Computers & Electronics

APRIL 1983

formerly Popular Electronics

$1.50

The Commodore-64 Computer: Its Wonders & Potential

A Remote Security Controller & Voice Communicator

Converting TRS-80 Computer Data to Analog Signals

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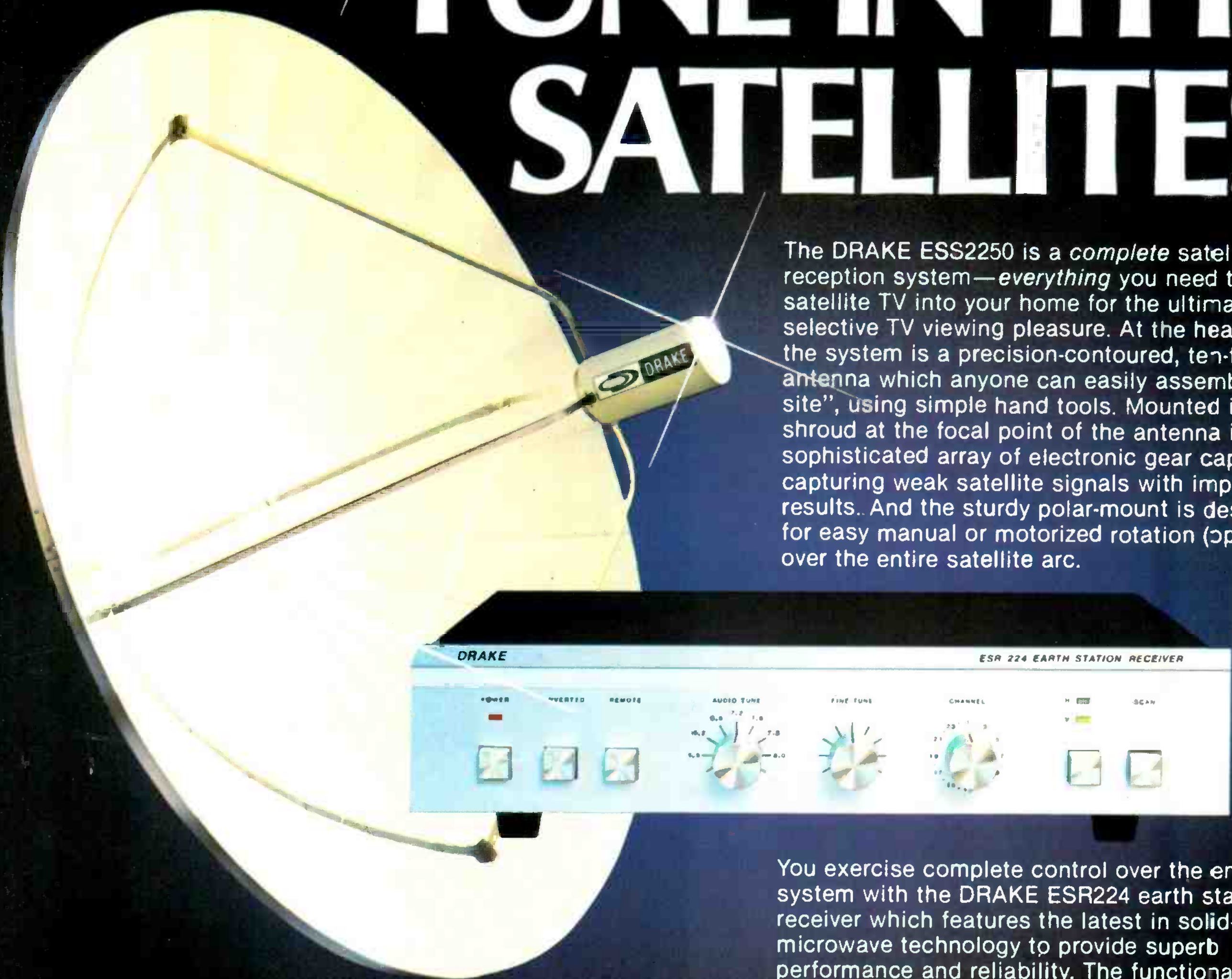
Also in This Issue:
Computer Game Reviews
New Digital Audio Hardware

TUNE IN THE SATELLITES



The DRAKE ESS2250 is a *complete* satellite TV reception system—*everything* you need to bring satellite TV into your home for the ultimate in selective TV viewing pleasure. At the heart of the system is a precision-contoured, ten-foot antenna which anyone can easily assemble "on-site", using simple hand tools. Mounted in the shroud at the focal point of the antenna is a sophisticated array of electronic gear capable of capturing weak satellite signals with impressive results. And the sturdy polar-mount is designed for easy manual or motorized rotation (optional) over the entire satellite arc.

You exercise complete control over the entire system with the DRAKE ESR224 earth station receiver which features the latest in solid-state microwave technology to provide superb performance and reliability. The functional design and contemporary styling of the receiver (along with a full line of accessories) will complement and ensure compatibility with any audio/video entertainment center for years to come. This system can be simply attached to any TV set and detailed instructions make it easy for the homeowner or local dealer to install everything with confidence. The entire package is easily shipped via U.P.S. to any continental U.S.A. location.

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TEXAS INSTRUMENTS
INCORPORATED

Model		Name	Mfr. Sugg. Ret.	Elek-Tek Price
CONSOLE				
PHC	004A	TI 99/4A Home Computer (incl RF Modulator)	450.00	CALL
PERIPHERALS				
PHP	1200	Peripheral Expansion Box	249.95	180.00
PHP	1220	RS-232 Card	174.95	130.00
PHP	1240	Disk Controller Card (One Disk Manager module packed with each Disk Controller)	249.95	180.00
PHP	1250	Expansion System Disk Drive (Disk Drive Controller required)	399.95	285.00
PHP	1260	Memory Expansion Card (32K RAM)	299.95	215.00
PHP	1270	P-Code Card (32K RAM Memory Expansion required)	249.95	180.00
PHP	1500	Solid State Speech™ Synthesizer	149.95	110.00
PHP	1600	Telephone Coupler (Modem)	224.95	163.00
PHP	2500	TI 80 Column Impact Printer	750.00	500.00
PHP	2300	VCR Controller	699.95	500.00
PHP	2400	P-Code Peripheral	399.95	290.00
PHA	2100	R F Modulator (TV Adapter)	49.95	38.00
PHA	4100	10 Color Monitor	399.95	320.00
OPTIONAL ACCESSORIES				
PHP	1100	Wired Remote Controllers (Pair)	34.95	28.00
PHA	1950	Thermal Paper (2 Pack)	9.95	8.00
PHA	2000	Dual Cassette Cable	14.95	12.00
PHA	2010	Monitor Cable	19.95	15.00
PHA	2020	Audio Adapter (Headphone Jack)	19.95	15.00
PHA	2310	Panasonic VCR Controller Cables	99.95	85.00
PHA	2320	Sony Video Controller Cables	99.95	85.00
PHA	2330	Pioneer Video Controller Cables	99.95	85.00
APPLICATION PROGRAMS				
Home Management/Personal Finance				
		Command Modules		
PHM	3006	Home Financial Decisions	29.95	24.00
PHM	3007	Household Budget Management (Data storage system is required)	39.95	32.00
PHM	3012	Securities Analysis	54.95	44.00
PHM	3013	Personal Record Keeping (Data storage system is recommended)	49.95	40.00
PHM	3016	Tax/Investment Record Keeping (Disk system is recommended)	59.95	56.00
PHM	3022	Personal Real Estate (Data storage system is recommended)	69.95	56.00
PHM	3044	Personal Report Generator (Data storage system is recommended)	49.95	40.00
PHM	3111	TI Writer (32K Memory Expansion required)	99.95	75.00
PHM	3113	Microsoft™ Multiplan (32K Memory Expansion required)	99.95	75.00
		Diskette		
PHD	5001	Mailing List	69.95	56.00
PHD	5003	Personal Financial Aids	19.95	16.00
PHD	5021	Checkbook Manager	19.95	16.00
PHD	5022	Business Aids Library—Finance Management (Extended BASIC Command Module is required)	39.95	32.00
PHD	5024	Business Aids Library—Inventory Management (Personal Record Keeping or Statistics Command Module is required)	69.95	56.00
PHD	5027	Business Aids Library—Invoice Management (Personal Record Keeping or Statistics Command Module is required)	69.95	56.00
PHD	5029	Business Aids Library—Cash Management (Extended BASIC Command Module is required)	39.95	32.00
PHD	5038	Business Aids Library—Lease Purchase Decisions	69.95	56.00
		Cassette		
PHT	6003	Personal Financial Aids	14.95	12.00
PHT	6038	Business Aids Library—Lease Purchase Decisions	59.95	45.00
Educational/Personal Enrichment				
		Command Modules		
Texas Instruments Packages				
PHM	3002	Early Learning Fun	29.95	24.00
PHM	3003	Beginning Grammar	29.95	24.00
PHM	3004	Number Magic	19.95	16.00
PHM	3005	Video Graphs	19.95	16.00
PHM	3008	Video Chess	69.95	56.00
PHM	3010	Physical Fitness	29.95	24.00
PHM	3020	Music Maker (Data storage system is recommended)	39.95	32.00
PHM	3021	Weight Control and Nutrition (Data storage system is recommended)	59.95	48.00
PHM	3040	TI LOGO (Memory Expansion is required)	129.95	75.00
PHM	3064	Touch Typing Tutor* (Available for TI 99/4A only)	39.95	32.00
PHM	3109	TI Logo II* (32K Memory Expansion is required)	129.95	75.00
Scott, Foresman Reading and Math Packages (Developed by Scott, Foreman)				
PHM	3015	Early Reading (Solid State Speech™ Synthesizer is required)	54.95	44.00
PHM	3043	Reading Fun (Solid State Speech™ Synthesizer is recommended)	54.95	44.00
PHM	3046	Reading On	54.95	44.00
PHM	3047	Reading Roundup	54.95	44.00
PHM	3048	Reading Rally	54.95	44.00
PHM	3082	Reading Flight	54.95	44.00
PHM	3027	Addition and Subtraction I (Solid State Speech™ Synthesizer is recommended)	39.95	32.00
PHM	3028	Addition and Subtraction II (Solid State Speech™ Synthesizer is recommended)	39.95	32.00
PHM	3029	Multiplication I (Solid State Speech™ Synthesizer is recommended)	39.95	32.00
PHM	3049	Division I (Solid State Speech™ Synthesizer is recommended)	39.95	32.00
Scholastic Packages (Developed by Scholastic, Inc.)				
PHM	3059	Scholastic Spelling—Level 3 (Solid State Speech™ Synthesizer is required)	59.95	48.00
PHM	3060	Scholastic Spelling—Level 4 (Solid State Speech™ Synthesizer is required)	59.95	48.00
PHM	3061	Scholastic Spelling—Level 5 (Solid State Speech™ Synthesizer is required)	59.95	48.00
PHM	3062	Scholastic Spelling—Level 6 (Solid State Speech™ Synthesizer is required)	59.95	48.00
Addison-Wesley Computer Math Games (Developed by Addison-Wesley Publishing Co.)				
PHM	3063	Computer Math Games II	39.95	32.00
PHM	3088	Computer Math Games VI	39.95	32.00
Milliken Home Math Series—K thru 8th grade (Developed by Milliken Publishing Co.)				
PHM	3090	Addition*	39.95	32.00
PHM	3091	Subtraction*	39.95	32.00
PHM	3092	Multiplication*	39.95	32.00
PHM	3093	Division*	39.95	32.00
PHM	3094	Integers*	39.95	32.00
PHM	3095	Fractions*	39.95	32.00
PHM	3096	Decimals*	39.95	32.00
PHM	3097	Percents*	39.95	32.00
		Diskette		
Texas Instruments Packages				
PHD	5007	Teach Yourself BASIC	34.95	28.00
PHD	5009	Music Skills Trainer	29.95	24.00
PHD	5011	Computer Music Box	19.95	16.00
PHD	5018	Market Simulation	19.95	16.00
PHD	5019	Teach Yourself Extended BASIC (Extended BASIC Command Module is required)	24.95	20.00
PHD	5020	Music Maker Demonstration (Music Maker Command Module is required)	14.95	12.00
PHD	5023	Basketball Statistics (Extended BASIC Command Module is required)	24.95	20.00
PHD	5026	Bridge Bidding I	29.95	24.00
PHD	5030	Speak & Spell™ Program (Solid State Speech™ Synthesizer is required)	29.95	24.00
PHD	5031	Speak & Math™ Program (Solid State Speech™ Synthesizer and Terminal Emulator II are required)	29.95	24.00
PHD	5039	Bridge Bidding II	29.95	24.00
PHD	5041	Bridge Bidding III	29.95	24.00
PHD	5042	Speller Writer (Terminal Emulator II Command Module and Solid State Speech™ Synthesizer are required)	29.95	24.00
PHD	5067	Beginner's BASIC/Tutor	29.95	24.00
MECC Packages (Developed by Minnesota Educational Computing Consortium)				
PHD	5078	Metric and Counting* (Extended Basic Command Module is required)	[illegible]	24.00
PHD	5079	Elementary Economics	[illegible]	24.00
PHD	5080	Elementary Math and Science* (Extended BASIC Command Module is required)	29.95	24.00
PHD	5081	Astronomy* (Extended BASIC Command Module is required)	29.95	24.00
PHD	5082	Word Beginnings* (Extended BASIC Command Module is required)	29.95	24.00
PHD	5083	Exploring* (Extended BASIC Command Module is required)	29.95	24.00
PHD	5084	Math Practice* (Extended BASIC Command Module is required)	29.95	24.00
PHD	5085	Science Facts* (Extended BASIC Command Module is required)	29.95	24.00

† Developed by Scott Foresman
†† Developed by Milton Bradley. The Attack, Blasto, Hustle, ZeroZap, Connect Four and Yahtzee are trademarks of Milton Bradley
††† Developed by Microsoft™ Inc. Multiplan™ is a trademark of Microsoft™ Inc.

Model		Name	Mfr. Sugg. Ret.	Elek-Tek Price
APPLICATION PROGRAMS CONTINUED				
Education/Personal Enrichment Continued				
PHD	5086	Natural Science* (Extended BASIC Command Module is required)	29.95	24.00
PHD	5087	Social Science* (Extended BASIC Command Module is required)	29.95	24.00
PHD	5088	Teacher's Tool Box* (Extended BASIC Command Module and printer are required)	29.95	24.00
		Cassette		
PHT	6007	Teach Yourself BASIC	29.95	24.00
PHT	6009	Music Skills Trainer	24.95	20.00
PHT	6011	Computer Music Box	18.95	12.00
PHT	6018	Market Simulation	14.95	12.00
PHT	6019	Teach Yourself Extended BASIC (Extended BASIC Command Module is required)	19.95	16.00
PHT	6026	Bridge Bidding I	24.95	20.00
PHT	6031	Speak & Math™ Program (Solid State Speech™ Synthesizer and Terminal Emulator II are required)	24.95	20.00
PHT	6039	Bridge Bidding II	24.95	20.00
PHT	6041	Bridge Bidding III	24.95	20.00
PHT	6042	Spell Writer (Terminal Emulator II Command Module and Solid State Speech™ Synthesizer are required)	24.95	20.00
PHT	6067	Beginner's BASIC Tutor	24.95	20.00
Entertainment				
		Command Modules		
Texas Instruments Packages				
PHM	3009	Football	29.95	24.00
PHM	3018	Video Games I	29.95	24.00
PHM	3023	Hunt the Wumpus	24.95	20.00
PHM	3024	Indoor Soccer	29.95	24.00
PHM	3025	Mind Challengers	24.95	20.00
PHM	3030	A-Maze-Ing	24.95	20.00
PHM	3052	Tombstone City 21st Century	39.95	32.00
PHM	3053	TI Invaders	39.95	32.00
PHM	3054	Car Wars	39.95	32.00
PHM	3057	Munch Man	39.95	32.00
PHM	3042D	Tunnels of Doom (2 Diskette Games Included)	59.95	45.00
PHM	3042T	Tunnels of Doom (2 Cassette Games Included)	59.95	45.00
PHM	3056	Alpiner*	39.95	32.00
PHM	3110	Chisholm Trail	39.95	32.00
PHM	3112	Parsec*	39.95	32.00
Milton Bradley Packages (Developed by Milton Bradley Company)				
PHM	3031	The Attack††	39.95	32.00
PHM	3032	Blasto††	24.95	20.00
PHM	3033	Blackjack and Poker††	24.95	20.00
PHM	3034	Hustle††	24.95	20.00
PHM	3036	ZeroZap††	19.95	16.00
PHM	3037	Hangman††	19.95	16.00
PHM	3038	Connect Four††	19.95	16.00
PHM	3039	Yahtzee††	24.95	20.00
Adventure International Packages (Developed by Scott Adams)				
PHM	3041D	Adventure (Pirate Adventure Diskette Game Included)	49.95	40.00
PHM	3041T	Adventure (Pirate Adventure Cassette Game Included)	49.95	40.00
Gabriel Industries Packages (Developed by Gabriel Industries)				
PHM	3067	Othello† (Developed by Gabriel Industries)	39.95	32.00
		Diskette		
Texas Instruments Packages				
PHD	5002	TI Trek (with optional speech)	14.95	12.00
PHD	5010	Mystery Melody	14.95	12.00
PHD	5015	Oldies But Goodies—Games I	19.95	16.00
PHD	5017	Oldies But Goodies—Games II	24.95	20.00
PHD	5025	Saturday Night Bingo (Solid State Speech™ Synthesizer is required)	29.95	24.00
PHD	5037	Draw Poker (Extended BASIC Command Modules is required)	24.95	20.00
PHD	5057	Tombstone City 21st Century (32K Memory Expansion and Extended BASIC Command Module are required)	19.95	16.00
PHD	5058	TI Invaders (32K Memory Expansion and Either Extended BASIC or Editor Assembler Command Module are required)	19.95	16.00
PHD	5060	Munch Man (32K Memory Expansion and Either Extended BASIC or Editor/Assembler Command Module are required)	19.95	16.00
Adventure International Adventure Series (Developed by Scott Adams) (PHM 3041D required)				
PHD	5046	Adventureland	29.95	24.00
PHD	5047	Mission Impossible	29.95	24.00
PHD	5048	VooDoo Castle	29.95	24.00
PHD	5049	The Count	29.95	24.00
PHD	5050	Strange Odyssey	29.95	24.00
PHD	5051	Mystery Fun House	29.95	24.00
PHD	5052	Pyramid of Doom	29.95	24.00
PHD	5053	Ghost Town	29.95	24.00
PHD	5054	Savage Island I & II	39.95	32.00
PHD	5056	Golden Voyage	29.95	24.00
		Cassette		
Texas Instruments Packages				
PHT	6010	Mystery Melody	9.95	8.00
PHT	6015	Oldies But Goodies—Games I	14.95	12.00
PHT	6017	Oldies But Goodies—Games II	19.95	16.00
PHT	6025	Saturday Night Bingo (Solid State Speech™ Synthesizer is required)	24.95	20.00
PHT	6037	Draw Poker	19.95	16.00
Adventure International Adventure Series (Developed by Scott Adams) (PHM 3041T required)				
PHT	6046	Adventureland	29.95	24.00
PHT	6047	Mission Impossible	29.95	24.00
PHT	6048	Voodoo Castle	29.95	24.00
PHT	6049	The Count	29.95	24.00
PHT	6050	Strange Odyssey	29.95	24.00
PHT	6051	Mystery Fun House	29.95	24.00
PHT	6052	Pyramid of Doom	29.95	24.00
PHT	6053	Ghost Town	29.95	24.00
PHT	6054	Savage Island I & II	39.95	32.00
PHT	6056	Golden Voyage	29.95	24.00
OTHER APPLICATION PROGRAMS				
		Command Modules		
PHM	3001	Demonstration	69.95	58.00
PHM	3011	Speech Editor (Solid State Speech™ Synthesizer is required)	44.95	36.00
PHM	3014	Statistics (Data storage system is recommended)	44.95	36.00
PHM	3026	Extended BASIC	99.95	75.00
PHM	3035	Terminal Emulator II	49.95	40.00
PHM	3055	Editor/Assembler	99.95	80.00
PHM	3058	Mini Memory (4K)	99.95	80.00
PHM	3045D	SMU Electrical Engineering Library (2 Diskettes included)	149.95	120.00
PHM	3045T	SMU Electrical Engineering Library (10 Cassettes included)	149.95	120.00
		Diskette		
PHD	5004	Programming Aids I	14.95	12.00
PHD	5005	Programming Aids II	24.95	20.00
PHD	5006	Math Routine Library	29.95	24.00
PHD	5008	Electrical Engineering Library	29.95	24.00
PHD	5012	Programming Aids III	19.95	16.00
PHD	5013	Graphing Package	19.95	16.00
PHD	5016	Structural Engineering Library	29.95	24.00
PHD	5044	AC Circuit Analysis	29.95	24.00
PHD	5063	UCSD PASCAL Compiler (32K Memory Expansion and P Code required)	124.95	100.00
PHD	5064	UCSD p System Assembler/Linker (32K Memory Expansion and P Code required)	99.95	80.00
PHD	5065	UCSD p System Editor/Filer/Utilities (32K Memory Expansion and P code required)	74.95	80.00
PHD	5066	TI PILOT (32K Memory Expansion and P code required)	79.95	60.00
PHD	5068	Course Designer Authoring Package (Extended BASIC required and Video Controller optional)	199.95	150.00
PHD	5075	Text To Speech (English) (Solid State Speech™ Synthesizer 32K Memory Expansion and Extended BASIC Command Module are required)	29.95	24.00
		Cassette		
PHT	6004	Programming Aids I	9.95	9.00
PHT	6006	Math Routine Library	24.95	20.00
PHT	6008	Electrical Engineering Library	24.95	20.00
PHT	6013	Graphing Package	14.95	12.00
PHT	6016	Structural Engineering Library	24.95	20.00
PHT	6044	AC Circuit Analysis	24.95	20.00
SOFTWARE LIBRARIES				
PHL	7001	The Home Financial Manager	139.95	100.00
PHL	7002	The Family Entertainer	89.95	65.00
PHL	7003	The Elementary Educator	99.95	75.00
PHL	7004	The Music Educator	64.90	50.00
PHL	7005	The Super Programmer	119.00	90.00
PHL	7006	The Speaking Math Teacher	119.85	90.00
PHL	7007	The Speaking Reading Teacher	109.90	85.00
PHL	7008	The Speaking Scholastic Spelling Teacher	219.80	160.00
PHL	7009	The TI Arcade Game Series	119.85	90.00
PHL	7010	The Milton Bradley Game Series	114.75	90.00
PHL	7011	The Computer Introductory Package	119.85	90.00

* Available only until replaced by peripheral card
UCSD, UCSD Pascal and UCSD p System are all trademarks of the Regents of the University of California
Othello is a trademark of Gabriel Industries
Course is designed to be used with Circuit Analysis [illegible]

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Computers & Electronics

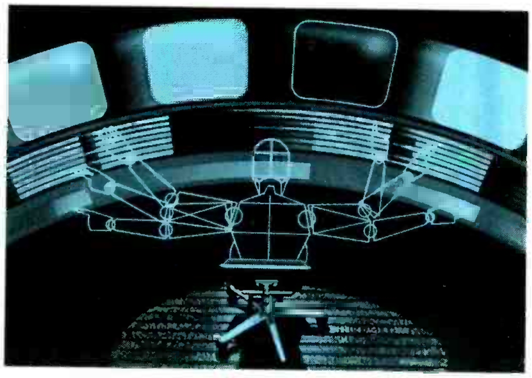
APRIL 1983

VOLUME 21, NUMBER 4

FEATURE ARTICLES

EQUIPMENT REVIEWS

COLUMNS



DEPARTMENTS

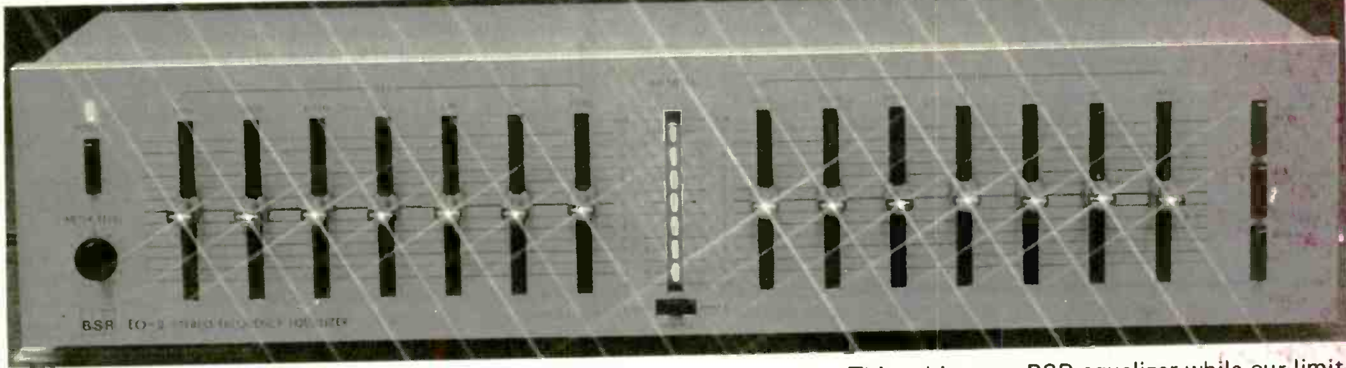
COVER ART BY JAMES HEGEDUS

 Computers & Electronics (ISSN 0032-4485) April 1983, Volume 21, Number 4. Published monthly by Ziff-Davis Publishing Co., at One Park Ave., New York, NY 10016. Richard P. Friese, President; Selwyn Taubman, Treasurer; Bertram A. Abrams, Secretary. One year subscription rate for U.S. and Possessions, $15.97; Canada, $20.97; all other countries, $23.97 (cash orders only, payable in U.S. currency). Second Class Postage Paid at New York, N.Y. 10016 and at additional mailing offices. Authorized as second class mail by the Post Office Dept., Ottawa, Canada, and for payment of postage in cash. POPULAR ELECTRONICS including ELECTRONICS WORLD trademark registered. Indexed in the Reader's Guide to Periodical Literature. Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Popular Photography, Skiing, Stereo Review, Electronic Experimenter's Handbook, and Tape Recording & Buying Guide. **POSTMASTER:** Send address changes to COMPUTERS & ELECTRONICS, Circulation Dept. P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address, enclosing, if possible, an address label from a recent issue.

$79 CLOSE-OUT

Sound Detonator

Make your stereo system's sound explode with life, improving the sound quality by 30 to 50%, with this limited $79 close-out from BSR.



It's like night and day. Crashing cymbals, the depth of a string bass, more trumpets or more voice. Now they'll all come bursting forth from your stereo system at your command.

You'll make your music so vibrant that it will virtually knock your socks off when you use this professional quality stereo Sound Detonator equalizer.

It has a frequency response from 5hz to 100,000hz ±1db. And, it's made and backed by a 2 year limited warranty by BSR, the ADC equalizer people. Our $79 close-out price is just a fraction of its true retail value.

CAN YOUR STEREO SOUND BETTER?

Incredibly better. Equalizers are very different from conventional bass and treble controls.

Bass controls turn up the entire low end as well as the low mid-range making the sound muddy and heavy. With an equalizer, you simply pick the exact frequencies you want to enhance.

You can boost the low bass at 60hz, and/or 150hz, and the mid-bass at 400 hz to animate specific areas of the musical spectrum.

And, best of all when you boost the part of the bass you like, you don't disturb the mid-range frequencies and make you favorite singer sound like he has a sore throat.

The high frequencies really determine the clarity and brilliance of your music. You can boost the high mid-range at 2400hz, or the high end at 6000hz and 15,000hz. So, you can bring crashing cymbals to life at 15,000hz while at the same time you cut tape hiss or annoying record scratches at 6000hz.

You can also boost or cut specific midrange frequency areas to add or subtract vocal, trumpets, guitars or whatever instrument ranges you prefer.

THERE'S MORE

You can push a button and transfer all the equalization power to the input of your tape deck. So, if you have a cassette deck in your car, or a personal stereo that you wear, now you can pre-equalize your cassettes as you record them with no cables to switch.

Now you can get all the dramatically enhanced sound wherever you are. This is an especially great feature for bass starved portables and high-end starved car stereos to make them come alive.

EASY HOOK UP

Use your tape monitor circuit, but don't lose it. Just plug the equalizer into the tape 'in' and 'out' jacks on your receiver. We even supply the cables.

As you listen to your records, FM stereo or 'aux', any time you push the tape monitor switch on your receiver you'll hear your music jump to life.

For your tape deck, simply plug it into the tape 'in' and 'out' jacks on the equalizer exactly as it was plugged into your receiver.

The output from your receiver is always fed direct to your tape deck for recording and with the touch of a button, you can choose to send equalized or nonequalized signal to your recorder.

When you want to listen to your tape deck, just press tape monitor on the equalizer and your tape deck will work exactly as it did before. Except, that now you can choose to listen to it with or without enhancing equalization.

You won't be listening to any distortion or hum. The Sound Detonator has a 95db signal to noise ratio and total harmonic distortion of only 0.018%.

Once you've set your equalizer controls, switch it in and out of the system. Then you'll hear such an explosive improvement in sound you'll think you've just added thousands of dollars of new speakers and equipment.

No one would believe that a $159 component let alone one at our $79 close-out price could do so much.

WHY A CLOSE-OUT

BSR is a very large company. Somebody decided to market equalizers under both their ADC subsidiary and the BSR names. Well, we never thought it was a very practical idea. And, now they seem to agree.

From now on you'll only see ADC equalizers. But, because they didn't know what to do with these that were labeled BSR, we got them for a song.

So, you can go to any HiFi store and buy an ADC equalizer made by the parent company BSR, or you can get this super BSR equalizer while our limited supply lasts for only $79.

Oh yes, if you want to know more about BSR, they also own DBX, the noise reduction company and if you're familiar with the X10 remote control system for your home, that's BSR too.

THE FINAL FACTS

There are 14 slide controls each with a bright LED to clearly show its position. Each control will add or subtract up to 12db. (That's a 24db range!)

There are separate sound detonation slide controls for each channel at 60hz, 150hz, 400hz, 1000hz, 2400hz, 6000hz, and 15,000hz.

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CIRCLE NO. 67 ON FREE INFORMATION CARD

EDITORIAL

Robot Shacks

If one believes all the media hype about robots, we should expect to see a chain of retail stores down the road that caters to robotic enthusiasts. Let's color them Robot Shack, emulating the name of Tandy's famous Radio Shack electronics stores.

Sounds far-fetched, does it? Well, across my desk today came a press release announcing formation of a new company devoted to personal robot kits, parts, and plans, called—you guessed it—Robot Shack! The El Toro, California operation (P.O. Box 582) is a mail-order house whose first products are your basic $99.95 robot kit, called "Droid-Bug," and an expandable one called "Personal Robot-1" for $499.95. The latter has a male-face front side and a female-face back. The 38"-tall robot is reported to "walk" forward and backward, turn, circle, sound a noisemaker, and flash eyes, nose and heart. Options permit arms to rotate and include a sound responder, digital clock, light sensor, water gun, balloon inflator positioned on the "girl's" side, remote radio control, and computer subsystem (about which nothing is said).

Yes, it appears to be more toy than useful robot at this stage. But who knows what contortions evolution will bring? More likely candidates to be called personal robots are B.O.B. and Topo, recently introduced by Androbot Inc. (1287 Lawrence Station Road, Sunnyvale, CA 94086). The board chairman of Androbot is none other than inventive Nolan Bushnell, the Henry Kloss of the video-game world. (Bushnell is founder of Atari and the Pizza Time Theater restaurant chain.)

The $2495 B.O.B. uses three 8088 microprocessors and squirrels away 3 megabytes of memory. The self-contained, battery-powered robot boasts two infared sensors to detect body heat and five ultrasonic sensors for determining an object's range *and location*. Add sturdy wheels that can propel the robot up to two feet per second or turn on a dime without tipping, arms that perform as carrying trays (sorry, no articulated arm or claw grippers), and you've got an independent robot that can find you in the dark and serve you your favorite drink or snack.

The $995 Topo looks similar, but its brainwaves are transmitted through a radio-frequency device that's tied into a computer. (Right now it's an Apple II, though links for other computers are promised.) A joystick controls direction while software-directed signals—BASIC, and the $125 per diskette Topologo and Topoforth languages—reach out up to 90 ft away. There's a "voice" option, too, for $200. Together with the Heath robot and others discussed in our past January issue, personal robots appear to be a growing breed.

Aside from educational/fun robots, a state-of-Michigan-sponsored study indicates that U.S. industrial robot population is expected to grow from 6800 robots to 50,000-100,000 units by the year 1990. (In contrast, Androbot's president sees personal/educational robots being produced at a 5-million clip annually by this date.) Up to 24,000 jobs are expected to be lost to robots in Michigan, while up to 18,000 new jobs are anticipated as a result. Not surprisingly, the study finds that more than two-thirds of the workers in robot manufacturing are in white-collar jobs rather than traditional blue-collar areas.

Computerized personal robots can help to train people for entrance into the robotics industry, of course, which federal occupational studies indicate is a fine growth field. In fact, a *Newsweek* article estimated 1990 employment in industrial robot production to be 800,000 people. The Michigan study, however, cautions that robotic-industry employment is limited right now by the small number of robots in use.

Whether for fun, learning purposes, career reasons, or a combination of the foregoing, robotics promises to be a fulfilling activity.

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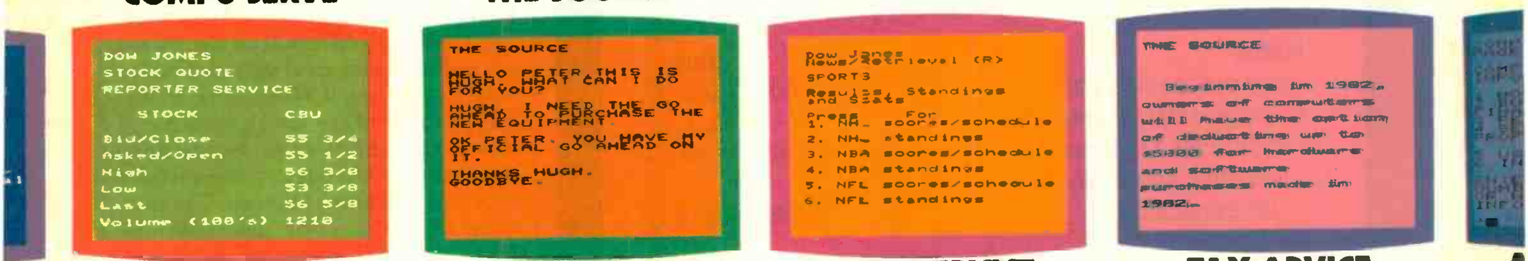

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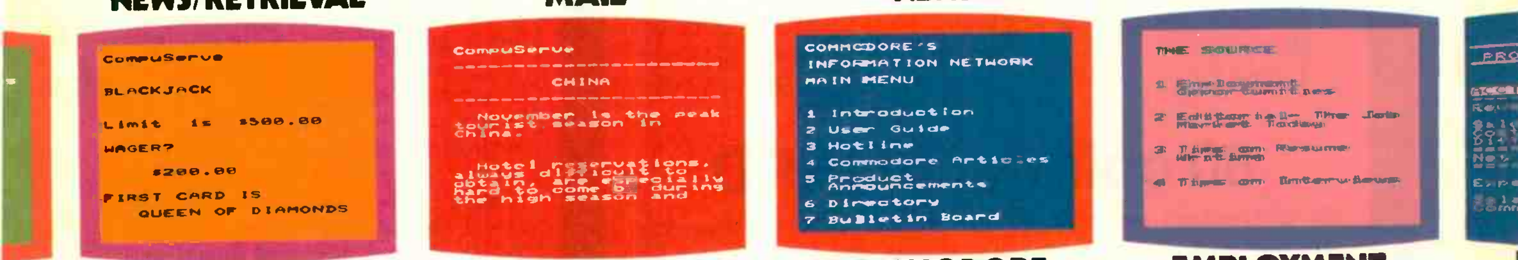

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The screens below them give you a few examples of how much more versatile they can be with the addition of a Commodore VICMODEM.

For around $100, the Commodore VICMODEM will turn your VIC 20 or Commodore 64 computer into a telecomputer.

To make matters even better, Commodore includes a few little extras (such as a free hour's time on the two most popular telecomputing services) that add up to a value of $197.50.* A nice return on an investment of about $100.

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CIRCLE NO. 29 ON FREE INFORMATION CARD

LETTERS

SMALLTALK

In your February Editorial ("Beyond Pac-Man"), you mentioned "Smalltalk," which was developed by Xerox. You said that is "is reputed to be a powerful, flexible language that should be simple enough for novices when canned software becomes available." It is obvious, at least to me, that Xerox's idea of what they call "general accessibility" is that it be available only to those rich enough to be able to buy a Zerox Star or on one of those other $14,000+ "workstations" made by one of the relatively few large corporations allowed to have Smalltalk. If your readers would like to express their opinions on the lack of a version of Smalltalk they *can* have, they should write to: Adele Goldberg, Manager, Learning Research Group, Xerox Palo Alto Research Center, 3333 Coyote Hill Rd., Palo Alto, CA 94304. Maybe if we show interest in Smalltalk, Xerox will have to publish the books on it that they promised over a year ago.—*Diana Blackhawk, Chicago, IL.*

IN THE RIGHT DIRECTION

I like the new direction you have taken with your editorial content. I think it is well timed—not "bandwagon" and "me too." The long-standing integrity of the POPULAR ELECTRONICS editorial quality has been maintained.—*Perry Trunick, Kent, OH.*

PHONEMES AND ELECTRONICS

I have been studying your recent articles on speech synthesizers with avid interest. I can't fault your authors on the electronics but it appears they have certain misconceptions about phonemes. The word does not refer to a single universally definable entity. It is a purely theoretical concept used for convenience in the formal analysis of language. It describes a set of phonetic bundles that may or may not be similar in all occurrences and supposed by the analyst to be subjectively interpreted as equivalents.

What the Votrax chip produces are limited approximations of some American English phonemes. The sounds are not sufficient to accurately reproduce what I call General Western American. The handling of the vowels leads me to believe that the table of sounds must have been worked out by someone from New England or the Midwest. The vowel surrogates combine phonemic distinctions with nonphonemic distinctions of length that depend on position. This is a sensible approach to one of the more characteristic features of English, but it should be remembered that these are *phonetic* representations, not phonemes pure and simple.

It is unfortunate that English has a particularly unique and complex phonology that poses a very severe challenge for anyone attempting to synthesize it adequately by electromechanical means. Anyone interested should consult the writings of Block and Trager.

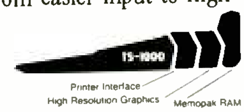
An alternative approach to speech synthesis seems to me to be the use of a chip such as the SN76477 along with external oscillators and filters under microprocessor control.—*B.R. Pogue, Bowie, AZ*

OUT OF TUNE

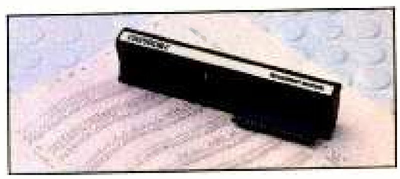
In "The Optimized Graphic Equalizer" (Dec. 1982 and Jan. 1983), in Fig. 4, *R64* and *C28* should be reversed; in Figs. 5 and 9, pads P and R should be reversed; in Fig. 7, *C23* should be 0.001 μF, *C34* should be 0.0022 μF, and pin 14 of *IC3C* should be pin 9; and Fig. 10, left side of *C24* should be marked with a plus sign.

TIMEX MAKES THE COMPUTER, BUT WE MAKE IT TICK.

If you own a TS-1000 or ZX-81 computer and want to bring out the power within it, you'll want Memotech. From easier input to high quality output and greater memory, Memotech makes the add-ons you demand. Every Memotech peripheral comes in a black anodized aluminum case and is designed to fit together in "piggy back" fashion enabling you to continue to add on and still keep an integrated system look.



MEMOPAK RAM All Memopak RAMs are directly addressable, user transparent and are neither switched nor paged. No additional power supply is required. **16K RAM BASELINE** The 16K Baseline is our most economical way to add memory to your TS-1000. It is fully compatible with Memopak 16K and 32K RAMS to provide you with up to 32K or 48K of RAM respectively. **16K RAM** The Memopak 16K RAM offers expansion capabilities through its "piggy back" connection and is fully compatible with Timex or Memotech 16Ks to give a massive 32K of RAM. **32K RAM** The 32K Memopak enables you to execute sophisticated programs and store large data bases and like the 16K RAM is fully compatible with Timex's or Memotech's 16K RAMs to give you a full 48K of RAM. **64K RAM** The 64K Memopak is powerful enough to turn your TS-1000 into a computer with capabilities suitable for business and educational use. It accepts such BASIC commands as 10 DIM A (9000). **MEMOCALC** Memocalc, our spreadsheet analysis software, enables TS-1000 users to perform complex number crunching routines with ease. With the 64K RAM a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Quick revisions can be achieved by entering new data to your formula.



MEMOTECH KEYBOARD For ease of operation, the Memotech keyboard is a high quality standard typewriter keyboard, with TS-1000 legends. The keyboard is cable connected to a buffered interface which is housed in a standard Memopak case and plugs directly into the back of the TS-1000 or other Memopaks. **MEMOPAK HRG** The Memopak High Resolution Graphics, with up to 192 by 248 pixel resolution, enables display of high resolution "arcade game" style graphics through its resident 2K EPROM, programmed with a full range of graphics subroutines.

CENTRONICS PARALLEL AND RS232 INTERFACES
Memotech's Interfaces enable your TS-1000 to use a wide range of compatible printers. The resident software in the units gives the complete ASCII set of characters. Both Memopak Interfaces provide lower case character capabilities and up to 80 column printing. The RS232 Interface is also compatible with modems and terminals.

SEIKOSHA GP 100A PRINTER The Seikosha GP 100A uses a 5x7 dot matrix printing format with ASCII standard upper and lower case character set. Printing speed is 30 characters/second with a maximum width of 80 characters. The printer uses standard fanfold paper up to 9-1/2 inches wide. The GP 100A is offered as a package including cable and interface. Other printer packages are also available through Memotech.

ORDER AT NO RISK. All Memotech products carry our 10 day money back guarantee. If you're not completely satisfied, return it within ten days and we will give you a full refund. And every Memotech product comes with a six month warranty. Should anything be defective with your Memotech product, return it to us and we will repair or replace it free of charge. **Dealer inquiries welcome.** To order any Memotech product use the order coupon or call our toll-free number **800/662-0949.**

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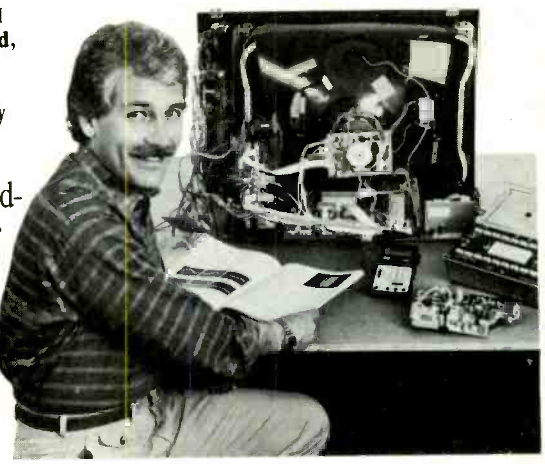

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NEW PRODUCTS

APPLE PERSONAL COMPUTER

The Apple IIe is an enhanced version of and is priced below the Apple II+. This 6502-based color computer has 64K of RAM (expandable to 128K); 16K of ROM; u/lc characters; typewriter keyboard; speaker output; cassette I/O; seven expansion slots; hand-control games I/O signals; and r-f-modulated and video display outputs. Text display is 24 lines × 40 char. or × 80 char. with optional 80-column card. $1395.

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RAM AND I/O PORT CARD FOR IBM-PC

Antron's "answerRAM" multi-function board has multiple-port design and is configurable for 56K, 128K, 192K, and 256K of additional RAM. Ready-to-go ports include two asynchronous serial and one "Centronics" parallel for printer. A 3-in-1 cable provides take-off from a single 37-pin connector in standard rear expansion slot. Has connectors for serial and parallel interfaces.

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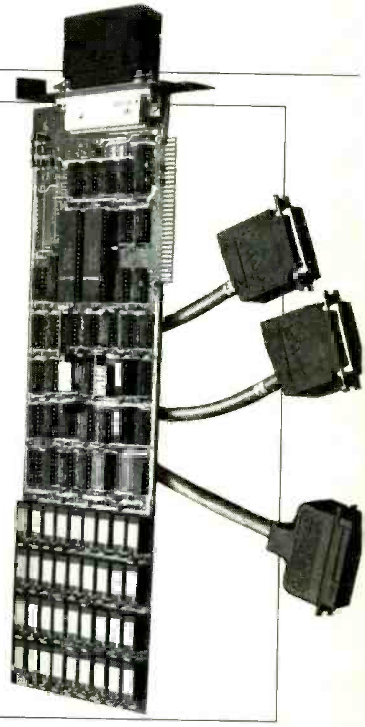


MATTEL HOME COLOR COMPUTER

Mattel's Z80A-based, CP/M compatible Aquarius, designed to operate with a color TV, has 8K of ROM with Microsoft BASIC, 4K of RAM (expandable to 52K with memory cartridges), 49 movable keys, u/lc and 256 graphics character sets, 40-column × 24-line on-screen display, 320 × 192-pixel resolution, and 16-color palette. Measures 13" × 6" × 2"; weighs 68 oz. Options include: LOGO, memory, and program cartridges; games-playing modules; cassette data recorder; and 40-column printer. $200.

Circle No. 95 on Free Information Card

JOYSTICK FOR VISICALC

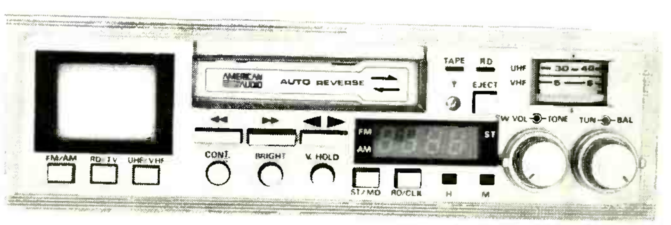
Quik-Vis from Kraft Systems is a quick-revision subroutine that adds joystick control for Visicalc. When prebooted prior to Apple version of Visicalc, it permits cursor movement to anywhere on the speadsheet by means of a joystick (not included), eliminating four to six procedures required to move the cursor with standard Apple keyboard. Also includes time-saving functions for two buttons on joysticks: red takes cursor immediately back to A-1; black gives extra-fast cursor speed.

Circle No. 94 on Free Information Card

CAR VIDEO/AUDIO SYSTEM

American Audio's compact "Car Video" is a combination TV/AM/FM-stereo radio/cassette player. When properly installed in-dash the CRT is disabled when ignition switch is on; but it can be installed in back for viewing with car running. Has 2" B/W TV with vhf and uhf; AM/FM stereo tuner with digital frequency time display; and 50-W rms stereo power amp. Measures 8"D × 7"W × 1¾"H. $1495.

Circle No. 96 on Free Information Card



REVOX LINEAR-TRACKING TURNTABLE

The Model B791 tangential-tracking turntable from Revox incorporates a "Hall-effect" direct-drive platter, ultra-short Linatrack tonearm, and pushbutton cueing controls. Features include a quartz variable-speed control with 5-digit LED display, Shure Tracer TXE-SR cartridge, and disco-start capability. Speed can be varied in 0.1% increments to a maximum of ±9.9%, while the display indicates selected nominal speed and exact percentage of deviation. A LED illuminates when the platter is rotating at quartz-locked speed.

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TIMEX SINCLAIR COLOR COMPUTER

Color graphics and sound generation are featured in the Timex Sinclair 2000 computer. Also: a compact moving-key keyboard; 256 × 192-pixel hi-res graphics; high-speed load and save for standard cassette software; Z80A microprocessor; 8-color palette; 10-octave/130-semitone sound; speaker; r-f modulator; and ac adapter. Measures 9⅛" × 5⅝" × 1¼"; weighs 20 oz. $149.95 for 16K-RAM version; $199.95 for 48K-RAM.

Circle No. 98 on Free Information Card

SHARP STUDENT COMPUTER

Sharp Electronics' low-cost Model PC-1250 Student Computer Kit, programmable in Extended BASIC, uses an 8-bit CMOS CPU and a 24-character LCD display. Comes with 24K of ROM and 2.2K of RAM (1.7K user available). Has 18 reversible user-definable keys; typewriter keyboard layout with separate numeric keys; memory safeguard when power is off; pass code security function; and automatic power-off. Uses rechargeable Ni-Cd batteries and comes with wallet case. Measures $5^5/_{16}$" W × $2^3/_4$" D × $^3/_8$" H. $110.

Circle No. 99 on Free Information Card

COMPACT BETAMAX VCR

Sony's Model SLO-420 VCR offers Beta II/III record and Beta I/II/III playback in a case 17" W × 3⅛" H. Also: front cassette loading, BetaScan high-speed picture search; Swing Search System multi-speed bidirectional playback and freeze frame; electronic Tab Marker System for random access of up to nine locations on a tape; programmable 2-week timer; and linear tape counter. Optional full-feature wireless remote controller.

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LES SOLOMON ON COMPUTER HARDWARE

It's a Long Haul Since the Altair

HOW would you like to have a complete computer system including many K bytes of RAM, an operating system (including CP/M if you desire), a high-level language in ROM, a high-resolution LCD display, a keyboard, joystick, I/O port, and a modem (direct connect), all in a package small enough to fit easily in a shirt pocket? To further titilate you, such a system can be built at the present time.

Let's take a closer look at this proposition. If you were at the last CES show in Las Vegas, you would have seen the latest from Casio—the model LCV-30 Casiovision TV receiver whose outside dimensions are a mere 3 3/16" H × 4 11/16" W × 1" D. The high-resolution twisted nematic LCD screen is 2 3/4" diagonal. This takes care of the raster scan video monitor.

Then, you can purchase any of several digital wristwatches that also include a calculator (and keypad) for the keyboard. The same store that sells you the watch/calculator probably also carries many palm-sized LCD display video games with joysticks.

Recently, Intel announced that it could supply CP/M on a chip, and we all know that BASIC comes in ROM. So there you have your operating system and high-level language.

So, all you need are the semiconductors required to tie the system together. This is where VLSI (very large scale integration) comes in. To realize a pocket computer, we must understand one of the limitations of VLSI—namely, how dense can it get?

Most of us have lived since the days when we first had only a handful of gates on a single chip and now there are complex microprocessors with several tens of thousands of transistors on chips of almost the same areas. Every week, it seems, new density breakthroughs are coming out of the research laboratories. We now appear to be in the "gazillion" element density which means that it is becoming possible to diffuse a CPU, ROM, a considerable amount of RAM, and possibly an I/O port, sound generator, and direct-connect modem, all on a single chip.

Obviously, there has to be a limit to how many elements can be deposited on one chip. The limit is determined not by the diffusion techniques involved, but by our old pre-computer nemesis—voltage breakdown.

New Voltage Standard. Since the introduction of TTL logic, most hardware has been living in a 5-V environment. In fact, other than RS-232, the "5-V standard" is the oldest we have in the microcomputer industry. Even the S-100/IEEE-696, although it is the oldest "hobby" computer bus, is a relative newcomer.

We are now due for a change. The JC42.3 committee for MOS memories of the Joint Electronics Devices Council (JEDEC) has proposed the use of a 3.3 ±0.3-V power supply standard for regulated supplies, and a 2-to-3.6-V standard for battery operation of semiconductors.

The 3.3-V level for the regulated supplies will still provide the minimum of 2.4 V required as a TTL logic 1. If this 3.3 V bothers you, keep in mind that, not too long ago, you could purchase static RAM cards that used about 3 V from a small rechargeable cell to maintain the logic when the computer main power was turned off. The small NiCad was trickle-charged when the bus power was turned on. In fact, shortly before the advent of microcomputing, we were using 3.6 V as the operating voltage for RTL (resistor-transistor-logic), a digital approach that fell by the wayside when TTL appeared on the scene.

The 2-to-3.6-V battery standard takes into account such factors as load, temperature, aging, etc., each of which affects battery performance. At the low end, the 2V will accommodate lead-acid cells that have a nominal 2.2-V output, approximately the same as a single lithium or a pair of NiCad cells.

(Continued on page 16)

The Casio Model LCV-30 is 3 3/16" × 4 11/16" and weighs 12.35 oz.

Ad designed by Todd Lerner

WORD PROCESSOR?

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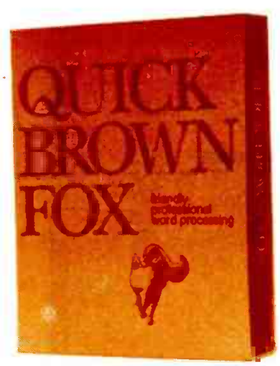

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...LES SOLOMON (from p. 14)

Now we get to the main reason for the reduction in voltage requirements.

When we hit the densities of some of the modern VLSI chips, we start looking at some mighty small distances between adjacent elements, and in fact, the "insulation" is reduced to the point where even 5 V will produce a breakdown. Since we still live in a basically TTL world, any new semiconductors must be compatible with TTL—thus the 3-V suggested operating voltage standard. This voltage level is safe for the 1-to-1.25-micron structures currently being used, but higher densities mean smaller inter-element spacing, requiring a lower operating voltage to prevent catastrophic breakdown.

Keep in mind that we have had a high-density, low-voltage situation for quite a while. Look first at the functions contained in a typical digital wristwatch (including the LCD readout), then at the power cell that makes it work. If this is any sign, how far can we be from the computer in a wristwatch?

A spokesman for JEDEC points out that 3-V logic may have to be replaced by 2-V logic in the foreseeable future if sub-micron elements are used in chip fabrication. However, it is hoped that the 3-V logic standard will be maintained for at least one decade. So, it looks like the 21st century will start with 2-V logic, and go down from there. What is the bottom line? Could we arrive at biochemical voltages? Could we be in for implanted systems? Would we have DB-25 implants to interface to the world? The mind reels. ◇

"Sure we have video machines here—but no quarters!"

STAN VEIT ON COMPUTER SOFTWARE

The Latest CP/M Software and Hardware, Including CP/M-Plus

THE CP/M-'83 Show held in the new Moscone Center in San Francisco was both innovative and a tribute to Dr. Gary Kildall, President of Digital Research Inc. and author of CP/M. Sponsors of the show had predicted that about 22,000 people would attend the seminars, lectures and exhibits during the three-day show. When the final count was made, more than three times that number had shown up.

What was it that drew so many people to this first major show devoted to a software system? Well, I believe that part of it was the announcement that Version 3.0 of CP/M had been released under the name "CP/M-Plus," and that thousands of users wanted to find out how this would affect their 8-bit CP/M systems. Another group wanted to see what was new in the latest battle in the war between Digital Research and Microsoft for 16-bit operating system dominance. Still others wanted to see the latest in CP/M-based software and hardware. All these were satisfied at the show.

For those of you who do not know the history of CP/M and its supporting language software, let me quickly recap it for you. Gary Kildall wrote the disk operating system called CP/M for Intel in the ancient days of microcomputing—1974-1975.

It was adopted by Imsai for its disk system and also by many other manufacturers because of several important characteristics:

It worked!

It was easily adapted to any I/O and computer.

It was inexpensive to acquire and distribute.

It supported many languages and applications.

CP/M was not the perfect system but it became almost universal for the 8080/Z80 family of microcomputers. A good part of the credit for this is owed to the library of public domain software distributed by the CP/M Users Group. Another sizable block of credit is due to the people who adapted CP/M to every 8080/Z80 computer that came on the market regardless of the type of disk drive it used. The name of the company that performed this great public service is Lifeboat Associates and the men responsible are Tony Gold and Larry Alkoff.

Also important in the growth of CP/M was that it supported MBASIC from Microsoft and CBASIC from Digital Research and these became the major languages for microcomputer applications.

Now the plot thickens as they say in the theatre. IBM wanted to use MBASIC for its new personal computer and it contracted with Microsoft for both ROM and disk BASIC.

It is said that IBM asked Microsoft to get Digital Research to design CP/M for the 16-bit 8088 chip without saying who it was for. I do not know if this story is correct or not but, somehow, Digital Research dropped the ball and Microsoft recovered. In any event, the principal operating system for the IBM-PC became Microsoft's MSDOS (called PC-DOS by IBM). This is a CP/M "somewhat-look-alike" originally designed by Seattle Computer Co.

Digital Research's CP/M-86 became one of the secondary operating systems for the IBM-PC, but IBM sold it for a high price, while merchandising PC-DOS for only $40, and threw in the BASIC for free! Naturally PC-DOS became the preferred system for this important microcomputer. What little application software there was developed for the early PC's was written in it.

The relationship between Digital Research and Microsoft became somewhat strained, especially when DRI went into the language business by buying CBASIC and PASCAL MT. Microsoft then announced that PC-DOS and MSDOS would be upward compatible with its Xenix (a licensed version of UNIX from AT&T).

The foregoing is a quick rundown on the situation at the time of CP/M-'83. Most of the computer companies with 16-bit 8088's and 8086's announced support for both operating systems because they had no idea how it would all come out.

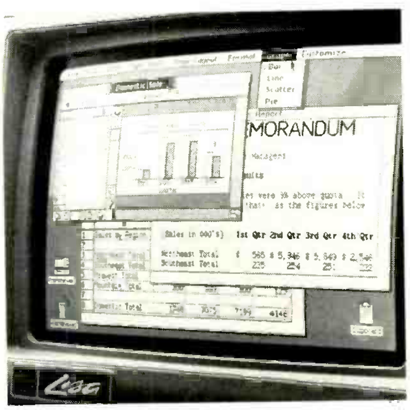
Before the show, I attended several seminars given by Digital Research to bring the press up to date on developments. Digital Research announced it would now sell CP/M-86 for the IBM-PC through its own dealers rather than through IBM. The package will cost only $60 and will include a print spooler and new graphics software. Now, you do not get a free language, but you do get an assembler (which is extra with PC-DOS) and a package of utilities. Languages are separate, but will be offered at reasonable cost.

I think that this is a deal that will attract a lot of users and software developers to CP/M-86. There is also the lure of the familiar and the fact that there is upward mobility within the CP/M family to the new Concurrent CP/M-86, MP/M, and CP/Net.

Upward mobility within the PC-DOS family leads to Xenix, which is another world. One of the things that annoys me with both CP/M and MS-DOS (PC-DOS) is the terrible Line Editor you get. We have come far enough in this business towards "user friendly" software to forget about such monsters as line-oriented editors. I have seen the screen editor that IBM has for the PC and it is real nice. Why don't they release it?

In the seminars, DRI talked a lot about Concurrent CP/M-86, which allows several tasks to be run on a single-user system. They have also released a CBASIC Compiler in a 16-bit version, and a 16-bit version of PL/1.

Gary Kildall has been personally developing a new LOGO called Dr.



Using the new Apple Lisa computer.

LOGO. I wondered why DRI should be involved with a children's educational language? Well, Dr. Kildall is deeply interested in the educational uses of personal computers, but beyond that he is interested in the application of LOGO to commercial and scientific purposes. After seeing Apple's new business machine, Lisa, and VisiOn from Visicorp (more about this later) I understand where he is going. LOGO is the ideal language for use with Mouse inputs and three-dimensional bit pads, and even voice input of data.

Just to show that it still thinks the 8-bit world will be around for a long time, Digital Research announced the new update to CP/M known as CP/M Plus (Version 3.0).

A whole new group of manufacturers exhibited machines running CP/M at the show. NCR introduced its new Decision Mate V Personal Computer using CP/M in the 8-bit version and CP/M-86 for the 16-bit version, all with CP/M graphics software. The multi-user versions will use CP/NET. It was no coincidence that the NCR announcement came just after the Digital Research press seminar. Gary Kildall was one of the speakers and his company has had a major role in the software development of the NCR personal computer. I predict that this company and its new personal computer will be an important factor in small-business computing.

I had been away from my desk on a tour of Silicon Valley and not seen my mail, so when I walked into the show I was surprised to see that Radio Shack, long a hold-out from the world of CP/M, joined it with its new Model 12 Computer. This looks like the Model 16, except it has no 68000 CPU. On the other side of the coin, Radio Shack also announced that the Model 16 will run Microsoft's Xenix on the Model 16's 68000 CPU. I've been working on the Commodore 64 computer, but had not received the CP/M cartridge. However, at the Commodore booth there it was, the very-first CP/M cartridge for the Commodore 64 shown to the public! I was impressed and pleased that the world of CP/M software would be open to low-cost computers.

The biggest crowds at the show were at the VisiCorp booth, where they were showing VisiOn, the new Mouse-operated, multi-dimensional, intregrated software environment. This system enables the user to have many related spreadsheets on the screen and use the Mouse device to originate and update them. The demo used the analogy of a desktop and file cabinet to explain how the system worked, and it worked very well indeed. This is the way we likely will be working in the near future—instead of being "paper pushers" or "keyboard jockeys", we will become "Mouse chasers"!

Since the Cable Cars are gone from the streets of San Francisco (and I miss them), I went over to one sitting on the show floor. It was the exhibit of Perfect Software, celebrating release of their whole package of intregrated Perfect Software. This is one of the systems that includes Perfect Writer, Perfect Speller, Perfect Filer, and so on. They were giving away Tee-shirts, but since I am not Perfect, they didn't have my size!

I was attracted to a whole group of small single-card computers with 64K of RAM, a Z80 CPU, and I/O that fit inside the case of a 5" floppy drive. A typical model is the PMC-Mate from PMC Computers, which formerly made TRS-80 clones. We will hear more about these tiny Z80-based CP/M computers.

As I walked the show I met many people that I know from all over the country. One of them was Tony Gold. Not many people realize that this man almost single-handedly founded the CP/M Users Group, which provided the almost-free library of public-domain software. When I say "almost-free," I mean that they charged only $8 for a disk full of software at a time when the empty diskette cost about $5.

While resting my sore feet at the PC Magazine booth, owned by our parent company, Ziff-Davis Publishing Co., I met Seymour Rubenstein, President of Micropro International, which publishes the famous WordStar, SpellStar, InfoStar, and Mail Merge. His company was not represented at the show, and he was just a visitor enjoying the exhibits. I asked him how come they were not there and he said that they had been in a lot of shows and did not expect this one to be so well attended.

At the Ashton-Tate booth there was a thick crowd throughout the show. I pushed my way through the crowd because I hoped that my old friend, George Tate, had finally released the super word processor that he and Jerry Pournelle have been touting, but the attraction was only a new book, *Everyman's Data Base Primer Featuring dBase II.* It is an indication of the serious interest of the crowd at this show that they were mobbing the booth to buy a $12 book about a data base!

I was amazed to see a Seiko booth devoted to software! It was promoting a locking system whereby a person buys a software package and pays only a portion of the total price, say $49. The purchaser gets partial use of the software, enough to demonstrate the value of the package. If it's wanted, the buyer pays the dealer the full price and then is given a key number to unlock the rest of the software. Bets were being laid at the show about how long it will take to crack the "protection" scheme. (Just because it's there!)

Prior to going to the CP/M-83 Show, I attended the Apple Computer meeting where the Lisa and Apple IIe computers were introduced. The Lisa will sell for almost 10 kilobucks and the Apple IIe for about $1400. Lisa is an acronym for Local Integrated Software Architecture.

The outstanding feature of this M68000-based computer is its "Mouse" environment. A Mouse is a little gadget that fits in the palm of your hand and you move it over a flat surface which represents the screen you are watching. As you move the Mouse, the cursor on the screen moves. For example: if you move the Mouse to the upper-right corner of the surface, the cursor will move to the upper right-hand corner of the screen. There are buttons on the Mouse and, if you press them, things happen. Say there is a form in a window on the upper-right corner of the screen and it has sales numbers on it. If you use the Mouse to place the cursor on these figures and press a button, you can move the Mouse to another form in a window in the lower-left corner, press another button, and you have transferred the figures! (Since a picture is worth a thousand words, see the Lisa screen illustration pictured here.)

There are six integrated software applications for Lisa covering the core of office work. These include spreadsheets, word processing, business charts and graphics, graphic images, personal filing, and project management. These are all set up for use with the Mouse and by top-level managers who want to do as little keyboard work as possible. However, the price of $10,000 will keep all but businesses from buying Lisa. For the rest of us, Apple will shortly release Mackintosh, a more modestly priced computer that will incorporate some of the same features. When Steve Jobs was asked if he could give the release date for Mackintosh, he answered "I could, but I won't."

Just so all the eggs are not in one basket, Lisa will also run under the UniPlus operating system, a version of UNIX from Bell Labs. This is Version III as enhanced by the University of California, Berkley. In addition, it will run Micro Focus COBOL and, in the future, it will run CP/M-68000 now being written by Digital Research in the "C" to make it portable to all M68000 machines. ◇

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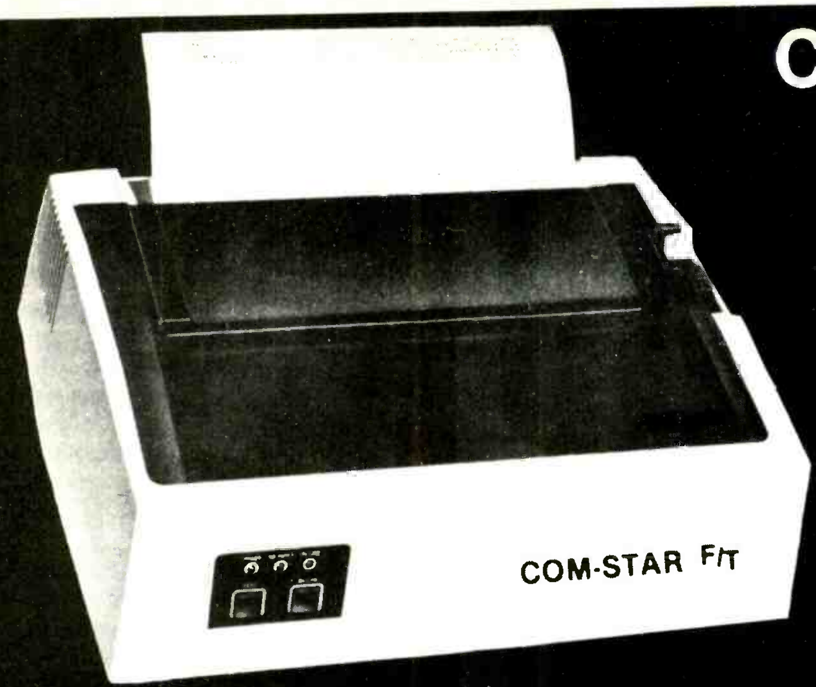

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CIRCLE NO. 40 ON FREE INFORMATION CARD

Two new Products Go A Step Beyond PCM

By Len Feldman

AT THE recent Audio Engineering Society (AES) Convention in Anaheim, CA, there were at least two product developments in digital audio hardware that could have an important and immediate impact on the way we enjoy musical reproduction in our homes. One product was designed specifically for home audio recording. The other was designed for recording studios but its attractive cost and superior performance suggest that a consumer version is not far behind.

Digital audio processors designed to work with video tape transports have been a mainstay of recording studios for several years. A few low-cost Pulse Code Modulation (PCM) processors have also been made available on a limited basis for use with home video recorders, enabling serious audiophiles to record true digital sound on video tape. PCM processors for professional use, capable of working with digital editing equipment have generally cost over $25,000 for the basic processor alone. The high price tag has prevented many small recording studios from entering the digital audio era so there has been a rather slow start in the accumulation of digitally mastered musical fare that could ultimately be used to build digital disc libraries. That, in turn, has discouraged many producers of compact digital disc players from offering their products at as early a date as they had planned.

A Processor Without Costly PCM. dbx, Inc., best known for its linear companding noise reduction systems, has developed a processor scheduled to sell to professional audio studios for less than $5000.00, less than one-fifth of what typically had been the price of PCM equipment. The Model 700, (Fig. 1) is totally unlike any currently available digital audio processor since it does not employ PCM at all. Rather, it is based on an improved version of another method for digitizing audio signals, called "Delta Modulation."

In the conventional PCM approach, each sampled level of audio signal amplitude is represented by a number, produced by an analog-to-digital (A/D) converter. In Delta Modulation digital audio encoding, the numbers produced by the A/D converter represent the *differences* between successive sampled signal amplitudes rather than the total instantaneous amplitudes themselves. In its simplest form, Delta Modulation yields dynamic ranges of only around 55 dB; substantially less than the best analog records or tapes are capable of providing.

A variation of the Delta Modulation ideas is called Adaptive Delta Modulation (ADM). In this process, digital numbers produced by the A/D converter are allowed to represent *varying* differences between successive audio amplitudes. When the input signal level is changing quickly, the step-size becomes large, producing a digital output that tracks the input. Likewise, when the input signal changes slowly, the step-size is adjusted to be smaller. ADM extends the dynamic range of ordinary Delta Modulation to around 90 dB (about the same dynamic range now achieved by 16-bit PCM digital systems). While ADM represents a significant improvement over ordinary Delta Modulation in dynamic range and is far less expensive to implement than PCM, it does have other problems.

Because the introduction of a random noise floor (known as "dither noise" in PCM) is hard to implement in ADM, such noise is not used. As a result, the ADM noise floor may exhibit a definite tonality, and low-level signals may be highly distorted. Furthermore, with typical real-world circuits, the step size referred to earlier can be adjusted only over a range of about 500 to 1, reducing the practical dynamic range of the system. ADM also tends to produce a shifting noise floor because the quantization error of an ADM system changes with signal level. If the noise floor is not far enough below the noise level input signal, "breathing" may become audible. Finally, when the input to an ADM system becomes very small in amplitude (during quiet musical pasages), the converter may be asked to compare two values that differ by very small amounts. The result may be a limit on minimum step size and a consequent raising of the noise floor.

Companded Predictive Delta Modulation. That's what dbx calls its solution to the problems of Adaptive Delta Modulation. CPDM (its acronym for the new system) differs from ADM in two major respects. First, the dbx 700's converter used a precision compander in which the signal itself is varied with a voltage-controlled-amplifier to avoid overloading a fixed Delta Modulator. Second, the dbx Delta Modulator uses a "linear-prediction filter," which analyzes the history of the audio signal to predict its future.

While the term companding has

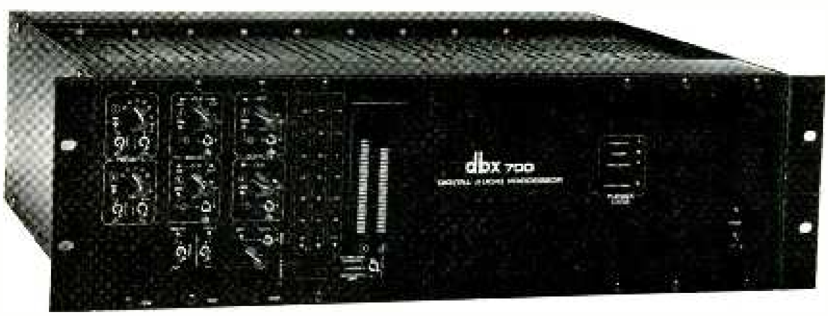

Fig. 1. The dbx Model 700 Digital Processor uses a form of delta modulation instead of PCM.

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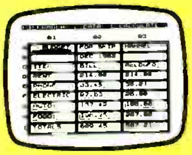

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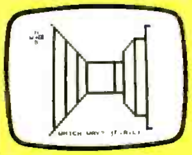

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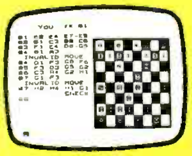

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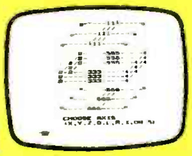

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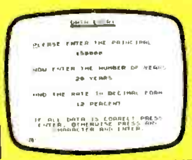

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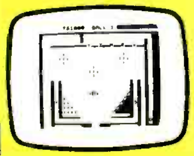

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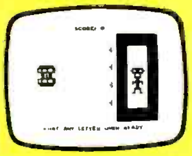

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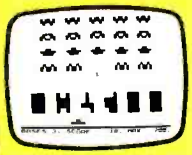

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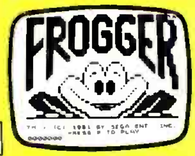

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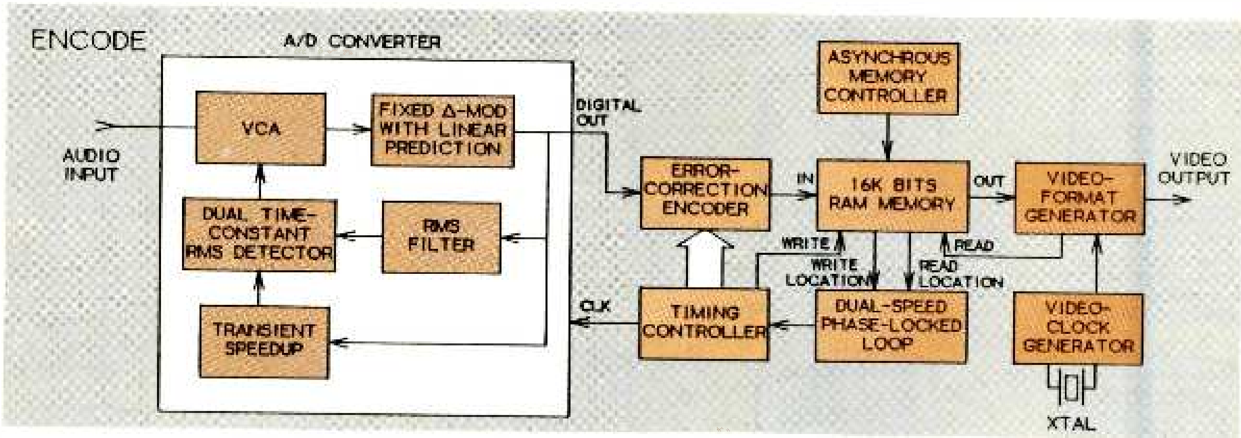


Fig. 2. Encoding in the dbx 700 digital audio processor quantizes the audio input directly, without an intermediate storage medium.

been associated by many audio enthusiasts with some undesirable forms of "breathing" or "pumping," it is important to understand that such effects are not really the fault of any companding circuit, but rather the fault of a nonlinear intermediary storage medium (such as the tape). In the case of the CPDM processor, however, the level sensing circuit of its compander obtains information directly from the digital bit stream in both the encode (record) and decode (play) modes. Since these bit streams are identical, mistracking of the system cannot occur.

As for the Linear Prediction circuit, it estimates the parameters of a coming signal by monitoring the signals that immediately preceded it. This is done 700,000 times per second. The dbx Linear Prediction circuit increased the dynamic range of a basic Delta Modulator from 55 dB to 70 dB. The companding circuit further increases the dynamic range to more than 110 dB—some 20 dB higher than the dynamic range achieved by conventional 16-bit PCM systems. While space does not permit a detailed circuit explanation of the new dbx digital audio processor, the block diagrams of Figs. 2 (encode) and 3 (decode) may help you to understand the basics.

Tricode PCM From Sansui. Sansui's new product introduced at the AES convention is intended strictly for home audio systems. Rather than abandon the PDM approach to digital audio recording, Sansui supposedly improved upon it, with a system called Tricode PCM. The chief virtue of the PC-X1 Processor (Fig. 4) is its ability to recover accurate PCM digital code from a VCR even when the VCR is operated at its slowest video tape speed. Previously, processors designed to work with home VCRs had to be operated at their highest speeds (Beta II, in the case of Beta-format recorders or SP in the case of VHS machines).

When digital data is accurately stored and transmitted in a PCM system, it produces clear and open "eye patterns" on an oscilloscope, as illustrated in the lower traces of the photos in Fig. 5. A clear pattern is an indication that the 1's and 0's that represent digital data are being faithfully reproduced (lower trace). When data is jumbled, or if some digits are unrecognizable by the system, "eye" patterns appear blurred or closed, as in the upper trace of Fig. 5.

There are at least four reasons why it has been impractical, until now, to record digital PCM signals on video tape at such slow speeds.

1. A VCR scans video tracks of a video tape as it records and plays back digital data. At normal speed, track width is 58 microns. At one-third speed on a VHS machine, track width is only 19 microns. This reduction in width leads to a three-

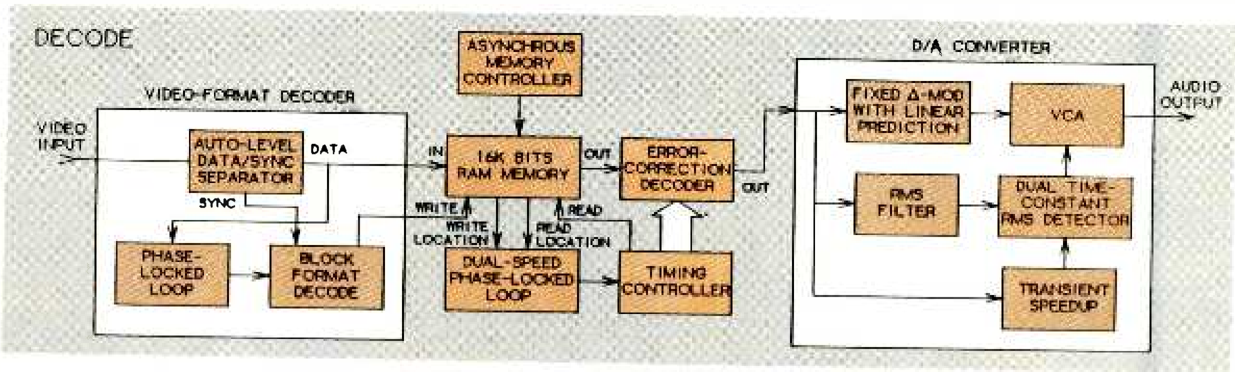


Fig. 3. The decoding scheme used in the dbx 700 digital audio processor.

Fig. 4. The Sansui PC-X1 Tricode PCM processor works with any VCR.

fold increase in noise. In addition, the head tends to trace not only the desired track but adjacent tracks.

2. Any misalignment in a VCR transport is likely to show up more prominently at slow speed than at the faster SP speed. If the mechanism is not precisely aligned, jitter or vibrational shifts in the time base occur. During playback, data must be read on a regular time base; therefore, any shifts in data time base can lead to reading errors.

3. Since the frequency response of the system is narrower at slower tape speed, variations in amplitude of the digital data are more likely to occur, causing the eye patterns to close in from top to bottom. There is not as much amplitude difference between a 0 and a 1 in the data stream.

4. VCR manufacturers, conscious of the degraded video picture quality at slower speeds, usually incorporate special circuitry to compensate. While the circuitry often achieves its purpose as far as picture quality is concerned, digital audio data is often damaged beyond recognition. For example, one form of video compensation mixes adjacent pairs of horizontal lines. Since adjacent lines are quite similar in content, such mixing tends to reinforce the image and improve video signal-to-noise ratio. In digital PCM audio, however, adjacent lines are *not* interrelated, and mixing them is likely to produce data pulses that are neither distinctly 0 nor 1. They are therefore illegible to an ordinary digital PCM processor, and cause the blurred (and undecipherable) patterns seen on the scope.

At this writing, Mr. S. Takahashi, General Manager of Sansui's Research and Development Division, would not discuss the circuit details of his invention. (Patent filings are, apparently, still in progress.) In simplest terms, however, he explained the Tricode PCM Processor by saying that it extrapolates future pulse patterns from past patterns. Thus, if there is an improper variation in amplitude, the Tricode PCM restores the correct amplitude by analyzing previous data and reinstating a pulse pattern consistent with it. Similarly, if there are jitters or vibrational shifts in the time base, Tricode PCM predicts the direction of each shift, so that data at any instant is read correctly.

The Tricode PCM circuitry is complex, but it has been entirely incorporated into a single integrated circuit. As a result, Sansui's PC-X1 Tricode PCM Processor will work with any home or portable VCR and is expected to sell for around $1500. (It should be available in March.) With prices for standard VCRs as low as they are, that means that a recording enthusiast could be recording digitally on video tape for under $2000—hardly more than a good stereo analog open-reel recorder or a state-of-the-art stereo cassette deck. ◇

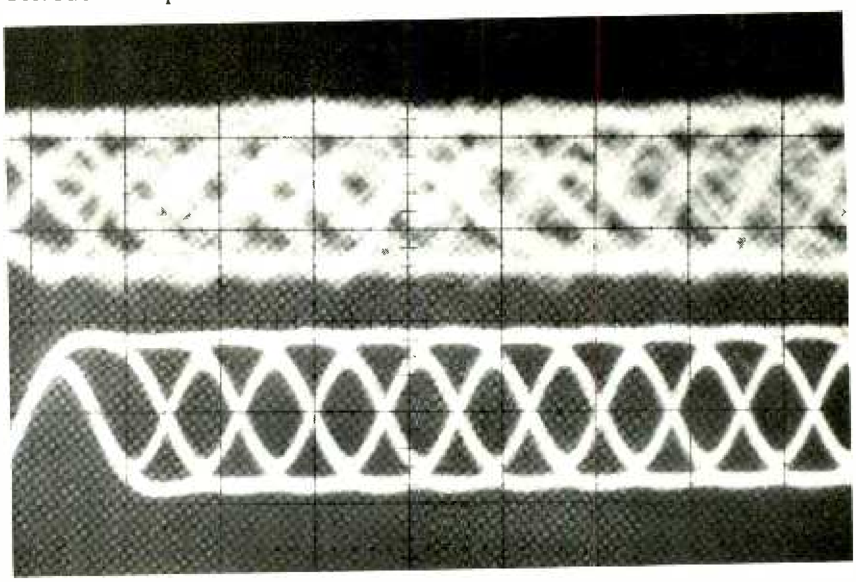
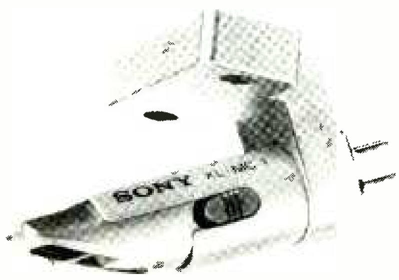


Fig. 5. Digital data recovered during playback from an ordinary processor (top) and the Sansui Tricode PCM (below).

Sony Model XL-MC1 Moving Coil Cartridge



THE Sony Model XL-MC1 brings the features and general performance characteristics of moving-coil (MC) phono cartridges into the budget price range. Its low output voltage, typical of MC cartridges, requires use of either a head amplifier or a step-up transformer to develop a signal of sufficient amplitude to drive amplifiers through conventional moving-magnet (MM) phono inputs. The stylus is not replaceable, but the cartridge plugs into its mounting bracket and can be removed and replaced almost as easily as any replaceable stylus. Suggested retail price of the Sony XL-MC1 is $60.

General Description. The active part of the cartridge is a slender cylinder that measures about $^1/_4$" in diameter and $^{11}/_{16}$" long. Four short pins at the rear end of the cylinder plug into a mounting bracket that fits any tonearm headshell with standard $^1/_2$" mounting centers. Terminals on the bracket accommodate the pin connectors from the tonearm shell. Weight of cartridge body alone is a mere 1.2 grams, while total weight of cartridge and bracket is only 3 grams, or about half that of a typical moving-magnet cartridge. For tonearms that cannot balance so light a cartridge, Sony supplies a small weight (about 2.8 grams) that installs between cartridge bracket and headshell to increase the mass to that of a conventional moving-magnet cartridge.

Inside the cartridge, a coreless armature coil, is wound in a "figure-8" pattern on a small flat bobbin. Good channel separation is achieved by having two coils wound at right angles to each other on the bobbin. A fixed magnetic field is generated by a "symmetrical flux" magnet that has no iron yoke or pole-piece structure. With the armature set inside the open end of the cylindrical magnet, it is surrounded by a uniform flux field.

An aluminum-alloy stylus cantilever extends forward from the coil bobbin, supported and damped by a rod attached to its rear. It is fitted with an elliptical stylus (exact dimensions not specified). Cantilever and stylus are protected by an angled extension of the tubular cartridge body, whose top is cut away to allow the stylus to be viewed from above while playing a record.

Tracking force can be 1.2 to 1.8 grams with 1.5 grams recommended. The force can be increased to no greater than 2 grams if ambient temperature falls below 50°F or for playing severely warped records. Resistance of the cartridge coil is 40 ohms/channel, permitting termination in any resistance from 40 to 100 ohms without affecting performance.

Rated frequency response of the cartridge is 10 Hz to 30 kHz (no deviation tolerance given). Channel separation is specified at more than 26 dB at 1000 Hz, and channel levels are claimed to be balanced within 1.5 dB. Rated output is 0.2 millivolts.

Laboratory Measurements. Our lab tests were performed with the XL-MC1 mounted in the tonearm of a Dual Model 741Q record player. A number of high-level tracking ability test records were used to establish the vertical force required for optimum performance before we conducted our performance tests.

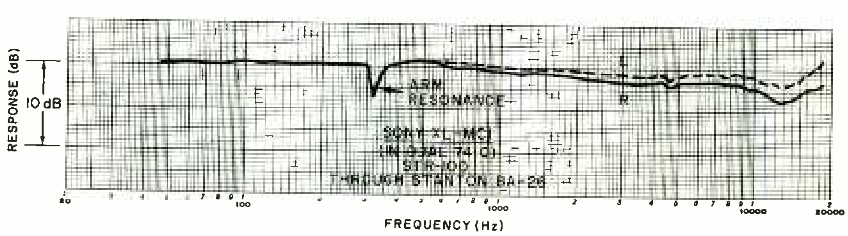
Very high-level low-frequency material could be played at the 1.2-gram minimum force rating, but 30 cm/s, 1000-Hz tones required a force of 1.8 grams. The German Hi-Fi #2 record could be played at the 50-micrometer level of its 300-Hz test tones at 1.5 grams and at 60 micrometers at 1.8 grams. Since we consider the latter to be a minimum requirement for a good high-fidelity cartridge, we used 1.8 grams for the remainder of our tests.

Frequency response, crosstalk, and output voltage were measured with a CBS STR100 test record. A Stanton Model BA-26 head amplifier, which has a rated voltage gain of ×20 (26 dB), was used to boost cartridge output to usable levels for all tests. At a recorded velocity of 3.54 cm/s, the 1000-Hz output from the cartridge (sans head amplifier) was 0.165 mV, and channel levels were matched within 0.5 dB. A gradual rolloff in output was observed with increasing frequency, to about −2 dB at 10,000 Hz, and the output returned to or slightly exceeded midrange levels, at 20,000 Hz. Total variation was +0/−3 dB from 40 to 20,000 Hz. Crosstalk response was relatively uniform, with channel separation of about 25 dB from 500 to 5000 Hz, after which it was at least 20 dB out to 20,000 Hz.

The low-frequency tonearm/cartridge resonance was about 10 Hz, the optimum for tracking warped records. Vertical stylus angle measured 20°. The response to the 1000-Hz square waves of the CBS STR112 test record resembled what we have measured from most good moving-coil cartridges: acceptable squareness, with top and bottom portions exhibiting extended ringing at about 40 kHz (an artifact of this record).

Tracking distortion was measured with two Shure test records. The TTR-102 is an intermodulation test record that has a mixture of 400- and 4000-Hz tones in a 4:1 amplitude ratio, recorded at peak velocities from about 7 to 27 cm/s. A standard IM analyzer was used to monitor the playback signal. Distortion did not fall below 2% at the lower velocities and was only 6% at 27 cm/s. Although this test has little correlation with the listening quality of a cartridge, it does give an indication of its ability to track very high levels without severe mistracking.

Shure's other record, the TTR-103, tests high-frequency tracking with 10.8-kHz tone bursts, at a 270-Hz repetition rate and at levels from 15 to 30 cm/s. The percentage of the 270-Hz repetition



Frequency response with a Stanton BA-26 head amplifier.

rate that is found in the cartridge's output is an indication of its ability to trace high-level bursts. In this test, the XL-MC1 was comparable to many of the better cartridges we have tested, with "distortion" readings between 0.7% and 0.9%.

User Comment. Subjective tracking tests of the Sony XL-MC1 cartridge were conducted with Shure's "Audio Obstacle Course" ERA IV and ERA V records. ERA IV confirmed our selection of 1.8 grams as a tracking force. At 1.5 grams the cartridge mistracked the two highest levels of all the selections on the record, while at 1.8 grams it exhibited only slight mistracking of the top level (#5) of the bells and flute sections. ERA V has a very different tracking test, using mixed tones instead of music, but results were similar. At 1.5 grams, the cartridge mistracked level 4; at 1.8 grams, it mistracked level 5 (out of 6).

This cartridge has the extended frequency response and strong, uniform channel separation that are hallmarks of a good moving-coil cartridge. It also shares with most moving-coil cartridges a somewhat limited tracking ability, as compared to the better moving-magnet types, even at a higher tracking force than is required by most of the latter. Output voltage is fairly typical of moving-coil cartridges. Using a Stanton BA-26 head amplifier and our Carver C-4000 preamplifier, the cartridge provided a very ample system gain with a very low noise level.

Although it is perhaps risky to talk of a "typical" moving-coil cartridge, given the diversity existing among available models, it seems fair to say that the Sony XL-MC1 is both less expensive and lighter than any other we have seen. These differences are not trivial, with both factors being about half as great as with other moving-coil cartridges. Since a number of moderately priced receivers now have built-in moving-coil head amplifiers, the XL-MC1 becomes a reasonable choice for an inexpensive music system. On the other hand, if one must spend several times the cost of the cartridge for a head amplifier, there is little justification for its use.

We will not go into detail about the sound of the XL-MC1, beyond stating that it was as good sounding as its response measurements suggest. Its tracking ability limitations, though real, will not necessarily be detected with most record material, which it is perfectly capable of tracking. On occasion, when playing very-high-velocity recorded passages, it had a tendency to generate harsh or muddy sound, but this was a rare occurrence during our use tests, considering that we were choosing records calculated to stress the cartridge beyond its limits. *Julian D. Hirsch*

CIRCLE NO. 101 ON FREE INFORMATION CARD

MOVING-COIL VS. MOVING-MAGNET CARTRIDGES

IT IS interesting and instructive to briefly compare moving-coil (MC) and moving-magnet (MM) phono cartridges in general and then to compare Sony's Model XL-MC1 (reviewed here) to a couple of other MC models we have recently tested.

There has been and still is a considerable amount of hyperbole—"hype"—that claims special sonic qualities for MC cartridges, based solely on their physical construction. However, none of this has ever been confirmed by measurement or by any properly controlled listening comparison that has come to our attention.

Comparisons. Both MM and MC cartridges are magnetic transducers in which the voltage generated is proportional to the rate of change of magnetic flux linkages with a conductor. In principle, it makes no difference whether the conductor is in a fixed field, as in MC cartridges, or the conductor is fixed and the field changes, as in various forms of moving-iron cartridges (which we lump together in the MM category). This is not meant to imply that all phono cartridges are alike or of equal merit. Rather, it means that differences result from specific design details, not transduction principles. Almost all audible distortion in record playing is due to differences in geometry between playback and cutting styli or to mistracking.

Let us consider the real advantages and limitations of each basic type of cartridge. On the plus side, MC cartridges have very low impedance, are essentially resistive, and have a response that is virtually independent of loading. Because MC cartridges have negligible inductance, their high-frequency response, which typically extends into the ultrasonic range, is solely a function of the mechanical moving system. (Extended high-frequency response is not necessarily an advantage, as we will see below.) A low coil impedance acts like a short circuit on the input of a preamplifier and minimizes pickup of hum and noise. Also, the geometry and symmetry of good MC cartridges make it possible to achieve uniform channel separation over a wide frequency range, although this is not really fundamental to the design.

Among the disadvantages of the MC design is usually higher price, due largely to the difficulty of winding two minuscule coils in an exact physical relationship. In most cases, output voltage is less than 10% that of an MM cartridge, requiring use of a step-up transformer or a "head amplifier" to drive the magnetic inputs of most amplifiers. Using either of these "signal boosters" can, at the very least, add considerably to the cost of using MC cartridges and increase system hum and noise if they are not properly installed. (There are, however, high-output MC cartridges that can drive a reasonably high-gain amplifier directly.) Styli are usually not user-replaceable, requiring a return to a factory-authorized center for replacement.

Other disadvantages of MC cartridges have to do with actual performance. Effective tip mass of the stylus, for example, is usually greater than for an MM cartridge, although the reverse has often been claimed, and compliance is frequently lower. The result is a need for somewhat greater tracking force and a generally poorer ability to track high-level recordings. Finally, the ultrasonic response of the MC cartridge has been claimed to overload amplifier stages, giving rise to so-called "TIM" or "SID" distortion in some amplifiers.

Among the advantages of MM cartridges are lower manufacturing cost; easy user replacement of styli; sufficient output voltage to directly drive virtually all existing amplifiers without a signal booster; usually greater tracking ability at lower tracking forces; and frequency response extending only slightly beyond the audio band.

Chief among the disadvantages of the MM cartridge is a certain dependence on load conditions, since coil inductance is frequently resonated with total external load capacitance to compensate for high-frequency stylus resonance to flatten response. Even if this is not done by design, the high-frequency response of most MM cartridges is affected by load capacitance (and to some extent, resistance). Also, the high-frequency RIAA equalization of some amplifiers can be affected by the presence of a large cartridge inductance at the input.

Beyond the above factors, there are few real differences between MM and MC cartridges. Either can be expensive, though no MM cartridges so far has matched the $1000 price of some MC types. Conversely, either type can be inexpensive, although even Sony's Model XL-MC1 cannot quite match the $15 price of some good but inexpensive MM cartridges. A few MM cartridges provide lower output voltage than some MC cartridges, and either type can be light or heavy in weight.

Recently Tested. An excellent example of a relatively inexpensive high-output, high-quality MC cartridge is Dynavector's Model DV10X Type 3, priced at $150. It has an output of 2.75 mV and tracks at 1.7 g. It also has exceptionally good tracking ability, low inherent distortion, and an unusually flat frequency response. In our tests, the DV10X was a notably fine cartridge, irrespective of its type of transduction.

A very different cartridge is Stanton's Model 980LZS, which is not a moving-coil cartridge but is promoted by Stanton as a "moving-coil replacement." This cartridge can be considered a moving-coil "emulator," since there is no way one can tell from external characteristics or measurements that it is not an MC cartridge. Actually, it is an MM cartridge with very-low-impedance coils that generate an output of about 0.2 mV/channel, like a true MC cartridge. And, like most MC cartridges, it is immune to the effects of load capacitance and resistance. Even its $250 price resembles that of a good-quality MC cartridge. However, it also has the advantages of the MM design, including easy stylus replacement by the user, low tracking force of 1 g or less, and superior tracking ability.

Published specifications and results of our key measurements for each of these cartridges are listed below. As we view them from the same perspective, we can see that the real differences between them reflect prices more than actual operating principles. In any given situation, a good argument could probably be made for selecting one or the other of these cartridges—or others that might have been included in this comparison—on the basis of cost, tonearm properties, etc. We feel that each of these cartridges represents good value at its price.

With many, if not most records, there would be little or no difference in listening quality between these cartridges. Any real differences would be attributable largely to slightly different high-frequency response characteristics. With wide-dynamic-range records, such as digitally mastered or direct-to-disc recordings, the superior tracking ability of the Stanton and Dynavector cartridges would give them a noticeable advantage in sound clarity over Sony's XL-MC1 cartridge, but at considerably greater price. The major operating difference between these two cartridges would probably be in tracking force, which is about half as much for Stanton's as for Dynavector's cartridge.

Bottom Line. From the foregoing, it should be fairly obvious that how a cartridge works should be of only minor importance compared to how *well* it performs its task. The same holds true for *any* high-fidelity component. ◇

MOVING COIL CARTRIDGE COMPARISON

Manufacturer's Spec.	Sony XL-MC1	Dynavector DV10X Type 3	Stanton 980LZS
Type	MC	MC	MM
Output voltage (Hz-kHz ± dB)	10-30 (NA)	20-20 (2)	10-50 (NA)
Channel separation (1 kHz, dB)	26	20	35
Channel balance (dB)	1.5	NA	1
Dc resistance (ohms)	40	NA	3
Inductance (mH)	NA	NA	1
Load resistance (ohms)	40 to 100k	47k *	at least 100
Load capacitance (pF)	NA	50 *	less than 1000
Compliance (× 10^{-6} cm/dyne)	20	12	NA
Tracking force in grams (recommended)	1.2-1.8 (1.5)	1.5-1.9 (1.7)	0.5-1.5 (1)
Cantilever	aluminum tube	tapered alum. tube	NA
Stylus shape	elliptical	elliptical	stereohedron line contact
Replaceable	no—entire cartridge unplugs	no	yes
Weight in grams	3.0 **	4.6	5.5
Price	$60	$150	$250

* Nominal values. Completely noncritical

** Additional 2.8-gram weight supplied for arms requiring greater cartridge weight.

Measured Performance	Sony XL-MC1	Dynavector DV10X Type 3	Stanton 980LZS
Output voltage @ 3.54 cm/s	0.165mV	2.75 mV	0.21 mV
Channel balance (dB @ 1 kHz)	0.50	0.0	0.33
Channel separation (dB)			
@1 kHz	25	33	25.5
@10 kHz	20.5	30.5	24
Freq. response (dB re 500 Hz) 40-20,000 Hz	+0/−3.5	+0/−3	±2
Tracking force (grams)	1.8	1.7	1.0
Tracking ability at F* (300 Hz micrometers)	60	70	80
IM distortion at F** (%)	6	3	2.5
Lowest level mistracked on Shure ERA IV record	5 (bells, flute)	none mistracked	5 (bells, flute)
Vertical stylus angle (degrees)	20	22	28

* German HiFi Institute Record #2

** ShureTTR-102

All others using CBS STR100

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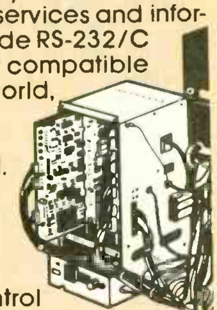

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CIRCLE NO. 28 ON FREE INFORMATION CARD

COMPUTER VIDEO GAMES

Hands-On Reviews By the C & E Staff of Latest Computer Games

YOU MAY have bought your Apple, Atari, VIC-20, IBM PC, Radio Shack, Commodore, Timex, or other personal computers for the best of reasons: business, hobby, teaching aid for the kids, or product development: maybe even just out of elitism or even curiosity. But when all the work's done, it's play time, and nothing is quite as good as a computer for engaging, totally involving, interactive entertainment.

If you look upon home video games with bewildered dismay, you have good reason. The basic machines used for this don't have much brain power. The old Atari VCS (or 2600 if you will) for example, comes equipped with a big, fat 128 bytes of memory. That's not kilobytes—that's *bytes!* Virtually everything with any intelligence, memory, screen mapping and actual programming has to be on the plug-in ROM game cartridge. The wonder of it all is that nearly 15 million of the dumb video game machines have been sold so far, and they're still selling.

Yet, while home game machines from Atari and other manufacturers are getting better all the time, and some now come with a whopping 32K of RAM, the imaginative game programming geniuses have naturally, had more room to develop games for home computers.

Right now, there are over a dozen companies making ROM cartridge games for home game machines. Each one has to commit enormous amounts of capital to production, game development, advertising and promotion if the company's going to get anywhere near success. Some of these companies are ailing from undercapitalization and at least one went in Chapter XI last year.

Computer game companies don't have such grave problems. Successful game software houses have started in garages, living rooms—anywhere that there's a computer. In fact, anyone can do this if he knows how to write a program and has a home computer. Duplicating the games is simply a matter of using two disk drives, and good-quality blank disks are very reasonably priced.

The net result of all this is a proliferation of computer-game companies. Some are big, some still in the living room.

This does create one difficulty from the game buyer's standpoint. A game may be super-good and reviewed as such in these pages. But by the time you, the readers, go out to buy it, the company may be out of business.

So we'll help—a little at least. With each computer game review is the software company's name, address and phone number. If you want a game and your favorite store doesn't have it, usually the company will be glad to fill a mail order for you.

SUBMARINE COMMANDER

ROM Cartridge for Atari 400/800/1200.
Thorn EMI, 1370 Avenue of the Americas, New York, NY 10019, 212-997-8990. $49.95.
Graphics ★★★★
Gameplay ★★★
Sustained Interest ★★★★
Type: *Joystick and keyboard strategy/action game.*
Memory required: *Minimum resident (16K)*

While the joystick and firing button are part of the controls for this excellent game from our British cousins, it is primarily a game of strategy, skill and patience. As the commander of a World War II submarine, it's your job to sink all enemy shipping in the Mediterranean Sea.

One of the game's three displays is a map of the Mediterranean, with your position marked by a white cross and the five or six enemy fleets, each marked by a black square. A second screen gives you the view from the periscope, but you have to be at proper attack depth for it to work (no more than 35 ft under the surface). The third screen is a display of your sonar and hydrophone screens, and an accumulator that tells how much enemy tonnage you have sunk.

All three displays show your gauges and instruments, which include bow plane angle, rudder angle, compass heading, air supply, sonar bottom profile, speed, torpedo supply, fuel supply, battery charge, and damage indicators.

There's a lot to keep track of, and the game has nine different skill levels. You learn how to maneuver close to the enemy on the surface, where you can make 20 knots (maximum speed submerged is 9 knots). While on the surface, your batteries recharge and your sub is gradually repaired.

You learn how to use the hydrophone to zero in on the enemy and the sonar to aim your torpedoes. The periscope lets you watch the wake of the "fish" you have fired and the explosion when you hit a ship.

But it's not all that easy. When you make your presence known by attacking, or getting too close to the ships, they start dropping depth charges, and it's time to crash dive to get away from the attack. You can be sunk, you can get stuck on the bottom in shallow waters, and you can run out of air, torpedoes, battery charge or patience with yourself. You can blow your ballast tanks to surface in a hurry, and you can adjust your speed with keyboard controls. But maneuvering appears to happen in real time, which can be agonizingly slow if you're used to fast-moving shoot-em-up games.

You can expect to take a clobbering the first few times you play this game. You must learn to adjust your attack speeds, your submerged strategy, and a number of other factors. Also look forward to spending about an hour on one game, unless you get destroyed first.

There are also different schools of thought about gameplay. Some players prefer an attack depth of 25 ft. while others may feel more comfortable at 35 ft. It's really a matter of personal style, and you can add plenty of that to this game. It's great fun, and really engrossing.

ESCAPE FROM VULCAN'S ISLE

Diskette for Atari 400/800/1200 and Apple II.
EPYX (Automated Simulations, Inc.), 1043 Kies Ct., Sunnyvale, CA 94086. 408-745-0700. $39.95.
Graphics ★★★★
Gameplay ★★★★
Sustained Interest ★★★
Type: *Joystick and keyboard strategy/action game*
Memory Required: *Atari BASIC cartridge and 40K RAM.*

While adventure games are nothing new to computer buffs, the new breed of adventure—like this one—has excellent screen graphics and presents a visual scenario for most of your activities. As with the more traditional text-only adventures, you are presented with several options during the course of gameplay.

In "Escape" you are a shipwrecked sailor who is stuck on Vulcan's Isle, at first a seemingly benign place with friendly natives who live in a little village near the shipwreck site. But there are creatures who will try to destroy you—the Harrises, Satyrs, Giant Med Flies, Guards and Winged Demons. You can outmaneuver them or fight them and you get fair warning when one is nearby or about to attack.

You can win battles once you have increased your energy (power) level, which you build, along with your supply of gold. Use the gold to trade with the natives to buy useful objects like a lantern, which you will need during your explorations.

Keyboard commands let you choose various options, and you use the joystick to move your alter ego around the screen, exploring, collecting goodies, avoiding getting killed, and looking for a way to escape from the island once and for all. And yes, escape is possible, but only after playing the game several times can you learn the technique and the secret. Oh, by the way, if you try to walk out into the ocean, the computer stops you and prints on the screen, "You cannot swim!"

The computer lets you inventory your treasures and energy level at any time with an "I" command. And if you want to stop the game and resume it later, you can store it on the diskette with an "S" command.

In your wanderings, you explore the inside of a volcano, underground tombs and caverns, and through it all, you keep running into dangerous adversaries. It's fun, it's engrossing. and frustrating—in short, quite a good game.

VIDEO VERMIN

ROM Cartridge for Commodore VIC-20.
United Microware Industries, Inc., 3503-C Temple Ave., Pomona, CA 91768, 714-594-1351. $49.95.
Graphics ★★★★
Gameplay ★★★★
Sustained Interest ★★★★
Type: *Joystick action game*
Memory required: *Minimum resident (3.5K)*

When you're dealing with joystick/action video games, it's always natural to look for an arcade game counterpart, and Video Vermin particularly lends itself to this comparison. It's something like, but definitely not a copy of, Centipede.

Like the arcade game, VV has plenty of fast action, and if you happen to have one of the new Wico accessory trackball controllers, it becomes even better and faster.

As the "gardener" in this piece, you're trying to shoot and otherwise stop the many pests that invade your garden—including ants, fleas, beetles, butterflies, spiders, and even snails. When you shoot any of these creatures, mushrooms instantly grow in their place, blocking further shots in that column until you shoot them out of the way. You have to shoot out these fungi to get a clear field of fire back in that column.

You start with three "gardener" shooters (we assume they're using DDT spray guns) and you get a bonus shooter for every 10,000 points you score. You lose a spray gun every time a beastie comes in contact with you, so fast movement and accurate shooting are important.

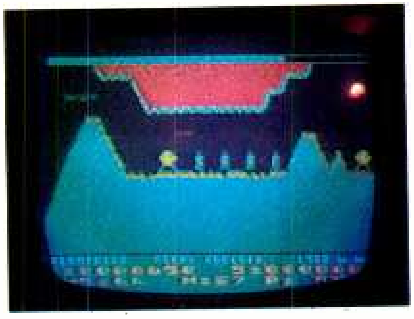
Unlike somewhat similar games, you can shoot machine-gun fashion, which helps to build the score. Every so often, a snail scoots across the field and you'd do best to nail him because he's worth a lot of points.

Video Vermin gets very high grades as a VIC-20 game. In fact, it's one of the best VIC ROM cartridge games we've seen so far.

AIRSTRIKE

Cassette or Diskette for Atari 400/800/1200.
English Software Company, PO Box 3185, Redondo Beach, CA 90277, 213-372-3440. $39.95.
Graphics ★★★★
Gameplay ★★★
Sustained Interest ★★★★
Type: *Joystick, action game*
Memory Required: *16K*

If you've ever spent many hours and quarters playing Scramble in the arcade, you'll recognize the similarity to this game. All the elements are there: the horizontal-flying rocketship with la-



ser cannon and bombs, the ground-to-air missiles, the fuel and ammo dumps to be bombed to replenish your own supplies, and the frustration of getting so far only to crash or be shot down by one of the nasties.

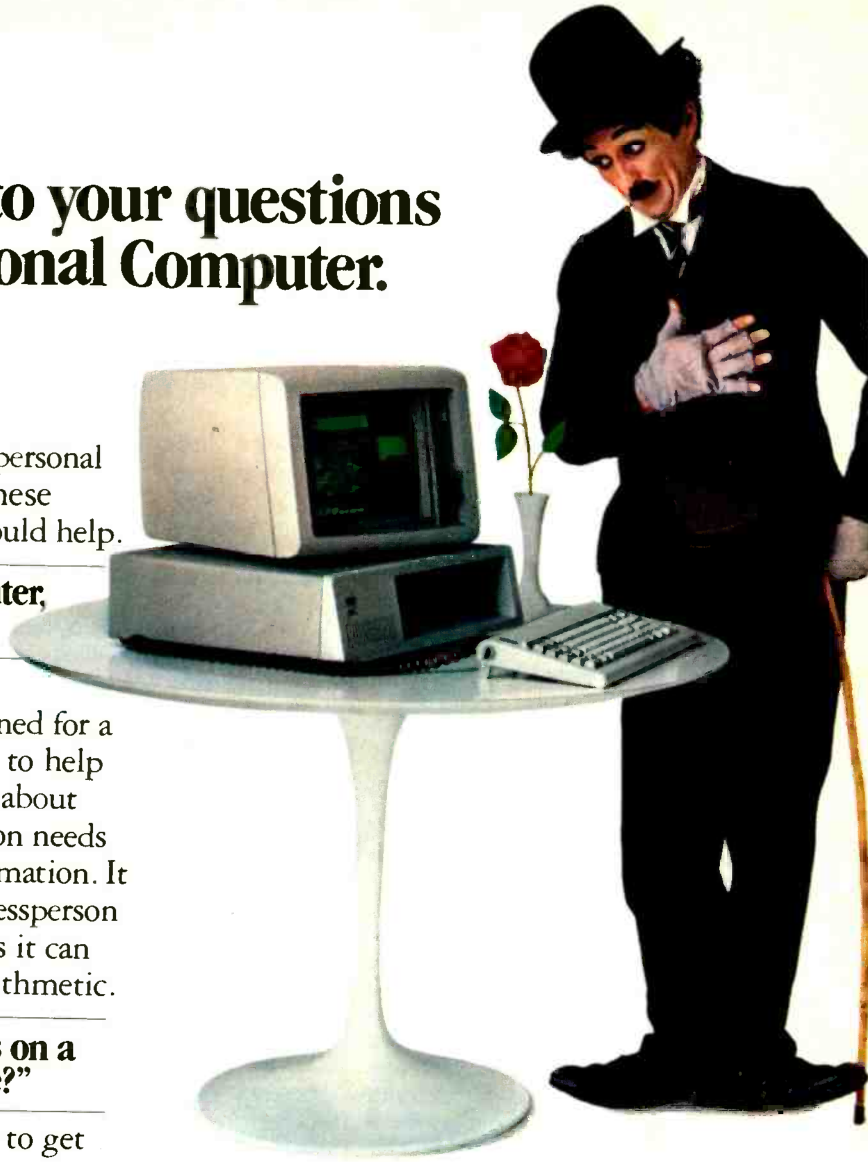
The one problem with this game is that it requires two shooting controls: one to fire the laser cannon (operated by the joystick fire button) and one to drop the bombs. You release bombs by hitting the spacebar on the computer, but this bit of derring-do requires contortions that would do credit to Plasticman or a four-armed Hindu goddess. It's just not that easy for a normal, two-armed human.

The game is advertised as "Very, very difficult." And so it is! It's also very, very frustrating because of the contortions needed and the fact that it takes an awful lot of practice to get past even the first part of the game's formidable obstacles.

The directions are printed in very small type on the back of the package's box, which promptly gets lost, so it's a good idea to memorize them right away. They're not all that complicated, so this part's easy at least.

Overall, Airstrike is a good effort from a new company for the arcade freak turned home-computer devotee. It has a lot of player involvement, interest and staying power, and gets our vote as one of the better Atari computer games we've seen. ◇

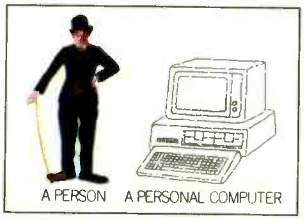
Simple answers to your questions about the IBM Personal Computer.



If you're personally interested in personal computers, but want to know more, these definitions, descriptions and details should help.

"Just what is a personal computer, and how can I use it?"

The IBM Personal Computer is a computer designed for a *person*. It's a tool to help accomplish just about anything a person needs to do with information. It can help a businessperson solve complex problems just as surely as it can help a small child improve his or her arithmetic.



"Suppose I've never had my hands on a computer. How 'easy' will it be?"

As with any new tool, you'll want to get comfortable with the IBM Personal Computer before putting it to serious use. You'll have some step-by-step reading, but our instructional literature involves you from the start. And the computer is on your side too—interacting with you as you learn.

There's no reason why you can't be executing programs and feeling good with the results within your first week. After a month, it should be clear that you've made a good investment, and you'll probably be telling your friends why they should get one.

"Is the IBM Personal Computer simpler or more advanced than others?"

Both. Our system has been engineered with many advanced design features (see the chart) but their purpose is to make it simpler for you. Our ten function keys are a good example. We added them to save you a lot of time and error. They are *advanced* features that add to *simplicity* and ease of operation, and that is typical of our total design.

"What kind of software programs do you have to help me?"

IBM Personal Computer software comes in many varieties, and it's all quality.

For example, if planning is part of your work, we have VisiCalc*— the "electronic worksheet." If you maintain a business, we offer programs that help handle everything from accounting to inventory and payroll record keeping. We also have carefully chosen programs for educational use, intelligent games, a word processing program, plus communications packages that connect you and your computer to outside information services via your telephone and a device called a modem.

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Microprocessor
16-bit, 8088*

Auxiliary Memory
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83 keys, 6 ft. cord attaches to system unit*
10 function keys*
10-key numeric pad
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Power-on self testing*
Parity checking*

Display Screens
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High-resolution*
80 characters x 25 lines
Upper and lower case

Operating Systems
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Languages
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Printer
All-points-addressable graphics capability
Bidirectional*
80 characters/second
18 character styles
9 x 9 character matrix*

Permanent Memory
(ROM) 40 bytes*

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16 colors*
256 characters and symbols in ROM*
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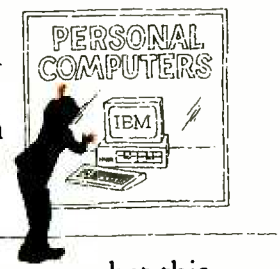

For more information on where to buy the IBM Personal Computer, call 800-447-4700. In Alaska or Hawaii, call 800-447-0890.

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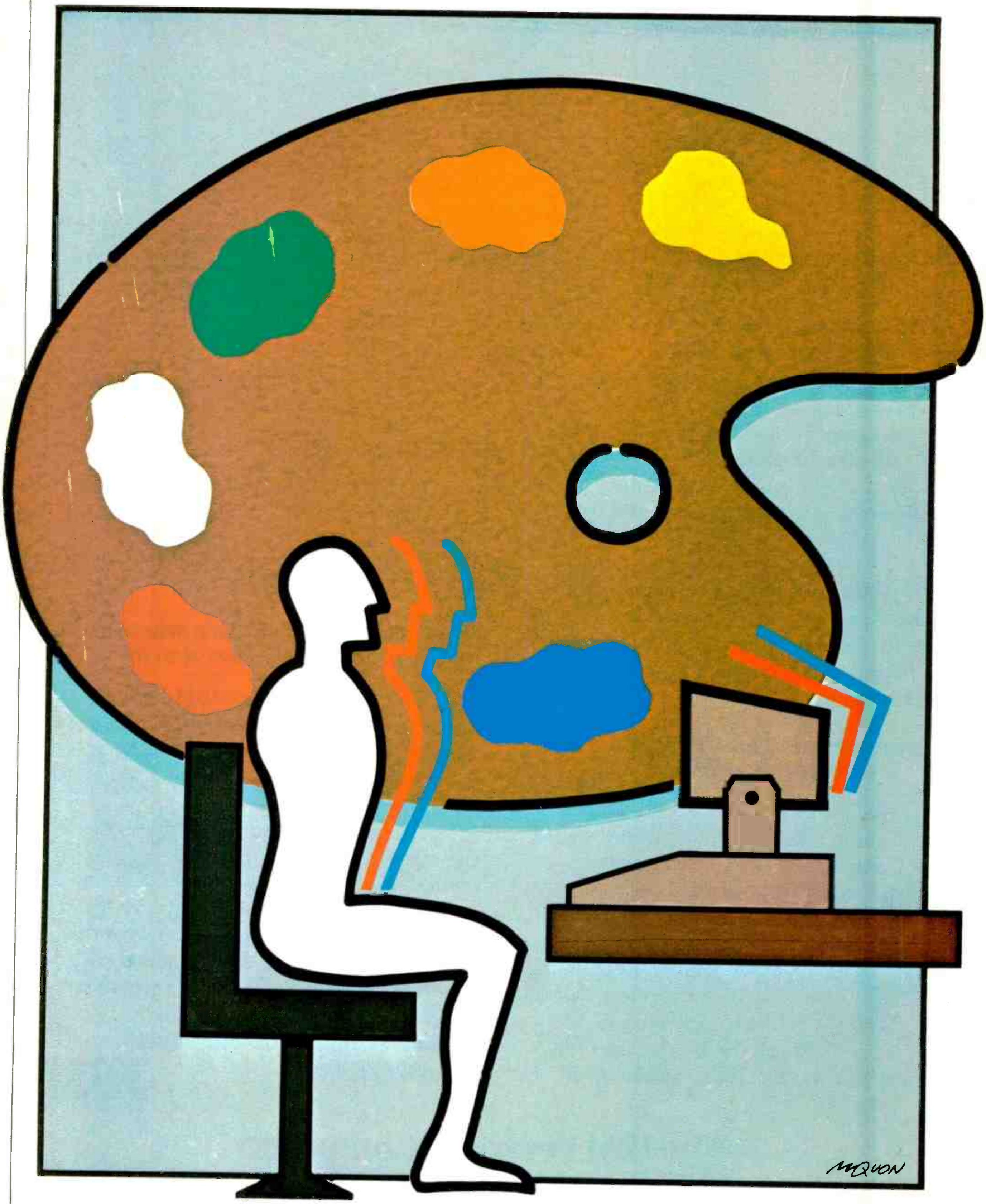
MCQUON

Maximize YOUR COMPUTING COMFORT & EFFICIENCY

There are a host of ergonomic considerations that influence design of computers and workstations and the way they impact on users

By Les Solomon and Al Burawa

RESEARCH into the human-engineering aspect of computing has taken on a new dimension of importance as more and more people become computer users. The end goal is to reduce as much as possible any form of human strain or stress resulting from long sessions at a computer, whether it's a sore back, irritated eyes, tired wrists, or even unnecessary operating complexities related to "unfriendly" software.

The efforts of manufacturers to adapt systems to human characteristics, which is an application of ergonomics or biotechnology, is a factor that buyers of computer(s) should weigh, along with how much memory comes with a machine and other considerations. Moreover, one should consider improving work-station conditions to enhance computing productivity. The following is some insight to what's being done and could be accomplished to make a human being and a computer more compatible.

Similarities to Typing. There are some basic similarities between operating a computer and typing on an ordinary typewriter. For comfortable and efficient typing, ideal height of the computer keyboard from the floor with respect to the seated operator is well established. It's the same as for a typewriter. And, since inputting (typing) is the same in both cases, a similar type of lumbar (lower-back) support chair—one that promotes good posture for minimal fatigue while seated at the keyboard—should be used.

Other computing environment features to take into account would be ambient lighting (the same or only slightly different for typing and computing), comfort index of the air-conditioning system, ambient noise levels, and a variety of physical and psychological factors.

Perhaps the most important physical (hardware) item that determines user comfort is the computer or terminal itself. There is currently a controversy over which is the "best" type of keyboard input/video-display output (terminal) to use. Two general designs are available: (1) keyboard, floppy disk, and video display integrated into a single package; (2) systems in which these items are separate and interconnected by cables.

Two-piece terminals are most often described as having "detachable" keyboards. This configuration has two basic advantages over the integrated keyboard/display system. The keyboard can be located almost anywhere, independent of the video display unit, to offer a degree of setup flexibility not possible with integrated systems. Keyboard and video display unit, then, can be set up for the best possible arrangement for a given work station. The other major advantage of this configuration is that, should the keyboard become inoperative for any reason, *only* this item need be removed and temporarily replaced with an alternate unit until the original is restored to operating condition.

The major disadvantage of the two-piece approach is that the keyboard may prove to be *too* "portable." Since it's usually very light in weight, the keyboard unit might be placed in locations where it can be accidentally dropped, such as from a lap, or swept off a narrow work surface. Also, because the keyboard is connected to the video display unit via an umbilical cable, one can expect eventual problems with the cable or connectors due to flexing.

Virtually all modern integrated keyboard/video-display systems are ergonomically engineered to maintain the two subsystems in fixed positions designed for user comfort and efficiency. Another important advantage is that integration keeps everything neat.

About Keyboards. A tremendous variety of keyboards are in current use. Even among keyboards that perform identical functions, different manufacturers use different criteria for their designs. Shape, layout, and "feel" of the keys can be extremely important, especially in applications that require intensive keyboard use, as in word processing. Once again, ideal parameters for computer keyboards can be borrowed from those of the standard electric typewriter.

Professional word/data processing operators prefer the same layout and spacing of the keys (on the main keyboard) that closely approximates the geometry used in modern office electric typewriters. A standard QWERTY keyboard in which alphabetic and numeric keys are the same as for typewriters has been, in most cases, adopted as the "standard," although punctuation and special characters might be located on unfamiliar keys.

All main keyboard keys should be laid out and contoured to assure maximum speed and typing efficiency with minimal effort. Extra banks of keys (for numeral entry, cursor control, and special functions), not normally within easy reach of the main keyboard, should be in a logical, easy-to-learn arrangement and the keys themselves should be shaped and sized about the same as for the main keyboard.

The slope of the keyboard, height of the "home" keys above the level of the typing surface, and pressure required for positive and reliable keystroking are just as important as keyboard geometry. A keyboard that's too high or too low for comfortable typing will cause an operator's wrists, forearms, and even neck and back to tire quickly. Keys that require too much pressure will have a similar effect on fingers, while too little pressure will result in erratic entry of data.

The "feel" of the keys is frequently the most important ergonomic factor professional users take into consideration. It's not uncommon for an operator to reject a keyboard with perfect geometry because the keystrokes don't "feel" right. High-quality keyboards have a feel much like that of a good office electric typewriter and provide either tactile or audible feedback to assure the user of successful entry. Keys shouldn't feel "rubbery" or "stiff" and must move very smoothly, with no evidence of sticking or other erratic behavior. Any departure from these ideals will reduce typing speed, efficiency, and comfort.

Finally, the height of the front edge of the keyboard, where the operator usually rests his wrists or the heels of his hands, should be considered in selecting a unit. Very-low-silhouette keyboards might have the SPACE-bar row of keys only a fraction of an inch above the surface on which the keyboard rests, eliminating any concern in this area. But most keyboard assemblies, even those in ergonomically designed professional systems, place this row of keys an inch or more above the surface, which could place stresses on the hands and forearms unless corrective measures are taken. In such cases, professional operators might push the keyboard several inches away from them to allow their wrists to rest on the table surface. A more direct solution, and one that keeps the keyboard at a more comfortable proximity, is to use a device known as a wrist rest.

The terminal keyboard, then, is a very important part of a computing work station, ergonomically speaking. A wide range of factors must be taken into account, choices becoming increasingly more critical as time spent per session at the work station increases. All-day operation demands selection of the best human-engineered keyboard designs available.

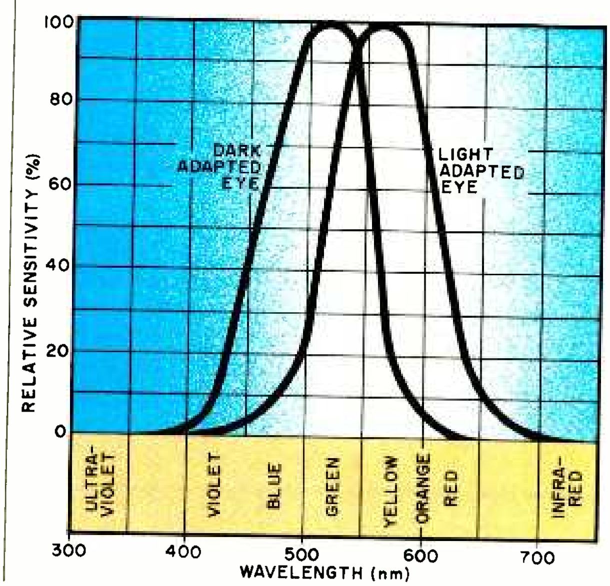

Fig. 1. Sensitivity to light of dark-adapted and light-adapted eyes.

Video Display Monitor. When personal computing first became a practical reality, no one really anticipated the severity of the operator problems that began to appear with prolonged sessions at video terminals. (One can't escape using a video monitor, basically because of the economy of displaying text and graphics on a CRT screen, and editing and correcting errors *before* printing it out in hard-copy form.) Since serious operators spend a large portion of their time at a terminal viewing video displayed material, the video display monitor has recently been the subject of much controversy.

Solving the ergonomics of keyboard design, didn't quite eliminate the complaints made by computer operators. Some of the remaining

complaints, it was soon discovered, specifically concerned the size of the CRT screen, displayed number of lines vertically and number of characters horizontally, distance away from the viewer, angle of view, and even color of the display.

Early attempts at relieving irritations induced by video displays resulted in integrated keyboard/display terminals with screens set at a fixed distance and nonadjustable angle for comfortable viewing. Screen size was more or less standardized at 10″ to 13″ diagonally, with 24 or 25 lines of 80 characters of displayed text the norm for professional systems. Addition of variable intensity, contrast, and focus controls made it possible for users to adjust displays for minimal eye stress. These changes, singly and in combination, went a long way toward solving many of the prevalent complaints. But they didn't solve all of them.

What Color? The latest controversy to come to the attention of computer terminal users revolves about, of all things, the *color* of characters displayed on video display screens. A steadily growing body of evidence is proving that display color is *very* important for operators who work at their computers for prolonged sessions. So much evidence has been gathered by very credible people and organizations, in fact, that it would be foolhardy to dismiss as unimportant the question of the color of the display.

Earliest full-screen video displays presented the viewer with white characters on a black background. In general, black-and-white displays have a high degree of contrast that viewers might initially find easy on the eyes. However, it was frequently found that white characters on a black background (and black characters on a white background) caused "burning" eyes and other temporary eye irritations. A few years ago, in an effort to relieve these problems, green-on-black character displays became popular. It was found that green displays helped to relieve many of the complaints of computer operators.

Until very recently, the only color choices available for monochrome video displays were white and green. Now, we're hearing and reading about yellow/amber, which some purport to be superior, ergonomically speaking, to both of the "traditional" colors. Some very impressive data has recently been compiled and published to support the contention that a yellow/amber display is, indeed, the best color to use for video displays. A brief review of the research that led to the announcement by proponents of yellow/amber displays is in order.

Confronted with complaints of eye irritations, a great deal of research has been conducted both here and abroad to determine the causative factors involved and to determine how to solve the problems. To make the research as meaningful and complete as possible, just about every physical and psychological parameter has been investigated, including time pressures, work loads, ambient lighting, air conditioning, video monitor placement, and the total work environment. Going a step further, even the physiology of the eye has come under scrutiny. These studies revealed many interesting facts about video monitors.

One very important fact noted early was that much of the eye problems encountered are attributable to the human eye mechanism with respect to color of the video display monitor. As early as 1976, only a year after the personal microcomputer became a practical reality, a study conducted by Skandia Insurance Company of Sweden revealed that the eyes were more frequently identified as a source of discomfort than either the back or shoulders, which ranked second and third, respectively.

Research into eye/video-screen interaction has revealed many psychophysical factors. At the top of the list is the spectral sensitivity of the eye in relation to the wavelength of light. As illustrated in Fig. 1, sensitivity to brightness is greatest at about 555 nanometers (nm), in the yellow/green range of the color spectrum. The graphed data also reveals a slight difference between light- and dark-adapted eyes.

A study of the spectral energy distribution of a "white" P4 phosphor commonly used in video CRTs reveals peaks in the blue and yellow regions about one diopter apart. It was assumed that the eye would continuously refocus between these two peaks, causing stresses and, if prolonged, headaches. While there's no concrete evidence to actually *prove* this premise, we do know that the eye oscillates naturally at about a 0.25-diopter amplitude at a 1-to-2-Hz rate.

After considerable study and ex-

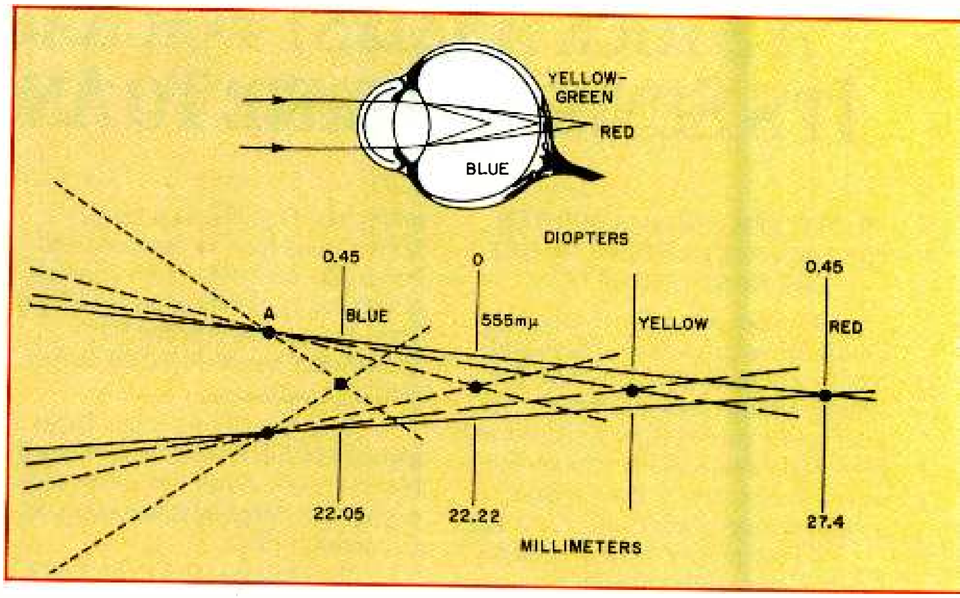

Fig. 2. Physical and diagrammatic representations of the chromatic aberration of the human eye.

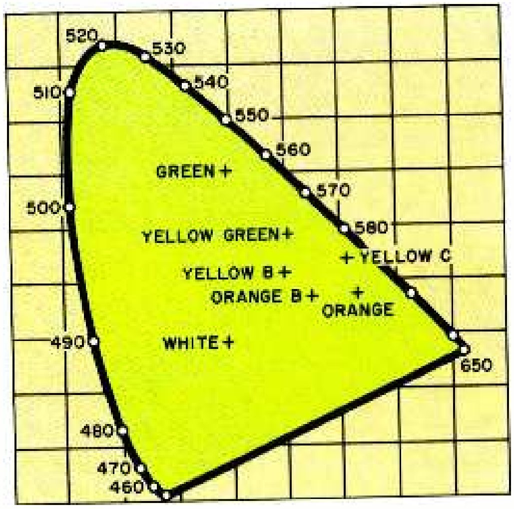

Fig. 3. At left are the positions of six different color symbols and white in the German Standard color diagram; and below are the results of a study of which are preferred on video monitors.

	Relative Performance	Preference Scores*
Green	+0.91	6.91
White	+1.83	6.48
Yellow-B (white with filter)	+5.58	7.18
Orange-A (white with orange filter)	−4.91	2.20
Yellow-A	+5.66	7.46
Yellow-C (yellow with amber filter)	+7.83	8.16
Orange-B (yellow with orange filter)	−16.5	1.65

*Scale ranges from 0 (no preference) to 10.

perimentation long before video terminals were developed, yellow proved to be such a highly visible color that it's now extensively used for road signs. The body of evidence that proves this point can be exemplified by a series of experiments conducted back in 1958 by Heinson. On a scale of 0 to 100, to rate quality of color visibility at a distance of about 200 yards, results were as follows: yellow rated 95; fluorescent yellow, 73; fluorescent orange, 69; orange, 54; fluorescent red, 51; red, 35; blue, 26; and green, 24.

Armed with the knowledge that the human eye is a highly chromatic but not color-corrected mechanism, Hartridge concluded in 1939 that it would appear that color fringes would be an important adjunct of vision. Absence of color fringing can be explained by assuming that yellow focuses at the retina of the eye and red and green focus slightly to either side of the retina, making circles of larger dimension, but of almost equal size and combining to produce yellow. This slightly enlarges the blur circle. Furthermore, the blue end of the spectrum is so poorly focused as to be relatively dispersed and perhaps even below the threshold of vision (Fig. 2).

One recent study asserts that, if the symbol displayed is a different color from that of the background, the eye won't be able to bring the two into focus simultaneously. Actually, color contrast between symbol and background may be an aid to visual acuity, as long as the color differences are great enough.

In a German study, white and six different symbol colors were produced by CRTs with different phosphors (Fig. 3). Thirty test subjects (male and female between 19 and 42 years old), were required to make eye movements between the video screen and a sheet of paper for each combination of symbols and phosphors. With all tests completed, participants were asked to specify which color combination they preferred for their own video monitors. Results of the query, shown in the table accompanying Fig. 3, reveal that a yellow screen with an amber filter results in performance figures four times greater than those for a black-and-white display (7.83 to 1.83) and that green, yellow, and amber screens were preferred. Few of the test subjects cast votes for orange displays.

The German experiments also revealed that brightness and contrast of the displayed symbols were more important than the colors themselves when they were within the desired area of the spectrum. Filters placed in front of a white or other color phosphor offered no advantage, since they reduced spectrum bandwidth and luminescence. Only CRTs with phosphors that generate the desired colors were recommended. Finally, stray light impinging on the CRT screen had the effect of reducing contrast and creating blur.

An Austrian study focused attention on yellow and green. Some test subjects found no difference at all between the two colors, while others leaned definitely toward one or the other. Performance improvement was shown over a three-hour work period, with a higher rate of improvement for subjects who used yellow characters. Heart rates also declined during the test periods, but less for subjects who worked with yellow characters. Decrease of visual acuity during work (temporary myopization) correlated well with different lengths of working periods and ocurrence of breaks. It takes 10 to 15 minutes to regain good distance vision after focusing continuously on a video screen. Less myopia appeared among subjects who used yellow screens; yellow characters producing less reduction in visual ability than green characters.

The paper in which the Austrian test results and remarks appeared concludes that sustained working with a video display monitor does not change visual receptor functions but leads to functional changes in accommodation mechanisms and selective color adaption.

Although considerable scientific evidence is mounting in favor of using yellow/amber phosphors for video displays, manufacturers have been slow to move in this direction. Norway, Sweden, and Germany are now starting to use green, amber, and yellow in their terminal designs. German Trade Association Regulations covering design and use of video monitors have selected

Inside Apple

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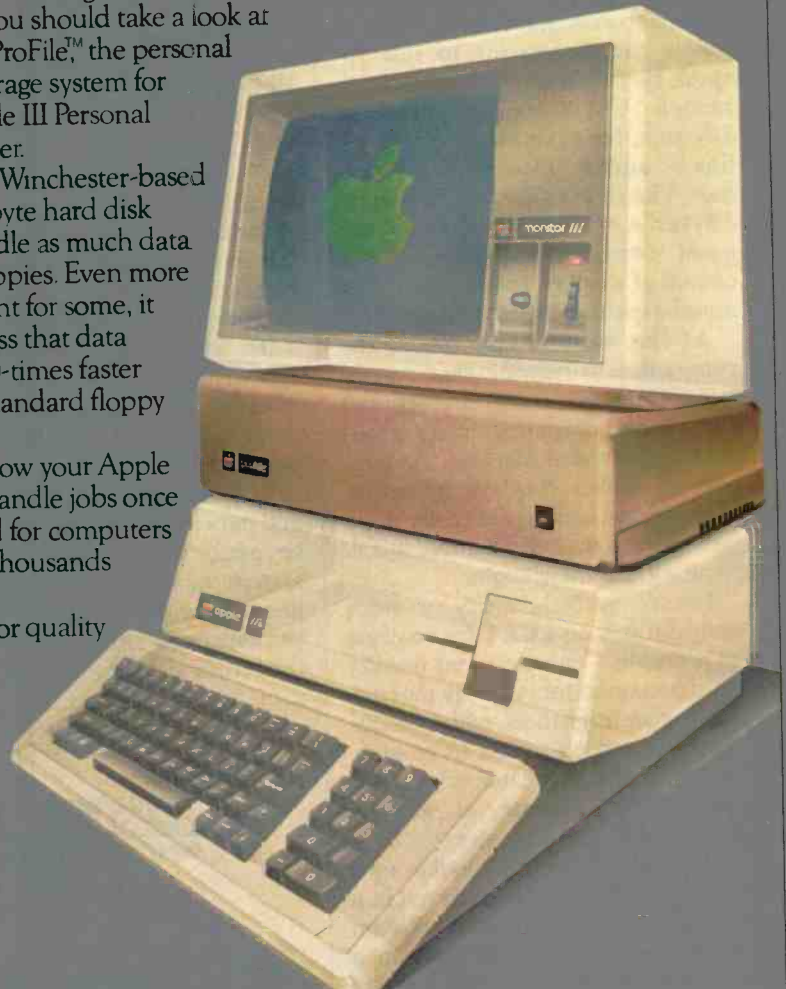
As for quality and reliability, you need only store one word of wisdom:

Apple.



Up the creek without a paddle?

Or lost in space? Or down in the dungeons?

Whatever your games, you'll be happy to know that someone has finally come out with game paddles built to hold up under blistering fire. Without giving you blisters.

Apple Hand Controller II game paddles were designed with one recent discovery in mind:

People playing games get excited and can squeeze very, very hard.

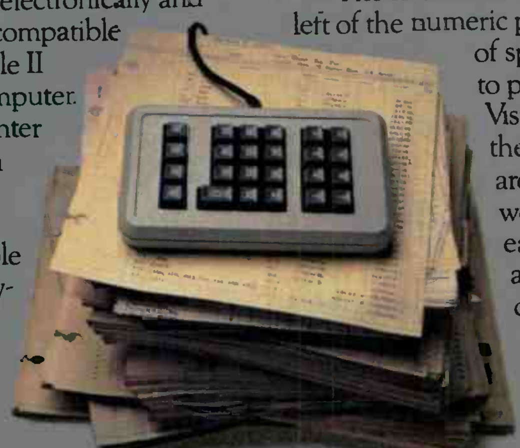
So we made the cases extra rugged. We used switches tested to 3,000,000 life cycles. We shaped them for holding hands and placed the firing button on the right rear side for maximum comfort.

So you'll never miss a shot.

Launching pad for numeric data.

Good tidings for crunchers of numerous numbers:

Apple now offers a numeric keypad that's electronically and aesthetically compatible with the Apple II Personal Computer. So you can enter numeric data faster than ever before.



The Apple Numeric Keypad II has a standard calculator-style layout. Appropriate, because unlike some other keypads, it can actually function as a calculator.

The four function keys to the left of the numeric pad should be of special interest to people who use VisiCalc.® Because they let you zip around your work sheet more easily than ever, adding and deleting entries.

With one hand tied behind your back.

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yellow, orange, or green for monochrome displays. While American manufacturers have been slow to follow the Europeans in this respect, there is some move in this direction. USI Computer Products Division, for example, is offering a line of amber video display terminals. The Heath Company's new H-100 series of all-in-one desktop personal computers offers buyers a choice of display colors, including nonglare white, green, and amber.

At this writing, very few of the companies worldwide that manufacture products for professional and home computing make available amber video displays. As support of amber displays increases, however, we can expect to see more and more terminal products incorporating the "new" color.

Use of neutral-density or color optical filters on a CRT for contrast or perception enhancement usually results in operators slightly increasing display brightness, which causes spots created on-screen to enlarge. One does obtain greater brightness, but at the expense of slightly defocused (blurry) images.

When the matrix that makes up a displayed character is observed in a slightly blurry condition, it takes on the effect of being displayed on a medium-to-low-bandwidth video monitor and may lead to eye fatigue.

At a viewing distance of 18", a typical user can usually separate dots (that form displayed characters) on the order of 0.005". Since viewers usually feel most comfortable with bright, sharply focused images that produce a brightness range of at least 30:1, screen filters should be carefully selected.

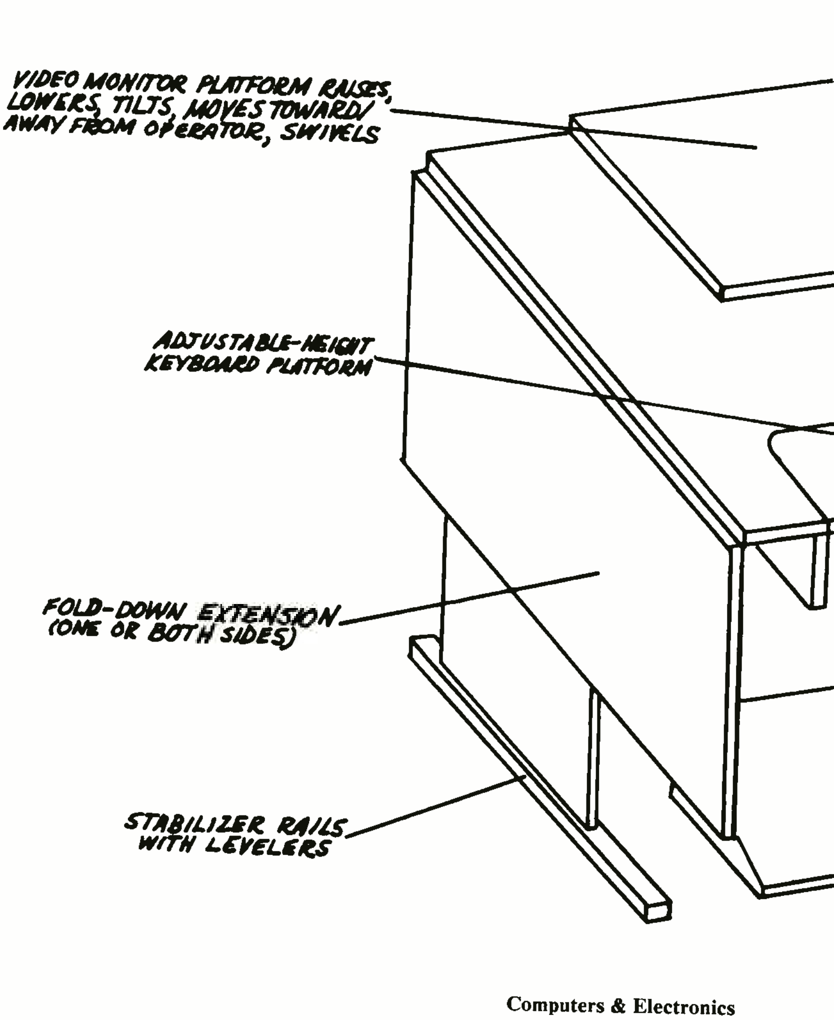
Computer Furniture. It would be inaccurate and unfair to place all the blame for operator ills on computer terminals. Except in relatively rare cases, manufacturers of computer products, having been made aware of the complaints, have striven to correct deficiencies. In general, professional and many home computer products are generally designed following sound ergonomic principles. Almost all of the complaints remaining can be directly attributed to factors outside the computer, perhaps the most important being the furniture used at computer work stations.

An ergonomic computer work station begins with the surface on which the video terminal sits. The task is greatly simplified for all-in-one computers and systems in which keyboard and video display monitor are integrated into a single terminal unit, since obtaining a typewriter-table height with sufficient depth and workspace on both sides will suffice. Standard office typewriting stations can be directly adapted for use in environments with this type of terminal or computer.

For stations at which only word and data processing functions are to be performed, a simple computer system table, preferably with adjustable height and with sufficient workspace on either or both sides of the terminal's location, will suffice. This type of "desk" is very similar to the typing returns common with secretarial desks, except that it's usually 30" deep. (Add-on returns, on the other hand, are only 24".)

As a rule, the computer system table is the least expensive type of "desk" available for the computer office. In its least expensive form, the table consists of little more than a work surface and the legs to support it. However, it can be made to suit just about any special need by adding an optional module that bolts to the bottom of the work surface to provide storage facilities for manuals, floppy disks, extra disk drives, etc. and bookshelves that mount above the computer or terminal.

In very elaborate single-operator setups, full-size desk-height modules can be bolted to computer system tables. Individual computer system tables can be bolted together with the aid of sturdy triangle connectors to give one operator more work space or to provide work sta-



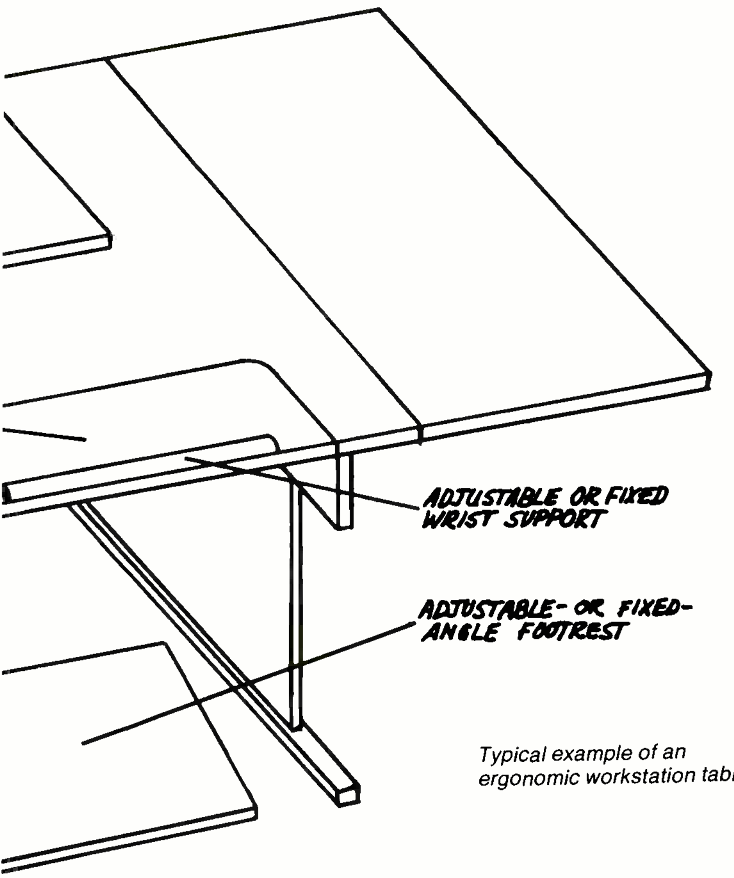
tions for two or more operators in multi-user setups.

Computer-system-table-based setups can be used with both integrated and two-piece video terminals, although they're more appropriate for the former. Most retailers who sell computer products to the professional market offer at least one version of these modular systems at point of sale.

Home computerists who buy from electronics specialty stores, computer outlets, discount stores, and mail-order houses can also obtain this type of furniture—but not presently from furniture or most office-supply stores. Local computer stores are good places to try. Even if they don't have the furniture in stock, most can order it.

True ergonomic computer work station furniture is designed for maximum user flexibility. For example, it allows you to adjust the height of the terminal keyboard independently of the video display monitor (in two-piece systems) to the most comfortable levels and positions. Additionally, a turntable accessory placed under the video display monitor can provide a means for swiveling the monitor and even tilting it by 5° to 10° up and down for easy viewing. If a work station is equipped with a video display monitor platform, it might be adjustable by 6" or more in height above the work table, by as much as 9" toward and away from the operator, and by 5° to 10° tilt up and down, with 360° of rotation around its perpendicular axis.

It's obvious from the foregoing that application of ergonomics to computer furniture isn't based on the size of the "average" person, as has traditionally been the case with other office furniture. By offering a wide range of controls, ergonomic computer furniture can be adjusted for operators who are much shorter or taller than "average."



Typical example of an ergonomic workstation table.

Ergonomics in the computer environment also takes into account conditions that formerly escaped consideration. For example, any work station can be equipped with an adjustable (or fixed) resilient wrist support that greatly reduces wrist, shoulder, and arm strain. Also, a fixed- or adjustable-angle footrest can be used to good advantage for comfortable in-place computing. Being seated at a computer terminal for hours at a time with the feet flat on the floor can and often does cause reduced circulation and tiring of the leg muscles. By slightly elevating the feet and placing them at a more natural angle while seated, a footrest promotes good circulation and places less stress on leg muscles.

The chair at a work station is a very important element of any computer setup. No matter how well designed the rest of the furniture at a computer work station, poor selection of the chair will erode operator comfort and result in decreased efficiency. The typical ergonomic chair is designed to promote good posture, which assures maximum comfort and encourages maximum efficiency.

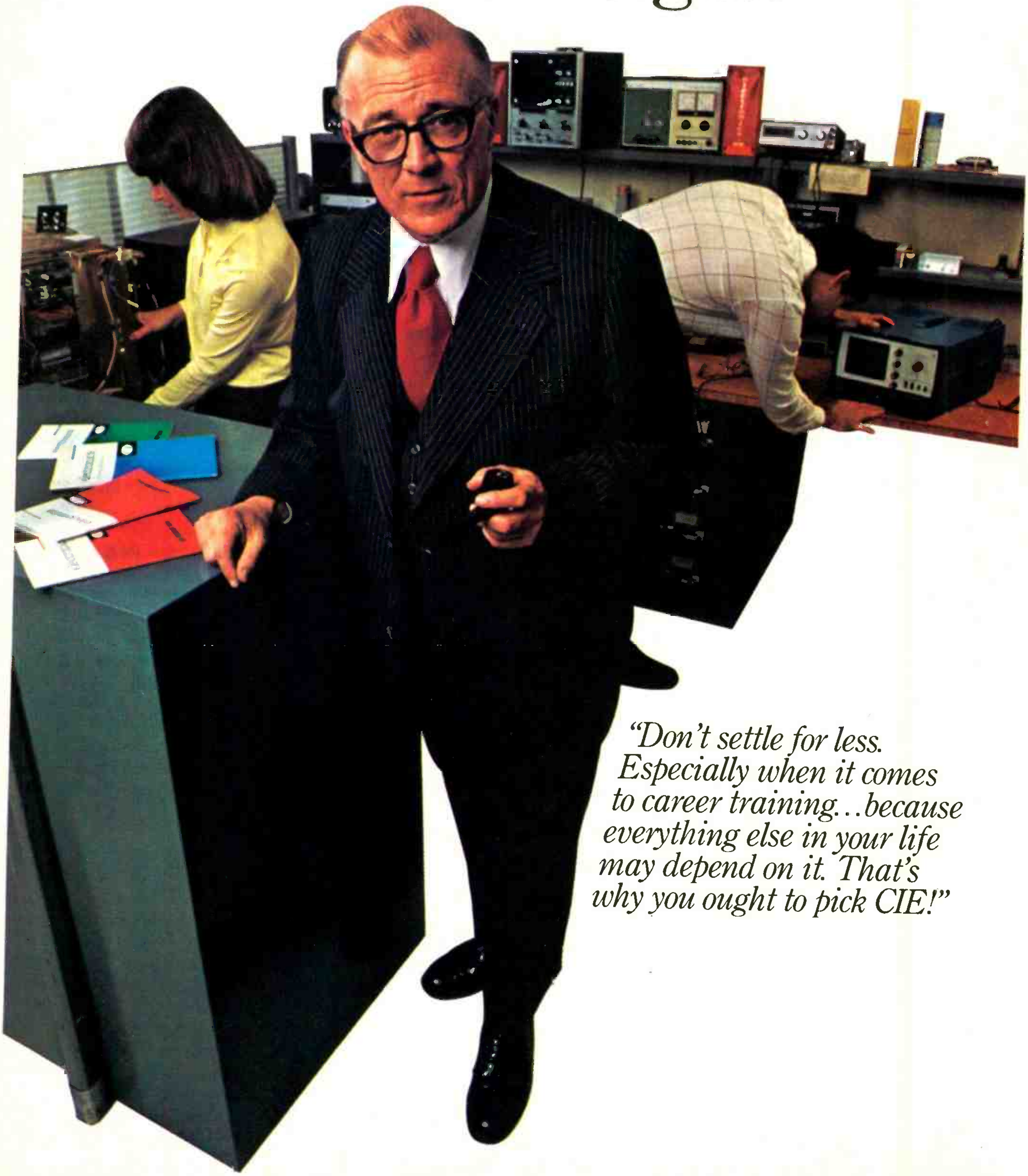
Ergonomic chairs, like work stations, are sturdy and fully adjustable. Available with and without arm supports, they're equipped with casters for easy movement. They have facilities for adjusting height and horizontal positioning of lumbar-support backs, height of seat above floor, and arm-rest height (where applicable). Additionally, all seats, backs, and armrests are specially contoured and padded for comfort and to aid in circulation.

Physical Parameters. Just how everything at a computer work station should be arranged for maximum comfort depends on the individual operator. However, some generalized guidelines that roughly define limits of the physical parameters involved have been suggested by the National Institute for Occupational Safety and Health. The various dimensions and angles illustrated in Fig. 4 are defined as:

• A) Height of the home row of keys on the keyboard should be be-

(Continued on page 48)

"If you're going to learn electronics, you might as well learn it right!"



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...COMPUTING (from p. 43)

tween $28\frac{1}{4}$" and 31". The European recommendation is $28\frac{1}{4}$" to $29\frac{1}{2}$", while the U.S. military specification is $29\frac{1}{4}$" to 31". In the design of ergonomic computer furniture, at least this, and usually greater, range can be accommodated via operator-adjustable controls.

- **B)** Viewing distance to the screen of the video display monitor should be between $17\frac{1}{4}$" and $19\frac{3}{4}$", but not over $27\frac{1}{2}$", for screens measuring between 10" and 13" diagonally.
- **C)** The center of the CRT screen should be 10° to 20° below the horizontal plane of the viewer's eye level. There's some controversy here, however. At least one researcher recommends that the top of the screen be below eye level, while another researcher claims that the top of the screen should be 10° to 15° below eye level, with no portion of the screen at an angle greater than 40° below the horizontal.
- **D)** Recommended angle between upper and lower arms when seated at the keyboard is between 80° and 120° for maximum operator comfort.
- **E)** Angle of the wrist in the typing attitude should be no greater than 10°.
- **F)** The keyboard should be at or below elbow height.
- **G)** Sufficient room should be left under the work surface to accommodate all leg movement without hindrance.

The above recommendations should be followed to initially set up an ergonomic work station. With actual experience garnered from several extended-period sessions at the work station, the various parameters can be adjusted to suit individual needs and desires.

Environmental Conditions. Selecting an ergonomic computer work station and equipping it with an ergonomic chair doesn't complete the task of setting up an ergonomic center. One must also take into consideration other physical and psychological factors that will encourage efficiency.

Ambient lighting is an important factor to bear in mind. As a rule, the light level should be sufficient for *all* tasks to be performed, including viewing video-displayed text and any printed and written matter without strain. Generally, a mix of natural sunlight and indirect overhead fluorescent lighting is best, but fluorescent-only lighting is a good alternative. *Never* place a video display terminal in a location where the CRT screen will receive direct sunlight, for example. The same ap-

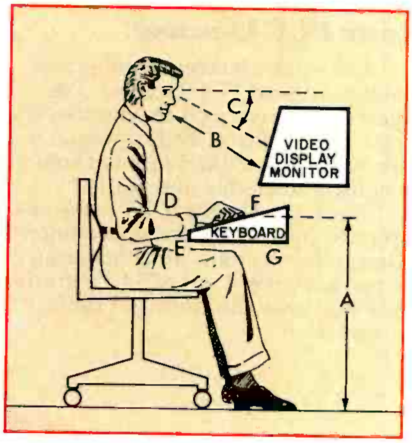


Fig. 4. Recommended workstation dimensions as detailed in text.

plies to man-made light. If a terminal can't be located where it will be shielded from direct overhead lighting, equip the display unit with a CRT visor, which can be obtained from most computer specialty products suppliers.

Ambient sound level should be minimized to eliminate distractions that can reduce operator efficiency. Some of the noise sources that greatly intrude on a computer operator's concentration include: constantly ringing telephones, typewriters, passing traffic, loud music, and even the hard-copy printer used with the computer.

If possible, locate computer work stations away from telephones (or reduce the level of the telephone's bell to minimum or replace the bell with a less insistent tone signal) and typewriting stations. There are two ways to deal effectively with traffic noise—select a room away from the street or acoustically treat the room (carpeting and acoustical tiles on walls and ceiling work wonders).

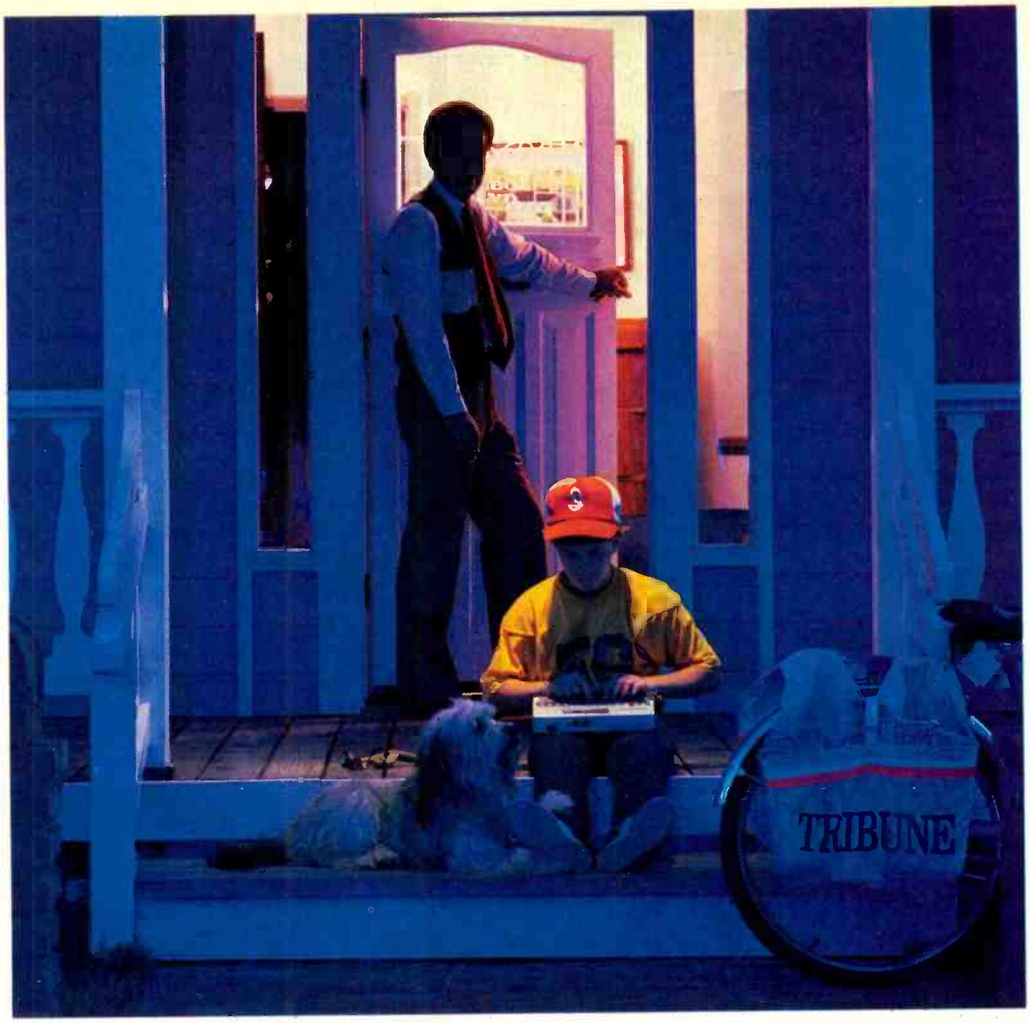
Music is OK in the computing environment, as long as it isn't intrusive. If you must have it, keep it soft and select a type that doesn't reduce concentration.

There's no need to keep a hard-copy printer at the computer work station, since all copy will normally be reviewed on the video display monitor's screen before it's printed out. Therefore, it's best to locate the printer where it will be convenient if necessary, but not so near that its normal operating noise will be intrusive. Of course, if the printer *must* be near the computer work station, you can consider buying one of the new low-noise printers or equip an existing noisy printer with a noise shield, which can be obtained from some computer specialty houses.

Adjusting ambient temperature for 68° to 72° F and humidity to 30% to 40% will eliminate any concern about the "air" factor and operator efficiency. (These are also the ranges recommended for optimum computer operation.)

One psychological factor sometimes overlooked in setting up a computer work environment—any office environment, for that matter—is the color scheme. The working environment can have a very beneficial effect if a color scheme that doesn't intrude is used. Very bright and highly contrasting colors can be disadvantageous. Some colors, specifically the fluorescent variety, can have a disturbing "pulsing" effect, while dark and drab colors (dark green, brown, gray, etc.) can set the wrong mood. Practically speaking, mixing neutral and earth-tone colors, such as pearl-gray, tans, toned-down oranges, wood-tone browns, and greens, sets a good psychological mood and contributes strongly to an efficient, comfortable working environment.

Summing Up. A carefully planned and executed ergonomic computer working environment is at its best when all factors, physical and psychological, are considered. This is particularly true in professional applications, where computer operators are required to spend hours at a time computing and word/data processing. ◇


TRIBUNE

An Active VOLTAGE REFERENCE

Variable zener makes useful voltage calibrator

By Michael Andrews

WHEN a reasonably accurate dc source is required for calibration purposes, some of us reach for what we hope is a good alkaline or mercury cell. As many have discovered, this is usually not the best choice. One can also use a zener diode having the desired (or close to desired) voltage breakdown. However, if the zener current varies, so does the output voltage.

The Active Reference shown in Fig. 1 reduces this inconsistency by presenting a constant impedance to the zener source, coupled with the capability of providing four (or more if desired) output reference voltages from a single zener.

Zener diode *D1* uses *R1* and one of the 9-volt batteries to develop the 5.1-volt (in this case) source. Op amp *IC1*, in conjunction with *R2* (R_{in}) and a switch-selectable *R3* through *R6* (R_f) serves both as a buffer and active attenuator whose output is defined by the choice of the selected R_f value. In this arrangement, *IC1* is an inverting amplifier whose stage gain is equal to R_f/R_{in}. By proper choice of these elements, output of the op amp is predictable.

For example, if R_f is 100,000 ohms and R_{in} is 100,000 ohms, the stage gain is 1, making the output equal to the input (zener) voltage. If R_f is 10,000 ohms with R_{in} remaining at 100,000 ohms, the stage gain equals 0.1 which equates to a divide-by-10. Therefore, the output voltage becomes 0.51 volts. There are limits on how far this concept can be carried, and these are determined by the noise floor of the op amp and associated circuit components.

If you have a laboratory-calibrated voltmeter, a 100,000-ohm potentiometer can be substituted for the switched R_f, and the output monitored by the voltmeter. Accuracy of the Active Reference is dependent on the tolerance of the resistors and zener diode used.

The Active Reference can also be used to emulate odd values of zener diodes in regulated power supplies, such as that shown in Fig.2. This illustrates a conventional series-pass configuration with the output determined by the Active Reference level. The transformer, rectifier, and filters should be able to handle the desired output; the 2N3055 should be heat sinked. ◇

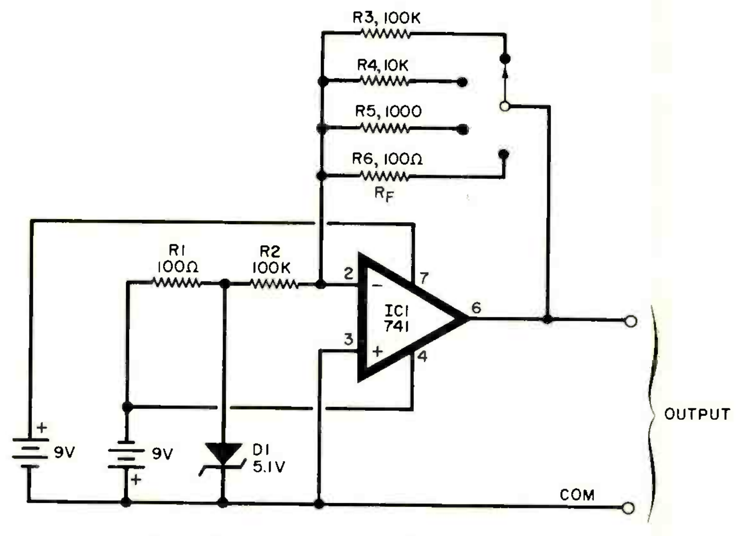


Fig. 1. Schematic of the active reference circuit.

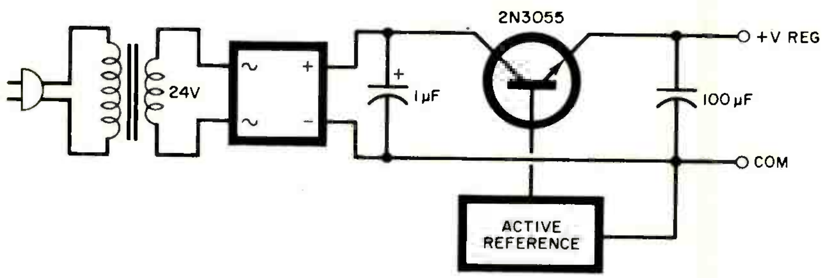


Fig. 2. The active reference can be used in regulated power supplies.

THE COMMODORE 64 MICROCOMPUTER

...ITS WONDERS AND POTENTIAL

Utilizing the new 6150 microprocessor and 64K user memory, and packed with a host of new features, Commodore's latest is no mere beefed-up VIC-20

AT THE 1981 National Computer Conference, displays of personal computers were relegated to the basement floor at the exhibit hall in Chicago. To me the most interesting product at the entire show reposed there—the Commodore VIC-20.

(continued overleaf)

PHOTO: JAY BRENNER

It had only 5K of memory at that time, with a 3K expansion unit promised in the future. The only method of loading and saving programs was with the VIC tape-cassette recorder, though plug-in program cartridges and disk drives were promised down the road. What it did have to fire my imagination was color graphics, four voices of music, a full-stroke typewriter keyboard, and a low price.

After a while, the promises were indeed fulfilled. In fact, much farther than one would have imagined. Now Commodore has introduced its big brother, the Commodore 64. It looks like a VIC-20 with 15 times as much memory, a few extra features, and a suggested retail price of $595, twice that of the VIC-20 (which is heavily discounted). As with any other new computer, a bevy of appropriate software and peripherals can be expected in the future, according to its maker. (Judging from past performance, Commodore should provide proper support for this machine.) Come with me as we take a "hands-on" tour of the Commodore 64 to explore its wonders and potential.

From the onset you should know that the 64 is no mere beefed-up VIC-20. Beneath its grey plastic shell lies an original computer design. Whereas the VIC-20 is a 5K machine that's expandable to 32K, the 64 comes supplied with 64K of RAM. Furthermore, the 64 has a 40-column by 25-line screen display compared to the VIC-20's 22-column by 23-line screen. And where the VIC-20 employs the ever-popular 6502 CPU, the 64 uses the new 6510 microprocessor. For you software writers, the latter has the same instruction set as the 6502, but features more input/output lines. And there are other major differences.

General Description. The basic Commodore 64 package is composed of a keyboard unit, an external power supply unit, a video switch for a TV set, a connecting cable, and a User's Manual.

Looking at the rear and right side of the unit, one sees many connectors, switches, and card-edge slots. To those familiar with the VIC-20, this would be the first realization that this is a different machine.

Inside view of the Commodore 64. Note the few number of parts due to use of VLSI.

On the right side, are two control ports, where as the VIC-20 has one. Each is a "D" shaped 9-pin socket. They are used to connect joysticks, paddles, or other game controls. The port nearest the front of the machine can also be used to connect a light pen. Next comes the ON/OFF power switch and a socket for the power cable connector.

Looking at the rear of the unit, we see a rectangular slot with a 44-pin edge-connector card. This is for plugging in program or game cartridges. Cartridges for the VIC-20 will not fit into this connector, unfortunately. Since there are so many cartridges for the VIC, it seems wasteful not to be able to use them on the Commodore 64. However, there are sound reasons having to do with the 64's memory structure that explain why this cannot be done.

Next to the cartridge slot is the TV channel selector. A built-in r-f modulator works with channels 3 or 4. As in the VIC-20, we found this to be unsatisfactory because it was hard to adjust and the leads pick up all kinds of radio-frequency interference from the environment. (Our test area is in mid-town Manhattan, one of the highest TV interference areas in the United States. So our results typify a worst-case situation. We discovered that, if the video leads are wound through a ferrite core, it helps a great deal. Try it if you have problems like ours. An RCA-type jack is located next to the channel selector switch, which is for the cable to the video game/computer switch.

Next is a 5-pin DIN connector for audio/video connections. Pins 3 and 5 are audio-out and audio-in, respectively. They can be connected to an audio system for use in reproducing the music you compose with your Commodore 64. Pin 1 controls video luminance. Pin 4 is video-out; Pin 2 is GND. This connector provides NTSC composite color video. If you have a monitor, you can attach it directly to this connector. It substantially improves color and graphics quality.

The next connector is the serial port. It is a six-pin DIN connector and serves the Commodore 64's serial bus. This is a daisy-chain arrangement designed to let the computer communicate with such serial devices as the VIC-1541 disk drive and the VIC-1525 graphics printer. It is not an RS232 serial bus, however, but a serial network arrangement. There are three types of operation possible over this bus: Controller, Listener, and Talker.

A Controller device controls operation of the bus, a Talker transmits information over the bus, and a Listener receives information. The Commodore 64 Computer may be any of these devices. It can control operation of the bus; it is a Talker when it sends information to a printer or a disk; it is a Listener when it receives information from a disk. Since all the devices connected to the bus receive the same information, each one on the bus has an address. The Commodore 64 routes the information to the correct device address. Only one device on the bus can be a Talker; all the other devices are Listeners. The Commodore 64 serial bus can support up to five devices at one time. At this time, the VIC-1525 printer uses address 4 or 5, and the VIC 1541 disk drive uses address 8.

The 44-pin edge connector user port connects to either parallel or serial devices. If an RS232C cartridge is installed, the Commodore 64 can be used with all kinds of RS232C devices. The circuits are designed so that, when the serial bus is in use, the RS232C circuits are disabled.

The cassette port is a six-pin male edge connector that the Commodore "Datasette" plugs directly into. The Datasette digital data storage device can record and playback programs. The cassette port controls the drive motor as well as transmitting and receiving the data.

The final connector on the rear of the computer is an expansion port. This is a 44-pin, female connector that brings out all the data, address, and control lines for system expansion.

Keyboard. The Commodore full-size, typewriter-style keyboard appears to be identical to that on the

PIN DESCRIPTION OF THE EXPANSION PORT

NAME	PIN	DESCRIPTION	
GND	1	System ground	
+5 VDC	2	(Total USER PORT and CARTRIDGE devices can	
+5 VDC	3	draw no more than 450 mA.)	
$\overline{\text{IRQ}}$	4	Interrupt Request line to 6502 (active low)	
R/$\overline{\text{W}}$	5	Read/Write	
DOT CLOCK	6	8.18 MHz video dot clock	
$\overline{\text{I/O1}}$	7	I/O block 1 @ $DE00–$DEFF (active low) unbuffered I/O	
$\overline{\text{GAME}}$	8	active low ls ttl input	
$\overline{\text{EXROM}}$	9	active low ls ttl input	
$\overline{\text{I/O2}}$	10	I/O block 2 @ $DF00–$DFFF (active low) buff'ed ls ttl output	
$\overline{\text{ROML}}$	11	8K decoded RAM/ROM block @ $8000 (active low) buffered ls ttl output	
BA	12	Bus available signal from the VIC-II chip unbuffered 1 ls load max.	
$\overline{\text{DMA}}$	13	Direct memory access request line (active low input) ls ttl input	
D7	14	Data bus bit 7	
D6	15	Data bus bit 6	
D5	16	Data bus bit 5	
D4	17	Data bus bit 4	unbuffered, 1 ls ttl load max (D7–D0)
D3	18	Data bus bit 3	
D2	19	Data bus bit 2	
D1	20	Data bus bit 1	
D0	21	Data bus bit 0	
GND	22	System ground	
GND	A		
$\overline{\text{ROMH}}$	B	8K decoded RAM/ROM block @ $E000 buffered	
$\overline{\text{RESET}}$	C	6502 RESET pin (active low) buff'ed ttl out/unbuff'ed in	
$\overline{\text{NMI}}$	D	6502 Non Maskable Interrupt (active low) buff'ed ttl out, unbuff'ed in	
$\phi 2$	E	Phase 2 system clock	
A15	F	Address bus bit 15	
A14	H	Address bus bit 14	
A13	J	Address bus bit 13	
A12	K	Address bus bit 12	
A11	L	Address bus bit 11	
A10	M	Address bus bit 10	
A9	N	Address bus bit 9	
A8	P	Address bus bit 8	unbuffered, 1 ls ttl load max (A15–A0)
A7	R	Address bus bit 7	
A6	S	Address bus bit 6	
A5	T	Address bus bit 5	
A4	U	Address bus bit 4	
A3	V	Address bus bit 3	
A2	W	Address bus bit 2	
A1	X	Address bus bit 1	
A0	Y	Address bus bit 0	
GND	Z	System ground	

Overbar means active low

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8-bit: 8085

DISK STORAGE:
Built-in standard 5.25" disk drive, 320K bytes/disk

KEYBOARD:
Typewriter-style, 108 keys, 13 function keys, 18-key numeric pad

GRAPHICS:
Always in graphics mode. 640h/225v resolution; up to eight colors are available**

COMMUNICATIONS:
Two RS-232C Serial Interface Ports and one parallel port

DIAGNOSTICS:
Memory self-test on power-up

AVAILABLE SOFTWARE:
Z-DOS (MS-DOS)
CP/M-85
Z-BASIC Language
Microsoft BASIC
Multiplan
SuperCalc
WordStar
MailMerge
Data Base Manager
Most standard 8-bit CP/M Software

*128K bytes standard. **Optional.

The H-100 is easy to build – the step-by-step Heathkit manual shows you how. And every step of the way, you have our pledge – "We won't let you fail." Help is as close as your phone, or the nearest Heathkit Electronic Center.

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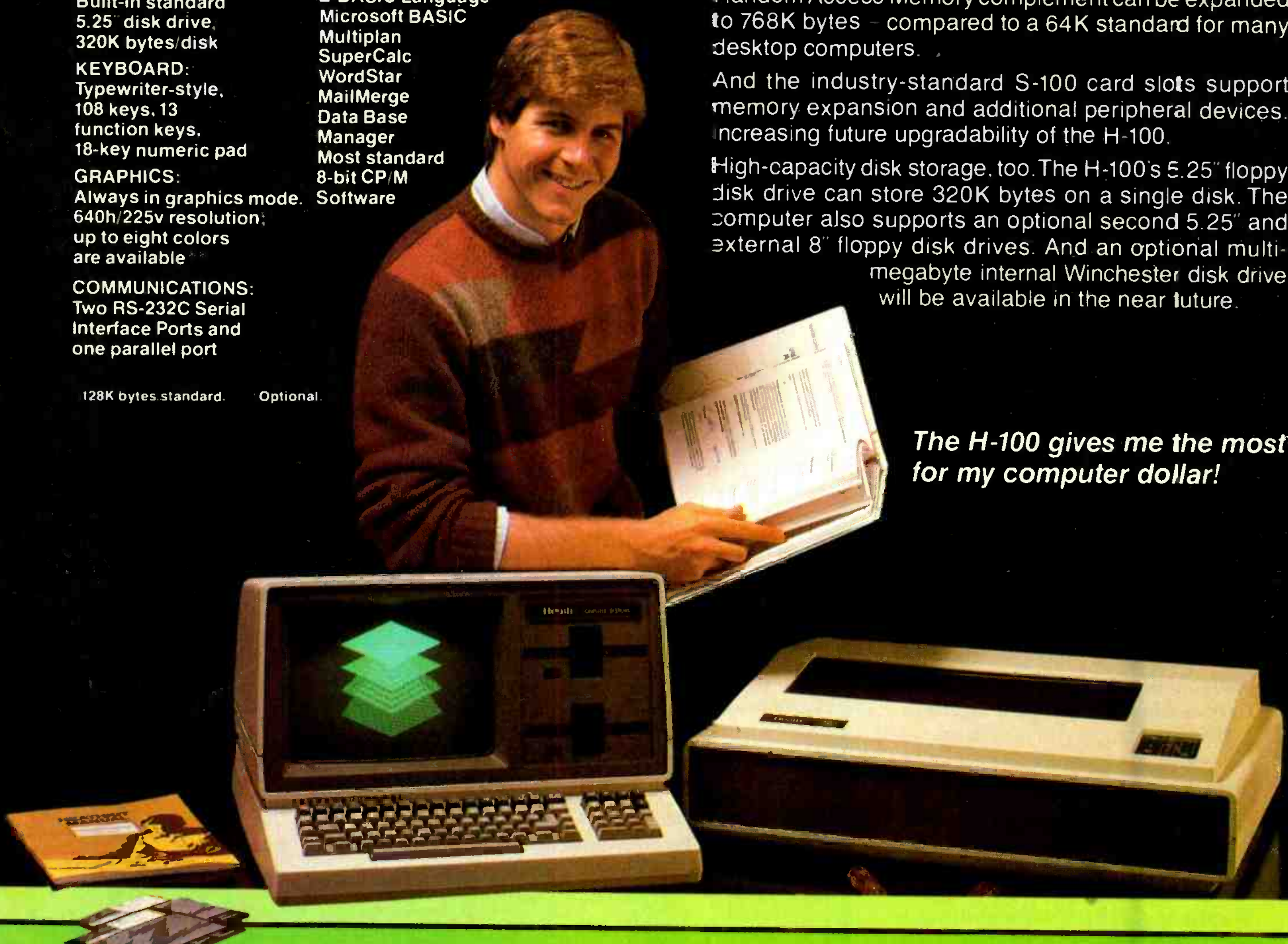

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COMPUTER:	Heathkit H-100	IBM Personal Computer	Apple II
MICROPROCESSORS:			
16-bit:	8088	8088	–
8-bit:	8085	–	6502
RANDOM ACCESS MEMORY:			
Minimum:	128KB	16KB	128KB
Maximum:	768KB	576KB	256KB
FLOPPY DISK STORAGE:			
Per Diskette:	320KB	320KB	140KB
Maximum Internal:	640KB	640KB	140KB
8" Floppy Support:	Standard	—	—
EXPANSION SLOTS:	Five S-100 (four available)	Five (three available)	Eight
I/O PORTS:			
Parallel:	1	Optional	–
Serial:	2	Optional	1
VIDEO DISPLAY:			
Line Columns	25 x 80	25 x 80	24 x 80
Pixels Colors	640 x 225 (8 colors)	640 x 200 (2 colors) 320 x 200 (4 colors)	560 x 192 (16 colors)
OPERATING SYSTEMS:	CP/M-85. Z-DOS (MS-DOS)	CP/M-86 PC-DOS (MS-DOS) UCSD P-System	Apple SOS

Information current as of 8/31/82. External disk storage available soon.

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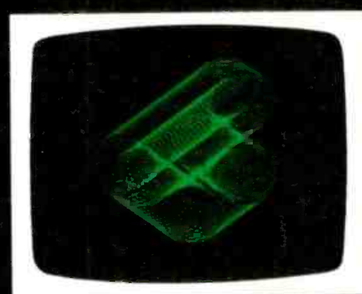

Always in graphics mode, you can control each of the H-100's 144,000 screen dots! (Color graphics optional)

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Heathkit
Heath Company

VIC-20, but there are differences in operation. The Commodore 64 keyboard, which has 66 upper/lower-case keys, has a ten-character type-ahead buffer that is used to hold data in the keystrokes until the computer can process it. Data is processed in the order in which it is received. While the computer is processing the first character, the second and third can be held in the buffer. This is a useful feature because it enables the user to anticipate input to familiar programs.

The keyboard has much the same appearance as a typewriter's, except that there are additional keys and there is a second set of markings on the cube-front of the keys. The SHIFT key works just like that on a typewriter. Many of the keys are capable of displaying two letters or symbols and two graphic characters. In the upper/lower case mode, the SHIFT gives you standard upper-case characters. In the upper-case/graphics mode, the SHIFT key will display the graphic character on the right-hand side of the key front.

There are also two keys for cursor control and a key that controls operation of the cassette recorder and program execution. In addition, there are keys for editing the characters shown on the screen. Two of these are marked CRSR (for cursor) and each has an arrow to indicate the direction it moves the cursor. The CLR/HOME key positions the cursor at the upper-left corner of the screen. When it is shifted, it clears the screen. The INST/DEL key moves the cursor and deletes the character as it moves. When it is shifted, it allows you to insert characters. The RESTORE key is used to return the computer to the state it was in before you made some program changes.

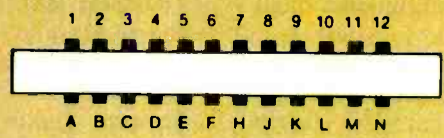
The four user-defined function keys on the right side of the keyboard are used in many different ways, depending on the program being run. The keys are marked F1, F3, F5, F7 on the tops and F2, F4, F6, F8 on the fronts. We like this idea because it helps in making repetitive entries, but we must admit that the first time we saw a reference to F4 it confused us and we had to stop and figure out where it was. The SHIFT key is used to obtain the even-numbered functions.

The CTRL (control) key also has the function of changing the colors of text being entered, as well as in usual control functions. Text colors are marked on the front of the number keys.

There is a key marked RUN/STOP that's used to stop a running program in the lower-case position and to automatically load a program using the tape cassette unit. We found this to be a very useful addition to the keyboard.

Another useful key only found on Commodore keyboards was marked with the company logo. This is called the "Commodore" key, and

PIN DESCRIPTION OF THE USER PORT



PIN TOP SIDE	DESCRIPTION	NOTES
1	GROUND	
2	+5V	(100 mA MAX.)
3	RESET	By grounding this pin, the Commodore 64 will do a COLD START, resetting completely. The pointers to a BASIC program will be reset, but memory will not be cleared. This is also a RESET output for the external devices.
4	CNT1	Serial port counter from CIA #1
5	SP1	Serial port from CIA #1
6	CNT2	Serial port counter from CIA #2
7	SP2	Serial port from CIA #1
8	PC2	Handshaking line from CIA #2
9	SERIAL ATN	This pin is connected to the ATN line of the serial bus.
10	9 VAC+phase	Connected directly to the Commodore 64 transformer (50 mA MAX.).
11	9 VAC−phase	
12	GND	
BOTTOM SIDE		
A	GND	
B	FLAG2	
C	PB0	
D	PB1	
E	PB2	
F	PB3	
H	PB4	
J	PB5	
K	PB6	
L	PB7	
M	PA2	
N	GND	

it has several functions. It moves you between the text and graphic display modes, for example. When you turn on the computer, it is in the upper-case/graphic mode and everything you type is upper case. When you shift, you get the graphic symbols marked on the front of the keys. To get into the upper/lower-case mode normally used for text, you must hold down the Commodore key and SHIFT key. Since that is the mode normally used, we found this annoying, but we got used to it after a while. The Commodore key has another function: if you hold it down and press any of the number/color keys, you get a second set of eight text colors.

Graphics. The Commodore 64 can use the same kind of character graphics as the VIC-20. In addition, it can also use bit-mapped graphics and a new type of graphics called "Sprites". (More about them later.) All graphics abilities of the computer are generated by a 6567 video interface chip, called the VIC-II chip. It provides a variety of graphic modes, including a 40-character by 25-line text display, a 320-by-200-dot high-resolution color display, with 16 color choices, and the Sprites can be combined with any other mode.

In the character display mode, a user can select the character set in the character ROM or can program his own set in RAM. You can program any type of character that can be composed in an 8 by 8 matrix; this character set can be saved and substituted for characters in the ROM. These characters can also be seen in a multicolor mode formed by turning on the very small dots in the character memory; when the dots are turned off, the color seen is the selected background color. When the dots are programmed on, the color is the selected foreground color.

In the multi-color mode you can select any one of four colors: the screen color, the background color, the character color, or the color held in either of the background registers.

The high-resolution bit-mapped graphic mode provides a screen of 320 by 200 picture information locations (pixels). Each one is a dot that can be either turned on or off. There are 64,000 locations in screen memory, each one being a bit that is either set to a one or a zero. It takes 8000 bytes of memory to map the entire screen. Programming of these pixels is done in machine language through BASIC by poking and peeking memory locations. There are two high-resolution graphic modes available in the Commodore 64. First is the standard bit-mapped mode with 320 by 200 pixels. This allows a choice of two colors per 8-by-8-bit section. The second mode is the multi-color bit-mapped mode with 160 by 200 pixels and a choice of four colors. The colors may be selected from the background, the foreground, the video matrix, or color memory.

The VIC-II chip supports smooth scrolling in either the horizontal or vertical direction. This means the entire picture can be moved in either direction, with new information coming on the screen as old information is removed.

A Sprite is a special type of user-defined programmable character that can be displayed anywhere on the screen. It is composed of up to 24 horizontal by 21 vertical dots that can be any of 16 colors or up to four different colors each. In multicolor, horizontal resolution is halved. Sprites can be used with any of the display modes such as graphics or bit-mapped graphics.

Up to 8 Sprites can appear on the screen at one time and they can be moved, with detection of collision with either another Sprite or with the background. Once collision is detected the action is interrupted and can be dealt with by the program. It is obvious how useful this is for programming games.

Sound and Music. The Commodore 64 contains a 6581 Sound Interface Device (SID chip), a true music synthesizer capable of producing Attack/Decay, Sustain/Release (ADSR) sounds, with three totally addressable voices. It also contains filters and a white-noise generator.

The music can be programmed into the 64 by poking into memory locations and played back by peeking into these locations. Volume can be controlled in software, and multiple voices and timbre can also be controlled. The audio output can be sent to a sound system from the audio/video port for use of additional controls available on mixers and preamps. The music can also be heard on the 64's built-in speaker. The Programmer's Reference Guide contains complete information on music composition with the Commodore 64.

Technical Aspects. The Commodore 64 owes its unusual capabilities and low price to the advanced LSI chips used in its construction.

The CPU is a 6510, which is a multipurpose CPU design similar to the 6502 except that it contains a built-in, 8-bit, bidirectional output register located at memory location 0000 and a data direction register located at memory location 0001. The purpose of this I/O port is to manage the memory map and permit switching of various memory configurations.

The Commodore 64 has 64K bytes of user RAM plus 20K bytes of ROM containing the BASIC language, the Kernal operating system, and the standard character set. In addition, the CPU accesses a 4K block of memory for input/output devices. The 6510 controls selection of the memory map configurations that will appear in certain portions of the system memory. The data directional register controls operation of the data cassette system and the flow of data to the system. Programming of the memory management is done by setting the bits of the I/O port low (high is active). Since all the lines are brought out to the cartridge connector, when a cartridge is plugged in, it can ground pins that will select the proper memory configuration. For example, when you plug in the cartridge for The Quick Brown Fox Word Processor, the computer comes up running that program rather than BASIC. The word-processing program replaces BASIC in the memory map and takes control of the bus.

All the I/O is handled by the two

6526 Complex Interface Adapter (CIA) chips. These can handle either serial or parallel data. Additionally, they contain two independent 16-bit linkable event timers and a 24-hour (a.m./p.m.) time-of-day clock with programmable alarm.

One of these 6526 CIA chips is used as the input for the keyboard and the two control ports. The other controls the user port and the serial bus. There is an RS232C Interface available on the Commodore that's controlled by the #2 CIA chip. However, the levels are TTL rather than the normal −12-V to +12-V RS232C levels. To use the Commodore 64 with an RS232 device, you must plug in an RS232 Adapter Cartridge from Commodore.

The 6566/6567 VIC-II chip is a multi-purpose LSI chip that provides all of the video and graphics in the computer. It operates the character mode, the bit map mode, and, through a facility called Movable Object Blocks, makes the Sprite display possible in every other mode.

The 6581 SID chip is a single-chip, three-voice electronic music and sound synthesizer. It provides wide-range, high-resolution control of frequency, tone color, and sound volume. Three tone oscillators with a range from 0 to 4 kHz are featured, and there are four waveforms per oscillator: a triangle, a sawtooth, variable-pulse and noise. There are three amplitude modulators with a range of 48 dB. The three envelope generators have an attack rate of 2 ms to 8 s, a decay rate of 6 ms to 24 s, a sustain level of 0 to peak volume, and a release rate from 6 ms to 24 s. The programmable filter has a cutoff range of 30 Hz to 12 kHz, with 12-dB rolloff. It has high-pass, low-pass, and notch outputs, and variable resonance. There is also a master volume control, a random number/modulation generator, and provision for external audio input. There are 29 registers in the SID to control generation of sound from the program source. These are either write only or read only.

The memory section of the computer consists of eight 4164-2 64K dynamic RAM chips and two 2364A ROMs. One contains the BASIC interpreter and the other contains the Kernal operating system.

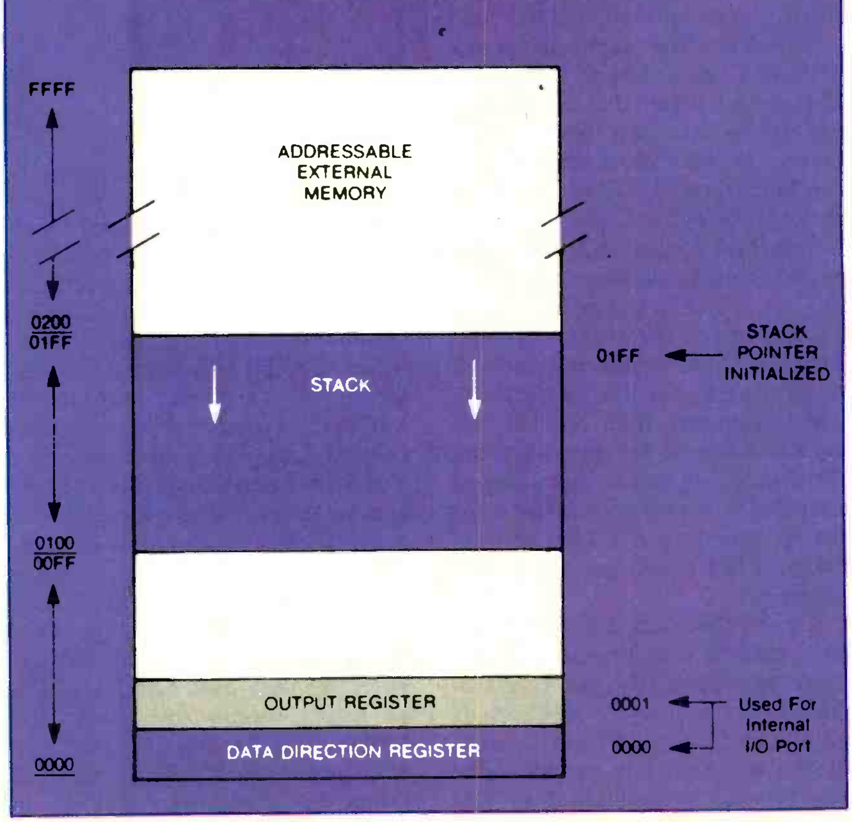
There is also a 2332A character ROM containing the standard character set and a 2114-30 color ROM. An 82S100 PLA (Programmed Logic Array) controls some of the memory characteristics.

Basic and Operating System. The Commodore 64 comes up running BASIC. All operations are executed through that language, although the graphics, color, and music are operated by machine-language commands poked into memory locations. Because of this, a user must never be far away from his Programmer's Reference Guide. It is just not possible to remember all of th poke and peek locations.

In time there is expected to be "user friendly" software to eliminate the endless peeks and pokes, but currently there is not even a way to get out of BASIC and to program directly in machine language or in assembler. Commodore promises to release the 64MON cartridge, which provides a monitor that will allow you to access any memory location, display it, and change the contents of RAM. In addition there will be an assembler in the 64MON to allow programs to be written in assembly language. This will help greatly in the development of software for the Commodore 64.

The operating system of the computer is called the Kernal. It provides all of the input, output, and memory management functions of the system. It is normal for revisions to be made from time to time, which in some systems can render software obsolete. To prevent this, Commodore has provided a jump table to all the routines in the system. It is located on the last page of memory in the Kernal's U4 ROM. To use this jump table, programmers set up parameters and then jump to the routines in the table. These call the actual routines in the operating system. If the system is changed, the routine calls will also be changed, but the jump table will not change. Thus, software using it will not be obsoleted by modifications.

6510 CPU MEMORY MAP



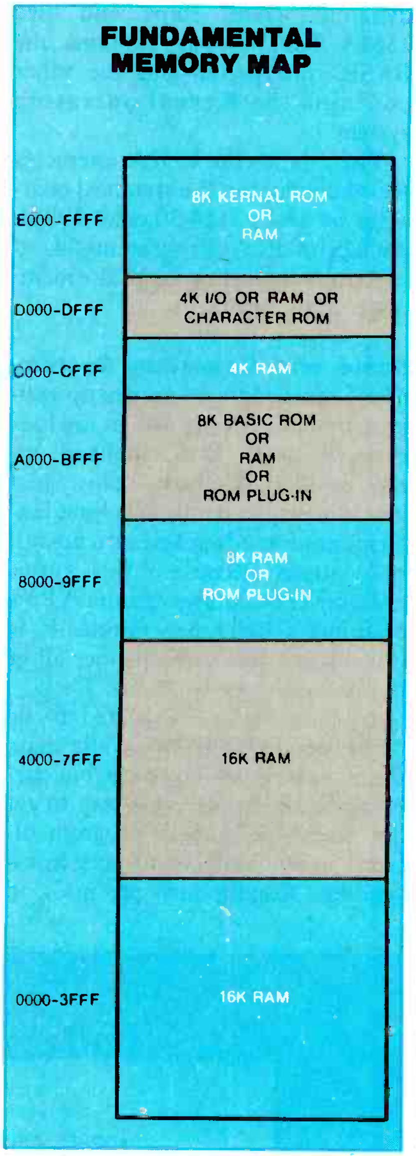
Peripherals. The CP/M Cartridge contains a Z80 CPU and the CP/M operating system. When CP/M is installed, it uses the installed memory and I/O circuits. However, the screen editing features of the 64 do not work with CP/M. Therefore, special CP/M software in the Commodore 64 format are required to run on this computer, and a better disk system than the VIC-1548 will be required.

The Commodore 64 uses two forms of data storage. The first is the digital cassette, which plugs into the cassette port and provides serial data storage. Unlike audio frequency shift recording, the digital recording techniques used by Commodore are reliable. However, they are slow. Since the recorder can only control the drive in one direction, real file handling is not possible. Instead, it is customary to read the entire file into memory, examine the data, edit it, sort it, and then rerecord it on tape. This procedure is limited by the size of the memory, and thus, it is not always satisfactory. In any event, the cassette tape provides a low-cost, reliable way of storing large amounts of data.

The disk drive supplied for use with the Commodore 64 is the VIC-1541, an intelligent disk system controlled by its own 6502 microprocessor with a 2K RAM buffer. It can hold about 175K of data, with about 167K to 168K per file.

This disk system has the drawback of communicating over the serial bus, which is a slow procedure. Further, it has a low data capacity. This last characteristic will make it unsatisfactory for use with CP/M, which requires that considerable system software be accessed from the disk. (Commodore is talking of adapting its larger disk systems for the Commodore 64. This will require the IEEE interface and special software.)

The VICModem is a direct-connect modem that operates at 300 baud and plugs into the Commodore 64 (as well as the VIC-20). It plugs into the user port and has a cable that connects into the telephone line through a modular jack. The device has FCC approval and, therefore, requires no telephone-company device to directly connect into the lines. Commodore supplies communication programs at three levels. Level 1 is a program called Term 64 (a modification of VICTerm-1) that enables the user to communicate with networks like The Source and CompuServe. Level II is called EasyCom 64, which will provide extra communications facilities. Level III is called Office Terminal. This is a program for the business user, providing for electronic mail and auto dial and answer. We only used Level I, which we had to modify to use with the Commodore 64. It works well and we could contact the Commodore group on Compuserve. That is where we found out that we were not the only ones having trouble with the disk drive.



VIC-1525 PRINTER. The VIC-1525 is a serial dot-matrix printer designed to work with either the VIC-20 or the Commodore 64 computers. It is capable of printing upper/lower case characters, graphic characters, numerals, symbols, and dot-matrix graphics from the Commodore 64 screen. The printer receives its input from the Serial Bus, being "daisy-chained" with the VIC-1541 disk drive.

This printer works well and is an excellent value for a low-cost printer with graphics printing capability. Unfortunately, the 6 by 9 character matrix gives the output a crude look that we associate with early dot-matrix printers. The actual character size is only 7 by 5 dots and this is not pleasing to look at. As a compensation, the VIC-1525 is so easy to connect to the computer and to operate, using the same OPEN, CMD, and PRINT# used with Commodore files, that it is easier to buy it than go to the trouble of interfacing a different printer.

User Comments. The Commodore 64 was tested here as both a stand-alone microcomputer machine and as a system. For the latter we used Commodore's printer, disk drive, and cassette tape machine. We also had a test and demonstration diskette as well as a word-processing plug-in cartridge and some software on a floppy disk.

Employing the User's Guide, we had no trouble assembling the system and running BASIC programs, including color, sound, and character graphics. An initial problem we had was in using the VIC-1541 disk drive provided to us. We could read and save to disks supplied, but were not able to format and save data on our own diskettes. Other modes of operation worked fine. This was overcome when a disk arrived later with new software that included a simple word processor called The Word Machine and a simple database program called the Name Machine. On the disk with these programs was a wonderful program called the DOS Wedge (DOS 5.1).

Using it we were able to format a disk and transfer a program to it.

Using a Quick Brown Fox plug-in cartridge (actually, it was a plug-in board, since it was not enclosed in a plastic container), we marveled at the software loading ease it made possible. Plug it in, turn on the computer, and there we were into word processing. No fuss, no muss. We were able to save our files on both the cassette and disk as well as print out the text.

By now we had outgrown the User's Guide and turned to Commodore's $19.95 Programmer's Reference Guide. If you want to do anything beyond simple tasks with the Commodore 64, you *must* get this approximately 500-page guide. It demonstrates how to operate the computer in any of its advanced modes, provides technical descriptions of the computer's innards, and includes schematics. Referring to it, we were soon playing "music," drawing color graphics, and watching Sprites dance over the screen. This was fun in spite of all those hundreds of pokes, peeks, and data statements. After a while, however, programming in this manner wore thin. Happily, the DOS Wedge provided an easy way out. Using its menus and a music program with keys on the screen, for example, eliminated the need for those pokes and peeks.

Our one major criticism of the Commodore 64 system concerns the separate disk drive. The transfer rate of the disk seems to be painfully slow, which appears to be the fault of the serial bus idea. This deficiency is emphasized when using the company's CP/M cartridge which enables one to enter a more sophisticated computing world. Slow, single-density diskettes will simply not suffice for serious applications software. One of the company's large-capacity disk drives like the 8050 or 8250 should be made available for the Commodore 64 so that business programs listed in the Commodore Software Specifications brochure can be used effectively.

Right now there is a dearth of software for the Commodore 64, as cited earlier. With the enormous VIC-20 library on hand, we expect that it would be converted to a 64 format, of course. As a likely "big seller," independents will naturally create software for the machine, too. And with the forthcoming CP/M cartridge (Commodore recently set a deal with Zilog for its Z80 CPU), there should soon be relief from the lack of software on the market for the Commodore 64.

After extensive use of the Commodore 64, one can only conclude that this is a fine computer with so many features that it will take some time to fully utilize them. This is a computer for serious users, not just a game player or a let's-learn-the-fundamentals-of-BASIC machine. There are less-expensive machines with "music" capabilities, for example. But they are merely sound generators, not music synthesizers as in the 64. With the Commodore 64 you can make music, not just sound effects. Also, the Commodore 64 uses a bit-mapped format, allowing it to use graphic software and printers that can take advantage of this for print-out purposes. Furthermore, the novel Sprites make it possible to create especially exciting animated arcade-like games. Add a good expansion port, handy editing keys, plug-in cartridge facility, and 64K of use memory for $595, along with previously mentioned features, and we must acknowledge that the Commodore 64 is a formidable new contender in its class. Cheers for its versatility, but let's see that user-friendly software on stream. *—Stan Veit*

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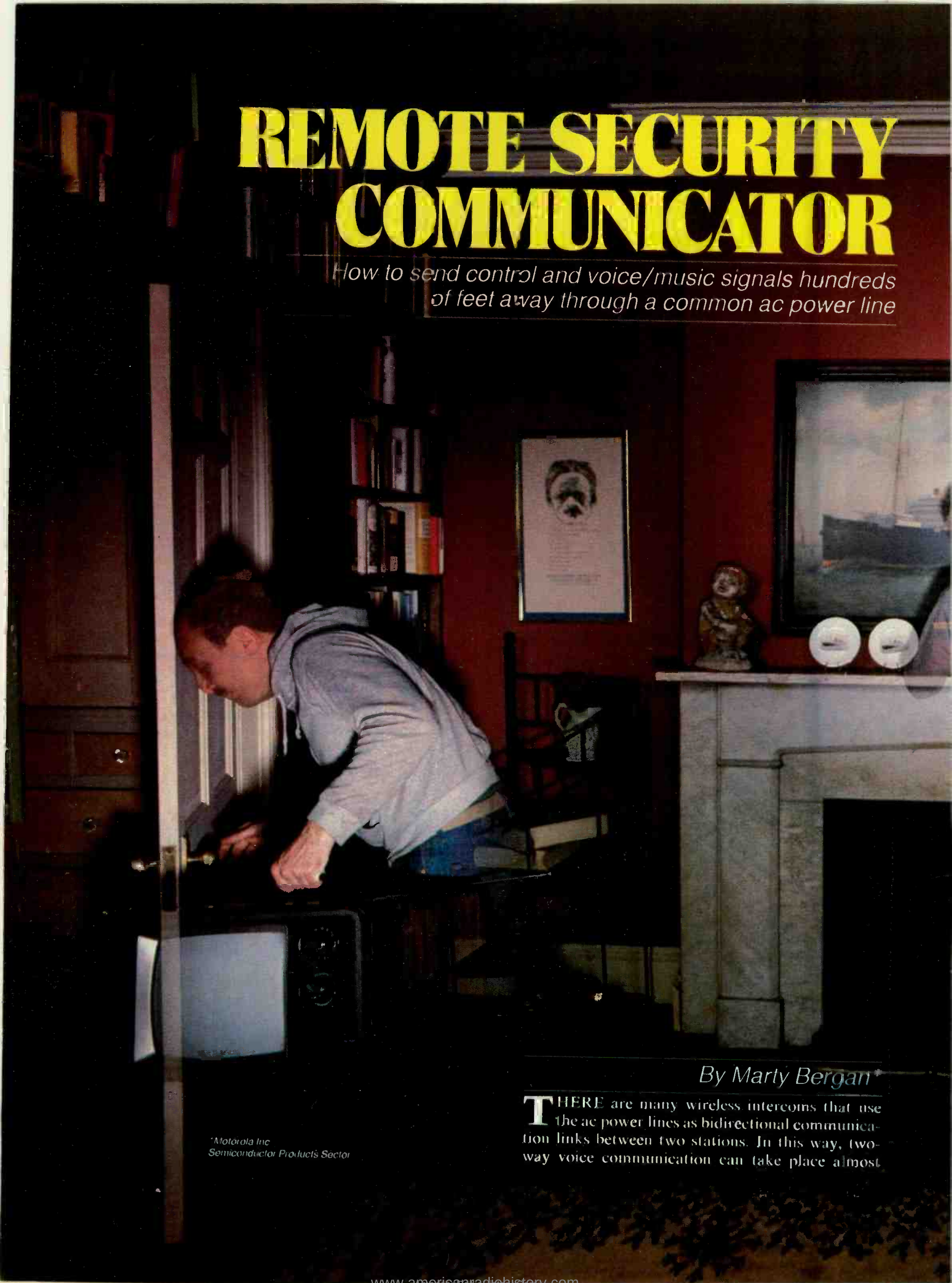

REMOTE SECURITY COMMUNICATOR

How to send control and voice/music signals hundreds of feet away through a common ac power line

*By Marty Bergan**

THERE are many wireless intercoms that use the ac power lines as bidirectional communication links between two stations. In this way, two-way voice communication can take place almost

**Motorola Inc Semiconductor Products Sector*

anywhere within a building without the installation of separate wiring. The Security Communicator described in this article uses this principle to provide a transmission link for a security system as well as a distribution system for music or one-way voice communication. A security sensor as simple as a

Photo Jay Brenner

contact switch on a door or window can be used to protect a room's contents by sending a signal to a remote receiver to sound an alarm.

As shown in Fig. 1, the system utilizes conventional "carrier-current" transmission techniques over ordinary ac building wiring. Frequency modulation is used to minimize the effects of noise that is often found on power lines.

The FM transmitter can be modulated from two sources: either a conventional audio amplifier that can accept a microphone, radio, or other input signal or a 5-kHz tone generator that is turned on when an associated normally-closed contact switch is opened. The remote FM receiver uses a simple audio amplifier and built-in speaker for voice or music output. It also has a digital circuit that operates when the 5-kHz tone is detected to allow control of external loads.

Although the transmitter has only a 30-mW output, it will operate over several hundred feet of power line, even between two buildings if they share the same power line and there is no transformer between.

The sensor switch (controlling the 5-kHz tone generator) at the transmitter can be activated by any electronic or mechanical device that can simulate a simple on/off switch. This approach can also be used to turn on (or off) any appliance at the receiving end of the system via a suitable relay connected to the receiver digital output circuit.

Circuit Operation. The transmitter, shown in Fig. 2, is designed around *IC2*, a chip intended for use in cordless telephones. This IC can operate as an FM modulator between 1.4 and 14 MHz and, although not suitable for true high fidelity, it can handle wide deviations with low distortion. The carrier frequency in this Communicator, 3.125 MHz, is determined by *L1*, *C3*, and *C4* and was selected so that the companion receiver could use an inexpensive 3.58-MHz color-TV crystal to produce the required 455-kHz intermediate frequency. The FM output from pin 7 (about 600 mV peak-to-peak with less than 1% harmonic distortion) is passed via *R12* and *C7* to the base (pin 2) of a buffer transistor within *IC2*. The emitter of this transistor is grounded via pin 4, while the collector at pin 3 uses *R14* as the load. Resistor *R13* is a bias resistor.

For additional gain and impedance matching to the power line, the output of *IC2* drives transistor *Q1*. The collector load of *Q1* is formed by the primary of *L2* tuned by both a slug and *C10*, with *L5* and *C9* keeping the r-f from entering the operating voltage supply. The secondary winding of *L2* passes the FM signal to the ac power lines through a pair of 1-kV disc ceramic capacitors, *C11* and *C12*. It is imperative that the latter be a very-high-voltage type for safety. Note that the r-f is kept out of power transformer *T1* by the high impedance of inductors *L3* and *L4*.

The transmitter is voice- or music-modulated by a signal applied to *J1* and amplified by *IC1A* and its associated components, with *R1* acting as the gain control. Enough gain is provided in this circuit to allow it to work with most crystal or ceramic microphones. A paper cone speaker can be used as a microphone if the resistance of *R2* is reduced. However, if you use this approach, make sure that the value of *R2* does not drop below 2000 ohms.

A 5-kHz audio oscillator, is formed by *IC1B* with its associated components. The circuit is kept from oscillating by normally closed *S2*. When *S2* is opened, *IC1B* immediately oscillates at 5 kHz and this signal is applied to *IC2* (in parallel with the voice/music input from *IC1A*) to modulate the transmitter. Switch *S2* can be any normally closed switch from a simple pushbutton to a closed-loop intruder alarm system (normally closed switches on windows or doors, or a loop of conductive tape on glass areas). No matter what is used, when the switch circuit is closed, the 5-kHz oscillator does not work; and when the switch is opened, the 5-kHz tone is modulated onto the FM carrier.

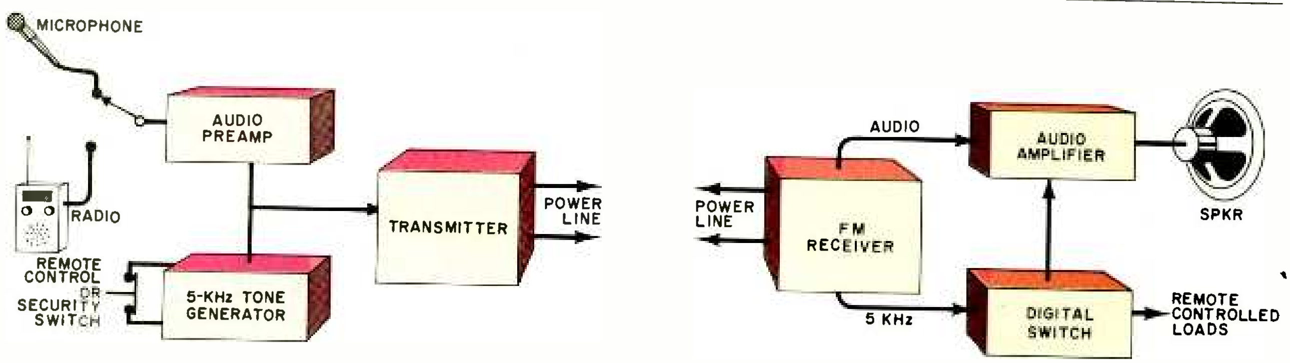

Fig. 1. Basic block diagram of the system with transmitter and receiver plugged into ac line.

The heart of the receiver circuit (Fig. 3) is *IC1*, a low-power, narrow-band FM device that includes the local oscillator, mixer, six i-f limiter stages, afc output, quadrature discriminator, isolated op amp, squelch, scan control, and mute switch. The IC was designed to detect narrow-band FM signals in FM dual-conversion communication equipment. The device has a 20-dB quieting sensitivity of about 8 μV. Signal pickup from the ac power lines is through high-voltage isolating capacitors *C8* and *C9*; coil *L1* tuned by a slug; and *C7*, with *L3* and *L4* acting as a high impedance

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PARTS LIST (Fig. 2)

C1,C9,C14,C15,C17,C18—0.1-μF ceramic disc capacitor
C2—0.005-μF ceramic disc capacitor
C3,C6,C8—0.001-μF ceramic disc capacitor
C4—680-pF mica capacitor
C5—1-μF, 16-V electrolytic (radial)
C7—50-pF ceramic disc capacitor
C10—62-pF mica capacitor
C11,C12—0.001-μF, 1-kV disc capacitor
C13—330-μF, 25-V electrolytic (radial)
C16—22-μF, 16-V electrolytic (radial)
D1 through D4—1N4001 diode
D5—1N4148 or 1N914 diode
F1—¼-A fuse
IC1—MC1376 FM modulator
IC2—LM358 dual op amp
IC3—7812 12-V regulator
J1—RCA phono jack
L1,L2—See Fig. 6
L3,L4—12-μH r-f choke
L5—10-μH r-f choke
Q1—MPSA20 transistor
The following are ¼-W, 5% carbon film resistors unless otherwise noted:
R1—1-megohm potentiometer
R2—10 kilohms
R3,R5,R7,R8,R10,R11,R15—100 kilohms
R4—1 megohm
R6,R12,R16—1 kilohm
R9—22 kilohms
R13—56 kilohms
R14—1.8 kilohms
S1—Spst switch
S2—Normally closed pushbutton switch
T1—Transformer (16-V, 100-mA secondary)(Triad F132P, Stancor PPC-2 or similar)
Misc.—Suitable enclosure, fuse holder, mounting hardware, etc.

Note: See Fig. 3 for kit information.

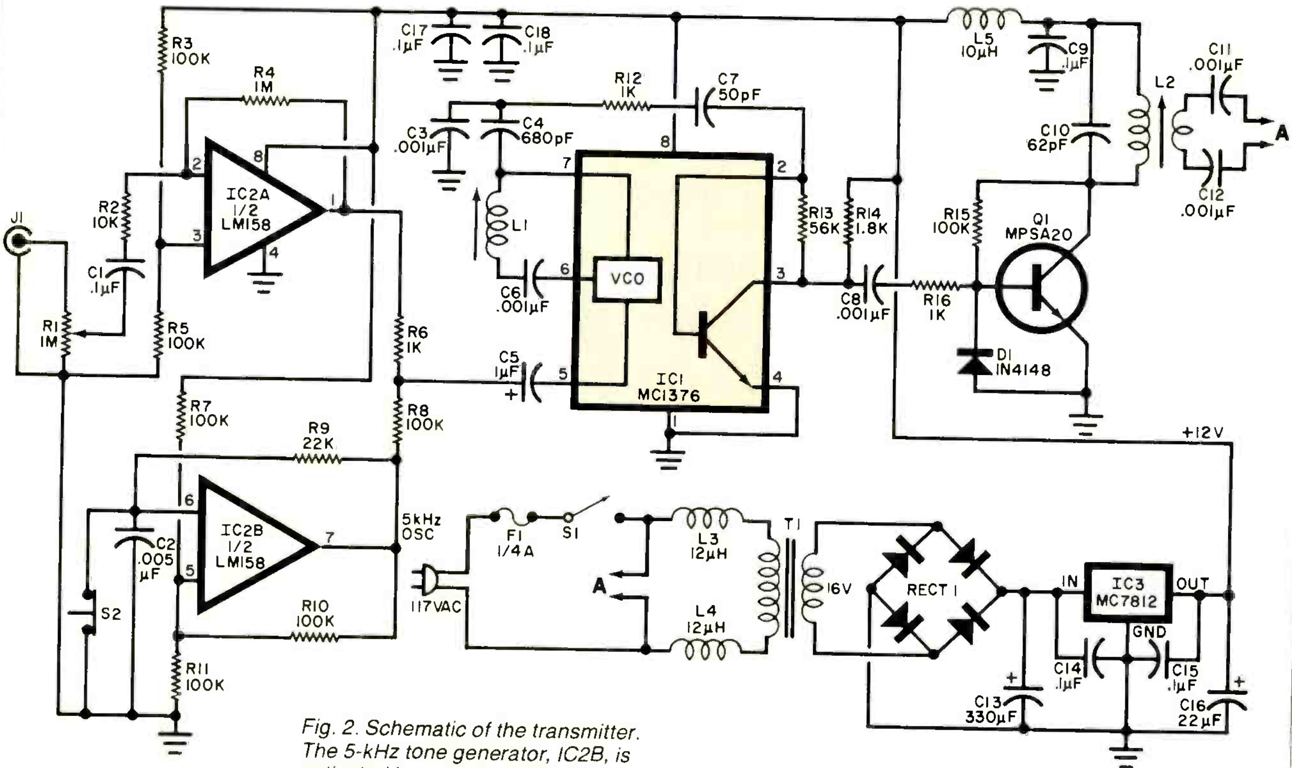

Fig. 2. Schematic of the transmitter. The 5-kHz tone generator, IC2B, is activated by security switch S2.

to keep *T1* from loading the signal.

The local oscillator uses *XTAL1*, a conventional 3.58-MHz color-TV crystal, in conjunction with 5% mica capacitors *C2* and *C3* for stable operation. The mixer output at pin 3 is passed through a 455-kHz ceramic filter *(XTAL2)* to the limiter stages. This ceramic filter narrows the bandpass to ±7.5 kHz to eliminate undesirable audio noise, and simplify i-f tuning.

The signal is then internally connected from the last limiter stage to the quadrature detector that uses *L2* and *C12* as its tank circuit.

The recovered audio is present at pin 10, where any remaining i-f components are removed by filter *R6-C17*. Capacitor *C18* couples the audio to volume control *R20*, whose rotor is connected to audio amplifier *IC3*.

The rotor of *R20* is also connected to pin 16 of *IC1*, the internal mute switch. This signal mutes the audio amplifier when a 5-kHz tone appears in the bandpass. When the tone appears, all that is heard is a short "beep" when the remote switch is opened. Without the mute signal from pin 16, the tone would be heard as long as the remote switch was open.

The op amp within *IC1* has one input internally referenced, with the other input available at pin 12 and the op amp output present at pin 13. In the configuration shown in Fig. 3, the op amp in conjunction with components *R2, R3, R7, C15, C14,* and *C13,* is used for a narrow bandpass filter for the 5-kHz signal. The filter connects to a detector formed by *D1, D2,* and *C20* which drives the squelch input at pin 14. This generates a dc level change at pin 15 that is fed to, and amplified by, *Q2*. A small amount of feedback is inserted by *R12* and *C24* to help square up the rising edge of the level change. SQUELCH potentiometer *R19,* connected between the power and ground, biases the squelch input to any selected level.

The collector of *Q2* drives flip-flop *IC2,* connected as a divide-by-

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two, resulting in a "push-on, push-off" function. The output of *IC2* at pin 13 drives electronic switch *Q1*, which, when turned on, supplies current via current-limiting resistor *R17* to a load in its emitter circuit. Almost any type of device—a single LED, relay coil, or solid-state relay—can be used as the load. Just make sure that *Q1* can deliver enough current to drive whatever is used. An opto-coupler can be used to drive a high-power device connected to the ac power lines without an isolation transformer.

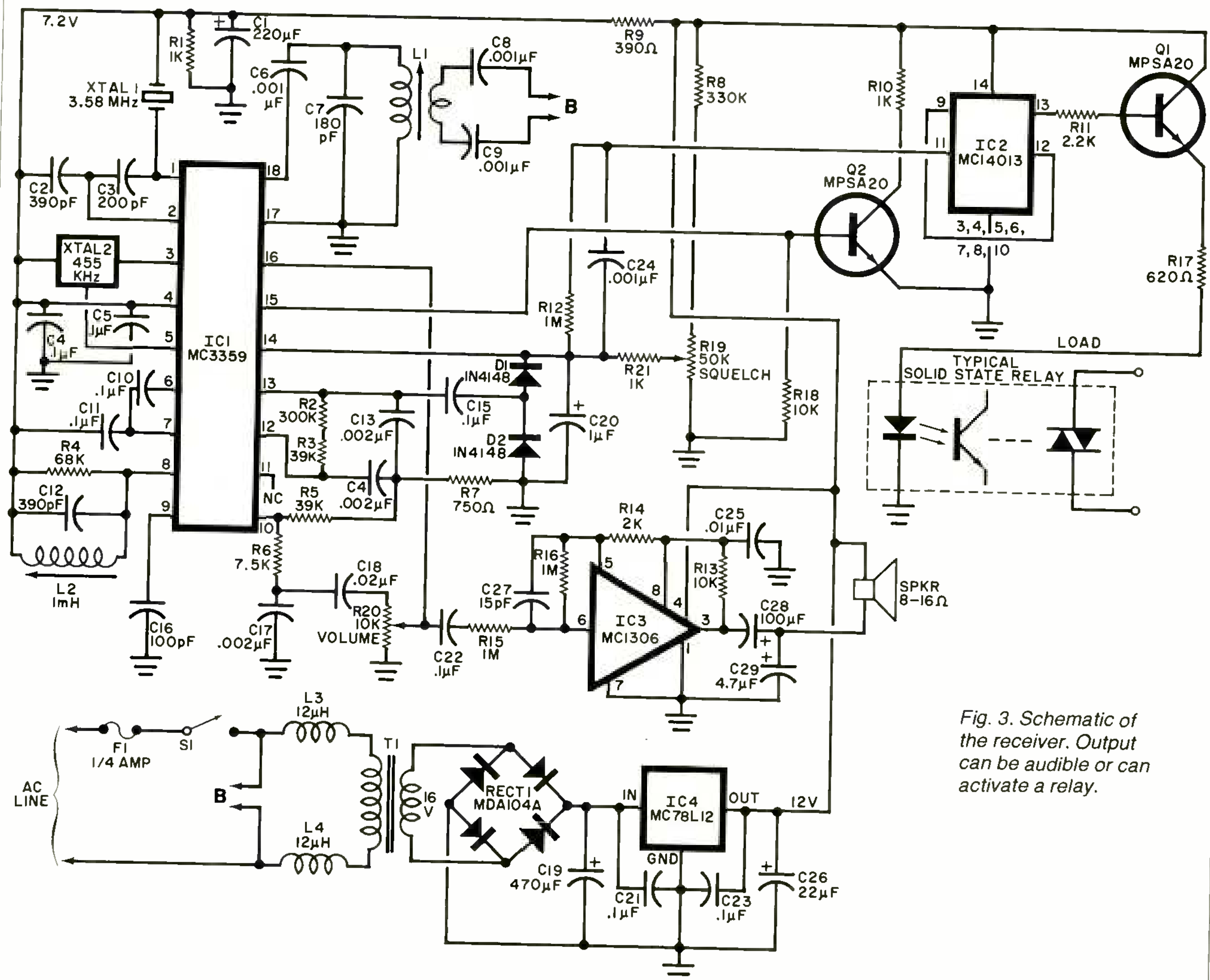

Fig. 3. Schematic of the receiver. Output can be audible or can activate a relay.

PARTS LIST (Fig. 3)

C1—220-µF, 16-V electrolytic (radial)
C2—390-pF mica capacitor
C3—200-pF mica capacitor
C4,C5,C10,C11,C15,C21,C22,C23—0.1-µF ceramic capacitor
C6,C24—0.001-µF disc capacitor
C7—180-pF mica capacitor
C8,C9—0.001-µF, 1-kV disc capacitor
C12—390-pF mica capacitor
C13,C14,C17—0.002-µF disc capacitor
C16—100-pF mica capacitor
C18—0.02-µF disc capacitor
C19—470-µF, 25-V electrolytic
C20—1-µF, 16-V electrolytic (radial)
C25—0.01-µF disc capacitor
C26—22-µF, 16-V electrolytic (radial)
C27—15-pF mica capacitor
C28—100-µF, 16-V electrolytic (radial)
C29—4.7-µF, 16-V electrolytic (radial)
D1,D2—1N4148 diode
F1—¼-A fuse
IC1—MC3359P FM demodulator
IC2—14013 flip-flop
IC3—MC1306 audio amplifier
IC4—78L12 12-V regulator
L1,L2—See Fig. 6
L3,L4—12-µH r-f choke
Q1,Q2—MPSA20 transistor
The following are ¼-W, 5% carbon film resistor unless otherwise noted:
R1,R10,R21—1 kilohm
R2—300 kilohms
R3,R5—39 kilohms
R4—68 kilohms
R6—7.5 kilohms
R7—750 ohms
R8—330 kilohms
R9—390 ohms
R11—2.2 kilohms
R12,R15,R16—1 megohm
R13,R18—10 kilohms
R14—2 kilohms
R17—620 ohms
R19—50-kilohm linear-taper pot.
R20—10-kilohm audio-taper pot.
RECT1—MDA104A
S1—Spst switch
SPKR—8- or 16-ohm loudspeaker
T1—Transformer (16-V, 100-mA secondary)
XTAL1—3.58-MHz color-TV crystal
XTAL2—455-kHz ceramic filter (Kyocera KBF455 or Murata CFU455)
Misc.—Suitable enclosure, fuse holder, mounting hardware, etc.

Note: The following are available from Circuit Specialists, 738 S. Perry Lane, Tempe, AZ 85281: complete transmitter kit TR1 at $36.50; complete receiver kit XR1 at $49.95. Also available separately are the transmitter and receiver pc boards at $4.95 each.

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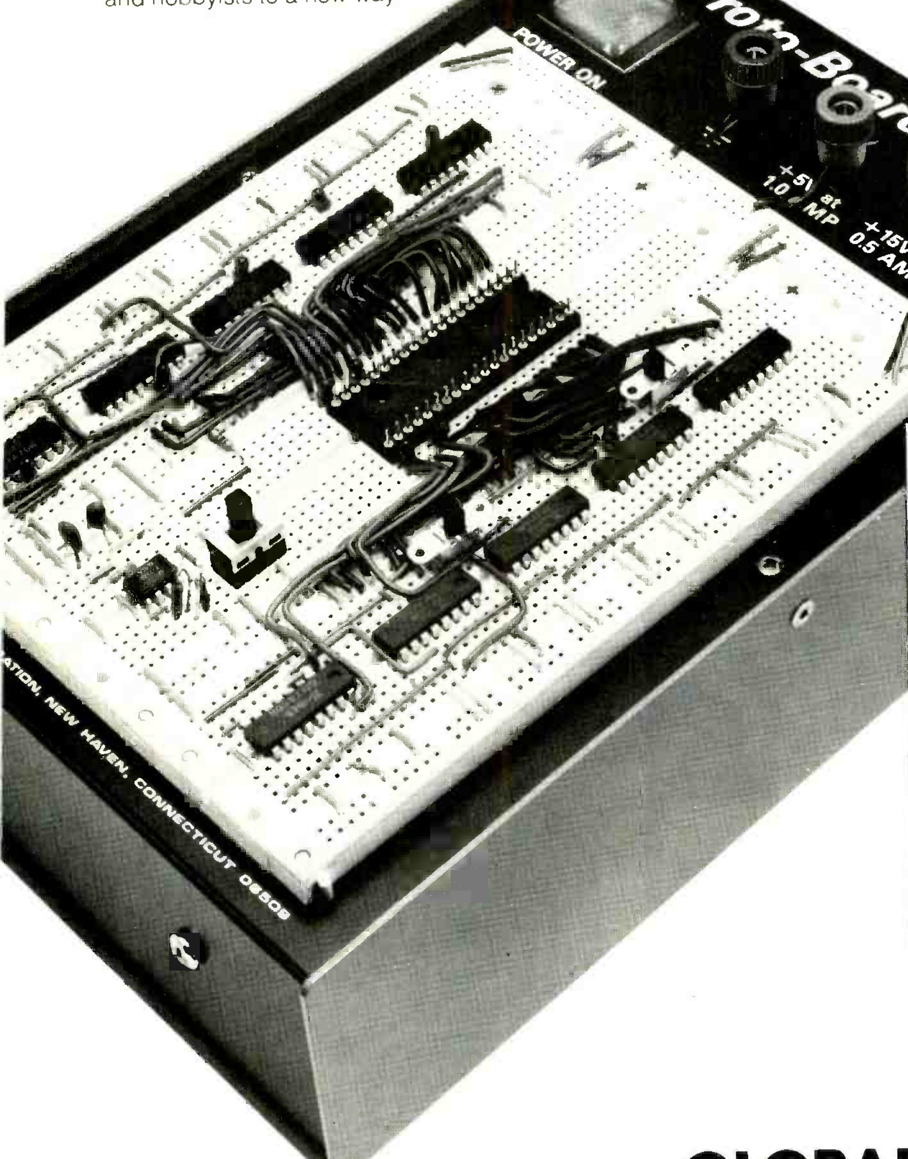

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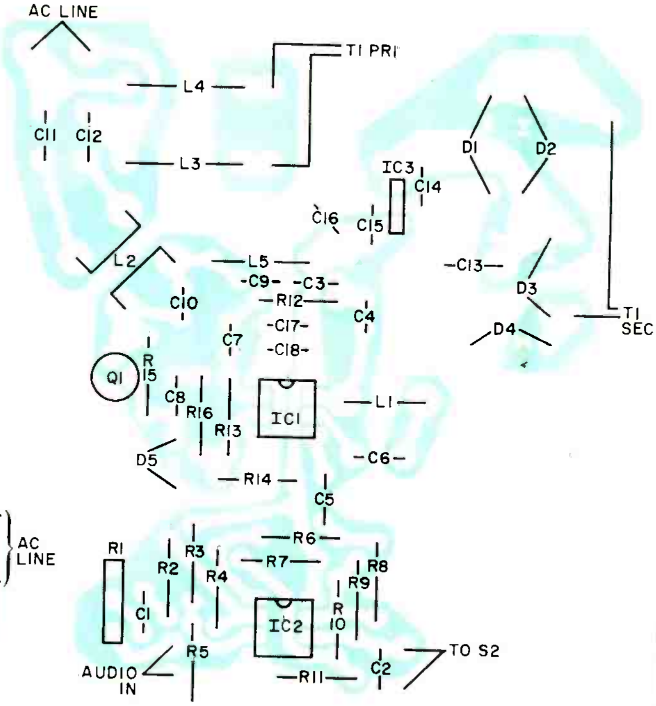
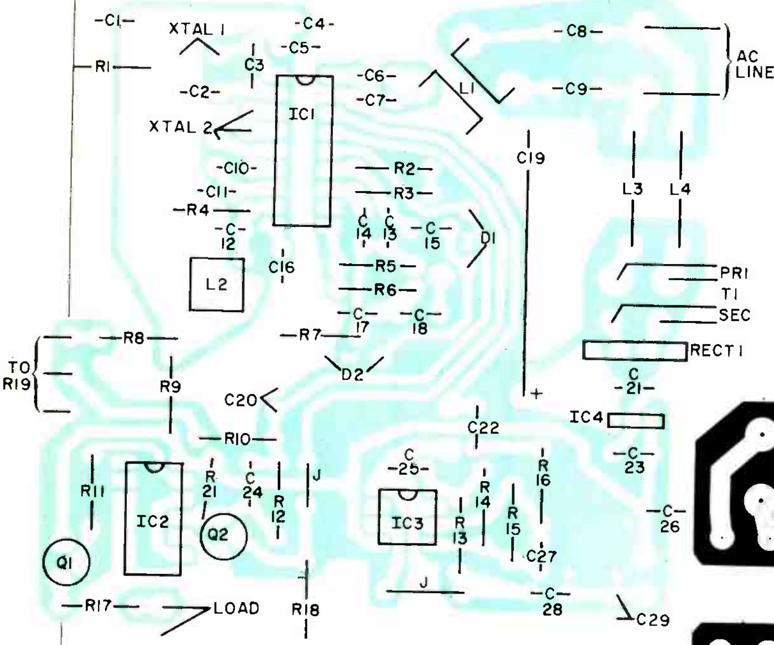


Fig. 4. Exact-size foil pattern (left) and component layout for the transmitter.



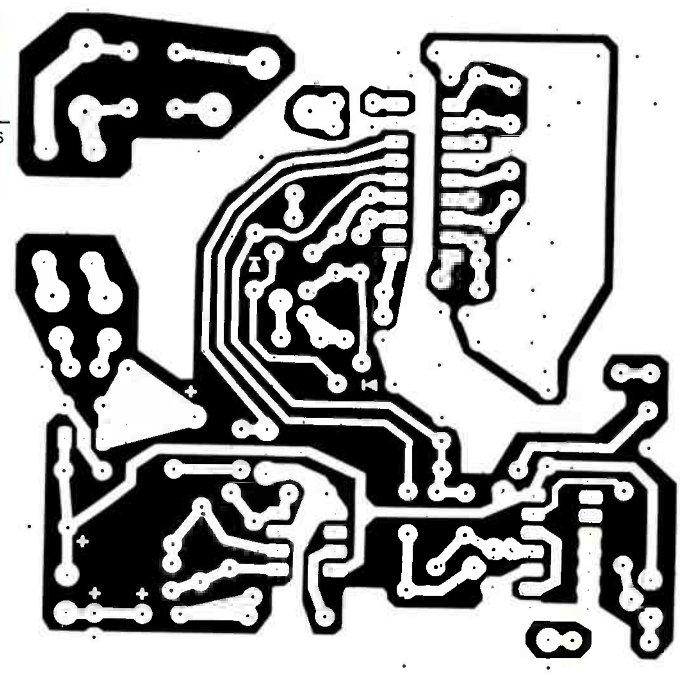


Fig. 5. Exact-size foil pattern (below) and component layout for the receiver.

Audio amplifier *IC3* can provide an output of about ½ W into an 8- or 16-ohm speaker. If more gain is required, reduce the value of series resistor *R15*. However, do not go below 100,000 ohms.

Construction. The system can be constructed using point-to-point wiring or pc boards. A foil pattern and component layout for the transmitter are shown in Fig 4, and for the receiver in Fig 5. Low-profile low-capacitance sockets should be used for both *IC1*s to minimize stray capacitance in the r-f circuits.

As shown in Fig. 6, the transmitter oscillator coil, *L1*, uses a ⅜" diameter plastic form having a #2 ferrite tuning slug. It is closely wound with 36 turns of #28 enameled wire with each end connected to suitable solder pins on the form. The receiver quadrature coil, *L2*, consists of 150 turns of #36 enameled wire tightly wound and layered on a ¼" diameter form about ¾" long. The form should have a #1 powdered-iron tuning slug core (Miller 23AO14-1 or similar). Both line coupling coils (*L2* in the transmitter and *L1* in the receiver) are fabricated in the same way. Wind 80 turns of #28 enameled wire tightly on a ⅜" diameter form having a #2 ferrite tuning slug. Cover the winding with two layers of high-voltage Mylar tape for insulation. Wind 20 turns of #28 enameled wire over the tape to use as the secondary winding. The windings can be held in place with glue or coil dope.

Use shielded cable for the audio lines connected to the remote inputs (microphone or radio). When wiring the shielded cable to the volume control of the receiver, connect the shield to the pc board at only one point. This avoids a ground loop, and a possible source of hum.

The transmitter and receiver can be housed in almost any suitable enclosure. It is only necessary to provide access to pushbutton switch *S2* (or a connector for a remote switch), *J1*, and if desired, volume control *R1*. The receiver requires access to volume control *R20* and the LOAD connectors.

Alignment. Using a dc voltmeter, check for +12 volts at the output of *IC4*, the voltage regulator in the receiver, and approximately 7.2 volts at pin 4 of *IC1*. Using an oscilloscope, check pins 1 and 2 of *IC1* for the presence of 3.58 MHz.

Turn off the power to the receiver, then disconnect the power line from the ac wall receptacle. Remove the connections between *C8* and *C9* and the power line. Connect these capacitors to the output of a signal generator tuned to approximately 3.12 MHz and having a deviation of 3 to 4% or a maximum of 7.5 kHz at 1 mV rms output. With the receiver power turned on, use a scope to observe a 455-kHz sine wave at *IC1*, pin 5. Adjust the slug within *L1* to maximize this signal amplitude. It may be necessary to retune the signal generator slightly, since ceramic filter *XTAL2* determines the 455 kHz. In either case, adjust *L1* and the signal generator to maximize the signal. Once this has been done, move the scope to *IC1*, pin 10 (audio output), and tune *L2* for maximum amplitude of the sine wave. Some residual 455 kHz may still appear at pin 10.

Observe the signal at the *C18* end of VOLUME control *R20* and note that a clean sine wave appears at that point in the circuit.

Remove the test equipment, turn off the receiver, and unplug its power cord from the wall socket. Reconnect *C8* and *C9* to the line cord connectors.

With the receiver turned on and the volume control set to midscale or higher, and with no incoming signal, adjust squelch control *R19* until a hiss (similar to that heard from a conventional FM receiver when it is tuned between stations) is heard.

Connect the transmitter to a wall socket and turn on the power. Apply some type of audio signal (microphone, radio, audio signal generator, etc.) to *J1*, at an amplitude of about 10 mV rms. Adjust the slug within transmitter coil *L1* until the audio source is heard in the receiver. If *L1* cannot be tuned to the receiver, the value of *C4* can correct frequency.

Once a signal is received, adjust the transmitter output coil, *L2*, to maximize the signal at the receiver.

Set the receiver volume control to the desired level, then adjust the level control (*R1*) in the transmitter for the highest level without distortion. After this, adjust the receiver volume for the desired listening level.

To test the 5-kHz tone circuit, connect a LED across the LOAD terminals of the receiver with the anode to *Q1*'s emitter and the cathode to ground. Depress (open) *S2* in the transmitter and listen for the tone at the receiver. The LED should not change state when the switch is depressed. The tone can be blocked by adjusting squelch control *R19* at the receiver, until the audio is just muted. As muting occurs, the logic circuit should change state as indicated by the LED.

If a momentary action of the digital switching is desired (with the output load enabled only when the remote 5-kHz switch is opened and held open, then disabled normally), remove *IC2* and connect pins 11 and 13 on its socket together (bypassing the flip-flop so that *Q2* directly drives *Q1*).

Separate the receiver and transmitter by several rooms, and test for operation of both voice and 5-kHz tone operation. ◇

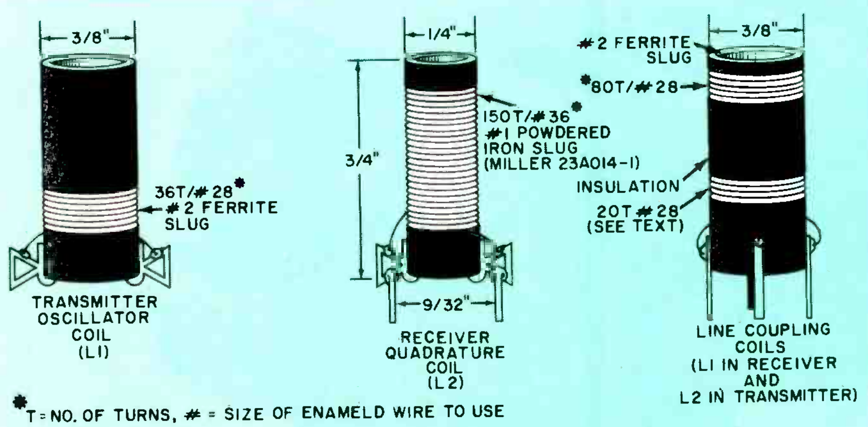


Fig. 6. Follow the instructions in the text and the diagrams above for winding the various coils.

A DAC for TRS-80 INTERFACING

Low-cost digital-to-analog converter transforms bits into ac waveforms

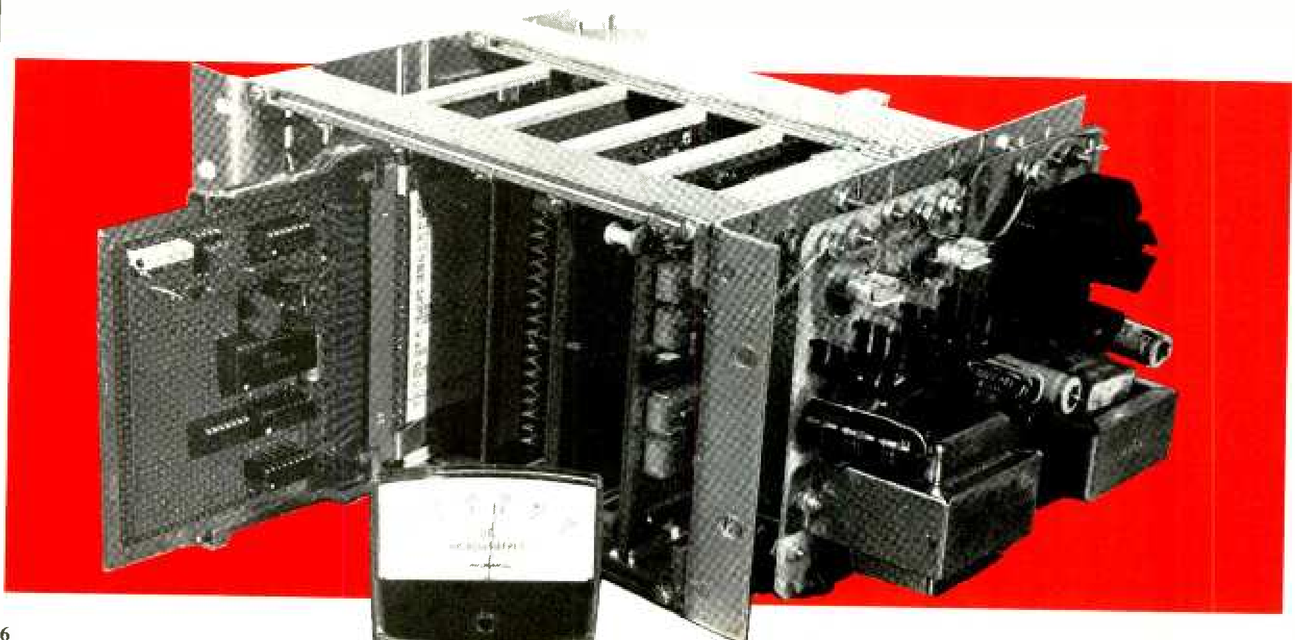
By Adolph Mangieri

ONE of the most interesting challenges of microcomputing is interfacing the machine to the outside world. To do this, a digital-to-analog converter (D/A or DAC) and its counterpart analog-to-digital converter (A/D or ADC) must be added to the system. The device we are concerned with here is the D/A converter, which has a host of applications that include audio-signal processing, A/D conversions, and the generation of simple and complex waveforms.

This low-cost D/A converter uses the DAC1000, which provides 10-bit conversions with 0.05% linearity. The converter interfaces with the TRS-80 Model I, Levels I and II. Several short machine language programs are included to get you started, even with little or no familiarity with machine language programming.

Circuit Operation. The schematic diagram in Fig. 1 shows the D/A circuit. Line buffers *IC1* and *IC2* protect the CMOS inputs of *IC6*. Address decoder *IC3* supplies an active-low, chip-select signal $\overline{CS1}$ in the address range of FF00H thru FFFFH at the high end of unused memory space. The address-decoder output and address line A0 are ANDed active low in gate *IC7* which drives control lines $\overline{XFER}$ and BYTE1/$\overline{BYTE2}$. This precludes enabling of $\overline{XFER}$ at times when the port is not selected. Voltage-follower op amp *IC5* supplies a regulated reference voltage of 0 to −10 V depending on the setting of potentiometer *R2*. Current-to-voltage converter op amp *IC4* converts *IC6* output current I_{OUT1} to output voltage V_{OUT}. Potentiometer *R3* zeros the op amp. The analog output voltage is positive going with the negative reference voltage. If you need a negative going output, reverse the reference voltage by connecting the top end of *R1* to the +12-V supply and reverse the connections of *C10*.

Construction. Use any construction technique that ensures a low-impedance ground circuit. The prototype was assembled on a Vector 4112-5 44-contact plug board. Parts placement is not critical. Install *IC4* near *IC6*'s output pins for short connections. Install bypass capacitors *C1* through *C8* beside the several gates and buffers. You can assemble the card cage as shown in the photo using the Vector CCK135AS card-cage kit supplied with twenty snap-in card guides. Install card guides 1½" (38.1 mm.) apart for six



wire-wrapped cards. Install six 44-pin card receptacles (Vector R644-3) on the rear T-struts and wire wrap the backplane. Connect a TRS-80 ribbon cable with edge connector to the backplane preferably through a 40-pin IDC connector. Do not carry the TRS-80 5-V line (39) to the backplane. You may power the cage using a Jameco JE200 5-V, 1-A regulated power supply (or similar) and the Jameco JE215 adjustable dual-power supply (or similar) set to deliver an output of ±12V.

If you must use a long ribbon cable, it may be neccesary to terminate the cage bus lines. On each data, address, and control line, connect a 1200-ohm pullup resistor from line to +5 V. Connect an 1800-ohm pulldown resistor from each line to ground. The resistors can be mounted on the 3362-5 plug board installed at the far end of the cage. Decouple the bus termination card by connecting a 20-μF tantulum capacitor and a 0.1-μF disc capacitor at the entry pin of the 5-V supply line. To operate a dynamic memory board in the cage with a long ribbon cable, use 220-ohm pulldown resistors on lines MUX, $\overline{CAS}$, and $\overline{RAS}$.

Checkout and Adjustment. Energize the card cage and verify that the correct supply voltages are at the IC socket pins before installing

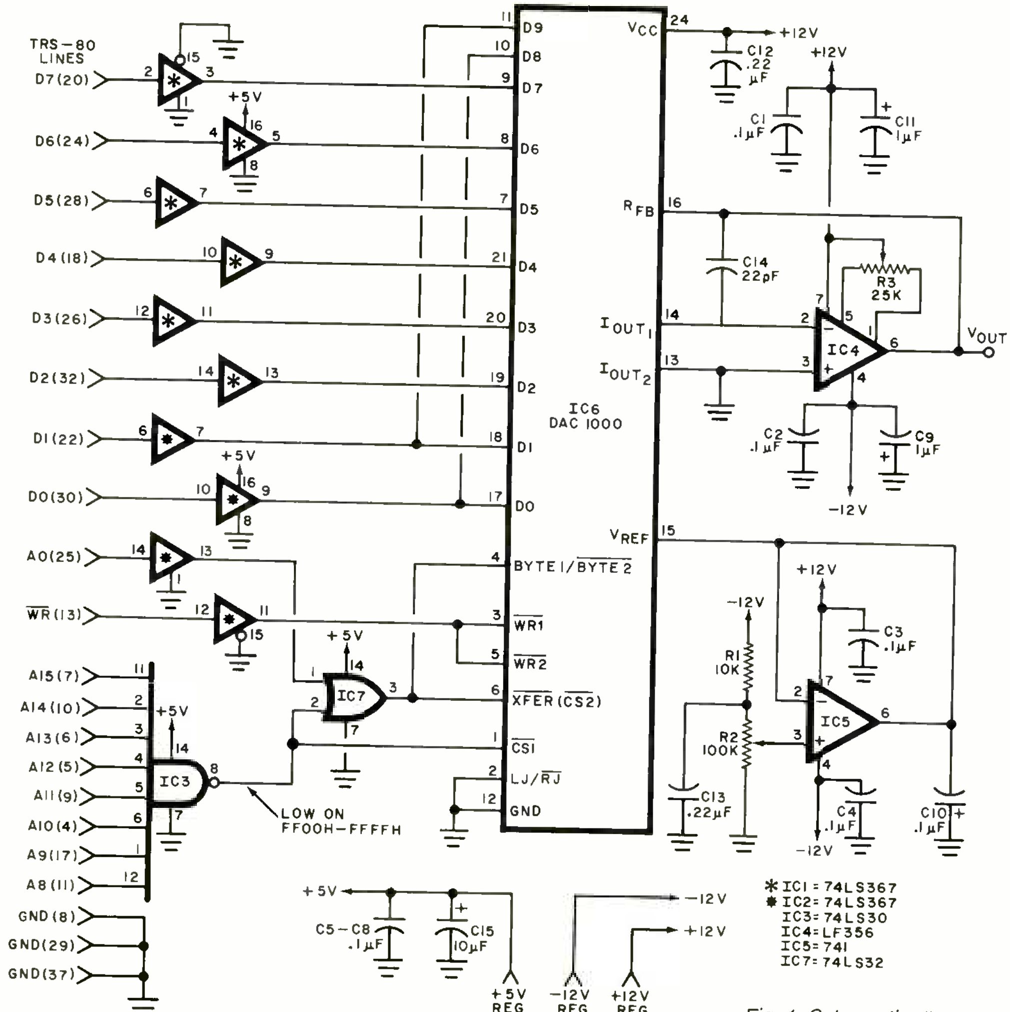


Fig. 1. Schematic diagram of the digital-to-analog converter.

PARTS LIST

C1 through C8—0.1-μF disc capacitor
C9,C10,C11—1.0-μF, 35-V tantalum electrolytic
C12,C13—0.22-μF, 15-V disc capacitor
C14—22-pF, 5% dipped mica
C15—10-μF, 35-V tantalum electrolytic
IC1,IC2—74LS367 hex buffer
IC3—74LS30 NAND gate
IC4—LF356 op amp (do not substitute)*
IC5—741 op amp
IC6—DAC1000 10-bit D/A converter*
IC7—74LS32 quad 2-input OR gate
R1—10-kilohm, ¼-W resistor
R2—100-kilohm, 10-turn trimpot
R3—25-kilohm trimpot
*Available from Jameco Electronics, 1355 Shoreway, Belmont, CA 94002.
Misc.—16-pin DIP sockets (2); 14-pin DIP sockets (2); 8-pin DIP sockets (2); 24-pin DIP socket; plug board (Vector 4112-5 or equivalent); card cage (Vector CCK135AS kit); wrap posts (T46-5-9); Jameco JE200 and JE215 power supplies (or equivalent); TRS-80 ribbon cable and connector; 44-pin card receptacles (Vector 644-3); wire; etc.

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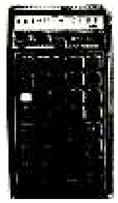

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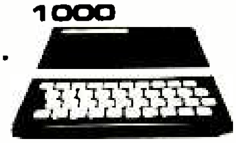

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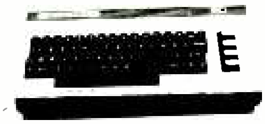

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the devices. Make certain that cage supply voltages do not feed back to the TRS-80 through the cable. Observe usual CMOS handling precautions when installing the DAC1000. Connect the converter to the computer and energize the card cage first. Connect a dc voltmeter set to read 12 V from V_{OUT} to ground.

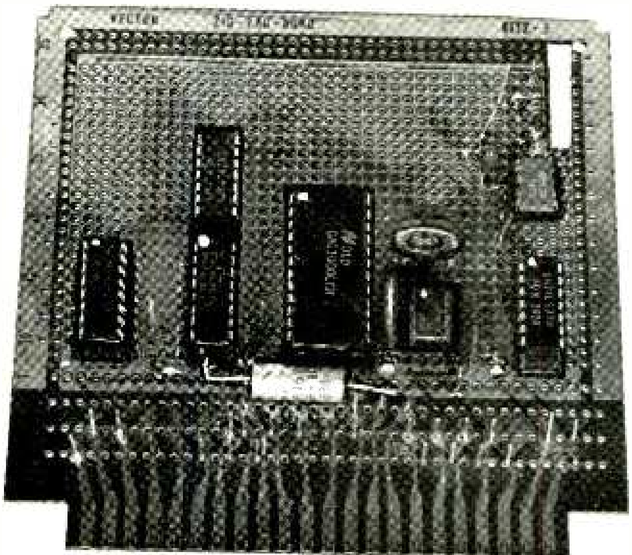
Using the TBUG (TRS-80 machine language monitor) memory command, enter code 00 at addresses FF01H and FF02H in that order. Any upscale indication of the meter should drop to zero on the second data entry. Set the meter to its lowest voltage range (or use a millivoltmeter) and adjust offset-null pot *R3* for zero output. If you cannot null V_{OUT} connect V_{OUT} to a scope and check for oscillations. If *IC4* oscillates, double the value of *C14*. Also, try cleaning the TRS-80 card edge connections.

Set the meter to read 12 V. Enter code FF at address FF01H and code 03 at address FF02H which sets all DAC data bits to one or full-scale. Adjust voltage-reference pot *R2* for the desired maximum output voltage such as 5 or 10 V. If you use a DVM and set V_{OUT} to 10.23 V, the DAC resolves the voltage range in 10-mV steps.

Software. The brief machine language programs included with this article illustrate the simplicity of generating common repetitive waveforms. Connect the converter output to an oscilliscope or to an analog or digital voltmeter. In the SQWAVE program, the HL registers are loaded with zero and output to the DAC. Then, a CALL to DELAY provides 0.886 seconds delay. The HL registers are then loaded with 1023 or maximum output and loaded into the DAC. The delay is again CALLed and the program loops to repeat the waveform. Alter the delay time by entering suitable constants at addresses 4A53H and 4A54H. The delay is 48.4 us using code 01 00.

A waveform varying between two specific voltage levels is obtained by entering suitable values into HL. A train of short-duration pulses is obtained by deleting the CALL to DELAY at address 4A0FH. The 'up' time and 'down' time of a rectangular pulse is adjusted independently by CALLing two DELAY subroutines. Omission of CALLS to DELAY produces a rectangular pulse of approximately 28 kHz.

The RAMP program generates staircase waveforms. The BC registers are loaded with step size (height) 0080H or 128. The HL reg-



The author's prototype was assembled on a 44-contact plug board.

BASICS OF D/A CONVERSION

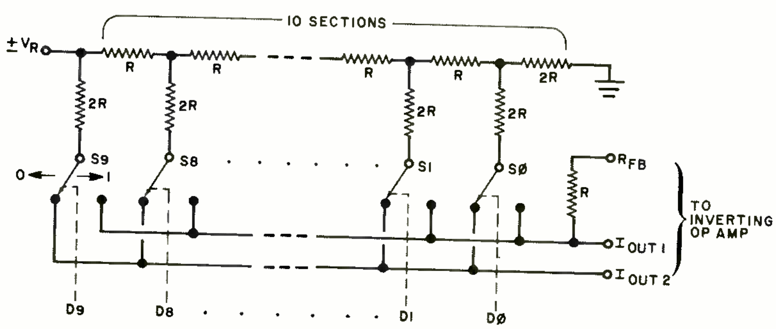
A digital-to-analog converter uses a binary word as its input and delivers an analog current or voltage in proportion to the binary value as its output. For example, the relationship between the binary input and the analog output of a 3-bit converter delivering 10.5 V full scale would be as follows:

Input	Decimal	Output (V)
000	0	0
001	1	1.5
010	2	3.0
011	3	4.5
100	4	6.0
101	5	7.5
110	6	9.0
111	7	10.5

The output range consists of 2^3 or eight values in 1.5-V steps. A 10-bit converter would provide 2^{10} or 1024 output values (10.26 mV per step) over the same voltage range.

Conversion of a binary value to an analog output current can be accomplished by using an R-2R resistive-ladder network as shown here. The ladder is supplied with a stable reference voltage $\pm V_R$. Each of the solid-state switches, *S0* through *S9*, goes to the right when the data bit applied to it is a 1. As a result, the binary weighted output, I_{OUT1}, increases and I_{OUT2} decreases an equal amount.

Provided that current I_{OUT1} "sees" zero resistance to ground, the output current is proportional to the binary input value. This requirement is met by using an inverting op amp to divert I_{OUT1} into feedback resistor R_{FB}. The inverting input of the op amp hovers near ground potential, differing from the noninverting input by a slight voltage E_{IN} sufficient to cause the high-gain op amp to fully divert I_{OUT1}.



THE DAC1000 D/A CONVERTER

The DAC1000 is a 10-bit D/A converter that easily interfaces with 8-bit and 16-bit microprocessors. Figures 1 and 2 show the block and timing diagrams for the device. Eight data lines feed information to an 8-bit input latch as well as a 2-bit latch. When using the DAC1000 with a Z80 CPU, data can be formatted as either right- or left-justified in a register pair as shown in Fig. 3.

For right-justified data, register L of the Z80 microprocessor is first loaded into the DAC 8-bit data latch followed by loading register H into the 2-bit latch on the second byte transfer. Although any register pair can be used, the HL registers serve as an accumulator with 16-bit arithmetic instructions to simplify software. The DAC can be mapped as part of the TRS-80 memory allowing use of a single memory-load instruction that moves both bytes into the DAC in proper sequence.

The DAC1000 has six control lines permitting a number of operating modes (detailed in the instruction sheets). To simplify software and hardware for our purposes, the DAC was configured as part of memory along with the use of right-justified data and automatic-output mode. In the latter, the analog output is updated immediately following the data transfer to the DAC. Control line LJ/$\overline{\text{RJ}}$ (left-justification/right-justification) is grounded for right-justified data. Write lines $\overline{\text{WR1}}$ and $\overline{\text{WR2}}$ connect to the Z80 $\overline{\text{WR}}$ line. Chip select line $\overline{\text{CS1}}$ (primary chip select line) enables the DAC to accept data. The $\overline{\text{CS1}}$ line is connected to the address decoder which maps the port as memory locations.

Byte-sequencing line BYTE1/$\overline{\text{BYTE2}}$ controls the entry of data. The control line is pulled high on the BYTE1 data transfer and both data latches are enabled. The line is then pulled low on the $\overline{\text{BYTE2}}$ data transfer.

The 8-bit latch is disabled and the 2-bit latch accepts the two bits of $\overline{\text{BYTE2}}$. At this point, the second chip-select line and data-transfer line $\overline{\text{XFER}}$($\overline{\text{CS2}}$) is pulled low and activated. This enables the DAC 10-bit register to enter new data into the R-2R ladder network which in turn updates the analog output voltage. This sequence is termed "double buffering" wherein the output is updated only after both bytes have been transferred to the DAC.

The control line $\overline{\text{XFER}}$ can be driven directly by address line A0 under the following conditions. On any double-byte, memory-write instruction, the CPU issues two consecutive memory addresses as shown in the timing diagram. By choosing an odd memory address such as FF01H for the memory-write instruction, address bit A0 is a 1 during the BYTE1 data transfer and changes to 0 on the $\overline{\text{BYTE2}}$ data transfer for control of $\overline{\text{XFER}}$ without additional logic. ◇

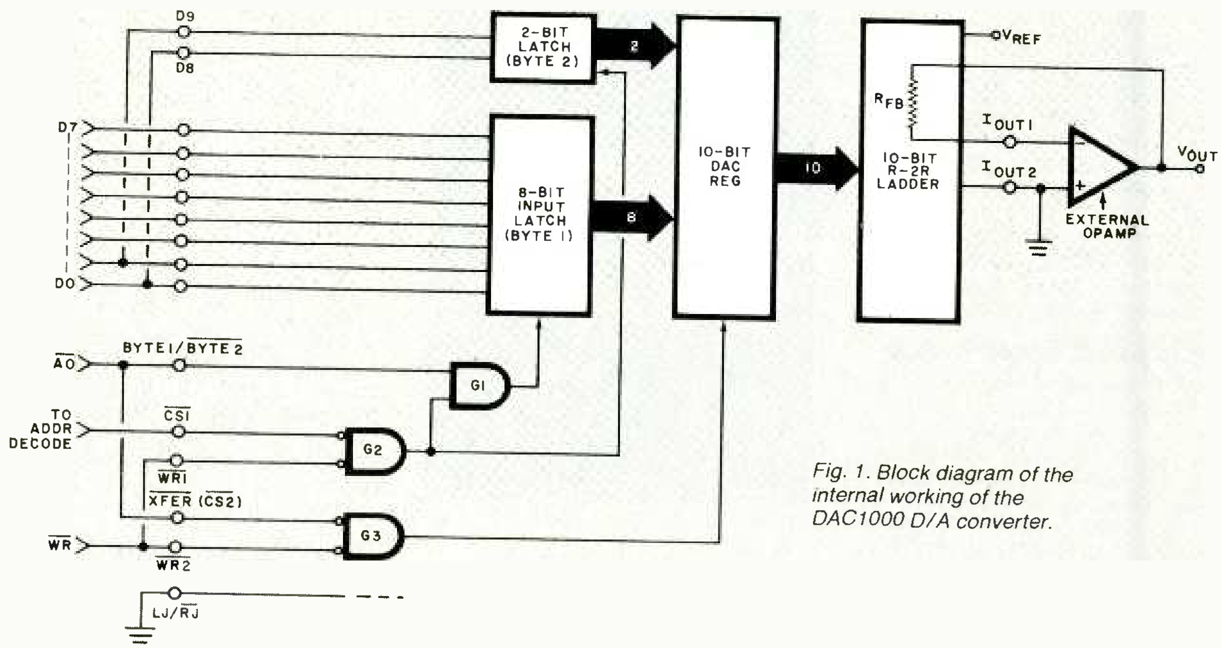


Fig. 1. Block diagram of the internal working of the DAC1000 D/A converter.

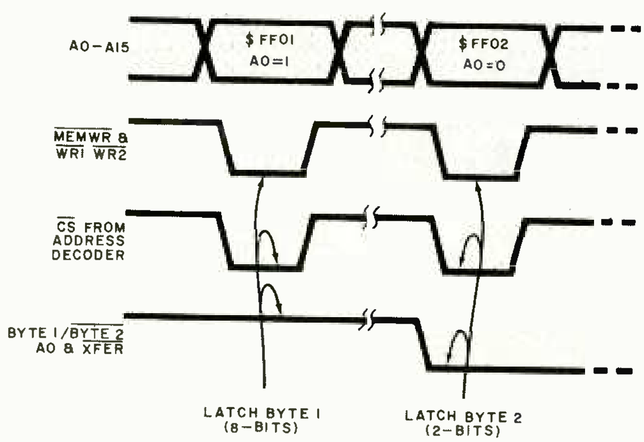


Fig. 2. Timing diagram of the converter.

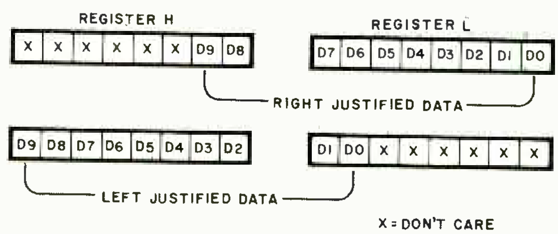


Fig. 3. Data can be formatted as either left- or right-justified.

isters are initialized to zero and loaded into the DAC. You may insert a CALL to DELAY if you are observing the output on a voltmeter. The step size is then added to the current value of HL and the program loops back. The step sizes of this program are limited to powers of two such as 1, 2, 4, etc. to effect identical repeat of the staircase. Verify this by entering an odd step size and observe the results on a DVM. To use an odd step size, modify the program by adding a loop counter to effect an exit once the required number of steps have been generated. To obtain a descending staircase, replace code 09 at address 4A3CH with code B7 (OR A to clear carry) followed by code ED 42 (subtract DC from HL) and JUMP instruction C3 36 4A.

You may use two register pairs to source data to the DAC. Initialize the registers at the same or diverse values. Then, increment one register pair and decrement the second pair or hold it constant. The results include various modulated pyramidal and sawtooth waves. An approximation of sine waves and others may be obtained by fetching and displaying data held in a table in memory.

Applications. For immediate applications of the converter, use it as a programmable signal generator for testing digital and linear devices and circuits. Program the waveform and voltage excursions to suit the particular test. You may use the ramp waveform with 1023 steps as a linear x-axis sweep of an oscilloscope at the lower frequencies. By adding a second converter to the plug card, you can output x-y display plots on the scope. Data for one or both axes are fetched from tables or data-acquisition buffers in memory.

On the test bench, the converter serves as a precision voltage divider supplying accurate voltage ratios for checking the linearity of analog and digital meters and dc amplifiers. If you further calibrate the converter output against a voltage standard or precision DVM, you have a source of programmable voltages of known precision. Use the TBUG memory command to set the output voltages directly.

For special applications, the converter is easily programmed to generate any sequence of waveforms and time delays by CALLing subroutines. Output op amp *IC4* is best limited to ±10 V at up to 5 mA. For higher power levels, add a discrete or integrated-circuit power amplifier. The LM380 audio amplifier can be used to amplify sound effects, tones, and musical tone sequences.

These are just a few simple ways to use the D/A converter. A more advanced application would be in a feedback control system to regulate motor speed, temperature, light intensity, or pressure. The controlled apparatus would include an analog sensor such as a tachometer, thermocouple, photoresistor, or barometer. The sensor monitors the variable and transmits an analog signal to an A/D converter, which in turn transmits digital information back to the computer. (An A/D converter for the TRS-80 by the author was described in the January 1982 issue of POPULAR ELECTRONICS.) The computer program then examines the data and takes any corrective action via the D/A converter.

It's clear that analog-to-digital and digital-to-analog conversion can greatly enhance the power and productivity of a microcomputer like the TRS-80 Model I. The ideas suggested here are just some of the applications possible. As you become more adept at interfacing your computer with the outside world, many more applications will become apparent. ◊

DEMONSTRATION PROGRAMS

```
                 00100 ;FILENAME - DIGANA
                 00110 ;BY ADOLPH A. MANGIERI
                 00120 ;DEMO PROGRAMS GENERATE SQUARE, PULSE
                 00130 ;AND RAMP WAVEFORMS WITH 10-BIT CONVERTER.
4A00             00140           ORG   4A00H         ;START 'SQWAVE'
4A00  210000     00150 SQWAVE    LD    HL,0000H      ;LD ZERO IN HL
4A03  2201FF     00160           LD    (0FF01H),HL   ;SEND HL TO DAC
4A06  CD504A     00170           CALL  DELAY         ;CALL TIME DELAY
4A09  21FF03     00180           LD    HL,03FFH      ;LD 1023 IN HL
4A0C  2201FF     00190           LD    (0FF01H),HL   ;SEND HL TO DAC
4A0F  CD504A     00200           CALL  DELAY         ;CALL TIME DELAY
4A12  C3004A     00210           JP    SQWAVE        ;LOOP
                 00220 ;END  'SQWAVE'
4A30             00230           ORG   4A30H         ;START 'RAMP'
4A30  018000     00240 RAMP      LD    BC, 0080H     ;SET STEP SIZE
4A33  210000     00250           LD    HL, 0000H     ;INITIALIZE HL
4A36  2201FF     00260 STEP      LD    (0FF01H),HL   ;SEND HL TO DAC
4A39  00         00270           NOP                 ;THIS SPACE FOR
4A3A  00         00280           NOP                 ;A CALL TO TIME
4A3B  00         00290           NOP                 ;DELAY
4A3C  09         00300           ADD   HL,BC         ;NEXT STEP
4A3D  C3364A     00310           JP    STEP          ;LOOP
                 00320 ;END 'RAMP'
4A50             00330           ORG   4A50H         ;START 'DELAY'
4A50  F5         00340 DELAY     PUSH  AF            ;SAVE STATUS
4A51  D5         00350           PUSH  DE            ;SAVE
4A52  11FFFF     00360           LD    DE,0FFFFH     ;SET DELAY HERE
4A55  1B         00370 DECDE     DEC   DE            ;DECREMENT DE
4A56  7A         00380           LD    A,D           ;GET D
4A57  B3         00390           OR    E             ;IS RESULT ZERO?
4A58  C2554A     00400           JP    NZ,DECDE      ;LOOP TILL ZERO
4A5B  D1         00410           POP   DE            ;RESTORE
4A5C  F1         00420           POP   AF            ;RESTORE
4A5D  C9         00430           RET                 ;RETURN
0000             00440           END
00000 TOTAL ERRORS
DECDE    4A55
STEP     4A36
RAMP     4A30
DELAY    4A50
SQWAVE   4A00
```

The COMPUTER NETWORK MAZE

Part 2: Concluding a description of how the various computer communications networks can be utilized to your best advantage

By Stan Veit

LAST month, in the first part of this article, we described CompuServe, the largest and most widely used of the computer communication networks. Here are some of the other networks.

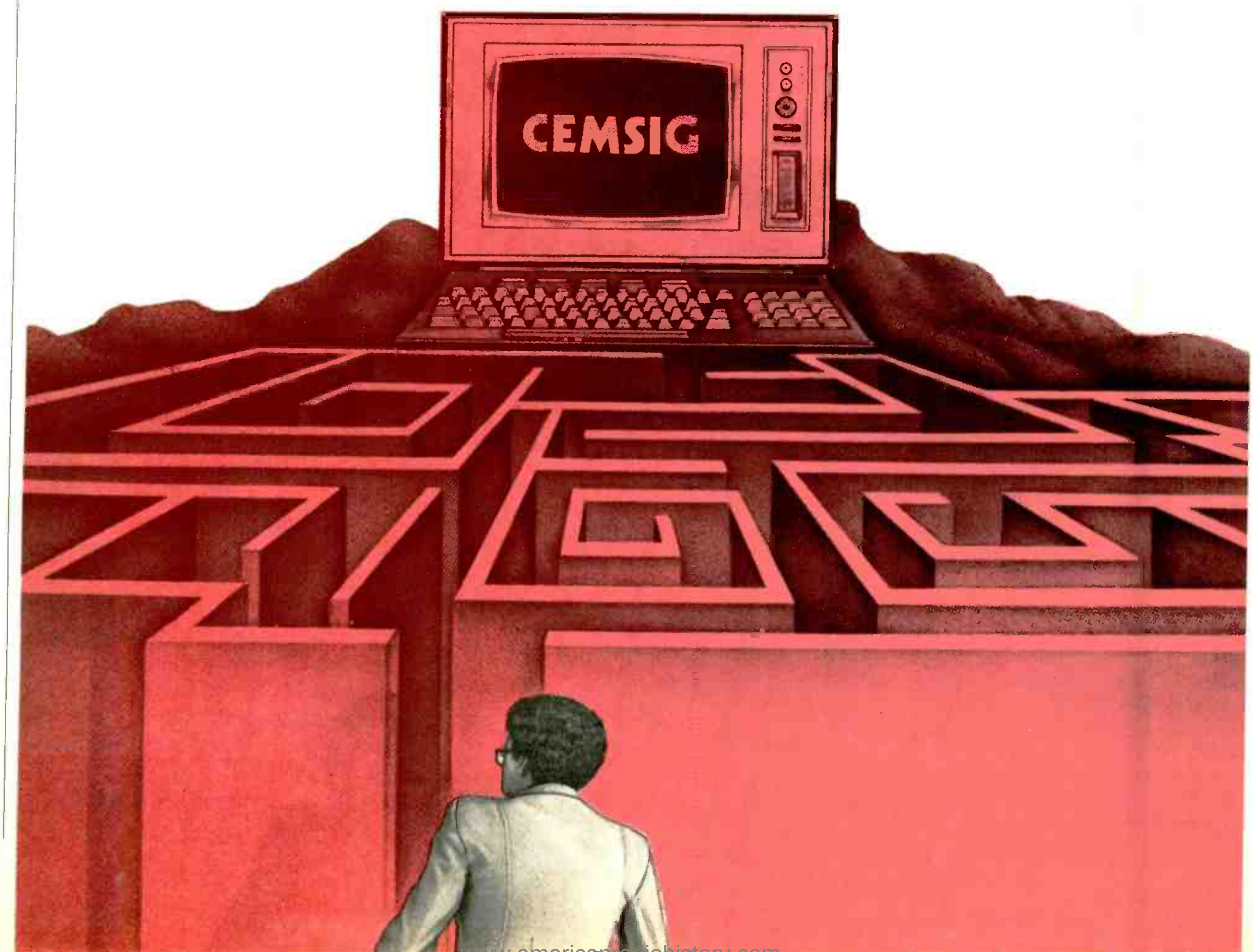
The Source

THE Source is the other large, general-information computer network available to the public. There is an initial sign-on charge and an hourly charge for use of the service with a minimum of $10 per month. The equipment needed to connect to The Source is the same as that required for CompuServe; most of the popular personal computers can be adapted to work on this network.

Access to The Source is through major network common carriers Telenet and Tymnet. They do have access over their own nodes in the Washington, D.C. area but not beyond that location. The user is asigned both a number and a password to identify his account on the network. One difference in sign on between The Source and CompuServe is that The Source assigns the user to a specific computer system. That is, System 10, 11, 12, or 13. It is necessary to give this system number in the sign-on procedure.

Once you are connected to the correct computer system you give your individual user number and password.

There are two methods of accessing information on The Source: the Command Level and the Menu. If you are using the Command Level, you type commands when you see the caret prompt, naming the program you want after writing a prefix word that states what you want to command the program to do. The most commonly used prefix words are INFO or DATA, which provide an introduction and background to



the program, or may demonstrate how it works.

DEMO is only used with a handful of programs like Adventure, Blackjack, and Blackdragon to show how they work. At the Command Level, you tell the system the specific program or information you want by entering a Key Word. These are listed in the manual and in the handy Source Digest provided to subscribers. Typical Key Words are:

UNISTOX—brings up today's reports

MOVIES—brings up current movie reviews

MAIL—allows you to read or send electronic mail

SPORTS—brings up sports section

PARTI—brings up teleconferencing section

MUSICSOURCE—music to order

Assistance for each of the Key Words is obtained by prefixing its name with HELP. Within each Key Word section are Commands to select operations that may be performed within the section.

The Welcome Menu. When you sign on The Source, the first thing you see will be as shown in the first box of Illustration V.

If you select Command Level, you see the caret prompt and then move through the network by entering KEY Words. If you select the Source Menu you see the Main Menu and move through the network by entering selections from the Main Menu or from branch menus.

The News and Reference Resources is one of the most important areas of The Source. The following subject listing can be quickly searched by moving from level to level through the branches. Each item has a sub-menu relating to the subject material. For instance, under Travel and Dining, you will find:

1. Domestic flights
2. International flights
3. Travel tips
4. Travel reservations
5. Metro restaurant guide
6. National restaurant guide
7. Wine

The Source shines in the area of electronic mail. This is featured as an important resource. All subscribers have a mailbox in their assigned systems. The correspondence can be scanned, checked, or read by the subscriber.

The Source also allows you to send the same message to a whole list of Source subscribers. This is the only network with this feature.

You can also send electronic mail to subscribers when you are away from a terminal. All you have to do is phone The Source and send a Voicegram. There is an extra charge for this service, but it is the only one of its kind on the networks. Another service of The Source is the capability to send Mailgrams from the Source and the U.S. Postal Service.

While The Source does not have a conference area such as the ones on the CompuServe SIGS, it does have the Chat facility which permits conversations between two subscribers. There is no equalivent to CB on The Source.

The Source does not have Special Interest Groups (SIGS) in which subscribers can communicate, help one another, and share public domain software. Instead it has a conference area called Participate or PARTI. This is a scheme that permits any subscriber to start a conference by entering a subject. Other subscribers can join the conference to add their comments. In time others will comment on the answers and a branch subject usually starts. The resulting subject area will be a tree structure that includes all of the conference branches.

The main difference between PARTI and the CompuServe SIGS is the SYSOPS who moderate the SIGS and bring a human element to the conference. Individual SYSOPS develop a following based upon their ability to organize and direct an interesting group. The PARTI only has the system computer as moderator and, thus, is not as interesting.

The Source has been one of the pioneers in a new method of merchandising. The COMP-U-STORE organization offers all kinds of discount merchandise to members via the network. It publishes an electronic catalog describing the merchandise for sale. The subscriber can order the goods and charge them to his credit card. They are shipped directly to his address.

There is also a free classified advertising service for subscribers who want to barter or sell things, or who just want to comment briefly on some subject. This is called the POST service, and it allows subscribers to place ads in more than 70 different subject areas. The ads remain on the board for 14 days unless they are removed by the originator.

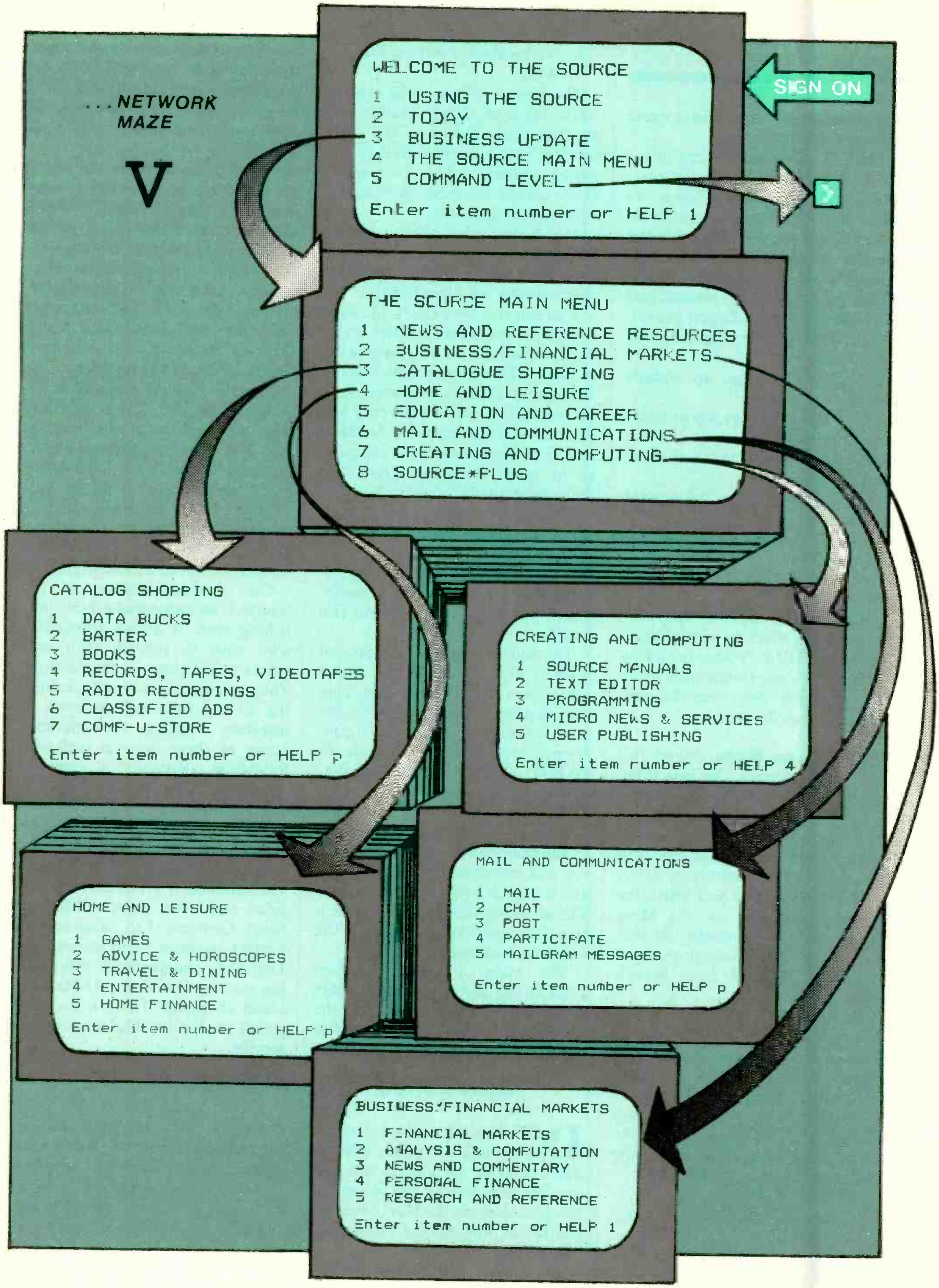
One unusual feature on The Source is an individual private publishing area. It allows subscribers who wish to publish their own works to put them on the network. They can receive a royalty according to the time and accesses by members reading the material. Some of these develop dedicated followings. Recently a complete novel was written and published on The Source.

Science Plus is an enhanced group of information services featuring Media General stock analysis, Commodity News Service daily price and news reports, Management Contents Ltd. abstracts of leading business publications, The Legi-Slate congressional bill-tracking service, and Comp-U-Star discount shopping. There is an additional charge for The Source Plus service.

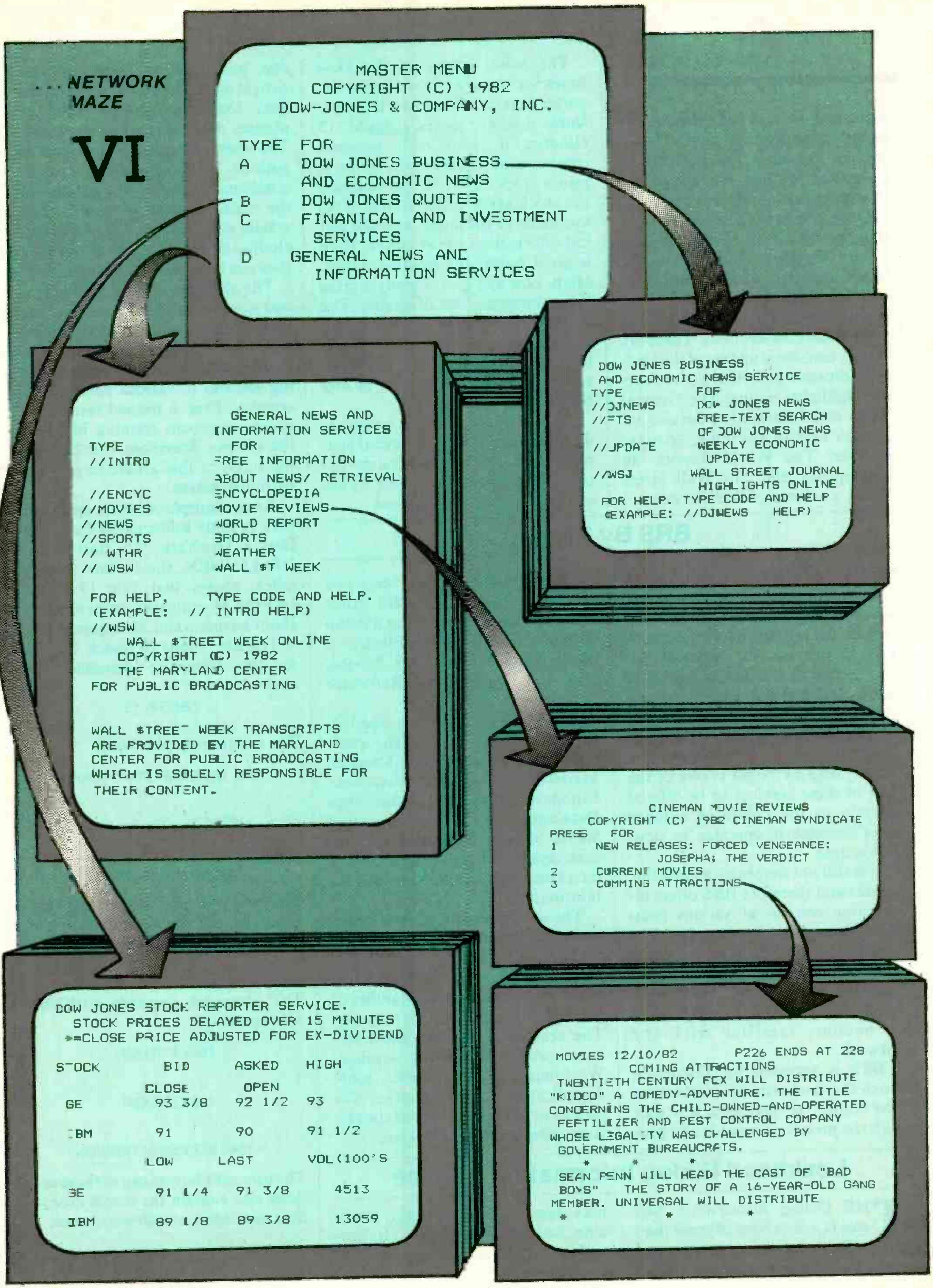
Dow Jones News/Retrieval Service

Dow Jones & Company offers an on-line service to individuals requiring its unique business services (Illustration VI). As might be expected from the Dow Jones organization, the service is oriented toward financial users.

The service is accessed through the public common carriers according to instructions provided by Dow Jones. In many cases this service is offered through a package sold by computer stores, or supplied as part of the purchase of a modem or packaged software. The initiation package includes a free full-service pass-



...NETWORK MAZE
V
SIGN ON
WELCOME TO THE SOURCE
1 USING THE SOURCE
2 TODAY
3 BUSINESS UPDATE
4 THE SOURCE MAIN MENU
5 COMMAND LEVEL
Enter item number or HELP 1
THE SOURCE MAIN MENU
1 NEWS AND REFERENCE RESOURCES
2 BUSINESS/FINANCIAL MARKETS
3 CATALOGUE SHOPPING
4 HOME AND LEISURE
5 EDUCATION AND CAREER
6 MAIL AND COMMUNICATIONS
7 CREATING AND COMPUTING
8 SOURCE*PLUS
CATALOG SHOPPING
1 DATA BUCKS
2 BARTER
3 BOOKS
4 RECORDS, TAPES, VIDEOTAPES
5 RADIO RECORDINGS
6 CLASSIFIED ADS
7 COMP-U-STORE
Enter item number or HELP p
CREATING AND COMPUTING
1 SOURCE MANUALS
2 TEXT EDITOR
3 PROGRAMMING
4 MICRO NEWS & SERVICES
5 USER PUBLISHING
Enter item number or HELP 4
HOME AND LEISURE
1 GAMES
2 ADVICE & HOROSCOPES
3 TRAVEL & DINING
4 ENTERTAINMENT
5 HOME FINANCE
Enter item number or HELP p
MAIL AND COMMUNICATIONS
1 MAIL
2 CHAT
3 POST
4 PARTICIPATE
5 MAILGRAM MESSAGES
Enter item number or HELP p
BUSINESS/FINANCIAL MARKETS
1 FINANCIAL MARKETS
2 ANALYSIS & COMPUTATION
3 NEWS AND COMMENTARY
4 PERSONAL FINANCE
5 RESEARCH AND REFERENCE
Enter item number or HELP 1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VI
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B DOW JONES QUOTES
C FINANICAL AND INVESTMENT SERVICES
D GENERAL NEWS AND INFORMATION SERVICES
DOW JONES BUSINESS AND ECONOMIC NEWS SERVICE
TYPE FOR
//DJNEWS DOW JONES NEWS
//FTS FREE-TEXT SEARCH OF DOW JONES NEWS
//UPDATE WEEKLY ECONOMIC UPDATE
//WSJ WALL STREET JOURNAL HIGHLIGHTS ONLINE
FOR HELP. TYPE CODE AND HELP
(EXAMPLE: //DJNEWS HELP)
GENERAL NEWS AND INFORMATION SERVICES
TYPE FOR
//INTRO FREE INFORMATION ABOUT NEWS/ RETRIEVAL
//ENCYC ENCYCLOPEDIA
//MOVIES MOVIE REVIEWS
//NEWS WORLD REPORT
//SPORTS SPORTS
// WTHR WEATHER
// WSW WALL $T WEEK
FOR HELP, TYPE CODE AND HELP.
(EXAMPLE: // INTRO HELP)
//WSW
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IBM 89 1/8 89 3/8 13059
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COMING ATTRACTIONS
TWENTIETH CENTURY FOX WILL DISTRIBUTE "KIDCO" A COMEDY-ADVENTURE. THE TITLE CONCERNINS THE CHILD-OWNED-AND-OPERATED FERTILIZER AND PEST CONTROL COMPANY WHOSE LEGALITY WAS CHALLENGED BY GOVERNMENT BUREAUCRATS.
* * *
SEAN PENN WILL HEAD THE CAST OF "BAD BOYS" THE STORY OF A 16-YEAR-OLD GANG MEMBER. UNIVERSAL WILL DISTRIBUTE
* * *

word and one hour of introductory usage in non-prime time. This is enough to sample the services and determine if they are worth the charge to any individual.

Once you have signed on the first thing you see is the Master Menu.

The Business and Economic News includes Dow-Jones News and free text search of the Dow Jones News. This is based upon *Wall Street Journal* news. There is a weekly economic update of the leading indicators and *Wall Street Journal* highlights online. The General News and Information Service includes movie reviews; sports; weather; The World Report; an encylopedia; and The Wall Street Week, a column of Wall St. news.

The main feature of the Dow Jones Service is the Stock Quote Reporter Service. This gives the daily stock market quotes delayed 15 minutes, it turns each personal computer, anywhere in the country, into a stock ticker. Upon entering the stock symbol, the system gives the name of the stock, and the last bid information (or at close). Then it gives Asked Information, Open, High, Low and Last. Finally it gives the volume in 100s of shares. The user can Quit at any time and return to the main menu for analysis information or news of the stock. He can return to the quote service at any time.

Since The Dow Jones system is designed to be used by financial people rather than by computer experts, it is by far the easiest to use and obtain information from.

BRS By Night

THIS IS a new service designed for the scientist or researcher who needs to research published literature for articles referencing subjects of interest. Biographical Research Service is a data base of data bases designed for use by professional researchers who are paid to find references in all the various data bases on line throughout the world. BRS by Night is one of the first of these services to be offered directly to the public at reduced rates because it operates in non-prime time.

It is still not simple to operate this service and therefore BRS offers instruction courses at various locations throughout the country. The fees for this instruction are very reasonable and there are courses for both the beginner and the experienced researcher who merely needs to become familiar with the network.

BRS is accessed by Telenet in much the same way as it is done on The Source. It supplies a new user with the proper passwords and protocol to use the system. Once you are connected to the BRS After Dark service, you are given a menu with selections for News, Electronic Mail, News of The BRS Service, and the Data Base Reference Service.

If the reference menu is selected, the system prints a list of the available databases including, Science/Medicine Databases, Business/Financial Databases, Education Databases, Energy Database, and Social Science Databases. Within each category there are hundreds of data bases that can be searched for information.

The user enters the search terms, including logical qualifiers such as "AND" and "NOT," and the system searches the specified data bases. It then reposts the number of "hits" it finds and where they are. The searcher can have the references printed out at his terminal. We found the system much more complicated to use than either The Source or CompuServe, but simpler than other systems of its type.

Lockheed Dialog Information Service

THE Dialog Information Service is a data base of more than 55 million records covering all phases of science, education, business, law, finance, the arts, medicine, and the humanities. It provides references to technical reports, journal and magazine articles, patents, newspapers, and statistical data. The user can search the data bases by typing words or phrases describing what is wanted. The titles, abstract words, names of authors or corporations, patent numbers, or specified portions of the machine-readable records. The system will print out full records including abstracts at the terminal, or they can be mailed to the subscriber.

The ability to use the Dialog system is acquired only by learning the system and the form of the command statements. To train people to use the system, Dialog holds training sessions in various parts of the country. Even a trained researcher needs classroom training in using the system. Therefore, it is beyond the scope of this article to provide such instruction.

As an example of how it operates, here is some information from the Dialog brochure. To start with, DIALINDEX, the on-line subject index, shows that File 15 ABI/INFORM contains information about business and management.

The user wants to search File 15 so the following command is entered:

? BEGIN 15

The system responds with:

File 15:AB/INFORM-71-JAN

(Copr. Data Courier Inc.)

Set Items Description

The user asks for any article that would include the word *stress* or the word *tension*, as follows:

? SELECT STRESS OR TENSION

The computer responds with the references:

1564 STRESS

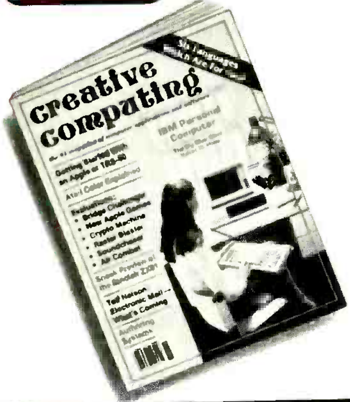
395 TENSION

1 1840 STRESS or TENSION

The user asks how many of these articles also contain the words *executives*, *managers*, or *administrators:*

? SELECT EXECUTIVES OR MANAGERS OR ADMINISTRATORS

7 Good reasons why you should subscribe to *Creative Computing.*



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Every month *Creative Computing* provides you with a continuing education on everything related to microcomputers and computer equipment. Useful articles, "how to" tutorials, exciting new applications, games and "no holds barred" reviews of the latest software and equipment make up a major part of *Creative Computing*'s editorial content.

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3 *Creative Computing* helps you decide which computer equipment is best for you.

Our tough, no-nonsense equipment profiles arm you with the facts before you walk into a computer store. You'll know the right questions to ask and how to cut through the jargon and sales hype. We give you authoritative guidance in deciding what you need, what you don't need—and what's right for you and your pocketbook.

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We started out as a computer education publication, and we're still committed to the educational community. We regularly carry articles on designing educational software, evaluating educational software, teaching concepts and terminology in computer education, text editing applications for literature and computer simulations in the classroom—plus a great deal more.

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(please print full name)

Address________________ Apt.______

City________________

State__________ Zip__________

Offer valid in U.S. and possessions only. Please allow 30 to 60 days for delivery of first issue.

The system responds with the selected set:

7072 EXECUTIVES

14435 MANAGERS

20707 EXECUTIVES OR MANAGERS OR ADMINISTRATORS

The user asks how many of these articles contain the words *stress* or *tension* and also the words *executives, managers,* or *administrators.*

? COMBINE 1 AND 2

3 460 1 AND 2

He can then ask which of these articles were published in 1982.

? SELECT S3 AND PY = 1982

26623 PY = 1982

4 80 S3 AND PY = 1982

The selection process can go on until the researcher finds the exact document that he wants, each time narrowing the search among the items found by the previous statement on the network. Once located, the article can be printed at the terminal or printed by the network and mailed to the user.

This is a process that requires experience and skill. It is thus sometimes better to hire a skilled researcher than learning the process. The rate charged by the various data bases can be quite high and therefore money is saved by having the search conducted by someone who knows what he is doing. This of course applies during day-time hours (prime time).

At night, when the computer usage is quite low because people are normally not working, Dialog has started a new service at much lower rates, called KNOWLEDGE-INDEX. It permits access to a selected group of data bases covering Agriculture, Business Information, Computers, Electronics, Corporate News, Education, Engineering, Government Publications, Magazines, Medicine, News, and Psychology. The equipment required is a computer terminal and modem or a personal computer with a serial interface, modem, and terminal software. The charge is a flat $24 per hour, with no minimum fees or monthly handling charge. While this hourly charge is higher than that for the general-purpose information networks, it results in a low charge for the average reference search. When a document reference is found, the user can get the full text of articles on-line. The charge is $4.50 plus $0.20 per page photocopied. Actual documents are sent for a $4.50 charge, plus the actual cost of the document. The operation of KNOWLEDGE-INDEX is the same as for the full Dialog.

Conclusion

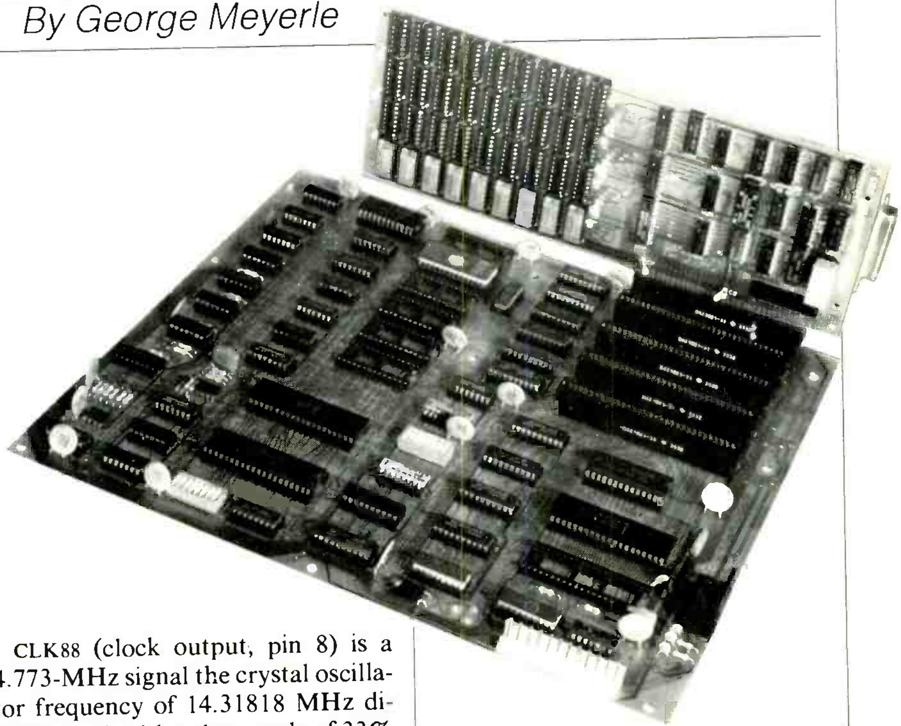
THE utilization of public information networks can add to the owner's benefits derived from his personal computer beyond the scope of published software because it gives him the ability to use the capabilities of a mainframe computer. It also gives the subscriber contact with others throughout the country. This leads to increased knowledge on the part of everyone on the network. It is an amplification of knowledge by multiplexing experience. The reference networks such as BRS By Night and Dialog give the personal computer user access to the accumulated published knowledge of the decade. It makes information previously available only to a few researchers, or the people able to pay them, accessible to everyone with a personal computer.

In the near future the public information networks will grow and perhaps they will become a part of the video revolution now in progress on the cable television networks. We are only a few years away from two-way video communication and when that happens, the vast knowledge in the data bases will be available to everyone with a television receiver. ◇

Learning 16-BIT MICROCOMPUTER TECHNOLOGY

Part 2: To understand what is happening in the system, we discuss the signals generated at various stages

By George Meyerle



LAST month we introduced in very general terms a 16-bit 8088-CPU computer for use as a learning tool that can also be expanded to be compatible with IBM-PC hardware. Here we will deal with the hardware in more detail.

To understand what is happening in this rather complicated system, we must first have a basic picture of the signals generated by the system. The 8088 controls operation of all the supporting circuits. Reviewing Fig. 1 (note: figures 1 through 9 appeared in last month's issue), we see that address, data, and control buses are shared by the main processor, auxiliary processor, DMA controller, interrupt controller, I/O ports, and a 62-pin expansion bus. The processor decides which device has control of the buses at any given time. Since the generation and management of the system signals is too complicated for a 40-pin microprocessor like the 8088, the signals have to be produced by a combination of the 8088, a clock generator (8284), and a bus controller (8288) (Fig. 10).

The 8088 produces the address- and data-bus signals, the 8284A clock generator provides the master clock, reset, and ready signals to the processor, and the the 8288 generates, using signals received from the processor, all the bus-control signals required. Here is a description of signals generated by these three chips, using a timing diagram (Fig. 11) for the timebase relationships between the various signals.

8284 Clock Generator Signals. (Refer to Figs. 2, 10, and 11.) The 8284A generates five signals for the control bus as well as providing ready and reset synchronization for the system. The clock signals are generated by a built-in oscillator that requires only an external crystal.

CLK88 (clock output, pin 8) is a 4.773-MHz signal the crystal oscillator frequency of 14.31818 MHz divided by 3) with a duty cycle of 33% (a requirement of the 8088). This signal is the main system clock and is labeled CLK88 on the timing diagram.

RESET (reset output, pin 10) is a master reset line for the control bus and CPU. This signal is active high and is synchronized to the falling edge of CLK88. The POWERGOOD input, pin 11, is actually the reset input of the 8284. When this line goes low a RESET signal is output to the bus. In the event of a power failure, the CPU is automatically reset. This input could be gated with a manual reset button.

READY (ready output, pin 10) is an active-high signal that indicates to the control bus that nothing in the system is requesting a wait or delay. Wait states are generated during DMA and memory refresh cycles. Pins 3 and 4 are used to signal when wait states are required. The wait request signals from the memory or the I/O are synchronized by the 8284 to form the proper READY signal for the CPU.

OSC (oscillator output, pin 12) is the TTL output of the internal oscillator (14.31818 MHz). This frequency was chosen because a color-burst signal can be derived simply by dividing the OSC output by four on the optional color board. This signal is not used on the motherboard but is available on the expansion bus. The duty cycle is 50%.

PCLK (peripheral clock output, pin 2) is a TTL level clock signal whose output frequency is one-half that of CLK88 (2.387 MHz). This signal is used by the optional IBM compatible keyboard as well as the system timer (8235-5).

8088 CPU Bus Signals. (See Figs. 2, 10 and 11.) The 8088 can be configured for either a minimum (single processor) or maximum (multi-processor) mode. The pin functions are not the same. The descriptions given here assume that the processor is in the max (multi-processor) mode.

Address/data lines AD7 through AD0 (pins 9 through 16) are time-multiplexed address- and data-bus signals. The timing diagram shows that the address signals appear on the bus first. During this time the bus is considered an address bus. In the data time period that follows, the bus is considered to be a bidirectional data bus. The additional hardware required to separate these signals will be discussed later. The signals are active high and float to a 3-state off during interrupt and local bus hold acknowledges.

Address lines A15 through A8 (pins 39 and 2 through 8) provide address signals 8 through 15 and are not multiplexed with other signals. The timing diagram indicates when the addresses are valid. The addresses are active high and float to 3-state off as above.

Address/status lines A19/S6, A18/S5, A17/S4, and A16/S3 (pins 35 through 38) are time-multiplexed address-and status-bus signals. The high-order addresses appear first followed by status lines S3 through S6. The status lines reveal the processor's operations as well as the status of certain flags (i.e. the status of the interrupt-enable flag, S5, is updated at the beginning of each clock cycle). Status lines S3 and S4 indicate which segment register is presently being used for data accessing. These lines float to a 3-state off during local bus hold acknowledge. The additional hardware to demultiplex these signals is not used in this design.

$\overline{\text{RD}}$ (read strobe, pin 32) indicates that the processor is performing a memory or I/O read. This line is not connected in this design. The memory and I/O read/write strobes are generated by the 8288 bus controller.

READY (ready input, pin 22). When the ready line is high, the processor assumes that the memory or I/O device has enough time to complete the data transfer in progress. The 8284 synchronizes any wait requests and generates the READY signal.

INTR (interrupt request input, pin 18) is sampled at the end of each instruction clock cycle to determine if the processor should enter into an interrupt acknowledge operation. If activated, interrupt controller *IC2* supplies an interrupt vector address to the 8088. The processor then executes the required subroutines. The INTR line can be internally disabled by software resetting the interrupt enable bit.

$\overline{\text{TEST}}$ (test input, pin 23) is tested by the "wait for test" instruction. If this input is low, execution proceeds, otherwise the processor waits in an idle state. This input is used when adding the coprocessor. It is pulled high in this design and the "wait for test" instruction is not used unless a coprocessor is added.

NMI (non-maskable interrupt, pin 17) initiates an interrupt when it changes from low to high. A software subroutine is vectored to via an interrupt-vector lookup table located in system memory. The NMI pin is not maskable internally by software, but the design does allow it to be disabled via hardware. Switch position 2 of *S1* and the INT output (pin 32) on the 8087 coprocessor (see Fig. 7, *IC41A*) control the NMI channel along with NMI register *IC43*, which is initialized by the power-up routines. The software monitor and BIOS initialize the NMI off. This mask can be set and reset via system software as shown in Table II, the I/O address map (see the March issue).

RESET (reset input, pin 21) causes the processor to terminate its present activity. It restarts by fetching its first instruction from ROM memory location FFFF0. The instruction at this location is a jump to the system initialization software routines. These routines initialize the timer, DMA, interrupts, UARTS, etc., and then jump to the operating system.

MN/$\overline{\text{MX}}$ (min/max configuration input, pin 33) is used to configure the processor to either a minimum or maximum (multi-processor) design. The current design is set up for maximum utilization of the 8088, including provisions for a coprocessor when available. The following pin-function descriptions pertain to 8088 signals in the max mode.

Processor status outputs $\overline{\text{S2}}$, $\overline{\text{S1}}$, and $\overline{\text{S0}}$ (pins 26 through 28) are used by the 8288 bus controller to generate all memory and I/O access control signals. They are encoded as follows:

$\overline{\text{S2}}$	$\overline{\text{S1}}$	$\overline{\text{S0}}$	Control Signals
0	0	0	Interrupt acknowledge
0	0	1	Read I/O port
0	1	0	Write to I/O port
0	1	1	Halt
1	0	0	Code Access
1	0	1	Read memory
1	1	0	Write memory
1	1	1	Passive

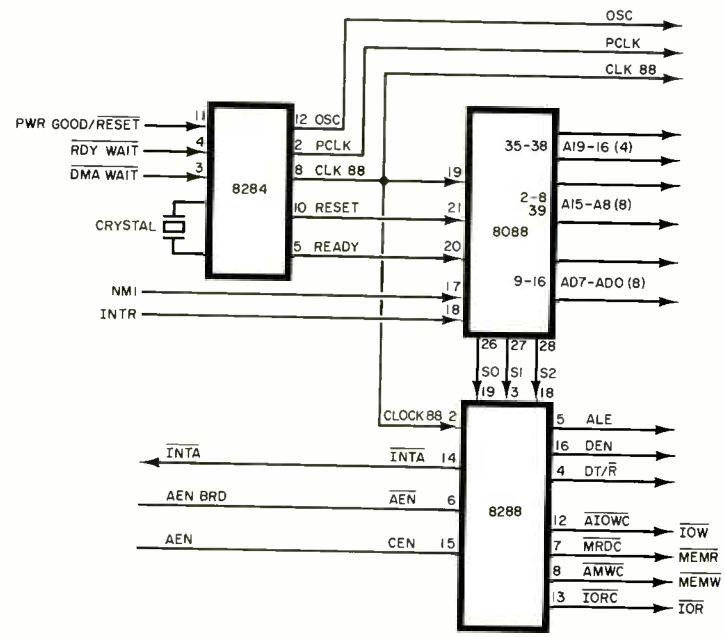


Fig. 10. Signals generated by the 8088, 8284 and 8288.

These signals float to 3-state off during hold acknowledge and do not appear on the system bus.

RQ/GT1 and RQ/GT0 (request/grant I/O, pins 30 and 31. Request/grant pin RQ/GT1 is used by the coprocessor to force the main processor to release the bus at the end of the processor's current bus cycle. It is pulled high by *R23* and not used unless a coprocessor is installed. Request/grant pin RQ/GT0 is grounded and not used in this design.

LOCK (lock output, pin 29) indicates to the control bus that the coprocessor is not to gain control of the system bus while it is low. The lock output is activated by the LOCK instruction and remains active until the completion of the next instruction. This signal floats to 3-state off during hold acknowledge.

Queue status outputs QS1 and QS0 are on pins 24 and 25. One of the main differences between the 8088 and its predecessors is that it can fetch instructions while the processor is executing a previous instruction. The instructions fetched are held in a queue. The QS1 and QS0 pins provide status information allowing external tracking of the internal 8088 instruction queue. These signals are used by the coprocessor in this design.

Pin 34 is always high in the max mode and is not connected in this design.

8288 Bus Controller. The 8288 bus controller decodes CPU status outputs S2, S1, S0 to provide command and control timing signals for the system bus. The following is a description of the pin functions. (see Figs. 10 and 11 for an overview.)

Status inputs S0, S1, and S2 (pins 3, 18, 19) are decoded by the 8288 to generate command and control signals at the appropriate times.

CLK88 (system clock input, pin 2) is from the 8284 clock generator. The clock acts to synchronize the outputs with the CPU signals.

ALE (address latch enable, pin 5) serves to demultiplex the address/data outputs as well as to latch the high-order addresses from the 8088 bus while they are valid. The addresses are latched during the falling (high to low) transition of ALE. Note the relationship of the falling edge of the ALE signal and the status of the address signals A0 to A19. The three 74LS373's (*IC7, IC8, IC9*) latch the addresses from the 8088 outputs and present the system with 20-bit address lines.

DEN (data enable output, pin 16) is an active-high signal that serves to enable data transceivers (Fig. 2). The DEN signal is NANDed at *IC45* with the normally high output control line on the interrupt controller to form an active-low enable signal on bus transceiver *IC8*. (Note that *IC8* is incorrectly labelled as a 74LS373 on Fig. 2. It should be a 74LS245.) A software halt sets DEN low.

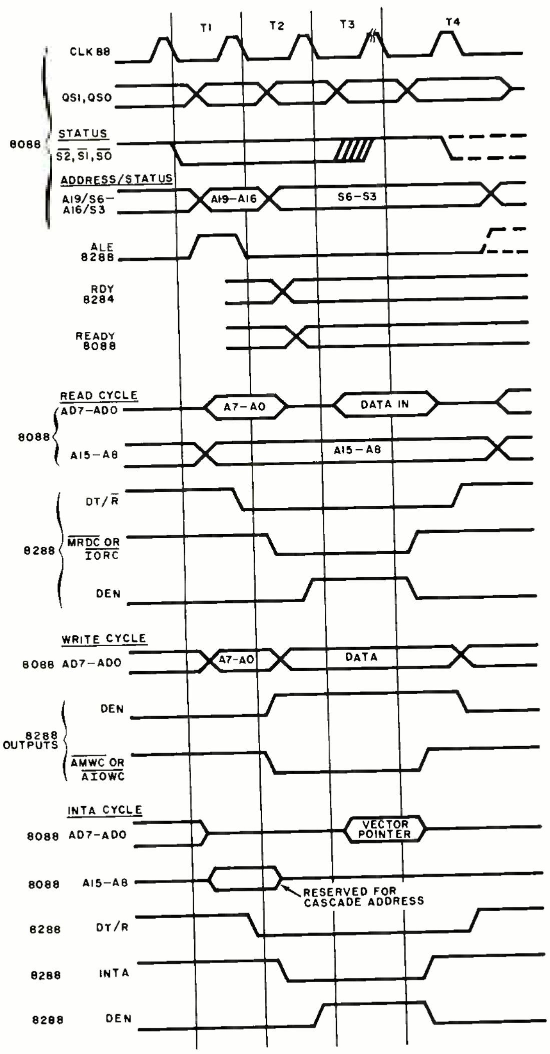


Fig. 11. Timing diagram for the various signals.

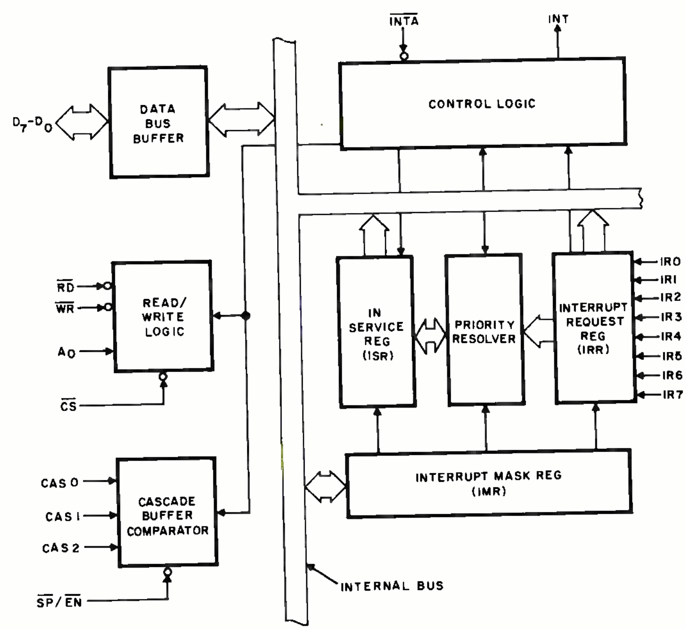


Fig. 12. The 8259A programmable interrupt controller.

DT/R (data transmit/receive output, pin 4) determines the direction of data flow through data transceiver *IC8*. A high indicates that data is being transmitted to I/O or memory. A low indicates that data is being received from I/O or memory.

$\overline{\text{AEN}}$ (address enable input, pin 6) is connected to the normally low AEN BRD signal. It goes high only during DMA transfers or at the request of the I/O channel, at which time the 8288 gives up control of the command bus to the DMA or I/O system (Fig. 7). This allows the DMA controller or I/O channel to issue the required read/write and other control signals to the control bus.

CEN (command enable input, pin 15) when high enables the command and DEN outputs. When low, CEN forces DEN and all command outputs to their inactive states. This pin is connected to AEN, which is simply the complement of AEN BRD.

Command Signals Generated by the 8288. The 8288 issues five command signals to the system control bus. Their appearance on the bus is controlled by the S0, S1, and S2 status data supplied by the 8088. The following is a description of these signals and the status logic required to produce them.

$\overline{\text{S2}}$	$\overline{\text{S1}}$	$\overline{\text{S0}}$	8288 COMMAND
0	0	0	$\overline{\text{INTA}}$ (interrupt acknowledge)
0	0	1	$\overline{\text{IORC}}$ (I/O read)
0	1	0	$\overline{\text{AIOWC}}$ (advanced I/O write)
1	0	0	$\overline{\text{MRDC}}$ (code access)
1	0	1	$\overline{\text{MRDC}}$ (read memory)
1	1	0	$\overline{\text{AMWC}}$ (advanced memory write)
1	1	1	none

$\overline{\text{INTA}}$ (interrupt acknowledge, pin 14) advises an interrupting device that its interrupt has been acknowledged and that it should place vectoring information onto the data bus. The signal is active low.

$\overline{\text{IORC}}$ (I/O read command, pin 13) instructs an I/O device to drive its data onto the data bus. The signal is active low and is labelled $\overline{\text{IOR}}$ on the bus.

$\overline{\text{AIOWC}}$ (advanced I/O write command, pin 12) issues an advanced I/O write signal to an I/O device. It is advanced to allow for an early indication that a write is in progress. The signal is active low and is labelled $\overline{\text{IOW}}$ on the computer control bus.

$\overline{\text{MDRC}}$ (memory read command, pin 7) issues a read signal that instructs the memory addressed to force its data onto the data bus. The signal is active low and is labelled $\overline{\text{MEMR}}$ on the bus.

$\overline{\text{AMWC}}$ (advanced memory write command, pin 8) issues a memory write command earlier in the machine cycle to give memory devices an early indication that a write cycle is in progress. The signal is active low and is labelled $\overline{\text{MEMW}}$ on the bus.

We have now shown how the various bus signals are generated. This should give you a firm foundation for understanding all chip functions and signal lines in Fig. 2 except for interrupt controller *IC2*, which we will now discuss.

8259A Programmable Interrupt Controller. The 8259A programmable interrupt controller (*IC2*, Fig. 2) is relatively complicated device internally (Fig. 12). However, from a circuit point of view, it is very straightforward. The main purpose of this chip is to keep track of various I/O devices to determine if they require service (thus, relieving the processor from this chore).

The 8259 accepts interrupt requests from up to eight sources. Each interrupt source is assigned a priority number determined by the system designer. The chip has a built-in priority resolver that continually identifies the highest priority active interrupt request and notifies the CPU in the event a request from a higher priority is received. The programmer can assign the vectoring addresses corresponding to a given interrupt line by writing command words to the 8259 via I/O ports 20 and 21 (see Table II, I/O map).

An interrupt is begun by placing a high-level signal on one of the interrupt lines. This initiates a conversation between *IC3* (CPU) and *IC2* (PIC) (Fig. 2). An interrupt is then requested by *IC2* (INT, pin 17 is set high). The system responds by issuing an $\overline{\text{INTA}}$ (interrupt acknowledge) to *IC2*. This sets the internal in-service register, which keeps track of any interrupts in progress and also resets the interrupt-request register making *IC2* available for another interrupt request.

The system then issues another $\overline{\text{INTA}}$ to *IC2*. This causes the $\overline{\text{EN}}$ line (pin 16) to go low disconnecting *IC8*, the data bus transceiver, from the bus and connecting *IC2* data lines to *IC3*. The interrupt subroutine program pointers are now transferred to *IC3*, which begins executing the interrupt service program. After completion of the interrupt service, the subroutine must write an EOI (end of interrupt) command word to *IC2*, which clears the in-service register.

The $\overline{\text{RD}}$, $\overline{\text{WR}}$, A0 and $\overline{\text{CS}}$ lines are inputs used to write data to the mask register (enable/disable various inputs), set priorities, program the interrupt vector addresses, set up the other various mode functions, and read the status of the in-service register.

This design uses three of the interrupt lines as follows:

1. Interrupt line 0 (IR0) is connected to one of the 8253-timer outputs that periodically interrupts the system. IBM uses this interrupt to update a system "time of day" program. It is not used in the minimum configuration system.
2. Interrupt line 1 (IR1) is connected to the optional IBM compatible keyboard port. This line activates a keyboard read routine supplied in the BIOS ROM used when installing the IBM compatible keyboard.
3. Interrupt line 4 (IR4) is connected to the interrupt line from the terminal communications port located on the 64/256K memory board. Each key input activates a subroutine that reads the terminal input.

Next month we will continue with a discussion of the DMA controller and give an overview of its functions. Future articles in the series will cover other hardware and software for the computer, including programming instructions. ◇

(To be continued)

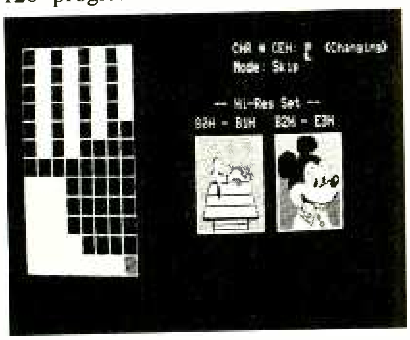
COMPUTER SOURCES

Hardware

ZX81 Reference Card. This 10-panel, 20-page accordian-style card is for anyone who is moving up from the ZX80 to the ZX81 and Timex 1000 computers. The pages cover graphics, BASIC commands and functions, special commands and operators, screen layout, all codes from 0 to 255, selected ROM calls, tips on using FOR-NEXT and IF-THEN statements, ZX80 and ZX81 memory maps, Z80 timing charts, condition code chart, nex/dec conversion, and Z80 op codes including decimal equivalents for peek and poke. $5.95. **Address:** Nanos Systems Corp., Box 24344, Speedway, IN 46224 (Tel: 317-244-4078).

Hardware Instruction. The McGraw-Hill Continuing Education Center has created a line of modular self-instructional programs consisting of 15 units each containing an audio cassette, a printed workbook, hardware experiments and components, and a self-checking examination. Series includes basic electricity, electronics, digital logic, circuit analysis, power supplies, oscillators, and microprocessors. The teaching format is an interactive audio tutorial presentation and is applications oriented. Each module is $19.95 plus handling and postage. **Address:** Contemporary Electronics Series, McGraw-Hill Continuing Education Center, 3939 Wisconsin Ave., NW, Washington, DC 20016.

TRS-80 Model III Graphics. The 80-Grafix board provides an effective resolution of 512 × 192 (256 × 192 in the 32-character mode) through the use of 128 programmable characters. These



are on an 8 × 12 matrix of individually controlled dots. Normal graphics are not affected. In the hi-resolution mode, new graphic characters are given by the values 128 to 255. The board is supported by 20 programs/files. Included are Create, Gethr, and Hires83. The latter allows editing and entire character set one character at a time on an enlarged grid. Installation requires clipping six clips, cutting two traces, and removing three ICs from their sockets. $169.95. **Address:** Micro-Labs Inc., 902 Pinecrest, Richardson, TX 75080 (Tel: 214-235-0915).

IBM-PC Super Board. The Nirvana plug-in for IBM-PC occupies only one slot and features a Z80B operating at 4.77 MHz synchronously with the 8088 in the master mode, where only the 8088 can access on-card memory with the Z80 disabled, or in a dual mode where both processors can access on-card memory. The board runs standard CP/M 80-86 as well as IBM MS-DOS software and can handle up to 576K bytes of RAM with parity. Main card holds 192K with "piggy-back" cards holding two additional 192K, allowing one card to hold all the RAM. Global area is common to every 64K RAM segment accessible to Z80 with the 8088 controlling which 64K bank is used by the Z80. $1395 with 576K; $995 with 192K. **Address:** Hurricane Labs., 5149 Moorpark Ave., Suite 105, San Jose, CA 95129 (Tel: 408-257-8676).

Portable Computer. The Zorba Portable Computer comes with a 7" CRT having an 80 × 25 display and a pair of 400K floppy disks. It uses a Z80A with

64K of RAM and has a communications port, a printer port, an IEEE bus connector, and a PIA port. Weight is 22 lb. $1595. **Address:** Telcon Industries, Inc., 1401 NW 69th St., Ft. Lauderdale, FL 33309 (Tel: 305-971-2250).

ORIC I Computer. Although the new Sinclair Spectrum has yet to reach these shores, it already has competition from England in the form of the ORIC I—which is also aimed at the ZX81. Using Microsoft BASIC, the ORIC I features 16 colors and two versions, one with 16K and the other with 48K of RAM. Features include 24 lines of 40 characters, Centronics printer interface, and a cassette port. The keyboard has 57 moving keys, upper/lower case, sound feedback, and no keys have more than two functions. A sound generator uses an internal speaker to generate full six octaves. A number of game sounds are pre-programmed ready for use. **Address:** Oric Products, Coworth Mansion, Coworth Park, London Road, Sunninghill, Ascot, Berks, SL5 7SE, England.

68000 on S-100 Bus. The PCU68K accesses 16 megabytes of memory on the IEEE 696/S-100 bus. It handles both 8- and 16-bit memory and permits mixing both types. It can be changed from full to half speed via a simple jumper. It includes a 68000 processor, a socket for the 68451 Memory Management Unit, and sockets for 16K bytes of EPROM. An on-board wait-state generator allows up to five wait states and the interrupt structure works with either the internal vector generation circuit or with an external source. The 8-MHz version is $695 and the 10-MHz version is $850. **Address:** CompuPro Systems, Oakland Airport, CA 94614 (Tel: 415-562-0638).

Apple Printer Interface. The Versa serial interface for the Apple II provides only those signals required by an RS232 serial printer. Switchable baud rates range from 300 to 19,200 baud. The package is 4.5" x 2.7" and plugs into one slot. It is provided with a 16-pin DIP header that can be connected to any RS232 cable and connector. $79.95. **Address:** Versa Computing, Inc., 3541 Old Conejo Rd., Suite 104, Newbury Park, CA 91320 (Tel: 805-498-1956).

Software

Mind Tools. Sams Financial Planning Mind Tools offers a series of 17 preset calculations that automatically correct formulas and headings on spreadsheet programs. They superimpose the correct formulas and column headings on each spreadsheet and give the user immediate access to compound interest rates, internal rate of return, amortization schedules and other calculations used in financial forecasting. The tools work with Multiplan, Visicalc and Supercalc on the TRS-80 Model II, IBM-PC and Apple II microcomputers. The price is from $69.95 to $89.95 depending upon the version. **Address:** Howard W. Sams, 4300 West 62 St., PO Box 7092 Indianapolis, IN 46206 (800-428-3696).

For dBase 2 Users. A new service for users of dBase22 Data Base has been established by Standard Software Corp. Called dBase II hELPLINE™ it is a nationwide network that puts dBase II users in contact with each other to exchange information on programming with this universally used data base system. To join the dBase II hELPLINE write to Standard Software Corporation of America, 10 Mazzeo Drive, Randolph, MA 02368. Give your name, address, phone number and the length of time you have used dBase II and the model computer you use. You will then get a list of other users in your area, along with their phone numbers.

Supercalc 2 for 16 Bits. The popular electronic spreadsheet system Supercalc has been extended and enhanced to run on 16-bit CPUs. This new version called Supercalc 2 ($345) runs on 8086 and 8085 based 16-bit systems and will also run on 8-bit systems. It runs under the CP/M-86, MS-DOS amd PC-DOS operating systems as well as CP/M-80 systems. Enhancements include the ability of 16-bit systems with 256 bytes of memory to fill all 16,002 cells of the worksheet (63 rows by 254 columns)—enough space for a 10-year projection by month. Users with color capability will be able to see messages displayed in red with protected areas shown in yellow. The system can also do consolidation with automatic addition of the values from any part of the spreadsheet with values stored on the disk, which allows single-command arithmetic operations on areas of the worksheet without additional memory. Supercalc 2 can sort rows or columns in memory by either numeric, or alphanumeric sequence and has a rounding function with additional formatting and print options. Sorcim Corporation, 2310 Lundy Ave., San Jose, CA 95131 (408-942-1727).

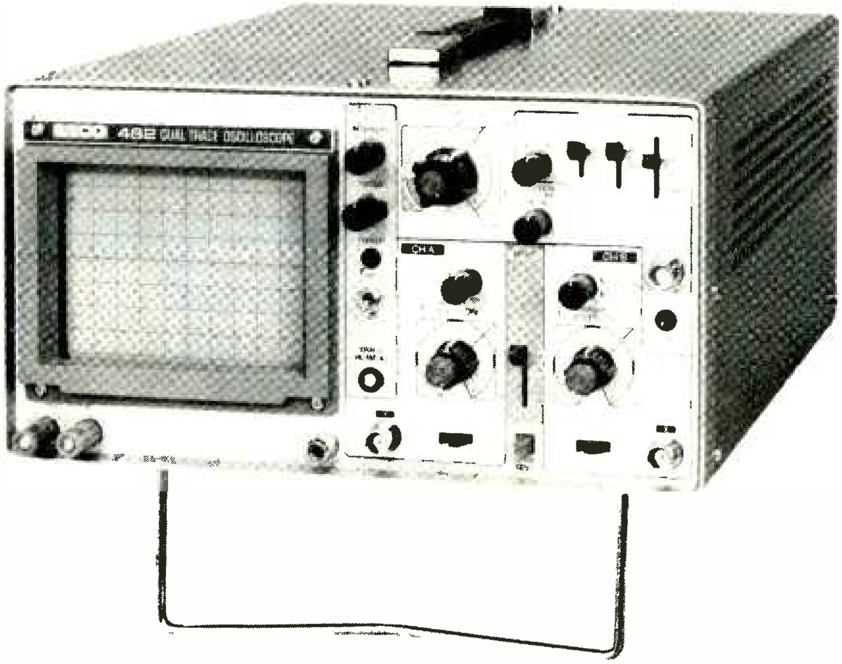
Two New Games. Just announced for the Timex/Sinclair T-1000/ZX81 computers are "Vault of the Centaurs" and "Mega-Mind." The former pits the user against the Centaur Warriors in a battle to obtain a precious fuel, Zykon. The player flies his starship through space, avoiding meteorites and missiles, until he reaches the Vault of the Centaurs. He must then calculate the entrance position, sweep past the guard, steal the Zykon, and return home through even more obstacles. $19.95 on cassette for 16K computers. "Mega-Mind" pits the player against the computer, with the object being to conceal six shapes in four positions to encode a secret pattern that the opponent must then decipher. The player must use logic and memory to decode the computer's pattern before the computer decodes his. Since the computer has perfect memory, this is no easy task. **Address:** Orbyte Software, PO Box 2686, Waterbury, CT 06720.

DB Master for the IBM-PC. The top-selling data-base system for the Apple II Computer has been rewritten and expanded for the IBM-PC. The new version has a 3000-character record in place of the 1020-character record used in the Apple version. Records can contain complex mathematical formulas which offer storage capacity up to 240 characters. Computed fields formulas may contain Boolean and mathematical formulas. There is an Array Search feature that allows a selection of records that contain multiple entries for the same items. This enables selection of such items as manufactured goods containing many parts, or components. There is also a browse mode, which allows fast display of selected fields and records. Records can be edited while the display is continued. DB Master for the IBM-PC requires at least 192K bytes of RAM (additional memory will extend the capacity of the data base) and two 320K double-sided drives. $499. **Address:** Stoneware Inc., 50 Belvedere St., San Rafael, CA.

EZDatabase for IBM-PC. Consists of four modules: EZDataentry, EZDisplayaid, EZDatalabel, and EZReportaid. EZDatabase is designed to use the IBM Monochrome Monitor, 48K memory, and two double-sided disk drives. $350. The modules can also be purchased separately. **Address:** Data Consulting Group, 877 Bountry Dr., Suite 203, Foster City, CA 94404. ◇

TEST REPORT: TEST EQUIPMENT

Eico Model 482 Dual-Trace Oscilloscope



THE Eico Model 482 Dual Trace Oscilloscope is a general-purpose bench instrument having a sensitivity of 5 mV/division and a smooth rolloff above 20 MHz. Other than the CRT, the Model 482 is completely solid-state. It has a modern low-profile look, with a brushed-aluminum front panel and a matching enclosure.

Physically, the Model 482 is 6½"H × 12"W × 14"D and weighs 15 lb. The 5" CRT has a 4" × 3" viewable surface and is surrounded by a plastic bezel that can support a scope camera. The suggested retail price is $799.95.

General Description. Immediately to the right of the CRT bezel are the INTENSITY, FOCUS, and POWER (ON/OFF) controls, along with a screwdriver-adjustable TRACE ROTATOR adjustment. The remaining front-panel space is essentially divided in half. The lower portion contains the CH A (channel A) and CH B (channel B) operating controls, and the various sweep/trigger functions are on the upper portion.

The Z-AXIS input, and the power fuse are on the rear apron where there are also four corner posts on which the power cord can be stored. Skid-proof feet and a tilt stand are mounted on the bottom, with a carrying handle on the top surface.

All operating controls are clearly marked and color coded, with excellent finger spacing between adjacent controls. Interlocking functions are connected via a printed gold stripe on the front panel.

Each vertical channel has three controls: the AC/GND/DC input selector, an 11-step (arranged 1-2-5) VOLTS/DIV selector switch whose coaxial vernier allows an overall sensitivity from 5 mV/div to 10 V/div, and a vertical POSITION control. Selection between CH A, CH B, DUAL, and ADD is made by the MODE switch. Each input is via a BNC connector, and a separate ground binding post is provided.

The horizontal sweep can be selected from 0.5μs/div to 0.5 seconds/div through a 19-step SWEEP TIME/DIV rotary switch, arranged in a 1-2-5 sequence, and a coaxial vernier. The horizontal POSITION control includes a pull-out 5X magnifier. The EXT TRIG input is provided with a BNC connector.

The trigger SOURCE can be selected from INTernal, CH B, LINE, or EXTernal, while trigger SYNC is selected from AC, HFREQ, or TV. The 20th position of the SWEEP TIME/DIV switch is marked CH B. In this position, the scope can be used for vector display, with synchronization from either CH A or CH B.

The unique function of the Model 482 is the component testing feature. A pair of COMP TEST IN binding posts, mounted under the CRT bezel, operating in conjunction with the COMP TEST pushbutton, allows qualitative checking of semiconductors, resistors, and capacitors.

The instrument comes with two probes that can be set to either X1 or X10 by simple end-piece rotation. The center position of the tip rotation grounds the probe tip through a 9-megohm resistance. Complete specifications for the Model 482 oscilloscope are shown in the Table.

User Comment. The Model 482 was tested by the Lockheed Electronics Instrumentation Measurement Laboratory (Plainfield, NJ) against standards traceable to the National Bureau of Standards, and was found to meet or exceed its claimed specifications in all cases.

It has been many years since we used an Eico instrument. So, it was a pleasant occasion to test out this latest Eico scope.

As usual, the instrument was put on our test bench and used for several weeks so we could get the "feel" of it. During this period, we found the Model 482 to be an excellent scope. Its 20-MHz bandwidth, coupled with the 17-nanosecond rise time made it extremely useful for viewing digital, or high-frequency, signals. The sync was stable, even at high input frequencies. All controls were easy to employ and spaced sufficiently far apart to enable comfortable use.

The trace brightness and sharpness were excellent and, when synced to a TV video source, special internal circuits made the horizontal and vertical waveforms appear

EICO MODEL 482 DUAL-TRACE OSCILLOSCOPE TECHNICAL SPECIFICATIONS

VERTICAL:
Deflection Factor: 5 mV to 10 V/div, 11 ranges, vernier.
Bandwidth: Dc to 20 MHz (−3 dB).
10 Hz to 20 MHz (−3 dB).
Risetime: Less than 17.5 ns.
Overshoot: Less than 3%.
Input Impedance: 1 megohm shunted by 20 pF ±3 pF, 600 V p-p, or 300 V dc + ac peak.
Operating Modes: CH A, CH B, DUAL, ADD.
Chop Frequency: Approximately 200 kHz.
Channel Separation: Better than 60 dB at 1 kHz.
Polarity: Channel B can be inverted.

HORIZONTAL:
Time Base:
Type: Auto and triggered. In auto, sweep obtained without input.
Sweep Times: 0.5 μs to 0.5 s/div, 19 ranges and X/Y.
Magnifier: X5 on all ranges.
Linearity: Less than 3%.
Triggering:
Sensitivity: INT—1 div or more; EXT—1 V p-p.
Source: INT, CH B, LINE, EXT.
Level: Positive/negative, continuously variable, AUTO.
Range: 20 Hz to at least 20 MHz.
Sync: AC, HF REJECT, TV, positive or negative.
At TV, TV-H/TV-V auto switched by SWEEP TIME/DIV.
TV-V: 0.5 s/div to 0.1 ms/div.
TV-H: 50 μs/div to 0.5 μs/div.
Deflection:
Deflection Factor: 5 mV to 10 V/div, 11 ranges, vernier.
Frequency Response: Dc to 1 MHz (−3 dB).
Input Impedance: 1 megohm shunted by 20 pF ±3 pF.
Max. Input Voltage: 300 V dc + ac peak, or 600 V p-p.
X-Y Operation: Selected by SWEEP TIME/DIV switch. CH A forms Y axis, CH B is X axis.
Intensity Modulation: TTL level (3 V p-p to 50 V), positive brightens, negative darkens.

OTHER:
CRT: 5″, 2 kV.
Calibration Voltage: 0.5 V p-p, ±5%, 1 kHz square wave.
Power: 100/120/220/240 V, 50/60 Hz, 19 W.
Probes: Two: ×1, ×10 selectable.

rock steady. It is easy to see the VITS using this mode. In the vector mode for TV chroma alignments, CH A provides the vertical and CH B the horizontal component of the displayed signal. The chroma "petals" were clear and sharp, and other phase analysis was also excellent.

The special function of the Model 482, simple component testing, was really appreciated. To use this feature, one places the SWEEP TIME/DIV switch in the CH B position and depresses the COMP TEST pushbutton. The semiconductor junction, resistor, capacitor, or inductor is connected across the COMP TEST IN binding posts; and the display is observed. No values are derived, but it is easy to tell if the device under test is open or shorted; and a pretty good idea of its value can be determined by the display (as explained in the manual).

Semiconductors are tested by observing the diode breakdown. Zener diodes are easy to check using this technique. It is also easy to identify matched sets of semiconductors if that is required for the job at hand. We used this function to sort out a large box filled with unknown diodes, collected over the years, and were able to identify and save quite a number of them.

After many hours of operation on a crowded workbench, the Model 482 remained cool to touch, and there was very little or no trace change with the power line fluctuations we usually encounter during the working day. However, the case is not magnetic proof. Thus, the trace does move when a magnet (speaker, etc.) is brought in close proximity with the enclosure, especially over the CRT area. R-f shielding is somewhat better; very little trace distortion was seen when a CB or ham transmitter was operated close by.

The consensus of our users is that the Model 482 is an excellent scope, and compares favorably with others in the same price range. The dc-to-20 MHz bandwidth, coupled with the excellent sync stability, makes this latest entry from Eico a good place to start if you are contemplating an electronics workbench or service department. —*Les Solomon*

CIRCLE NO. 104 ON FREE INFORMATION CARD

SOLID-STATE DEVELOPMENTS

Personal Radiation Detectors

By Forrest M. Mims

RADIATION is a very broad term for energy emitted by a source. Most forms of radiation are *nonionizing.* While such radiation may heat or even physically or chemically alter a substance, it does not ordinarily cause atoms within the substance to gain or lose electrons and thus become *ionized.* Nonionizing radiation includes visible light, infrared, and radio waves.

There are, of course, exceptions. For example, focused optical radiation from a laser having a power density of at least 1 to 10 megawatts per square centimeter (depending upon the wavelength) will create a spark-like miniature plasma of ionized air molecules. Ionizing radiation, however, is a descriptive phrase almost always reserved for electromagnetic radiation of very short wavelength such as gamma rays and both alpha particles (the nuclei of helium atoms) and beta particles (fast moving electrons). These particles ionize atoms when they collide with them at very high speeds.

Substances that emit ionizing rays or particles are collectively termed *radioactive.* The effect of ionizing rays and particles upon most forms of life can be profound. For this reason alone, considerable effort has been devoted to the development of sensitive and reliable detectors of radioactivity.

One of the earliest detectors of radioactivity was invented by Hans Geiger. It consisted of a sealed metal tube filled with air, argon, or other gases and containing a wire electrode. Geiger's detector is operated by placing a high voltage across the wire electrode and the metal tube. The potential is set below the breakdown point of the gas.

A gamma ray or alpha or beta particle entering a thin glass or mica window in the side of the tube will cause the molecules of gas along its path to become ionized. The resulting low impedance path allows a brief flow of current through the tube. Additives called *quenching agents* cause the gas to quickly deionize following passage of the ray or particle. This greatly increases the life of the tube and enhances its detection capability in high radiation fields.

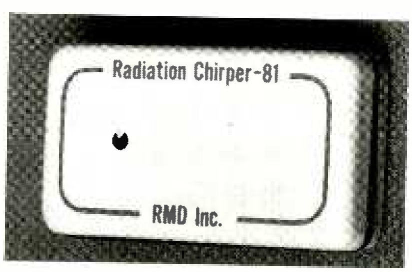


Fig. 1. Chirper from RMD Inc.

The current pulse through a geiger tube can be easily amplified and caused to generate an audible click. In high radiation fields, the clicks will merge into a continuous rasp or even a buzz. A simple integration circuit can convert the noisy clicks into a series of chirps that indicate by their frequency of occurrence relative radiation intensity. An analog meter, digital readout, or simply a flashing LED can also be used to indicate relative radiation levels.

Geiger tubes are still commonly used to detect the presence of radioactivity. They are relatively expensive and fragile, however, and require a high operating voltage.

The *scintillation effect* radiation detector utilizes a fluorescent mineral or crystal such as thallium- or cesium-activated sodium iodide or bismuth germanate. Ionizing radiation entering the crystal causes the emission of light, which is detected by a sensitive photomultiplier tube.

Though a scintillation crystal alone is a solid-state device, the requirement of a fragile photomultiplier tube with an accompanying high-voltage power supply gives scintillation detectors the same drawbacks as geiger tubes. Recently, however, new kinds of scintillation crystals have been developed. They emit at slightly longer wavelengths, which can be detected by silicon and gallium-arsenide-phosphide photodiodes.

One such crystal is cadmium tungstate. When stimulated by ionizing radiation, it emits green light having a peak wavelength of about 530 nanometers. This light can be detected by a suitable photodiode connected to a low-noise, high-gain amplifier.

A scintillation crystal paired with a photodiode forms a rugged solid-state detector of radioactivity. A simpler approach, however, is to detect radioactivity *directly* with a semiconductor. Silicon pn junction diodes can detect gamma rays and both alpha and beta particles. While not as sensitive as other detectors, they are mechanically sturdy and require no high-voltage power supply. Even commercially available silicon diodes, photodiodes, solar cells, and

(Continued on page 101)

zener diodes have been used to detect ionizing radiation.

Cadmium telluride is a more sensitive detector of ionizing radiation than silicon. Cadmium-telluride detectors are used in nuclear medical research, space research, brain scanners, and compact personal radiation monitors.

Personal Radiation Detection Systems. There are many different commercial systems and devices for detecting ionizing radiation. Those intended to warn people about the presence of radioactivity are often designed to emit audible chirps at a rate directly proportional to the radiation level. Of those that use a geiger tube, one of the most compact is the RT-1A Personnel Radiation Detector made by Eberline Instrument Corporation (Box 2108, Santa Fe, NM 87501). This $165 monitor has dimensions of 1.2" × 2.4" × 3.1" and weighs 6 oz. It emits approximately 150 audible chirps per milliroentgen. The Environmental Protection Agency (EPA) recommends a maximum exposure level to civilians of no more than 500 milliroentgens per year.

Fig. 2. Wall-mounted Radiation Sentry sounds an alarm at preset level.

Compact geiger tube radiation monitors are also made by Solar Electronics (156 Drakes Lane, Summertown, TN 38383). Their Radiation Alert Monitor 4 indicates radiation by an audible signal and a meter calibrated in milliroentgens per hour. Three detection ranges (0.5, 5 and 50 milliroentgens per hour) are switch selectable. The unit is powered by a 9-V battery and measures 3.1" × 5.8" × 1.4". It sells for $150 plus $5 for shipping. Incidentally, this detector was featured in an article about possible radiation hazards of thoriumimpregnated lamp mantles in the November/December issue of *The Mother Earth News* (No. 78, pp.58-61).

Solar Electronics also makes a smaller (2.8" × 4.3" × 1.3") monitor designated the Radiation Alert Mini. The Mini has an audible signal and an array of three LEDs to indicate levels as low as 0.1 milliroentgens per hour. Its price is $249.50 plus $5 for shipping.

The major drawback of these radiation monitors is their requirement of a 500-to-550-V power supply to provide sufficient bias for the geiger tube. Cadmium-telluride detectors can be operated directly from low-voltage batteries and can therefore be used to make even smaller monitors and chirpers.

One such chirper was developed by Los Alamos Scientific Laboratory (Los Alamos, NM 87545) and Radiation Monitoring Devices, Inc. (44 Hunt St., Watertown, MA 02172). It utilized hybrid construction and could be clipped to a shirt collar or pocket. This tiny chirper was later manufactured by Radiation Monitoring Devices. Because of its high price (about $300), comparatively few of these tiny chirpers were sold and production was stopped.

Dositec, Inc. (72 Irving St., Box 4744, Framingham, MA 01701) makes miniature chirpers, digital dosimeters, and a family of tiny alarm dosimeters. All these devices employ cadmium-telluride detectors. The compact DOS-100 miniature Dositec Alarm Dosimeters weigh only 1.2 oz and measure 1" × 1" × 1.5". Various models of the device provide five radiation threshold detection ranges. The prices for these dosimeter devices range from $295 to $315.

Radiation Engineering, Inc. (PO Box 103, Beltsville, MD 20705) manufactures a line of economical radiation detection systems that use ionization chambers to detect the presence of ionizing radiation. The ionizing chambers used in these instruments can be considered capacitors having two plates separated by an air gap. Ionizing radiation allows a small leakage current to flow through the air dielectric. By placing the capacitor in series with a very large resistance, the small current appears across the resistance as a proportionally higher voltage.

For example, the company's Radiation Sentry RD-1 incorporates an ionization chamber that generates 1 picoampere of ionization current in response to a radiation field of 10 milliroentgens per hour. In a 1-teraohm (1 x 10^{12} ohms) resistor in series with the chamber, this current causes a potential of 1 V to appear across the resistor. This voltage is coupled to a very high input impedance CMOS comparator. When the voltage exceeds a preset level (the threshold), the comparator switches and activates a 75-dB warbling alarm tone.

The RD-1 Sentry measures 9.5" × 7.5" × 2.5" and will operate continuously for one full year when powered by a single 9-V battery. It is designed primarily for detecting gamma and x-rays. The RD-2 is a similar unit that will detect gamma and x-rays and both alpha and beta particles. The RD-1 sells for $79.95 and the RD-2 sells for $89.95 (plus $2 for postage and handling). These devices are by far the least expensive of those reviewed for this column.

The RD-1 and RD-2 Radiation Sentry monitors are designed to be mounted on a wall much like a smoke detector. They might, therefore, be of interest to persons who reside near nuclear power plants or factories that process radioactive materials. For personal protection where moderate to high-levels of gamma or x-ray radiation are expected, Radiation Engineering makes the smaller RD 100, a belt or wall-mounted unit measuring 4.5" × 3.5" × 1". Housed in a rugged aluminum package, the RD 100 sells for $149. It will operate from a 9-V battery for a full year and provides an audible warning when the radiation level exceeds 100 milliroentgens per hour.

You can find out much more about these and other personal radiation monitors by writing the companies whose products are described in the preceding discussion. You can find the names of additional manufacturers of such equipment in advertisements carried in health/physics periodicals and other such publications received by most technical libraries. For information about scintillation crystals and related products, write Harshaw Chemical Company (6801 Cochran Rd., Solon, OH 44139). ◇

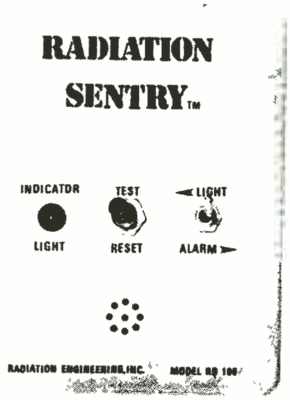


Fig. 3. Ruggedized Radiation Sentry.

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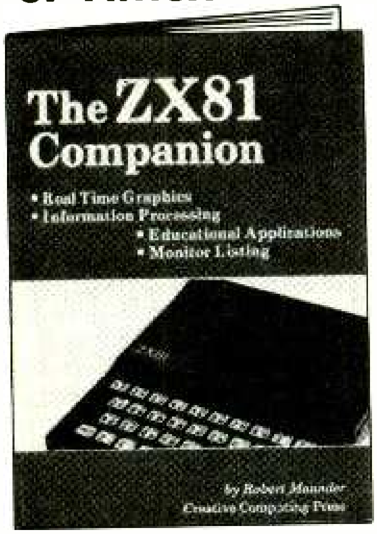
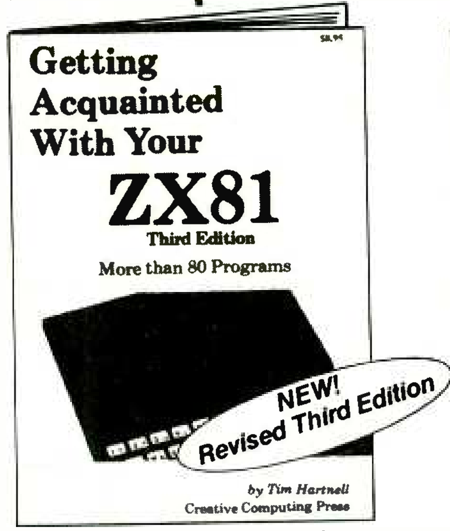


The ZX81 Companion
by Bob Maunder

The ZX81 Companion follows the same format as the very popular *ZX80 Companion,* and assists the ZX81 or Timex Sinclair 1000 user in four applications areas: graphics, information retrieval, education and games. This practical guide contains scores of fully documented short routines plus complete programs and a disassembled listing of the ZX81 ROM Monitor. "Thoughtfully written, detailed, and illustrated with meaningful programs." —MUSE

5½"x 8", Softbound. #17P $9.95 ($2.00)



Getting Acquainted With Your ZX81
by Tim Hartnell

This informative volume for the new ZX81 or Timex Sinclair 1000 user contains more than 80 programs to help the reader get the most from his Sinclair computer. Game programs include Checkers, Alien Imploders, Blastermind, Moon Lander, Breakout, Star Burst and Derby Day. The book also shows programs for cascading sine waves, plotting graphs and tables, data sorting, equation solving, plus the use of PLOT, SCROLL, PRINT, TAB, PEEK, POKE and much more!

5½"x 8", Softbound. #15Y $9.95 ($2.00)

The Gateway Guide to the ZX81 and ZX80
by Mark Charlton

The Gateway Guide is a practical programming manual for the beginner that furnishes over 70 fully documented programs. The majority of the programs have been written for easy conversion from machine to machine (ZX81 or Timex Sinclair 1000, 4K ZX80 or 1K ZX80). *The Gateway Guide* describes each function and statement, illustrates it with a demonstration routine or program, and combines it with previously discussed material to help you understand your computer.

5½"x 8", Softbound. #160 $9.95 ($2.00)

Computers for Kids (Sinclair Edition) by Sally Larsen

This new edition of *Computers for Kids* is written specifically to introduce children aged 8 to 13 to the ZX81 or Timex Sinclair 1000. The book requires no previous knowledge of algebra, variables or computers, and it enables a youngster to program a Sinclair in less than an hour. There's also a section for parents and teachers. "*Computers for Kids* is the best material available for introducing students to their new computer."
—Donald T. Piele, Professor of Mathematics, University of Wisconsin-Parkside.

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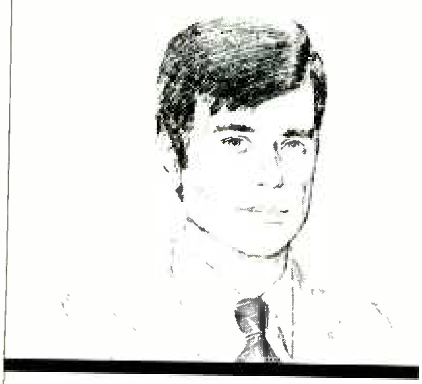


Solderless Breadboards for Experimenters

By Forrest M. Mims

THE INVENTION of solderless breadboards has played an essential role in the evolution of modern solid-state electronics. Before such breadboards became available, experimental and prototype circuits had to be laboriously assembled using point-to-point wiring and soldered connections. Needless to say, circuit changes were difficult and time-consuming.

A little more than a decade ago, Barry Instrument Corporation introduced the Springboard®, a plastic base containing 120 rectangular slots. In each slot was a 0.3″ long spring. Component leads and wires were inserted into the springs by means of an awl-like tool that opened a space in any desired spring.

I assembled hundreds of transistor circuits much faster than ever before with the help of a Springboard. The board still comes in very handy for prototyping circuits that have oversize leads such as heavy-duty rectifiers and SCRs. Unfortunately, the Springboard is not suitable for use with much smaller pins and leads of integrated circuits.

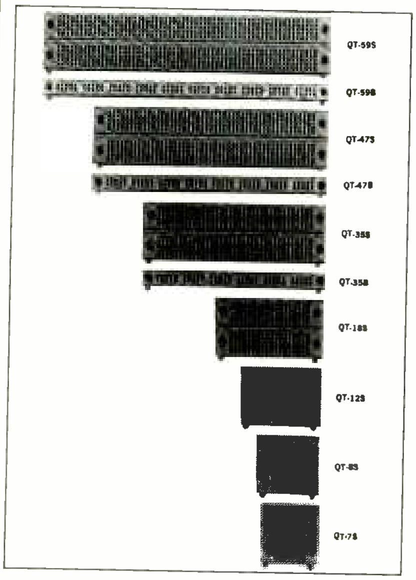


Fig. 1. Solderless breadboards available from Global Specialties.

Wire-Wrappable Panels. Eventually several clever solderless breadboards were developed specifically for ICs. Among these were expensive wire-wrapping panels. Still available today in numerous styles and configurations, wire-wrappable panels have rows of IC sockets on one side. The other side contains matching rows of square cross-section pins extending from the sockets. Circuits are assembled by installing the required chips and making the necessary interconnections with wrapping wire.

Wire-wrappable panels and boards are available from many companies. Among those whose products are sold to experimenters and hobbyists are Vector Electronics, Inc. (12460 Gladstone Ave., Sylmar, CA 91342) and Cambion (Cambridge Thermionic Corporation, 445 Concord Ave., Cambridge, MA 02238). Both these companies make a wide assortment of pre-assembled wire-wrapping boards as well as perforated boards into which compatible wire-wrappable terminals and sockets can easily be installed.

The Electronic Products Division of the 3M Company (3M Center, St. Paul, MN 55101) has developed a particularly interesting do-it-yourself breadboarding system. The system uses unique dual-contact IC sockets that will accept an IC pin from one side and a plug strip pin from the other. The sockets are placed on a perforated card and secured in place by plug strips inserted into the back of the socket from the opposite side of the card. Interconnections are made with the help of an insertion tool that forces insulated wire into the U-shaped slots in the ends of the plug strip terminals.

3M has combined an assortment of dual-contact IC sockets and plug strips in its Scotchflex 3303 Breadboard Kit. This kit also includes a wire insertion tool, socket extraction tool, a cleverly designed plug-strip break-off tool, and a spool of connection wire.

You can easily custom design your own breadboards using hardware from Vector, Cambion, 3M, and other companies. Or you can improvise by installing rows of wire-wrappable IC sockets in a standard perfboard having copper solder pads at each hole (Radio Shack 276-152 or similar). Solder the socket's corner pins to the copper pads and the board is ready to use. Alternatively, you can use a standard (copperless) board and secure the sockets to it with a thin bead of cyanoacrylate cement.

Wire-wrappable panels are excellent for prototyping complex digital circuits of a repetitive nature such as large-capacity, solid-state memories. In fact, assembled wire-wrapped boards can even be used in permanent applications. Because of the difficulty of making changes, however, they aren't suitable for developing and experimenting with most analog/linear circuits and experimental logic circuits.

Plastic Solderless Breadboards. The plastic solderless breadboard has become an indispensable item on every electronic experimenter's workbench. AP Products, Inc. (1359 West Jackson St., Painesville, OH 44077) originated the concept of a solderless, plug-in breadboard. In addition to AP Products, major solderless breadboard makers include Vector Electronics, Global Specialties Corporation (70 Fulton Terrace, PO Box 1942, New Haven, CT 06509), and E&L Instruments (61 First St., Derby, CT 06418).

Figure 1 is a photograph of some of the solderless breadboard elements

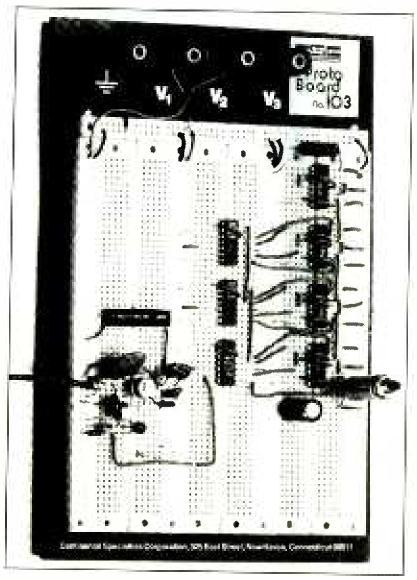


Fig. 2. Global's Proto-Board 103 has 2250 connection points.

made by Global Specialties. Similar in configuration to competing modules, each breadboard element includes parallel arrays of five common tie-points. Inside the five socket holes at each row of tie-points is a replaceable spring clip having precision-formed, nickel-silver contacts. The result is five physically independent but electrically common socket hole tie-points that accept wire leads having a diameter of 0.015" to 0.033". The contact resistance of each connection point is under 0.005 ohm.

Some solderless breadboards are configured as modules that include two or more rows of bus connection points across both sides of the breadboard. Others require separate plastic bus strips. Most modules snap or clip together to form arrays of modules.

Most manufacturers of solderless breadboards make various breadboard assemblies or prototyping systems. Figure 2, for example, shows a Global Specialties Proto-Board 103. Measuring 6" × 9", the PB-103 includes eight separate plastic breadboards installed on an aluminum panel having rubber feet. Four power-supply binding posts are included. The 450 common terminals of the PB-103 have a total of 2250 connection points (socket holes). The company also manufactures other breadboard assemblies with fewer or considerably more connection points.

Fig. 3. AP Products' Hobby-Blox panels are installed in a tray.

Prototyping systems that include built-in power supplies and other circuit design aids are made by several companies. Among those made by E&L Instruments, for example, is the CD-1 CMOS/TTL Designer. This compact console-style prototyping tool, which is designed around a single solderless breadboard, includes a 5-V fixed supply, a variable 3-to-15-V supply, an adjustable frequency (1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz and 100 kHz) logic clock, four CMOS/TTL compatible LED indicators, and various switches, binding posts, and connectors. Though sophisticated prototyping systems like the CD-1 are expensive, they provide an unprecedented degree of circuit design flexibility.

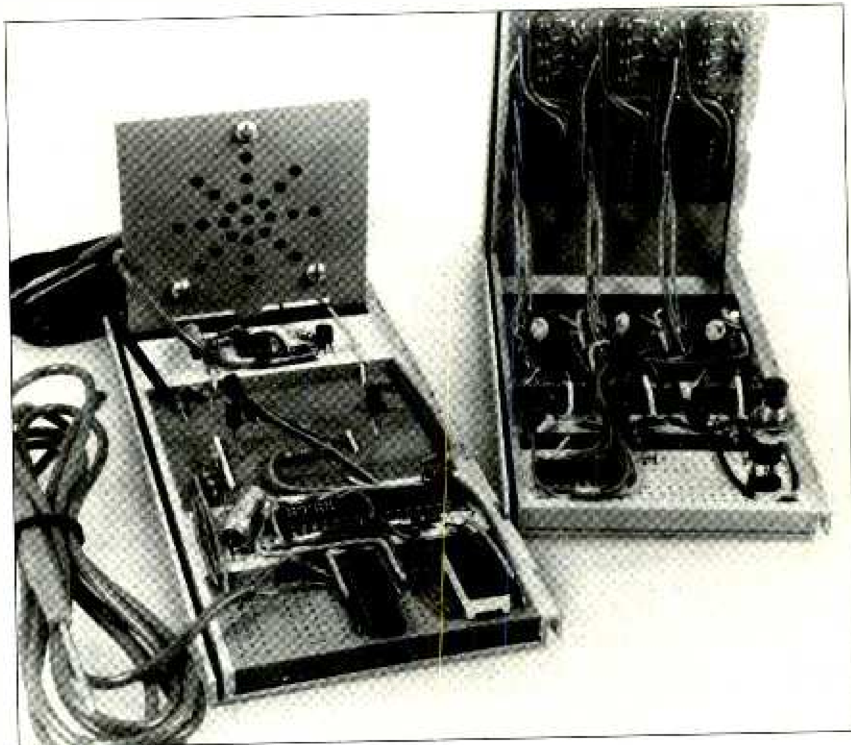


Fig. 4. Two examples of use of Hobby-Blox.

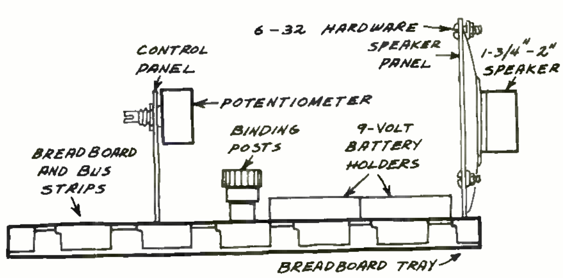
A New Modular Breadboarding System. AP Products has a Hobby-Blox™ family of compatible solderless breadboard products designed specifically for experimenters. Ideally suited for this use, the Hobby-Blox system is designed around a sturdy plastic tray into which various color-coded bus strips, solderless breadboard strips, and spacers can be installed as shown in Fig. 3. The tray will also accept a binding post strip and an exceptionally well-designed 9-V battery holder.

All the Hobby-Blox breadboards include row and column index markings. Two types are designed specifically for ICs or digital readouts. A third is designed for discrete components. A 6-position LED strip is also available.

The most notable feature of the Hobby-Blox system is its flexibility. Breadboard strips, spacers, and other members of the family can be installed in any desired arrangement. One or more additional trays can be added to the main tray with the help of an interlocking bus strip containing 60 connection points or a simple tray extender clip.

Even more important is the ability to install vertical panels that extend upward from the tray as shown in Fig. 4. These include a speaker panel with preformed holes (Fig. 4, left) and a control panel with six holes for installing switches, potentiometers, and indicator LEDs or lamps (see Fig. 3, right). Blank panels are available for custom designs. All these panels are mounted by inserting their three extensions into the slots in a spacer/support strip. The blank

Fig. 5. A Hobby-Blox op amp prototyping system.



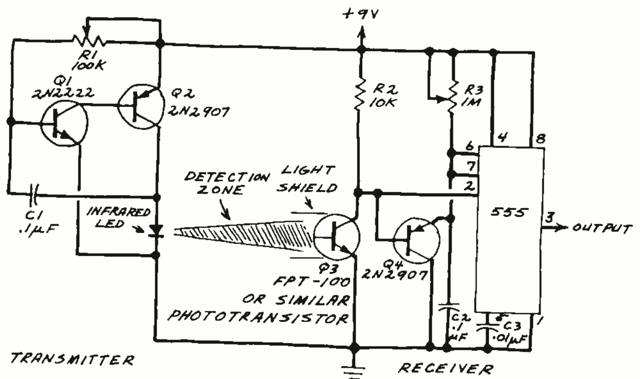


Fig. 6. An optoelectronic trigger for a camera or electronic flash.

panels are ideal for mounting joysticks, fiber optic connectors, piezo alerters, optoelectronic components, and other specialized devices and components.

A tray shorter than the main tray can be vertically mounted on the main tray by means of an adaptor strip (Fig. 4, right). This tray will accept all the Hobby-Blox modules and is therefore ideal for LED displays. It's also well suited for assembling optoelectronic circuits that require careful location or spacing of components such as infrared-emitting diodes and photodetectors.

Hobby-Blox Applications. Of the many applications for the Hobby-Blox system, two that I've found particularly handy are compact, self-contained, op-amp and CMOS prototyping systems. Figure 5, for example, shows one way to make an op-amp prototyping system. Dual-polarity, self-contained 9-V supplies are provided along with a speaker. The optional binding posts can be used when the system is powered by an external supply. A control panel with three potentiometers (10 kilohms, 100 kilohms, and 1 megohm) is also included. With a single 741 op amp and a dozen or so resistors, capacitors, diodes, and LEDs, this prototyping system can be used to assemble scores of different op-amp and comparator circuits. The system can easily be expanded by adding one or more additional trays to it with the help of extender clips or a bus strip.

The vertically mounted blank panel and short tray make possible many unique circuit applications. Figure 6, for example, shows an experimental optoelectronic detection circuit that will trigger a camera or an electronic strobe when an object enters the space between an infrared emitting diode and a phototransistor. With this arrangement you can take well-focused photographs of flying insects and projectiles automatically. Note that the camera will be triggered only when an object is directly between the LED and phototransistor.

In operation, a LED transmitter delivers a train of fast risetime pulses to the sensitive surface of the receiver's phototransistor. Transistor *Q4* and the 555 form a missing-pulse detector that is reset each time a pulse from the transmitter is received by the phototransistor. When an object blocks the path between the transmitter's LED and the receiver's phototransistor, the 555 completes its timing cycle and the output at pin 3 changes from high to low.

The receiver output can be connected directly to the trigger inputs of some cameras, but an inverter and a common ground may be necessary. Other cameras may require a relay (between pin 3 and +9 V) or SCR (pin 3 to gate) interface.

The system can be adjusted to ignore very fast moving objects by increasing the values of *R3* or *C2* in the receiver and slowing the frequency of the transmitter by means of *R1*.

You can quickly assemble the circuit in Fig. 6 using Hobby-Blox modules. One possible arrangement is to assemble the transmitter and receiver on breadboard strips installed in short trays. The assembled trays should then be installed facing one another in a main tray. The battery should be installed in a holder located between the two facing circuits. Any potentiometers and switches should be installed on one or two control panels located anywhere but between the two facing circuits. One method is to use extender clips to add a short tray that can contain any required control panels.

If you plan to photograph insects, place a flower or an appropriate bait between the facing circuits. Depending upon the time of year and your location, you may be able to attract flies, moths, beetles and other insects. Be sure to shield the phototransistor from external light with a length of heat-shrinkable tubing.

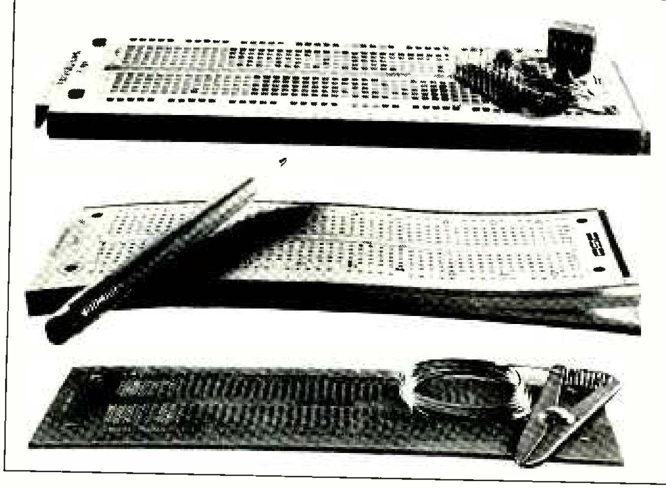


Fig. 7. Global's Experimentor System allows breadboard systems to be transformed quickly into permanent versions.

Going Further. Solderless breadboards can be used for finished circuits, but this becomes rather expensive if you build lots of different projects. Global Specialties has developed a simple but effective method for quickly transferring a breadboard circuit onto an etched circuit board. Shown in Fig. 7, this concept is based upon an etched circuit board that exactly duplicates the array of terminal holes in a plastic breadboard. A paper version of the circuit board (available in pads) allows experimenters to make new designs and layouts easily, and to keep a record of successful designs.

Global Specialties calls this clever concept The Experimentor System™. It's but one way to convert your circuits into permanent versions. Thanks to some very creative engineers, there are many effective methods for making permanent soldered and wire-wrapped circuits. If you're still building circuits using perforated boards and point-to-point soldered connections, you should take time to investigate the many new circuit assembly aids and hardware now available. ◇

DX LISTENING

News of Stations and Programs Around the World

By Glenn Hauser

Cape Verde. *A Voz de Sao Vicente* began testing a new 10-kilowatt transmitter last August on 7155 kHz. The broadcast between 0730 and 0900 GMT was heard by Bob Hill in California, Gerry Bishop in Pennsylvania, and Sholom Gliksman in Illinois, but on a very irregular basis.

China. On January 1, *Radio Peking* officially became *Radio Beijing;* the city itself adopted the new spelling in 1979, so radio listeners were given four years to become accustomed to the idea. In Seattle, David Newkirk notes that *Radio Beijing*'s 17650-kHz frequency appears to be 500 kilowatts and from a southern site, since it is very strong and free of flutter (unlike other frequencies). Unfortunately, it's used for Spanish rather than English broadcasts.

Columbia. During a DX-cursion on St. Croix, US Virgin Islands, we noted, with an extra-longwire antenna strung along the beach, several relatively weak and presumably unlicensed broadcast stations between 1628 and 1673 kHz in the evenings, the strongest of which was *La Voz Cultural* on 1645, closing at 0100 GMT and opening at 0950. *Radiodifusora Nacional* has programs that are more "cultural" in our sense; it often puts a strong single-sideband signal on 17866 kHz in the evenings.

Cuba. Radio Havana indignantly denied to a listener visiting from Spain, that any of its transmissions are relayed from the USSR, blaming these "lies" on the US and international press agencies. Yet, it is easy for monitors to identify such transmissions, and such frequencies have been freely registered with the International Telecommunication Union, either by the Cuban or Soviet authorities.

The most audible anti-Castro station is *La Voz del CID* (a literary allusion; CID actually stands for Cuba Independiente y Democratica). It has been broadcasting up to five different programs simultaneously on five different transmitters, each bearing the name of a revolutionary hero. The peak hour is 0100 or 0200 GMT. Two transmitters, on 5106 and 7355 kHz, were busted last September by the FCC in south Florida, but returned a few weeks later, possibly from locations outside the U.S. Another unknown site produces the 7412-kHz signal, while the remaining two are overt: via commercial stations *Ecos del Torbes*, Venezuela on 4980, and *Radio Clarin*, Dominican Republic, on 11700. The latter has carried a great deal of CID programming, reported at many times of the day, as early as 1700.

Denmark. Like many stations which have been on shortwave since the early days, Radio Denmark's transmitter site at Herstedvester has subsequently become an urban area, preventing expansion and raising environmental concerns. After a long struggle to obtain a new site on the island of Mors, which would entail a much-improved antenna and transmitter system, *Radio Denmark* last year was looking forward to a brighter future. Then, environmental concerns forced cancellation of the project. It was feared that migrating birds would be caught in the antennas (although this could happen anywhere). However, Radio Denmark has taken one step forward—a new transmitter, still operating at only 50 kilowatts, but unlike the old one capable of using frequencies other than 15165—such as 25850, 17770 and 11715 kHz.

Greece. The *Voice of Greece* has become the first multi-frequency Western station to operate entirely out of band—and the frequencies chosen are by no means limited to those designated at WARC-1979 for shortwave broadcast expansion in the near future. *VOG* has been using bands which are and will continue to be fixed, aeronautical, and amateur.

One of the *VOG* transmitters, the most powerful one, is operated by the *Voice of America* at Kavala; another one is reportedly under construction as part of the price *VOA* pays for such a strategic relay site.

Guatemala. *Adventist World Radio* switched from TGMUA on 5980 kHz to TGMUB on 6090, but remains poorly heard due to low power, unfavorable antenna direction, and heavy interference. Several listeners, including Mitch Sams in Arkansas and Terry Krueger in Florida, have heard it better on harmonics such as 12180 and 30450 kHz, between 2330 and 0400 GMT, half in Spanish and half in English. The station laments that it cannot (deliberately) broadcast on higher frequency bands.

Honduras. *El Eco de Honduras* is a new operation from San Pedro Sula on 6000 kHz, not to be confused with the unrelated *Radio Swan* formerly on this frequency. It can be heard when there is a darkness path between 1100 and 0400 GMT, also identifying as "Gadena Zeta" and "Radio Vareidades" when relaying programming from Tegucigalpa. Our correspondent in Honduras, Don Moore, has learned that two usually inactive stations are keeping their shortwave transmitter on standby in case of emergencies or special events—*La Voz de Honduras* on 5875, and *Radio San Ysidro* on 4845. Look for the latter around Good Friday, and San Ysidro Day in mid-May.

Italy. Several non-illegal private shortwave stations have been heard in North America despite their low power—*Radio Tele-Pace* on 15460 between 1700 and 0600, which seems to be concerned with reaching Italian missionaries in Latin America; *IBC* on 11584 and 6275, best around 0600 but also known to carry programs from other stations such as *World Music Radio,* and *Radio Time.*

Japan. *Radio Japan* carried out single-sideband tests last October on 21832 and 17552 kHz. They were generally well heard in North America, often superior to parallel broadcasts on higher-powered AM transmitters, but at presstime *Radio Japan* had not confirmed that it would begin regular SSB broadcasting.

Korea. The North and the South are competing with each other for listener loyalty by offering tangible giveaways, not just broadcasts. A listener in India, Michael D'Souza, had been overwhelmed by hardbound books in exchange for photos of himself listening to Radio Pyongyang. A listener in Texas, Wyatt Cox, was a winner of a doll, a book, a tape and several IRC's, in *Radio Korea*'s 29th anniversary contest.

Libya and **Sudan** are carrying out a more serious shouting match, sponsoring clandestine stations opposing each other's government. Libya started it with "Sudan Corner" on 17930 and/or 17940 kHz. Then there appeared another Arabic-speaking station, *Voice of the Libyan People,* at 0530 on 11977 and later 11997 kHz, 1700 on 12230, and best heard of all, 11365 kHz at 2100-2200. The latter transmission once had a segment in English.

Malta. Investing in a relay station on foreign soil can be a risky proposition. West Germany's *Deutsche Welle* had a 25-year contract, through 1995, for the Cyclops relay, but the Maltese government literally pulled the plug on it during October and November 1982 in accordance with a newly-passed "Foreign Interference Act."

Scotland. Here's a country normally missing from the shortwave broadcast scene (all BBC transmitters in the U.K. are in England). But a pirate station, *Weekend Music Radio* planned to put Scotland on the map this winter with a series of tests for North America, with 50 watts on 6260 and 20 watts on 6235 kHz at 0500-0800 on Sundays such as February 20 and March 6. Reports should be sent to 42 Arran Close, Cambridge, England. ◇

(To be continued)

Computers & Electronics

ADVERTISERS INDEX

PROJECT OF THE MONTH

Adjustable Threshold Temperature and Light Alarms

By Forrest M. Mims

IF you enjoy gardening as much as I do, you could probably use a circuit that sounds an alarm when the temperature approaches freezing. Figure 1 shows a very simple circuit that signals a distinctive alarm tone when the temperature approaches 0° Centigrade. Since the temperature detection threshold is adjustable, the circuit can sound an alarm at any point over a wide temperature range.

The circuit uses a 741 op amp as a voltage comparator. An adjustable voltage divider, *R2*, provides a reference voltage to the noninverting input (pin 3) of the 741. A temperature-dependent voltage for the inverting input (pin 2) of the 741 is obtained from thermistor *TCR1* and fixed resistor *R1*.

The resistance of *TCR1* is inversely proportional to temperature. In other words, the resistance of *TCR1 increases* as temperature *decreases*. Therefore, the voltage output from the divider formed by *TCR1* and *R1* falls as temperature decreases. When this voltage reaches the reference voltage, the comparator output switches from low to high. This turns on *Q1*, to actuate the piezo alerter.

The output from the 741 can be connected directly to *R3*, but the low-state output voltage will then turn *Q1* partially on and cause the alerter to emit a low-amplitude, but audible, tone. This off-state tone is eliminated by *D1*, *D2* and *D3*. The total forward voltage drop of these diodes is about 1.8 V, enough to cancel the effect of the low-state output voltage from the 741.

Thermistors can be purchased from Newark Electronics and other electronic parts distributors. For best results, use a thermistor having a room temperature resistance of 25 to 50 kilohms. Glass-bead and bulb thermistors are more expensive than other kinds, but since they can be safely immersed in water they are easily calibrated. Use crushed ice or snow to achieve an exact 0° C calibration point if you plan to use the circuit as a freeze detection alarm.

The circuit in Fig. 1 can drive more powerful alarm devices such as sirens by substituting a relay for the piezo alerter. The following circuit shows how this is accomplished.

An Adjustable Light Detection Switch. Replacing the thermistor in Fig. 1 with a cadmium-sulfide photoresistor allows the circuit to function as an adjustable threshold light/dark detection switch. Figure 2 shows one possible circuit configuration.

In operation, *R2* sets the circuit's threshold. When the light intensity at *PC1*'s surface is decreased, the resistance of *PC1* is increased. This decreases the voltage at the inverting input of the 741. When the reference voltage at the 741's noninverting input is properly adjusted via *R2*, the comparator will switch from low to high when *PC1* is darkened. This turns on *Q1* which, in turn, pulls in relay *K1*.

The low-state output voltage from the 741 does not have sufficient amplitude to pull in the relay. Therefore, this circuit does not require the diodes used in Fig. 1.

Going Further. The sensors used in both these circuits are interchangeable. You can use a cadmium-sulfide photoresistor in place of the thermistor in Fig. 1. And you can use a thermistor in place of the photoresistor in Fig. 2. Furthermore, both circuits are adjustable over a very wide temperature or light-intensity range. Therefore, you should have little difficulty adapting one or both of these useful and versatile circuits to your specific application.

Finally, be aware that the reliability and accuracy of these circuits is determined by both your calibration procedure and the physical location of the finished circuit. For example, when the circuit in Fig. 1 is configured as a freeze detector, it may fail to operate consistently if the battery is exposed to temperature extremes. It may also sound false alarms or fail to operate if water bridges any of the leads from *R1*, *R2* or the thermistor. Be sure to keep these caveats in mind when you plan your application. ◇

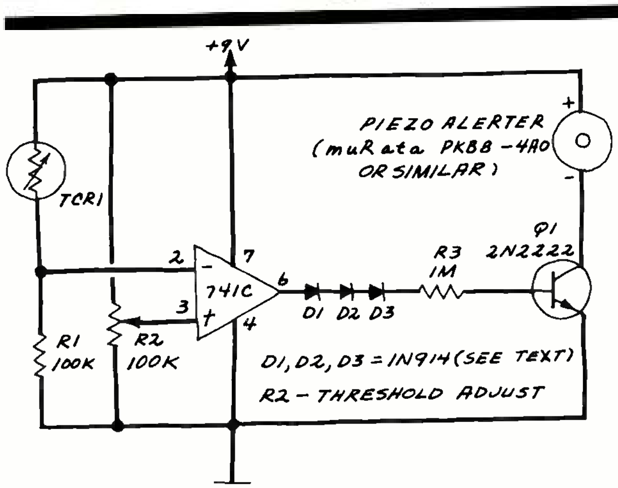


Fig. 1. Adjustable threshold temperature alarm.

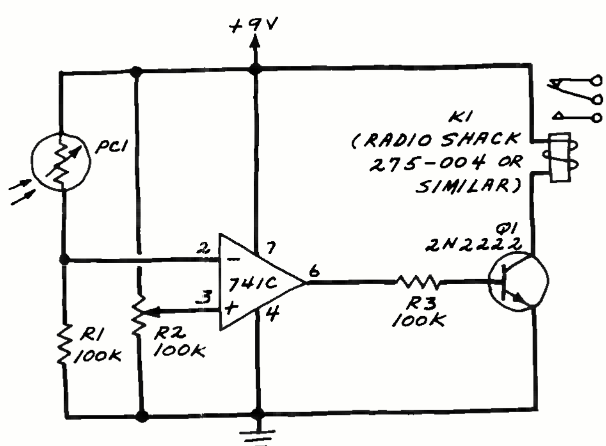
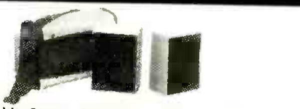


Fig. 2. Adjustable threshold light-dark detection switch.

Portable Speakers For "Walkman" Style Stereos

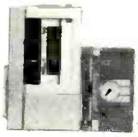


Portable Stereo Speakers with Carrying Case

After skating, skiing, jogging or any other outside activity, just plug these portable stereo speakers into your stereo and you and your friends can enjoy your favorite tapes reproduced by these full range speakers. Great for motel rooms, the beach, or in your car. They weigh just 3 lbs. and measure 5⅝"H x 4⅛"W x 2⅞"D. This unit uses 3" x 5" 8ohm speakers with a 3 oz. magnet. Speaker system includes two speakers, a carrying case, auxiliary speaker connector cable, and signal connector cable. Uses 8 "AA" batteries. Can be used with both portable stereos shown below, and is compatible with most mini-portable stereo cassettes and FM stereo units.

Part No. TSU-012 .... $29.95
AM3-8 8 AA Alkaline Batteries ..... 8 for $7.90

Stereo Cassette Player
with FM Stereo Tuner Pack



- Lightweight Headphones
- Cr02/Metal/Normal Tape Selector
- Anti-Rolling Mechanism

FEATURES: • Blue carrying case, shoulder strap, belt strap, lightweight headphones, FM stereo tuner pack & instruction manual • Talkline • Tone selector • Cr02/Metal/Normal tape selector • LED operation indicator • Built-in microphone • Stop/eject, play, rewind/review, fast forward/cue, tape/radio selector functions • Vol. control • Ext. power input jack • Headphone jack • Auto-stop mechanism (shuts off player when tape ends) • Anti-rolling mechanism (prevents sound from quivering when walking, jogging, etc.) • Weight: 13 oz. • Requires 4 AA batteries (not included) • Size: 6"L x 4"W x 1-1/8"H

Model TWF-802 .... $69.95
AM3-4 AA Alkaline Batteries ..... 4/$3.95

CREDIT CARD AM/FM RADIO
World's Thinnest Stereo Hi-Fi

This is a pocketable AM/FM stereo radio with a folding stereo headphone. It weighs just 5 oz. and measures 4⅜"L x 2⅝"W x ⅛"Thk. Comes complete with radio, headphones and headphone case. Uses two AAA batteries (not included).

Part No. TCR-809 .... $29.95 each

JOYSTICKS

JS-5K (Pictured)

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JS-150K	150K Linear Taper Pots	$4.75
JVC-40	40K (2) Video Controller in Case	$4.95
JS KNOB	Knob for JS5K,100K,150K	$.99 ea.
JVC KNOB	Knob for JVC-40	$.99 ea.

Jameco ELECTRONICS Digital Thermometer Kit

Dual sensors — switch controls for indoor/outdoor or dual monitoring — can be extended to 500 feet. Continuous LED .8" ht. display. Range: -40°F to 199°F, -40°C to 100°C. Accuracy ±1° nominal. Calibrate for Fahrenheit/Celsius. Simulated walnut case. AC wall adapter included. Size: 6⅜"L x 3⅛"H x 1⅞"D.

JE300 ..... $39.95

BOOKS
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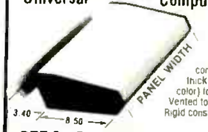
30001	National CMOS Data Book (1981) (640 pages) 74C, CD4000, and A/D Converters	$6.95
30002	National Interface Data Book (1980) (704 pages) DP, DS8000, DS3600, DS5700, etc.	$6.95
30003	National Linear Data Book (1982) (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30004	National Series 80 — Board Level Computer (1980) (224 pages)	$4.95
30005	National TTL Logic Data Book (1981) (624 pages) 7400,LS,L,H,S, and DM8000 Series	$9.95
30006	Above (3) 30001,3,5 as set	$24.95
30008	National Memory Data Book (1980) (464 pages) RAMs, ROMs, PROMs, EPROMs Series	$6.95
30009	Intersil Data Book (1983) (1356 pages) Complete line	$9.95
30010	National Audio/Radio Handbook (1980) (240 pages) Pre Amps, AM, FM & FM Stereo, Power Amps	$5.95
30011	National Linear Application Handbook (1980) (736 pages) Application Notes, Linear Briefs, etc.	$15.95
30012	National PAL Data Book (1982) (176 pages) Data Sheet, PAL Design	$5.95
30013	Zilog Data Book (1983) (641 pages) Microprocessors and Support Chips	$7.95
010400	Intel Component Data Book (1982) (1405 pg.) Full data sheets for Intel's products incl. mem. devices, microproc., periph. & ind./mil. products	$14.95
205610	Intel Peripheral Design Handbook (1981) (828 pages) Full data sheets, application notes for Intel peripheral device components	$9.95

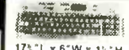
Universal Computer Keyboard Enclosures



"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency. Rigid construction provides unlimited applications. Assembly instructions included.

DTE-8	Panel Width 7.5"	$24.95
DTE-11	Panel Width 10.13"	$27.95
DTE-14	Panel Width 13.5"	$29.95
DTE-20	Panel Width 19.25"	$34.95

KEYBOARDS — POWER SUPPLIES



17⅜"L x 6"W x 1⅞"H

DATANETICS 73-KEY KEYBOARD (ASCII) — Apple Compatible
Data Entry Keyboard uses MM5740 BEE/N encoder chip (included). 73-Key Keyboard features 11-key numeric keypad. SPST switching, 24-pin edge card connection. Includes pin-out.
Part No. KB261 (Fits DTE-20 Enclosure) ..... $49.95 each

16⅝ L x 5¼"W x 1⅝"H

MICRO SWITCH 69-KEY KEYBOARD
Data Entry Keyboard, Encoded Output: 8-bit Parallel EBC DIC. Switching: Hall Effect, 24-pin Edge Card Connection. Complete w/Pin Connection. Can easily be modified to ASCII code.
Part No. KB69SD12-2 (Fits into DTE-20 Enclosure) ..... $19.95 each

23" L x 5¾"W x 1-3/8"H

MICRO SWITCH 85-KEY KEYBOARD
Word Processing Keyboard, 26 Pin Edge Card Connection. Supply Voltage +5VDC. Main Keyboard is QWERTY. Additional Key Pads for Cursor and word processing functions.
Part No. 85SD18-1 ..... $29.95 each

11⅞"L x 3⅞"W x 1⅞"H

HI-TEK 58-KEY KEYBOARD
SPST switching, mechanical, monolithic housing, charcoal grey keycaps. Keyboard is not mounted on circuit board (each key is individually accessible).
Part No. K-58 (Fits DTE-14 Enclosure) ..... $19.95 each

3"L x 3"W x 1½"H

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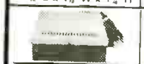
SPST switching. Charcoal grey keycaps, matches HI-TEK K-58 Keyboard (above). Mounted on printed circuit board.
Part No. K-14 ..... $9.95 each

9⅞"L x 4⅛"W x 1⅝"H

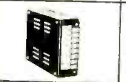
ALPS 29-KEY CALCULATOR KEYBOARD
Features one 6-position decimal select switch, one 3-position switch, and two 2-position switches, mechanical SPST switching, 22-pin edge card connection. Pin-out included.
Part No. KB297D40 (Fits DTE-11 Enclosure) ..... $4.95 each



POWER SUPPLY +5VDC @ 1 AMP REGULATED — Transaction Tech
Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz. 2-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. 6⅛"W x 7"D x 2⅛"H. Wt. 3 lbs. Data sheet incl.
Part No. PS51194 ..... $19.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED — Deltron
Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 6VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces. UL recognized. Size 4"W x 4½"L x 2-7/16"H - wt. 2 lbs. Data sheet included.
Part No. OPS-1 ..... $29.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50/60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¼"D x 3⅝"H. Wt. 6 lbs.
Part No. PS94VO ..... $49.95 each



POWER SUPPLY 4-Channel Switching Power Supply
Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A, +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple, 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj. 5V main output ±10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.
Part No. FCS-604A ..... $69.95 each

POWER SUPPLY Adjustable Switching 4-24VDC to 5 Amps
Adj. 4-24VDC: 5VDC @ 5A, 6VDC @ 4.8A, 9VDC @ 4.1A, 12VDC @ 3.3A, 18VDC @ 1.9A, 24VDC @ 5A. Overvoltage Protection. Input: 115VAC 50/60Hz. Output variations within 20mV. 8.25"L x 4.25"W x 2.25"H. Wt. 3.25 lbs.
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BUG BOX™
Please specify color code (B) Blue, (R) Red, (W) White, (Y) Yellow

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BGX-010-( )	10	19.99
ANTI-STATIC		
BGX-001-( )AS	1	$ 3.29
BGX-010-( )AS	10	28.89

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BUG CAGE™ — 12 locations store Bug Boxes, Big Bug Boxes or Bug Trays • Modular and interlocking • Heavy duty injection molded plastic • Each cage has 6 slip-on locations • 2 cages per pkg. • Cage size: 5-1/8" x 5" x 3-7/8" • 4 colors available — please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

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BTV-001	Vertical Bug Tray	1.95
BTO-001	Open Bug Tray	1.95
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Part No.	Description	Price
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LSI BIG BUG BOX™ — Designed to store large IC's, Resistors, Capacitors and Diodes • Divided into three compartments measuring 1" x 4.15" x .5" deep • Three vertical and three horizontal dividers included • Bug Rugs not included • Box size 4.9" x 3.3" x .6" • Weight: 1.75 oz.

LSI BIG BUG BOX™
Please specify color code. (B) Blue, (R) Red, (W) White, (Y) Yellow

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ANTI-STATIC		
BLX-001-( )AS	1	$ 4.29
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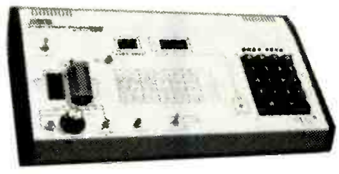
8K, 16K, 32K, 64K EPROM Programmer



2708,2716,2732 & 2764 EPROM Programmer
JE664 EPROM PROGRAMMER
8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES
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• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz ◄ 10W power consumption • Enclosure: Color-coordinated light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8⅞"D x 3½"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer $995.00
Assembled & Tested (includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80* Model I, Level II Computer. Baud rate 9600. Word Lgth. 8 bits · odd parity · Stop bits 2. Option may be adapted to other computers.

JE664-ARS EPROM Prog. w/JE665 Option $1195.00
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EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

Part No.	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI	$14.95
JM16B	TMS2716	Motorola, TI (+5,-12,+12)	$14.95
JM32A	TMS2532	Motorola, TI	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	$14.95
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FDD100-8	Buy 2 for	$259.95 each
FDD100-8	Buy 10 for	$249.95 each

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FOR TRS-80 MODEL I (Industry Standard)

Pertec Computer Corp.

Features single or double density. Recording mode: FM single, MFM double density. Power: +12VDC (±0.6V) 1.6A max., +5VDC (±0.25V) 0.8A max. Unit as pic. at left (does not incl. case, power supply, cables) 30-pg. data book incl. Wt. 3½ lbs. Size: 5¾"W x 8"D x 3¼"H.

Part No. — Limited Quantity! — Price
FD200 ..... $179.95
Single-sided, 40 tracks, 250K bytes capacity
FD250 ..... $199.95
Double-sided, 35 tracks, 438K bytes capacity

EXPAND YOUR MEMORY
TRS-80 to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

*Model 1 equipped with Expansion Board up to 48K Two Kits Required — One Kit Required for each 16K of Expansion —

TRS-16K3 *200ns for Color & Model III $12.95
TRS-16K4 *250ns for Model I $10.95

TRS-80 Color 32K or 64K Conversion Kit

Kit comes complete with 8 each 4164-2 (200ns) 64K dynamic RAMs and conversion documentation. Converts TRS-80 color computers with D and E circuit boards, and all new color computers to 32K. Minor modifications of 32K memory will allow the use of all 64K of the dynamic RAM.

TRS-64K2 .... $54.95

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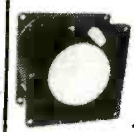

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- 10 yrs. cont. duty at 20°C
- 115V 50/60Hz

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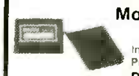
Mostek DC/DC Converter
+5 VOLTS TO -9 VOLTS



Input: +5V. Output: -9V (regulated) @ 30mA. Printed circuit mounting. Specifications incl.
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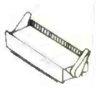

cam actuated, true zero insertion – tin plated solder tail pins – capable of being plugged into dip sockets, including wire wrap.

Stock No.	No. of Pins	1-9	10-49	50
11055	24	4.98	$4.35	$3.90
11056	28	5.15	4.50	4.05
11057	40	6.81	5.95	5.35
11058	64	12.02	10.50	9.45

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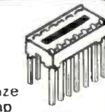
Stock No	Dia	Length (feet)	Weight (oz.)	Price
50075	062	9	1.5	$1.16
50076	062	25	4	2.39
50077	062	50	8	4.25
50078	032	33	1.5	1.31
50079	032	88.5	4	2.47
50080	032	175	8	4.57

TI WIRE WRAP SOCKETS



Tin plated phosphor bronze contact – 3 wrap

Stock No.	No Pins	1-99	100-499	500
11301	8	$.40	$.36	$.30
11302	14	.59	.54	.45
11303	16	.64	.58	.48
11304	18	.73	.66	.55
11305	20	.99	.90	.75
11306	22	1.12	1.02	.85
11307	24	1.25	1.14	.95
11308	28	1.52	1.38	1.15
11309	40	2.05	1.86	1.55

TI LOW PROFILE SOCKETS

Tin plated copper alloy 688 contact pins with gas tight seal.

Stock No.	No Pins	1-24	25-99	100-999
11201	8	$.10	$.09	$.08
11202	14	.14	.13	.12
11203	16	.16	.15	.14
11204	18	.18	.17	.15
11205	20	.20	.18	.16
11206	22	.22	.20	.18
11207	24	.24	.22	.20
11208	28	.28	.26	.25
11209	40	.40	.37	.33

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13801-1 Data Sheet for 13801 ... .25

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13825	CB3801	3.0-7.0	12±0.6	0-25	.48x.51x3.05	$ 7.95
13826	CB3811	3.0-7.0	-12±0.6	0-25	.48x.51x3.05	7.95
13827	CB3802	3.0-7.0	15±0.7	0-20	.48x.51x3.05	7.95
13828	CB3812	3.0-7.0	-15±0.7	0-20	.48x.51x3.05	7.95
13829	CB3804	3.0-7.0	28±0.7	0-10	.48x.51x3.05	7.95
13830	CB3814	3.0-7.0	-28±0.7	0-10	.48x.51x3.05	7.95
1.5 W TYPE						
13831	CL3801	4.0-7.0	12±0.6	125	.651x1.2x1.77	$24.95
13832	CL3811	4.0-7.0	-12±0.6	125	.651x1.2x1.77	24.95
13833	CL3802	4.0-7.0	15±0.7	100	.651x1.2x1.77	24.95
13834	CL3812	4.0-7.0	-15±0.7	100	.651x1.2x1.77	24.95
13835	CL3804	4.0-7.0	28±1.4	50	.651x1.2x1.77	24.95
13836	CL3814	4.0-7.0	-28±1.4	50	.651x1.2x1.77	24.95
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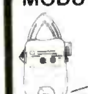

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allows singling one conductor out of many without disarrangement.

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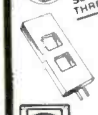

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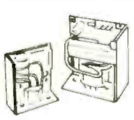
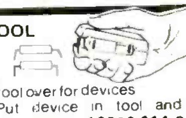


SINTEC Stock No.	ELPAC Part No	Output Voltage	Output Current Rating	Dimensions (HxWxD) In Inches	OVP	Price
13802	SOLV15-5	5	3.0A	4-7/16x4x2	Fixed included	$39.95
13803	SOLV15-12	12	1.5A	4-7/16x4x2	Fixed included	39.95
13804	SOLV15-15	15	1.2A	4-7/16x4x2	Fixed included	39.95
13806	SOLV15-24	24	0.75A	4-7/16x4x2	Fixed included	39.95
13808	SOLV30-5	5	6.0A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
13809	SOLV30-12	12	4.0A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
13810	SOLV30-15	15	3.3A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
13812	SOLV30-24	24	2.0A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
13802-1	Data Sheet for SOLV Series					.25

PIN FORMING TOOL



puts IC's on their true row to row spacing. One side is for .300 centers, Flip tool over for devices on .600 centers. Put device in tool and squeeze.

NEW! Stock No. 10200 $14.95 (ANTI-STATIC MODEL)

ONE TOOL DOES 8 thru 40 PINS! Stock No. 11059 $12.95

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DIP socket-sized plastic panels with numbered holes in pin locations. Slip onto socket before wire wrapping to identify pins. Also write on them for location IC part number function etc. Simplifies initial wire wrapping trouble shooting and repair.

13295	14 pin
13296	16 pin
13297	18 pin
13298	20 pin
13299	22 pin
13300	24 pin
13301	28 pin
13302	40 pin
13303	96 pin

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14⁹⁵

Indicates "opens", "shorts" and current gain in small-signal and power types, PNP and NPN. In or out of circuit. Requires "AA" battery.
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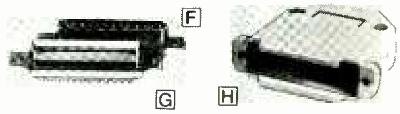
Computer Connectors



F G H

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[F] **Male. 276-1547** 2.99
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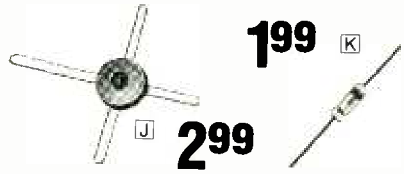

1⁹⁹ K

J **2⁹⁹**

[J] **MRF-901.** Low-noise NPN for small-signal RF use to beyond 2 GHz. Manufacturer's prime. 300 mW. **276-2044** . . . 2.99
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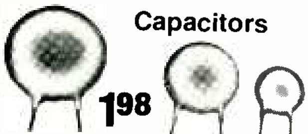
Capacitors



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12VDC. Switches up to 4 circuits. Rated 3A at 125 VAC. 75 mA, 160-ohm coil.
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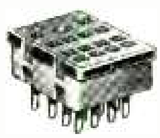

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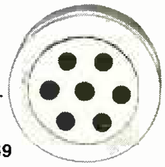

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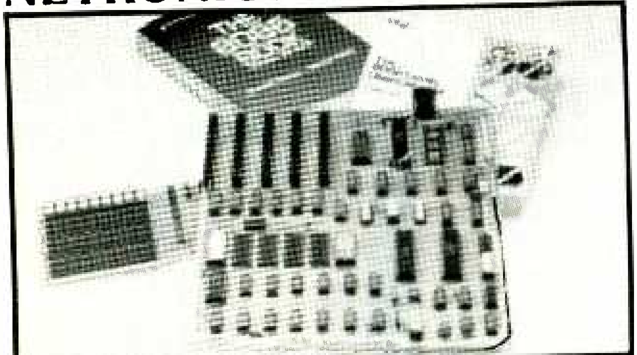

LEARN 16 BIT TECHNOLOGY IN EASY LOW-COST STEPS. This 2-board system features (1) an 8088 mother board with a 5-slot expansion bus that will accept any hardware designed for the IBM personal computer and (2) a 64K (expandable to 256K) memory board that also features an IBM compatible RS 232 communications port. All circuits are functionally equivalent to the IBM except for the cassette ROMS. This means that all programs written in basic designed to run in an IBM can be compiled to run in this system and that any disk-operating system that will run on an IBM will work directly in the EXPLORER 88-PC. The system monitor ROM included in the Starter's system features a user-friendly operating system that allows easy program generation and debugging. The commands include display/modify memory... display/modify registers...input/output data to I/O ports...block moves...single-step trace mode...go/run with optional breakpoint and register reports...cassette load/save with file labels...plus a complete system test program that tests and reports condition of ROM, RAM, cassette interface, timer, DMA controller, interrupt controller, and the communications port. These test programs not only allow easy debugging of software but they serve as hardware and software learning tools.

The EXPLORER 88-PC STARTER'S KIT includes a mother board, memory/I/O board, all components needed, sockets for IC's used, one 62-pin bus connector and complete assembly/test instructions. All you need is a soldering iron, solder, a +5 volt @ 3 amps & -5 & +/- 12 volt @.5 amp power supply, and a standard RS 232 terminal (Netronics has 2 low-cost ones to choose from).

☐ Explorer 88-PC Starter's Kit ...$399.95 + 10.00 p&i (wired & tested, add 100.00).
☐ Extra 62-pin connectors @ 4.25 ea. + 1.00 p&i.

If you do not own a terminal you may want to consider using our IBM compatible keyboard (see photo) in conjunction with an IBM compatible color graphics board. This combination, although not necessary at the introductory level, may be desirable if you plan to expand the EXPLORER 88-PC to be fully IBM compatible. These items require additional power and are only available wired and tested as follows:

☐ IBM compatible keyboard...$299.95 + 10.00 p&i
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☐ Additional ROM required...$35.00

The EXPLORER 88-PC can be expanded at any pace you decide. Invest and learn at a pace that is comfortable for you. Netronics is dedicated to supplying the finest hardware and software to make this a meaningful learning experience. Hard disks, built-in modem board, eprom burner, print buffer system plus more will be available shortly. The following items are available now:

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☐ THE 8086 BOOK by RECTOR & ALEX...$16.00 + 1.50 p&i.
☐ Special IBM compatible system: with keyboard, color graphics board, floppy disk controller, 64K RAM, cabinet, standard power supply and a single 5¼" floppy drive...$1899.95 + 25.00 p & i.

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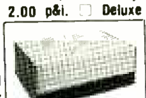
EXPLORER 85

Learn computing from the ground up. Start with the Explorer/85 Level 'A' kit which includes an expandable mother board. The Kit includes the 8085 CPU, 2K Monitor program used to enter, test, run and save programs plus the parts to allow you to start programming. Just add a power supply and terminal or hex keyboard. ☐ LEVEL A Terminal version or ☐ Hex Keypad version 129.95 + 3.00 p&i. Add ☐ Level 'B' 49.95 + 2.00 + two 100 pin connectors @4.85 ea. and have a powerful S-100 computer. Add ☐ Level 'C' 39.95 + 2.00 p&i + five 100 pin connectors to increase S-100 slots to 6. Add memory using the JAWS 16-64K S-100 board or add ☐ Level 'D' 4K to main board 49.95 + 2.00 p&i. ☐ Level 'E' 5.95 + 1.50 p&i adds decoding for 8K of 2716 eproms. Need a power supply? Use the ☐ 5 amp AP-1 at 39.95 + 2.00 p&i. Select one of our low-cost terminals or use the ☐ Hex keypad w/display at 69.95 + 2.00 p&i. ☐ Deluxe system cabinet 49.95 + 3.00 p&i. ☐ Optional fan 16.50. Now add ☐ Microsoft 8K basic & a powerful ☐ Text editor/assembler in ROMS, just 99.95 ea. Add ☐ 8" floppy 499.95 + 12.00 p&i. ☐ Floppy controller board 199.95 + 2.00 p&i. ☐ Floppy cabinets & power supply 69.95 + 3.00 p&i. ☐ Two drive cable 29.95 + 1.50 p&i. Hard disk also available (see insert.)



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68B00 2 MHZ	

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6551	11.85
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74LS04	.24	74LS93	.55	74LS175	.55	74LS363	1.35
74LS05	.25	74LS95	.75	74LS181	2.15	74LS364	1.95
74LS08	.28	74LS96	.89	74LS189	8.95	74LS365	.49
74LS09	.29	74LS107	.39	74LS190	.89	74LS366	.49
74LS10	.25	74LS109	.39	74LS191	.89	74LS367	.45
74LS11	.35	74LS112	.39	74LS192	.79	74LS368	.45
74LS12	.35	74LS113	.39	74LS193	.79	74LS373	.99
74LS13	.45	74LS114	.39	74LS194	.69	74LS374	.99
74LS14	.59	74LS122	.45	74LS195	.69	74LS377	1.39
74LS15	.35	74LS123	.79	74LS196	.79	74LS378	1.18
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74LS54	.29	74LS157	.65	74LS266	.55	74LS684	3.20
74LS55	.29	74LS158	.59	74LS273	1.49	74LS685	3.20
74LS63	1.25	74LS160	.69	74LS275	3.35	74LS688	2.40
74LS73	.39	74LS161	.65	74LS279	.49	74LS689	3.20
74LS74	.35	74LS162	.69	74LS280	1.98	74LS783	24.95
74LS75	.39	74LS163	.65	74LS283	.69	81LS95	1.49
74LS76	.39	74LS164	.69	74LS290	.89	81LS96	1.49
74LS78	.49	74LS165	.95	74LS293	.89	81LS97	1.49
74LS83	.60	74LS166	1.95	74LS295	.99	81LS98	1.49
74LS85	.69	74LS168	1.75	74LS298	.89	25LS2521	2.80
				74LS299	1.75	25LS2569	4.25

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call

ZIF = TEXTOOL (Zero Insertion Force)

7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74186	18.50
7453	.23	74190	1.15
7454	.23	74191	1.15
7460	.23	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.33	74196	.79
7475	.45	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7485	.59	74248	1.85
7486	.35	74249	1.95
7489	2.15	74251	.75
7490	.35	74259	2.25
7491	.40	74265	1.35
7492	.50	74273	1.95
7493	.35	74276	1.25
7494	.65	74279	.75
7495	.55	74283	2.00
7496	.70	74284	3.75
7497	2.75	74285	3.75
74100	1.75	74290	.95
74107	.30	74293	.75
74109	.45	74298	.85
74110	.45	74351	2.25
74111	.55	74365	.65
74116	1.55	74366	.65
74120	1.20	74367	.65
74121	.29	74368	.65
74122	.45	74376	2.20
74123	.49	74390	1.75
74125	.45	74393	1.35
74126	.45	74425	3.15
74128	.55	74426	.85
		74490	2.55

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4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
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7815K	1.39	7912T	.99	LM323K	4.95
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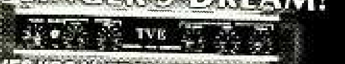

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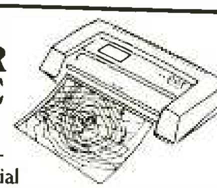

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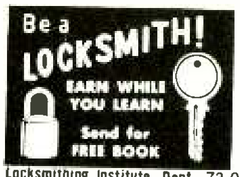

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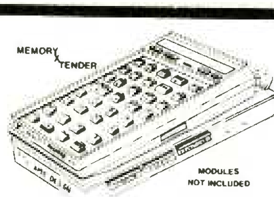

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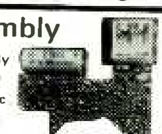

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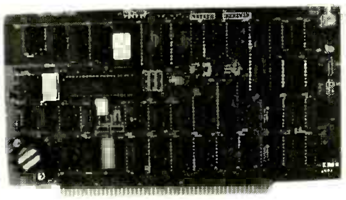

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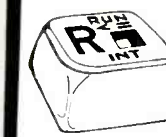

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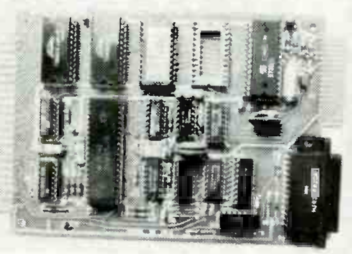

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FREEDOM-OF-CHOICE CALL MONITORING. If you're busy or not in the mood to talk, let Cobra answer the phone for you while you listen to the caller over the built-in loudspeaker. Then if you do decide to talk, simply pick up the phone yourself.

RED L.E.D. LIGHT FOR CALLS RECEIVED. Light will flash if messages have come in while you were away.

FULL-FEATURED KEYBOARD Simple and convenient, the Cobra Remote is the only all-push-button machine with all the luxury features including fast forward, fast rewind, and remote rewind.

FAMOUS COBRA QUALITY AND FULL-YEAR WARRANTY. We guarantee both the Cobra Remote and telephone for a full year because it is highly unlikely that anything will go wrong. Cobra manufactures these units with the same precision that goes into their famous CBs and cordless phones.

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P. S. If you think you've found a better value than this, let us know and we'll beat it. We love the Cobra for quality and price, but also carry every brand of phone equipment. Call or write us with your best price.

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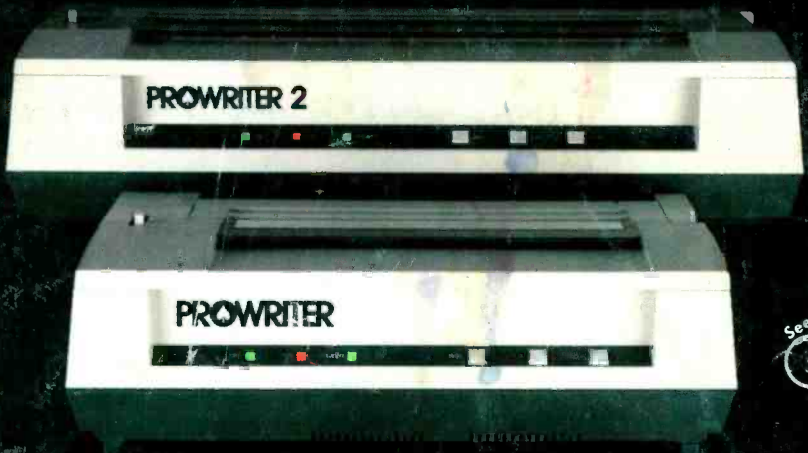

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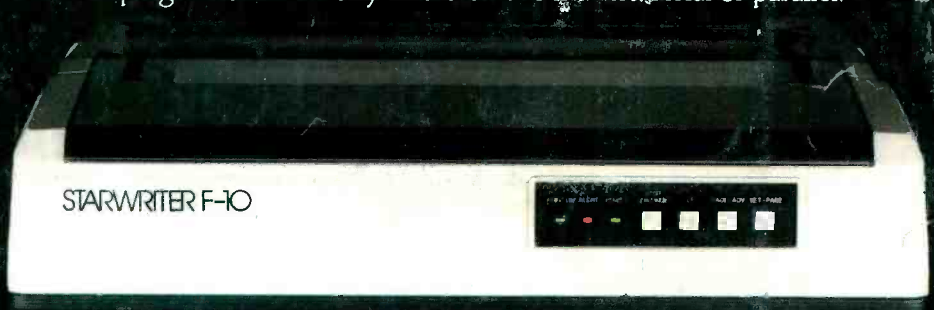

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