Desktop Video–Putting It All Together

ComputerCraft

THE PRACTICAL MAGAZINE FOR PERSONAL COMPUTERS & MICROCONTROLLERS

April 1992 $2.95
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Model	Size	Brand	Speed	Dimension	Bare	XT/Tandy	16 Bit Kit
ST225	21 M	Seagate	48 ms	5.25	183.	224.	234.
ST125	21 M	Seagate	28 ms	3.5	224.	255.	265.
KL320	21 M	Kalok	39 ms	3.5	144.	196.	206.
ST238R	32 M	Seagate	40 ms	5.2	193.	237.	257.
ST138R	32 M	Seagate	28 ms	3.5	226.	254.	278.
KL330	32 M	Kalok	39 ms	3.5	163.	225.	234.
ST251	42 M	Seagate	28 ms	5.25	245.	286.	295.
ST151	42 M	Seagate	24 ms	3.5	336.	367.	376.
SN2040	42 M	Samsung	35 ms	3.5	197.	257.	267.
KL343	42 M	Kalok	28 ms	3.5	234.	N/A	254.
CP3044	42 M	Conner	28 ms	3.5	286.	N/A	315.
WD2044	42 M	Western Digital	18 ms	1.0	294.	N/A	325.
ST157R	48 M	Seagate	28 ms	3.5	266.	316.	326.
ST157A	48 M	Seagate	28 ms	3.5	235.	N/A	287.
PT1357R	48 M	PTI	28 ms	3.5	257.	314.	334.
MK134A	68M	Toshiba	22 ms	3.5	307.	356.	375.
ST1277R	62 M	Seagate	28 ms	5.25	257.	304.	326.
MC8085	85 M	Microscience	40 ms	5.25	326.	387.	424.
ST296N	85 M	Seagate	28 ms	5.25	317.	356.	385.
ST1096N	85 M	Seagate	28 ms	3.5	394.	455.	486.
MX7080A	80 M	Maxtor	19 ms	1.0	384.	N/A	397.
ST1125N	111 M	Seagate	19 ms	3.5	694.	724.	754.

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CIRCLE NO. 88 ON FREE INFORMATION CARD

ComputerCraft

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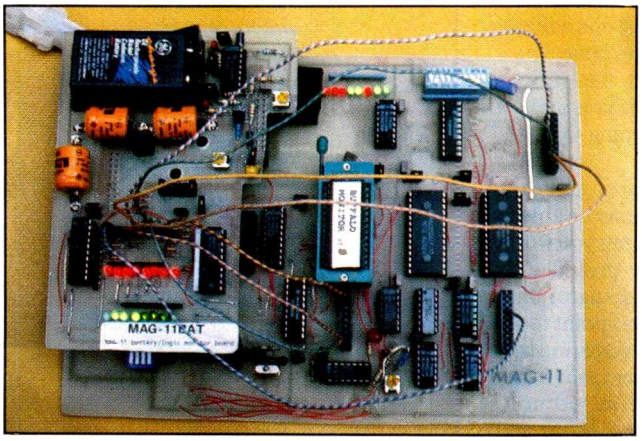
April 1992



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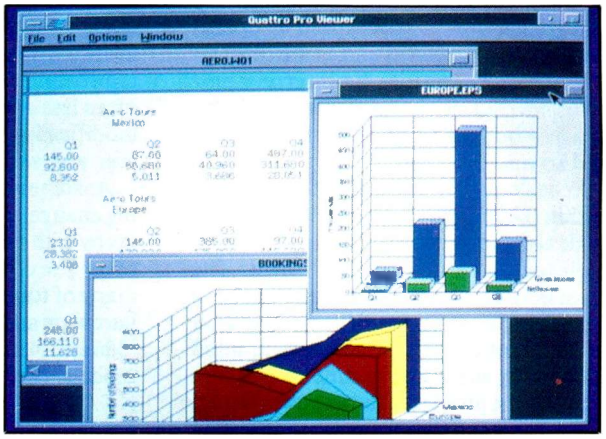

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UPGRADING & ENHANCING

APPLICATIONS

REVIEWS

COLUMNS

DEPARTMENTS

ON THE COVER: Getting down to cases, a *ComputerCraft* reader readies a circuit of his own design for use with the Motorola 68HC11EUB single-board computer. The circuit being breadboarded might be an interface, data-acquisition unit or any of a host of other devices.

Cover Photo: by Larry Mulvehill

Editorial

Built-In Upgrading

The PC is a remarkable machine: it's easily upgradable. You can add more memory and greater disk storage, speed up operations with faster RAM and cache controllers, stretch functions by inserting new cards into bus slots, transfer the works into a new body, such as a tower enclosure, and so on.

What's more, doing the foregoing is within the grasp of anyone who has some basic computer hardware and software experience and a do-it-yourself bent. The most desirable attribute anyone can have when making such modifications is a bit of self-confidence. If one keeps in mind that just by exercising common-sense care (remove the plug from the ac power outlet, never exert extreme force when inserting one device into another, make sure IC pins are all lined up with socket holes before pressing it in, handling the card with the precautions required for static-sensitive devices, etc.) you can't harm a new device or the machine.

This doesn't imply that you won't encounter any problems. You well might due to poor installation instructions and other hurdles. But this only means that you might face some frustrating problem-solving challenges, not damage of any kind. Moreover, with success likely to follow your efforts, you become an expert of sorts in a growing number of computer-enhancement areas.

Even though computer prices are relatively cheap compared to what they were a year or two ago, it all still amounts to a fairly hefty expenditure. A host of manufacturers recognized this and, to overcome buying reluctance due to anticipated obsolescence, introduced machines with upgrading conveniences built into them.

For example, Intel is touting i486SX motherboards that have an accompanying processor socket that will enable the owner to plug in another IC to convert the system to an i486DX equivalent. This simple modification will, according to Intel, double the machine's performance while adding math coprocessor capabilities, should one want this capability at a later date.

In cooperation with Intel, Acer introduced PCs whose upgrade implementation is easy. Essentially, it combines the design of three system boards into one motherboard in order to accommodate i486 CPUs that run at different speeds (20, 25 and 33 MHz). Advanced Logic Research (ALR) is another company that endorsed "Just Upgrade the CPU" design, providing buyers with a lower-cost 486SX entry point. In essence, these companies are bypassing the need to substitute a whole new system board with just a single chip-replacement upgrade path.

Upgrading a PC is almost a way of life for most of us due to fast-moving advances made in this industry. You just don't throw away a whole computer every time a new improvement is introduced. The ante is often less and very fruitful if you make a modification and continue doing so whenever you wish.

At some point, you'll want to make the big change, of course. You may be able to get by with an old XT or AT, but you won't savor the computing power provided by many of today's software packages. Both hardware and software makers point to the '386 and i486 machines when creating new models. Nevertheless, I expect that many XT/AT users who have limited non-graphics-oriented computing needs will continue along with their systems largely as they are.

The coming year or two will be volatile ones, however, as designers and marketers shift and turn. For example, the sub-notebook-size portable computer is expected to come into its own, one that falls in size and weight between the 8½" × 11" notebook computer and palmtop devices such as Hewlett Packard's HP95LX. SCSI ("scuzzy") I/Os will blossom as CD-ROM drive ownership grows and multi-media systems are adopted.

But it will probably be in the area of operating systems where revolutionary changes will be observed. Rickety old DOS can't go on forever. Or can it for many people? After all, there are about 70-million DOS computers being used in the world today.

Switching to a new operating system, whether it's OS/2, *Windows NT* or whatever, shouldn't be a particular calamity in itself. But the need for new applications software and computers with faster operating speed, quick-working multi-tasking and much more memory will, indeed, be a hardship for many people and businesses.

At some point, however, DOS has to be put out to pasture so that others can march forward with greater computer productivity and higher-quality work. It means that there will be at least two distinct groups of PC users for as long a time as it takes for DOS users to switch to a more-advanced computing system.

For some, this may not ever occur, leaving a great number of computer DOS orphans to serve. As they diminish over the years, they'll join users of CP/M-type eight-bit machines still being feverishly used today by a stalwart minority.

Art Salsberg

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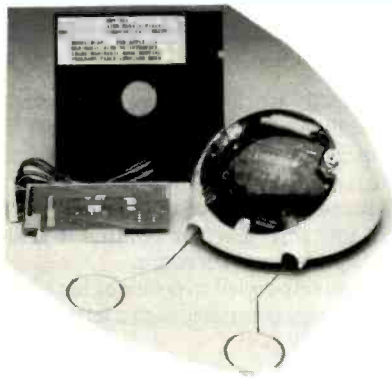
LS9201	TOSHIBA	670nm	5 mW	80 mA	2.4 V	59.99	56.99	51.29
LS9211	TOSHIBA	670nm	5 mW	50 mA	2.3 V	69.99	66.49	59.84
LS9215	TOSHIBA	670nm	10 mW	45 mA	2.4 V	109.99	104.49	94.04
LS3200	NEC	670nm	3 mW	85 mA	2.2 V	59.99	56.99	51.29
LS022	SHARP	780nm	5 mW	65 mA	1.75 V	19.99	18.99	17.09
SB1053	PHILLIPS	820nm	10 mW	90 mA	2.2 V	10.99	10.44	9.40

WAO II PROGRAMMABLE ROBOTIC KIT

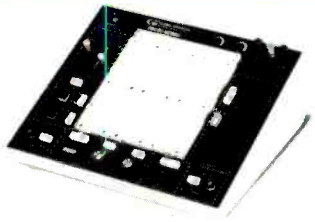


The pen mechanism included with the robot allows it to draw. In addition to drawing straight lines, it can also accurately draw circles, and even draw out words and short phrases. WAO II comes with 128 x 4 bits RAM and 2K ROM, and is programmed directly via the keypad attached to it. With its built-in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

- Power Source - 3 AA batteries (not included)

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

PROTOBOARD DESIGN STATION



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  +5 - to +15 VDC @ 0.5 amp, ripple - 5 mV
- **Variable DC output**
  -5 - to -15 VDC @ 0.5 amp, ripple - 5 mV
- **Frequency generator**
  frequency range: 0.1 Hz to 100 KHz in 6 ranges
  output voltage: 0 to ± 10V (20 Vp-p)
  output impedance: 600 (except TTL)
  output current: 10mA max., short circuit protected
  output waveforms: sine, square, triange, TTL
  sine wave: distortion 3% (10 Hz to 100 KHz)
  TTL pulse: rise and fall time 25ns
  drive 20 TTL loads
  Square wave: rise and fall time ± 1.5 s
- **Logic indicators**
  8 LED's, active high, 1.4 volt (nominal) threshold, inputs protected to ± 20 volts
- **Debounced pushbuttons (pulsers)**
  2 push-button operated, open-collector output pulsers, each with 1 normally-open, 1 normally-closed output. Each output can sink up to 250 mA
- **Potentiometers**
  1 - 1K , 1 10K , all leads available and uncommitted
- **BNC connectors**
  2 BNC connectors pin available and uncommitted shell connected to ground
- **Speaker**
  0.25 W, 8
- **Breadboarding area**
  2520 uncommitted tie points
- **Dimensions**
  11.5" long x 16" wide x 6.5" high
- **Input**
  3 wire AC line input (117 V, 60 Hz typical)
- **Weight**
  7 lbs.

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

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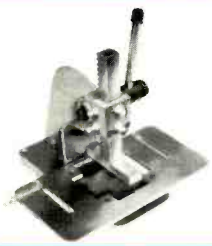

The Panavise PV505 1/4 ton manual IDC bench assembly press is a rugged, practical installation tool designed for low volume, mass termination of various IDC connectors on flat ribbon cable.

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- Additional accessories below
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- Weight - 5.5 lbs.

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

COLLIMATING PEN

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

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

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

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

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

LASER DIODE MODULE

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

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

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

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

COLLIMATING LENS

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

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

DUAL MODE LASER POINTER

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

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

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

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LT1001	*He-He Laser Tube*	69.99	66.49	59.84

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- Output: +5v @ 3.75A
  +12v @ 1.5A
  -12v @ .4A
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CIRCLE NO. 140 ON FREE INFORMATION CARD

And the Winner is . . . Kenneth R. Stoddard

Many thanks to the thousands of you who responded to the *ComputerCraft* Reader Poll in our December 1991 issue. Your responses were enlightening and will be helpful in helping us direct our editorial content to your needs.

Along with the poll was a drawing among respondents for a free Tandy 2810 HD Notebook Computer. The winner was Ken Stoddard of Lathrup Village, MI. Congratulations, Ken!

Ken used a PC at work, where he worked as an Employee Benefits Consultant, and at home, where he owns an IBM 55SX computer, IBM VGA color monitor and an NEC P5 24-pin dot-matrix printer. Like most *ComputerCraft* readers, he has upgraded his system unit by himself. Ken

generally works with word-processing, graphics, spreadsheet and Microsoft *Windows* software, and buys PC hardware and software mostly through mail-order sources, expecting to spend $2,000 to $4,999 this year for computer-related equipment and software.

Ken responded to notice of his winning the Tandy computer with a letter, part of which follows:

"Thank you again for the computer. It arrived on January 2. . . and I got immediately into the serious business of playing with it. It's already pretty well set up the way I want it.

"You couldn't have picked a more appropriate day to announce my prize. That date, December 20, 1991, was the date of my early retirement. When we spoke, I had been retired for about 45 minutes! In addition, it could not have been more appropriate as a companion to my wife's retirement present to me of Davis Instruments' Weather Monitor II hardware and Weatherlink *software. I'll be moving to Oregon, where I intend to develop a weather database so that I can analyze data relative to planning a vineyard for the production of personal wines.*

"I also plan to take up flying, using software for flight planning, weather briefings and interfacing with a variety of navigational instruments, moving-map displays, etc. The 2810 will be an invaluable tool in these endeavors.

"Again, thank you for the prize. . . . we are excited!"

Good luck, Ken, with your early retirement in your new home and with your new portable computer. Next month, we'll give readers the results of our Reader Poll as a sort of profile of a *ComputerCraft* reader. Thanks again to all of you who participated in this study.

The Editors

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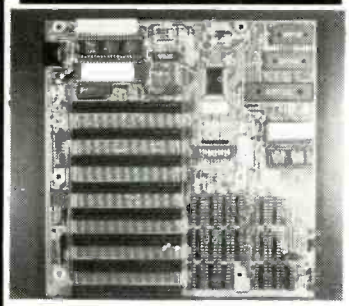
TERMS: No surcharges on credit cards. For C.O.D. orders add $5. C.O.D. orders are cash or certified check only. Minimum C.O.D. order is $25. P.O.'s accepted from approved accounts. Government, Institutional and Corporate purchase orders welcome. FAX your order for faster service. All orders under $99 will be assessed a $3 handling charge. Orders over $99 or more no handling charges. All shipping charges are F.O.B. San Antonio, Texas and will be added to invoice. Texas residents add 8 1/4% sales tax. All returns require RMA# and we ask that all returns are sent back in the same condition in which you received them. A 15% restocking fee will be assessed on product that is returned in non-resaleable condition. Prices and product descriptions subject to change. **CALL FOR CURRENT PRICING.** Products are trademarks of their respective companies. We are not responsible for typographical errors. In a hurry? Federal Express your order: 2nd Day Economy - $8 up to 20lbs. Overnight Priority - $17.50 up to 20lbs.

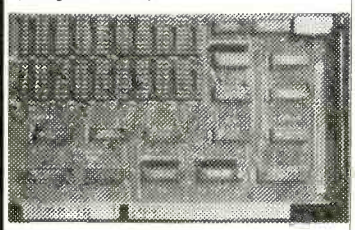
MOTHER BOARDS



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
MB486-33	486 33 MHz Motherboard	$799

MEMORY BOARDS

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



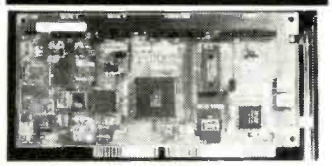
Part#	Description	Each
MEMO-576	576K Ramboard	$23
MEGALITH	Enhanced EMS Memory Board, 4 MEG AT	$119
IFC-47A	BOCA 128K AT Memory Board	$79
IFC-60	AT Plus - Up to 8 MEG RAM	$119
IFC-60A	AT Memory Board 8 MEG Using SIMMS	$119
IFC-62	PS-2 MOD 50 60 EMS up to 2 MEG	$129
IFC-64	PS-2 - EMS up to 2 MEG	$99

IIT MATH CO-PROCESSORS

2C87-12	For 286 up to 12.5 MHz	$78
2C87-20	For 286 up to 20 MHz	84
3C87-16SX	For 386SX up to 16 MHz	109
3C87-20SX	For 386SX up to 20 MHz	119
3C87-25	For 386 up to 25 MHz	169
3C87-33	For 386 up to 33 MHz	179

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	$55
IFC-26	Floppy, Fixed Disk RLL Controller AT	$59
IFC-27-2	AT 2 IDE, 2/Floppy Controller	$19
IFC-27X	XT 2/IDE Controller	$69
IFC-28	XT MFM Hard Drive Controller Board	$47
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

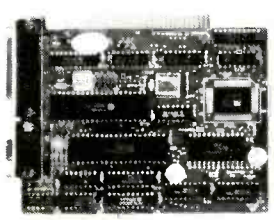
EXPANSION BOARDS

Part#	Description	Each
IFC-12	Serial Board PC/XT	$11
IFC-12A	Second Serial Port Kit for IFC-12	$6
IFC-25	2 Serial, Parallel, Game Board XT/AT	$16
IFC-13	Parallel Board XT/AT	$9
IFC-19	Clock Board PC/XT	$10
IFC-19B	Chipchip for PC/XT	$24
IFC-20	Game Board XT/AT, 2 Ports	$9

COMMUNICATION BOARDS

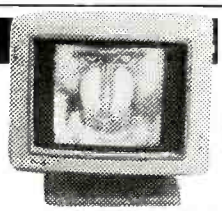
Part#	Description	Each
MS-400A	Multi-Serial Board for PC/AT	$99
MS-422A	Dual RS-232/422 Serial Card for PC/AT	$69
MU-440	Multi-User Board	$139

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-7000	Super VGA w/512K	$139

RELISYS MONITORS



RM9502	Monochrome PS/2 (800 x 350, 400, 480)	$149
RE-9514	Super VGA (1024 x 768) Unlimited Colors	$359
RE1520	15" Super VGA Monitor Noninterlaced up to 1024x768	$469

LASER MONITORS

Part#	Description	
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

POWER SUPPLIES

PS-150	150 watt XT Power Supply	$32
PS-150UL	Same as PS-150 - UL Listed	$69
PS-200M	200 watt XT power Supply	$36
PS-200MUL	Same as PS-200M - UL Listed	$89
PS-200	200 watt AT Power Supply	$42
PS-200UL	Same as PS-200 - UL Listed	$89
PS-220	220 watt Vertical Case Power Supply	$79
PS-230UL	230 watt Vertical Case Power Supply - UL Listed	$99
PS-200MINI	200 watt Baby Vertical Case Power Supply	$59

DISK DRIVES

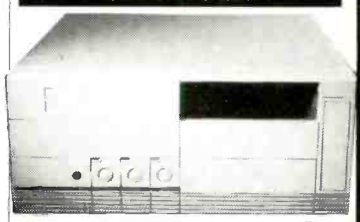
Part#	Description	Each
DDD-04	5 1/4 inch DSDD 360K black faceplate	$59
DDD-05	5 1/4 inch DSDD 360K beige faceplate	$59
DDH-06	5 1/4 inch DSHD 1.2MB beige faceplate	$59
DDH-09	3 1/2 inch 720K beige w/brkt	$68
DDH-10	3 1/2 inch 1.44MB beige w/brkt	$59
DDH-11	Same as DDH-10 without 5-1/4" mounting bracket. Fits in 3-1/2" bay	$55
RAIL01	AT Drive Rail Kit	$1.99
FP-BLK	1/2 Height Black Faceplate	$2.49

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
STC-08	Medium Vertical Case w/230 Watt Power Supply	$119
CASE-TH8	Regular Vertical w/250 Watt Power Supply	$249

KEYBOARDS

KBY-60	AT Style 10 Function Keys XT or AT	$19
KBY-39	Enhanced Style 12 Function Keys XT or AT (XT,AT)	$49
K-156	101 keys with regular footprint for XT or AT. Size: 20 1/2"L x 7 7/8"W x 1 13/16"H.	$35
K-160	Narrow Footprint 101 keys XT or AT. Size: 18 1/2"L x 6 1/2"W x 1 5/16"H.	$36
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.	$43
K-158-1	Small Footprint Spanish Language	$47

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"	$199
ST-3096A	80 MB IDE 15 MS Hard Drive 3-1/2"	$309
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

New Multimedia PC Specs. The base specification for the multimedia PC has been modified by the MPC Marketing Council. Now the minimum configuration is a personal computer with a 386SX microprocessor instead of the original baseline of a 10-MHz 802826 microprocessor. Moreover, the market for upgrade kits for multimedia purposes is expected to be 386DX- and i486-based.

Good Viruses. Not all viruses are bad, it seems. It has been reported that the U.S. introduced a virus to Iraq's control-command defense system--with success--before its initial attack in the Gulf war.

The National Computer Security Association (NCSA) has upgraded its security-oriented bulletin board, expanding it to four dedicated lines. It features information on all known viruses and a "Virus Door" provides on-line lookup of all common viruses, nature of their effect, and information on what products detect and remove it. The BBS at 202-364-1304 operates seven days a week, 14 hours per day. Non-members can try it out. Set communication software to N-8-1, dial at 300 to 9600 baud, and use any password you like when signing on.

A Million Synonyms. Mycrolytics updated its "Word Finder" electronic thesaurus with "Word Finder Plus." It features one-million synonyms that requires less than 200K of disk space. The mew software, which was available initially for Apple Macintosh computers, employs a powerful linguistic technology called "autoinflection." This produces the correct grammatical form of a word for more concise synonym choices. "List" is only $69.95. Current Word Finder users can upgrade for $19.965 by calling Microlytics at 1-800-828-6293 or 716-248-9150.

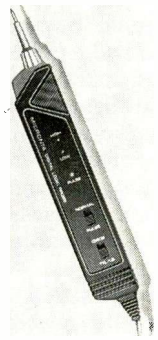
Memory-Card Technology. The PCMCIA's (Personal Computer Memory Card International Association) new Release 2.0 specification for the 68-pin memory card is expected to increased its use for portable equipment. Fujitsu Microelectronics' IC Division introduced enhanced memory card design kits that comply with it. They contain a Fujitsu 68-pin memory card connector and a "ThinCard Drive" from Databook Inc, complete with software, cables and manuals. The drive interfaces to a PC/XT/AT computer. Product information: 1-800-642-7616.

Computer Speech Doings. Fax-to-voice and E-Mail-to-voice software was announced by Malibu Software Group, Malibu, CA. The new software is said to quickly and accurately convert faxes or E-mail into spoken words. It can be used as a stand-alone system or integrated into most other voice mail systems. Tel. 213-456-8940.

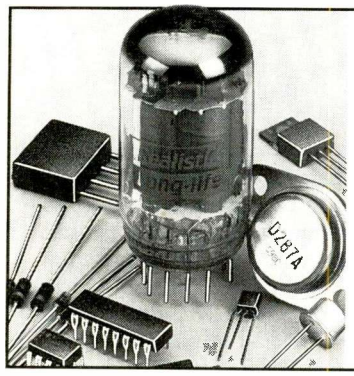
Statistics-keeping during professional sporting events may get a real efficiency boost soon. A prototype conversational voice interface for capturing, retrieving and displaying statistics at sporting events has been developed by Applications Express. It's used in conjunction with voice recognition equipment supplied by Verbex Voice Systems and STATMAN II from Play By Play Corp. Coupled with them, the system is reported to free the announcer to follow each play while simultaneously capturing statistics in a natural conversational manner.

RADIO SHACK

THE PARTS PLACE℠



Digital Logic Probe. The *fast* way to pinpoint problems and check operation in all types of digital circuits. LEDs and "beep" tones reveal logic states instantly. Includes owner's booklet with valuable troubleshooting tips. #22-303 . . **16.95**



Special-Order Hotline

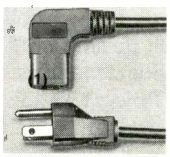
The Radio Shack near you stocks over 1000 electronic components—and another 15,000 items are available fast from our special-order warehouse. Make Radio Shack your complete source for linear and digital ICs, transistors and diodes, vacuum tubes, crystals, phono cartridges and styli, selected computer accessories and SAMS® service manuals.

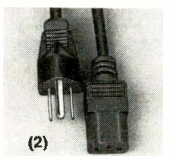
There's no postage to pay because we send your order to the Radio Shack near you. Delivery time for most items is about a week. Come in for details.

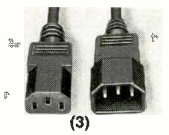
Halogen Bulbs. Long-life, brighter-than-original replacements for your flashlight or lantern.

HPR50. 6V for 4-cell flashlight or 6V lantern. #272-1189, **3.95**

HPR52. 3V for 2-cell flashlight or 3V lantern. #272-1190, **3.95**





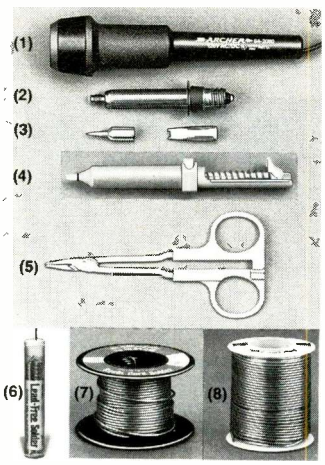


"Business" Power Cords. UL listed AC cords with CEE-type connector for many PCs, printers, monitors, copiers and test instruments.

(1) 6-Ft. Cord With Right-Angle Connector. #278-1260, **5.99**

(2) 12-Ft. CEE Cord. #278-1261, **5.99**

(3) 6-Ft. CEE Extension. #278-1259, **4.99**



Build a Soldering Iron!

(1) "Cool-Grip" Handle. UL listed. #64-2080 . . . . . **6.49**

(2) 23-Watt Heating Element. UL listed. (Interchangeable 33W and 45W elements also in stock.) #64-2081 . . . . . **5.99**

(3) Light-Duty Tips for Above. Set of two. #64-2089 . . . . . **4.99**

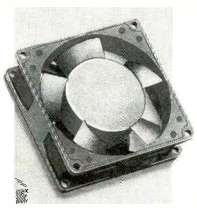
(4) Vacuum Desoldering Tool. #64-2120 . . . . . **6.95**

(5) Mini Forceps. Insulated grips. #64-1910 . . . . . **1.79**

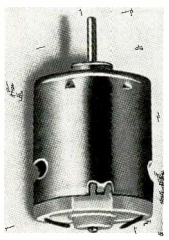
(6) Lead-Free Solder. 96% tin, 4% silver formula. 0.032" size. 0.25 oz. #64-025 . . . . . **1.99**

(7) High-Tech Solder. 63/37%. 0.050" size. 1.5 oz. #64-015 . . . **2.49**

(8) One-Lb. Electronic Solder. 0.062" size. #64-008 . . . . . **8.99**



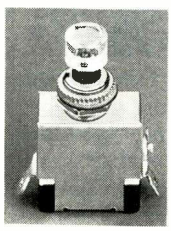
3" Brushless 12VDC Fan. Best choice for cooling mobile equipment or hum-sensitive circuits. Low noise level—34dB max. 27 CFM airflow. #273-243, **14.95**



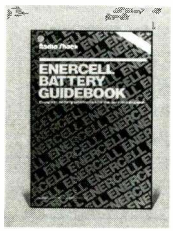
High-Speed 12VDC Motor. Up to 15,200 RPM at no load. Ideal for science projects and robotics. About 2" long (including shaft) by 1" diameter. #273-255, **2.99**

12VDC Magnetic Buzzer. Nicer tone than piezos. #273-026, **2.19**

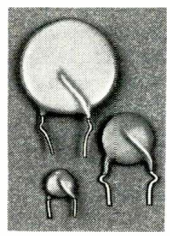
"Ding-Dong" Chime. IC and mini-speaker entry alerter. 6 to 18 VDC. #273-071, **8.99**



Lighted AC Switch. Panel-mountable switch with heavy-duty 10-amp rating. 125VAC use only. Push-on, push-off action. Button lights when on. #275-671, **3.99**

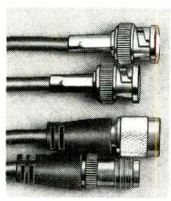


Battery Guide. Save money by choosing the right battery! Data on our top-rated ENERCELL® brand plus a wealth of basic battery info. 230+ pages. #62-1304, **5.95**



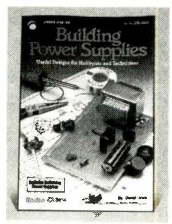
Set of 100 Ceramic Disc Capacitors. Popular values at a bargain price. Ratings up to 1000 WVDC. (Big selection of resistor assortments in stock, too!) #272-801, **Set 1.98**

LCD Multimeter With Automatic Shutoff. We've never seen such quality and features in a *UL-listed* meter priced so low! Full autoranging with manual override, data-hold, analog bar graph to spot trends, 10 amp and 200 microamp ranges. 7½" high. #22-167 . . . . . **69.95**

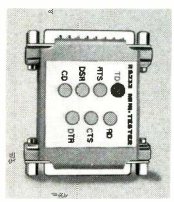


6-Ft. BNC-to-BNC Patch Cable. For test, RF hookups. #278-964, **5.99**

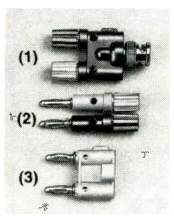
3-Ft. Cellular Phone Extension. Male TNC to Female TNC. #278-976, **4.99**



Building Power Supplies. Covers linear and switching types and includes full construction plans for five supplies. 96 pages. #276-5025, **4.95**



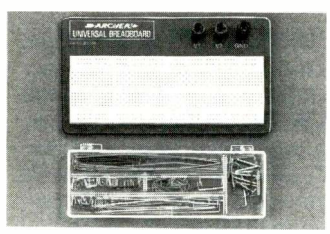
RS-232 Tester. Dual-color LEDs monitor seven data/control lines to help you spot problems quickly. D-sub 25. Connects inline. #276-1401, **14.95**



(1) Binding Posts to BNC Male. #274-715 . . . . **8.95**

(2) Binding Post to Banana Plugs. Stackable. #274-716, **Set 4.95**

(3) Dual Banana Plug. Accepts test probes, wire and/or banana plugs. #274-717 . . . . **2.99**



Deluxe Breadboard. Our best! Molded 2¼ × 6½" board is mounted on a 7 × 4" steel base with stabilizing rubber feet. Features 640 plug-in points and three binding posts. #276-169 . . . . . **19.95**

Breadboard Jumper Wire Kit. Includes 140 insulated, preformed, stripped wires in a snap-shut plastic box. #276-173 . . . . . **Set 4.95**

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

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

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AMERICA'S TECHNOLOGY STORE℠

CIRCLE NO. 82 ON FREE INFORMATION CARD

Epson SX Computers

Epson has two new machines in its desktop line, the Equity 486SX/25 Plus and 386SX/16 Plus. The 486SX/25 Plus, based on the Intel 25-MHz 486SX CPU, has 4M of RAM (expandable via SIMMS to 16M), 32K cache, 200M hard drive, 1.4M floppy drive, AT-

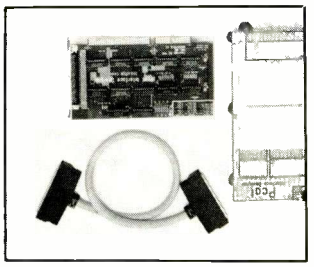
style keyboard and integrated VGA/serial/parallel/mouse ports. Two external and one internal drive bays are open and available for expansion. The unit comes with MS-DOS 5.0, *Windows* 3.0, Asymetrix *Daybook* and Bitstream *Facelift* installed. $4,959.

The 386SX/16 Plus is based on the 16-MHz 386SX CPU and features 2M of RAM (expandable via SIMMS to 24M), 1.4M and 1.2M floppies, 40M hard drive and the same bundled software. $2,050. *Epson America, Inc., 20770 Madrona Ave., Torrance, CA 90509-2842; tel.: 1-800-922-8911.*

CIRCLE NO. 10 ON FREE CARD

PC/AT Breadboard

TMC's Pcat Interface Designer and Breadboard System plugs directly into an AT bus slot and can be used in building and testing interfaces. It allows access to all AT bus signals using solderless tie-point blocks. Circuit assembly is on two high-quality solderless breadboard sockets. The isolation card buffers and isolates all internal IBM/AT bus signals. Address and data bus drivers isolate the bus from external circuits and eliminate the need to construct bidirectional drivers common in I/O and memory circuits.



This approach doesn't restrict you to a particular port or memory address and permits master/slave co-processing. $495. *TMC, Inc., 20 South Lakeshore Dr., Brookfield, CT 06804; tel.: 203-775-5167; fax, 203-740-9313.*

CIRCLE NO. 11 ON FREE CARD

Time-Delay Surge Suppresser

The Power Pause surge suppresser from Tripp Lite protects electronic equipment from unstable or extreme overvoltage conditions that often occur when power is restored after a blackout, as well as against typical voltage spikes. After-blackout protection is accomplished with a time-delay relay that waits five seconds before reconnecting to the ac line.

The Power Pause is an attractive, compact unit that features direct plug-in connection. Two protected outlets are rated at 15 amperes. A green light indicates that the unit is functioning properly. The Power Pause

is UL 1449 listed. $70. *Tripp Lite, 500 N. Orleans, Chicago, IL 60610-4188; tel.: 312-329-1777; Fax: 312-644-6505.*

CIRCLE NO. 12 ON FREE CARD

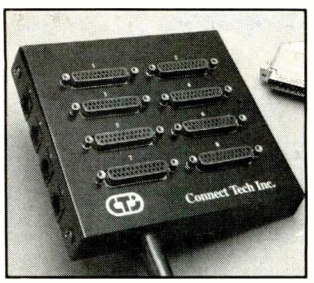
PC Power Module

The Intelligent Power Module from Server Technology Inc. is a computer-activated power module that sits in-line between an ac wall outlet and a power strip. It accepts signals from a PC serial or parallel port to turn on/off ac power. This product was designed for use with computers assigned to unattended operation. By placing the power OFF command at the end of a batch file used to run unattended operations, a PC can shut itself down when the job ends. A PC with multiple ports can be used to control other equipment, turning it off and on via additional modules. The Intelligent Power Module ships with software and a signal cable. $59. *Server Technology Inc., 2332-B Walsh Ave., Santa Clara, CA 95051; tel.: 800-835-1515.*

CIRCLE NO. 13 ON FREE CARD

Multi I/O Box

Connect Tech has a new I/O connector-box option for its product line of intelligent and standard multi-port serial communications adapters. These adapters currently ship with four- or eight-port cable harness assemblies. The I/O connector box option provides such features as an external eight-port connector box, both

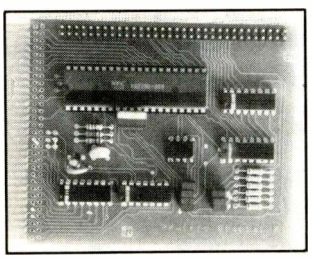


RJ-45 and female DB-25 connectors, connector configured as DCE, connection to the Intellicon and DFlex communications adapters and a variety of installation configurations. *Connect Tech Inc., 18-340 Woodlawn Rd. W., Guelph, Ontario, Canada N1H 7K6; tel.: 519-836-1291; fax: 519-836-4878.*

CIRCLE NO. 16 ON FREE CARD

Data Acquisition

Prairie Digital's model 30 is a low-cost data-acquisition and control system for XTs and ATs (ISA/EISA bus). It features 24 lines of programmable TTL-level I/O, eight-bit A/D converter, eight-channel analog multiplexer for A/D signals, 12-bit CMOS counter, 30-volt, 0.5-ampere open-collector driver option, easy interface to all popular programming languages, quarter-slot plug-in card and sample program on 5¼" floppy. Digital I/O is in 24 bits, arranged as three eight-bit groups (Ports A, B and C); Port C can be divided into two four-bit ports. The board is



configured using a fourth control port.

A/D has eight-bit resolution and a 0-to-5-volt scale. Input range for the counter is 0 to 5 volts in a user-configurable CMOS circuit. $79. *Prairie Digital, Inc., 846 17th St., Prairie du Sac, WI 53578; tel./fax: 608-643-8599.*

CIRCLE NO. 14 ON FREE CARD

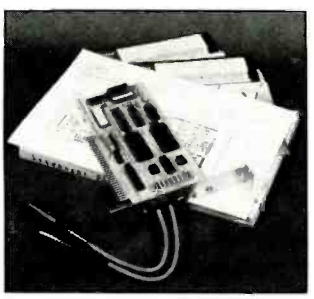
Math Program Update

CompMath version 2.0 from BSOFT Software is a menu-driven mathematics program with enhanced graphics. It is useful in the areas of General, Complex, Matrix, Engineering and Statistical Mathematics. Requirements are an IBM/compatible computer, 256K RAM, DOS 2.1 or later and a graphics adapter. $39. *BSOFT Software, Inc., 444 Cotton Rd., Columbus, OH 43207-3902; tel.: 614-491-0832; Fax: 614-497-9971.*

CIRCLE NO. 15 ON FREE CARD

Low-Cost MIDI

PAIA Electronics' PCM68 MIDI interface is designed in the currently popular UART style and is supported by major publishers of MIDI software. A second MIDI port expansion option is available for



$15. The PCM68 is available in both kit and factory-assembled and tested versions. A starter set that consists of the PCM68 and Voyetra's *Sequencer Plus*, is also available. $50, kit; $60, assembled, $99, set. *PAIA Electronics, 3200 Teakwood Lane, Edmond, OK 73013; tel.: 405-340-6300.*

CIRCLE NO. 25 ON FREE CARD

The Stephen Cobb Complete Book Of PC And LAN Security

By Stephen Cobb
(Windcrest/McGraw-Hill. Soft cover. 556 pages. $24.95.)

Most of us are absurdly complacent about computer security. "It's something that only networks must be concerned with." Or, "I've never had a virus. The virus scare is just groundless panic." And so on. According to Cobb, such a view is shortsighted. He poses a rhetorical question in Chapter 1, "Next Monday morning you arrive at work to find the office in chaos. There has been a break-in. Your PC has been stolen. What is your first thought?" Do you have records of the serial numbers? When did you last make backups? Any mention of credit card numbers? Passwords to on-line services? These questions just scratch the surface of the problem, but Cobb covers computer security in detail.

Cobb sees computer security ranging from the obvious (theft and viruses, for instance) to issues far less obvious with subtle implications. For instance, he devotes an entire chapter to software piracy and the threats it poses to a company. Other topics covered include securing hardware, keeping computers running, controlling computer access, controlling file access, file backup, network security and hacking.

The approach to preventative measures in this book is as practical and unclouded as the author's vision of the problems. He suggests that you should familiarize yourself with the basics of DOS and use the tools available for enhanced security before investing in expensive alternatives. Some of the security measures he suggests actually require no hardware. For example, would you permit a temporary employee from an agency to update your payroll files? If a floppy is damaged, what's the best method for disposing of it? At the other end of the spectrum is a discussion of network security software and hardware.

The author covers both IBM-type and Macintosh computers. Although the dustcover blurb and title make the book sound like an esoteric treatise useful to only LAN and MIS managers, this volume will be of value to anyone who makes significant use of a personal computer. Cobb's writing style is clear and upbeat. In spite of the daunting title, it's a fun book to read.

Software For Home

Radio Shack has upped the ante in the "home computer" wars with *Automatic House Companion* software and Plug'n Power computer interface. The software lets users set and control electric lights, appliances and security devices throughout the home. They can establish daily routines or schedule events for a specific time of day or day of the week. With Plug'n Power remote modules, *Automatic House* can handle up to 128 separate time events and control as many as 256 modules. The program runs on any Tandy or IBM-compatible computer and requires MS-DOS and *DeskMate* 3.0 or later.

Automatic House has three primary functions: Floor Plan, Routine Maker and Schedule Manager, that you use to graphically program the Plug 'n Power Interface through the computer serial port. After programming the interface, you can detach it from the computer and then use it for other purposes or turn it off. $70. *Radio Shack, 700 One Tandy Center, Fort Worth, TX 76102.*

CIRCLE NO. 17 ON FREE CARD

On the health front, *DINE Windows* 3.0 and *MacDINE II* from DINE Systems are designed to help you create complete nutrition and fitness programs that meet individual needs. Using food records, activity records, diet analysis and a proprietary scoring system, you can improve nutrition and lose weight by becoming aware of and altering your eating patterns. These programs feature expandable food databases with 5,656 brand-name, generic, ethnic, processed and fast foods. Each food record contains the number of calories and amount of major nutrients in it. *DINE Systems, Inc., 586 North French Rd., Amherst, NY 14228; tel.: 716-688-2492; fax: 716-688-2505.*

CIRCLE NO. 18 ON FREE CARD

Multi-Media Workstation

The Imagination Station from CCSI is a 12-slot, 33/50-MHz multi-media workstation. This new product line provides both NTSC and S-video input and output ports to facilitate overlaying or mixing of external video sources with text, graphics and animation created within the workstation. Additional NTSC and S-video ports provide for digitizing video images from such external sources as camcorders, laser disks, video tapes and video still cameras. Ports are available for recording and playback of digital stereo audio for voice-overs, music and sound effects.

The workstation features 4M of RAM (expandable to 64M), a 200M hard drive, 1.2M and 1.44M floppy drives, CD-ROM drive and library, NMB 101-key keyboard, DOS 5.0, mouse and 400-watt power supply housed in a heavy-duty tower case. The Imagination Station arrives with a full complement of multi-media software already installed. *Computer & Control Solutions Inc., 1510 Stone Ridge Dr., Stone Mountain, GA 80083; tel.: 404-492-1131; fax: 404-493-7033.*

CIRCLE NO. 19 ON FREE CARD

Semiconductors On A Disk

SGS-Thomson's new semiconductor selection guide comes on an IBM/compatible disk and works with virtually any computer configuration. It provides users with complete selection information and pricing for SGS-Thomson's semiconductors. It is designed specifically for engineers who make design-in choices. *CyberSoft, Inc., 1820 W. Drake Dr., Suite 108, Tempe, AZ 85283-4312; tel.: 602-491-0022.*

CIRCLE NO. 21 ON FREE CARD

Dust Repellent

TORNADO, a dust removal system, and WIPES, cleaning cloths with LintBlock Protection, join flagship STATX (a dust-repellent cleaner and anti-static protector) in the STATX Brands Co. line of high-tech cleaning products. TORNADO directs a powerful blast of air to clear dust and lint from hard-to-reach areas through its nozzle or with its supplied extension tube. WIPES are reusable lint-free and non-abrasive cleaning cloths. These products are available separately or in a combination pack priced at $19. *STATX Brands Co., RTW International Corp., 1110 Lake Cook Rd., Buffalo Grove, IL 60089; tel.: 708-520-0007; fax, 708-520-1951.*

CIRCLE NO. 22 ON FREE CARD

Low-Cost Network

Server Technology's Easy-OFFICE Network is said to be an easy-to-install resource-sharing network that averages less than $99 per IBM/compatible computer installed. In addition to normal printer sharing, E-mail and file-transfer capabilities, it incorporates a smart communication port that allows a single modem to support both inbound and outbound calls. The network can be expanded to support up to 32 systems.

EasyOFFICE requires no network operating system, trained consultant or adapter cards. Using telephone-style cables with snap-on connectors, each computer, modem, printer and plotter in the network connects directly to the control unit via the computer's serial port. File transfers occur at speeds up to 115KB. $500, four-computer package; $750, eight-computer package. *Server Technology, Inc., 2332-B Walsh Ave., Santa Clara, CA 95051; tel.: 408-988-0142; Fax: 408-988-0992.*

CIRCLE NO. 23 ON FREE CARD

Heavy-Duty DMM

Fieldpiece Instruments has added models HB75 and HB77 to its heavy-duty HB70 series of multimeters. The meters include a variable-pitch tone, a logic probe and 600-volt fusing on all current jacks. Variable-tone pitch is useful for spotting intermittents while wiggling suspect connections. The 20-MHz logic probe responds with both visible and audible indicators. Both meters can measure

capacitances up to 200 μF, current from 200 μA to 20 amperes, voltages from 0 to 1,500 volts dc and 1,000 volts ac.

The meters are manual ranging on voltage. The HB77 measures true-rms ac voltages and currents. Both meters incorporate Valox housings to protect against drops, "O" rings to seal the housing and MOVs to protect against transients. Both measure 6¾" × 2¾" × 1½". HB-77, $179; HB-75, $139. *Fieldpiece Instruments, Inc., 8322B Artesia Blvd., Buena Park, CA 90621; tel./fax: 714-992-1239.*

CIRCLE NO. 24 ON FREE CARD

Networking Basics

How circuits talk to each other to keep computers in communication

Many computer-controlled devices can act as independent, self-contained units. However, sometimes computers need to be able to exchange information, to send or receive instructions, or communicate with each other in some way. For example, a scientist studying tomato varieties might want to grow the plants in a series of enclosed boxes, with temperature, light intensity and duration, air flow and humidity controlled individually in each box. To do so, each box could have its own microcontroller that controls lamps, heaters, fans and so on according to preset conditions.

Now what if the scientist wants to monitor and vary the conditions in each box from a central location, or vary the environment in one box according to conditions in another? This is a job for a network, where each microcontroller can act independently, yet can exchange information with the others. This is just one example of the many uses for networks.

This month we'll look at microcontroller networking: when and how to do it, with a look at an efficient nine-bit network you can implement using hardware and software from Cimetrics Technology. As usual, my focus will be on single-purpose or embedded microcontroller projects you might design and build yourself, rather than on applications limited to general-purpose personal computers.

Networking is one of the more-challenging microcomputer projects. Instead of just building and programming a single device, you have to get two or more devices working, and then get them working together, with all of the quirks of serial communication thrown in. The result—devices that can communicate and interact—is rewarding, with the rewards usually well-earned.

When to Network

A network is a solution if you need to send and receive complex information over distance (typically from several feet to several thousand feet), especially if there are more than two devices, or nodes, that need to communicate. A microcontroller, keypad and simple display don't normally require a network, since distances are short and the keypad and display can interface directly to pins on the microcontroller.

But what if you want to enter information at a keypad at one location and have a circuit at another location respond? You can design a network so that one device sends commands like "Decrease humidity by 10%," or "Send me the sensor readings from yesterday," or whatever it is you want to accomplish, and the receiving device will interpret the commands and execute them.

To establish a network between two or more computers, you need three things: a physical path for the data to travel on, hardware interfaces to connect the network devices, or nodes, to the communications path and a software protocol, or set of rules, that enables the nodes to understand the information carried by the network. Let's look at each in turn.

• *Physical Path.* The physical path for the data is usually copper wire, though it doesn't have to be. Fiber-optic cable or transmission through the air on radio or infrared signals are other possibilities. In this article, we'll stick with copper-wire networks and leave more exotic media for another time.

To save on cabling expense, networks use serial communications. Instead of using eight conductors to send a byte of data (one conductor for each bit), the transmitting computer sends bits out one by one onto a single pair of wires. The receiving computer captures the bits as they arrive and converts them back into parallel data for processing.

A common, low-cost form of network cabling is the twisted pair, which consists of two insulated conductors twisted around each other once every few inches or so. Twisting helps to reduce electrical noise induced by changing magnetic fields. You can buy twisted-pair cable or twist your own pair of conductors using ordinary hookup wire. To prevent r-f interference caused by the network and protect the network from electromagnetic interference (emi), use shielded cable and connectors with shielded metal head shells.

Network transmissions can be half-duplex or full-duplex. In half-duplex communication, data travels in one direction at a time over the same conductors. In full-duplex communication, transmitting and receiving use separate conductors, and both can occur at the same time.

• *Hardware Interface.* On the transmitting end, the hardware interface must convert the data into a format suitable for transmitting and send the data onto the network with enough power to assure that it arrives in good shape at the other end. The receiver's hardware interface has to convert the received signals into a format that the receiving computer can accept and understand.

A UART (universal asynchronous receiver-transmitter) normally handles the task of converting between a microcomputer's parallel data and the network's serial data. The UART also adds and removes the start, stop and parity bits used in serial communication. All personal computers with a serial port contain a UART, as do many single-chip microcomputers.

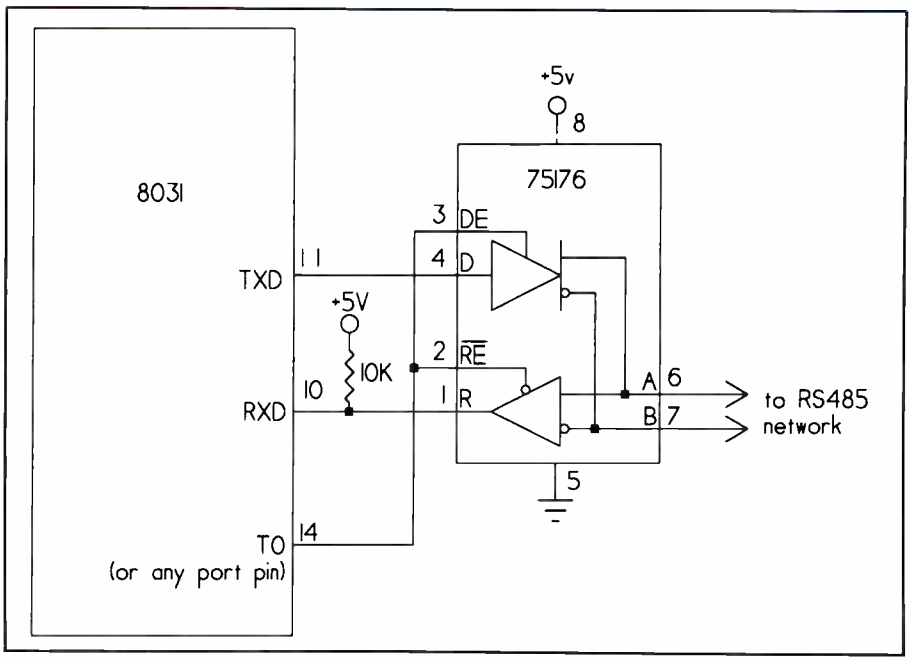


Fig. 1. Texas Instruments TS176 transceiver chip interfaces an 8031 microcontroller's serial port to an RS-485 network.

The UART's serial input and output are normally compatible with TTL or CMOS logic. This is fine for interfacing between chips on a circuit board, but for network transmission over greater distances, drivers with more power are required.

One interface standard especially suited for microcomputer networking is RS-485. Like its RS-232 and RS-422 predecessors, RS-485 is a standard drawn up by the EIA (Electronic Industries Association). The EIA is an association of private industries that develops standards like these, with the goal of eliminating the expense and confusion that result when each organization designs its own way of performing a common task (like serial communications).

RS-485 communication permits up to 32 receivers and transmitters (but only one transmitter at a time), cable lengths up to 4,000 feet in length and speed up to 10M bits per second (but not at maximum cable length and maximum speed). It requires only a single + 5-volt supply and uses differential transmission, where signals are measured as the voltage difference between two signal conductors, rather than as the difference between a signal conductor and a common ground. Differential transmission tends to reject noise and, thus, allows transmission over greater distance.

In contrast, RS-232 was intended for communication between just two devices, at a maximum bit rate of 20,000 bits per second and, because it doesn't use differential transmission, limits cable length. RS-422 is similar to RS-485, but allows only one transmitter and ten receivers.

See "PC Serial Communications" in the September 1991 issue of *ComputerCraft* for more on differential transmission, UARTs and RS-422. The text of the RS-485 standard is available from Global Engineering (see Sources box) for a steep price of $45 for a 27-page document.

Figure 1 shows an RS-485 interface to an 8051 microcontroller. The interface uses a Texas Instruments 75176 transceiver chip, available from Jameco and other sources. The chip contains a three-state differential line driver, or transmitter, and differential-input line receiver, with an active-high enable (DE) for the driver and an active-low enable (RE) for the receiver. By tying DE to RE, you get a single direction-control line, high enabling transmit and low enabling receive.

The DE, RE, D and R pins are TTL-compatible, with low inputs of 0.8 volt or less, and high inputs of 2 volts or more. On the RS-485 side (pins A and B), a valid logic level is indicated by a difference (A to B) of 0.2 volt or more, with a logic high occurring when A is greater than B and a logic low occurring when A is less than B.

Figure 2 shows multiple RS-485 devices connected to form a network. These are the requirements for the interconnection:

(1) Wire the transceivers directly to the network wires, or connect them via short stubs (such as pc-board traces from the transceiver chips to the network connectors). You can use twisted-pair cabling.

(2) Add a 120-ohm termination resistor across the signal conductors at each end of the network. No matter how many nodes you have, there should be just two terminating resistors, one at each end of the network.

(3) Keep track of which conductor is which, and don't cross-connect conductors. On 75176s, one conductor connects to all inverting inputs (pins 7), the other to all noninverting inputs (pins 6).

(4) Provide a common return path for all nodes, to prevent large and possibly damaging ground currents from developing due to differences in ground potentials among the nodes. You can achieve a common ground by connecting signal ground at each node to a common earth ground or by adding a third, common, ground conductor to the network cable. If you use the third conductor, connect it through 100-ohm current-limiting resistors to signal ground at each node.

(5) Ensure that the network is biased to a high state when idle to prevent spurious signals from being interpreted as data. In Fig. 2, the 560-ohm resistors in series with the two parallel 120-ohm resistors bring the "A" line about 250 millivolts more positive than the "B" line, which the transceivers interpret as a logic high. A properly designed network should have only one biasing circuit.

If your network requires more than 32 transceivers, you can use repeater chips, such as Texas Instruments' 75177 and 75178, to extend it.

Protocols

Once your nodes are interconnected, they need to be able to understand each other. The control program

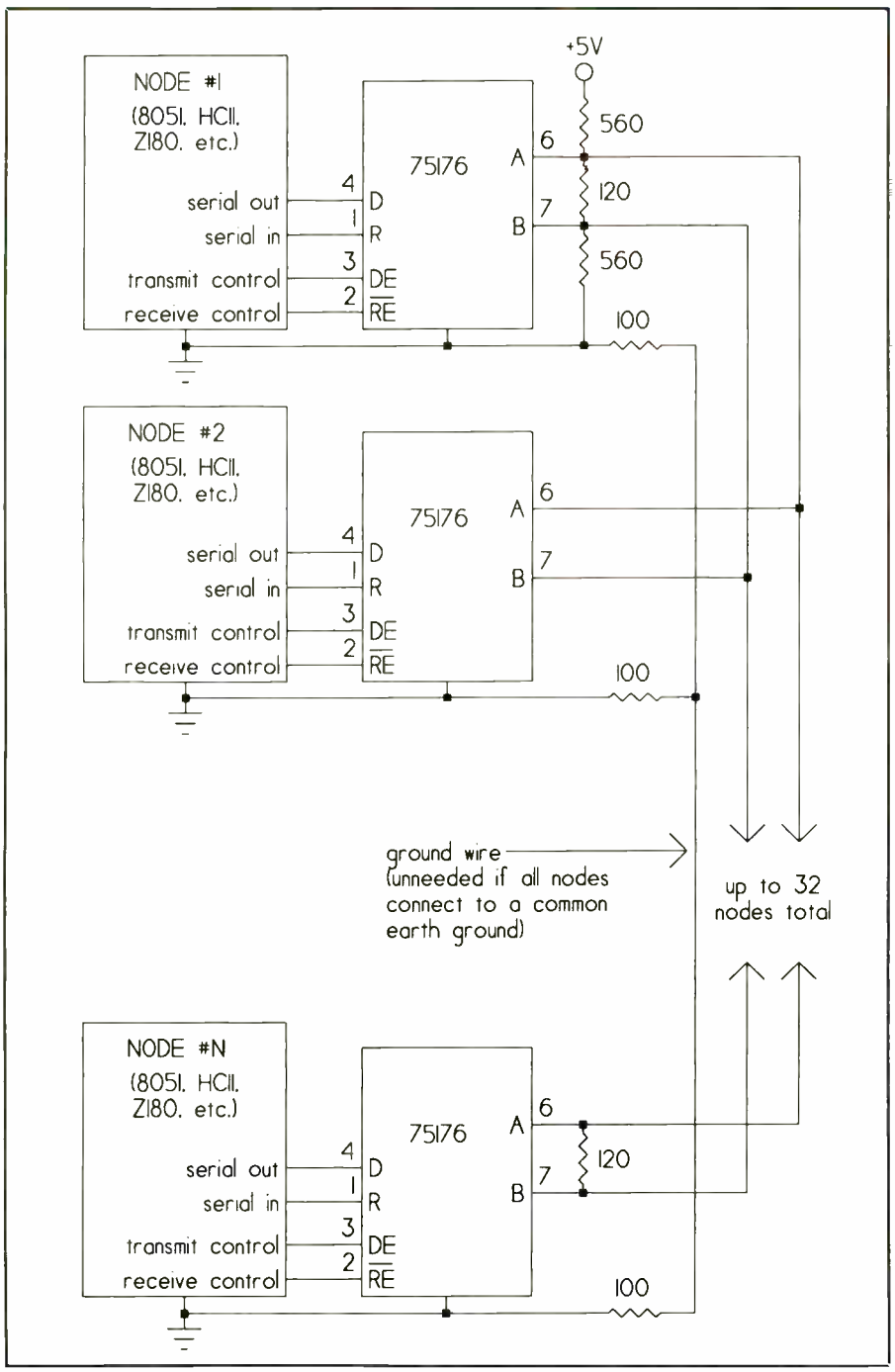


Fig. 2. Up to 32 devices can be connected in an RS-485 network on a single pair of conductors. This example shows a half-duplex network in which data travels in both directions but in only one direction at a time over two conductors.

stored in each node must carry out several functions, among which are:

- Configure the serial port (bit rate, number of start and stop bits, etc.) to a common standard.
- Detect and process incoming messages.
- Ensure that the node doesn't try to transmit when the network is busy.
- Handle transmission errors and other problems.

These are in addition to the fact that each node will be busy with its own tasks, with the network interface as a sideline! Now let's look at each function in turn:

Function 1: *Configure the serial port.* With RS-485, as with all asynchronous serial communications, all nodes must agree on bit rate, number of start and stop bits and parity type. This is usually done by programming the microcomputer's registers. For example, in the 8051, the SCON and TCON or T2CON registers control the bit rate and number of bits per frame.

Function 2: *Detect and process messages.* The control programs at each node also must watch for incoming messages, interpret them and act on them if required.

First, each node must be able to detect when a message has been received. Two ways to do this are by interrupts and by polling.

With an interrupt, the program branches automatically to a subroutine whenever a byte is received at the serial port. In the 8051, serial-port interrupts are enabled by setting a bit in the IE register.

With polling, the program must check periodically to see if a byte has been received and, if so, branch to a subroutine. In the 8051, reception of a byte can be detected by checking the RI bit in the SCON register.

Since most networks have several nodes, each node must be able to detect whether a message is meant for itself or another node. If it's for another node, the message is ignored. Otherwise, the node must interpret and act on the message.

One efficient way of identifying the target node is to use a standard message format. For example, all nodes might be programmed to expect messages that are 15 bytes long, with the first byte in each message identifying the node for which the message is meant. This way, each node needs only to examine the first byte of a message to determine whether or not the message is intended for itself. It then can act on or ignore the next 14 bytes as appropriate.

A standard message format can include other information at specific locations, such as the sender's node, error-checking information or message length (for varying-length messages).

Function 3: *Ensure that two or more nodes don't try to transmit at once.* Otherwise, the result is a garbled mess. There are several ways to keep things under control. Three common protocols are master/slave, token passing and collision detection.

Master/slave is simplest. In this type of network, one computer is designated the master, the others as slaves. The master controls all network communication, and a slave can transmit only when the master requests a response from it. For example, a master might send a message to Slave 1, asking it to transmit a reading from a sensor. The master can then process the information received from Slave 1 and send a message to Slave 2, requesting it to increase or decrease light intensity in response to the sensor reading. Slave 2 might respond to the master by acknowledging that it has received the message and has taken the requested action.

To give everyone a chance to transmit, the master can poll each slave periodically by sending a message asking if it has anything to send.

Master/slave protocol keeps everything under tight control, but with a sacrifice in speed, since slaves have to wait to be polled by the master, and all messages must funnel through the master because slaves can't talk to each other directly.

With token passing, there's no fixed master. Any node can act as the master, but only one at a time. The master is whoever possesses the token, which may be indicated by receiving a pre-defined message. When a node receives the token-passing message, it knows it must transmit next.

Token passing is more flexible than master/slave, since nodes can communicate directly. But token passing is more difficult to program.

A final way of controlling a network is with collision-detection. With this protocol, any node can decide on its own to transmit. If two nodes decide to transmit at the same time, they must detect the collision (noise) that results and either wait and try again later or have some way of deciding who wins the right to transmit.

Collision detection can work well if the network is lightly used, resulting in few collisions. But it's the most complex protocol to implement and becomes less and less efficient as network traffic increases.

Function 4: *Handle errors.* Each node should be able to handle transmission errors without causing the network to go wild or grind to a halt. For example, each node should know what to do if it receives an unintelligible message or no response to a request.

To help detect messages that don't arrive intact, the transmitting node can add checksums or other error-checking information to the messages. The receiving node must then determine if there has been an error. If so, it must know what to do (request a repeat transmission, for example).

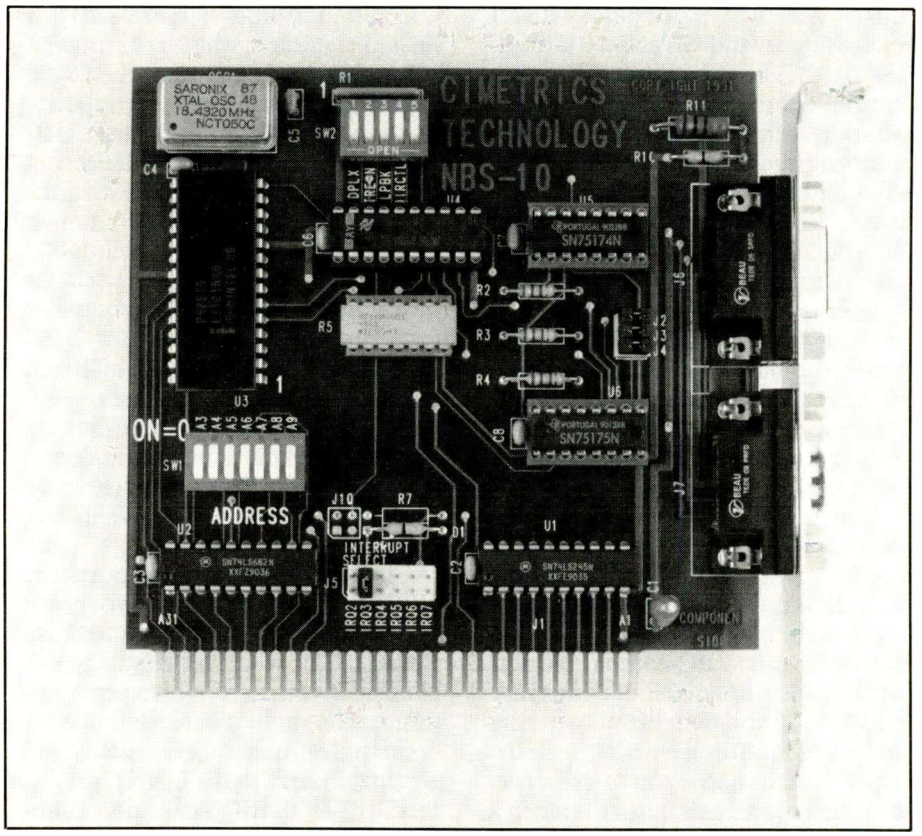


Fig. 3. Cimetrics Technology's NBS-10 card contains an 82510 serial controller and RS-422/485 interface for networking.

Nine Bit Networks

Cimetrics Technology has developed a set of hardware and software networking tools for microcontrollers. All are based on a nine-bit protocol that's supported by many chips, including Intel's 8051, 8096 and 80C186; Motorola's 68HC05, 68HC11, 68HC16 and 68332; Zilog's Z180 and Super8; Hitachi's HD64180; Texas Instruments' TMS7002/7042; and National's COP888CG, COP884CG and HPC46000.

With Cimetrics' products, you can do the following:

- Use a personal computer as a master in a microcontroller network.
- Use a personal computer to help develop and debug a microcontroller network. (After debugging, the personal computer can be removed from the network.)
- Use Cimetrics' code as a base for developing custom microcontroller network programs.

Applications for Cimetrics' products have included home control, access-card security systems, point-of-sale terminals, waste-water treatment systems and energy management.

Nine-bit networks have one big advantage. They free the nodes from having to examine (or at least recognize) each and every transmission on the network, to ensure that they don't miss any messages meant for them. If the nodes are busy with their own tasks, they can't afford to spend all their time listening on the network, just waiting until a message is addressed to them.

In a nine-bit network, the nodes use a ninth bit to signify whether a frame (nine bits plus a start and stop bit) con-

tains a node address or data, with a 1 indicating an address and a 0 indicating data. The microcontrollers are configured to ignore all frames until an address frame is received. When an address frame is sent, an interrupt occurs and all nodes examine the address. When a node recognizes its own address, it processes the data frames that follow. Otherwise, the data frames are completely ignored.

Some devices, like Intel's 83C51FA, have automatic address recognition, which automatically recognizes one address. With this feature, no interrupts are generated unless a message is addressed to that node.

Cimetrics has written software routines for nine-bit communications for the 8051 and other microcontrollers, including the HC11 and Z180, with more to follow. In addition, the company offers two PC-compatible network cards with an RS-485 interface and UART for nine-bit networking and software for use with the cards. The PC cards allow you to use a personal computer as a master node in a microcontroller network for easy monitoring and control with the PC's keyboard and video display.

A personal computer isn't required in a nine-bit network, however. A network can consist entirely of microcontrollers, with one dedicated as the master, if necessary.

Cimetrics offers a variety of products at different price levels to fit different needs and budgets. I've been experimenting with the NBS-10 serial communications card ($249) and Tiny-NSP software ($199). The NBS-10, shown in Fig. 3, is a PC-compatible expansion card that contains an Intel 82510 asynchronous serial controller (an enhanced UART), an RS-485/422 interface and switch-selectable configuration options.

The 82510 can emulate simpler UARTs like the 16450 found in many PCs, but it has additional features. A four-byte FIFO (first-in, first-out) buffer means that you don't have to read each character immediately after receiving it but can store up to four bytes. Transmission rates can be as fast as 288,000 bits per second, and there's an extra timer/baud-rate generator (allows different transmit and receive rates) and support for automatic address recognition.

Communication with the 82510 is via its 35 registers, which are arranged in four banks. In contrast, the 16450 has a single register bank, corresponding to bank 0 on the 82510. One 82510 register contains a bit that enables true nine-bit communication. With simpler UART chips, the parity bit must be pressed into service as a ninth bit.

To use the card, you must select a base address for it in your computer (you can use the address of a COM port or another address), an interrupt request number, half-duplex or full-duplex operation and handshaking options. The board includes male and female nine-pin D-connectors, wired identically, so you can use whichever is more convenient.

Cimetrics' software supports the NBS-10 card, or you can do your own programming in assembly language, BASIC, C or whatever language you choose. If you do your own programming, though, be aware that nine-bit communication requires reading and writing directly to the UART's registers. MS-DOS BIOS calls don't support nine-bit communications, nor do many statements in the higher-level languages.

Documentation for the NBS-10 includes an installation and configuration guide, a schematic diagram of the board, programming information, sample C code that allows two PCs equipped with NBS-10 cards to communicate and a reprint of Intel's 40-page data sheet for the 82510 UART.

Tiny-NSP, is a software toolkit consisting of several modules:

NBS10COM is assembly-language code that provides an interface to the NBS-10's UART. The code configures the UART, installs an interrupt handler and takes care of details involved in sending and receiving characters. The routines were written in assembly language for fast execution. Both source code and assembled formats are provided. Also included is equivalent NBS2COM software for Cimetrics' NBS-2 card.

TNSPPC is PC-compatible software that allows you to read and write to a network node and read the 82510's registers. It's provided as Microsoft C source code and as an executable file.

NETMONIT is PC-compatible software that displays all network traffic in hexadecimal format on a PC's monitor. Like TNSPPC, it's provided in executable format and C-language source code.

TNSP8051 is 8051-compatible code that enables an 8051 microcontroller to communicate with a PC running NBS10COM (or NBS2COM). It's provided in assembly-language source code and in Intel hex format.

You can run TNSPPC and NETMONIT as-is, in their executable formats, but eventually you'll want to customize the code, adding your own functions, and recompile. Both programs can be compiled with Microsoft C or QuickC, and both incorporate the NBS10COM and NBS2COM modules, which must be linked to the C code after compiling.

The 8051 code, TNSP8051, is written for the Archimedes 8051 assembler. Using other assemblers will require modifications (more on this later). You can program an EPROM or other memory device immediately with the hex file. But, as with the other programs, you'll eventually want to customize the code for your application and reassemble.

All of the Tiny-NSP programs use nine-bit communication and all use a common message structure, which includes dedicated fields for the target node address, source node address, message length, opcode (for example: reset network, read or write to slave, etc.), an error-checking byte and an optional message of up to 250 bytes. The master node places messages on the network, and slaves can respond with the requested information or by acknowledging receipt of the message.

Documentation for the Tiny-NSP Toolkit includes explanations of the code modules, an example schematic of an RS-485 interface to an 8051 microcontroller, advice on compiling and assembling the code and a helpful example project using an 8051 that controls a heater according to temperatures entered at the network master. Comments in the source code also help to document the modules' functions.

I experimented with the NBS-10 board and Tiny NSP software, using a '386 computer as a master and an 8031 clocked at 12 MHz, which allows communications at 62,500 bits per second. I followed the included instructions to configure the NBS-10 and installed it in my computer. I then wired

```
RP - read port
RI - read internal RAM
RE - read external RAM
WP - write port
WI - write internal RAM
WE - write external RAM

Type command: ri
Read internal RAM: starting address? (0 - 255) 0
How many bytes? (1 - 250) 8
Message from node 1: DATA:
48 1 55 55 55 55 55 55

Your options are:
  D - send a data transfer command
  S - get status from each node
  T - send test display message (to a PC only)
  M - send display message (to a PC only)
  R - display UART Registers
Esc - exit
 55   1   1   0   8  60   0   0
 55  40  21  30   0   0   0  12
 ff   0  41  20   8   0  1e   0
 50   4  61  84  fc   f   0  ff
```

Fig. 4. A sample screen from Cimetrics' TNSPPC program, which allows you to use a personal computer to read from and write to network nodes. Numbers in the bottom four rows are the contents of the 82510 UART's registers.

an RS-485 interface to the 8031 board (as shown in Fig. 2), programmed an EPROM with the TNSP8051 object code and installed the EPROM at program address 0 on my 8031 board.

I made a twisted-pair cable with a nine-pin D-connector on one end to connect to the NBS-10 and connected the other ends to the RS-485 interface on the 8031 board.

To get the basic network working on COM3 on my computer, I had to unload a mouse driver on COM1, (even though I wasn't using the mouse), since COM 1 uses the same interrupt as COM 3. I also spent some time tracking down a DIP switch on the NBS-10 that wasn't fully closed and prevented the network from operating properly. Eventually, I got everything working and was able to use my personal computer to read and write to the 8051. Fig. 4 shows an example screen from TNSPPC.

I next decided to try recompiling and assembling the code. I was able to recompile the C code without problems, using Microsoft C version 6. (Earlier versions of C that don't permit in-line assembly language to be used won't work.)

For the 8051 code, if you don't have the Archimedes 8051 assembler for which the code was written, you'll probably have to make some changes to get the code to assemble.

With some editing, I was able to use an A51 assembler from Systronix. My first try resulted in dozens of errors, but most were due to easily spotted differences in formatting or syntax conventions. The documentation provided clues to other problems, such as a warning to reserve enough room for the stack segment.

If you want to develop a microcontroller network, Cimetrics' products can help you put together an efficient, full-featured one, but you'll need some programming tools and expertise. Because the PC code is written in both C and assembly language, you must be familiar with both and have access to a C compiler as well as an assembler for your PC.

Modifying the 8051 code requires an 8051 assembler and an EPROM programmer. You also need a copy of the data book for your microcontroller, for details on its nine-bit interface.

By taking some time to study the code provided, you can add code to the modules and develop your own applications, without having to reinvent the network basics (which are considerable).

In addition to the nine-bit interface, I'd hoped to cover another serial communications protocol this month—Philips' I-squared-C synchronous serial interface. But since I've run out of room, I'll have to save that one for another time.

Next month: How to find and use sensors and transducers to detect and measure just about anything.

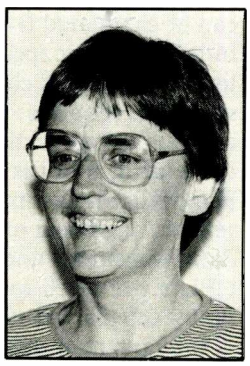
Send your comments, suggestions and questions on topics relating to designing, building and programming microcontrollers or other small, dedicated computers to Jan Axelson, ComputerCraft, *76 N. Broadway, Hicksville, NY 11801. For a personal response, please include a self-addressed, stamped envelope.*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

Sources

Cimetrics Technology
120 W. State St.
Ithaca, NY 14850
Tel.: 607-273-5715
Fax: 607-273-5712
Networking products.

Global Engineering
7730 Carondelet Ave., Ste. 407
St. Louis, MO 63105
Tel.: 1-800-854-7179
EIA-485 RS485 standard.

Jameco
1355 Shoreway Rd.
Belmont, CA 94002
Tel.: 1-800-831-4242
Fax: 1-800-237-6948
75176 RS485 transceivers.



Jan Axelson

Computer Speed

How a host of factors influence a computer's operating speed

Put two 33-MHz 386 computers side by side and run the same spreadsheet calculation, database query or compiler. In almost every case, the machines will finish at different times. In a perfect world, computers with the same CPU running at the same clock rate should work at the same speed, but few do. Buying a computer by CPU and clock speed alone is like buying a car based solely on the number of cylinders and valves it has. Both measures will give you some idea of the machine's performance, but no real standard.

Many factors affect a computer's processing speed. Most can be gleaned from the computer's engineering specifications. But some depend on how you use the computer and its exact status at any particular point in time.

The most important factors that determine your computer's performance are, of course, its CPU and its clock speed. Clock speed is the number of ticks the CPU receives each second. For example, a 33-MHz computer has 33,000,000 clock ticks per second. On each tick, the CPU performs an internal operation, such as fetching a piece of data, putting a result in a register or performing all or part of a calculation. Each full machine instruction, like the instructions you write in assembly language, takes two or more clock ticks to complete.

The time required for old and simple CPUs to perform a block of code can be calculated from the manufacturer's hardware specifications, which list the number of clock ticks each instruction requires. Intel processors and the computers they run in, on the other hand, aren't as easy to pin down. Factors like interruptions for memory refresh, alignment of instructions and data in memory and the state of the CPU's pre-fetch queue make exact timing calculations almost impossible.

Intel and many assembler manufacturers publish timings for each machine instruction but warn that they're approximations or best-case values. And some published timings, especially for integer division and multiplication instructions, are given as ranges because the CPU's performance depends on the data items involved.

However, the faster the clock speed, the faster a computer can calculate. Because computer speed is affected by more than CPU speed, a 50-MHz machine won't be twice as fast as a 25-MHz computer . . . but it will be close.

"A 50-MHz machine won't be twice as fast as a 25-MHz computer, but it will be close."

The exact type of CPU also has a large effect on computing speed. An instruction as simple as "ADD AX,2" requires a minimum of four clock ticks on an 8088 computer, three ticks on an 80286 computer, two ticks on a 386 computer and only one tick on an i486 computer. In general, the 80188 and 80186 are more efficient and perform instructions in fewer clock ticks than the 8088 and 8086. The 80286 is faster. The 386 (both DX and SX versions) is even more efficient, and the i486 is generally the most efficient of all.

There's no exact measurement of the relative speeds of different CPUs in the Intel family, however, because speed is strongly affected by the particular mix of instructions in a particular application. The relative speeds of machine instructions vary from one CPU to another. If you want to write the fastest code possible, you have to learn different optimizing tricks for each chip.

Waiting Around

Unfortunately, a CPU can't spend all of its time cranking through the machine instructions that make up an application program. It must also spend a lot of time fetching both instructions and data from memory. In most computers, memory is implemented as dynamic or static RAM (DRAM or SRAM) on the motherboard, added RAM on a card plugged into the expansion bus or the ROM BIOS chips built into the motherboard and many boards on the expansion bus.

DRAM chips are relatively inexpensive and compact. They used to be an ideal medium for volatile or on-line memory and are still the only economical choice for the multi-megabytes of RAM modern applications need. DRAM is called volatile because it loses the data it contains when the computer's power is shut off. DRAMs also lose data if they aren't constantly refreshed, which means that the computer has to spend a small percentage of its time refreshing these chips (by accessing every cell) instead of performing other work.

The speed of DRAM chips is usually measured in nanoseconds and is related to the time needed for the chip to receive a read instruction and put the requested bit on the data bus, or to store a bit from the data bus into a specific memory location. In early PC/XTs and 80286 AT/compatible computers, DRAMs could keep up with the CPU. Not all DRAM chips can keep up with today's faster processors, though.

To fetch a byte or word of data, the CPU puts the address of the data on the address bus, places a signal on the control bus that says it wants to read

data and then reads the data from the data bus. In the time between the read signal and actual data read, each affected DRAM chip must react to the read instruction, decode the address, look up the necessary bit internally and place the bit on the data bus.

DRAM technology has failed to keep pace with increases in CPU speed. At one time, all that was needed to make a faster memory system was to use faster DRAM chips. But CPU speeds keep increasing at a faster rate than DRAM speeds, which leads to a memory bottleneck.

"The simplest solution to match slow DRAM with a faster CPU is to use wait states."

The simplest solution for matching a slow device (DRAM, in this case) with a faster CPU is to use wait states. When the CPU sets up the address and signals that it wants to read a byte of data, the memory system puts the CPU into a wait or idle state by signaling on the wait-state line. When data is ready, after one or more clock ticks, the memory system turns off the wait state line and lets the CPU gather the data and proceed.

If your memory system asserts one wait state during each memory access, your computer loses a clock cycle each time it has to read or write data from memory. When it's reading machine instructions instead of data, the situation is less clear. Each CPU in the Intel "86" family contains an on-board prefetch instruction queue. The size of the queue has grown with each new member of the family.

One part of the CPU reads instruction bytes into the prefetch queue while other parts are busy performing internal calculations. In such cases, memory wait states may have no effect on performance at all because the internal calculations continue during wait cycles. But every time the CPU has to perform a jump to a new memory location or a call to a subroutine or respond to a hardware or software interrupt, it flushes the queue and must refill the queue from the new instruction location. When this occurs, wait states will slow down the CPU until it has its queue full again.

To avoid wait states as much as possible, manufacturers can choose among several different strategies. They can use faster (and expensive) DRAMs, build a memory architecture that takes advantage of the "flash" read mode of 386 and i486 processors and use an SRAM memory cache.

Static RAM chips are less compact and much more expensive than DRAMs, but they can also be much faster and they don't require refreshing. They retain data until it's changed or the computer's power is turned off. An SRAM cache acts as an intermediary between the CPU and main memory. When the CPU asks for data or machine instructions, the cache fulfills the request if it contains the correct bytes. If not, it reads data from memory at the same time the CPU does and stores the data in cache in case the CPU wants it again.

On many systems, read requests fulfilled by the SRAM cache use no wait states, while those that must come from DRAMs require at least one wait state. Overall speed of such memory systems depends on the efficiency of the cache controller.

Another memory-related method of speeding up a computer is to "shadow" the ROM BIOS. ROM chips tend to be much slower than either DRAMs or SRAMs. Many 386 and 486 computers have a boot-up option that copies ROM contents into faster RAM and then map the RAM block at the location where the system thinks the ROM is stored. The result is that instructions and data in the ROM chips can be read at full DRAM speed.

"You can't speed up a computer by simply installing faster DRAM chips."

You can't speed up a computer simply by installing faster DRAM chips on the motherboard. The memory system is engineered to operate at one specific speed. No matter how quickly the DRAM chips operate, the other memory hardware will enforce the original speed. If you install faster DRAMs, their extra speed capabilities will never be utilized. But if you put in slower DRAMs, they may not be able to keep up with the CPU and will eventually cause flaky operation or a system crash.

Faster Calculations

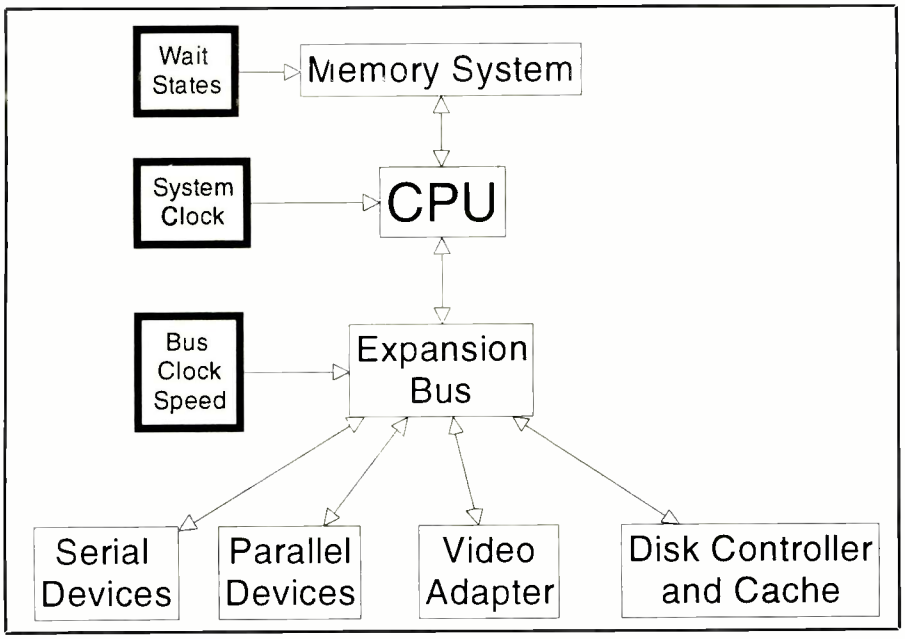
All programs spend a portion of their time performing calculations. These may be as simple as incrementing and decrementing pointers to video and data memory locations or as complex as pinpointing orbit positions for satellites. The CPU can perform integer addition, subtraction, multiplication and division with single instructions. But if it has to handle floating-point numbers or calculate square roots and transcendental functions, it must do so using long and slow subroutines.

If you use your computer for word processing, database management or graphics, it probably performs few floating-point calculations. But if you use spreadsheets or engineering applications, your computer spends a lot of time crunching numbers in floating-point subroutines.

Almost all 8088/8086, 80286 and 386 computers have a socket for a math coprocessor chip (no coprocessor is needed for i486DX CPUs because these chips have a built-in coprocessor). A coprocessor can handle floating-point numbers directly and perform complex calculations 10 to 100 times faster than the best floating-point subroutines. To install a coprocessor chip, you simply push it into a socket on the motherboard and perhaps set a switch or jumper or two inside the computer. The CPU and coprocessor perform all necessary communications automatically.

Any programs you run must be able to detect and use the coprocessor to realize benefit from its presence. There's nothing in the computer that keeps a dumb application from ignoring the coprocessor and continuing to use slow subroutines to perform its calculations. Most commercial programs can recognize and use a coprocessor, as can programs written with most popular language compilers.

Coprocessors in most 8088 and 386 computers usually run at the same speed as the main CPU. The same is



true of newer 80286 computers. However, many older 80286 computers have a motherboard that runs the coprocessor at a slower clock speed than the main CPU because Intel didn't release updated coprocessors at the same time as it did faster CPUs. Like DRAM chips, there's usually no advantage to installing a coprocessor that can run faster than the speed for which the computer's coprocessor socket was designed.

"Many older 80286 computers run a coprocessor at a slower clock speed than the main CPU."

However, Intel's 33-MHz 80387 coprocessors, which can usually be used in 25-MHz 386 computers, are more efficient than the 25-MHz and slower models. This means a 33-MHz 80387 coprocessor can perform calculations in fewer clock ticks than the 25-MHz model of the same chip. Intel apparently redesigned internals of the coprocessor before it released the faster version.

Thus, if you have a 25-MHz 386 computer, you might want to consider using a 33-MHz Intel 80387 coprocessor for fastest possible operation. For any other computer, choose a coprocessor that matches the speed of the coprocessor socket on your computer's motherboard. Intel-compatible coprocessors from companies like IIT and Cyrix are often less expensive and faster than the Intel-compatible chips they replace. As far as I know, there's never any advantage to buying a faster chip if you choose one of these compatible models.

There are inherent inefficiencies built into the linkage between the CPU and Intel (or Intel-compatible) coprocessors. To get around them, Weitek produces coprocessors that are favored for high-end engineering applications. They're faster than any Intel/compatible models for two reasons.

"Weitek chips are faster than any Intel/compatible models."

They avoid the linkage bottleneck by using a memory-mapped configuration (they use memory locations you'd never fill with DRAM chips). And they use fewer internal digits for each calculation to obtain answers faster, even though those answers sometimes have less precision.

Weitek coprocessors, however, require programs written with special compilers or hand-coded machine-language instructions. For this reason, they're generally used in only high-end engineering applications.

If you regularly perform floating-point calculations with programs that support a coprocessor, a math chip can make your computer seem much faster. But if you rarely perform such calculations, a math coprocessor will simply be an expensive heat generator inside your computer.

Waiting for the Bus

Microcomputers were designed to be expandable. Except for small laptop and notebook computers, almost every DOS-based machine has an internal expansion bus that can be used to install video cards, disk controllers, network cards, modems and a host of other peripherals.

In the original PC and PC/XT, the CPU ran at 4.77 MHz and so did the internal expansion bus. The original PC/AT ran an 80286 CPU at 6 MHz and the bus at the same speed. Bus speed was increased to 8 MHz, along with the CPU, in later models of the PC/AT computer.

As computer speed increased, users faced a real dilemma. If the speed of the bus kept pace with the CPU, add-in cards would become obsolete each time the user upgraded to a new and faster CPU. The solution was to keep bus speed at 8 MHz while the CPUs got faster and faster. The advantage of a slow bus is that all add-on cards will work in the computer, even ones that were designed for the PC/AT. But if you put an 8-MHz expansion bus in a 50-MHz i486 computer, the machine will come to a near standstill every time it has to access the video card, hard disk, memory expansion card or other peripheral.

The solution used by many manufacturers is to let the user pick the bus speed. The 25-Mhz 386 computer I'm using right now, for example, has a switch on the front that changes bus speed (after a reboot). Every card I've tried has been able to keep up with the bus running at full speed, but if I wanted to transfer some cards from one of my older computers, I'd have to slow down the bus.

(Continued on page 85)

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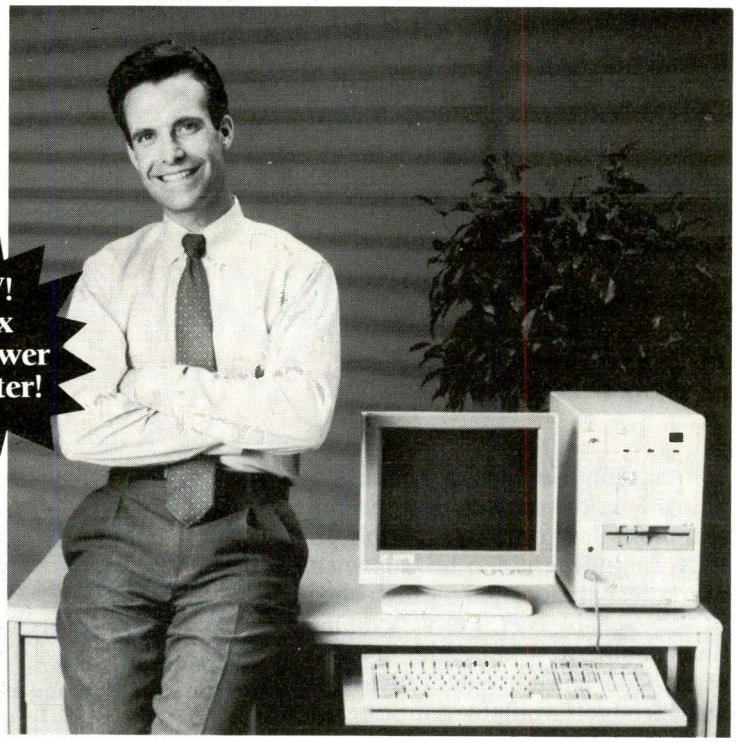

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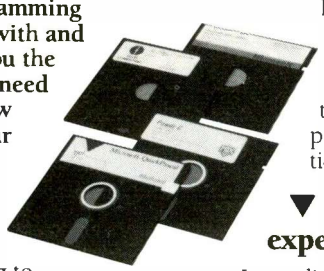

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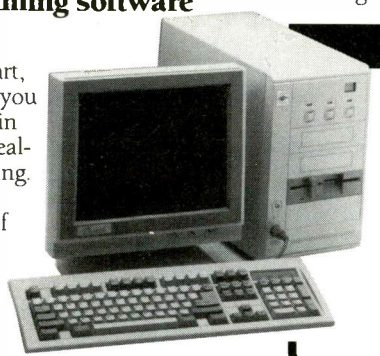

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PC Desktop Video

Part 2

Titling, animation, sound and video–putting it all together

Last month in Part 1, we discussed the major hardware components that make desktop video possible on PCs, including video boards with overlay capabilities and the high-end, PC-controllable NEC PC-VCRs. This time around, we'll be looking at some of the better and more innovative software products available for bringing PC video presentations and productions all together with a truly professional touch.

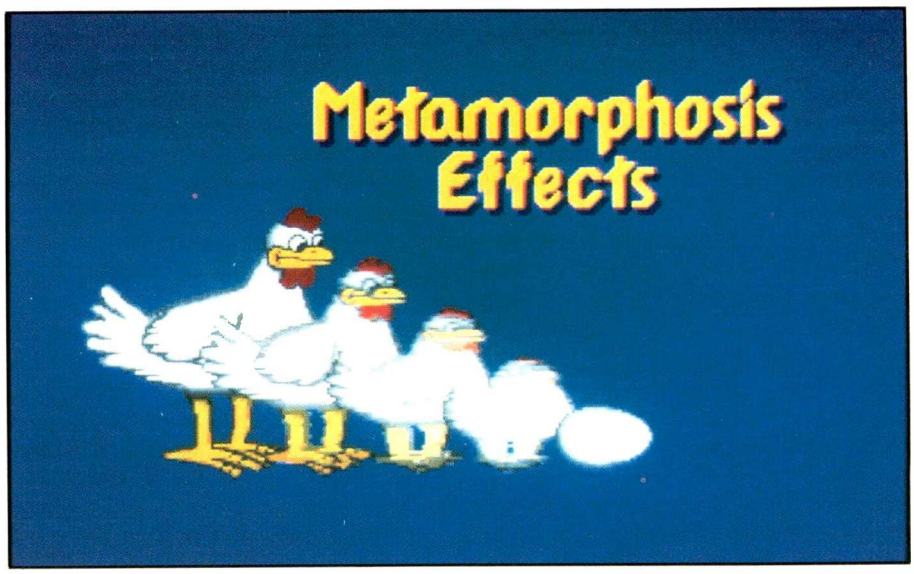
The principal production areas we'll be focusing on here are titling, animation, sound and combining all of these elements with video imagery to produce a finished desktop video production. Because we have lots of ground to cover this month, let's get right to it.

Video Titler, $495
Entropy Engineering
12317 Village Square Terr.
Suite 202
Rockville, MD 20852
Tel.: 301-770-6886

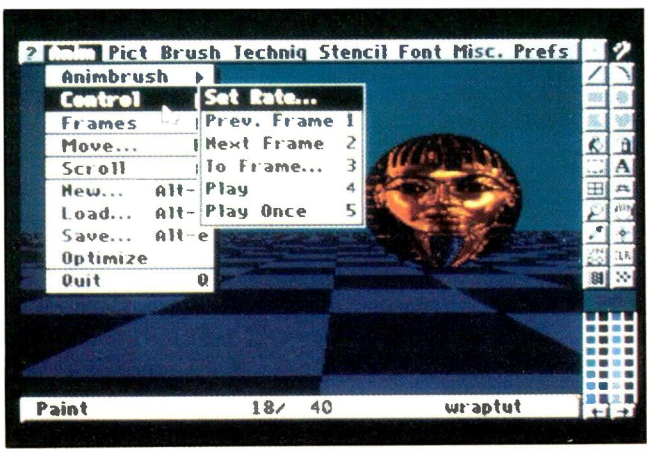
CIRCLE NO. 50 ON FREE INFORMATION CARD

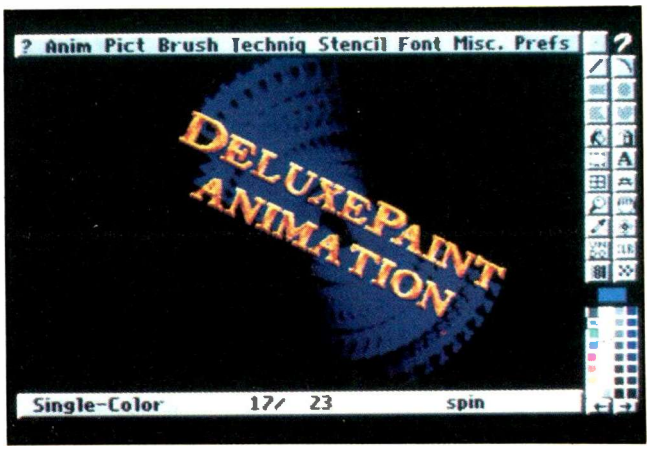
Entropy's *Video Titler* program comes packed with in an OEM version with the TrueVision Video VGA with Overlay board and the Willow Peripherals VGA-TV GE/O board covered in Part 1. Whether you're using the OEM version or stand-alone retail version, *Video Titler* is without a doubt the king of all video-titling software products.

To install and run *Video Titler*, you need at a minimum a 286 AT-class computer running at 12 MHz and preferably a 386- or i486 machine running at a faster speed, hard drive with at least 2M available and VGA graphics card with NTSC output and overlay capabilities. You also need 640K of RAM with 540K available, which may require relocating device drivers and TSRs to high-memory areas to free up more space in the lower 640K area. This is particularly important when using TSR-activa-

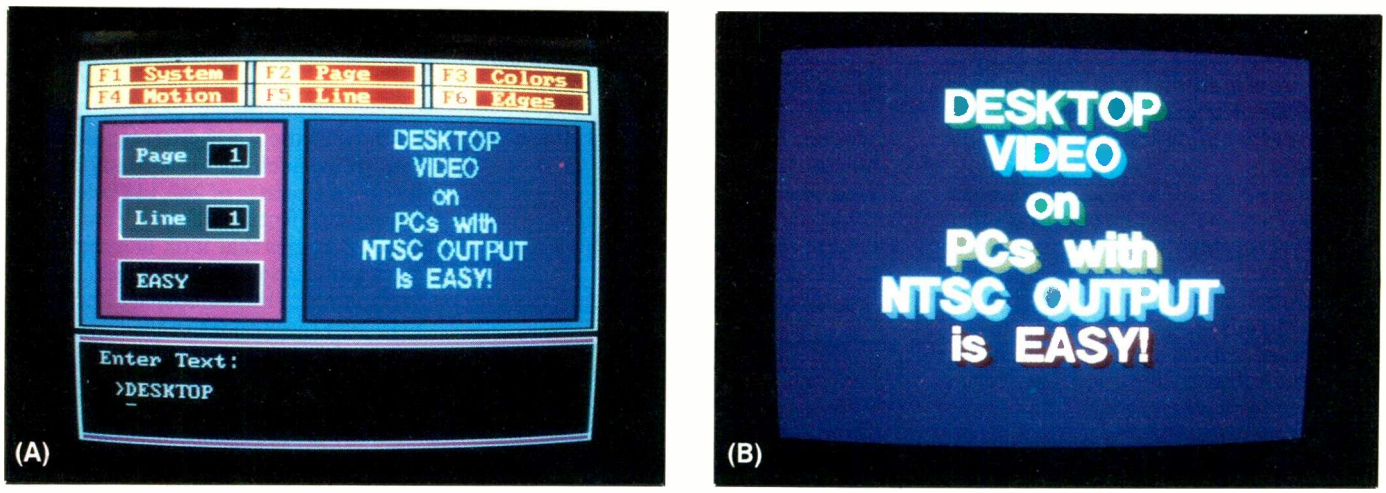


An example of Deluxe Paint Animation's "metamorphosis" effect.





Screen shots show DPA's user interface (left) and one possible spin/rotation effect (right).



Video Titler's (A) user interface makes it easy to enter text and choose a lettering style for (B) truly broadcast-quality results.

tion utility programs provided with video cards like the TrueVision Video VGA with Overlay and Everex Vision VGA video card, which both provide a TSR to toggle recordable and overlay modes from within an application as a handy alternative to the DOS-prompt command lines for the equivalent functions. Relocating TSRs to upper memory using the "load high" command tucks these handy utilities above the 640K mark and leaves extra room in which the *Video Titler* program can operate.

Software is supplied on six disks, and excellent user manuals come in a three-ring binder. Installation is fully automatic once you've selected the type of video board present in your system. Since the OEM versions are preset for the boards with which they ship, they don't give the board-selection options that are present in the stand-alone retail version. The retail version provides choices for 16 popular video boards, including a generic VGA driver and drivers for Tseng 3000- and 4000-based cards.

The software set is composed of an installation disk, display drivers disk, utilities disk and FontPak MI, the last on the three remaining disks. FontPak MI is a collection of 129 type fonts in assorted styles and sizes for creating video titles. The quality of the type faces is amazing—no crude letterforms here! Excellent renderings of such perennial typefaces as Park Avenue, Helvetica, Old English, Times Roman and many others are all proportionately spaced with the right amount of "air" around characters for proper appearance and high legibility on an NTSC display.

The overall controls of the program permit making each title line or even each character a different color. Such additional effects as underlining, drop shadows and more permit further enhancement of the basic letterforms. Title and text sequences of virtually any length can be created and saved, limited only by the amount of disk space available for storage.

More than 100 wipe, fade, dissolve, roll and scroll patterns are available for introducing text to the screen. These can be combined for all kinds of interesting effects. Timing intervals for duration of static screens and/or movement of "rolling titles" or scroll-across sequences can be set in infinite variations as well. Color palette selections allow you to "key" the background color of the titles to be transparent when combined with video to produce text overlays with live action.

Video Titler's user interface is amazingly simple, considering the amount of power and creative flexibility the program provides. In addition to a quick-reference card and the user manuals, on-line help is available. Drop-down menus, accessed through function keys, display choices for the current mode, whether it's entering text, editing, previewing or adjusting timing and effects. An included eye-catching demo program really showcases this amazing program's capabilities when multiple effects are combined.

Additional utilities provide more power and flexibility to *Video Titler* by allowing you to import and customize logo art in .PCX image format. An ASCII import utility facilitates using text files created in word processors or other applications in title sequences without having to retype the text. A page copy utility permits you to copy one or more pages of text and attributes to other pages in the sequence, another handy feature for "boilerplating" information that must be uniform from sequence to sequence, as in corporate presentations. A page print utility is also included for printing selected title pages from a sequence.

While character generators are commonly found in today's better camcorders and VCRs, they lack the truly professional options and broadcast video quality that you can get using *Video Titler*. It's really an indispensable tool for any kind of serious desktop video work that requires textual matter to be displayed or overlaid.

Deluxe Paint Animation, $134.95
Electronic Arts
P.O. Box 7578
San Mateo, CA 94403
Tel.: 1-800-245-4525

CIRCLE NO. 49 ON FREE INFORMATION CARD

If you've ever used *Deluxe Paint* from Electronic Arts, you'll have an almost zero learning curve for *DP Animation*. If you're a total novice, you'll be creating animations almost as quickly. *DPA* combines virtually all of the excellent painting tools found in the Paint program and adds motion control to them (along with some other nifty tricks) to produce a full-featured animation program that's truly intuitive to operate.

Having the color and shaping capabilities of a full-featured paint program endows *DPA* with a wealth of creative options from which to choose, including an assortment of interesting fonts. An optional Kara fonts package, available directly from Electronic Arts for $69.95, provides an excellent addition to the monocolor fonts that come with *DPA*. The full-color Kara fonts are named Bevel, Brick, Cast, Chisel, Chrome, Granite, Marble, Column and Wood, which simulate metal, carved wood and chiseled stone. Kara fonts are spectacular for creating main title animations and, using *DPA*'s 3D motion capabilities, the possibilities really become interesting. Spinning titles that zoom in from some point at infinity and tumbling, rotating and floating title sequences are surprisingly simple to produce.

Any image (including text) created on *DPA*'s screen can be turned into a "brush" you can then rotate, flip, shear, re-size, smear or shade. These brushes can also become "animbrushes" that allow you to select an area of animation as a brush and

paint with it. With animbrushes, the sequence of the brush itself changes as you paint with it so that you can "rubber stamp" blank frames with stepped animation to produce finished sequences in very little time.

Automated transitional animations that "metamorphose" one shape into another are also easily created with the metamorphous animbrush feature. Creating such transitional animation automatically is as easy to do as selecting a beginning image animbrush, such as an egg, and an ending image animbrush, like a chicken. When prompted you merely specify how many cells (frames) over which you wish the transition to take place and click on OK.

Specifying a cell number like 60 would make the transitional animation twice as long as specifying 30. The end result is a computer-generated metamorphosis of the egg image into the chicken image. It's nothing short of amazing to watch this off-the-shelf software product produce computer-generated animation sequences like this on a personal computer in a matter of seconds when you consider that the equivalent feat, if done manually, would take many hours of human effort.

Several sample animations and animbrushes supplied with the program files serve as teaching aids and impressive demonstrations of what's possible with *DPA*. The 256-color palette supports tiling and color cycling and a "wrap" feature that makes a tiled pattern follow the proper perspective of a shape like a ball or any other geometric shape to give the illusion that the selected shape is actually wrapped in the pattern.

Because the user manual for the program is exceptionally well written and indexed, finding a particular procedure or technique is easy. While *DPA*'s friendly menu-bar interface and context-sensitive options make using the program easy right out of the box, to fully exploit its features, power and capabilities takes many hours of reading technique descriptions and experimenting with different settings in the program to see their effects in action.

An optional and outstanding VHS videocassette is available for $27.95 directly from Electronic Arts. This hour-long tape gives invaluable tips and shortcuts for such advanced topics as AnimPainting (painting while the frames flip automatically), using the move dialog to achieve dazzling three-dimensional movement and rotation sequences and loads of pointers and ideas that aren't covered in the manual. If you're going to use *DPA*, this video is indispensable for getting the most from the program in the least amount of time.

Deluxe Paint Animation packs lots of bang for the buck and makes creating advanced animations an enjoyable and relatively easy process. It's an excellent animation package that's ideally suited for many desktop-video uses, from titling to cartooning and everything in between.

Autodesk Explorer (formerly *Autodesk Animator*), $199
Autodesk, Inc.
2320 Marinship Way
Sausalito, CA 94965-9910
Tel.: 415-331-0356

CIRCLE NO. 48 ON FREE INFORMATION CARD

The product covered here is really *Autodesk Animator*. By the time you read this, it will be replaced by *Autodesk Explorer*. The new package retains all the terrific features of *Animator* and adds *Windows* 3.0 compatibility for additional multimedia capabilities. However, since *Autodesk Explorer* wasn't available as of this writing, *Autodesk Animator* is the program I'm covering here.

If your desktop-video applications require a true "industrial-strength" product, *Autodesk Animator* is the animation package of choice for you. Created by the makers of *AutoCAD, Autodesk Animator* pushes the envelope limit of what's possible on a PC.

Offering a more comprehensive selection of drawing tools and coloring options than *Deluxe Paint Animation, Autodesk Animator* is capable of producing true broadcast-quality animations. Several examples of this are provided with the program disks. One example, an animated tidal chart showing the high- and low-tide times, looks amazingly similar to the animated graphic I've seen on a local TV station during the weather segment of its news broadcasts.

Like *DPA, Autodesk Animator* gets much of its strength from a well-designed, simple-to-use interface that integrates all paint, image-processing and animation functions together. Using a mouse-oriented point-and-click scheme to pull-down menus or pop-up dialogue boxes, other friendly features include slider bars, action buttons and scrolling windows to access a bewildering range of image- and motion-creation tools.

Integrating graphics, text and photos (or captured video images) with *AA* is easy to accomplish using the 22 different drawing tools that include polygonal lines, spline curves, boxes, circles, ellipses and stars supplemented with airbrushes, fills, streaks and gels. The program features 26 different "ink" types to simulate transparency, shading, embossing and color gradations.

By combining the ink types with the various drawing tools, 572 different combinations are available for use with any 256 colors out of a palette of 262,144 colors. An embossing effect is particularly unique for creating images that look like they were "punched" into (or out of) the video screen. An example of this embossed effect is the VH1 logo that resides in the lower-right corner of the screen on your local VH1 cable channel. This effect and hundreds of others are possible with *AA*.

One of the really neat things about the user interface is its control layout, which closely resembles a professional videotape editing console. Directional arrows signify forward or backward motion, play speed can be "dialed" up, and color cycling can be adjusted, individually or in groups, using the RGB overall controls. Animation sequences can be stepped through individually or played in continuous loops.

This is, indeed, a professional-level package that permits creating, editing and playing back a full-length presentation—in real-time—from your hard disk. With the right equipment (a recordable video board and VCR), you can record an entire production to videotape in one pass. Since *Autodesk Animator* uses the same video drivers as sister product *AutoCAD*, extended VGA modes are possible for stunning realism in animations and simulations.

Provided with the software diskettes are a quick-start card, 157-page tutorial manual and 320-page reference manual that answer virtually any question you could think of regarding a program feature, function or effect. A provided VHS videocassette gives a very impressive demonstration of the program's capabilities, although it isn't a tutorial. On the other hand, the tutorial manual leads you step-by-step through modifying the sample animations and creating your own animations to teach you the program from ground zero.

In addition to a huge assortment of type fonts and typographic effects, the paint portion of *AA* includes a metamorphosis feature called "tweening" that computer-generates a series of images 'tween the beginning shape and the final one of a transition. However, by selecting portions of the target image that contains a "tweenable" shape, you can customize the metamorphosis. If you've seen any of the new car commercials that metamorphose a car's dashboard and seats, you've experienced tweening. Since *AA* can accept digitized video images as raw material, tweening between two video images isn't only possible, it's fairly simple to accomplish.

No serious desktop-video or broadcast-video project that requires professional graphics and animation capabilities should

be attempted without a copy of *Autodesk Animator* at hand. I don't know of any other product that does so much, so easily and so well when it comes to creating show-stopping animations. *Animator*'s public-domain player utility is also included for distributing your animations to other computer users.

GRASP (GRaphic Animation System for Professionals), $349.
Paul Mace Software, Inc.
400 Williamson Way
Ashland, OR 97520
Tel.: 503-488-2322

CIRCLE NO. 47 ON FREE INFORMATION CARD

GRASP is an interesting and useful package that does double duty as an independent creative medium as well as serving as an integration tool for pulling DTV elements created with other products into a cohesive, smooth-running presentation. Its real strengths are an ability to create and animate images in CGA, EGA, Hercules and VGA modes up to 1,280 × 1,024 (with the right video hardware) in 256 colors and an ability to synchronize digitized sound created with a SoundBlaster or AdLib sound board with *GRASP*-created applications.

Additional sound support is also present in the program's ability to precisely control CD-ROM and audio CDs for music and sound effects. Just released as this was being written is an optional *Authentic Audio Tools* package ($99) that plays digitized sound from the PC's speaker, rather than through a sound board. More than 500 digitized sound effects are included, and sounds can be looped for sustained effects. Sound quality can also be adjusted using high-filter, bass boost and volume controls.

Animations and sequences created under *Autodesk Animator* can be utilized with *GRASP* since it handles .FLI (Autodesk) file types in addition to .PCX, .GIF and .TIF and other popular formats. A *Graphics Link Plus (TGL +)* image capture, file conversion and printing utility is included for converting images from one file format to another for added image-handling and manipulation capabilities.

A full-featured paint program is integrated into the package and is fairly easy to use, although not on the same level as either *DPA* or *AA*. The pattern and shading effects of the program, however, are quite extensive, and RGB or "process" color mixing is also supported. Multiple images can be manipulated with full control of the color palette, movement and timing for each.

A very handy included feature is a screen-capture program that can save and edit images from other programs, especially useful if you're doing work that requires "grabbed" images.

An included collection of programs called ARTOOLS automatically generates special animation effects based on your own artwork, whether created within *GRASP* or imported from other applications. Lots of interesting rotations, spins, tumbles, wipes and other eye-catching effects are possible and relatively easy to accomplish using these tools.

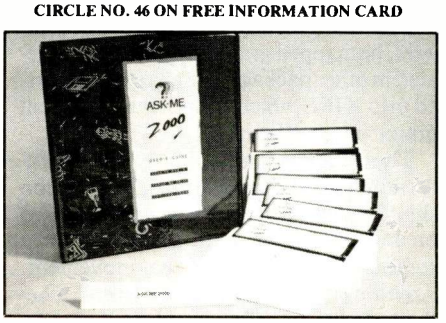
An optional add-on package called *GRASP Tools* ($79) is also available for serious users. This is a collection of advanced application utilities. Mostly devoted to file-management activities, the *Tools* package facilitates creating *GRASP* libraries automatically without unnecessary files, ridding the demo directory of unused files, adjusting clipping offset values, accessing important font information and making custom palette files to save memory space in addition to other file-management and housekeeping tasks.

Aside from creating productions and presentations for desktop video uses, *GRASP* also makes it possible to create interactive computer demos and presentations that support keyboard, mouse or touch-screen input from viewers. Another nice touch is a Glexe compiler utility, which creates self-contained executable versions of your productions for public distribution with no licensing fees.

GRASP is an excellent tool whose real strength is its ability to combine individual audio and visual elements into a seamless production that can be directly recorded on video tape or used as automatic/interactive computer presentations.

ASK-ME 2000, $495
Brown-Wagh Publishing
130-D Knowles Dr.
Los Gatos, CA 95030
Tel.: 408-378-3838

CIRCLE NO. 46 ON FREE INFORMATION CARD



ASK-ME 2000 is a multimedia authoring environment specifically designed to integrate and assemble elements from various sources and applications into a finished production. The finished product is suitable for recording on video or as an interactive multimedia application running on computers that support joysticks, touch screens or the keyboard as interactive input devices.

Rather than creating presentations or animated sequences from scratch, *A-M2000*'s main strength lies in its ability to integrate individual elements and capture video images (using a Digital Vision Computer Eyes digitizer board) to produce finished productions. Like *GRASP, A-M2000* can be used to produce automatic demos, interactive multimedia presentations and create productions for PC desktop video.

A-M2000 can handle any .PCX format image created with paint programs like *PC Paintbrush*. Supported are audio integration for the SoundBlaster and Video Associates sound cards and *Autodesk Animator* .FLI files.

A really unique feature of *A-M2000* is its script-based approach to multimedia authoring. The icon-based environment is very intuitive in design and very fast to learn. Based on a proprietary programming language called Stratos, commands are entered into three principal script-creation areas labeled "Before," "During" and "After." Each area is boxed and you literally tell *A-M2000* what to do with each screen to be displayed in the application. The kicker here is that you use plain-English words like "animate," "speak," "show" and "display," rather than some arcane programming structure, to achieve desired results. The learning curve for this program is remarkably small, considering the number of interesting functions and effects possible with it.

ASCII text files can be imported in addition to animations and graphics you can create outside the program. A 256,000 color-shade palette that permits up to 256 concurrent colors (with extended VGA modes) to be displayed at any one time is one of the strong presentation features of the package. *ASK-ME 2000* is an excellent product for seamlessly integrating individual elements and media into a sleek finished product.

Animation Works Interactive, $495
Gold Disk, Inc.
P.O. Box 789, Streetsville
Mississauga, Ontario, Canada L5M 2C2
Tel.: 416-602-4000

CIRCLE NO. 45 ON FREE INFORMATION CARD

If you have *Windows* 3.0 and Microsoft's Multimedia Extensions 1.0 or later on your system, *Animation Works Interactive* is an animation and presentation package that

Setting Up For PC Desktop Video

If the main article piqued your interest in desktop video for the PC, you'll probably want some guidance in selecting hardware, software and accessories to do serious work in this area. The best advice I can give you is research your needs carefully. And the best way I can show you how to do this is by giving you a rundown on dream desktop-video system.

• *PC*. My host PC is a system unit built around a 33-MHz i486 motherboard and has 8M of user RAM; 5¼" and 3½" high-density floppy drives; 85M hard disk (supplemented by a 105M hard card); and CD-ROM drive.

• *Video*. I use a Truevision VGA super-VGA card with Overlay card populated with 1M of video RAM and a 14" multi-frequency color video monitor (soon to be upgraded to a full-digital monitor).

• *Image Grabber*. I use a Digital Vision Computer Eyes/RT video digitizer board and the Computer Eyes host software for all image-grabbing work (the preview feature is especially useful; see Image Grabbing in December 1991 *Computer-Craft* for details).

• *Audio*. My Sound Blaster card is MPC-compliant with the Microsoft Multimedia Extensions under *Windows*. I also use a Covox Sound Master II card for creating more elaborate musical scores via the MIDI interface. After creating and storing them, I can then access MIDI files from within MPC extensions in *Windows* to integrate them into my applications and presentations as desired. This is an example of trying to have the best of both worlds. I like Covox's software and built-in MIDI capabilities, but I can't live without the Sound Blaster's MPC compatibility. This arrangement proves that you can have it all if you're willing to spend the bucks.

• *Video Sources*. Though I used to use a Canon Xapshot digital still camera for image acquisition, I now use a Panasonic PV-21 VHS-C camcorder instead. Since the Computer Eyes/RT board can do real-time captures in 1/30 second, there's no problem grabbing a frame from moving video tape, and the Panasonic camcorder offers much better resolution than the Xapshot. Another advantage is that the camcorder records sound, which I sometimes use for narrative passages or sound effects that I digitize via the MPC extensions sound recorder capabilities.

• *VCR*. Dual NEC PC-VCRs (see Part 1) are connected to the PC via the serial ports for fully computer-controlled editing. One PC-VCR functions as the "source," the other the "target" deck. While expensive, these incredible VCRs leave everything else in the dust when it comes to programmability and quality.

• *NTSC Monitor*. I use a portable 7" color Panasonic TV receiver/monitor to view my videotape and computer-generated video work. The Truevision board (with recordable VGA enabled) routes all video (both computer-generated and NTSC pass-through from the source deck or camcorder) to the Panasonic monitor so I can see what the result will look like before committing to video tape. Audio portions are also played via the Sound Blaster board through a pair of Walkman speakers to check sound quality and timing with the video portions.

• *System Software*. I run DOS 5.0 with MSCDEX 2.2 Microsoft CD-ROM extensions as the basic operating system. I also extensively use *Windows* 3.0 with Multimedia Extensions 1.0 in 386 Enhanced mode for many multimedia and desktop video projects. I don't use third-party memory managers, but I do load as many device drivers for the system as possible into DOS's high-memory area to free up as much of the base 640K.

• *Applications Software*. For basic image retouching and manipulation, I use *PC Paintbrush IV* under DOS and *Publisher's Paintbrush* under *Windows*; *Animation Works Interactive* for creating MPC productions under *Windows*; and *GRASP* when working under DOS. For simple title animations with rotations and spins, I use *Deluxe Paint Animation*. For more intricate sequences, where I combine captured video images with computer-generated imagery, I use *Autodesk Animator*. For overall titling and rolling video text I use *Video Titler*. When I want to put together something quickly, I use *2000* for integrating elements (it runs under DOS and is much faster than *Windows*-based equivalents).

• *Miscellaneous*. Of course, I have myriad cables, adapters and a variety of products like Inset System's *Hijaak* and Applications Techiques' *Picture Eze*, which I use for converting image formats. Other products play background roles in making a production come together, but the components mentioned here are the major players in my multimedia/desktop-video system.

As you can see, getting into PC desktop video isn't something you take lightly. Even if you go for a "minimum" hardware configuration and limit your software purchases to those packages that supply only minimal utility, you'll be making a hefty monetary investment. Too, be prepared to spend considerable time learning how to use all the elements that make up your system. Is it worth it? If you like to exercise your creative urges, you bet it is!

really exploits the possibilities of this environment. Predominantly intended for creating interactive multimedia presentations using a personal computer, *AWI* is a superb tool for creating desktop-video productions as well.

While *AWI* will run on a 10-MHz or faster 286-based machine, the recommended minimum configuration is a 386-SX or later-technology CPU with 4M of RAM, super-VGA or extended-VGA, MPC-compatible audio board and, for desktop-video applications, a video overlay board.

Since *AWI* runs under *Windows* 3.0, everything is oriented for point-and-click operation throughout the program. Three principal modules comprise the *AWI* package: background editor, cel editor and movie editor. A runtime player is included to allow you to distribute your completed presentations to any *Windows* user.

You use the background editor to create colorful backgrounds. It contains a full set of paint tools, including multi-color gradients. Scanned images, digitized video images, bitmapped graphics and artwork created in other packages are all easily imported into *AWI*, which supports virtually all major image filetypes.

The cel editor is abundantly rich in professional animation features, like "onion skin" that lets you trace a new image based on an existing one, auto-zoom and auto-rotate for multi-dimensional movement. Anything created with the cel editor, whether artwork or titling, is referred to as an "actor" in *AWI* terminology. A generous library of stock "actors" is included with the program. Automatic zoom and rotational features are extremely useful in producing striking title sequences.

With the movie editor module, you easily combine backgrounds and actors (text, graphics, charts, etc.) and sequence them with sounds, music, narration and wipes to make dynamic productions. Putting the whole show in motion is easily accomplished via the VCR-style interface with familiar controls like play, rewind and forward. If the production is to be used as an interactive system, you can add "action buttons" on which users can point-and-click. For desktop-video applications, the completed production can be recorded on

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8224	1.25	8748	7.00
8228	1.75	8749	7.00
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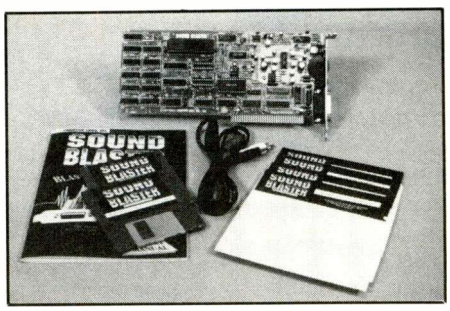
video tape in a single pass, complete with sound effects, if desired.

External devices like VCRs and laserdisc players can be controlled from within *AWI* for activating video segments upon command. This is a handy feature to have for exporting computer-generated material in concert with previously taped video to a recording VCR. At predetermined points in the presentation *AWI* activates the "source" VCR; adds any titling, graphics or overlay material; and lets you record the combined output on a "target" VCR. This feature can also be used for "live" interactive productions, such as point-of-sale and kiosk displays to show product videos from a VCR or Videodisc player.

AWI is a tremendously powerful package that makes all kinds of special effects both possible and incredibly easy to access. While its user's manual is excellent in its clarity and scope, I used it mostly as a reference work to learn some very advanced techniques. You can start producing animations as soon as the program is loaded since *AWI* is remarkably straightforward, and its interface is highly intuitive. *Animation Works Interactive* is an indispensable tool for anyone who wishes to produce professional-level presentations and productions under *Windows* 3.0 with Multimedia Extensions.

Sound Blaster, $200
Sound Blaster Pro, $300
Brown-Wagh Publishing
130-D Knowles Dr.
Los Gatos, CA 95030
Tel.:408-378-3838

CIRCLE NO. 44 ON FREE INFORMATION CARD



Creative Labs' Sound Blaster, distributed through Brown-Wagh, is probably the best-known and most widely-used audio board for IBM/compatible PCs. As such, it's in a cat-bird seat when it comes to software support and compatibility. This is further evidenced by its MPC (Multimedia PC) compatibility and it's support in Microsoft's Multimedia Extensions 1.0.

While it's possible to add sound after all the video is already on tape, there are numerous instances where it's desirable to have the sound concurrent with the video action. Here's where the Sound Blaster comes in handy. In addition to providing an 11-voice FM music synthesizer that's fully AdLib compatible, SB also permits digitizing and playing back your own sounds (including voice narration). So it's especially useful for putting "sound bytes" in sync with computer animation and graphics. The advantage of combining sound and images together in the PC is that when you export to video tape, both audio and video are taken care of in a single pass.

The ¾-length SB card easily installs in any available eight-bit slot. A stereo patch cord is included for connection to a home stereo system. However, I recommend a pair of inexpensive Walkman-type speakers for convenient audio playback on a PC. A volume control is on the card's mounting bracket, though speakers aren't included. If you wish to record voice or do other sound sampling, you'll also have to provide a microphone, which doesn't come with the card.

Software setup is a breeze. An included test program checks the FM music and voice sampling circuitry to ensure that no interrupt or DMA conflicts are present on the system. An included "intelligent organ" program facilitates creating music with SB, and a good assortment of sample musical selections is provided.

An optional MIDI interface kit ($79.95) allows you to generate sound via a MIDI-compatible keyboard or instrument. For most desktop-video applications, however, the internal 11-voice synthesizer should be quite adequate.

Brown-Wagh also has a number of optional support packages for the Sound Blaster, including *HSC Audio Tracks* ($79.95), which is an assortment of music clips and sound effects that are very useful for adding sound without having to create or record your own.

Musiclips ($149.95), a collection of more than 150 multi-track royalty-free MIDI song files for multimedia and desktop-video presentations, includes drivers that can integrate MIDI, FM and digital-audio support into existing applications. One of the most useful features is that song files can be played concurrently from the DOS command line while other applications (like animations) are running, for combining sound and imagery.

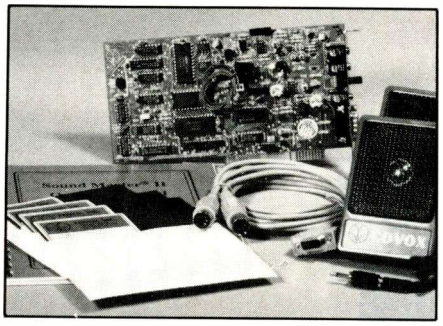
Recording Studio Professional ($199) is a professional-level editor for digitized sound samples. Its user interface is graphically-oriented with pull-down menus, windows and icons. The package is rich in features, including 3D frequency analysis, loop editors and tools with crossface, digital signal processing and assorted toolbox utilities. With this package it's easy to combine narration with a musical background, edit with cut-and-paste functions and add special effects via a digital equalizer with assignable center frequency.

If you're running *Windows* 3.0 with the Multimedia Extensions, you can also rec-

ord, edit (to a limited extent) and play back sound via the Extensions shell with a Sound Blaster. So some of the add-on packages listed above may not be necessary for your applications. If you're working from DOS, however, you'll want to obtain some of these add-ons to get the most from Sound Blaster.

Sound Master II, $230
Covox Inc.
675 Conger St.
Eugene, OR 97402
Tel.: 503-342-1271

CIRCLE NO. 149 ON FREE INFORMATION CARD



Covox has been in the business of making audio-enhancement products for personal computers for over a decade and gives the most bang for your buck with Sound Master II. Lots of the accessory items that are optional with the Sound Blaster come standard with Sound Master II.

The ¾-length SM-II card installs easily in any available eight-bit slot. Like Sound Blaster, it contains an 11-voice FM synthesizer chip and a UART-standard MIDI interface. Unlike SB, however, Covox gives you everything but the kitchen sink.

A MIDI interface cable with a DB-9 connector on one end and dual five-pin DIN MIDI-IN and MIDI-OUT connectors at the other is supplied, as is a pair of good-quality desktop mini speakers with an adapter supplied. (The monophonic card's adapter routes the mono audio to both speakers). If you want to do voice digitizing or sound sampling, you must provide your own microphone (both low- and high- impedance jacks are on the card's mounting bracket).

Software, supplied in abundance, includes basic recording and playback utilities and a very advanced editor that has many of the same capabilities for sound as a good word processor has for text. Among these are cut-and-paste, block move, copy and more. Playback rates can be altered, echo/reverb effects added, etc.

An included excellent *PC Lyra* music-composition program is quite easy to use for creating music. Compositions created with it can be played back through the FM synthesizer or via an external MIDI instrument; so output flexibility is good.(See September 1991 *ComputerCraft* for more details on SM-II's MIDI capabilities.)

The DMA-driven SM-II makes it possible to play back sound files while other applications are running. Covox provides a wealth of information on programming in its user manual. Implementing simultaneous sound with graphics or other applications is relatively easy from DOS. So producing multimedia works for export to video is possible.

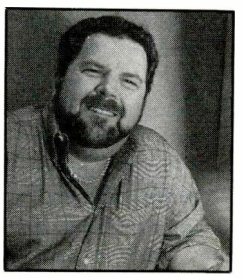
According to the Microsoft Multimedia Extensions, the SM-II isn't MPC-compatible. Therefore, if you're working under *Windows* with the MPC Extensions you're out of luck. This is really a shame because *Windows* 3.1, which may be available by the time you read this, will include the Extensions as part of the basic package. Since the SM-II doesn't comply with these standards, the audio capabilities of the board will go untapped when *Windows* MPC applications are being run.

There have been unconfirmed reports that Covox is working on a stereo version of the SM-II that, hopefully, will be MPC-compliant. However, no official confirmation of this was available from the company. If you're working on DTV projects under DOS, the SM-II is an excellent product. If you're running *Windows* and MPC-compatibility is important to you now (or will be in the future), this board won't be the ideal choice.

Summing Up

It isn't possible to cover all of the useful products available for desktop video, animation and multimedia, primarily because new ones are being released continually. In these two articles, I've limited discussion to products I've used extensively and of which I have personal knowledge regarding performance and application fitness for desktop video. The ones I've covered here and last month represent the cream of the crop. ■

Photos by Liz Benford

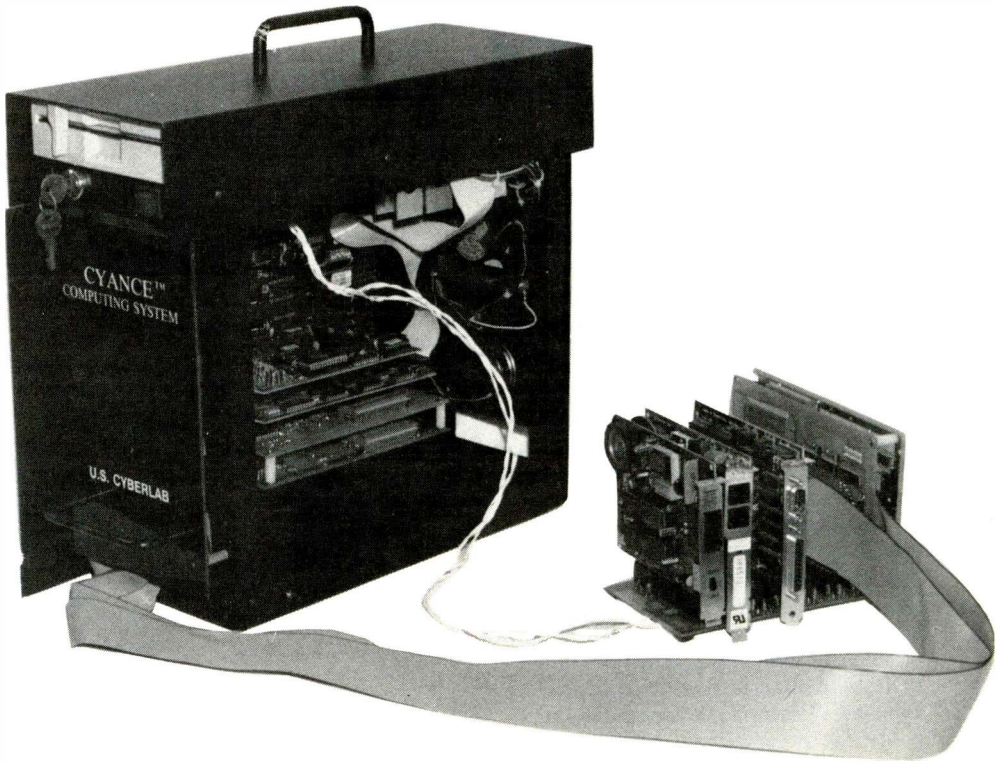


Tom Benford

A Tower of an Enclosure

Part 3

Installing a passive backplane and support cards and a dedicated power supply in the CYANCE enclosure extends your PC's bus by six expansion slots



Pc power users frequently run out of spare slots on the motherboard of their computers. If you find yourself in this condition and have more plug-in cards than you have expansion slots on your motherboard, the CYANCE Bus Expander system to be described is just what you need. By installing an eight-slot passive backplane system in the CYANCE enclosure that was the subject of Part 1 of this series, you can extend your computer's expansion bus by six slots. The two-slot penalty results from the fact that you must dedicate a slot on your motherboard and another on the backplane to interface cards for the Bus Expander.

With our Bus Expander, you have far more slots that are available on just your motherboard. Furthermore, these extra slots are fully isolated from the motherboard and have their own separate power supply. This takes takes the potential danger out of "proofing" untried hardware in your system, preventing possible damage to your main computing system.

One reason why you might want to extend the bus of your computer is to have more peripheral cards on-line simultaneously so that you can eliminate having to swap cards. If you're an experimenter who designs his own bus-oriented computer projects, you want to do so safely, without running the risk of trashing an expensive motherboard and any devices connected to it. If either, both or other considerations are important to you, you can connect our CYANCE Bus Expander to your present computer and solve such problems.

The basic CYANCE enclosure has its own power supply (your choice of power) that handles any hardware you put into the expansion unit. The Bus Expander provides its own separate address, data and control-line buffers. This assures complete isolation between the PC's motherboard bus and any development project plugged into the Bus Expander.

The CYANCE Bus Expander consists of five pc cards: two controllers, two slaves and a passive backplane. One master and slave (the latter is a daughterboard to the first) and the bus card reside in the CYANCE enclosure. The other master/slave combination resides in a slot on the bus of the host PC's motherboard. Master/slave combinations each require one expansion slot on the PC's motherboard and CYANCE's passive backplane.

Be aware that the Bus Expander isn't a project for beginners. To build and use it, you should be experienced in electronic practices and familiar with computer hardware.

Design Considerations

In theory, a computer bus expander simply consists of a couple of connectors and some ribbon cable. However, the demands of the PC bus make the reality much more complicated. As

motherboard clock speed increases and more peripheral cards are plugged into the bus, control, address and data signals can become distorted and unusable. This is why the number of motherboard expansion slots has settled in at eight cards or less. Increasing this number, not to mention placing slots remotely from a motherboard, presents serious technical challenges that must be overcome.

In designing the Bus Expander, a few minor concessions were made to keep it relatively inexpensive and eliminate the need for specialized and expensive assembly tools. Going this route resulted in a system that doesn't have the "hot" performance required for, say, a 486 system running flat out at 50 MHz.

Though it lacks the extremely wide bandwidth required by the speediest of processors, the Bus Expander performs well at more reasonable speeds. So if you want to expand a hot-performance motherboard, simply keep the cards that require maximum performance on the motherboard itself and delegate cards that place lesser demands on bus performance in the Bus Expander's slots. This way, you get the best of both worlds.

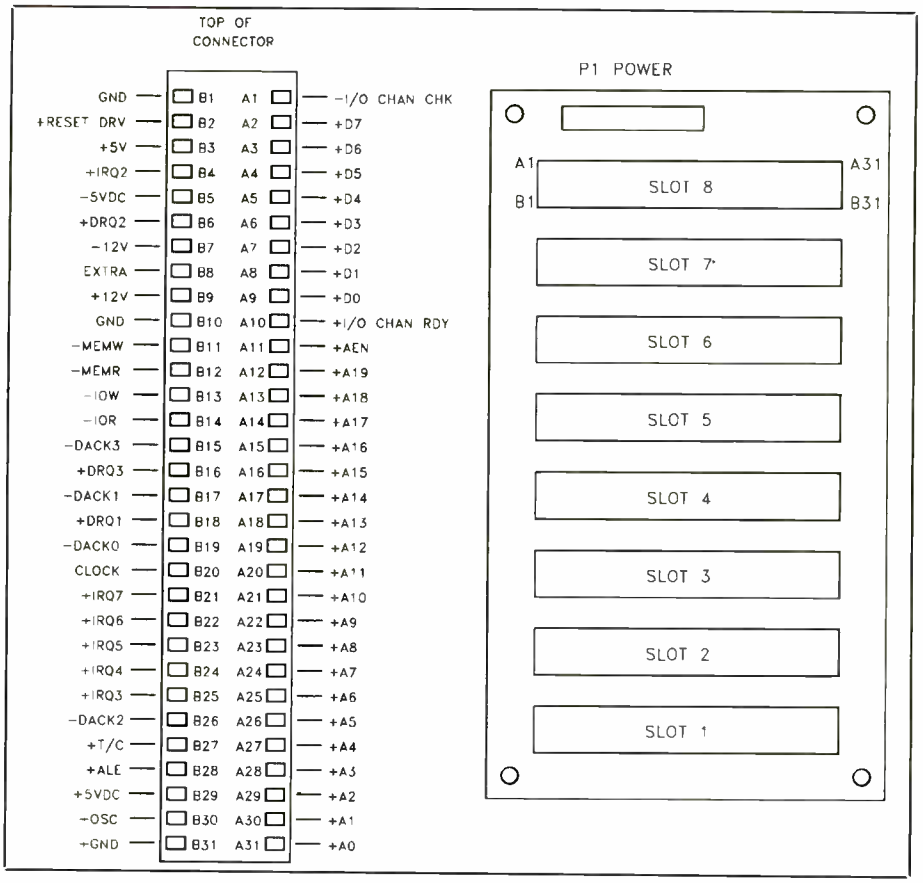


Fig. 1. Pinout assignments for IBM PC/compatible (left) and CYANCE Bus Expander (right) buses.

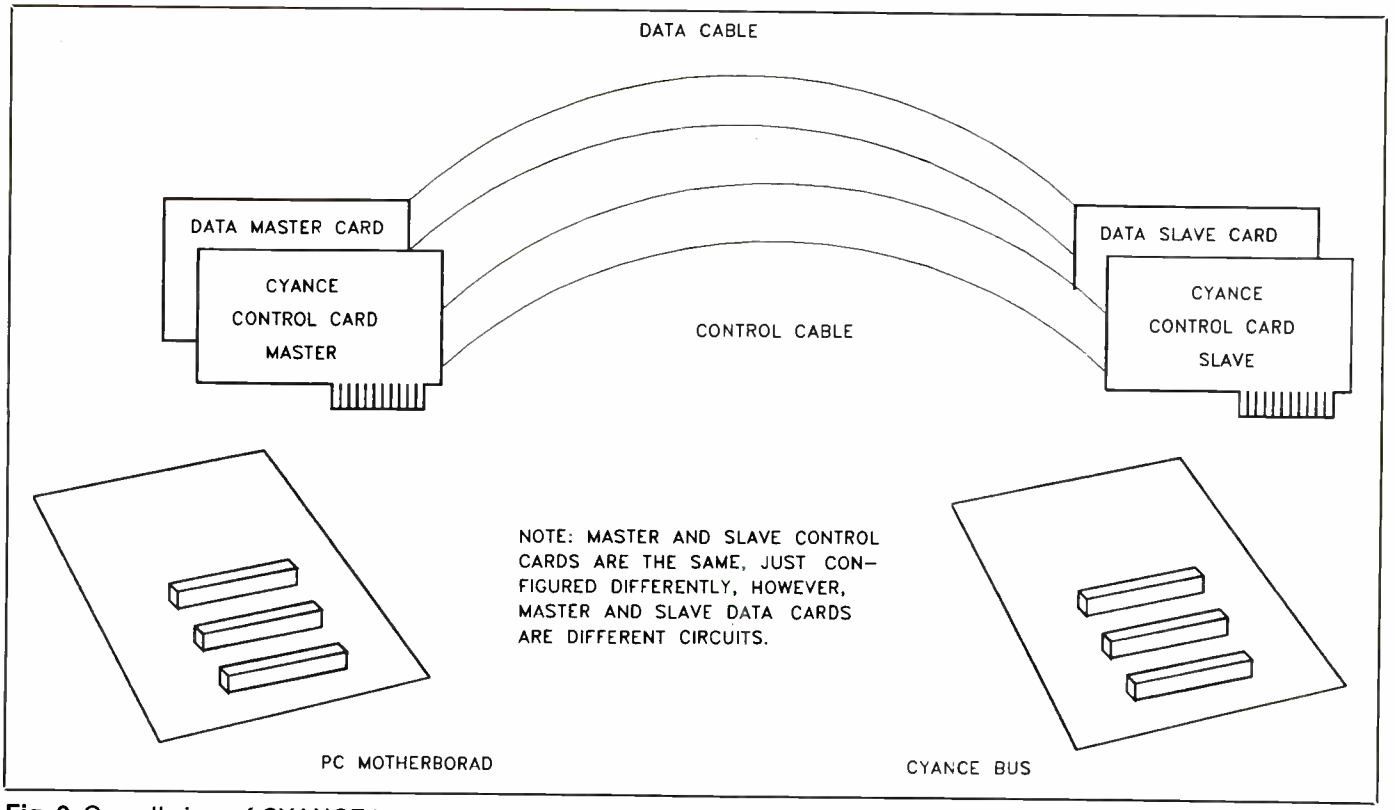


Fig. 2. Overall view of CYANCE bus-expansion system.

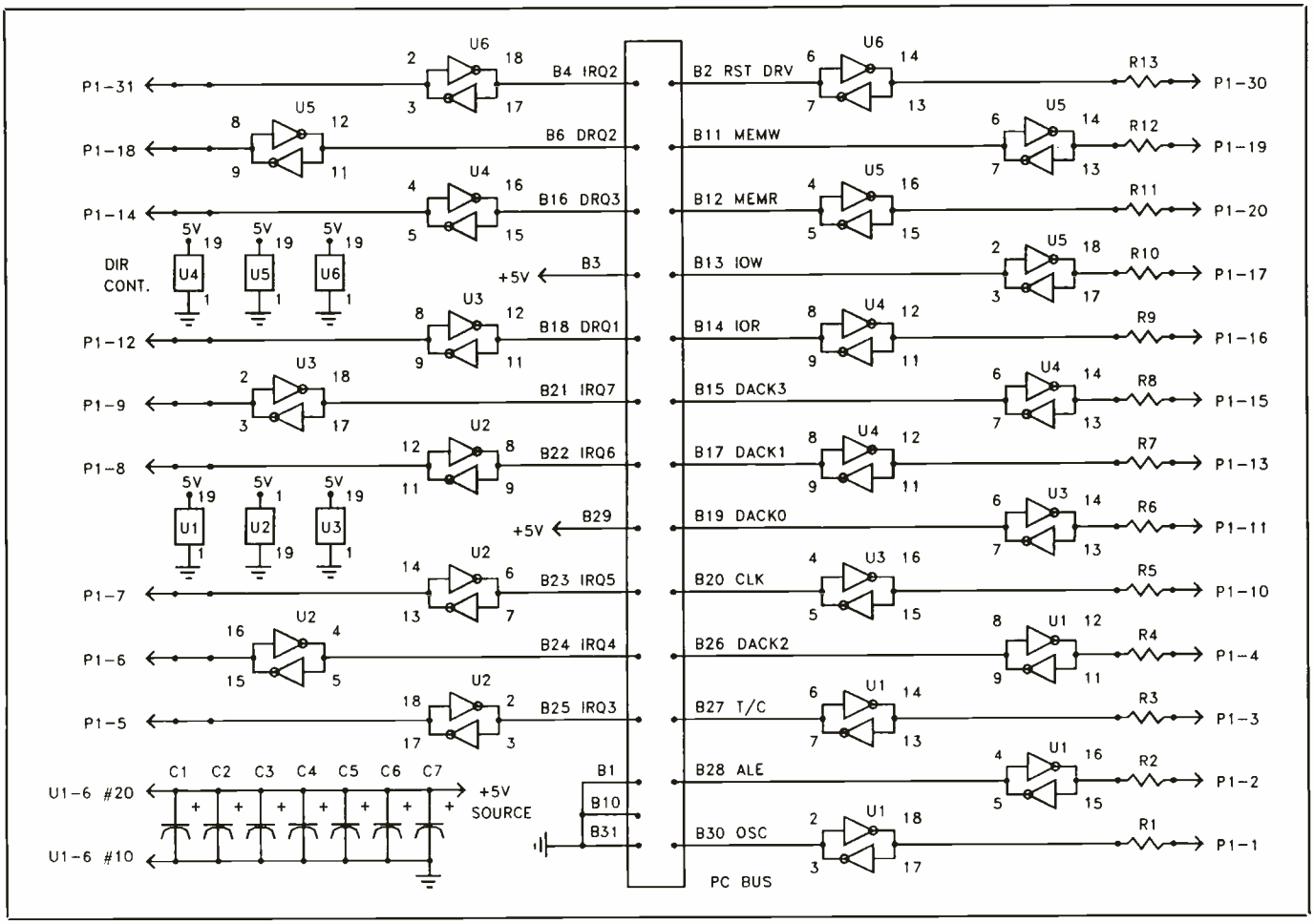


Fig. 3. Schematic details of Master Control Card circuitry.

Cost-cutting design compromises were made in two areas. One was the decision to use ordinary double-sided printed-circuit boards and through-hole components, rather than multilayer boards and surface-mounted devices, both of which would have added greatly to system cost and the latter requiring specialized and expensive tools. The performance edge multilayer boards and surface-mounted devices would have added would not have been justified by the additional cost of building the system.

The other area of compromise was use of ribbon cables to interconnect the two systems. Better performance would have been achieved by using shielded round cables and connectors for this purpose, but it would have done so at a dramatic boost in the cost of building the system.

By carefully selecting components and limiting cable lengths to less than 5 feet, the CYANCE Bus Expander should more than meet any expansion need that doesn't require the full bandwidth of the motherboard's bus, even with the compromises mentioned. With the CYANCE Bus Expander built according to the procedure described here, you'll have a safe platform for "proofing" untried hardware designs and a means to accommodate more hardware than the slots in your PC can support.

Circuit Operation

The pinout of the CYANCE Bus shown in Fig. 1 is the same as that for the PC bus (left). Take some time to examine the layout of the CYANCE Bus Card (right) with regard to the various card slots and power connector to familiarize yourself with the system and know your way around.

Figure 2 graphically shows the elements of the basic CYANCE Bus Expander system. As you can see, one motherboard slot must be dedicated to the Master Control Card that buffers and conditions the various bus control signals and routes them through the 40-conductor control cable to its companion Slave Control Card. Mounted on the Master Control Card, in daughterboard fashion, is a Data Master Card that buffers and conditions the address and data lines on the PC bus. The Data Cable connects the Data Master Card to the Data Slave Card.

On the bus of the CYANCE Bus Expander, one slot is used up by the Slave Control Card and its daughterboard Data Slave Card. Choice of a plug-in daughterboard and passive backplane scheme, rather than a one in which the CYANCE Bus Card contains the slave components, is better because it lets you make changes to the basic circuitry or expand the system to 16 bits.

As control, address and data signals are buffered and routed between the two buses, propagation delays are introduced by the buffer ICs and ribbon cable. By carefully selecting the logic family for the buffers and keeping the

ribbon cables as short as possible, you can minimize these delays. Furthermore, special consideration must be given to the extra capacitance that comes with the relatively long interconnect cables and peripheral cards.

• *Control Cards.* The PC Bus connector, shown in the center of the Master Control Card circuit in Fig. 3, uses a 62-contact edge connector with 31 each "A" and "B" contacts in the Fig. 1 pinout arrangement. The control cards use only the "B" side that routes most of the bus signals.

To keep construction as simple as possible, the same pc design is used for the Master and Slave Control Cards. The Master Control Card sits on the host PC bus, the Slave Control Card sits remotely on the CYANCE Bus Card and is controlled by the "Master" unit.

By connecting the adjacent pins of each 74S240 buffer, you can control the direction of the buffered signals using pins 1 and 19. When pin 1 is tied to ground and pin 19 to Vcc, signals at pins 2, 4, 6 and 8 are routed across the device to pins 18, 16, 14 and 12 to produce a bus "driver." Similarly, grounding pin 19 and tying pin 1 to Vcc, signals on pins 17, 15, 13 and 11 are routed through the device to pins 3, 5, 7 and 9 to create a bus "receiver" that conditions signals received on the interconnect cable.

All control signals on the PC bus must be conditioned and sent to the CYANCE Bus, which receives and conditions them. By configuring the voltages applied to pins 1 and 19 of the 74S240 buffers, both functions can be performed with one card.

In the Fig. 3 Master Control Card circuitry, the buffers located on the right send PC bus signals to the CYANCE Bus. Similarly, the buffers on the left condition signals received from the CYANCE Bus and apply them to the PC bus.

In the Fig. 4 Slave Control Card circuitry, the situation is reversed. Signals on the right are received from the Master Control Card and are conditioned and applied to the CYANCE Bus. On the right, the buffers send the CYANCE Bus signals back to the PC bus, while on the left, these signals are transmitted back to the Master Control Card.

Trace these signals using Fig. 1 through Fig. 4 until you completely understand the data flow. This will be important when you build and test your Bus Expander.

In studying Fig. 3 and Fig. 4, several "damping" resistors in series with the buffer output lines reduce the effects of under-shot signals. On the conditioning (receiving) side, these resistors are replaced with jumper wires. Hence, the difference between the Master and Slave Control Cards is determined by whether each has resistors or jumpers installed in the corresponding positions.

• *Data Cards.* In Fig. 5 and Fig. 6 are shown the schematic details of the circuitry on the Data Master and Data Slave Cards. In the Fig. 5 Data Master Card circuit, the PC bus connector is shown as an outline in the center. Recall that side "B" of the PC bus connector is composed primarily of control signals. Side "A" contains the address and data signals and a few control-line signals.

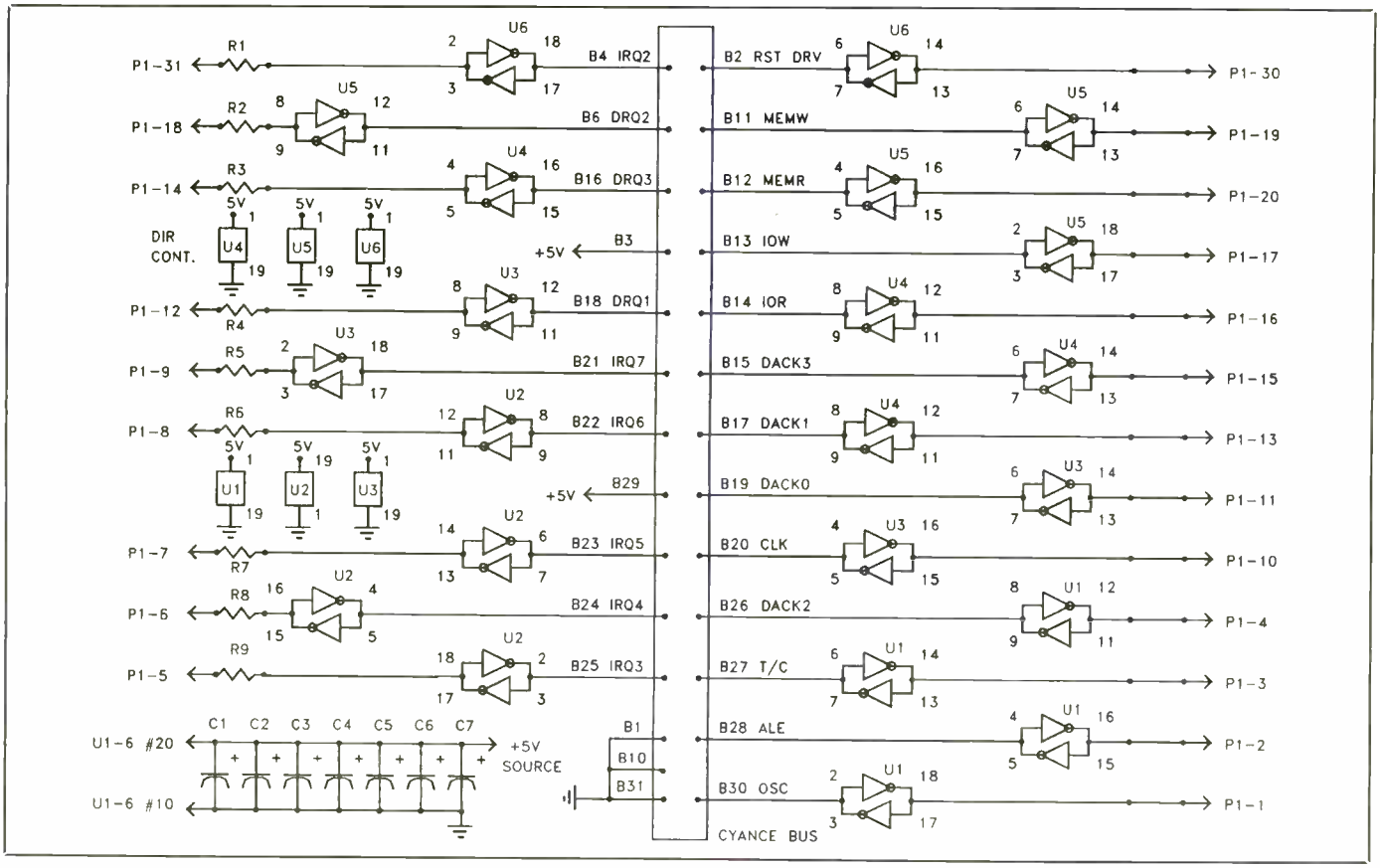


Fig. 4. Schematic details of Slave Control Card circuitry.

PARTS LIST

Master Control Card
Semiconductors
U1 thru U6—74S240 buffer
Capacitors
C1 thru C7—10-μF, 16-volt electrolytic
Resistors (¼-watt, 5% tolerance)
R1 thru R13—100 ohms
Miscellaneous
P1—40 pin DIP IC socket
P2—36-pin male single-row connector
Printed-circuit board; IC sockets (see text); solder; etc.

Slave Control Card
Semiconductors
U1 thru U6—74S240 buffer
Capacitors
C1 thru C7—10-μF, 16-volt electrolytic
Resistors (¼-watt, 5% tolerance)
R1 thru R9—100 ohms
Miscellaneous
P1—40 pin DIP IC socket
P2—36-pin male single-row connector
Printed-circuit board; IC sockets (see text); solder; etc.

Data Master Card
Semiconductors
U1,U2,U3,U6—74S240 buffer
U4,U5—74S38 quad two-input NAND gate with open collectors
U7—74S00 quad two-input NAND gate
D1,D2—1N4148 switching diode
Capacitors
C1 thru C6—10-μF, 16-volt electrolytic
Resistors (¼-watt, 5% tolerance)
R1 thru R20,R22 thru R29—100 ohms
R21—2,200-ohm SIP pack
Miscellaneous
P1—40-pin DIP IC socket
P2—36-pin female single-row connector
Printed-circuit board; IC sockets (see text); solder; etc.

Data Slave Card
Semiconductors
U1,U2,U3,U6—74S240 buffer
U4,U5—74S38 quad two-input NAND gate with open collectors
U7—74S00 quad two-input NAND gate
Capacitors
C1 thru C6—10-μF, 16-volt electrolytic
Resistors (¼-watt, 5% tolerance)
R1 thru R8—100 ohms
R10—470 ohms
R9—470-ohm SIP resistor pack
Miscellaneous
P1—40-pin DIP IC socket
P2—36-pin female single-row connector
Printed-circuit board; IC sockets (see text); solder; etc.

Bus Card
Capacitors
C1 thru C28—10-μF, 16-volt electrolytic with radial leads
C29—47-μF, 16-volt electrolytic with radial leads
C30—1-μF, 16-volt electrolytic with radial leads
C31 thru C37—10-μF, 16 volt electrolytic with axial leads
Miscellaneous
P1 thru P8—62-pin card edge connector with contacts on 0.100" centers
P9—12-pin male PC power connector
Printed-circuit board; solder; etc.

Note: The following items are available from U.S. Cyberlab, Inc., Rte. 2, Box 284, Cyber Rd., West Fork, AR 72774 (tel.: 1-501-839-8293 or 1-800-232-9865 voice only): All five double-sided pc-board kit with holes not plated-through, $79.95; complete CYANCE Bus Expander electronic kit, including pc boards, $169.95. Add $4.95 P&H. Akansas residents, please add 6% sales tax. MasterCard and Visa welcome.

As before, Master and Slave depend on which unit sits on the PC's motherboard bus and which sits on the CYANCE Bus. Address buffers *U1, U2* and *U3* buffer the address signals present on the PC motherboard's bus. Because these signals drive the 40-conductor DATA cable, damping resistors are again used.

In Fig. 6, the buffers are reversed and the resistors are replaced with wire jumpers. The buffers now condition the received signals coming from the Data Master Card and apply the reconstructed address signals to the CYANCE Bus.

At the right in Fig. 5, inverter/buffers and NAND gates *U4, U5* and *U6* are the heart of the data encoding and decoding circuitry. To share the data on the PC bus, the flow of data on the CYANCE Bus must be carefully controlled to and from the PC bus. This is accomplished by splitting the transmit and receive data path into 16 individual lines.

In Fig. 5, the data transmit lines come from the buffers at the right and have damping resistors in series with them. Just below each data-transmit line is the data-receive line that feeds one input of the NAND gate. If data signals are being sent from the PC bus to the CYANCE Bus, as in Fig. 5, for

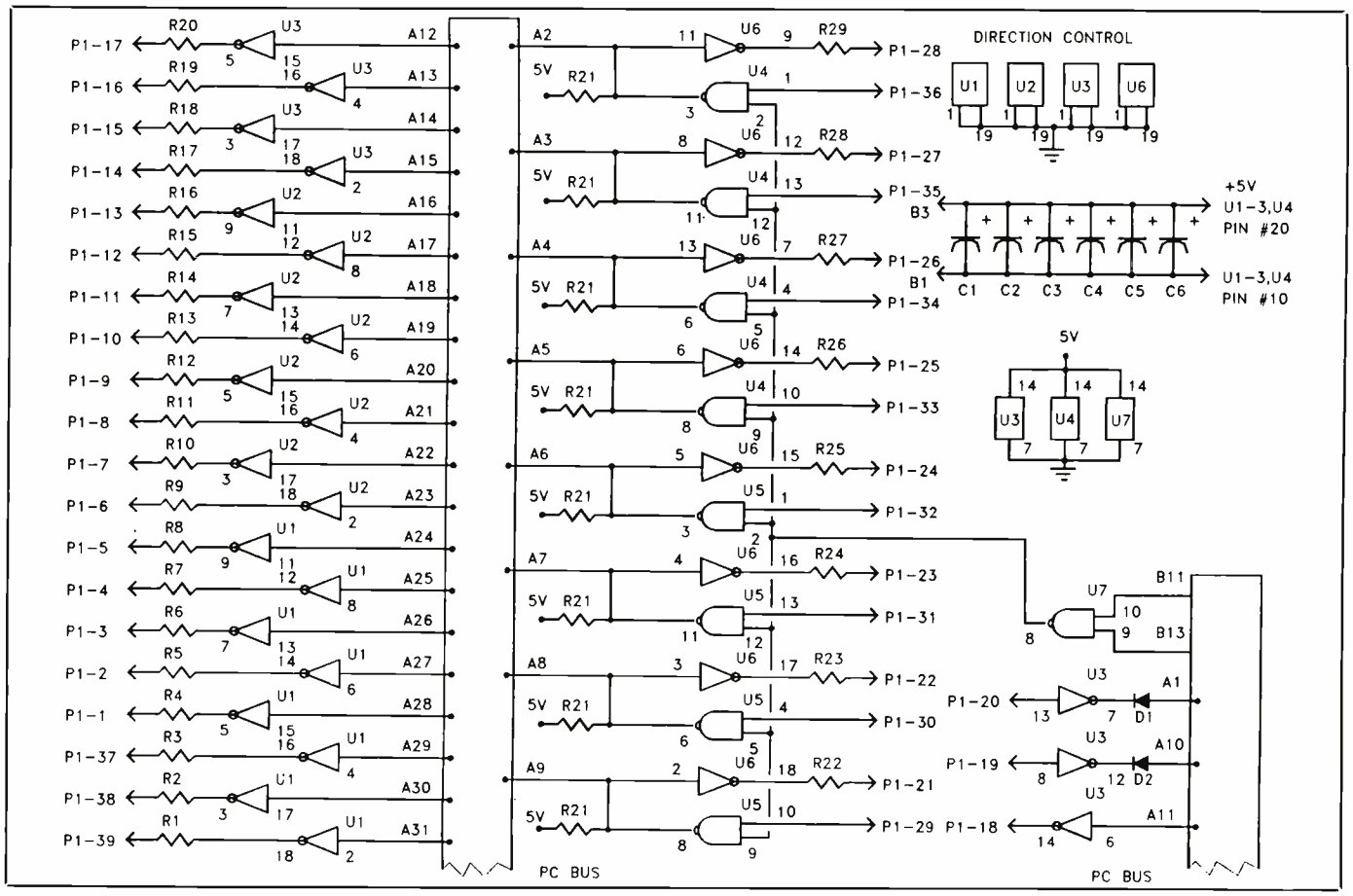


Fig. 5. Schematic details of Data Master Card circuitry.

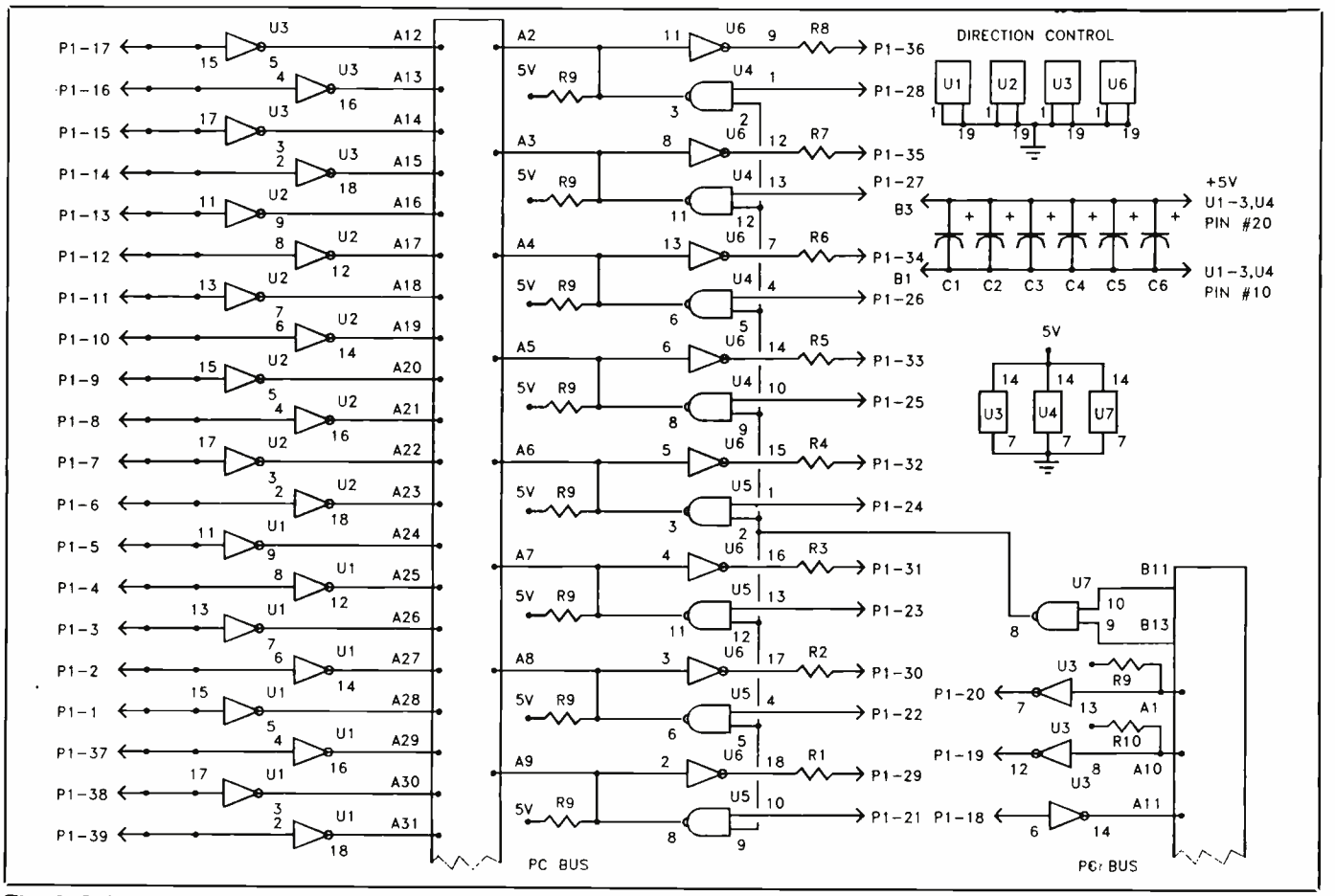


Fig. 6. Schematic details of Data Slave Card circuitry.

example, the data is simply buffered and placed directly on the interconnect cable. Likewise, in Fig. 6, the Data Slave Card directly buffers the returning data of the CYANCE Bus.

The critical part of the arrangement comes when you wish to place the transmitted data on either of the two buses. This data transfer must be carefully controlled to keep the computer from "crashing." Quad two-input NAND gate *U7* accepts two inputs from the bus. On the Data Master Card, these are the MEMR and IOR control lines, while on the Data Slave Card, they become the MEMW and IOW lines. Pin 8 of *U7* is used to enable open-collector quad two-input NAND gates *U5* and *U6*.

Every time the PC bus processor wants to receive data from the bus, it enables *U5* and *U6* on the Data Master Card. By virtue of their open-collector wired-OR design, *U5* and *U6* place data received from the CYANCE Bus directly on the PC bus. Likewise, when data is sent to the Data Slave Card, *U5* and *U6* place data from the PC bus directly on the CYANCE Bus. Because *U5* and *U6* are open-collector devices, *R21* provides the required pull-up source current across the CYANCE Bus data lines.

In addition to the address and data lines, the Data Master and Slave Cards transmit and receive the AEN control signal and I/O CHANNEL CHECK and I/O CHANNEL READY lines. Diodes *D1* and *D2* on the Data Master Card allow pull-down-only operation of the outputs of *U3*.

• *Bus Card.* The CYANCE Bus Card is passive owing to the fact that it contains no active components. The artwork you can use to make the pc board for it is laid out so that it can be either single- or double-sided. Several 10-μF capacitors placed across the card serve as "energy wells" and reduce switching noise on the +5-, +12-, −5- and −12-volt power lines.

There's also a place for eight capacitors at the termination end of the data bus at contacts A2 through A9. These capacitors, usually in the value range of 100 to 1,000 pF, may or may not be needed, depending on cable type and length and your arrangement of peripheral cards. Power for the CYANCE Bus is supplied by an independent power supply, preferably at least a 200-watt unit.

Next month, we'll finish up with construction, system checkout and installation of the Bus Expander in the CYANCE enclosure. ■

Nick Goss

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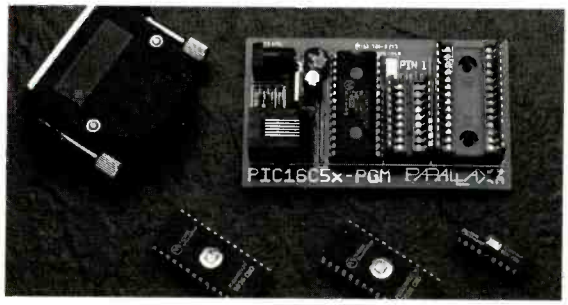

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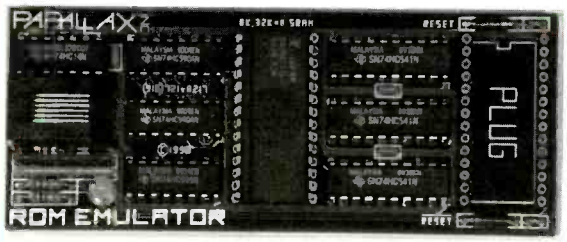

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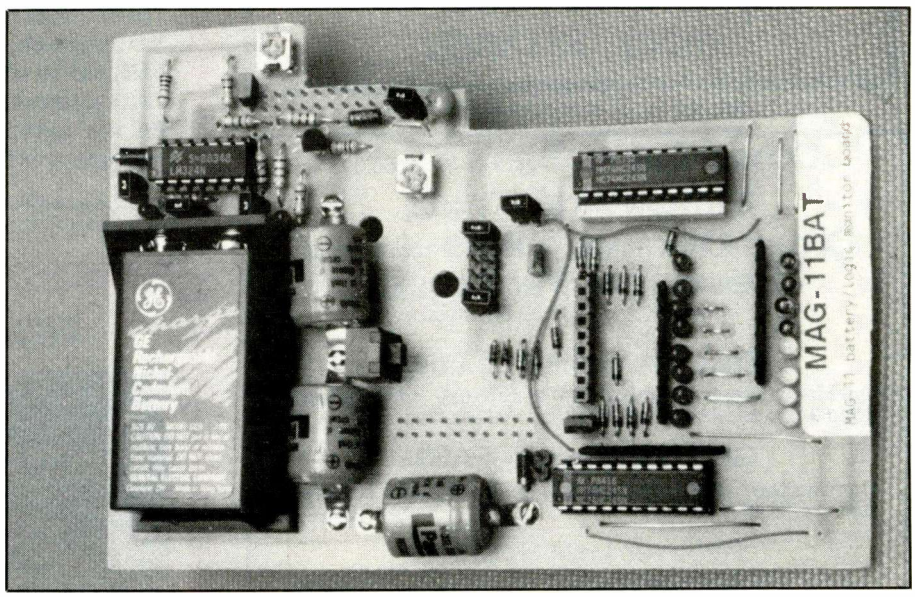
Experimenting With Motorola's 68HC11 True Single-Chip Computer

Part 4

Building a board to supply battery power, installing the monitor program, programming MAG-11's EEPROM and experimenting with the 68HC11 in Special Bootstrap/Modified Single-Chip mode

This time around, we have basically two focuses: operation, construction and use of a Battery Board for the MAG-11 single-board computer and the BUFFALO monitor program that makes it possible for you to use the MAG-11 Single-Board Computer for a wide range of applications.

Though the MAG-11BAT Battery Board is basically a convenient platform for supplying battery power to MAG-11, optional circuitry can be included to provide low-battery indication and an eight-channel Logic Monitor. The latter is useful as a diagnostic/instructional aid for the MAG-11 and expansion boards and for analyzing other projects. It's completely independent and plays no role in the operation of the SBC, but it is a low-cost option you might want to include if you ever have to troubleshoot the SBC or other digital circuits.



The BUFFALO (Bit User Fast Friendly Aid to Logical Operation) monitor program, available for just the cost of the call to Motorola's Freeware BBS and the time it takes to download it, is remarkably sophisticated. If you don't have the facilities to access the BBS and download files or prefer not to program your own EPROMs, you can obtain the BUFFALO monitor already programmed into a 27C256 EPROM for a small fee from the source given in the Note at the end of the Parts List. Also available from this source is a diskette that contains all the software for the first four parts of this series and the source code for the BUFFALO monitor and the file in Motorola S format.

About the Circuit

The MAG-11 single-board computer that was the subject of Parts 1 through 3 can be powered by a single 9-volt battery and uses a separate battery for memory back-up, in addition to the back-up provided by an on-board 0.1-Farad super-capacitor. Powering MAG-11 from batteries is optional, but it's a great convenience because it lets you use the SBC anywhere you happen to be, whether or not ac power is available. If you don't need such convenience, you can use just an ac-line-powered source that outputs filtered but unregulated 9 to 12 volts dc.

MAG-11 has its own UPS (uninter-

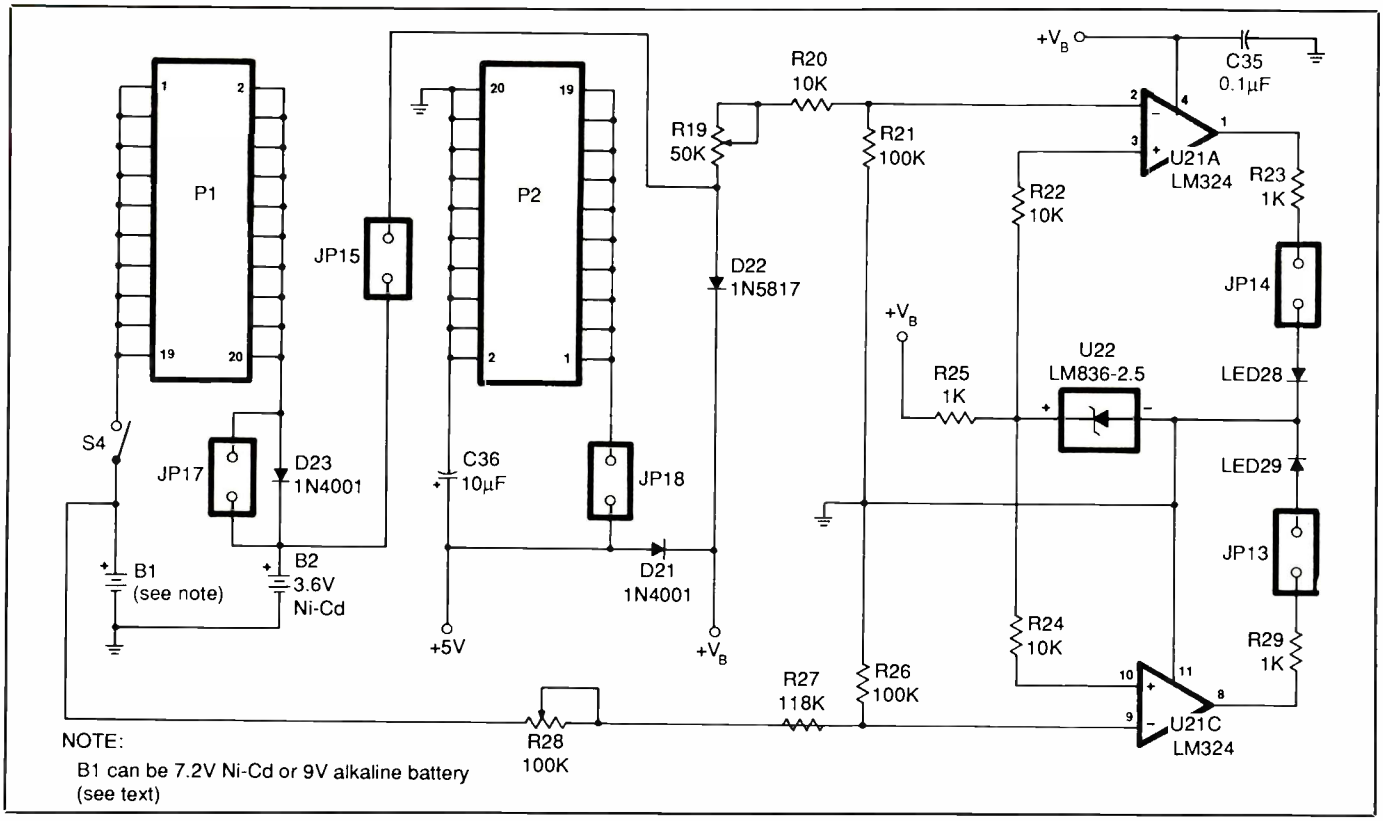


Fig. 7. Complete schematic diagram of optional battery-powering circuit for MAG- 11 SBC. This portion of the MAG-11BAT board offers a number of choices for battery-powering the system.

ruptible power source) and battery-backed memory system in addition to the built-in super-capacitor. The simple circuitry for the UPS is on the MAG-11 board, while the power source for the UPS (a 7.2-to-7.8-volt Ni-Cd battery is on the MAG-11BAT board) is identified as *B1* in Fig. 7. Battery *B2* consists of three ⅓-AA Ni-Cd cells located on the MAG-11BAT board and provides memory back-up for MAG-11.

Circuitry on-board MAG-11BAT provides separate visual low-battery alert for *B1* and *B2* via light-emitting diodes. The Fig. 7 circuit is a bit unusual because it has the capability of being powered by three distinct energy sources: ac line, *B1* and *B2*. In normal operation, the ac line or *B1* is the primary energy source. However, the system is still functional if *B2* or either of the other two energy sources is operating at more than about 50% of rated capacity. So, just about every power source has to give up the ghost for the low-battery alert circuit to fail.

MAG-11BAT's optional eight-channel Logic Monitor is shown schematically in Fig. 8. Channel 1 has a pulse-extender circuit that lets you view extremely short-duration pulses. This Logic Monitor has numerous applications. It can serve as an additional bank of LEDs for display purposes, an instructional aid for MAG-11 and expansion boards, a diagnostic tool for expansion boards and even MAG-11 itself, etc. If you don't wish to include this handy circuit, simply omit *U1, U2* and associated components.

Getting back to the battery-powering system in Fig. 7, *B1* can be either a 9-volt alkaline or a 7.2-volt (sometimes specified as 7.8-volt) Ni-Cd rechargeable type. If you use an alkaline battery, jumper pins 2 and 3 of *JP2*, and omit the jumper on *JP8* on the MAG-11 SBC board.

If you use an Ni-Cd battery, put a jumper on *JP8* and jumper pins 1 and 2 of *JP2*. If you use only battery power to run MAG-11 for short periods of time, select an alkaline battery for *B1*. Finally, if you plan on powering MAG-11 from the ac line, use an Ni-Cd battery if you wish the security of UPS service.

Potentiometer *R2* on the MAG-11 board sets the charging rate for *B1*. The three cells that make up *B2* provide about 3.8 volts when fully charged. Charging rate for *B2* is set with *R10* on MAG-11. Power is applied to and removed from MAG-11 by *S4* in Fig. 7. You need this switch if you operate MAG-11 solely on battery; otherwise, it's optional.

The low-battery indicator circuit consists of operational amplifiers *U21A* and *U21C*. Because these circuits are similar to each other, we'll examine only the one that turns on *LED17* when the voltage from *B2* is low enough to trigger it.

Notice that *U21* and *U22* are powered by both the +5-volt regulated source and *B2*. This permits the circuit to function even if the primary power supply is dead or missing, as long as *B2* has some charge left. A 2.5-volt reference source is provided by *U22*. While *U21* will operate down to 2.7 volts, the voltage-reference circuit starts to lose accuracy at about 3 volts. However, because the rate of change in the reference circuit is still less than the rate of change of V_B, the circuit operates okay down to 2.7 volts.

The 2.5-volt reference is applied to

PARTS LIST

Semiconductors
D5 thru D20—1N914 or similar silicon switching diode
D21,D23—1N4001 rectifier diode
D22—1N5817 Schottky barrier diode
LED12 thru LED19,LED28,LED29—Low-power, high-efficiency T-1 red light-emitting diode
LED20 thru LED27—low-power, high-efficiency T-1 green light-emitting diode
U19,U20—74HC245 octal tri-state transceiver
U21—LM324 quad operational amplifier
U22—LM336-2.5 2.5-volt voltage reference

Capacitors
C33,C34—1,500-pF, 25-volt ceramic
C35—0.1-μF, 25-volt monolithic ceramic
C36—10-μF, 20-volt electrolytic

Resistors (¼-watt, 5% tolerance)
R20,R22,R24—10,000 ohms
R21,R26—100,000 ohms
R23,R25,R29—1,000 ohms
R27—118,000 ohms, 1% tolerance
R19—50,000-ohm miniature pc-mount trimmer potentiometer
R28—100,000-ohm miniature pc-mount trimmer potentiometer
RN6—820,000-ohm × nine-element SIP resistor network
RN7—1-megohm × nine-element SIP resistor network
RN8,RN9—1,000-ohm × nine-element SIP resistor network

Miscellaneous
B1—9-volt alkaline or 7.2- to 7.8-volt nickel-cadmium battery
B2—Three ⅓-AA nickel-cadmium cells with solder tabs (Digi-Key Cat. No. P109 or similar)
J7—Nine-position female socket with contacts on 0.1" centers (Digi-Key Cat. No. 929974-01-10 or similar)
JP14 thru JP19—Two-post jumper header with posts on 0.1" centers
JP20—12-post jumper header with posts on 0.1" centers (Digi-Key Cat. No. 929836-01-36 or similar)
P1,P2—20-post, two-row plug with contacts on 0.1" centers (Digi-Key Cat. No. 929720-03-36 or similar)
S4—Miniature spst pc-mount pushbutton switch (Digi-Key Cat. No. SW100-ND or similar)
Printed-circuit board (see text); sockets for DIP ICs; shorting jumpers JP14 thru JP19; holder for B1 Digi-Key Cat. No. BH9V-PC-ND or similar); machine hardware for B2 (see text); solder; etc.

Note: Parts and software for the MAG-11 SBC are available from Magicland, 4380 S. Gordon Ave., Fremont, MI 49412. Hardware include: the double-sided MAG-11 pc board with plated-through holes and component-mounting overlay (No. MAG-11BD), $25; set of all ICs that are not optional, including the MC68HC11A1P, 27C256 EPROM with your choice of MAG-11DIAG or BUFFALO monitor firmware, thermistor and precision resistor, and MAG-11 software on 3½" or 5¼" PC-compatible diskette, but not including U9 and U10 (No. MAG-11CDK), $49.50. Price for both pc board and IC kit when ordered at the same time is $69. Available separately are: 68HC11, $25; 27C256 EPROM programmed with either MAG-11DIAG firmware (No. MAG-11DIAG/E-256) or BUFFALO monitor (No. BUFFALO/E-256), $12; PC-compatible disk loaded with software for MAG-11 on 5¼" disk (No. 6811-ME-5), $7.50 or 3½" disk (No. 6811ME-3), $10. Prices are in U.S. funds only. For shipment to Canada, add $5 and to all other countries via air add $10. Michigan residents, add 4% state sales tax.
For a complete list of the parts needed for MAG-11 SBC, see Parts 2 and 3 of this series in the February and March issues.

noninverting input pin 3 of *U21*, and a sampling of *B2*'s voltage is applied to inverting input pin 2. You use *R19* to adjust pin 2's potential to 2.5 volts when *B2*'s potential drops to some low value like 3 volts. Below 3 volts, pin 1 of *U21* goes high, causing *LED28* to light if *JP14* is jumpered. The circuit is isolated from the *C17* super-capacitor circuit on MAG-11 by jumpering *JP15* to isolate it from the super-capacitor to prevent needless discharge.

The remaining jumper blocks serve the following purposes:

JP16—logic-monitor power

JP17—memory backup power to the MAG-11 SBC

JP18—+5 volts to the entire MAG-11BAT board

JP19—storage for shorting jumpers that aren't being used.

Diode *D23* allows *B2* to be continually charged even if no jumper is placed on *JP17*.

The Fig. 8 Logic Monitor circuit consists of 74HC245 octal bus transceivers *U19* and *U20*, which have tri-state outputs. An off state isn't needed; so enable input pin 19 is grounded on both ICs.

With *U19*, direction control pin 1 is grounded. Thus, pins 11 through 18 (B bus) function as inputs and pins 2 through 9 (A bus) are outputs. Pin 1 of *U20* is at +5 volts, which reverses the direction of flow. Resistor network *RN6* contains a bank of 820,000-ohm pull-down resistors, and resistor network *RN7* contains 1-megohm pull-up resistors.

If diodes *D5* through *D20* weren't used, the inputs of the bus transceiver would see about 2.25 volts when the inputs to the Logic Monitor are left floating (2.25 volts is typical switch-over for high-speed CMOS—or HC—logic). Operation at this voltage causes the ICs to draw excessive current.

The forward drop across *D5* through *D12* causes pins 11 through 18 of *U19* to be at about 0.5 volt less than 2.25 volts, and the drop across *D13* through *D20* causes the potential at pins 2 through 9 of *U20* to be about 0.5 volt greater than 2.25 volts. The result is that even when the Logic Monitor pins are left floating, the voltage at the inputs to *U19* and *U20* isn't close enough to the switch-over point to cause excessive supply current drain.

Another advantage of using the diodes is that short pulses become visible on the LEDs since the extremely high reverse impedance of the diodes allows only the charge stored in the circuit's stray capacitance to discharge through the resistor networks. Capacitors *C33* and *C34* permit detection of very short-duration pulses when Logic Monitor input line 1 is used.

Notice the large-value current limiting resistors used for the LEDs. High-efficiency devices are recommended for all LEDs, which can be used with forward currents of as little as 1 mA, although 2 to 4 mA is more typical.

Construction

Printed-circuit construction is recommended for this project. You can make your own board from the actual-size artwork given in Fig. 9. To keep things simple, the artwork is designed to yield a single-sided pc board. Consequently, you'll have to install 15 jumper wires, as detailed later, after all components are mounted and soldered into place to get it working properly when you mate it with the MAG-11 SBC board.

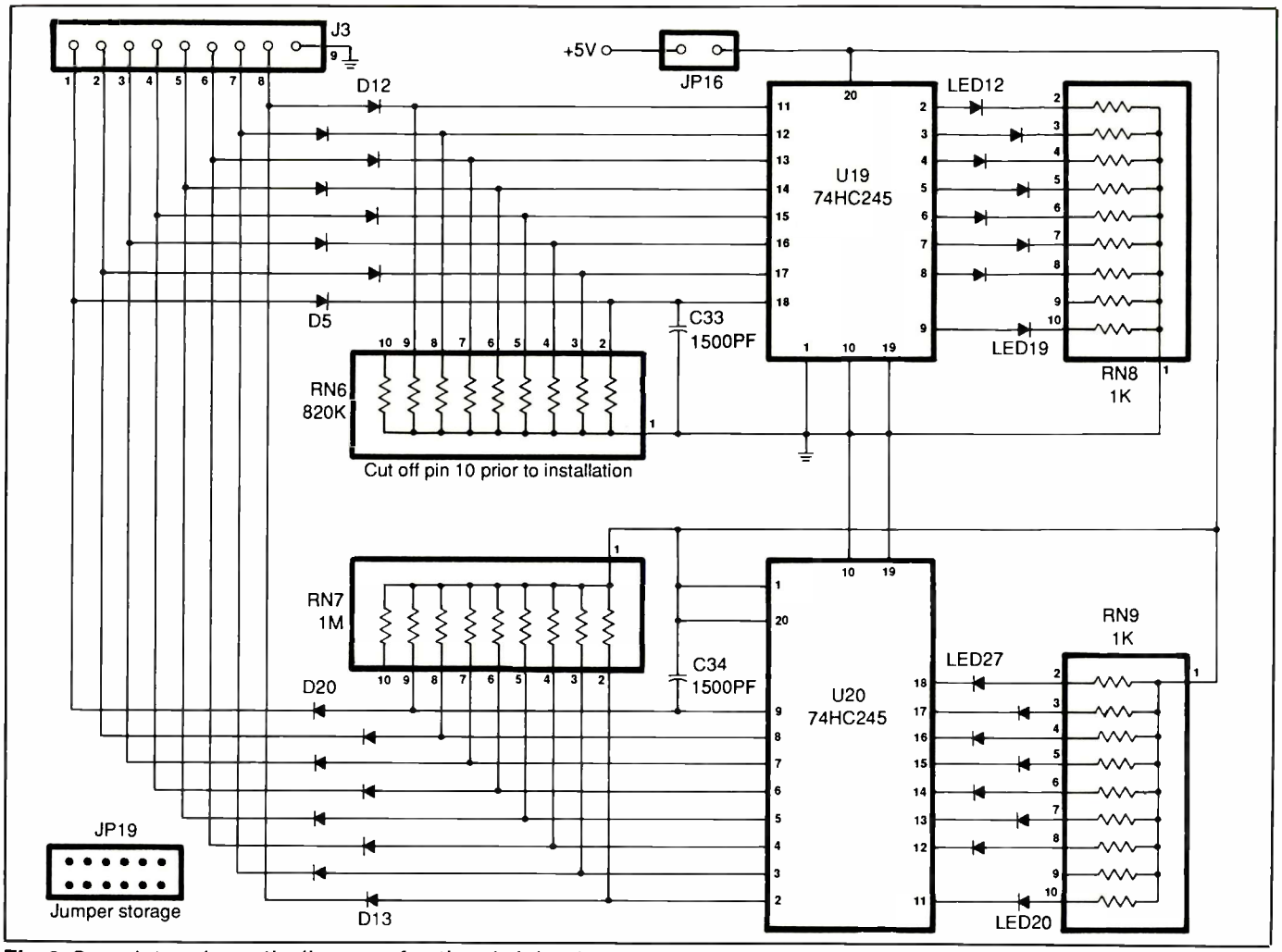


Fig. 8. Complete schematic diagram of optional eight-channel Logic Monitor for the MAG-11BAT board. It plays no role in operation of the SBC but does provide a convenient means for troubleshooting its circuitry and other digital systems.

Refer to Fig. 10 for component location and orientation details for populating the board. Use sockets for *U19, U20* and *U21*. If you don't now need the Logic Monitor circuit and would like to save a few dollars in component cost, omit all the components shown in Fig. 8.

Install *P1* and *P2* on the *solder* side of the board, leaving enough metal pin length exposed between the plastic insulating tie strip and board to provide soldering access. Though just about any size 20-pin headers with pins spaced on 0.1" centers can be used for *P1* and *P2*, it's best to use headers that have long pins on both sides of the insulating tie strip to make it easier to solder them.

The three ½-AA cells that make up *B2* have solder tabs. Use 2-56 or smaller machine hardware to secure the solder tabs to the board. If you use 2-56 screws, you'll have to enlarge the holes in the tabs to accommodate them. If necessary to make a good connection, solder the screws to the copper foil on the board.

Tests & Adjustments

Install fully charged Ni-Cd batteries *B1* and *B2*. Configure the jumpers on MAG-11 for installed Ni-Cd batteries. Then install all shorting jumpers on MAG-11BAT. Set *R2* and *R10* on MAG-11 to center of rotation. Line up *P1* and *P2* on MAG-11BAT with *J1* and *J2*, respectively, on MAG-11, and carefully push them together, as illustrated in Fig. 11.

Apply 9 volts dc to *SO1* on MAG-11. Wait about 30 minutes for the charging currents to stabilize. Then use a DMM set to the dc volts function to measure the potential dropped across *R7* on MAG-11. If don't obtain a reading close to 200 mV (± 100 mV), adjust *R10* on MAG-11 to get it. Access to *R10* is through a hole drilled in the indicated location in the MAG-11BAT board.

If the measured drop across *R1* isn't close to 150 mV, adjust *R2* as needed. It isn't possible to adjust *R2* with a standard screwdriver because MAG-11BAT obstructs it; so use either your fingers or longnose pliers.

For preliminary adjustment of the low-battery alert circuit, connect the common lead of your meter, set to measure 20 volts dc, to ground. Touch the "hot" probe to pin 2 of *U21* and adjust *R19* for a reading of + 3 volts. Move the "hot" probe to pin 9 and adjust *R28* for reading of + 3 volts.

At this point, *LED28* and *LED29* shouldn't be lit. Removing *B1* should cause *LED29* to light. Removing *B2* should cause both LEDs to light, assuming an external 9-volt source is connected to MAG-11. Replace *B1* and *B2*. Now *LED12* through *LED27* should be off.

Plug one end of a short No. 22 or 24 solid hookup wire into ground pin 9 of *J8* and the other end successively into the sockets at pins 1 through 8 of *J1*. Green *LED20* through *LED27* should light as you proceed to ground pins 1 through 8, respectively, with the wire.

Solder one lead of a 10,000-ohm resistor to one end of a solid No. 24 hookup wire and temporarily connect the free resistor lead to a source of + 5 volts on the board (use a small alligator clip or tack-solder the lead). As before, plug the free end of the wire into pins 1 through 9 of *J8* and note if *LED12* through *LED19* light.

If you experience any difficulty during this phase of testing, power down the system and correct the problem before proceeding.

Six functional jumper blocks are on MAG-11BAT, some or all of which can be replaced with permanent jumper wires. Use them to configure the board according to your needs. A hard-wired, soldered jumper can replace some or all (not recommended) jumper blocks. From Fig. 7, it's obvious that installation of a shorting jumper at the indicated jumper block activates/powers the respective system. Here's a list of the jumper-block functions with jumpers installed:

JP13—activates Low *B1 LED29*.

JP14—activates Low *B2 LED28*.

JP15—allows *B2* to supply power to *U21* when all other power sources are missing or dead. Install *JP15* only if *B2* is installed; otherwise, installation will discharge MAG-11's *C17* super-capacitor.

JP16—activates Logic Monitor.

JP17—activates MAG-11's memory battery back-up.

JP18—activates + 5-volt supply to MAG-11BAT.

The Logic Monitor on MAG-11BAT lets you visually detect pulses as short as several microseconds in duration. Because of the added capacitors, line 1 (connected to pin 1 of *J3*) is most sensitive to narrow pulses.

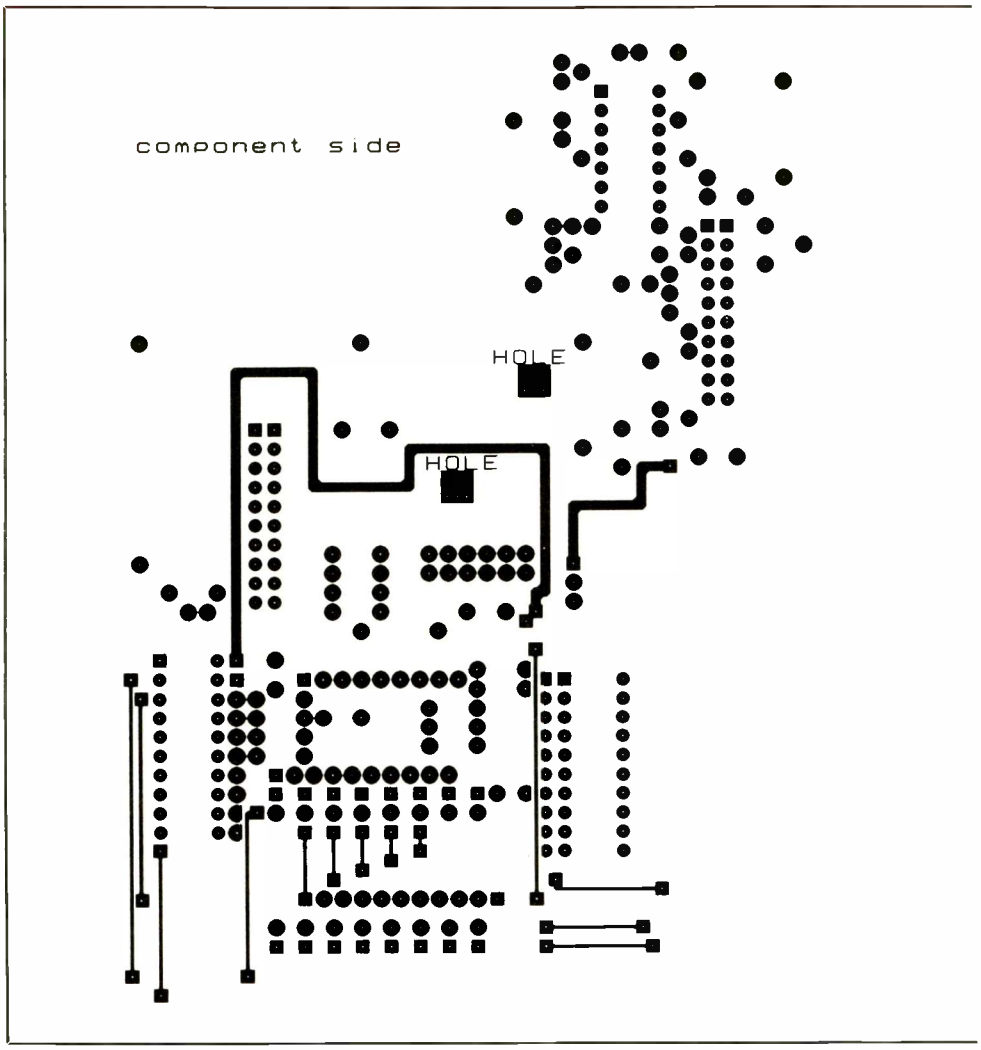


Fig. 9. Actual-size etching-and-drilling guides for MAG-11BAT's double-sided printed-circuit board.

If you use the Logic Monitor with any digital project powered by 5 volts dc, make sure to connect pin 9 of *J1* to ground in the circuit under test to activate it.

The BUFFALO Monitor

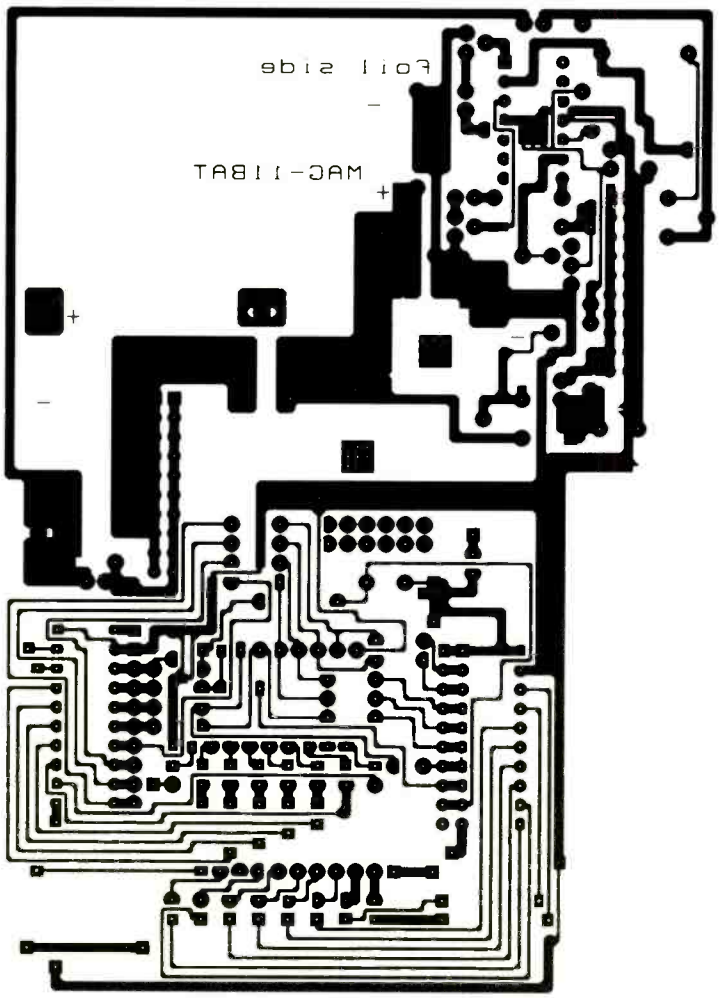
This monitor is very sophisticated, as evidenced by its more than 85-page source listing (BUF34.ASM). The S19 listing is about as long as BASIC-11's S19 listing!

You must make several minor changes to MAG-11 to be able to use the BUFFALO monitor. First, install a MAX232 RS-232 driver in the *U3* socket. Then replace *U7* with an EPROM that has the BUFFALO firmware programmed into it. Make sure pins 1 and 2 of *JP4* and pins 2 and 3 of *JP12* are jumpered.

If you program the EPROM yourself, keep in mind that the addresses in the MOT S file seldom correspond to the actual address in an EPROM, especially for EPROMs used with Motorola's chips.

With the BUFFALO monitor, the starting address is $E000 when obtained directly from the Freeware BBS. Addresses coincide exactly for 27C512 EPROMs. With 27C256 EPROMs, $E000 corresponds to $6000 in the EPROM, $F000 in the S-file to $7000. With 27128 EPROMs, $E000 corresponds to $2000 in the EPROM and $F000 to $3000. As you can see, address translation is required. It can be done directly to the .S19 file or more painlessly and invisibly by most EPROM burners.

You must use a 4-MHz crystal to communicate at exactly 4,800 baud.



Set position 1 of DIP switch *S2* to ON to ground pin 17 of *U1*. When pin 17 of *U1* is high, Version 3.4 of the BUFFALO monitor jumps to address $B600, the first address of the internal EEPROM.

To make use of the BUFFALO monitor, you need a terminal or a

```
ASM [<addr>]  Line asm/disasm
  [/,=]  Same addr,       [^,-]  Prev addr,       [+,CTLJ] Next addr
  [CR]  Next opcode,                              [CTLA,.]  Quit
BF <addr1> <addr2> [<data>]  Block fill memory
BR [-][<addr>] Set up bkpt table
BULK  Erase EEPROM,                  BULKALL  Erase EEPROM and CONFIG
CALL [<addr>] Call subroutine
GO [<addr>] Execute code at addr,          PROCEED  Continue execution
EEMOD [<addr [<addr>]] Modify EEPROM range
LOAD, VERIFY [T] <host dwnld command>  Load or verify S-records
MD [<addr1> [<addr2>]]  Memory dump
MM [<addr>] or [<addr>]/  Memory Modify
  [/,=]  Same addr,  [^,-,CTLH] Prev addr,  [+,CTLJ,SPACE] Next addr
  <addr>O Compute offset,                   [CR]  Quit
MOVE <s1> <s2> [<d>]  Block move
OFFSET [-]<arg>  Offset for download
RM [P,Y,X,A,B,C,S]  Register modify
STOPAT <addr>  Trace until addr
T [<n>]  Trace n instructions
TM  Transparent mode (CTLA = exit, CTLB = send brk)
[CTLW]  Wait,          [CTLX,DEL] Abort          [CR] Repeat last cmd
```

This printout is exactly what comes out of the BUFFALO monitor in the EEPROM.

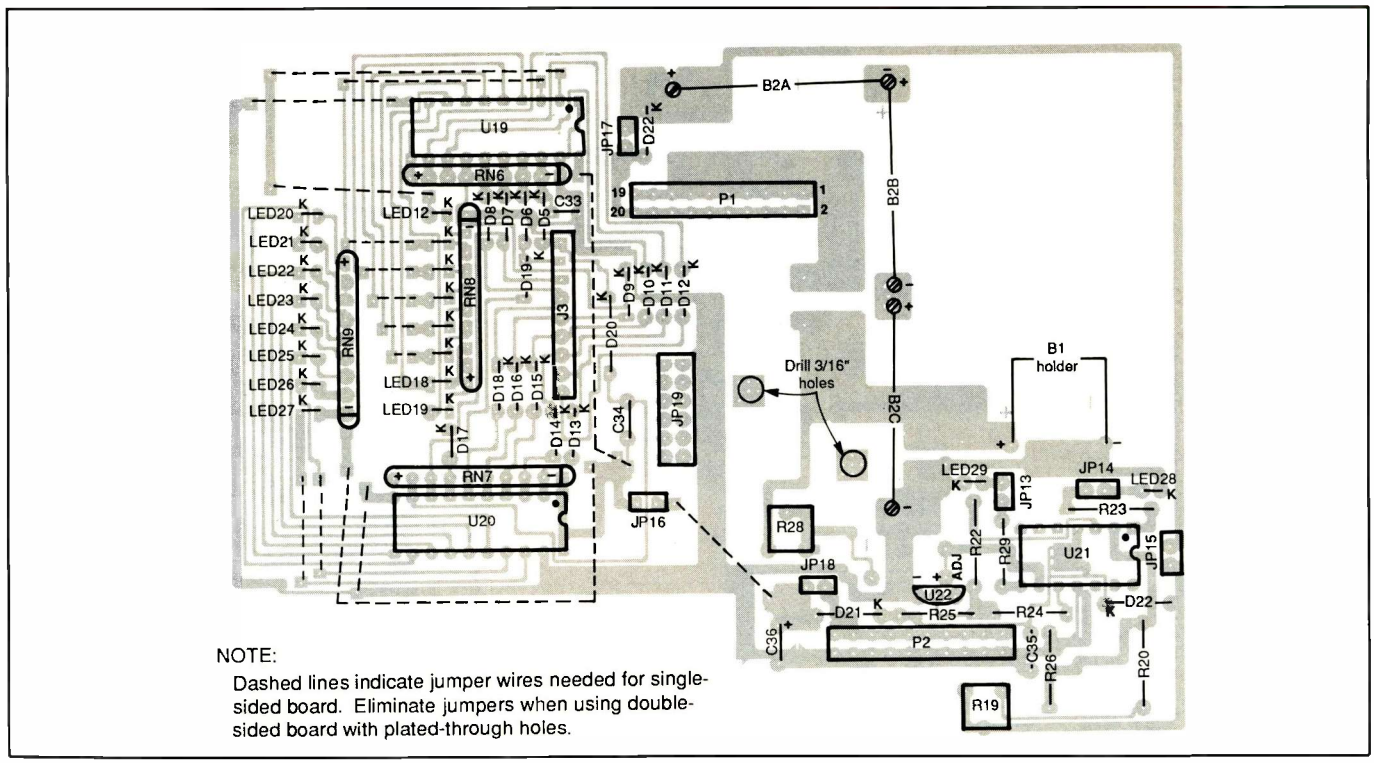


Fig. 10. Wiring guide for pc board. If you make your own single-sided board, eliminating the component-side conductors, install the jumper wires represented by the dashed lines.

computer with communication software and an RS-232 interface. We'll use the expression "terminal" even if you're using a computer with appropriate software because it's more appropriate in this context.

Set your terminal for 4,800 baud, eight data bits, one stop bit and no parity. Usa a cable with suitable connectors to connect MAG-11 via its *J7* DB-9 connector to the serial port on the terminal. Make sure Receive Data (RD) pin 2 of *J7* is connected to the terminal's Transmit Data (TD) line and TD pin 3 of *J7* is connected to the ter-

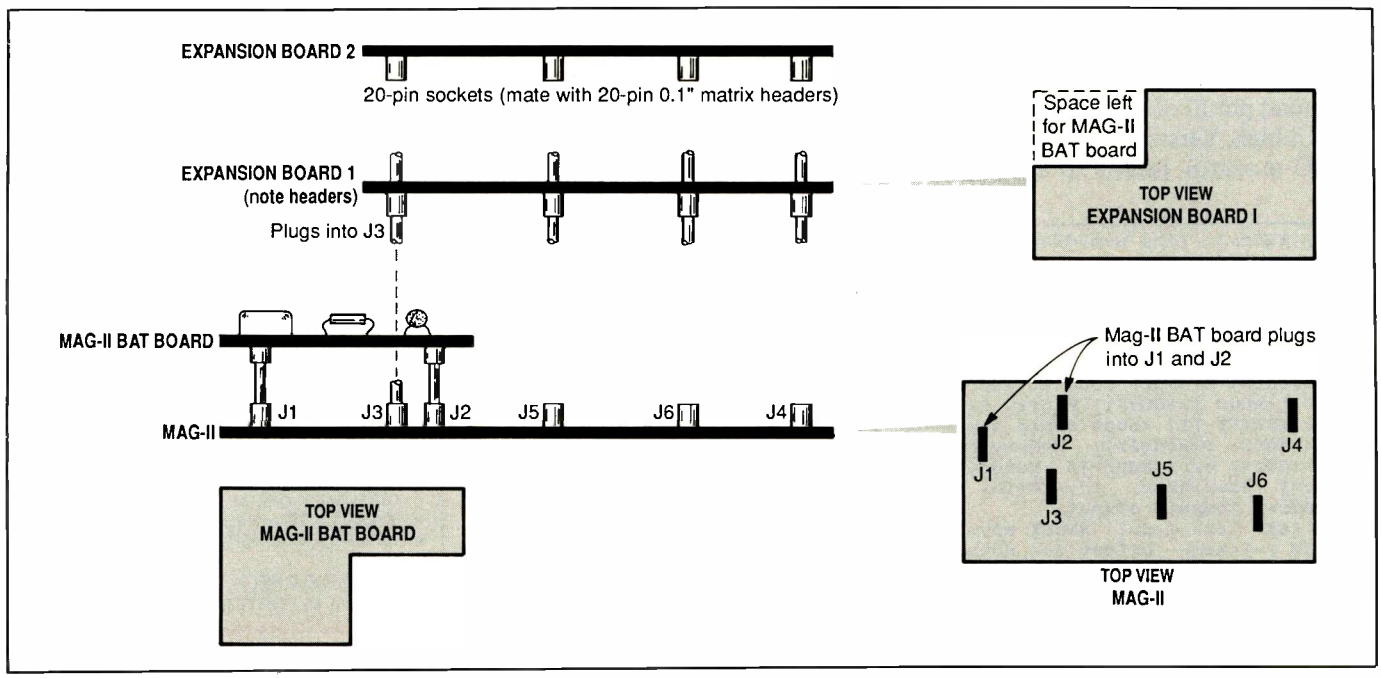


Fig. 11. Optional accessory boards plug into the MAG-11 SBC main board via single-row jack/plug arrangements.

minal's RD line. Ground pin 7 of *J7* to ground on the serial interface (normally pin 7 if the serial interface connector has 25 pins or pin 5 if it has only nine pins). No handshaking is used or required by either MAG-11 or the BUFFALO monitor.

After connecting MAG-11 to the terminal, turn on the latter. When you power up MAG-11, on-screen should appear the message: "BUFFALO v.3.4 (ext) - Bit User Fast Friendly Aid to . . . ." If it doesn't appear, use one line of MAG-11BAT's logic monitor (or a separate logic probe) to determine the source of problem. To do this, plug one end of a short length of No. 22 or 24 hookup wire into pin 1 of *J3* on MAG-11BAT. Touch the other end of the wire to pin 11 of *U3*; red *LED2* should light.

Press MAG-11's RESET switch (accessed through a hole in MAG-11BAT) while observing red *LED1* and green *LED9*. If both LEDs briefly light, the problem is most likely with the terminal or connections. Make sure you've set the terminal for 4,800 baud, eight data bits and one stop bit and have connected the pins correctly.

Once you obtain the proper message, press the terminal's ENTER or RETURN key to obtain the prompt: >. Then press ? or HELP to obtain a list of BUFFALO commands. See the BUFFALO Monitor Official Help List elsewhere in this article, which is printed exactly as it comes from the BUFFALO monitor in the EPROM.

BUFFALO expects the following format for commands:

<CMD[<wsp>arg>wsp>arg>...]<CR>

[ ] implies contents are optional; <WSP> is whitespace character (space, comma, tab); <CMD> is a command string of between one and eight characters; <ARG> is an argument particular to the command; <CR> is carriage return, which signifies the end of the input string.

As you can see from the Help List, the list of commands is extensive. Though no thorough description of how to use the BUFFALO monitor will be presented here, one precaution must be clearly understood. Unless you know exactly what you're doing, avoid using the BULKALL command with MAG-11 in Special Test Mode. This command is designed to erase the EEPROM (usually no problem) *and* the CONFIG register, which can be a real pain if you don't know precisely what you're doing.

Next month, we'll go into more detail on the BUFFALO monitor and how to use it. We'll also discuss how to use MAG-11 to produce an inexpensive do-it-yourself custom single-chip 68HC11 system. ■

Sources

Digi-Key Corp.
701 Brooks Ave., S.
P.O. Box 677
Thief River Falls, MN 56701
Tel.: 1-800-344-4539

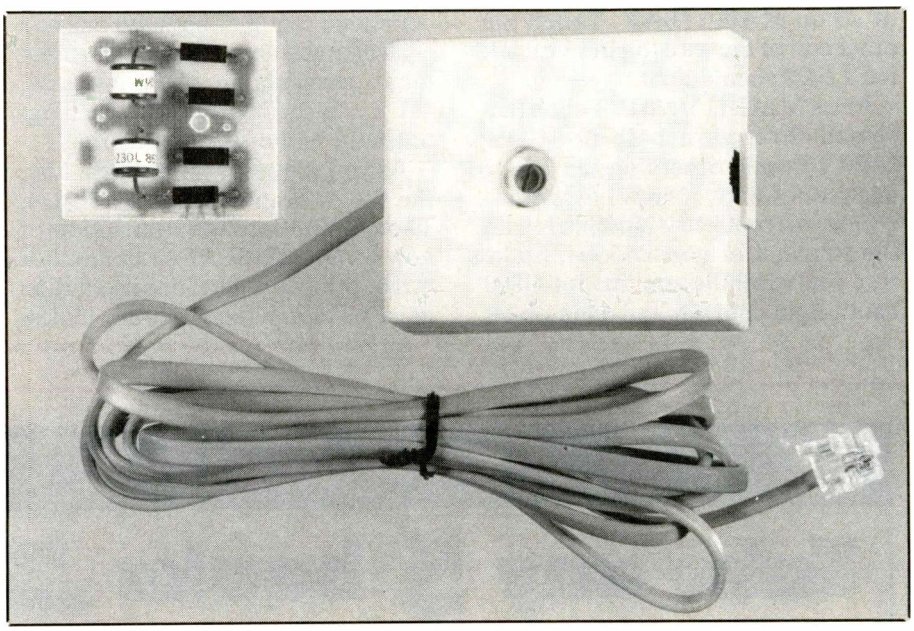
Motorola Freeware BBS
Tel.: 1-512-891-3733
Set modem for: 2,400, 1,200 or 300 baud; eight data bits; one stop bit; no parity.

Fast-Acting Modem Protection

Low-cost devices you can build and use to protect a computer modem, fax machine, telephone answering machine and computer from electrical damage

Computer modems, facsimile machines and telephone answering machines are usually operated just as they come out of the boxes in which they were purchased. If you use such equipment without protection, you run the risk of serious damage to it as a result of electrical storms, transients and surges generated whenever heavy-duty electrical equipment switches on and off and other phenomena.

In this article, we describe how to build three low-cost, high-energy devices that protect sensitive (and not-so-sensitive) electronic equipment. Protection with two of the three circuits to be described is *fast*, taking effect within 5 to 8 nanoseconds of the onset of a hazardous condition on a telephone or computer line. The circuits to be described use no moving parts, nor do they require ac line or battery power to operate, making them fail-safe and economical to use. The only requirement is connection to a good earth ground.



About the Circuits

A Modem Protector designed to protect electronic equipment connected to a telephone line is shown schematically in Fig. 1. It uses two CP Claire No. CG2301 or equivalent gas-discharge surge suppressors that have long been used for lightning protection. They handle a high-current arc discharge to ground when the gas inside them ionizes but are fairly slow to react to voltage surges. To offset this, two 180-volt, 5-watt 1N5386B or similar zener diodes connected back-to-back as shown can be wired from each telephone-line conductor to ground. The zener diodes can be wired cathode-to-cathode, as shown, or anode to anode.

With the zener diodes wired into the circuit, action is considerably speeded up to protect the telephone circuit from an initial surge. The zener diodes work almost instantaneously and continue to work until the surge suppressors catch up and take over handling the high-current energy.

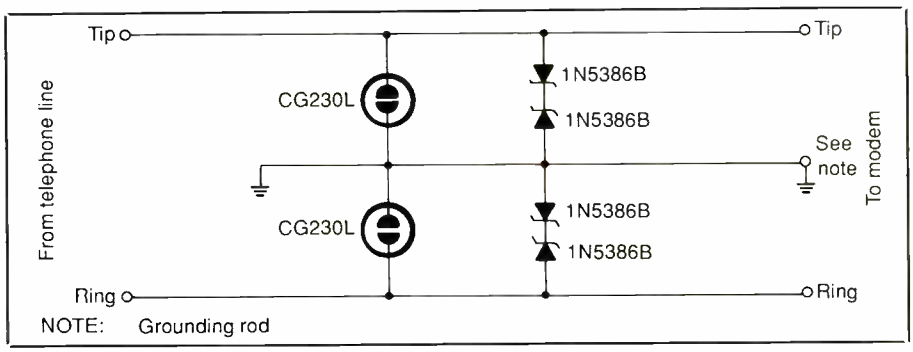


Fig. 1. A basic circuit configuration for protecting electronic equipment connected to the telephone line from voltage surges.

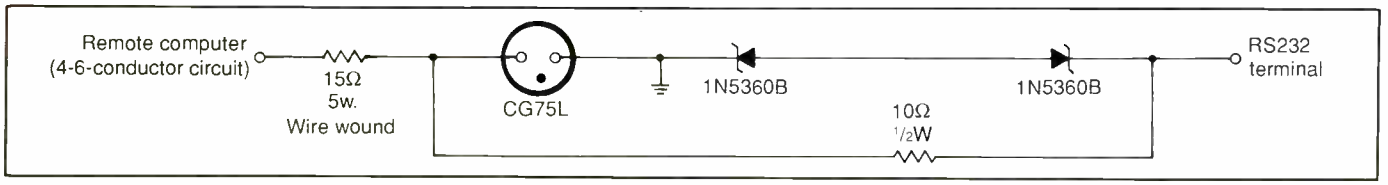


Fig. 2. This simple circuit protects computer serial port lines from voltage surges. Each port conductor must be equipped with an identical circuit.

To understand how this protection of a modem or any other electronic device connected to the telephone line works, let us review what happens on the telephone line. When a telephone instrument is on-hook, approximately 48 volts dc appears across the line. Lifting the handset off-hook drops the line potential to about 6 volts. With the receiver on-hook, when a ring signal appears on the line to signal an incoming call, about a 100-volt, 20-Hz ac signal is impressed on the already-present 48 volts dc. The amplitude of the ring signal determines the voltage required for the zener diodes and surge suppressors in Fig. 1.

Telephone circuits generally have built into them a resistive device on each line conductor to protect a telephone instrument from electrical spikes in excess of 500 to 600 volts. This "brute-force" approach is not very effective for all-electronic telephone instruments, modems and facsimile machines, which are more sensitive to voltage spikes.

Gas-discharge tubes initially used to protect telephone circuits could handle the high currents involved, but their response speed was slow. Later, an electronic device called a "varistor" served as a passive resistive shock absorber and was used in conjunction with gas-discharge tubes to yield much better performance. However, varistors are not as fast performers as semiconductor devices, and they wear out with repeated exposure to voltage spikes.

A variation on the Modem Protector theme, shown in Fig. 2, can be used to protect remote computer terminals connected over a long distance to a computer. If you decide to use this Serial Port Protector circuit, make sure you equip *each* conductor of the cable that goes to the remote computer with an identical circuit.

Shown in Fig. 3 is an AC Line Conditioner circuit that protects electronic equipment connected to the 117-volt ac line. It plugs into the ac line and has chassis-mount ac receptacles into which the equipment plug. Varistors prevent surges on the ac line from entering the power supplies of the equipment.

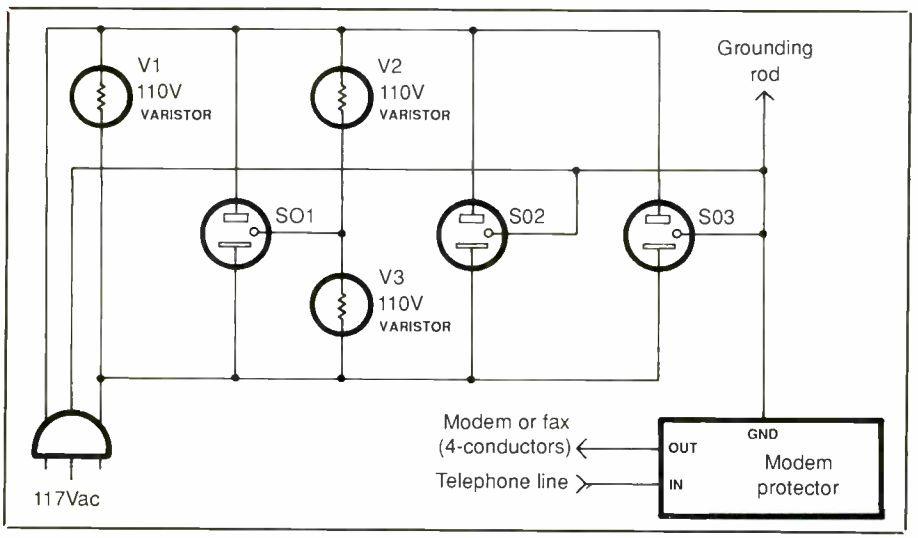


Fig. 3. This circuit protects electronic equipment from electrical surges on the ac power line.

For most applications that do not involve a computer, you should incorporate the Modem Protector (Fig. 1) and AC Line Conditioner (Fig. 3) into your system. Where a computer is involved, you need at least the Serial Port Protector (Fig. 2) and AC Line Conditioner, and if the computer connects to the telephone line, the Modem Protector as well.

Construction

You can build one or all three of the circuits described above from readily available components and materials. The Modem Protector circuit is so simple in terms of component count, you can wire it on a small piece of perforated board or fabricate a printed-circuit board (use the actual-size

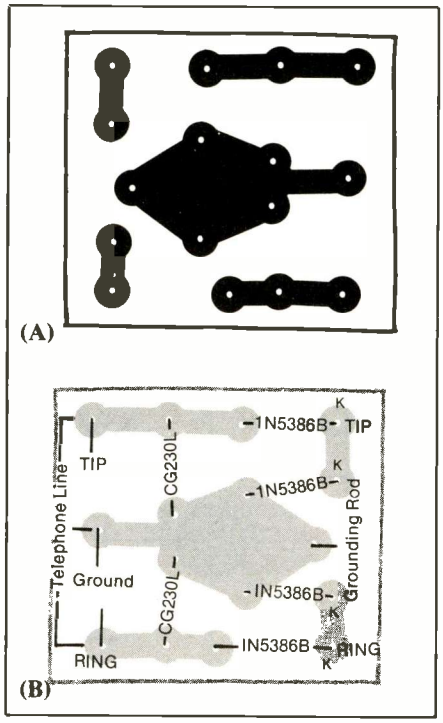


Fig. 4. Actual-size etching-and-drilling guide (A) and wiring diagram (B) for Modem Protector circuit.

etching-and-drilling guide and component-placement diagram shown in Fig. 4) and house it inside a standard telephone-jack wall box. As you build the Fig. 1 circuit, make sure you observe proper polarity between telephone line and the equipment to which it is to go.

Construction of the Fig. 2 circuit is almost as simple. Wire as many of these circuits as there are conductors in your serial cable side by side on perforated board. House the assembly inside a suitable size project box. Plan the physical layout inside the box so that the cable coming from the remote computer enters at one end of the box and the cable to the terminal exits the opposite end of the box. If you use a metal project box, deburr the holes or slots made for the cables and line them with rubber grommets or other insulating material.

House the Fig. 3 circuit inside a metal utility box that is large enough to provide room on its top panel for mounting the three chassis-mount ac receptacles. The box will almost certainly be large enough to house the assemblies for the Fig. 1 or/and Fig. 2 circuit assemblies as well.

Machine the box as needed. When you are done, mount the three ac receptacles on the top panel. Then, referring to Fig. 3, wire the three-conductor ac line cord and varistors into the circuit exactly as shown. Use heavy-duty stranded wire to interconnect the components. If you are planning on housing the Fig. 1 or/and Fig. 2 circuits inside the same enclosure, mount them into place as well, using spacers and suitable machine hardware.

Bring together all circuit grounds and tie them to a common point that then ties to your earth ground. (If you are using just the Fig. 1 or/and Fig. 2 circuits, tie their ground points to your earth ground separately.)

The effectiveness of your earth ground is extremely important with any and all of the circuits described above. The most effective ground is obtained by driving a grounding rod 6 to 8 feet deep into moist soil. [For full details on making effective earth grounds, see "Antenna Grounding Basics" in the August 1990 Communications column in *Modern Electronics*—Ed.]

If you are unable to establish a good earth ground by the grounding-rod method, your second choice is to use the cold-water pipe where you live. A third choice is the grounded contact on your electrical outlet. This last choice may not be adequate, however, because the ground can actually be many millivolts above true ground potential. Also, oxidation on the contacts of the ac electrical system can render the ground ineffective. Therefore, if you have a choice, avoid this type of ground.

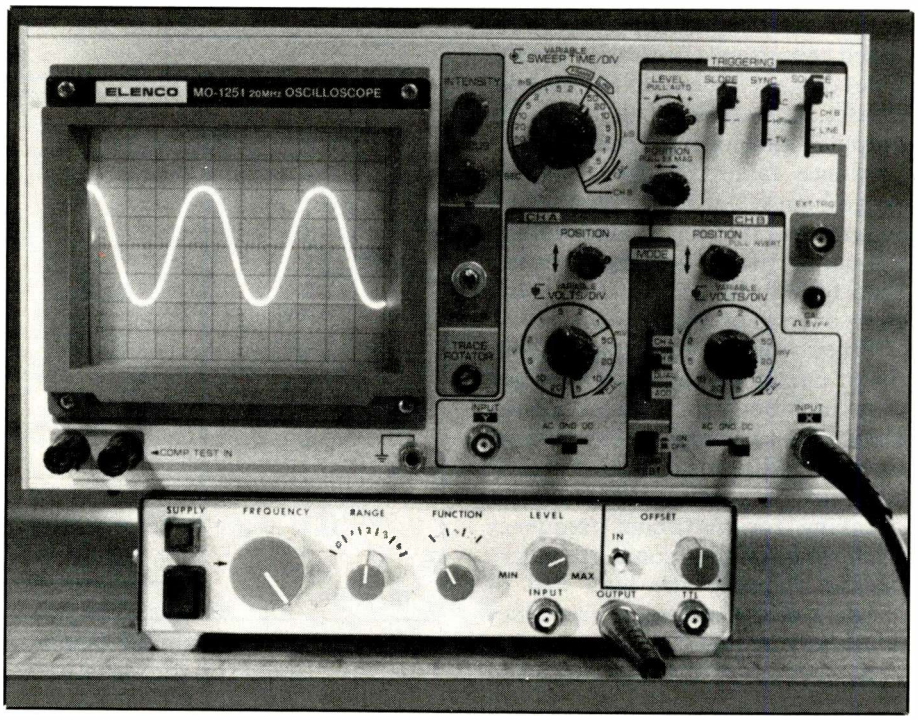
Once you have decided on the ground you will be using for your protection system, run insulated 14- or 16-gauge stranded wire from it to the Modem Protector circuit(s). Make sure you use very-low-resistance means of connecting this wire at both ends. ■

$50 Lab-Grade Function Generator

Full-featured 1-Hz to 250-kHz function generator construction project adds CMOS/TTL compatibility, an FM sweep input, near-zero distortion and a power-amplifier output to drive 50-ohm loads to the usual sine/triangle/square-wave outputs

Second only to the oscilloscope, a Laboratory-Grade Function Generator like the one described here is a real necessity for developing and debugging a broad range of circuits. With it, distortion can be measured, bandwidths extrapolated, clocks created, time constants tested and open circuits found, to name just a few of its almost inexhaustible applications.

Our Function Generator provides the usual sine-, triangle- and square-wave outputs at frequencies ranging from less than 1 Hz to beyond 250 kHz at virtually zero distortion. It offers CMOS and TTL compatibility for digital circuits and a variable ±15 volts. The Generator is also TTL/CMOS compatible for use in digital circuits. Other features include: an FM sweep input; variable offset to ±10 volts; and a power-amplifier output for driving 50-ohm loads. If you were to obtain all these features and functions in a single commercial function generator, the instrument would cost you many hundreds of dollars. By building the Function Generator, your cost should be about $50 or so for all materials, including enclosure.



About the Circuit

The heart of the Generator is a precision waveform generator/voltage-controlled oscillator chip that Digi-Key, among others, sells for less than $5. This is the ICL8038 shown as *IC2* in Fig. 1(A). This particular chip has been around for a number of years and is the foundation upon which every bench-top function generator on the market is built. To fully appreciate the potential of the ICL8038, you should contact Intersil, which makes the chip, via your local representative to request Application Note AO13, "Everything You Always Wanted to Know About the ICL8038." This informative publication explains in detail the functions and features of the ICL8038 and provides a variety of interesting applications for the chip.

Because the ICL8038 is basically a voltage-controlled oscillator (vco), some means for varying its sweep input at pin 2 of *IC2* must be provided. This is the task of operational amplifier *IC1* and its associated circuitry. A near-1,000:1 sweep ratio is provided externally via SWEEP IN jack *J1*.

Any varying voltage applied to pin 2 of *IC2* through *J1* within the range of ±12 volts produces frequency modulation (FM) of the output waveform at FINAL OUTPUT jack *J3* in Fig. 3(C). If no external sweep is used, output frequency is set via FREQ. ADJ control *R1* in Fig. 1(A).

Trimmer potentiometers *R4* (HIGH FREQ TRIM) and *R5* (LOW FREQ TRIM) permit one-time peaking of the upper

and lower frequency limits, respectively. These trimmer controls are adjusted as needed during circuit checkout with a frequency counter or oscilloscope connected to *J3*.

SYMMETRY TRIM control *R8* provides a one-time calibration of duty cycle and sine-wave symmetry. With an oscilloscope connected to *J3*, you adjust *R8* until the sine wave displayed on the CRT of the scope appears as uniform and symmetrical as possible. Further "tweaking" for minimal sine-wave distortion is accomplished by adjusting DIST TRIM controls *R6* and *R7*.

Frequency range is selected via *S2* in Fig. 1(B). As the FREQUENCY RANGE SELECT switch is moved through its positions, it selects different values of capacitance. As the selected capacitance decreases, the RC time constant internal to *IC2* also decreases. This results in an increase in output frequency from the chip. Capacitance values for the *S2* circuit range from 417 μF to less than 100 pF to provide a frequency bandwidth at the output of *IC2* ranging from less than 1 Hz to beyond 250 kHz, with some overlap between ranges.

When selecting the capacitors for the *S2* circuit, exercise care to obtain only high-quality, low-leakage devices. This ensures that the oscillator operates with maximum stability. Trimmer capacitor *C15* permits tweaking for maximum frequency while maintaining some frequency overlap between the high end of range 3 and the lowest frequency available on range 4.

A high-speed CMOS/TTL-com-

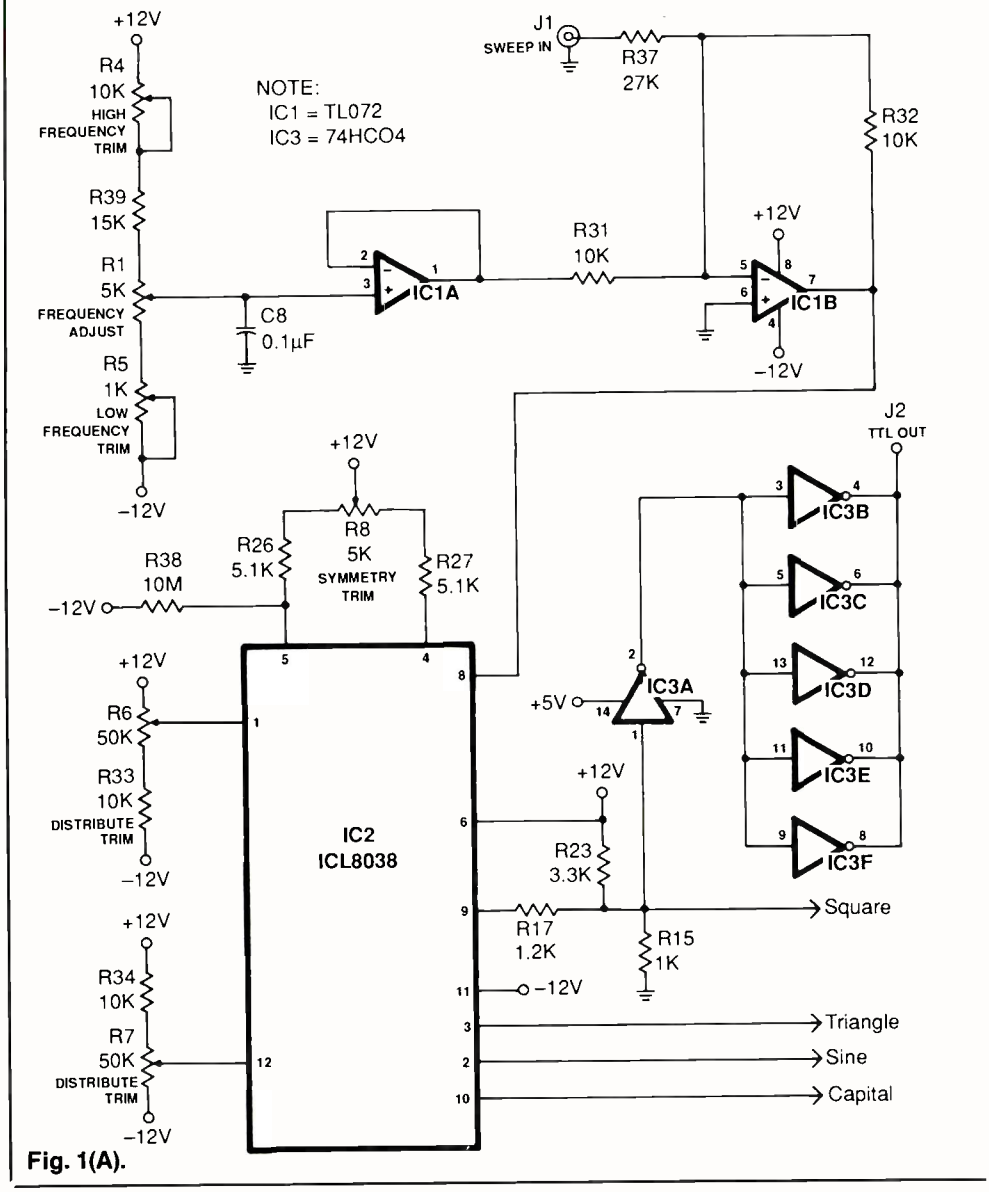


Fig. 1(A).

Fig. 1. Complete schematic diagram of Function Generator is shown here in four parts, labeled (A) through (D).

PARTS LIST

Semiconductors

D1—1N4001 silicon rectifier diode
D2,D3—1N4148 or similar small-signal switching diode
IC1—TL072 or similar internally compensated operational amplifier
IC2—ICL8038 waveform generator
IC3—74HC04 or 74HC14 hex inverter
IC4—7812 fixed +12-volt regulator
IC5—7805 fixed +5-volt regulator
IC6—7912 fixed −12-volt regulator
Q1,Q2,Q3—2N2222 or similar general-purpose npn silicon switching transistor
Q4,Q5—2N3906 or similar silicon pnp switching transistor
Q6—TIP31 silicon npn power transistor
Q7—TIP32 silicon pnp power transistor
RECT1—50-piv, 1-ampere bridge rectifier assembly

Capacitors

C1,C2—100-μF, 35-volt electrolytic
C3—4.7-μF, 35-volt electrolytic
C4—0.47-μF polypropylene or polyester
C5 thru C8—0.1-μF monolithic ceramic
C9,C10—0.33-μF, 35-volt tantalum
C11—0.047-μF polypropylene or polyester
C12—0.0047-μF polypropylene or polyester
C13—390-pF silver-mica or polypropylene
C14—6-to-50-pF trimmer (Radio Shack Cat. No. 272-1340 or similar)

Resistors (¼-watt, 5% tolerance)

R10,R11—10 ohms (½-watt)
R12,R13—33 ohms (½-watt)
R14—100 ohms
R15,R16—1,000 ohms
R17—1,200 ohms
R18,R19,R20—1,800 ohms
R21,R22—2,200 ohms

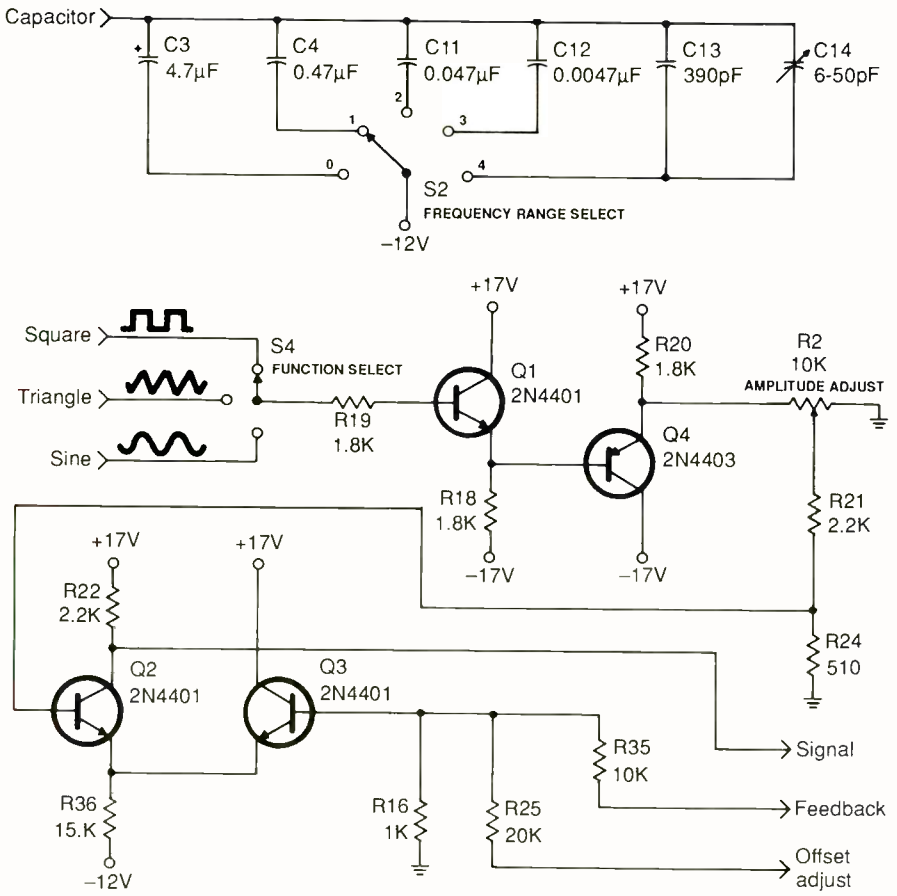


Fig. 1(B).

patible clock output is provided by HCMOS hex inverter *IC3* in Fig. 1(A). TTL OUT *J2* is quite useful as a variable logic clock when designing and troubleshooting digital circuits. Its fan-out is reasonably high. By utilizing the lower-frequency settings, you can better judge the logical operation of a circuit when testing different points in the circuit with a logic probe.

Selection of the sine-, triangle- or square-wave function is made using FUNCTION SELECT switch *S4* in Fig. 1(B). This switch permits you to connect the input of the output amplifier inside the Function Generator to one of the three available waveform output pins of *IC2*. The sine-wave output of *IC2* is on pin 2, the triangle-wave output is on pin 3 and the square-wave output is on pin 9.

Once a selection is made via *S4*, the output from *IC2* is fed to the buffer amplifier consisting of the *Q1/Q4* circuit. The buffered output from this circuit is fed to AMPLITUDE ADJ control *R2* to permit you set the signal amplitude output from *J3*.

A variable dc offset voltage is provided by the *Q2/Q3* circuit, also shown in Fig. 1(B). This offset can be switched between IN and OUT via OFFSET switch *S3* in Fig. 1(C). Infinite variability of the dc offset is provided by OFFSET ADJ control *R3*, while OFFSET TRIM ADJ control *R9* provides one-time calibration of the zero-offset adjustment. With *S3* set to OUT, you should adjust *R9* so that no dc offset is observed on the CRT of your scope connected to *J3*.

A power amplifier capable of driv-

R23—3,300 ohms
R24—510 ohms
R25—20,000 ohms
R26 thru R29—5,100 ohms
R30—6,800 ohms
R31 thru R35—10,000 ohms
R36,R39—15,000 ohms
R37—27,000 ohms
R38—10,000 megohms
R1—5,000-ohm linear-taper panel-mount potentiometer
R2,R3—10,000-ohm linear-taper panel-mount potentiometer
R4—10,000-ohm pc-mount trimmer potentiometer
R5,R9—1,000-ohm pc-mount trimmer potentiometer
R6,R7—50,000-ohm pc-mount trimmer potentiometer
R8—5,000-ohm pc-mount trimmer potentiometer

Miscellaneous

F1—0.5-ampere slow-blow fuse
I1—Neon panel lamp with limiting resistor
J1,J2,J3—Panel-mount BNC jack (Radio Shack Cat. No. 278-105 or similar)
S1—Spst toggle or slide switch
S2—Four-position non-shorting rotary switch
S3—Three-position non-shorting rotary switch
S4—Spdt toggle or slide switch
T1—Shielded 25.2-volt, 450-mA center-tapped power transformer (Radio Shack Cat. No. 273-1366 or similar)
Printed-circuit board or perforated board with holes on 0.1-inch centers and suitable Wire Wrap or soldering hardware (see text); suitable enclosure (Radio Shack Cat. No. 270-272 or similar); sockets for all DIP ICs; fuse holder; three-conductor ac line cord; pointer-type control knobs; rubber grommet; heat-shrinkable tubing; ½" spacers; lettering kit and clear acrylic spray (see text); machine hardware; hookup wire; solder; etc.

ing a 50-ohm load is provided by the push-pull output stage made up of *Q6* and *Q7* in Fig. 1(C). Correct biasing of this output circuit is provided by *Q5*, *D2* and *D3*. Signal feedback is provided by *R35*. As shown, the complete amplifier delivers a no-load output swing of almost ±15 volts, or 30 volts peak-to-peak, with less than 1% distortion.

Power for the Function Generator circuits is provided by the ac-operated circuit shown schematically in Fig. 1(D). The incoming 117 volts from the ac line is stepped down to 24 volts ac by shielded power transformer *T1*. The center-tapped secondary of *T1* provides two separate lines, both referenced to circuit ground, to bridge rectifier *RECT1*. The rectifier assembly converts the incoming ac into +17 and −17 volts pulsating dc. The pulsating dc is filtered to pure dc by *C1* and *C9* in the +17-volt line and *C2* and *C10* in the −17-volt. Both lines are then regulated to +12 and −12 volts by *IC4* and *IC6*, respectively, for delivery to the circuits inside the Function Generator.

Note also that regulator *IC5* in the +12-volt line is used to obtain +5 volts. The only point in the circuit to which the +5-volt line goes is power pin 14 of HCMOS hex inverter *IC3*.

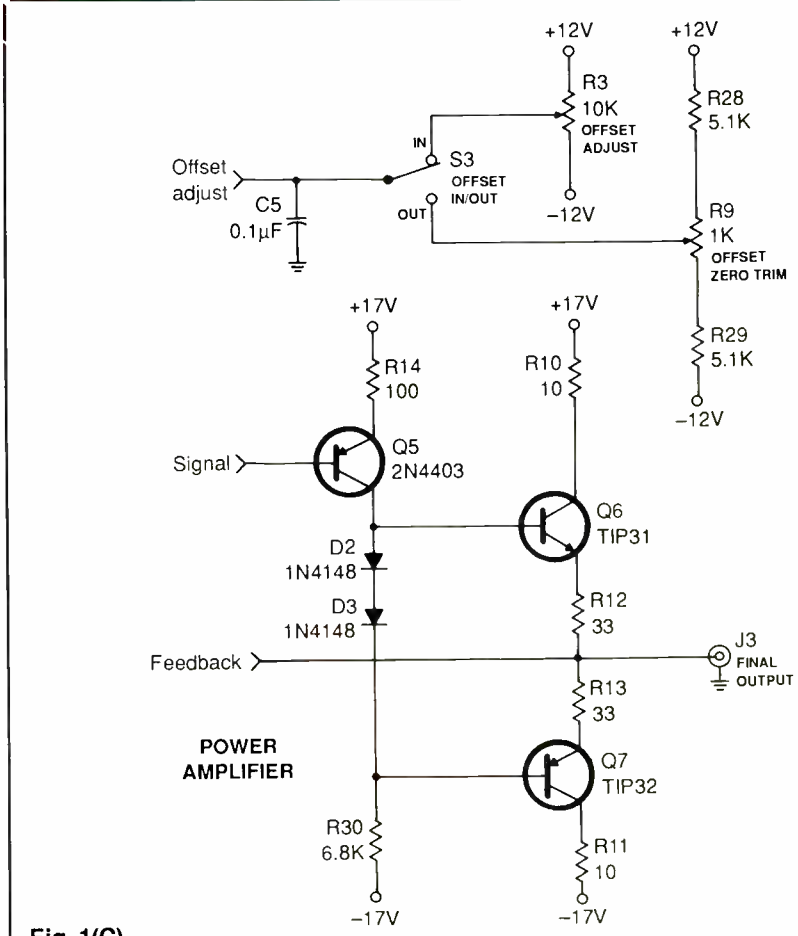


Fig. 1(C).

Construction

The circuitry for the Function Generator is relatively simple and lends itself to just about any method of wiring you wish to use. If you feel ambitious, you can design and fabricate a printed-circuit board on which to mount and wire together the components. Otherwise, use perforated board that has holes on 0.1-inch centers and suitable Wire Wrap or soldering hardware. Whichever way you go, be sure to use sockets for all DIP ICs. Also, if you can obtain it, perforated board that has each hole surrounded by a thin isolated ring of copper will ease securing components in place.

If you use perforated board, begin construction by laying out the circuit in a logical manner, with an eye toward maintaining physical isolation between the input and output circuits. Test fit the components (use the sockets—not the ICs themselves—in the IC locations) to determine ex-

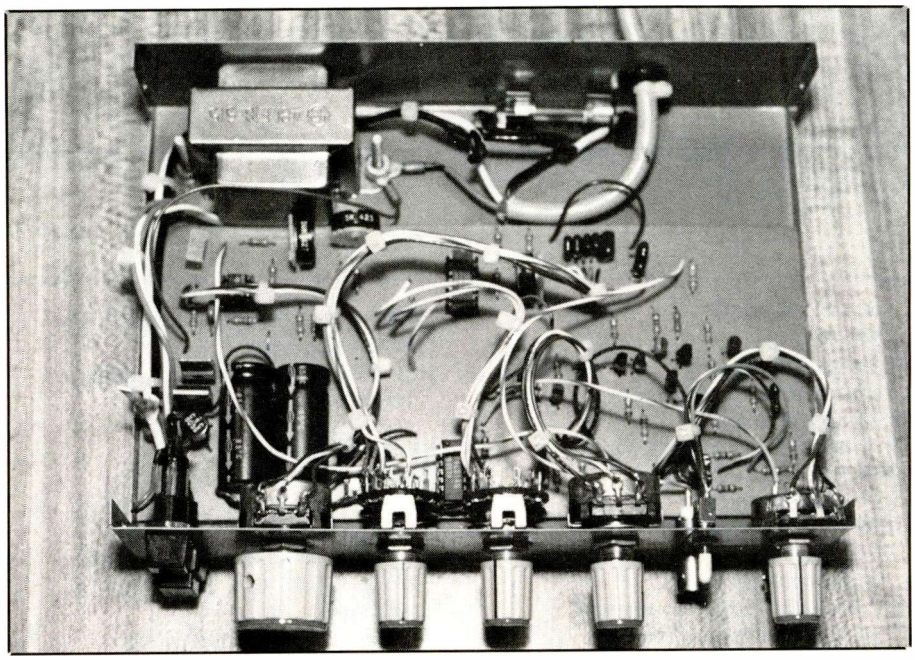


Fig. 2. Interior view of author's prototype shows details for mounting power transformer and fuse holder and how green conductor of ac line cord and ground lead from circuit-board assembly connect to enclosure ground via transformer mounting hardware.

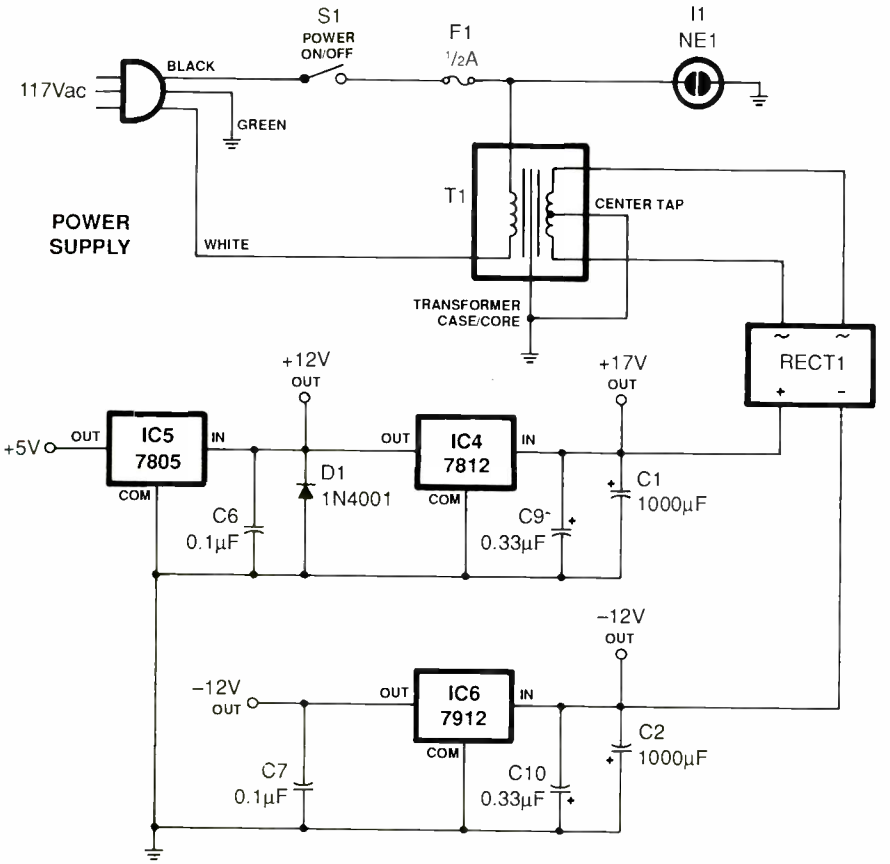


Fig. 1(D).

actly how the layout is to appear. The layout for the prototype project that appears in the lead photo is shown in the Fig. 2 interior-view shot. Notice here that all switches, all but two rotary controls, the jacks, the power transformer, fuse block and power transformer mount off the board. A fairly large enclosure was used for the prototype; so it wasn't necessary to minimize real estate.

Once you know how you want the components to lay out on the board, mount the IC sockets in their selected locations. If your board has copper rings around each hole, tack-solder the four corner socket pins into place. Use solder sparingly if you're using Wire Wrap hardware. Do *not* plug the ICs into the sockets until you've conducted preliminary voltage tests and are certain you have correctly wired the circuit.

When you're ready to wire the circuitry, photocopy all sections of Fig. 1. Then begin wiring the circuit board. As you make each conductor run, trace the appropriate conductor on the schematic. Whenever you reach a point where a connection must be made to an off-the-board component, terminate it in a solder post to which a wire can be connected and soldered after the circuit board is mounted in place.

After wiring the circuit board, carefully go over your wiring to make sure it's correct. If you made any soldered connections, inspect each. If you missed soldering a connection, solder it now. If a connection is suspicious, reflow the solder on it and add solder if needed. Finally, if you locate solder bridges, especially between the closely spaced pins of the IC sockets, clear them away with a vacuum-type desoldering tool or desoldering braid.

Select an all-metal enclosure for your Function Generator. You can use an "instrument" enclosure like the one shown in the lead photo. If you can't find such an enclosure, any other metal project box that can accommodate the circuit board and power transformer on its bottom panel and has sufficient room on its front panel on which to mount the power indicator, controls, switches and jacks will do.

Machine the enclosure as needed. Drill mounting holes for the power indicator, controls, switches and jacks through the front panel; holes through the floor panel for mounting the circuit-board assembly, fuse holder and power transformer; and an entry hole for the ac line cord through the rear panel. When you're done, deburr all holes to remove sharp edges.

Temporarily mount the rotary switches in their respective holes in the front panel. Place pointer-type knobs on their shafts. Adjust switch positioning for symmetrical sweeps, and use a soft lead pencil to mark the pointer location on the panel in each position. When you're done, remove the switches. Then use a dry-transfer lettering kit to label the panel with appropriate legends for all switches and controls. A typical lettering scheme is shown in the lead photo.

Spray two or three light coats of clear acrylic over the entire front panel to protect the legends from scratches while the project is in use. Allow each coat to dry before spraying on the next.

When the acrylic spray has completely dried, mount the circuit-board assembly to the floor of the enclosure using ½" spacers and suitable machine hardware. Then mount the power transformer and fuse holder, also to the floor panel, and the various items that go on the front panel.

Orient the project as shown in Fig. 3 to give you easy access to the lugs on the controls, switches and jacks. Note that the lugs of the controls, switches and jacks are all readily accessible. Using the photocopied schematic, crimp and solder the free ends of the wires coming from the circuit-board assembly to the appropriate lugs of the front-panel-mounted components.

Line the entry hole for the ac power cord with a rubber grommet. Pass the unfinished end of the cord through the grommet and secure a large plastic cable tie to it about 6" from the

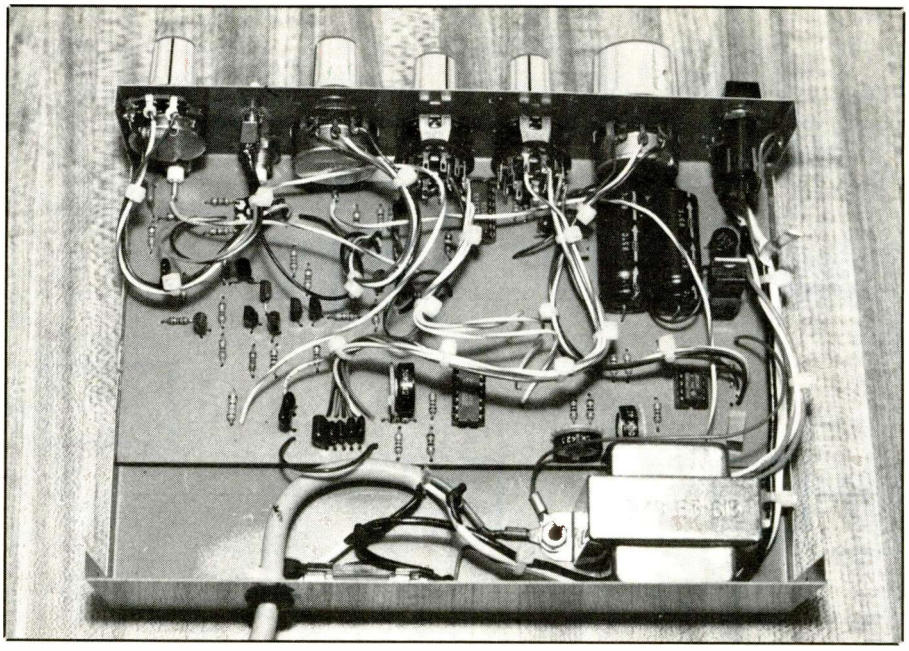


Fig. 3. This interior view shows how lugs of all front-panel-mounted switches, controls and jacks are easily accessible for connection to circuit-board assembly via hookup wires.

unfinished end inside the enclosure. Use the cable tie as a strain relief for the line cord.

Strip ⅜ inch of insulation from all three conductors. Tightly twist together the exposed fine wires in each conductor and sparingly tin with solder. Crimp and solder a spade or ring lug to the green-insulated conductor and another to the ground wire coming from the circuit-board assembly. Make the connection to chassis ground with the machine hardware that secures the near tab of the power transformer to the floor panel. Place a lockwasher on the screw, follow with the two lugs and another lockwasher and, finally, the nut.

Finish wiring the project according to the schematic diagram. Use heat-shrinkable tubing over the connections in the primary circuit of the power transformer.

Checkout & Adjustment

With no ICs plugged into the sockets on the circuit board, plug the line cord into an ac outlet. Clip the common lead of a dc voltmeter or multimeter set to the dc-volts function to the grounding hardware of the power transformer.

Setting the POWER switch to "on" and touching the "hot" probe of the meter to pin 8 of the *IC1* socket and pin 6 of the *IC2* socket should yield a reading of +12 volts. Similarly, touching the "hot" probe to pin 4 of the *IC1* socket and pin 11 of the *IC2* socket should yield a reading of −12 volts. The reading obtained when you touch the "hot" probe to pin 14 of the *IC3* socket should be +5 volts. Next, touching the "hot" probe to the collectors of *Q1* should yield a reading of +17 volts.

If you fail to obtain the proper reading at any given point, immediately power down your Function Generator and troubleshoot it to determine where the problem exists.

When you're certain you've properly wired the project, remove power from it and allow the charges to bleed off the electrolytic capacitors in the power supply. Then plug *IC1* and *IC3* into their respective sockets. Make sure each is properly oriented and that no pins overhang the sockets or fold under between ICs and sockets. Do *not* plug the 8038 into the *IC2* socket just yet.

Power up the Function Generator and set the OFFSET switch to the OUT position. Measure the dc voltage from the "signal" contact of OUTPUT jack *J3* to ground. If the reading isn't 0 volt, adjust trimmer control *R9* on the circuit board so that it is.

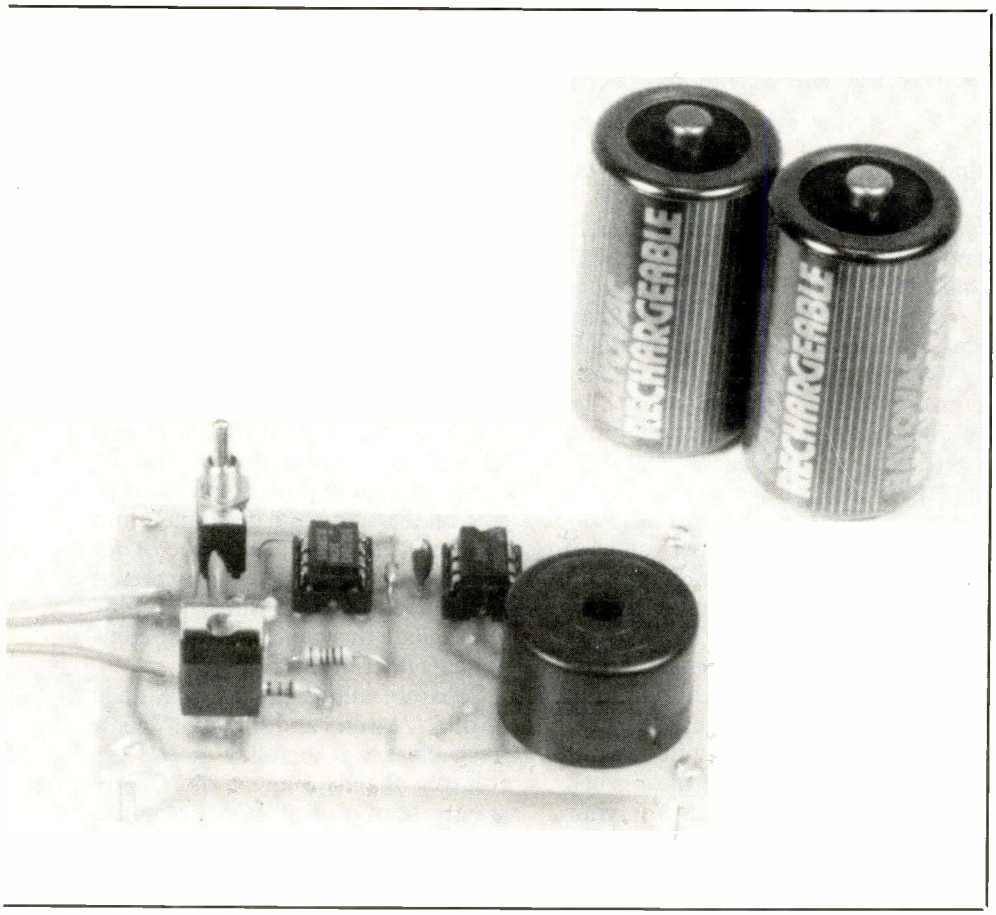
(Continued on page 86)

Low-Battery Alarm with Automatic Load Disconnect

Flashes a LED or sounds an alert when battery voltage drops below a predetermined level and, optionally, disconnects the load if no action is taken

Battery-powered devices free you from relying on power from an ac wall socket and, thus, permit portability. Of course, the tradeoff for the convenience of using battery power is that all batteries eventually run down and require replacement or recharging—usually at a very inconvenient time. The Low-Battery Alarm described here can be built into a portable device, where it flashes or beeps to alert you when battery voltage has dropped to a specified level. Forearmed by the alarm, you can change or recharge batteries at your leisure instead of being stranded without power at an inconvenient time.

The Low-Battery Alarm has a second function built into it that goes beyond simply flashing or sounding an alert. If you ignore the warning and battery potential drops to a second (still-lower) voltage, any circuits powered by the battery are automatically disconnected from the power source. Power is restored only when the voltage returns to a safe level for operation of the device. The automatic-disconnect feature is optional. If you include it, a switch allows you to override the disconnect function and restore power to the load even if battery voltage is low.



You can build the Low-Battery Alarm into your projects or add it to commercial products you own. Any battery-powered device that operates on 3 to 16 volts and draws up to 1 ampere is a candidate for the Alarm, as are devices with battery back-up. For example, if you have a clock or other device that contains a back-up battery that takes over when power fails, adding a low-battery alarm alerts you when it is time to change the battery to ensure that back-up power will be available when needed. Also, in computers that have small batteries that allow them to save important setup data when powered down, the Low-Battery Alarm will let you know when the internal one needs replacement. (Keep in mind, though, that adding circuitry to a commercial product may void its warranty.)

Another application for a low-battery alarm is to provide protection from damage due to over-discharging for rechargeable batteries. For longest life, nickel-cadmium (Ni-Cd) batteries should be discharged to about 1 volt per cell, but no further, on each discharge cycle. Lead-acid batteries may also be damaged if discharged too deeply. Low-battery warning and automatic disconnect

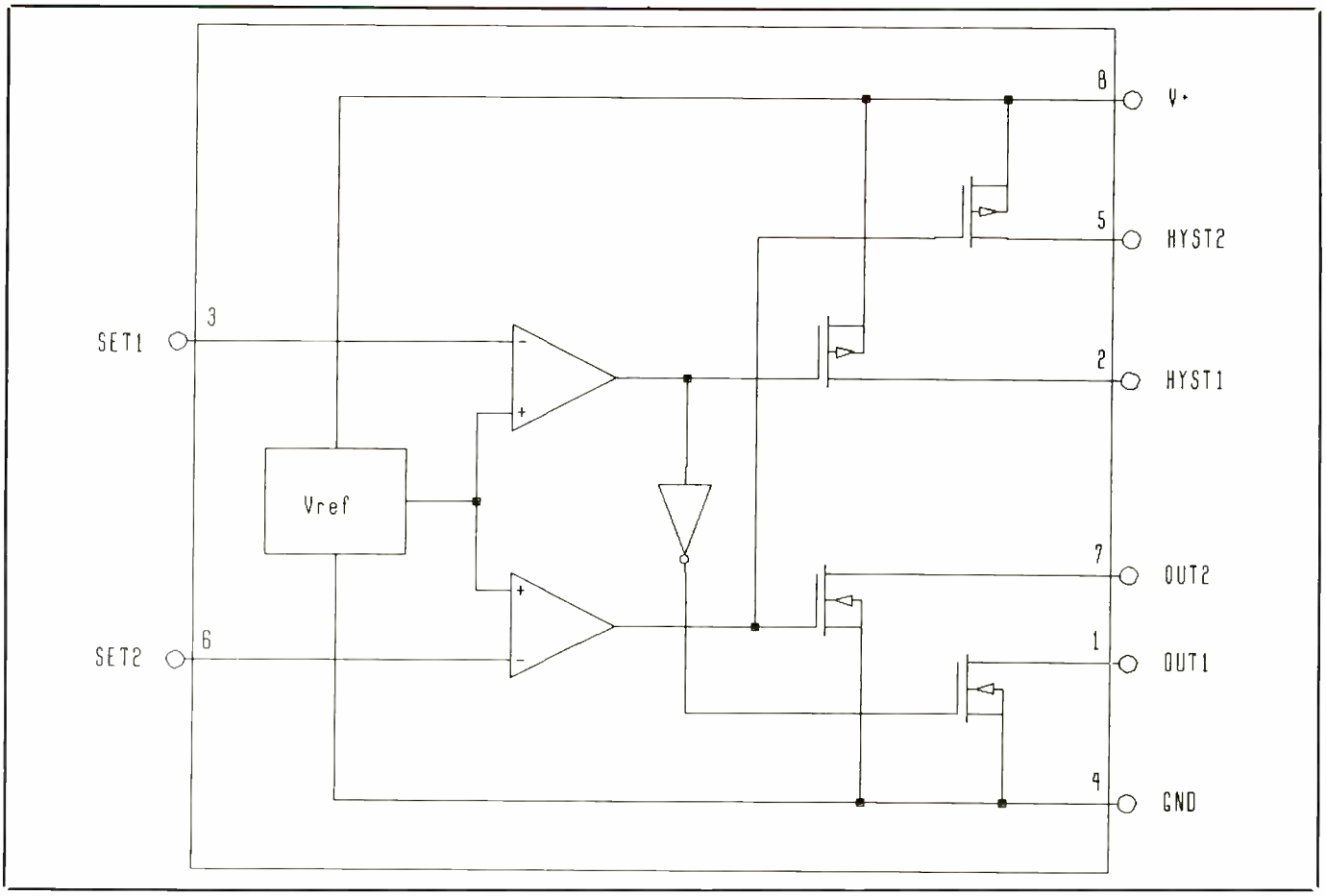


Fig. 1. The ICL7665 micro-power over/under voltage detector contains a voltage reference and two comparators. Output *OUT1* switches on when *SET1* is greater than Vref, and *OUT2* switches on when *SET2* is less than Vref.

lets you cycle fully any rechargeable batteries you have without risk of damaging them.

About the Circuit

The circuitry for the Low-Battery Alarm uses a special-purpose ICL7665 CMOS over/under-voltage detector. The Parts List gives one source for the IC, but other suppliers may carry it as well. Figure 1 shows that the IC contains a voltage reference, two comparators and outputs that are driven by open-drain MOS transistors.

You could build a circuit similar to the one shown in Fig. 1 using IC comparators and discrete components, but the ICL7665 has the advantages of compact size (an eight-pin DIP) and minuscule current consumption of 3 microamperes on average.

One half of the IC operates as an over-voltage detector, the other as an under-voltage detector: OUT1 switches on when the SET1 voltage is greater than Vref, and OUT2 switches on when the SET2 voltage is less than Vref. Connecting resistors to pins 2, 3, 5 and 6 allows you to program OUT1 and OUT2 to turn on and off at desired levels of V+. The outputs can sink up to 20 milliamperes of current.

Vref is a stable bandgap-type reference voltage. According to the ICL8665 data sheet, the temperature coefficient of Vref is 200 ppm/°C (parts per million per degree Centigrade). This means that Vref will vary at most just 0.2 millivolt per volt with each degree change in temperature.

From one IC to another, however, the voltages at which OUT1 and OUT2 switch may vary between 1.15 and 1.45 volts. For applications that switch at precise voltages, you will want to measure the switching voltages of your IC and use these when calculating resistor values for your circuit. (More about this later.) Another alternative is to use the "A" version of the IC, which has tighter specifications. One-percent-tolerance resistors are also recommended for best results in critical applications.

The complete schematic diagram for the Low-Battery Alarm is shown in Fig. 2. Battery *B1* is any dc supply that delivers 3 volts to 16 volts. LOAD is any circuit powered by *B1* and drawing up to 1 ampere of current.

The values of *R1* through *R5* and *R8* will vary, depending on the desired voltages at which you want to turn on the alarm and disconnect and reconnect the load. The value of *R9* depends on the maximum expected load current. We will show you how to calculate the values for these components later in this article.

Separate voltage dividers are made up of *R1*/*R2*/*R3* and *R4*/*R5*. When a fresh battery is installed at *B1*, the voltages at pins 3 and 6 of *IC1* are greater than Vref of *IC1*. So, pin 1 switches on and pin 7 switches off.

When pin 1 is on, base current flows through *Q1*, switching on this

PARTS LIST

Semiconductors
IC1—ICL7665 over/under-voltage detector
IC2—TLC555 or similar low-power CMOS 555 timer
LED1—Red light-emitting diode (see text)
Q1—TIP42 or similar pnp silicon transistor in TO-220 case

Capacitors (25 WVDC)
C1,C3—0.1ceramic disc
C2—1.0-μF tantalum electrolytic

Resistors (¼-watt)
R1 thru R5,R8,R9—See text
R6-1 megohm (5% tolerance)
R7—100,000 ohms (5% tolerance)

Miscellaneous
BZ1—Piezoelectric buzzer (Radio Shack -273-065 or equivalent—see text)
S1—Spst pc-mount toggle switch
Printed-circuit board or perforated board with holes on 0.1-inch centers and suitable Wire Wrap or soldering hardware; IC sockets; machine hardware; hookup wire; solder; etc.

Note: The ICL7665 over/under-voltage detector chip is available from Digi-Key, 701 Brooks Ave. S., P.O. Box 677, Thief River Falls, MN 56701-0677 (tel.: 1-800-344-4539)

transistor and allowing LOAD to receive power from *B1* through *Q1*. Since *Q1* is driven into saturation, its collector-to-emitter voltage drop is small, though it may be as great as a few tenths of a volt at higher load currents.

Over time, as *B1* discharges, its voltage and the voltages across *R3* and *R5* gradually drop. When the potential at the terminals of *B1* drops to the predetermined alarm level, the voltage on pin 6 of *IC1* equals V_{ref}, which causes pin 7 to turn on, providing a path to ground for *IC2*.

CMOS low-power timer *IC2* is configured as an oscillator. Its output at pin 3 drives either a piezoelectric buzzer (*BZ1*) or visual indicator (*LED1*), depending on whether you want an audible or visible alarm. When pin 3 of *IC2* is low, *LED1* or *BZ1* is on. The values of *R6*, *R7* and *C1* are chosen so that the alarm flashes or beeps briefly, at a rate of about once per second. This gives a noticeable, warning without consuming large amounts of power.

Resistor *R8* limits current through *LED1*. Its value is calculated so that a maximum of 20 milliamperes flows when *LED1* is on.

If the warning is ignored and voltage across *B1* continues to drop to a point where the battery potential reaches the predetermined load shutoff voltage, the potential on pin 3 of *IC1* equals V_{ref} and pin 1 switches off. This cuts off *Q1* base current and removes power from the LOAD. Since *IC2* also receives power through *Q1*, the alarm also shuts off at this point.

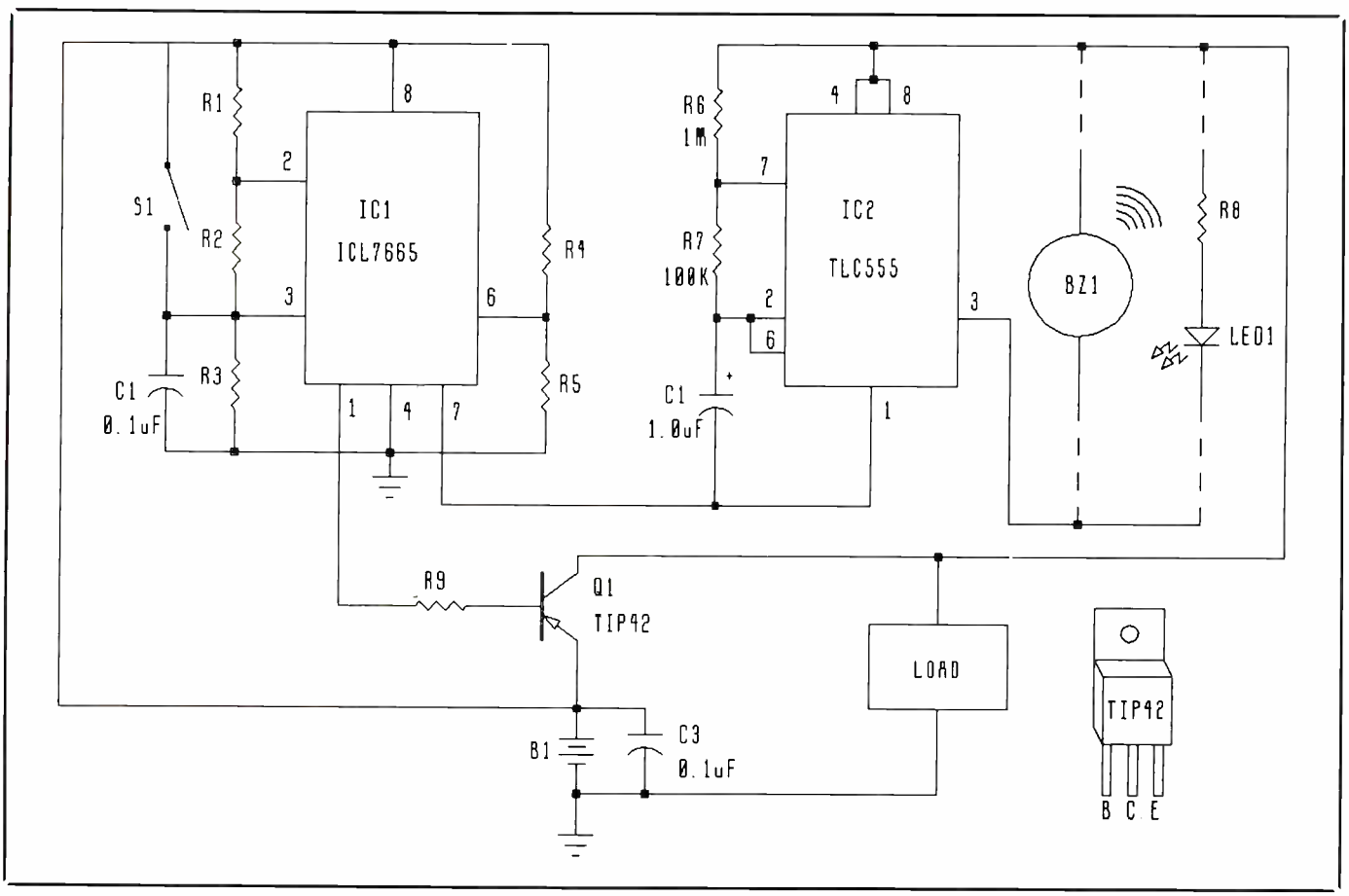


Fig. 2. Complete schematic diagram of the Low-Battery Alarm with circuitry automatic load disconnect.

When pin 1 switches off, *IC1* also removes *R1* from the circuit by providing a low-resistance connection from pin 2 to pin 8. Since *R1* no longer has an effect, the potential across *B1* must rise to a new, higher voltage before the potential on pin 3 equals V_{ref} and pin 1 switches on again to restore power to the load. In this way, the load-control circuit is prevented from chattering on and off when *B1* is at the load-disconnect voltage.

Resistor *R9* limits base current to *Q2*. The value of *R9* value must be chosen to minimize current consumption of the circuit, while still powering the LOAD effectively.

Closing *S1* allows you to override the load-disconnect circuit in case you want to power the LOAD in spite of weak batteries. When the circuit is powered up, if voltage across *B1* is not quite great enough to cause pin 1 of *IC1* to switch on, momentarily closing *S1* switches on pin 1 and power the LOAD.

Capacitor *C1* slows the response of the load shut-off circuit to prevent the circuit from responding to small "glitches" in the supply. For a fast response, you can eliminate *C1*. Capacitor *C3* provides power-supply decoupling for *B1*.

Customizing the Circuit

Several equations allow you to choose resistor values to fit your specific application. For best results, measure the switching voltages of SET1 and SET2 for each ICL7665 IC you use and use these values in the equations. Shown in Fig. 3 is a circuit for making these measurements. Connect a battery or other dc supply that has a voltage close to that of the battery you will be using in your circuit from pin 8 to pin 4 of the ICL7665. Then connect potentiometers and resistors as shown.

Connect the + probe lead of a dc voltmeter or multimeter set to the dc-volts function to pin 1 and the − lead to pin 4 of the ICL7665. Set the wiper of the potentiometer connected to pin 3 until pin 1 just switches from V+ to 0 volt. With this potentiometer set to this position, measure the voltage from pin 3 to pin 4 of the ICL7665. This is the value you should substitute for V_{S1} in the following equations.

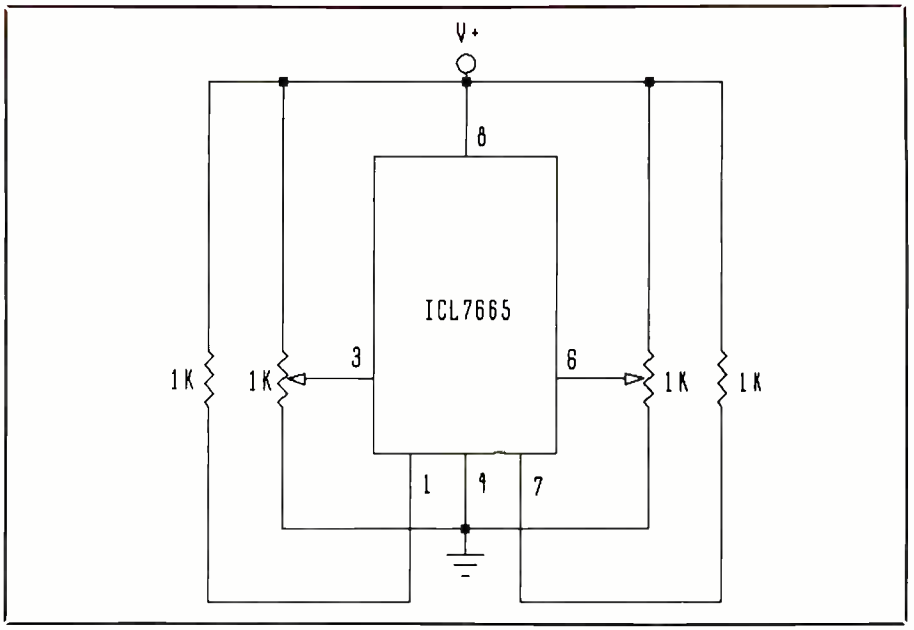


Fig. 3. To measure the switching voltages at pins 3 and 6 of a specific IC, connect the IC as shown. Adjust the potentiometer connected to pin 3 until the signal on pin 1 just goes low, and then adjust potentiometer connected to pin 6 until the signal on pin 7 just goes low.

To measure the switching voltage of SET2, move the + probe of the meter to pin 7 and adjust the potentiometer connected to pin 6 of the ICL7665 until pin 7 just switches from V+ to 0 volt. With this potentiometer set to this position, measure the voltage from pin 6 to pin 4. This is your V_{S2} in the following equations.

To illustrate how to make the calculations, we'll assume the following:

B1: four Ni-Cd cells in series
V_{S1}, V_{S2}: 1.3 volts
AOv (alarm turn-on voltage): 4.4 volts (1.1 volts per cell)
LFv (load shut-off voltage): 4 volts (1 volt per cell)
LNv (load reconnect voltage): 5 volts (1.25 volts per cell)
I_{max} (maximum expected load current): 0.5 ampere

Values for *R1* through *R5*, *R8* and *R9* are chosen as follows:

(1) Select a value for *R5*. The exact value is not critical, but at least 100,000 ohms is recommended for *R1* through *R5* to minimize current consumption of the circuit. In our example, we will use a 100,000-ohm 1%-tolerance resistor for *R5*.

(2) Find the value of *R4* by substituting V_{S2} and the desired ANv in the equation: $R4 = [R5(ANv)/V_{S2}] R5$.

With V_{S2} = 1.3 and ANv = 4.4, *R5* rounds off to 238,000 ohms. The closest 1%-tolerance standard resistor value to this is 237,000 ohms.

(3) If you plan to include *LED1*, calculate the value of *R8* by substitution in the equation: R8 = (ANv − 1.6)/0.02. In this equation, 1.6 represents the voltage drop across *LED1* and 0.02 is the 20 milliamperes that flows through *LED1* when the voltage of *B1* equals ANv. Because the value of *R8* is not super-critical, a 150-ohm 5%-tolerance resistor will serve.

(4) As in step 1, select a value for *R3* (at least 100,000 ohms). We will set *R3* to a value of200,000 ohms at 1% tolerance.

(5) Find the value of *R2* by substituting V_{S1} and the desired LFv using the equation: $R2 = [(R3 \times LFv)/V_{S1}] - R3$. With R3 = 200,000, V_{S1} = 1.3 and LFv = 4, the value of *R2* rounds off to 415,000 ohms. The closest 1%-tolerance value to this is 412,000 ohms.

(6) Find the value of *R1* by substituting *R2*, *R3*, V_{S1} and the desired LNv in the equation: $R1 = [(LNv \times R3)/V_{S1}] - (R2 + R3)$. With V_{S1} = 1.3, *R3* = 200,000 ohms, *R2* = 412,000 ohms and LNv = 5, the value of *R1* rounds off to 157,000 ohms.

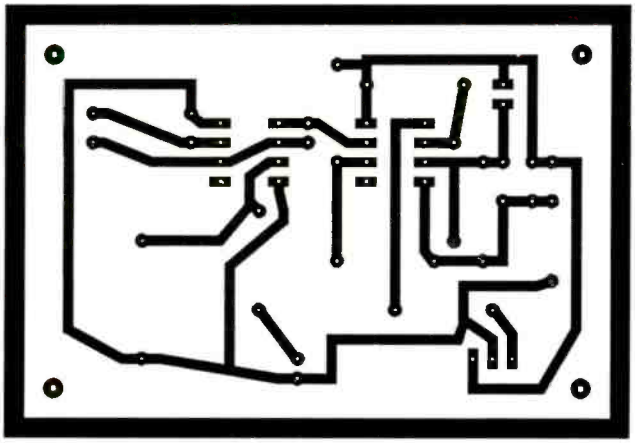


Fig. 4. The actual-size etching-and-drilling guide for the printed-circuit board for the Low-Battery Alarm.

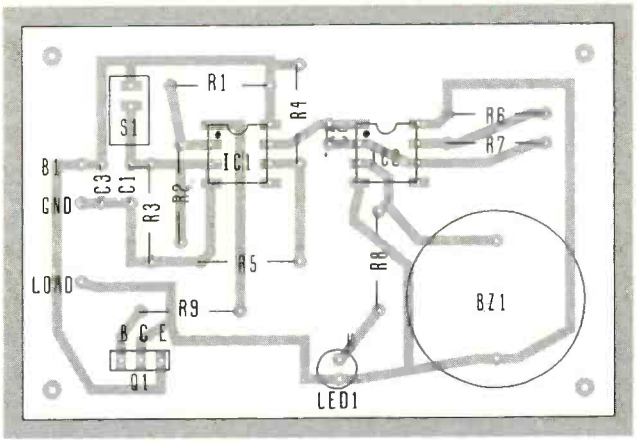


Fig. 5. The wiring diagram for the pc board.

The closest standard value to this is 158,000 ohms.

(7) Finally, find the value of *R9* by substituting in the equation: R9 = [(LFv − 0.6) × 50]/Imax, where 50 represents minimum current gain expected at *Q1* and 0.6 is the base-emitter voltage drop of *Q1*. By selecting the value of *R9* with this equation, you minimize base current of *Q1* while allowing *Q1* to provide sufficient current to power the load.

If Imax = 0.5 and LFv = 4, *R9* = 340 ohms, and a 330-ohm resistor at 5% tolerance will serve.

You can calculate resistor values for any ANv, LNv and LFv between 3 and 16 volts by following the above steps and substituting desired values in the equations.

In the Fig. 2 circuit, the alarm circuit is a simple level detector. The alarm is on when the voltage across *B1* is greater than ANv and off when the *B1* voltage is less than ANv. If you want the alarm to remain on once it is triggered, even if voltage across *B1* rises, you can add a resistor in series with *R4* and pin 8 of *IC1* and connect the junction between these resistors to pin 5. This results in a three-resistor divider like that of *R1/R2/R3*. The added resistor raises the alarm turn-off voltage in the same way *R1* affects LNv.

Battery Types

The ANv, LNv and LFv voltages to use depend on the number and type of batteries used, since different composition batteries have different discharge characteristics. Normally, you will choose resistor values so that the Alarm sounds or lights its LED well before it disconnects the load, to give you plenty of time to change or recharge batteries. You can experiment to determine the values that work best for a specific application, but here are some general guidelines.

Each Ni-Cd cell generally holds a steady 1.2 volts as it discharges. This voltage drops rapidly only when most of the cell capacity has been consumed. For Ni-Cd cells, recommended circuit voltages are: ANv = 1.1 volts per cell, LFv = 1 volt per cell and LNv = 1.25 volts per cell.

In contrast, the voltage on lead-acid batteries drops steadily as these cells discharge. To prolong the life of a typical deep-cycle lead-acid cell, recharge the cell or battery when 80% of its capacity has been exhausted. The voltage at which this occurs, however, varies according to the discharge current of the battery or cell.

For discharge rates of C/10 (1/10 of the ampere-hour rating of the cell), set ANv to 2 volts per cell, LFv to 1.9 volts per cell and LNv to 2.2 volts per cell. Shift the values slightly lower for higher discharge currents and slightly higher for smaller discharge currents.

For alkaline and carbon-zinc cells, an ANv of 1.2 should give plenty of low-battery notice before battery voltage drops sharply.

The output of lithium cells varies from 2.6 to 3.6 volts, depending on cell type. Like Ni-Cd cells, lithium cells have a flat discharge curve with a sharp drop-off when cell capacity is low. For lithium cells, set ANv to about 90% of specified cell voltage.

Since alkaline, carbon-zinc and lithium cells are not rechargeable, over-discharging is not a concern, but you may want to include the load-disconnect circuit to prevent your load from attempting to operate on less than its recommended supply voltage. If you do not need the load-disconnect circuit, eliminate *R1*, *R2*, *R3*, *R9*, *Q1*, *C1* and *S1*, and connect jumper wires where *R3* would connect and between the points where the emitter and collector of *Q1* would connect into the circuit.

A final consideration is temperature. The voltage of most batteries drops slightly as temperature drops below room ambient. If your circuit will be used at low temperatures, you may want to slightly lower your alarm and shutoff voltages to take this into account.

Construction

There is nothing critical about the construction of the Low-Battery Alarm. Therefore, you can use just about any construction technique that suits you, including printed-circuit board, point-to-point soldering and Wire Wrap. One admonition, though: Do *not* use small-diameter Wire Wrap wire for connections between LOAD, *Q1* and *B1* unless load current is less than 100 milliamperes. Shown in Fig. 4 is the actual-size etching-and-drilling guide for the pc board for this project. In Fig. 5 is

shown the wiring guide for this board. If you use point-to-point wiring, use Fig. 5 as a rough guide to component placement.

Since the Low-Battery Alarm is meant to be an add-on to another circuit (LOAD and its battery supply), how and where you mount the circuit-board assembly will vary. A separate enclosure for the Low-Battery Alarm is not necessary but can be used if desired. If used, *LED1* can be mounted on the circuit board. Alternatively, you can mount it off the board for better visibility (on the enclosure of the project or product in which the project is installed, for example) and connect it to the circuit board with hookup wire.

Decide whether you want audible alarm *BZ1* or visual indicator *LED1* and *R8*, and use the procedure described above for calculating resistor values for your circuit.

If you are using a pc board, fabricate it using Fig. 4. Then install and solder into place sockets for *IC1* and *IC2* and follow up with the rest of the components.

Use hookup wire to connect *B1* and LOAD to the circuit. Prepare three lengths of wire. (The exact lengths will depend on your circuit and battery supply, how these are arranged in their enclosure, and where the low-battery alarm will mount.) Strip ¼ inch of insulation from each end of the wires and solder one end of each to pads B1, LOAD and GND on the pc board. Then plug *IC1* and *IC2* into their respective sockets.

Checkout & Use

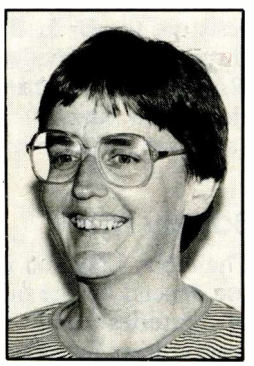
If you have a variable-voltage supply available, you can test your circuit before installing it permanently. To do this, use alligator-clip jumpers to connect your variable supply to the *B1* and GND wires on the pc board and connect your load (or a substitute, such as a LED and current-limiting resistor similar to *R8* and *LED1*), from LOAD to GND on the circuit board.

Adjust the power supply to the desired LMv, and the load should be powered. Slowly adjust the supply voltage downwards, and your alarm should sound or flash when the output voltage of the supply drops to ANv. Continue to adjust downwards, and verify that the load and the alarm switch off at LFv.

If you experience problems, verify that your wiring and component values are correct, using Fig. 2 as a reference.

When all appears to be okay, install your Alarm circuit permanently. Disconnect the normal + battery connection for the LOAD circuit (if any has been wired previously), and solder the free end of your LOAD wire in its place. Solder the free ends of the wires to *B1* and GND to the + and − connections of your *B1* supply.

When wiring is complete, mount the Low-Battery Alarm in the device it will monitor and install the battery. Now when battery voltage drops, your alarm will warn you. And if you ignore the alarm, the load will automatically disconnect until a safe battery voltage returns. ■



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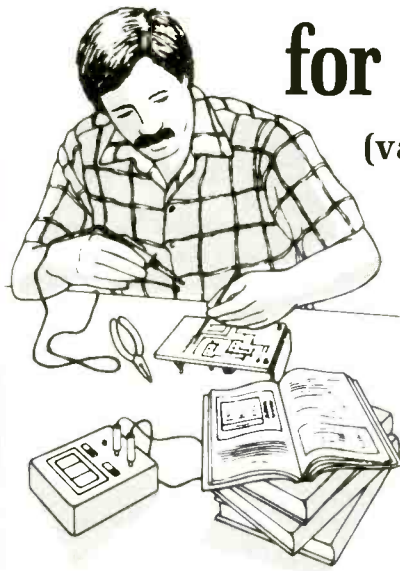

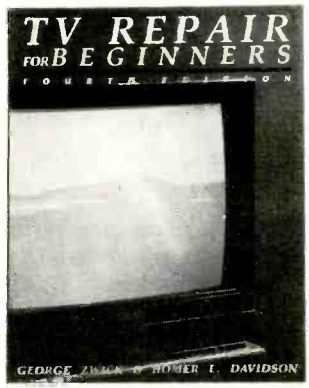

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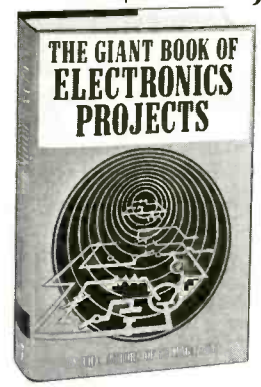

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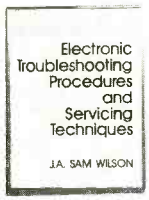

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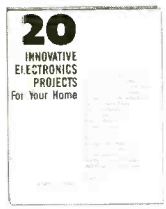

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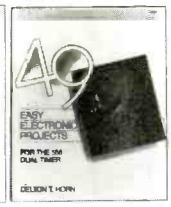

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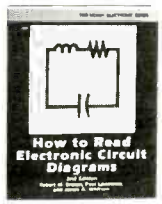

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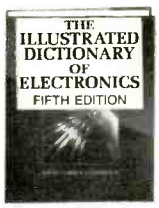

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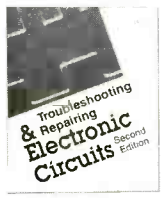

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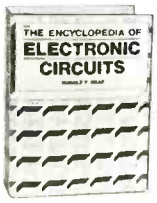

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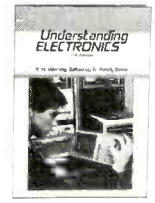

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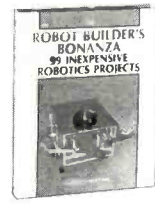

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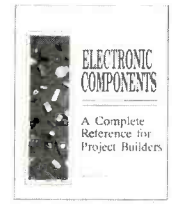

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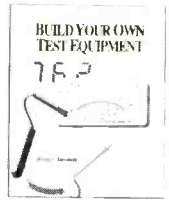

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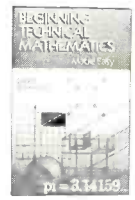

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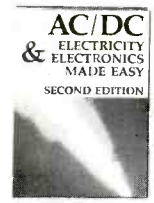

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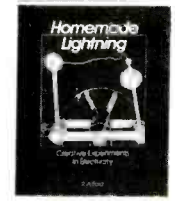

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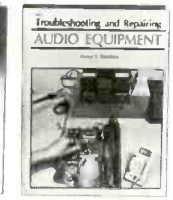

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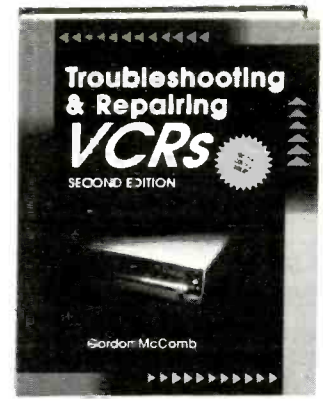

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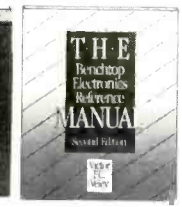

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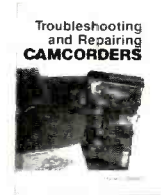

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WInvoice: Time & Billing for Windows

By nature, computers excel at quick manipulation of the tedium of data. This means that they are accurate, or can be, depending on the software that drives them. Accuracy is a quality that's mandatory in all forms of business.

After assigned work is done for a customer, say your customer, an invoice must be sent. The invoice should contain a detailed accounting of time, charges and materials, if any. Large businesses normally have hard and fast (and usually expensive) procedures in place that take care of time and billing. Smaller businesses, too, know the need for accurate billing but can have trouble tracking the right information all the time. If your business is wasting time, losing money or aggravating customers because of poor time and billing, a product named *WInvoice* can help.

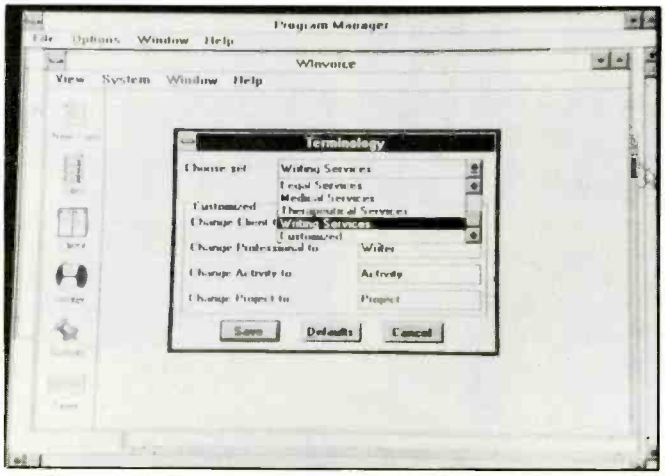
WInvoice is specifically a time tracking and billing software program the runs under Microsoft *Windows* 3.0. It's simple to install, as is generally the case with *Windows* applications, and is surprisingly complete in scope.

During installation, you can customize some aspects of *WInvoice*. One of the customizable items is Terminology. It defines, on a system-wide basis, the kind of language used to refer to customers, professional workers, job activity, and so on. Terminology is important because you have to define your environment before you can build it—which is organization.

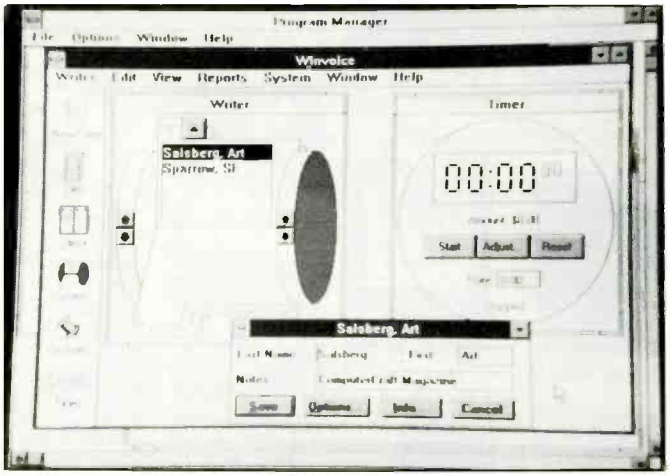
To illustrate, a business that provides medical services might use the terms Patient for customer, Physician for worker, Procedure for work done and Program for assigned project. To a worker who is routinely involved in medical services, the above terminology is self-explanatory. On the other hand, legal services might have terms more like Client, Attorney, Activity and Matter. *WInvoice* has a list of ready-to-use terminology so that you don't have to spend time creating definitions.

The first thing to do with *WInvoice* is add new information to build a database of clients, professionals, activities and projects. If you already have a large client base, it might take a long time to enter all your data into *WInvoice*. But if you want to turn everything over to *WInvoice*, some initial work has to be done. *WInvoice* has some import and export facility.

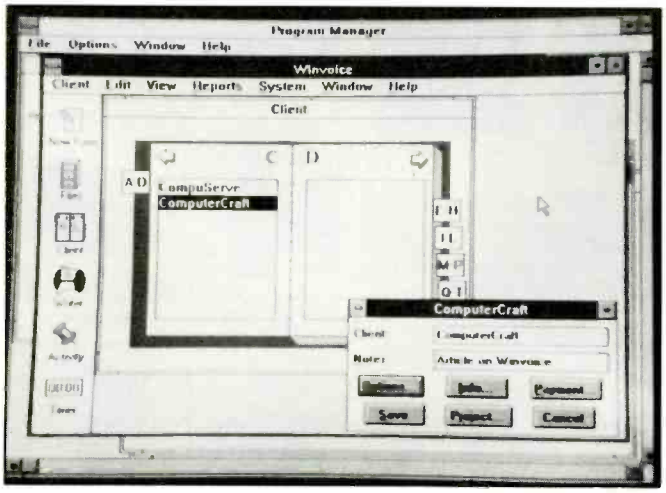
Users of *TimeSlips* can look forward to



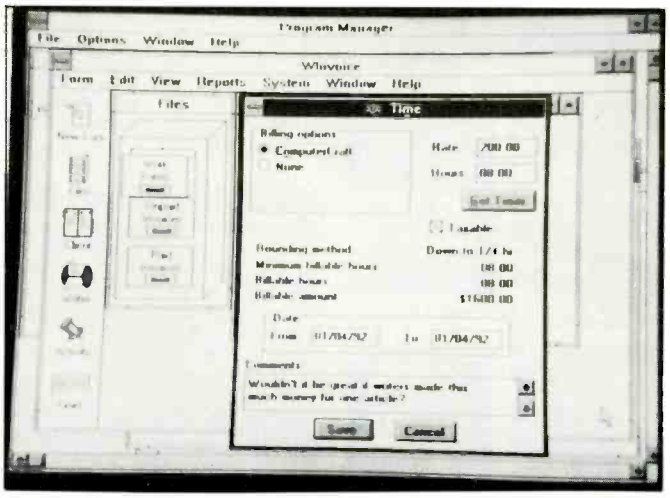
Setting Winvoice terminology.



Handy tools: Rolodex and Timer.



A sparse but important Address Book.



Example of a Time Forum. Actual data shown is imaginary.

a special conversion utility that changes *TimeSlips* data into *WInvoice* data. The utility goes to beta test at the time of this writing and will be available in a future release of the product.

Data from other sources might be indirectly converted through use of a comma-delimited ASCII file. If your present system can save its database in this format, *WInvoice* can read it. The catch with ASCII imports is that the format you create in *WInvoice* must exactly match your ASCII file. Chances are that when trying to move a large client database in this manner, you'll have to do careful planning and then some alert housekeeping before a transfer is perfect.

Another utility feature of *WInvoice* lets users set defaults for client billing. You can specify default rates of payment, minimum billable hours and even the preferred method of rounding used to calculate untidy fractions of hours. Furthermore, certain dollar amounts can be set for other expenses incurred, like tolls, parking, mileage or any charges normally incurred in your kind of work. For example, computer consultants will have charges for long-distance telephone calls and floppy diskettes. A default rate can be set for these. If need be, all defaults can be overridden.

Important Forms

Documentation is also very important in the business world. Therefore, businesses like to have a form for just about everything. *WInvoice* has three different kinds of forms: Time, Expense, Fixed Charge.

Time forms are most common. They take care of normal billing at a certain rate of pay. Expense forms document additional expenses while doing a job. Fixed charge is for a one-time cost of something related to the main job. All these forms are managed by *WInvoice* so that documenting potentially numerous items during long term assignments is made much easier.

Once a job assignment is finished, an invoice is issued. *WInvoice* automates creation of the invoice. The invoice lists all the proper forms with all the correct information and totals. At this point, you can group together certain items to enhance orderliness.

The automated invoice scheme uses a color-coding system to easily identify one client from another. If you don't like the color system, you can opt not to use it. The automatic invoice method is good for quickly coming up with a detailed invoice. But if you want to spend more time on it, or you don't like the automated format, you can customize an invoice to your own preferences. Then before the invoice is finalized, you can check it for accuracy.

WInvoice also handles the unpleasant business of credit memorandums, partial payments, refunds, late fees and write-offs. Credit memorandums can be viewed as negative invoices. When a *WInvoice* invoice is finalized, it can't be changed or deleted. So you must be absolutely certain of accuracy before finalizing it. When you need to reverse a finalized invoice, a credit memo effectively cancels the invoice and keeps track of what it's doing.

Partial payments are common in the business world and exist often as standard parts of business contracts. *WInvoice* tracks these, too. You can include type of payment made, along with check or credit-card numbers.

Reports

Organizing data in various ways helps to get a better picture of what you and your business are doing. *WInvoice* reports both paid and unpaid invoices and other items. One report is the Age Trial Balance report, which identifies all transactions during the period based on the invoice itself. This is called aging. Unpaid invoices are aged according to due date.

A Cash Receipts report lists all payments, early payment discounts and write-offs. A Client Analysis report summarizes period-to-date and year-to-date information for each client. You can select specific clients, all clients or a group of clients.

As you can see, there are reports for various usage, and they can become quite detailed. The right report at the right time is worth its weight in bank notes. *WInvoice* gives you wide latitude on reporting.

A few more *WInvoice* features need mentioning. Its Address Book stores a lot of information about your clients. Its Rolodex stores information about workers in your company. An especially handy extra feature is the Timer, which is simply a *Windows*-based stopwatch you can use to accurately track time-sensitive activities. Using the clock wisely will ensure precise billing so that you can conscientiously render fair work for cost. The Timer is started, stopped and reset at the click of a mouse button.

In traditional *Windows* fashion, all the various *WInvoice* functions run in windows that can be sized, enabling you to jump from one task to another. So you can jump from Work Forms to the Timer to Expense Form without trouble.

All this *Windows* graphical magic especially helps when managing a large client base with a large pool of professionals. This is when the Rolodex, Address Book and the Activity List save time. But if you have only a few clients or professionals, you could find yourself clicking up empty pages before finding a lonely name or address. If this prospect bothers you, turn the default icon presentations into straightforward line-by-line listings.

A recent upgrade to *WInvoice* offers more features. Users can now send monthly account statements to clients. If a statement isn't really needed at the time, a simple mentioning of previous balance can be sent instead.

For the professional who has a laser printer, *WInvoice* prints forms in dazzling *Windows* font. If you don't have a laser printer, you can still use whatever fonts your printer will handle—they just won't look as good as when printed on a laser printer. Something like font improvements may seem small to some users, but this kind of improvement shows that Infinity Software is responding to user needs.

Do you run a business? Is your somewhat inept tracking and billing procedure wasting valuable time and effort that could be spent elsewhere? It's easy to let a haphazard billing system get out of control. *WInvoice* helps to tame the ill nature of time and billing. It does so at a price that won't send you into bankruptcy. ■

Fact Box

WInvoice, $279
Infinity Software
5215 N. O'connor, Ste. 200
Irving, TX 75039
Tel.: 214-556-1395; fax: 214-556-1483
Requirements: Microsoft *Windows* 3.0 with 2M of RAM, hard drive and mouse.

Evaluation

Documentation	Good
Graphics	*Windows*-dependent
Learning Curve	Short for computer-literate users with accounting experience
Complexity	*Windows* graphical interface

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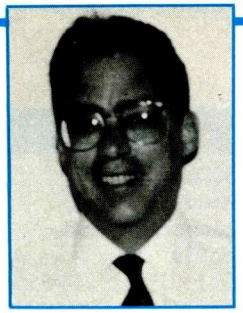


Joseph Desposito

A Sleep-Mode Op Amp; a New A/D Board for the PC/AT; a Fast SCSI Controller; a 14-ns RAM Cache; and a Programmable Multiplexer

Semiconductor companies are always looking for new ways to extend battery power, without trading off performance. This month's first device showcases Motorola's new Sleep-Mode™ that circumvents previous design limitations by allowing the chip to operate fully only when it's needed.

Sleep-Mode Dual Op Amp

Motorola's (EL340, 2100 Elliot Rd., Tempe, AZ 85284) dual Sleep-Mode operational amplifier IC offers two separate modes of operation, resulting in very low standby power operation. In "sleepmode," the MC33102 op amp operates at a very low current drain. Each amplifier automatically changes to "awakemode" when an input signal is applied to the amplifier, causing it to sink or source sufficient load current. The dual Sleep-Mode amplifier uses industry-standard pinouts, and each amplifier has independent sleep-mode capability, with no extra pins or external components required (see Fig. 1).

The MC33102 will find use in a wide range of applications, including consumer products, cordless telephones, portable computers, automobiles, sensors, handheld equipment, cordless appliances, baby monitors, tape recorders and battery-operated test equipment. Key applications will require improved energy efficiency, where the amplifier can operate in a mode that consumes just enough power to detect incoming signals and then shift to a higher-performance mode upon demand.

The MC33102 is the first product to incorporate newly-developed Motorola Sleep-Mode technology, which is also being applied to other ICs typically used in low-power applications.

Other key product features and specifications include: changes from sleepmode to awakemode in 4.0 μs when output current exceeds 160 μA; automatic return to sleepmode when output current drops below threshold; use as a fully functional micro-power amplifier in low-current sleep-mode state; independent Sleep-Mode function for each op amp; no deadband—crossover distortion as low as 1.0 Hz in awakemode; ESD clamps that protect the inputs, increasing reliability without affecting amplifier performance.

This Sleep-Mode device will also be available from Motorola's Military Products Operation. It's fully qualified under Mil-Std-883 for use over the full military temperature range.

The MC33102 is presently available for commercial applications in both eight-pin

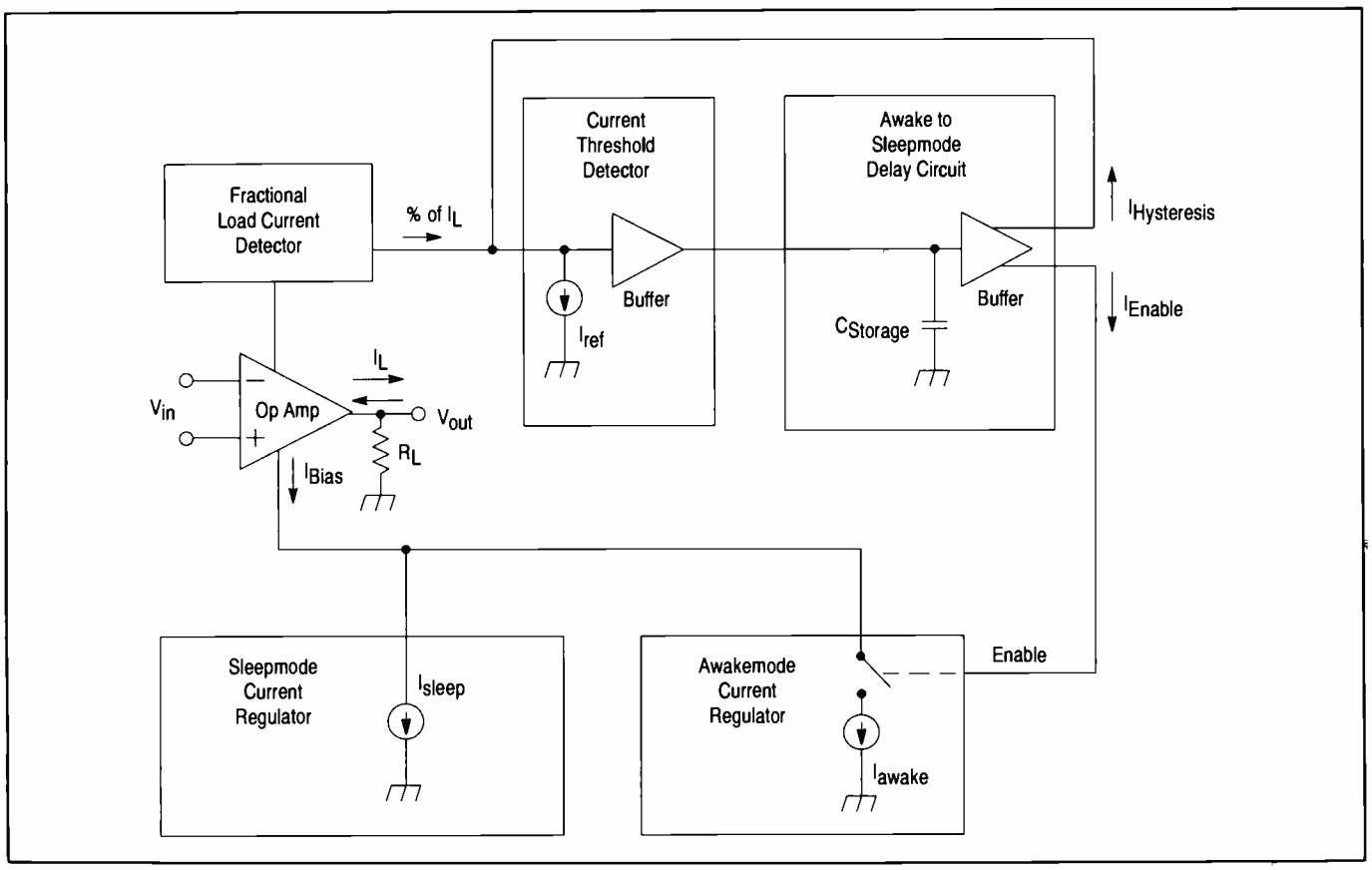


Fig. 1. Motorola's MC33102 Sleep-Mode op amp operates on very low current drain.

plastic DIP and SO-8 surface-mount packages.

Pricing for either package option is $1.60 each in quantities of 10,000 and up.

To gain a better understanding of Motorola's new Sleep-Mode, you need to consider that many operational amplifiers are designed to consume very low drain current. With their fundamental design limitations, they typically have poor frequency response and low output-current drive capability.

In many applications, an amplifier isn't required to drive the output load continuously. In these applications, power is wasted while maintaining the amplifier in a maximum performance state during periods when it would be sufficient to operate the amplifier in a lower power-consuming standby mode. From a system viewpoint, it's more energy efficient to operate in a mode that consumes just enough power to detect incoming signals and subsequently shift to a higher-performance mode on demand.

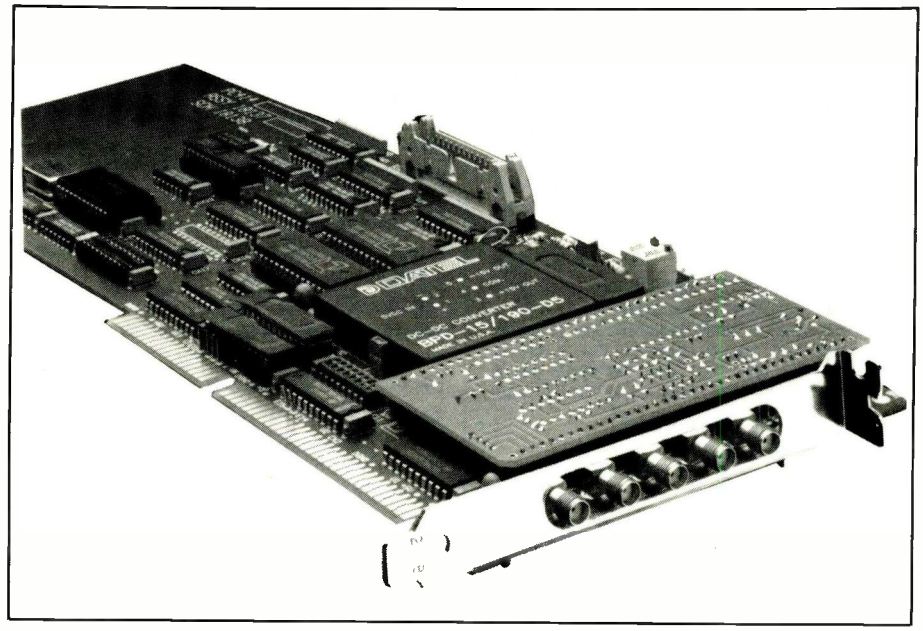
Motorola's Sleep-Mode technology is designed to overcome the low-power-consumption-versus-high-performance dilemma for applications where better frequency response and higher current drive are required only part of the time.

As Motorola's first integrated circuit incorporating this new technology (for which a patent application has been made), the new MC33102 Sleep-Mode dual operational-amplifier IC functions in either of two distinct current/performance states. This device minimizes current consumption in sleepmode state (typically, 45 μA per amplifier) until an input signal is detected that requires the amplifier to source or sink 160 μA or more. Once this condition is detected by the amplifier, it transitions to awakemode within a few microseconds. Each amplifier consumes approximately 750 μA when operating in awakemode, with a $\times$ 10 improvement in bandwidth and slew rate.

When the input signal is removed, the amplifier returns to sleepmode following a delay. An on-chip delay circuit prevents the amplifier from returning to sleepmode at every "zero-crossing" of the output voltage waveform. This delay circuit also eliminates crossover distortion, which is a problem in most conventional low-power amplifiers. Frequencies as low as 1.0 Hz can be processed without the amplifier returning to sleepmode condition.

A/D Board Samples Simultaneous Channels

Many applications need multiple analog channels sampled at exactly the same time. Examples include phased sonar arrays, correlation from multiple receiver channels and de-skewing of simultaneous signals. The Datel (11 Cabot Blvd., Mansfield, MA 02048) PC-414A analog input board satisfies these requirements with four simultaneous sample/hold (SSH) amplifiers multiplexed into a 1.5-MHz 12-bit A/D converter. Board design is optimized for A/D continuous non-stop "streaming" of millions of data points, with no sample loss to PC/AT memory.



Datel's PC-414A analog input board provides four simultaneous sample/hold amplifiers multiplexed into a 1.5-MHz 12-bit A/D converter and is optimized for A/D continuous non-stop streaming of millions of data points with no sample loss to PC/AT memory.

A/D data is passed through an on-board, first-in, first-out (FIFO) 4K memory and then to the PC/AT bus. The board can be installed in IBM-PC/AT, PS-30, EISA and compatible host computers.

The PC-414A's analog input section is designed for low noise and excellent harmonic characteristics to -72 dB THD. FIFOed analog data can be sent to RAM memory, tape, RAM disk or hard disk using DMA or block transfers at greater than 1 MHz speed. A/D output data can also be sent from the FIFO through an on-board parallel port at rates of up to 4 MHz. This port completely offloads the PC/AT bus and can be used as a "front end" to array processors or other vector math systems.

For precise A/D triggering in DSP applications, crystal-stabilized software-programmable on-board counter/timers control the A/D sample rate, number of samples and frame rate. External analog or digital triggers can also be accepted. Analog triggers use an on-board comparator and D/A converter to set a threshold trigger level. The 12-bit D/A converter can also be used as an analog output channel.

The PC-414A is ideal for filling blocks greater than 8M of extended memory without sample loss. In four-channel mode, each input channel may be continuously sampled at 250 kHz. Single channel sampling extends up to 1.5 MHz. Typical applications include long baseline studies in astrophysics and precision high-resolution image scanning.

Optional software includes a windowed setup-and-go program to save data to disk or memory and the *PC-DADiSP* windowed graphics DSP display and math package. A source code library is available. The PC-414 includes a comprehensive user manual with software examples.

The PC-414A uses +5 volts dc at 3.5 amperes from the PC/AT bus. Pricing starts at $1,850 in single quantity. PC-414SET setup software (executables only) costs $95; setup source code with the window library (PC-414SRC) is $395; and graphics DSP-math package (*PC-DADiSP*) is $1,695.

Fast SCSI Controller

NEC Electronics' (401 Ellis St., P.O. Box 7241, Mountain View, CA 94039) μPD72611 is a fast Small Computer System Interface (SCSI) for 32-bit CPU-based systems. It supports a maximum data-transfer rate of 10 M/s over an eight-bit SCSI bus. The product also provides a selectable host bus for support of 32-, 16-, and 8-bit widths.

In addition to the width-selectable host bus and fast data-transfer rate, the μPD72611 also provides an on-chip arbitration sequence control. This allows it to

be used as either a SCSI initiator or a target.

Other features include a 24-bit transfer counter and FIFO for high data throughput. On-chip single-ended SCSI bus drivers and Schmitt-type receivers minimize space and overall system cost. Differential drivers are supported externally.

NEC has reduced the host overhead required for interrupt servicing by incorporating its proprietary "Complex Commands" feature. These compound SCSI commands are issued by the controller and incur only one interrupt to the host throughout the entire process. In addition to Complex Commands, the μPD72611's tag-queuing scheme optimizes file and resource management by allowing the host (or target) to assign individual tags to each SCSI operation.

The μPD72611 was designed specifically for 32-bit CPU applications. Due to its width-selection capability, it can also be used in 8- and 16-bit designs. The microcontroller is EISA compatible and provides necessary features for PCs, voicemail systems and networking applications.

An EISA-style demo board and DOS device drivers are offered by NEC. The support tools are intended to assist engineers in both design and evaluation stages of system development.

The controller is packaged in a 100-pin plastic quad flat pack and is priced at $17.50 each in 10,000-piece quantity.

Fast Cache RAM

Cypress Semiconductor's (3901 N. First St., San Jose, CA 95134) 14-ns 256K BiCMOS cache RAM is customized to attain the fastest available cache memory performance for 486 machines. The synchronous 32K × 9 CY7B173 cache RAM delivers zero-wait-state memory access needed by systems designers to unleash the full performance of 50-MHz, i486-based systems. The CY7B173 integrates a high level of control logic with the cache RAM, allowing designers to eliminate performance bottlenecks and the cost, design-time and board-space penalties of external logic in cache systems.

Specifically, the CY7B173 sweeps the i486 burst counter, address and data registers and synchronous, self-timed write logic all on-chip. On-chip decoding logic simplifies expansion from one bank of four devices (128K bytes of cache) to two banks of four devices (256K bytes of cache) with no performance penalty.

This chip provides caching at 50 MHz through a combination of fast 14-ns access times and a glueless interface to the i486, cache controller and system clock. Separate pins for processor and cache controller address strobes enable the CY7B173 to switch control from the i486 to the cache controller during cache misses. Because the i486 doesn't relinquish control to the cache controller during cache misses, designers using previously available cache RAMs required external logic to accomplish this. By eliminating this multiplexing logic, the CY7B173 enhances system performance.

Cypress also has a 14-ns synchronous BiCMOS TTL cache RAM that supports linear burst sequences. The CY7B174 is designed to support the burst sequences of such CISC processors as the Motorola 68040/30 and Intel 80960CA up to 50-MHz. For RISC processors operating at up to 50 MHz, the CY7B174 delivers the speed to complete a new access each clock cycle.

The CY7B173 and CY7B174 are each priced at $69 in 100-piece quantities.

12-bit DAS With Programmable MUX

Maxim Integrated Products' (120 San Gabriel Dr., Sunnyvale, CA 94086) new MAX180 is a complete 7.5-μs (100-kHz sampling rate) data-acquisition system (DAS) that combines a 1/2 LSB integral nonlinearity (over temperature) 12-bit analog-to-digital converter (ADC), wide-bandwidth (6-MHz) track/hold, 25 ppm/°C voltage reference, fast parallel μP interface and Flex-Mux (Maxim's flexible eight-channel analog multiplexer), all in a single package.

Flex-Mux allows independent programming of each channel for differential or single ended, unipolar + 5-volt or bipolar ± 2.5-volt operation. Maxim's monolithic CMOS design reduces power consumption (110 mW), component count, cost, board space and design time.

For applications requiring signal conditioning, such as programmable-gain amplification or filtering, Maxim's six-channel version of the MAX180, the MAX181, gives access to the Flex-Mux output and the ADC's input.

Track/hold's full-power bandwidth permits undersampling of periodic signals with bandwidths exceeding the ADC's sample rate. The systems offer a reference input supplied by either an internal reference (reducing package count) or an external reference (providing optimum reference selection). Internal reference value and system offset are adjustable to allow nulling the overall system offset and gain errors. The control logic interfaces to either 8- or 16-bit-wide data buses.

The entire system is fully tested and guaranteed for both dc and dynamic applications and operates with + 5- and − 12- to − 15-volt dual supplies.

Both devices are available in 40-pin DIP and 44-pin PLCC packages. Prices start at $17 in 1,000-piece quantities. ■

Ted Needleman

GeoWorks–Windows for the Rest of Us?

If you've been following this column for a while, you know that I've somewhat reluctantly bought into Microsoft's *Windows*. I say reluctantly, because even though I really like using some of the newest applications, many of which are available for operation only under the *Windows* environment, I'm not all that pleased with *Windows* itself.

Introduced with the largest advertising budget—$10-million—ever targeted for a single-product launch, *Windows* 3.0 was supposed to make an MS-DOS-based PC as easy to use as a video game (or a Macintosh). Perhaps it succeeded in this (though I've never found my kids' Nintendo all that easy to play), but the price, in terms of machine resources needed to run *Windows*, is considerable. *Windows* will run on a 286 AT-class machine, though not in enhanced mode. But unless it's zooming along at 16 or 20 MHz, it doesn't run very well or very fast in an AT.

What do you do if you have an older PC, say an XT or an original AT, and want the advantages a graphical environment offers? You could upgrade your system with a new motherboard, or if it's a 286, with one of the new 386SX processor replacements. This will let you run *Windows*, but it will cost a minimum of several hundred dollars—before adding any software.

If it's just the graphical environment you want, and not specific applications like *PageMaker, Excel* and *WordPerfect* for *Windows*, you might consider *GeoWorks Pro*, the newest version of *GeoWorks Ensemble*. Like *Windows, GeoWorks* provides a graphical user interface, called PC/GEOS, that offers WYSIWYG (What You See Is What You Get) equivalence between the output of an application and what's displayed on-screen. It also offers an icon-driven graphical interface that, while not identical to the one in *Windows*, is very easy to use, as well as the same type of accessories offered in *Windows*.

The big difference between the two packages, though, is that *GeoWorks Pro* goes a bit beyond *Windows* in the accessories it offers, such as Borland's *Quattro Pro Special Edition* spreadsheet, and does it while requiring quite a bit less in the way of CPU resources. PC/GEOS runs on just about any MS-DOS PC, even the original 8088-based IBM XT. Of course, it runs much slower on a 4.77-MHz XT than it does on a 33-MHz 486, but it does run on the slower CPU, fast enough to be usable.

In its almost universal applicability to the Intel-based PC line, *GeoWorks*' PC/GEOS is more like the Mac's original operating system (consisting of System and Finder) than *Windows*. Until Apple released the last version, called System 7, the Mac's System and Finder ran on any Mac, from the earliest 128K machine to the most recent Quadra tower. The multi-tasking version, called MultiFinder, required more memory than the original Mac offered, as does System 7.

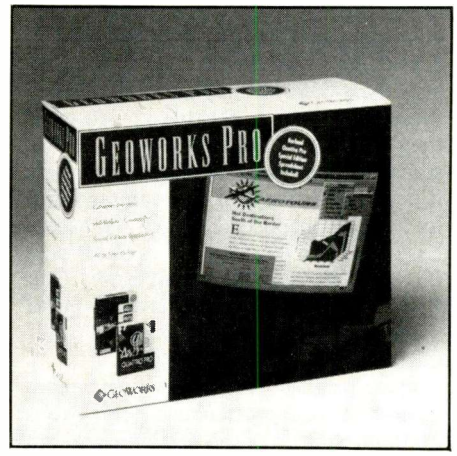
In at least one other way, PC/GEOS is more like the original Macintosh than *Windows*. As with those Macs running just System and Finder, it isn't a multitasking operating environment. *Windows*, on the other hand, can perform multitasking in enhanced mode. *GeoWorks Pro* can, however, work with MS-DOS 5.0's Task Switcher, should you want to put one application on hold to run a second task.

Easy Installation

Installing *GeoWorks Pro* is easy, but there are a few caveats you should be aware of before you start. PC/GEOS, the operating environment part of the package, doesn't require much in the way of machine resources. It will run on a plain-vanilla version of the original 4.77-MHz 8088 PC with at least 512K of RAM. It doesn't need a full 640K of DOS-addressable memory, though it will run a bit faster with it, or the large amounts of expanded memory required by *Windows*.

Nor does *GeoWorks Pro* require an EGA or VGA display card and adapter. It will run with monochrome graphics or a Hercules card if that's what you've installed in your system, though the VGA screens are much more readable and much closer to actual output.

What *GeoWorks* does need, though, is disk space—and lots of it! The documentation, some of which is for the original Ensemble, varies on this exact requirement from 3M up to the 7M requirement printed on the software's box. The packaging also notes that 9M of disk space is recommended. When I tried installing the entire package on a Bernoulli drive with a bit more than 10M of free space, I got a message that *Quattro Pro SE* couldn't fit. I installed



Quattro onto a different drive, but it's a good idea to budget at least 12M to 14M of disk space for *GeoWorks Pro*, especially if you intend to use both the spreadsheet and word processor. Remember, both applications also create data files (documents and worksheets) when used. In comparison, *Windows* usually doesn't take up more than about 2M or 3M of space on a hard disk.

Installation takes about a half-hour, 20 minutes of which are spent inserting the four installation disks to copy files to your hard disk. The software is provided on 1.2M high-density 5¼" floppies. If you need a different format, a card is included in the package for requesting it by mail, and a toll-free 800 number lets you request it by phone. If you have an older system with 360K drives, or one that uses 3½" diskettes, don't plan on buying *GeoWorks* and installing it the same day. Even if you call immediately for a different disk format, it will take a week or more to receive it.

The earlier version of *GeoWorks Pro, GeoWorks Ensemble*, was provided on 360K 5¼" disks, which greatly increased the disk swapping needed to install the software and added about another 15 or 20 minutes to the installation process. However, considering that a lot of users of older systems will be interested in the product, it would have made more sense going this route than selling a package that can't be immediately installed on many machines for which it will be purchased. Lots of other software products provide both 3½" and 5¼" disks in the package.

On the plus side, GeoWorks doesn't charge you for the new diskettes, nor does the company make you return the original disks, which would add another week or more to the exchange process.

Installation goes very smoothly once you log onto the floppy drive and type INSTALL. Other than prompting you to swap diskettes when necessary, the only other operator interaction comes at the end of the process when the software asks if you want your CONFIG.SYS and AUTOEXEC.BAT files altered. Too many packages these days blithely make changes to these files without alerting you to what they're doing. You can let *GeoWorks*' installation process make whatever changes it deems necessary, or you can (as I did) look at the proposed changes and accept or reject them. In my case, I let *GeoWorks* increase the FILES statement in my CONFIG.SYS file and declined having it insert a command that would always run PC/GEOS on starting up my PC.

Once installed, *GeoWorks* must be configured for your particular system. This is done automatically the first time you run it, either by rebooting the system (if you've specified that the software is always to be run on boot) or by changing to the correct subdirectory and typing in PCGEOS.

The configuration processes asks you to type the program's serial number (found on the registration card), verify the type of video display, specify what type of mouse is connected to the system and choose a printer. Printer support is extensive, with more than 450 different printers from which to choose, including some color PostScript models, though *GeoWorks* offers no support for daisywheel printers.

What You Get

The package touts *GeoWorks Pro* as "The Easiest Integrated Solution for Small Business." Considering what the software provides for a $200 list, this might not be hyperbole. Firstly, there's the PC/GEOS operating environment. When you first start up PC/GEOS, you're presented with a choice of three "workspaces"—Beginners, Intermediate and Advanced. Each of these varies in the capabilities and utilities it provides. For getting used to *GeoWorks*, the Beginners and Intermediate workspaces are somewhat less complex, but the Advanced workspace isn't really going to intimidate anyone who has used a PC for a few hours or so.

All workspaces are icon-based, and the Advanced workspace also uses the commonly found pull-down-menu approach. If you always want to go directly into a particular workspace, you can set this from the Preferences menu in Advanced.

As with *Windows, GeoWorks* has both small utilities and scaled-down applications. They are somewhat similar, though not identical, to those in *Windows*, such as GeoDEX, which stores names, addresses and phone numbers. GeoDEX can autodial your phone if a modem is attached and print phone books and address labels. Another utility, GeoPlanner, is a calendar/scheduler. GeoComm is an easy-to-use communications package that requires a Hayes-compatible modem (a special offer for American Online, an on-line service where the official *GeoWorks* forum resides) is packaged with the product.

I found the foregoing utilities similar in functionality to their counterparts in *Windows*, but they're a bit easier to use. As with *Windows, GeoWorks* comes with extensive printed documentation and on-line help. There's even a feature called "GEOHELP" that can help you on-line with installation problems if you're having trouble getting *GeoWorks* up and running.

GeoWorks Pro does lack several of *Windows*' utilities, most notably the Macro Recorder, which memorizes keystrokes, and the Notebook, a scaled-down editor. It does offer GeoDraw, a somewhat generic draw program that provides a bit more in the way of file import than Windows Paint. In addition to .PCX and .TIF formats, GeoDraw can handle the .EPS (Encapsulated PostScript) file format that *Quattro* uses for its charts and graphics.

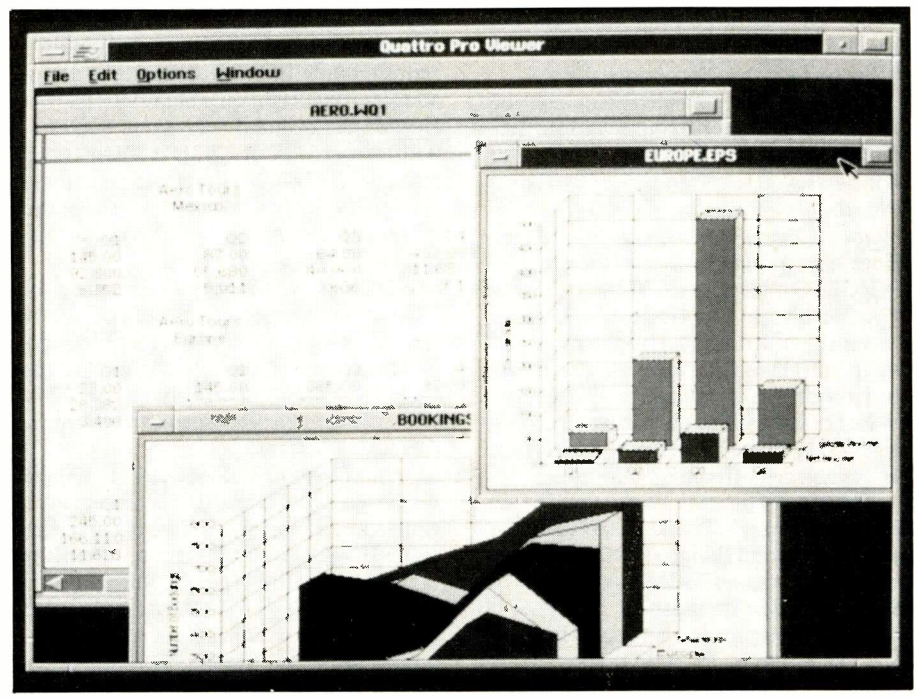
Where *GeoWorks Pro* shines is in the two applications it provides—GeoWrite and *Quattro Pro SE*.

GeoWrite is a quite serviceable graphical word processor. It doesn't quite have all the bells and whistles that *WordforWindows, WordPerfect for Windows* or Lotus' *Ami Pro* provide, but it does take WYSIWYG word processing a step beyond the Windows Write word processor.

In addition to nine scalable typefaces provided, you can include graphics, create tables and multiple columns and use such text effects as drop outs (white text on black background), colored text and even create title pages automatically.

Lots of document templates are provided, and there's even a banner-making utility. GeoWrite provides multi-line headers and footers and permits complete paragraph formatting. You can import and export text in ASCII format, which provides compatibility with other word processors. Most importantly, GeoWrite has a good 100,000 word spelling dictionary. Many users will find that GeoWrite more than satisfies their requirements in a word processor.

Borland's *Quattro Pro Special Edition* spreadsheet tops off the package. The Special Edition, or *SE*, version of *Quattro Pro* was designed as a high-value, low-cost spreadsheet and normally sells for $99 by itself. It can read Lotus *1-2-3* worksheet files and offers commands that are largely compatible with *1-2-3*. While the size of the worksheets you can create isn't as large



GeoWorks Pro Viewer screen.

as those in more-expensive versions of *Quattro* (and *1-2-3*), they should be sufficient for most users who aren't super-heavy power spreadsheet users.

In addition to the spreadsheet, *Quattro Pro SE* offers a flat-file database that can give you 254 characters per field, 256 fields and 8,191 records per database. Macros (which are a series of linked commands) are available, and you can link cells in different spreadsheets to produce consolidated reports. Most impressive, though, are *Quattro Pro SE*'s graphics. It offers 14 chart types (variations of bar, pie and line charts), some in 3D. *Quattro Pro SE* even comes with its own thick manual.

How They Compare

I have to admit that I'm very impressed with *GeoWorks Pro*. Not only does it give a lot of functionality at a very reasonable price, it can run on a fairly minimal system. It's also compatible with many networks, such as Novell and LanTastic. If the *Windows*-like applications (*Quattro Pro SE*, GeoWrite) and utilities that come with GeoWorks Pro can satisfy your needs, the $200 list price makes *GeoWorks Pro* a very attractive alternative to *Windows*.

On the other hand, much of the attractiveness of the *Windows* environment is the large suite of applications that run under *Windows*. No similar choice is available for *GeoWorks*, though the company does offer stand-alone versions of GeoDraw (called *GeoWorks Designer*), GeoWrite and the utilities (called *GeoWorks Desktop*) with a run-time copy of PC/GEOS, and several font packages. If you just want to try out some of the features and don't need the spreadsheet, this may be the way to go.

The volume of documentation is also somewhat daunting. There are thick manuals for *Quattro Pro SE* and *Ensemble* and several smaller booklets for new features added since the last release, customer service policies and procedures, and getting started. While I prefer well-documented programs, it's difficult to figure out just where the answer lies when you have a problem or question about the program.

On the whole, though, *GeoWorks Pro* is a terrific product. It's easier to use than Windows, offers better included applications and will run on many PCs too anemic to support *Windows*. You'd better have lots of disk space available, though! ■

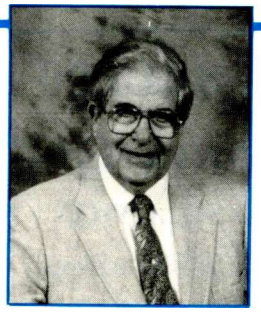
GeoWorks Pro, $199.99
GeoWorks
1218 Massachusetts Ave.
Cambridge, MA 02138
Tel.: 617-661-0590; fax: 617-661-0488

CIRCLE NO. 160 ON FREE INFORMATION CARD

CIRCLE NO. 71 ON FREE INFORMATION CARD

CIRCLE NO. 61 ON FREE INFORMATION CARD

CIRCLE NO. 59 ON FREE INFORMATION CARD



Portable Wireless Modems, a 14,400-bps Modem, Previewing Software for Free, Going to School on AOL and Virtual Reality

We're rapidly approaching a time when we'll cut the wires from our modems to the telephone and make our laptops truly portable. Motorola has been working toward this for some time and has built internal radio packet modems that work with portables. I was quite impressed with these at the Fall 1991 Comdex. Motorola has reduced the size of these devices by 25%. The new RF Modem, RPM405 Si, is small enough to fit into a Laptop computer and costs no more than the previous models.

Having this portable wireless modem is somewhat like having a cellular packet radio without a repeater—except that the entire infrastructure for radio packet, wide-area networks, doesn't yet exist. Also, there isn't even a specification for it. Nevertheless, it's surely coming on fast.

Meanwhile, Motorola is letting no grass grow in this potential goldmine. It has produced *Wave Guide* software that permits development of application links to the wide-area radio-link system. *Wave Guide* lets developers adapt their DOS or *Windows* applications work over radio links. They can also use it to develop communication systems that allows technicians and representatives in the field to access in-house databases. Motorola hopes this software's Application Programming Interface (API) will form the base for an evolving standard.

Both modem and *Wave Guide* software should be released by the time you read this. However, the complete radio-packet, wide-area network system will take a few years to perfect. Until then, many of its elements can be used for wireless LANS.

Meanwhile, in the world of cabled telecommunications (wired and fiber-optic) the transmission speed rate is rapidly approaching what was previously considered the maximum rate of 19,200 bps. Image Communications Inc., manufacturer of Twincom modems, has announced availability of the new 14,400-bps Twincom 14.4 DF Modem that features 14,400-bps fax and 14,400-bps data rates. This advanced external modem operates at 14,400 bps V.32bis, V.42, V.42bis and MNP 2-5 standards.

14,400-bps Modem

While offering a data throughput to 57,600 bps via compression, the modem is equipped for auto-fallback and auto-fall-foward to CCITT V.22bis and A/B Bell 212/103. It's supplied with DOS software. For use as a fax modem, the Twincom 14.4 DF operates in both send and receive modes of operation at 14,400 and 9,600 bps. It connects to all fax machines and fax boards and offers background operation.

The modem is equipped for Epson and Hewlett Packard print capture, as well as ASCII, PCX, TIF, BMP and other graphics formats. *Windows* software is available for fax operation.

This new ultra-fast modem is made in the USA using the latest Rockwell chip technology. It's an example of how US innovative technology can lead, given a level playing field.

It should be noted that this speed-advance technology is wasted on most of small fax machines in which input and output are limited by the scanning and printing speed of fax documents. However, for large companies that have a steady stream of fax transmissions and data flow, the rise to 14,400 bps will result in a much-reduced cost per unit. Perhaps this additional rise in modem speed will result in on-line services lowering what they charge for 9,600-bps operation.

Free Software Preview

Right now, more and more computer resources are available via on-line networks. Ziffnet has just put the Ziff-Davis Software Demos on-line. Any subscriber to Compuserve or Ziffnet can freely download any of the software demos from hundreds of ones that are on-line at any time. The only cost for this service are on-line and telephone charges. The idea of being able to actually see and work with a demo version of a program that interests you is more than worth the tariff.

In addition, you just might download an alternative to the program you set out to investigate and find it better suited to your needs. Previously, these software demos were available only on CD-ROM; to see any of them, you had to buy the entire CD ROM, even though you might be interested in only a few programs.

Going to School

The America On Line (AOL) network has established Programmers U, which offers free on-line courses in programming. It's located in the Developer's Forum section of the Computers & Software Department on AOL. The catalog of courses is growing, and the subjects seem to be exactly what's wanted by tyro programmers.

The current course is ANSI C, which is based on *The C Programming Language*, Second Edition, by Brian W. Kernighan and Denis M. Ritchie. This textbook, which served as the original specification for the C Language, is complete and easy to understand. Almost any compiler for ANSI C can be used for the course.

In addition to being one of the first to put interactive programming courses on-line, Programmer's U is attempting to provide double tracks for the course, one is for Mac users, another for PC users.

More than 300 people signed up for the C programming course, which led to some confusion at the first sessions. But the wrinkles are being ironed out, and it's to the credit of America On Line and the instructors that they're doing something that has never been done before. This is truly interactive computing at its best.

The interactive format of America On Line is what makes such courses possible. It's hoped that this will be the forerunner of many such educational ventures. If you miss part this course, the lectures will be available for downloading in the Programmer's U Library. Other courses are given in the same format.

Virtual Reality

We hear a great deal about Virtual Reality these days. This technique enables one to project into a computer scene as if the viewer were actually part of the action. This is usually accomplished by having the viewer wear a helmet or headpiece that has small CRTs in front of each eye. In simpler setups, stereo glasses equipped with position detectors are used. In addition, the user is equipped with a glove fitted to detect every motion of the hand in six axes. The 3D video and sensor glove give the wearer the sense of being inside a video graphic scene, or in place of a video-generated environment.

The video transmitters could be mounted as oculars of a robot, and the sensor gloves could control the arms and end ef-

fectors (hands) of a remote robot. Thus, an operator could control a mobile robot at a distance and have a sense of being on the scene. This type of operation is still in the future, but the means to do it already exist in current technology.

The reason why so many people are interested in this technology, which seems to be directed at games, is that its development will affect many other fields, like robotics and the development of prosthetic devices for disabled people. The study of virtual reality also offers insight to our perceptual abilities and the way we react to external stimuli.

There are experimenters on the cutting edge of virtual-reality technology who are taking glasses made for video games that are now available from Sega, the manufacturers of video games, and Matell's glove, which was developed for playing Nintendo games. VR experimenters are adapting theses items, available from toy stores, for use with Macs and PCs to produce VR graphics and games.

If you sign onto the Virtual Reality Forum that's part of the Graphics Forums on Compuserve, you can learn more about converting these "toy" devices for use with your PC to experiment with VR. Every Sunday night at 9:00 P.M., there's a conference on Compuserve (Go Comart) attended by some of the most experienced experimenters in field. Even if you've missed the earlier ones, you can catch up with previous messages because the proceedings of previous conferences on virtual reality are available in Library 13 of the Forum. You can download them to find out what went before. The schematics for converting the eyeglasses and gloves are also available in the Forum libraries.

If you feel there's nothing new for you to take part in because development was in the hands of big companies, get involved in virtual reality. This discipline is just at the stage where the personal computer was in 1975. It combines graphics, communications and programming and represents a challenge to all cutting-edge types. If you just want to experience a similar effect, try the program Virtual.Zip available, for downloading on America On Line in the Graphics Library. This demo does give you the effect of virtual reality with nothing more than VGA. ■

Playing against the clock, as it were, is fine for practice. This is a level of play that's good for gamers who are unfamiliar with data-gathering and Earth-romping. However, increasing levels of stress and subtly urging players to more fervent success is the game's antagonist, none other than the infamous Otto Von Slinkenrat, who secretly plans to keep all the artifacts for himself. It's, therefore, imperative you beat Von Slinkenrat and his buffoons to the punch. Missed clues and unfruitful destinations become much more critical.

Helping lesser-experienced scavengers is a basic map that outlines the travel routes for hopping across states, countries and continents. Its use cuts down guessing and enables a keen player to carefully plot his clue-searching. The map can be an invaluable item in staying abreast of Von Slinkenrat.

Another aid is a Finder's Log that lists all of the hidden artifacts by name. Almost every item available to the imagination is there, from a box of lava rocks to a Yeti footprint keychain—and those are the lesser exotic items.

Comparing *BushBuck* to *Carmen Sandiego*, it's easy to see that *Carmen* is generally a better game. It has better graphics, more integrated documentation and a stronger platform for game execution. Accordingly, a gamer tends to get more involved in game play. This isn't intended as a slight against *BushBuck* or its designers. It's also a fun game and a welcome complement to the *Carmen* series. If a players tires of one game, he can go to the other and back again to skillfully prolong the play life of both games.

Personal Memory Tool

Remember those pesky exams you had to take in high school and college when there seemed to be too many tests and too few hours in the week for preparation? A traditional preparation technique for tests, still used today, is to cram as much data as possible into an overworked brain. Hopefully, during test time something coherent came out.

A better way is offered by *Quiz Control* from Quick Study Software. This educational utility is a helpful software package that can be a powerful memory tool. To illustrate, imagine that you're cramming for an upcoming physics exam. Wouldn't it be great to have all potential test information on flash cards? And wouldn't it be great if family members or friends could ask you the questions and flash the answers? Then you could go over the information as many times as it takes to get everything nailed down tighter than the beam of a helium-neon laser. This sounds great, but it's so tedious to sit down and design a plethora of flash cards that could cover every potential aspect of the test, and it can be difficult to convince even a loving family member to flash hundreds of answers at you.

Use *Quiz Control* and do it yourself. The software has several optional study sets, including Basic Science, American History, English, Writing Skills and Computer Literacy. As you might expect, most of these ready-made study sets are generic, but it's surprising how dumb one can become after just a few years being out of school. So a brush-up on the basics is a good springboard to specialized disciplines.

Before jumping into *Quiz Control*, though, there's a problem that must be noted in connection with the ready study sets. The answer given to a question may be correct and still turn out to be incorrect. For example, during one of my quiz sessions on basic physics, *Quiz Control* put this before me: "The time it takes for ½ of radioactive nuclei to decay." The answer to this definition, as any junior high school physics student will tell you, is called the "half-life" of a given material, which was my response. But *Quiz Control* said I was wrong. A little investigation revealed that my answer was correct but that I'd left the hyphen out of my answer. Other questions fell victim to similar mis-communication. This indicates that *Quiz Control*'s parser needs to be smarter when it comes to using the ready study sets.

A way to beat the problem of mis-communication is to make your own quiz sets, which is pretty easy to do if you use *Quiz Control*. Just gather up your source material, select the items that are likely to appear on your exam and enter the questions and appropriate responses. It may take a couple of hours to get all your information correctly entered. Afterwards, you can cram and flash until your brain locks up. As long as you quiz the right information, you're bound to ace that next exam. Well, if you don't ace it, at least you'll be better prepared.

Uses for this kind of computerized self-quizzing aren't limited to school students. Working adults can use it, too, especially those who work in the rapidly changing field of computer technology. Field engineers and technicians can use it to keep up with new products. Field trainers can tailor their own instruction courses. Whether learning MS-DOS, Unix, Netware or anything else, it pays to quiz yourself. *Quiz Control* makes quizzing a faster and more efficient process.

Personal Planetarium

Stargazing is a popular hobby that seems to garner more followers each year. Don't look now, but even your next-door neigh-

bor may be housing a little reflector in dark corners of his closet or garage. An astronomy program like *The__Sky* from Software Bisque can prompt renewed interest and force even ex-astronomers to dust off their old eyepieces (other astronomy programs were reviewed in the June 1991 issue).

The__Sky is a well-written astronomy package that suits the needs of novice and expert astronomers alike, though it tends to favor more avid users who go beyond occasional viewing with binoculars and think a little 3" instrument just doesn't cut the ether. This bias is shown by the program's ability to electronically link to a telescope via data encoders, providing a system that makes it easy to find, identify and observe those intriguing points of light we call stars. *The__Sky* works especially well with the STG-MAX, which hard-core astronomers will appreciate.

Another feature indicating *The__Sky*'s leanings toward a more-experienced audience is that users can import databases of their own design into the program for viewing. Custom databases may include information that describes locations and magnitudes for stars, NGC or other objects and even comets. Technical information required for proper placing of custom objects is the kind of data that only serious astronomers would enjoy tracking. Casual gazers wouldn't want to get as deeply involved as this.

Creating comet data is an interesting item. Values required include those for inclination, period and eccentricity. While needed, star charts and catalogues may or may not give all the information directly. For those times, the included manual teaches users how to calculate unknown values from given values.

A favorite of many astronomers are the Jovian moons. *The__Sky* computes the positions of Io, Europa, Ganymede and Callisto and displays them from one of two views. After plotting, the moons can be set to leave a cosmic tail, clearly indicating orbital path. Additionally, the viewing angle may be widened or narrowed.

The__Sky has all the nifty features computer users might expect in an astronomy program, such as bright starry display, dynamic scrolling, variable time incrementation, animation of lunar and solar eclipses and common names for stars, planets, Messier and NGC objects. Handy as these features are, sophisticated users kind of expect such utility. *The__Sky* offers the utility and further proves its quality and worth with advanced features that would appeal to an enlightened crowd that tracks meteor showers, hand grinds their own mirrors and thrills at the thought of making magnitude estimates and light curves of events like last year's supernova.

More than enough for any amateur stargazer, *The__Sky* works well for advanced astronomers and, with its capability to display more than 10,000 objects, it staunchly holds its own against any competitor. Again, advanced users might like the opportunity to upgrade the initial Level I program or Level II. The advanced levels can display more than 46,000 objects and 271,000 objects, respectively. Clearly, *The__Sky* is an excellent personal planetarium.

Typing Tutor

One of the most helpful things I ever did in school was take a typing course. It didn't become apparent how important this skill was to become until my entry into computer technology. Maybe you've had a similar experience. If so, you may be smiling right now for having good judgment. If not, you may be wondering how you can improve your typing skills and get away from the lumbering method called "hunt-and-peck."

The only way to improve your typing is to practice, practice and practice some more. That's easy to do when you're still in school because somebody forces you to do it. At home is another story, though it's

one that can be helped by your own personal computer. The software is *Mavis Beacon Teaches Typing!*.

Mavis isn't the first computer-based typing tutor. Also, all typing tutors essentially do the same thing: force you to practice. Unlike the methodology used in schools, computerized typing teachers try to make practicing fun so that you'll actually want to practice. The key difference lies in the technique used.

Mavis opens on a classroom setting, complete with chalkboard. This is where you learn proper hand and finger placement and correct keying. On the computer's screen, a pair of shadowy hands work along with you, demonstrating technique. You follow along, typing what you're told to type. The trick is to watch the shadow hands and not your own hands—a difficult but necessary principle to learn.

When you feel confident enough, you can test yourself for speed and accuracy. A time clock, metronome and digital display track your performance. Other performance tests include the Arcade, which correlates typing efficiency to driving a race car. The faster and more accurate your typing, the faster your car goes. If you're good enough you can win the race. Later, if you're on a real hot streak, you can try 10-key.

Ordinarily, one wouldn't expect the manual for a typing tutor to be anything more than just a manual. *Mavis*' manual has all the instructions to run the program, and they're easy to follow. Its tour of the history of typewriting is plain fascinating.

A History of Typewriting kicks off in 1828 with William Austin Burt who came up with the first crude "typographer." The hulking device didn't catch on, though it began an evolution of shapes and sizes. Early models resembled a baby grand piano. Eventually, the portable typewriter showed up in 1891.

The typewriter as we know it wasn't hit upon until Charles Latham Sholes, who was the 52nd man to attempt a design. Sholes' "Type-Writer" was klunky and had a severe problem with jamming keys because the device didn't allow time enough for one key to return to its mooring before another key came up. Sholes addressed the problem in the inimical style of one who prefers a quick fix.

Instead of engineering an appropriate solution he redesigned his keyboard to make it so difficult to type that no typist would get to speeds fast enough to cause key jamming, creating the "QWERTY" system with which we're all familiar. In fact, after going through all the trouble of learning to type, I know some typists who'd like to get into a time machine, go back and tell Mr. Sholes a thing or two.

One valiant soul name August Dvorak embarked on a redesign of Sholes' convoluted mess of a keyboard. His humanized, more-sensible approach proved to have an accuracy increase of nearly 50% and speed increase of 15% to 20%. Unfortunately, the Dvorak keyboard fell to hard economic times and bad sales ventures, although there has been a modern resurgence of interest in it.

If you want to learn Dvorak, you can buy a Dvorak-style keyboard or Dvorak templates to go over your QWERTY keyboard. *Mavis* will help you with learning Dvorak, too. But expect to put in extra effort because in typing, its difficult to teach old fingers new tricks. ■

Bird's Eye View

BushBuck Charms, Viking Ships & Dodo Eggs, $49.95
PC Globe, Inc.
4700 S. McClintock
Tempe, AZ 85282
Tel.: 602-730-9000; fax: 602-968-7196

Requirements

Memory	512K
Graphics	VGA, MCGA, EGA, CGA
Sound	AdLib controllers

Evaluation

Documentation	Good
Graphics	Poor
Learning Curve	Short
Complexity	Easy
Playability	Easy

In Brief: Fun to play and educational world-spanning scavenger hunt.

CIRCLE NO. 136 ON FREE INFORMATION CARD

Bird's Eye View

Quiz Control, $49.95
Study Modules, $19.95 each
Quick Study Software Inc.
170 Hamilton Ave., Ste. 319
White Plains, NY 10601

Requirements

Memory	384K
Graphics	Text Based
Sound	Computer Speaker
Controllers	Keyboard

Evaluation

Documentation	Good
Graphics	N/A
Learning Curve	Short
Complexity	Easy
Playability	Good

In Brief: Easy to operate and very effective aid to memory.

CIRCLE NO. 139 ON FREE INFORMATION CARD

Bird's Eye View

The__Sky, $75; Level II $99; Level II, $175
Software Bisque
912 12 St., Ste. A
Golden, CO 80401

Requirements

Memory	640K
Graphics	VGA, EGA, CGA
Sound	N/A
Controllers	Mouse

Evaluation

Documentation	Good
Graphics	Good
Learning Curve	Medium
Complexity	Medium
Playability	Good

In Brief: Astronomy program that sports advanced features for experienced stargazers.

CIRCLE NO. 137 ON FREE INFORMATION CARD

Bird's Eye View

Mavis Beacon Teaches Typing!, $49.95; $59.95, *Windows* version
The Software Toolworks, Inc.
60 Leveroni Ct.
Novato, CA 94949
Tel.: 415-883-3000; fax: 415-883-3303
or call Electronic Arts: 800-245-4525

Requirements

Memory	512K
Graphics	VGA, EGA, CGA, Hercules
Sound	Computer Speaker
Controllers	Keyboard

Evaluation

Documentation	Excellent
Graphics	Good
Learning Curve	Short
Complexity	Easy
Playability	Good

In Brief: Effective help for improving typing skills; handles both QWERTY and Dvorak keyboard layouts.

CIRCLE NO. 1 ON FREE INFORMATION CARD

If your computer has a new MCA or EISA bus, cards made for its expansion bus will be able to run at your computer's full speed. But if your computer has an old-style ISA or "AT" bus, you'll have to be concerned with both its bus speed and the speed of the peripherals you add to it. And even if you have cards that can work in a fast bus, it doesn't mean they're running at full speed. Every expansion card can create wait states while it's being accessed if it needs extra processing time.

Another consideration for almost all cards installed in the expansion bus is the number of bits they use for communication with the CPU. Older cards that can work in both an XT and AT, and most serial- and parallel-port expansion cards, restrict themselves to eight bits of communication at one time. These cards fit into a short slot on the AT bus, which matches the original XT bus connector. Bus speed is rarely a consideration with parallel- or serial-port cards because the devices you're likely to connect to them, like a printer or modem, are relatively slow and won't use even the limited bandwidth on a slow eight-bit bus.

The bus-based devices that have the greatest effect on system speed are the video and disk controller. If you use graphics-mode programs, including Microsoft *Windows*, your system makes extensive use of the bus to draw on the screen. Even a simple line requires several communications between the CPU and graphics card.

"The video card and disk controller are the two bus-based devices that have the greatest effect on system speed."

Font-based characters, icons and other accouterments of a graphics interface require almost constant communication between the CPU and the video card.

If you want to use graphics-mode programs, make sure your computer has a fast bus and that you use a video card that can keep up with the speed of the bus. If you spend most of your computer's time running *Windows*, you may also want to investigate the *Windows* accelerator cards that move many of the required calculations from the main CPU to the video card to cut down on bus use and help the video run faster.

On the other hand, if you spend all your time with monochrome, character-based applications, an eight-bit video card may be all you need. It takes very little time for a program to manipulate character-based screen text because the character generator on the video card does all the work of forming each character.

Most systems also have a hard-disk controller on the expansion bus. Here again, speed is crucial to total system performance. A slow hard disk will make your entire computer seem sluggish, especially if you run large applications that use overlays, virtual memory on the disk or lots of data files.

"If you get the cheapest 386 or i486 computer, you might end up with one that doesn't run efficiently. . . . Make sure all components run at top speed."

The fastest hard-disk controllers for ISA computers use a full 16-bit-wide data path to communicate with the system. They also include their own built-in disk cache to speed up operations. A hard-disk cache is much faster than a software caching utility because it can fill while the CPU is attending to other tasks. Also, it doesn't use any valuable RAM space for the cache.

Extra memory in either extended or expanded memory format that's on an expansion board on the bus will also be limited to the speed of the bus. For this reason, most modern computers have a special memory bus, usually on the motherboard, that lets the machine use memory much more quickly than the expansion bus allows. Make sure you use all available memory sockets on your computer's motherboard before you even consider adding an expansion memory card.

If you go shopping for the cheapest 386 or i486 computer, you'll probably end up with a cheap computer that doesn't run efficiently. It will be faster than the 80286 or 8088/8086 computer you used before, but you could do better than that.

If you want best possible performance from your computer, make sure all of its components are designed to run at top speed. You may have to do some research and ask some tough questions when you go shopping for a computer and/or add-in cards. But you'll end up with a machine that will keep up with your work and the demands you place on it for several years to come. Even if you pay a few extra dollars, you'll be much happier than if you bought a computer that seems slow the first time you give it a challenging task to perform. ■

$50 Lab *(from page 60)*

Next, still monitoring *J3*, set the OFFSET switch to IN and vary the setting of OFFSET ADJUST control *R3* and note this control causes the dc offset should swing between +10 and −10 volts. This done, power down the Frequency Counter.

To accomplish final adjustment of *C15*, *R4* and *R5* through *R8* requires use of an oscilloscope. Set the Generator for a sine-wave output and connect the scope to *J3*. Adjust the settings of *R6*, *R7* and *R8* to obtain the most distortion-free, symmetrical waveform possible on the CRT screen.

With RANGE switch *S2* set to position 2, set FREQUENCY ADJUST control *R1* for maximum output frequency. Follow by adjusting trimmer control *R4* until you obtain a peak in frequency and then back off just slightly. Readjust the setting of *R1* for minimum output frequency and adjust trimmer *R5* to obtain minimum frequency.

If you have a variable dc voltage source, test the SWEEP input at *J1* by applying −12 to +12 volts to the jack. With *R1* set to its middle of rotation, the varying voltage at *J1* should cause the output frequency at *J3* to sweep through its minimum- and maximum-frequency range.

To adjust trimmer capacitor *C15*, disconnect any input to *J1* and set *R1* for maximum output frequency. Now set *S2* to position 3 to select timing capacitor *C13*. Using a frequency counter or oscilloscope, determine and note down the actual frequency of the signal coming out of *J3*. Then set *S2* to position 4, adjust *R1* for the slowest rate and use a non-metallic tool to adjust *C15* for an output frequency that is just below that of the previously measured maximum. This adjustment ensures a frequency overlap between the two highest ranges and eliminates possible "missing" frequencies from the selectable ranges. This completes adjustment of your Function Generator.

As you can see from the foregoing, the Function Generator described here provides all the functions and most of the features of a high-precision bench-top instrument. You'll soon come to rely on it so much that whenever you sit down at your test-bench, you'll power it up at the same time you power up your oscilloscope and multimeter. ■

BushBuck Charms, Viking Ships & Dodo Eggs . . . and More

The fanciful title that appears at the head of this review is the name of an interesting scavenger-hunt game. It and the other games considered here are the kind of computer adventures that have something to teach. Children and adults can have fun playing them and learn while doing it. Frankly, this stimulating combination is hard to beat.

Global Scavenger Hunt

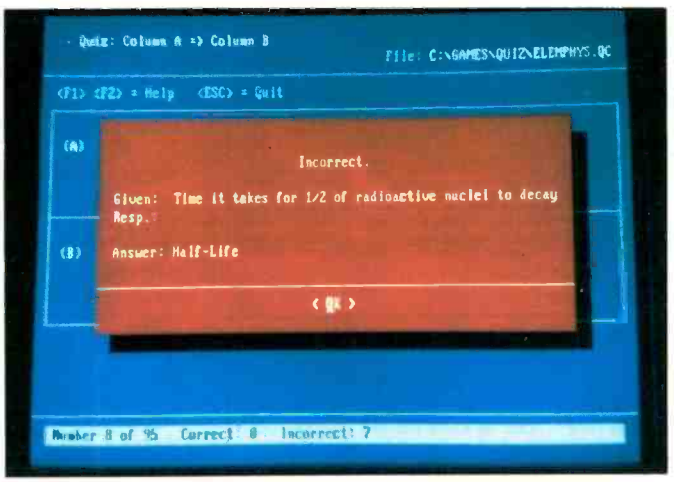
Computer users know the name PC Globe, Inc., the software maker that came to fame based on its informative country and world *PC USA* and *PC Globe* atlas/almanacs. In contrast with these previous continent-spanning databases, its new offering, *BushBuck Charms, Viking Ships & Dodo Eggs*, stretches the concept of world data-gathering and bends it into a game similar in concept to Broderbund's famous *Carmen Sandiego* series.

Normally I don't like to directly compare competing products unless there's a good reason. In most cases where I perform direct comparisons, the reason for doing so is provided by the manufacturer. Such is the case with *BushBuck Charms*. This game compares itself to the *Carmen Sandiego* series (which I reviewed in the November 1991 issue), albeit via advertised words by other reviewers.

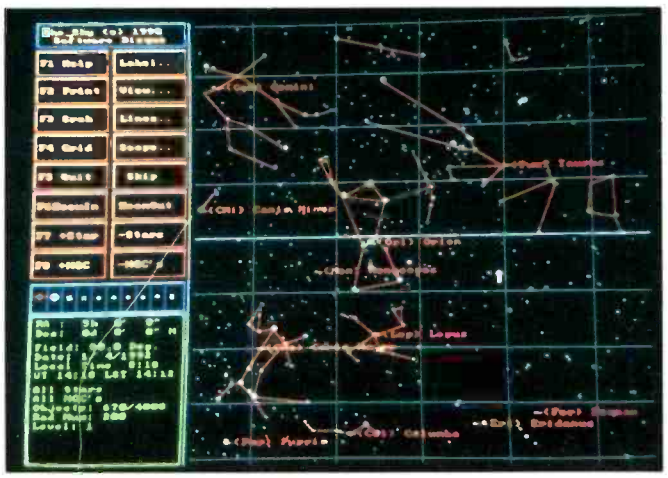
BushBuck and *Carmen Sandiego* are alike in that they both stir up a melting pot of people, places and facts. *BushBuck* sets gamers as contestants in a global scavenger hunt. Exotic items, like Viking ships and Dodo eggs, are hidden in major cities throughout the Earth. As the contestant, you must use 60 airline tickets as wisely as possible in your world quest. You have to travel to far-flung cities, initially choosing sites on nothing more than a whim. As clues pop up, selection of potential destinations becomes more tactical.

(Continued on page 82)

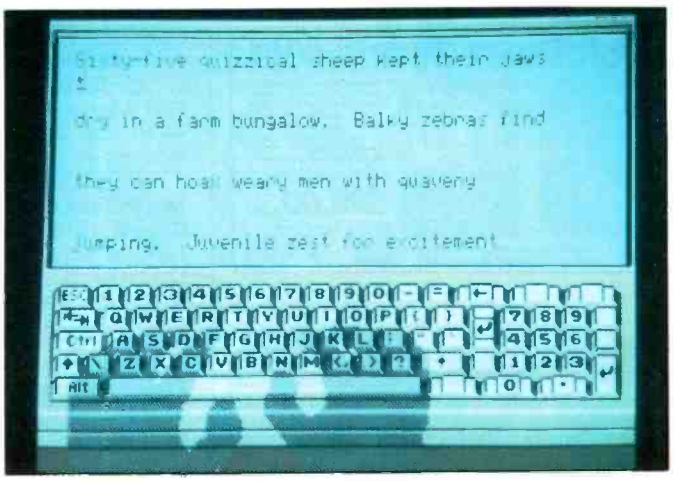
PC Globe's *BushBuck Charms, Viking Ships & Dodo Birds.*



Quick Study Software's *Quiz Control.*



Software Bisque's *The_Sky.*



The Software Toolworks' *Mavis Beacon Teaches Typing!*

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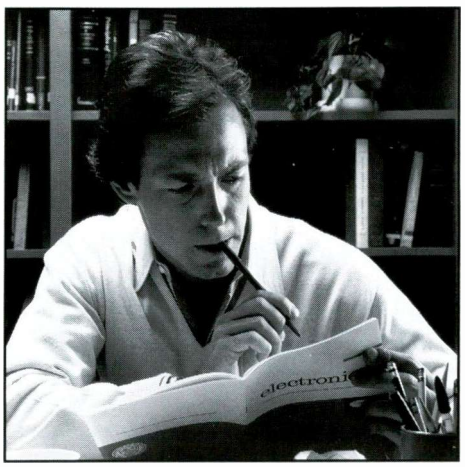

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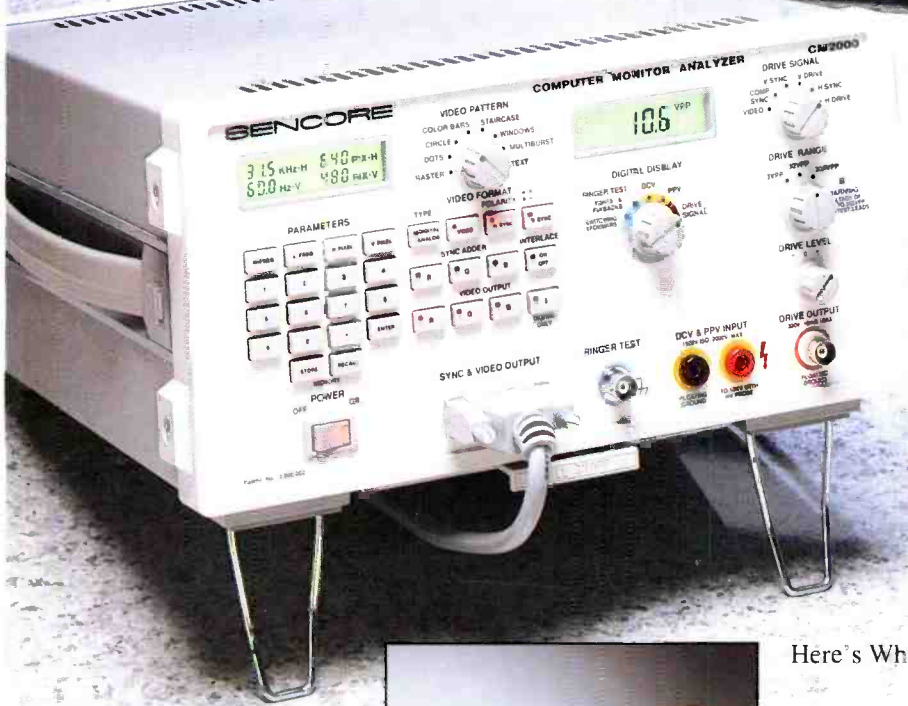

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