comes complete with a detailed barcode textbook, a portable barcode reader, RS-232 interface and barcode printing software for only $149.95. OBR Inc., RR3 BOX 47-7, Carbondale, IL 62901. 618-549-7100.

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 MAKE MONEY AT HOME with your PC. Remarkable Information. 24 Hour Recorded Message 201-512-0298.

FREE SOFTWARE for the IBM, CP/M and Commodore computers for info. Send $2.00 to TYLER ELECTRONICS, P.O. Box 493, Richmond Hill, N.Y. 11418.

$35 RING DIRECTOR PC SOFTWARE allows Fax and Modem or Modem and Answering Machine to share one phone line. Also calls pocket pager whenever phone messages are received. As seen in ComputerCraft, Page 14, June 1991. Call 1-800-325-7379.

FREE VGA Picture catalog, or Sampler Disks $10. Linken Graphics, Dept. 4, P.O. Box 98, Manville, NJ 08835.

PD NUDES, THE ULTIMATE GRAPHICS DEMO FOR YOUR COMPUTER. Disk prices: 1-$10, 3-$25, 6-$30, 10-$40. Must state you are over 18. Specify C64/C128, IBM, Atari-ST, Amiga. Send check to: Data Foundations, Dept 800G, Box 9324, Akron, OH 44305, or call 216-678-5365.

AMIGA, MACINTOSH, ATARI XL/XE/ST communications, electronic PD software $4.00/disk. SASE specifying computer for catalog! KDware, Box 1646, Orange Park, FL 32067-1646.

ANALOG TO DIGITAL CONVERTER IBM PC COMPATIBLE. SCANS EIGHT INPUTS. PLANS $5.00, COMPLETE KIT $30.00. KIRK BACH, P.O. BOX 9131, DAYTON, OH 45409

***FREE** Tutorial on decision tables shows how to design software logic fast! BONUS OFFER: Send *$5 (CK or MO) & get Pre-DEVA, A Powerful Decision Table Spreadsheet Program with tutorial! (For PCs & Comps w DOS 2.1+). *(Special Time-Limited Offer, Foreign addresses add $5). Binary Triangles, Dept. CC, 4940 Alzeda Dr., La Mesa, CA 91941.

COMPUTER INSURANCE

INSURANCE against your worst **Computer Nightmares!** Covers against: **THEFT, FIRE, POWER SURGES, NATURAL DISASTERS, EVEN EARTHQUAKES.** Replaces with no depreciation. The Computer Insurance Agency, Inc., 6150 Old Millersport Road, N.E., Pleasantville, OH 43148. **CALL NOW** for rates **1-800-722-0385.**

CABLE EQUIPMENT

CABLE TV SECRETS the outlaw publication the cable companies tried to ban. HBO, Movie Channel, Showtime, Descramblers, Converters, etc. Suppliers list included. $9.95. Cable Facts, Box 711-ME, Pataskala, Ohio 43062.

FOR SALE

ROCK-BOTTOM bargains, Used computer, video, office equipment. SASE, PUBNETIX, POB 1022, Laurel, MD 20725

IDEAS WANTED

INVENTORS! Can you patent and profit from your idea? Call AMERICAN INVENTORS CORP. for free information. Serving inventors since 1975. 1-800-338-5656.

CABLE

TOCOM VIP Test Chip. For models 5503 VIP and 5507. Unlike any other turn-on, this one works easily. Installs in just seconds. $50.00. No Calif. Sales. Call (213) 867-0081.

CABLE DESCRAMBLERS Jerrold 400, 450, Tri-Bi, SB-3. Scientific Atlanta, Oak, Tocom. Lowest Prices. Example: Jerrold From $25.00. No Calif Sales. Call us last and see! (213) 867-0081.

ZENITH Z-TAC. Special "test" board installs easily in minutes, and turns-on decoder for all modes. Great for "Flashing" problems. Only $50. No Calif. Sales. Call (213) 867-0081.

METRICS

METRIC System Explained - Learn, compute metrics. IBM compatible program. SASE for details. Newcastle, 13424 N. 33rd Place, Phoenix, AZ 85032.

CABLE TV EQUIPMENT

CABLE TV converters and descramblers discount center. Jerrold, Tocom, Hamlin, Scientific, Atlanta, Oak, Zenith. Order your today 800-962-6836.

FOR SALE

DESCRAMBLER KITS Complete cable kit $44.95. Complete Satellite kit $49.95. Add $5 shipping. Free Brochure. Summit MO, Box 489, Bronx, NY 10465.

MISCELLANEOUS

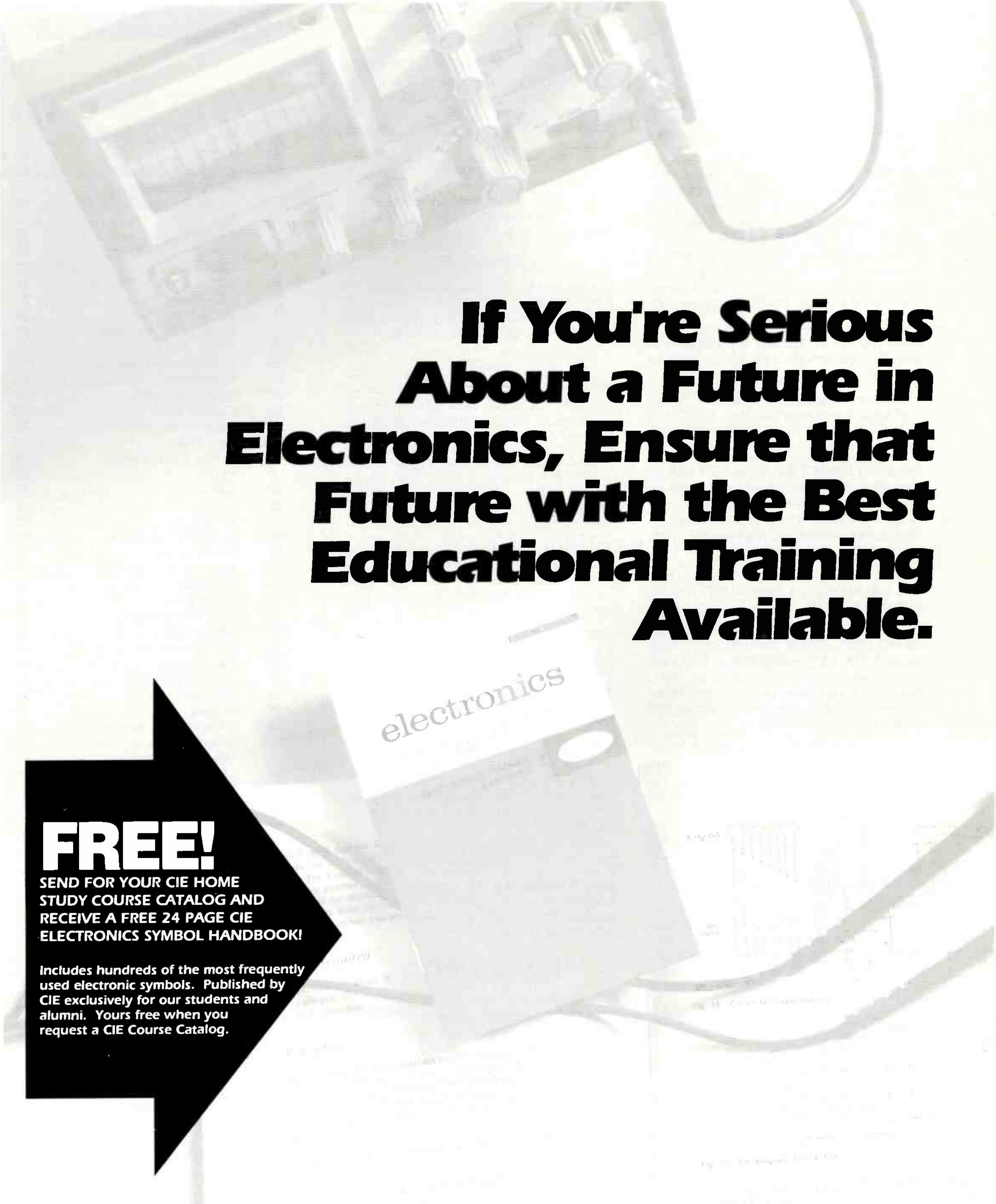
AMATEUR RADIO no Morse code requirement license approved by FCC effective Feb. 14, '91. Complete details with question and answer pools, rules & regulations. Send $15.00 for everything you need to obtain Amateur license to Dan Mobley, 1800 Williams St., Valdosta, GA 31602.

ASIAN LADIES want correspondence for friendship, marriage. SUNSHINE INTERNATIONAL-Dept. TW, Box 5500, Kailua-Kona, Hawaii 96745. (808) 325-7707.

THAILAND Women, Marriageable, Tours, Correspondence: 226 Photograph Brochure $3. Club Tai, Box 974(m), Miami 33233.

Advertisers' Index

We'd like to see your company listed here too. Contact Eric Teitelbaum or Margaret Milanse at 516-681-2922 to work out an advertising program tailored to suit your needs.


If You're Serious About a Future in Electronics, Ensure that Future with the Best Educational Training Available.
electronics
FREE!
SEND FOR YOUR CIE HOME STUDY COURSE CATALOG AND RECEIVE A FREE 24 PAGE CIE ELECTRONICS SYMBOL HANDBOOK!
Includes hundreds of the most frequently used electronic symbols. Published by CIE exclusively for our students and alumni. Yours free when you request a CIE Course Catalog.

If you want to learn about electronics, and earn a good income with that knowledge then CIE is your best educational value.

CIE's reputation as the world leader in home study electronics is based solely on the success of our graduates. And we've earned that reputation with an unconditional commitment to provide our students with the very best electronics training.

Just ask any of the 150,000-plus graduates of the Cleveland Institute of Electronics who are working in high-paying positions with aerospace, computer, medical, automotive and communication firms throughout the world.

They'll tell you success didn't come easy...but, it did come....thanks to CIE. And today, a career in electronics offers more opportunities and greater rewards than ever before.

CIE's COMMITTED TO BEING THE BEST....IN ONE AREA....ELECTRONICS.

CIE isn't another be-everything-to-everybody school. We teach only one subject and we believe we're the best at what we do. Also, CIE is accredited by the National Home Study Council. And with more than a 1,000 graduates each year, we're the largest home study school specializing exclusively in electronics. CIE has been training career-minded students like yourself for nearly 60 years and we're the best at our subject ..... ELECTRONICS ... BECAUSE IT'S THE ONLY SUBJECT WE TEACH!

CIE PROVIDES YOU WITH A LEARNING METHOD SO GOOD, IT'S PATENTED.

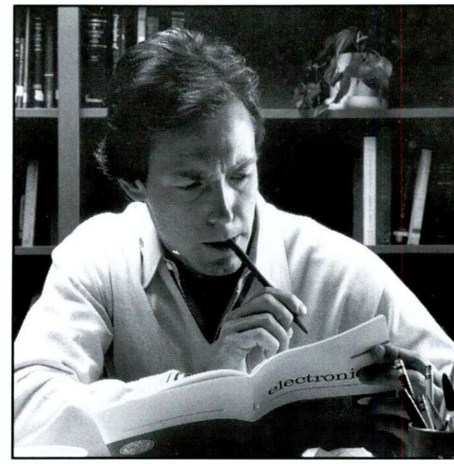
CIE's Auto-programmed lessons are a proven learning method for building valuable electronics career skills. Each lesson is designed to take you step-by-step and principle-by-principle. And while all CIE lessons are designed for independent study, CIE's instructors are personally available to assist you with just a toll-free call. The result is practical training... the kind of experience you can put to work in today's marketplace.

LEARN BY DOING...WITH STATE-OF-THE-ART FACILITIES AND EQUIPMENT.

In 1969, CIE pioneered the first Electronics Laboratory course and in 1984, the first Mircoprocessor Laboratory course. Today, no other home study school can match CIE's state-of-the-art equipment and training. And all your laboratory equipment, books, and lessons are included in your tuition. It's all yours to use while you study at home and for on -the -job after graduation.

PERSONALIZED TRAINING....TO MATCH YOUR BACKGROUND.

While some of our students have a working knowledge of electronics others are just starting out. That's why we've developed twelve career courses and an A.A.S. Degree program to choose from. So, even if your not sure which electronics career is best for you, CIE can get you started with



core lessons applicable to all areas of electronics. And every CIE course you take earns you credit towards completion of your Associate in Applied Science Degree. So you can work toward your degree in stages or as fast as you wish. In fact, CIE is the only school that actually rewards you for fast study, which can save you thousands of dollars.

SEND TODAY FOR YOUR CIE COURSE CATALOG AND WE'LL SEND YOU A FREE 24 PAGE CIE ELECTRONICS SYMBOL HANDBOOK!

FINANCIAL AID AVAILABLE TO QUALIFIED INDIVIDUALS.

WHY CHOOSE CIE FOR YOUR TRAINING?

- 150,000 successful graduates from every country around the world.
- Only CIE rewards you for fast study. CIE offers an Associate Degree program based on actual study time used. The faster you complete your degree the less your overall tuition.
- State-of-the-art laboratory equipment is yours to keep and it comes assembled, ready for hands-on experiments.
- Approved for educational benefits under the G.I. Bill for veterans and other eligible persons.
- Upon graduation, CIE offers free preparation to pass the Certified Electronics Technician Exams.

☐ **YES!** I want to get started.
Send me my CIE school catalog including details about the Associate Degree Program. (For your convenience, CIE will have a representative contact you – there is no obligation.)

Name: ____________________

Address: ____________________

City: ____________ State: ________

Zip: ____________ Age: ________

Phone No. (____) ____________

Check box for G.I. Bulletin Benefits
☐ Veteran ☐ Active Duty

CIE
CLEVELAND INSTITUTE OF ELECTRONICS
1776 East 17th Street
Cleveland, Ohio 44114
(216) 781-9400

ACCREDITED SCHOOL NATIONAL HOME STUDY COUNCIL NHSC

A school of thousands.
A class of one
Since 1934

AO24